Practical Computing

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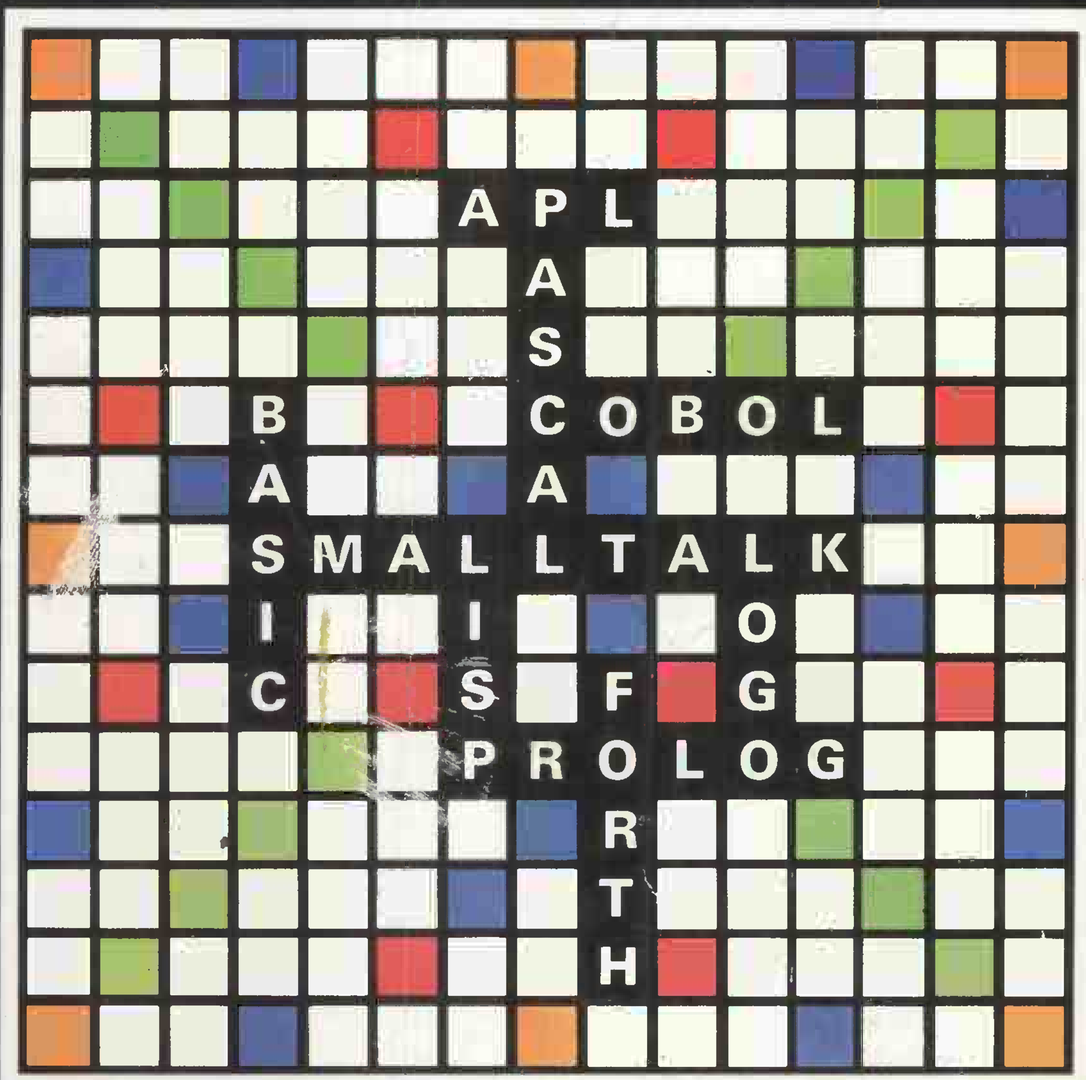
LANGUAGES



Special report - top 10 languages

Beginners' guide to Spectrum machine code

BBC word processor - on a chip

REVIEWS: new Apple IIe and Olivetti M-20


NEW MODEL
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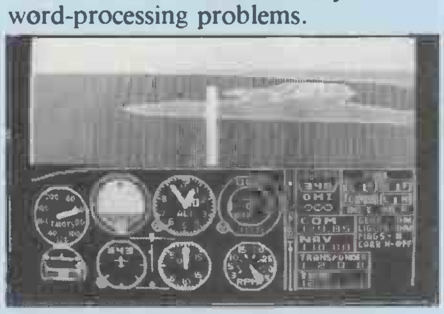

>LANGUAGES

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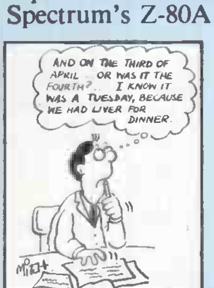

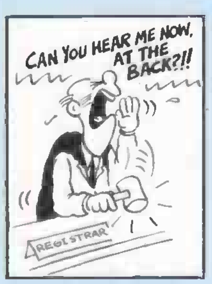

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Basic Babel

LANGUAGES are a problem. To begin with there are those broad categories of computer users who all seem to use different languages for their particular interests. To use the crudest generalisation, the business software writers are writing Cobol, the scientists are using Fortran, the educationalists are using Pascal and the hobbyists are using Basic. Contact between the groups only occasionally degenerates to the "Basic programming causes brain damage" level, but rarely rises above open indifference. This is unfortunate, because surely the knowledge of another language must illuminate one's own.

In the personal computer field covered by *Practical Computing,* Basic has become the *lingua franca,* but even here there are problems. Like Britain and America in the famous quotation, Basic users are separated by the barrier of a common language.

The American National Standards Institute has a committee working on a standard Basic and while this is laudable enough, the practical value will be limited. Even if every micro manufacturer were to embrace ANSI Basic there would still be large amounts of machine-specific coding in most worthwhile programs. Most personal computers seem to do their best tricks in response to obscure Pokes and Calls — and the cheaper the micro, the more this seems to be the case.

The result is that Basic programs written for one machine become unreadable to many of those people who own and use another.

Unfortunately few beginners will even bother to read an article which features, say, a Pet program if they happen to own, say, a Spectrum. This is unfortunate for them, as they might well learn something useful from the structure of the program and the algorithms used. They might even see how they could rapidly translate it for their own machine. But unfortunately for us, they may turn instead to a magazine that concentrates on their machine exclusively.

This raises the horrifying prospect of 350 different microcomputer magazines catering for the obscure preferences of the owners of the different brands, and no one talking to anyone else. In sum, the collapse of civilisation as we know it.

The special Languages section in this issue will at least inform you of some of the other possibilities and, we hope, encourage you to try something other than Basic, if you have not already done so. The comparison table of different Basics should help with translating programs written for one machine to run on another.

Another possibility is being explored in the Netherlands with NOS-Basicode. Specially written programs, supplied on tape, allow a number of different micros to use programs written in Basicode. Naturally these programs have to be written to somewhat rigorous specifications. But nonetheless, micros covered by the scheme now include the Acorn Atom, Apple, DAI, Pet, Exidy Sorcerer, TRS-80, Ohio Superboard and Philips P-2000.

Because of different graphics capabilities, Basicode only really works with text-based programs, not games. The main advantage of the system is that the original Basicode listing has to be written so simply and logically that just about everyone should be able to read it. Individual users are then left to put back all those "extended" Basic words that Basicode leaves out, and to dress up the display to suit the capabilities of their own micro.

As the power of microcomputers continues to increase, perhaps one day most models will be able to emulate, or imitate, the functions of several others. Until this bright day dawns, we will all have to revert to a form of pidgin-Basic, or else start learning and using other languages to the extent that we can understand what's happening, instead of just pushing buttons marked Goto.

Basicode is sponsored by NOS radio and Radio Netherlands. Enquiries to Hans G Janssen, Hobbyscoop, PO Box 1200, 1200 BE Hilversum, The Netherlands.

5 Years ago...

At present the U.K. boasts something like six companies making home and small business computers based on microprocessors, my own company being one of them.

The Government is considering investing £50 million in a product which has not yet been designed (the 64K RAM) to be made in a factory which has not yet been built. Foreign manufacturers are already beginning to produce prototypes to be made by experienced personnel in existing factories.

Why not invest some of that £50 million in an attempt to stimulate a home market by reducing the prices of the end products? There are several U.K. companies capable of designing better microcomputers than the Americans and with the world-famous U.K. software in them.

As an example we considered buying an American microprocessor development system for £365; in fact we designed our own with improved hardware, better interface facilities and much-improved software. It sells for £155, less than half of the American equivalent. A fall in component prices of about 25 percent helped but, even so, we could have done it for about half the cost of any equivalent American design.

Apply this philosophy to our $2,000 product and it would end up at about £700, and a simple home computer such as those currently selling at £500-£700, could be built for £350-£400.

John H Miller-Kirkpatrick,
Technical Director, Bywood Electronics.
Practical Computing Volume 1 Issue 2.

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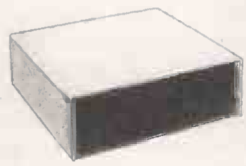

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British micro business

I AM IN THE MICROCOMPUTER BUSINESS buying and selling hardware and software. The British market is an interesting one as a lot of inventions and developments are made in Britain. But one thing worries me: communications and reliability are not of the same high level as the products.

What I mean is, the mail service is slow, slow, slow. When I write a letter it takes at least three weeks to receive an answer. Could it be that letters are not answered though they are already in the office? Are there not enough people who would be happy to be employed?

Even a three-week wait might be acceptable if the answer ever arrived! But it has often happened to me that enquiries are not answered at all. Is business going so well? Too well? Others have promised to send goods, and then nothing arrives. I have been waiting for some items for more than one year.

Perhaps I should not trade with Britain at all. Yet I am still convinced that good products can be made in the EEC and need not come from the Far East. Britain is renowned for its top-class electronics. British companies producing for the lower end of the market should jump at the opportunities open to them in Germany.

Joachim Müller,
Müller Mikrocomputer Mainz,
Postfach 42 10 12,
6500 Mainz 42,
West Germany.

● It is probably no consolation to Herr Müller to know that enquiries from U.K. users get exactly the same treatment.

Grid compass

YOUR ARTICLE on portables in the January issue stated that the Grid Systems Compass Computer "was designed by U.K.-based Moggridge Associates" and gave the prices "just over £8,000" which is rather misleading. This computer was designed at our California office ID Two, and is only being marketed in the U.S. at present. The price is around $8,000 — dollars not pounds!

Rosamary Lees
Moggridge Associates,
London NW5

Help with writing

I HOPE one of your readers will be able to help with advice, references, etc. Our youngest daughter is nearly seven and suffers from some brain damage. She is able to recognise letters and read simple words but her writing is held up by her inability to use a pen.

Microcomputers have been put forward as an answer, and she has shown that she enjoys using the keyboard on the Speak'n'Spell. We have a 48K Spectrum at home and I have access to the ITT version of the Apple with disc drives, including DOS 3.3. I would be grateful to hear from anybody who has experienced these difficulties.

Dr K B J Beswick,
Lime Tree House,
High Street,
Harwell,
Oxfordshire.

Microwriter

I WAS VERY SURPRISED to see no mention of the Microwriter in the review of word processing in the February issue, even though you had a special section on unusual keyboards. As an enthusiastic user of the Microwriter I can tell you that the six-key layout of the machine is by far the easiest to use of all the keyboards and will of course communicate with any computer which has an RS-232 interface.

Using a computer would be a great deal easier if other manufacturers could be persuaded to adopt the same layout. May I suggest you do a feature on the Microwriter, which is a unique pocket-sized fully portable word processor. Once you have one it is difficult to imagine working without it. One of these days I shall get around to transmitting my copy to the printer direct into setting over the telephone.

Peter Dean,
Brussels,
Belgium.

● Like the product, don't like the price.

A4 stationery

FOR SOME TIME I have been trying to source a supply of A4 continuous stationery for my word-processing requirements. It was with great interest therefore that I read the comments in your December news entitled "Letter Stationery", which clearly states that Moore Paragon supplies neat A4-size Kleen Edge sheets of paper.

Upon examination and indeed discussion with Moore Paragon, it transpires that it is not A4 but 11in. or 12in. stationery. This is therefore quite clearly a misinterpretation of the facts and I would ask you to take Moore Paragon to task for misleading your readers in this manner.

I would be grateful if you could advise whether the internationally accepted A4 standard could be obtained in continuous preprinted form.

Garrick S Wales,
Stewart Wales Somerville Ltd.,
East Kilbride,
Glasgow.

● Apologies for our mistake. Moore-Paragon said the paper was A4 *compatible*, which is not the same thing. Does no one supply A4 paper?

Dragon Pokes

DRAGON OWNERS may be interested in a simple way to overcome the automatic scroll on the computer. It is done by Poking the screen addresses instead of using the Print @ command. The addresses are:

Start — 1024
Finish — 1535

For example, Poke 1024,255 is the same as

PRINT @ 0,CHR£(255)

Using Poke instead of Print also allows inverse spaces as well as inverse characters such as inverse £ @ & ' " / etc., which are not available by using the Shift-0 combination. The program displays all the characters when using Poke. It is useful when using the block graphics from ASCII code to draw mazes, etc.

Dragon Pokes.

```
10 CLS
20 X=1024
30 FOR P=0 TO 255
40 POKE X,P
50 X=X+1 : IF X=1536 THEN
  70
60 NEXT P
70 GOTO 70
```

David West,
Taplow,
Berkshire.

More jargon

AFTER Chris Naylor's A-Z of computing terms in the March issue, here are some further definitions:

Algorhythm Fashionable dance from a planet of the star Algol.
Assembler One who puts together a computer kit.
Burn-in The result of dropping cigarette ends or a hot soldering iron on the computer.
Control-bus Transport for traffic wardens.
Card-reader Fortune teller.
Character buffer Bribe money.
Checksum Total amount paid for a computer.
Chip Light snack during programming.
Cross assembler 1. Manufacturer of souvenirs for places of pilgrimage. 2. Angry citizen of Dundee putting together a computer.
Exor First part of a psycho-thriller film.
Firmware Clothing worn by business people.
Floating point Optical disturbance resulting from extended periods of staring into a monitor.
Garbage collection routine Removal of scraps of paper, notes etc., from the desk after a long programming session.
Handshaking State of someone sitting at a computer for the first time.
Hidden refresh Secret drinking.
Indexed addressing Pointing the direction for someone asking

(continued on page 8)

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.

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the way.

Indirect addressing Writing to a box number.

Interface The place in which the solution of a problem often stares.

Interrupt routine Annoying habit of children/adults when adults/children are discussing computers.

Memory refresh A souvenir of Benidorm.

Nesting Activity of a newlywed programmer.

Packing density Standard measure of the volume of a suitcase.

Refresh logic Argument of a drinker.

Timesharing When two people own one watch between them.

Write enable To give someone pen and paper.

Dave Kurth and Ronald Baumgartner, Busswil, Switzerland.

Software please

WE RECENTLY PURCHASED a Newbrain Model A and have found it to be a very powerful micro. But like all Newbrain owners we are disappointed that no magazine has even given the Newbrain a second look. I know unless you expand it there is not enough memory for much, but could you publish a small program or tell us of any software available?

Richard Nash, Petts Wood, Kent.

● **We like the Newbrain and we are keen to support it. Some programs from readers will appear next month, but more would be welcome.**

Endless tapes

A COMMON COMPLAINT against the use of cassettes for data storage is the need to rewind if previous files or programs are to be reloaded. It is not possible to do this automatically with standard cassette recorders.

A means of overcoming this drawback is provided by the use of an endless cassette, such as the TDK EC3 cassette. The tapes are short, six minutes maximum, making them ideal for use with computers.

There are, of course, snags. The tapes cannot be rewound or run fast forward and they are expensive compared with standard E15 cassettes. These difficulties are offset by the ability to manipulate the cassette solely by software, since the tapes move forward only.

Because of the different operating systems used on micros it is only possible to generalise on the applications of these tapes. However, with proper program organisation it should be possible to develop an efficient file system on tape.

The tapes come into their own for management of databases. I am at present still experimenting with these tapes, but they have already proved invaluable in the manipulation of data and for record purposes. No doubt readers will be able to think up other suitable applications.

M J Bedford, Bradford, West Yorkshire.

Left in the lurch

I DO NOT BELIEVE that the computer industry will ever be taken seriously by the business world if it cannot provide an efficient repair service. I have been waiting over six weeks for my Pet 2001, which is essential for the efficient running of my farming business, to be repaired by one of Commodore's nationwide dealers. The dealer is still waiting for parts.

It seems to me that dealers are more interested in the big profits to be made from selling computer systems than actually providing what the customer wants, and that is a good back-up service. It is interesting to note that of the 18 Commodore dealers listed in your magazine in March 1979 only nine were still in business by October 1982.

Surely Commodore should vet its dealers more thoroughly in order to protect the customer and its own good name; otherwise, being an authorised dealer means nothing.

R H Pring, Crewkerne, Somerset.

● **Since we received Mr Pring's letter the matter was finally resolved through a local Commodore dealer.**

Plea for service

AS AN OWNER of a BBC Micro I must condemn Acorn for a lack of understanding to its customers and would-be customers, for not supplying sufficient telephone answering facilities. To get through to Acorn requires the patience of Job, unlimited time and an understanding boss or family when hogging the telephone. I must have been trying since early December, in order to sort out a problem with my micro, but to no avail.

It does not make sense: with over 3,000,000 out of work more people could be employed to answer customers' queries. If nothing is done, before long the BBC Micro will go the way of other British products and be replaced by competitors from Japan or America.

M C Krockel, Aberdeen.

Gödel and AI

IN THE FEBRUARY issue Boris Allan suggests that Gödel's theorem rules out the possibility of artificial intelligence. I would accept Allan's main thesis that AI is still a long way off, but not his use of Gödel's theorem.

What Gödel showed was that any mathematical system complex enough to include self-reference could not be fully consistent. As stated it applies to mathematical systems: it is an inductive leap to apply it to microelectronic structures. However, if that is taken for granted, all that Gödel's theorem suggests is that if machines become intelligent they can not be fully self-consistent, that is, they must become far more than glorified calculators following rigid functions. That seems to me to be hardly more than a truism.

Gödel's theorem is a masterpiece of formal logic and is of major importance in the fields of mathematics and metamathematics. However, trying to apply it outside its context is beset with pitfalls. One thinks of attempts to support ideas of free will by using Heisenberg's uncertainty principle — which properly only applies to elementary particles. Ironically, it is just this sort of unbridled extrapolation that Allan is arguing is inappropriate when applied to ideas about AI.

J de B Clarkson, Pratts Bottom, Kent.

BORIS ALLAN seems to have let a fallacy creep into his thoughts on AI. He states that Gödel's theorem implies that a machine cannot think about itself and that therefore a machine cannot be truly intelligent. Besides the rather obvious difficulty of saying what true intelligence is — perhaps just "something that most humans have" — the theorem applies equally to human beings.

Of course I can think about myself. I can even imagine of all the synapses clicking away in my

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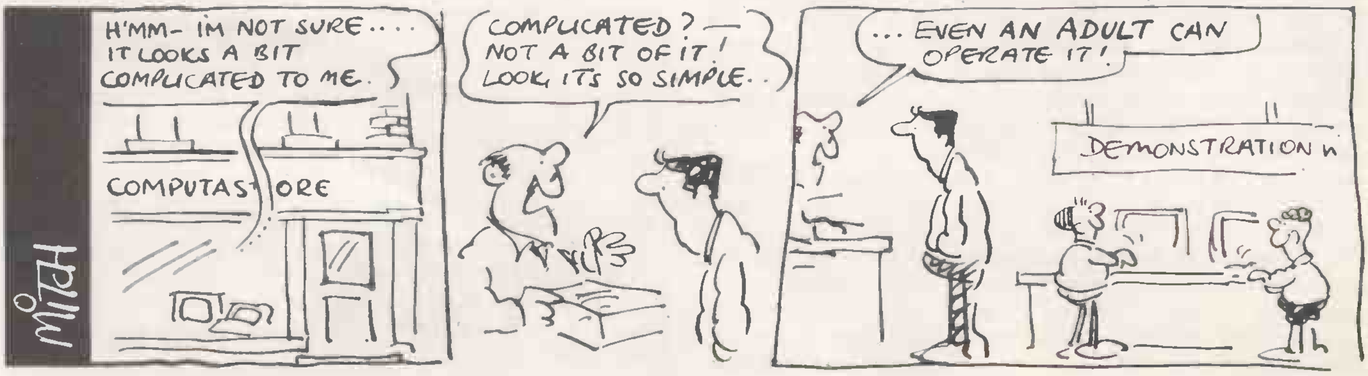

When it's time to stop playing games and get down to business...

Unfortunately, many of today's desk top computers are designed with too much emphasis on home use. That's fine, if you want to balance your checkbook, play "space war" or draw pictures. But when you have serious business requirements for a computer, you want one designed specifically for business.

The RAIR Business Computer is just that. A computer designed specifically for business applications, incorporating a host of features—optimised for the business environment. 8- and 16-bit microprocessors allow users to run available 8-bit—plus newer 16-bit—applications software simultaneously. And an integral high-capacity Winchester disk drive—plus provision for additional hard disk support—provides sufficient on-line storage for virtually any business application.

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RAM Memory: 256 kbytes expandable to 1024 kbytes
Integral Disk Storage: 19-Mbyte Winchester drive plus 1-Mbyte floppy drive
Storage Options: Up to 4 add-on Winchester drives plus streaming tape backup
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Printer: Bidirectional, 80 characters-per-second, friction and tractor feed

SOFTWARE

Operating System: User-friendly, multi-tasking, CP/M, MP/M, PC-DOS compatible
Languages: BASIC, COBOL, Pascal
Applications: Spreadsheet, Database, Text Processing Communications

CP/M and MP/M are trademarks of Digital Research
PC-DOS is a trademark of IBM

the RAIR Business Computer.

Three out of every four computers going into schools are BBC Micros. Is there a lesson to be learned by every user?

As part of the current government subsidised scheme aimed at introducing micros to schools, the Department of Industry undertook a survey of machines available and made recommendations to education authorities all over the country.

The BBC Micro met their priorities exactly: it is economical yet fast and powerful, and it can justify the investment involved, through its capability to grow with the needs of the user and with the rapid changes in technology.

Teachers and education authorities agreed, and today it represents over three-quarters of all micros being ordered for schools across the country under the DOI scheme.

The BBC's choice too.

In choosing a machine to put their name to for their massive Computer Literacy Project, the BBC had the same set of priorities as the DOI. The BBC Micro is now an integral part of that project, which includes books, software, courses and a number of major television series, one of which, "Making the Most of the Micro" is now being broadcast.

All this for only £399.

The BBC Micro is light and compact. It generates high resolution colour graphics, and is capable of synthesising music and speech using its own internal speaker. The keyboard uses a conventional layout and typewriter feel.

The most sophisticated version (called Model B) is available for only £399. (There is also a basic model available, the Model A, at £299.)

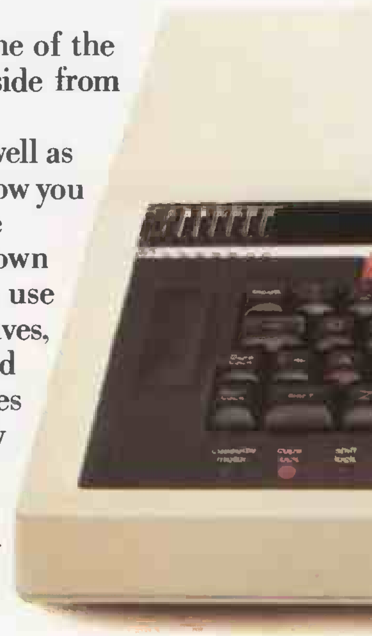
Designed to grow.

Last year the magazine "Which Micro?" said that the most attractive and exciting feature of the BBC Microcomputer was its 'enormous potential for expansion'.

This is indeed one of the features that sets it aside from the competition.

For example, as well as interface sockets to allow you to connect to a cassette recorder, and to your own television, you can also use video monitors, disc drives, printers (dot matrix and daisy wheel) and paddles for games or laboratory use.

You can also plug in ROM cartridges containing games with specialist application programs.



The Tube. A unique feature.

The Tube, which is unique to the BBC Micro, provides for the addition of a second processor via a high speed data channel. The possibilities are enormous. For example, the addition of a second

3MHz 6502 processor with 64K of RAM doubles processing speed. While a Z80 with 64K of RAM opens the door to a fully CP/M* compatible operating system, with all the benefits for business applications.

Linking up with other computers.

The BBC Micro also offers a facility of immense potential value to schools, colleges and businesses. It's called Econet® – a system which uses telephone cable to link with other BBC Micros. A number of machines can then share the use of expensive disc drive and printer facilities.

Make full use of Prestel & Teletext.

With special adaptors you will not only be able to turn your TV set into a Prestel terminal and Teletext receiver, but you can also take data and programs direct from these services. (The programs, which are known as telesoftware, are already being broadcast by BBC's Ceefax service.) This is another first for the BBC Micro.

BASIC plus.

A sophisticated version of BASIC has been chosen for the BBC Micro, which incorporates features normally found only in more advanced high level languages. However, there is also a facility allowing access through a simple command to another language – for example, PASCAL, FORTH and LISP.

*Trademark of Digital Research.

A full range of software.

Applications software for the BBC Micro already cover a very wide field. Packages covering games, education and business applications are available on cassette. All developed to the same high standards set by the hardware.

The best possible back-up.

Your BBC Micro comes with the backing of the BBC and an extensive dealer and service network.

Each approved dealer is able to offer advice and carry out expansion work and repairs.

BBC Microcomputer – Model A and Model B.
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How to buy your BBC Micro.

If you are a credit card holder and would like to buy a BBC Micro B, or if you would like the address of your nearest stockist, just phone 01-200 0200.

Alternatively, you can buy a Model B directly by sending off the order form below to: BBC Microcomputers, c/o Vector Marketing, Denington Estate, Wellingborough, Northants, NN8 2RL.

All orders are despatched by fully insured courier and come complete with easy to follow 500 page User Guide and Welcome cassette.

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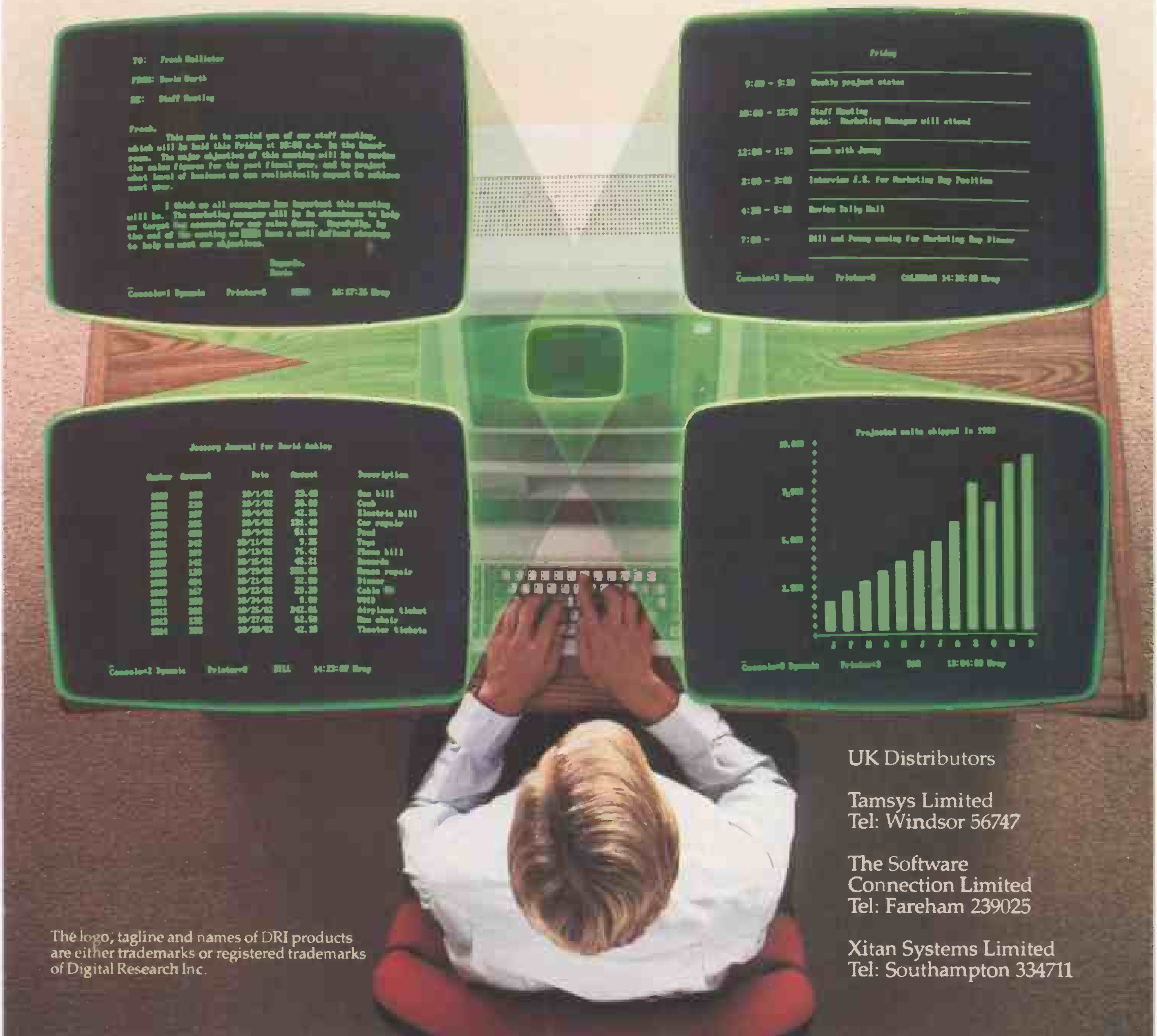

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● Circle No. 106

(continued from page 8)

brain or ponder what I was thinking about this morning. I would expect any "truly intelligent" machine to do this about itself. Gödel's theorem does not stop either of us, but rather it stops both of us from thinking about "what I am thinking about now."

Peter Kanssen,
Queen Mary College,
London.

Income tax

I AM WRITING concerning the Payroll program featured on page 148 of the April 1982 issue. I do not claim to be an expert at programming — though I do perhaps know something of income tax, having been in the business for 18 years — but it seems to me that the subroutine 7000 referred to near the top of page 150 is unnecessarily complicated by the use of arrays.

This routine, which should take up less memory space, will cope with codes of unlimited size.

John Doe,
Reigate,
Surrey.

Income tax.

```
7000 F = 0: IF T < 1 GO TO 7100
7010 L = INT (T/360 + 1)
7020 L = INT (T/L)
7030 K = T – INT (T/L) * L
7040 FOR M = 1 TO INT (T/L)
   – K:GO SUB 8000 : NEXT M
7050 IF K = 0 GO TO 7080
7060 L = L + 1
7070 FOR M = 1 TO K : GO
   SUB 8000 : NEXT M
7080 NN = N : IF E (J,4) = 1
   THEN NN = 1
7090 F = F * NN
7100 RETURN
8000 F = F + INT ((((L *
   10 + 9)/52 * 10    4)
   /10    4 + 0.049) * 20) /20 :
   RETURN
```

Pet characters

IN A LETTER in the July 1982 *Practical Computing* I described the unusual behaviour of shifted characters in Rem statements on a 4016 Pet. Recently I have discovered an even weirder behaviour of shifted characters anywhere in the program.

This behaviour works in either character set, but as capitals are easier to write than graphics I shall write as if the alternate character set is being used. Enter:

```
10 gO
20 sA
30 rU
40 lO
50 lI
```

and then list the program. The computer displays:

```
10 goto
20 save
30 run
40 load
50 list
```

This program is obvious nonsense and is used only to illustrate the point, but these half-shifted abbreviations are accepted by the computer just like the corresponding Basic word. A little research shows that there is a simple way to abbreviate any Basic word.

There are a few exceptions to this rule:

- two-letter words cannot be formed. tO does not give to.
- pR gives Print #, so ? must be used for Print.
- I can find no way to produce certain words such as gosub, and Input. iN gives input #.

Also, if two letters are used that are not the start of any word then the shifted letter is ignored:

```
10 zQ : sS
```

gives

```
10 Z : s
```

I can think of no reason for this to happen. Its practical use is obvious: almost any Basic word can be entered with just two key presses.

R J Dowling,
King's Lynn,
Norfolk.

Unfair to Ace

BORIS ALLAN does less than justice to the Ace computer — Forth thoughts, *Practical Computing*, January 1983. There is no need to define a special word to allow another word to refer to itself: recursion is already part of the Ace repertoire.

Further, Allan's program crashed on all three machines because a signed two-byte number cannot exceed 32,767. The eighth factorial is 40,320.

Peter Davis,
London N3.

Foolish remarks

BORIS ALLAN may think that it is easy to learn some computing, but surely I am not alone in being infuriated by his articles in *Practical Computing* — they imply crass ignorance of most of the subjects he is writing on. In his latest article, in Last Word — I wish it were — he puts forward some rather foolish remarks about artificial

(continued on page 16)

G. W. COMPUTERS LTD LONDON'S WEST END NATIONWIDE OVERNITE SERVICE MORE PRODUCT RANGES BETTER SERVICE PROBABLY THE WIDEST SELECTION OF NETWORKS... MICROS...AND PRINTERS ON DISPLAY NATIONWIDE

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record relational indexes..................................
translateable to any language..................................
User-defineable reporting..................................
field protection/classification..................................
sorts 'alpha or numeric' any window..................................
either-or. same as. greater. smaller..................................

32000 records per filename..................................
20 main/200 sub fields per record..................................
field and record related formulae..................................
'Jump-to' any of 32000 records per file..................................
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'if-then' questioning..................................
file protection/password entry..................................
speed of 500 records per 20 seconds..................................
range match. not match. integer match..................................

12 online file architectures..................................
240 fields using cross-referencing..................................
cross-record calculations..................................
'Jump-to' any record in 12 files..................................
User-defineable files/field words/sizes..................................
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formulate/recall on selection criteria..................................
12 interrogation question types..................................
short filing output/audit trails..................................

ONE OF THOUSANDS OF DIFFERENT TASKS ON WHICH THIS PROGRAM MIGHT BE EMPLOYED

DMS'S MACROS WORK FROM THE MOMENT YOU INSERT THE 'TASK DISK' IN THE COMPUTER'S DRIVE

Simply design your file, give its fields your words, setup your report mask, and then enter your records. Switch to 'automatic drive' and formulate any task you wish the program to fulfill, the task is stored as a macro. Take a copy of the program on another 'task disk' and from then on, the task disk will function without a single key-stroke. Think of a number of such 'task disks' such as "stock-re-order reports"; "stock-valuation reports"; "sale-mail-shots"; "production-process-analysis"; "patient history analysis"; "research-analysis"; "budgetting" "purchase/sales-analysis"; "personell-file-analysis"; "vehicle-location control"; "librarian analysis"; "plus more?"

Previous issues showed examples of 'employees-short-list', 'garage stock re-order', 'sales analysis' 'librarian's list' 'hospital's patient list' here is an example of a 'rental recording file' and some reports it might generate.

The record may look like this:
1-record number (413)
2-client (Radio cars ltd)
3-date of contract (01.04.81)
4-date last pmt (12.02.82)
5-period/frequency (36 / monthly)
7-amount of pmt (22.50)
8-item type (Taxi-phones)
9-repairs made (faulty microphone — item replaced)
10 cross reference (3.422!C details of full system spec and supplier)

One report might be: select ?? all records where the amount of payments are less than 50 pounds, that were taxi-phones and faults were detected. When found, pick up the cross reference code and look up that record to identify the supplier.

Another report might be: select ?? all records in the file where the commencing date of rental was 04.81 and the term was greater than 12 months. Print a list of all those records where the date last payment was prior to (ie smaller than) 03.82 and prepare a short address file for 'reminders'.

DBMS II (WITHOUT MACROS) AND DBMS III ARE FULLY IMPLEMENTED UNDER CPM-86 (tm) and MS-DOS (tm) ie: (SIRIUS/VICTOR/IBM) DBMS II IS 395.00 (or 250.00 by mail order ex. training). DBMS III is 575.00 (or 295.00 by mail order ex. training)

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All prices marked £ are 8/16 bit machines.

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Software formats on all micros in our hardware list.
All prices marked £ are available 8/16 bit formats.

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Features.	Design a form as wide as a window of 250 characters, long as needed. Cursor movements are 'left, right, up, down, delete left delete right, tab right-left-up-down' Paint your form as you like directly on the screen.
Text......	Write a letter as you see it on the screen, edit it then simply enter ^P to print.
Calc......	Set into the form, your data fields, "££££££" and specific file-related activities, formulae and validation checks. Enter values and see the spreadsheet calculate itself.
Database.	Search files for data to be inserted to fields specified. All the features of DBMS III, explained elsewhere in our ad.

Here's an example of an invoice you might design for your stationery ......
You could design your own spreadsheet, order form, statement, or any other kind of form that is required to fit your existing stationery.

<0 >£££££££££££££ **INVOICE**

To £<1 >£££££££££££££
£<2 >£££££££££££££££££
£<3 >£££££££££££££££££
£<4 >£££££££££££££
£<5 >££££££

From: G.W. Ltd
55 Bedford Court Mans.
Bedford Avenue
London W.C.1.
Tel: 01-636 8210

Date <6 >££.££ Tax point <7 >££.££ Agent <8 >£££

Quantity	Description	Cost	Tax	Total
<9 >£££	<10>£££££££££££££££	<11>££	££	<13>£££
<14>££	<15>£££££££££££££££	<16>££	<17>££	
<	1 8 >	£	£	£

and so on ......

Total......<19>££££££ Tax......<20>££££

<??>	items <1 >to <5 >internal command to request name input, and then search an address file for details.
<??>	items <6 >to <7 >request date input and validate.
<??>	item <8 >request agent number and validate range.
<??>	<9 >request quantity, validate range.
<??>	<10>request description, search file, accept, and calculate fields <11>, <12>, <13>, if finished invoice then calculate fields <19> and <20>

Now comes the more valuable facility, you can provide the 'FORM' with file-related instructions, not only to request a 'console' input for a file search against names, and stock, but after the invoice is finished the fields you have selected may be passed to related files.
EG: Send fields <0 >, <1 >, <6 >, <7 >, <11>, <12>, <13>, <19>, <20> to a sales ledger.
Then send fields <9 >, <10>, <11>, to product analysis file.
Then send fields <0 >, <1 >, <7 >, <19>, <20> to V.A.T. file
Then send fields <10>, <11>, <12>, <13> to Nominal ledger.

The program is only available from G.W. Computers Ltd <U.K.> with a system purchase at 575.00, note DBMS III comes free with system deals. or by mail order transaction at 395.00

● Circle No. 108

(continued from page 13)

intelligence, such as how it is not really intelligent.

If computers can never be intelligent then what makes him think that people are intelligent? Definititions of intelligence are notoriously difficult, but the trend in the past has been for computers to do more and more things that previously people would have said required intelligence. I see no reason for this trend to stop.

John Kleeman,
London NW3.

● **Last Word next month will be written by a computer.**

Some welcome!

AFTER TWO DAYS and a dozen temperamental attempts to load the BBC Welcome tape, as a last resort I changed over the Mic/Record jack plugs and all was then splendid. So be warned, if the jacks are the wrong way round, the screen may not show blank or rubbish.

It is like the navy pilot who took off not noticing that the wings of his plane were folded, and flew safely.

M Schaffer,
Haywards Heath,
West Sussex.

Alphabetical Sinclairs

I WAS PLEASED to see that you were able to publish my program in the January issue of your excellent magazine — page 115. Unfortunately, there were two small errors. Two lines should be inserted as follows:

1105 LET C(P) = C(P + 1)
1170 LET L (P) = 0

Various line numbers referred to in my explanation of the program related to an early version, rather than the later improved version which you printed. The corrected numbers are as follows:

For	13	read	40
	15		60
	17		80
	19		100
	21		120
	132		1200
	134		1220
	135		1230
	150		1370
	151		1380

The program will, of course, run without any alterations on the Spectrum, which I now use.

John Loncaster,
Hornsea,
Humberside.

Format 80

YOU WERE KIND enough to review our word processor Format 80 in the February edition of *Practical Computing*. For the most part the review was accurate but there are some matters of fact we would like to correct.

The price of Format-80 is now £199: the article "Apple words" prices it somewhat higher.

John Dawson should be pleased to hear that word-wrap now operates when inserting text. Format-80 is compatible with Super R, Omnivision, Videx Videoterm, Doublevision, Smart Term, Vision 80, U Term, Full-View 80 and others.

Michael Hardwick,
Elite Software Company,
Heston,
Middlesex.

Alphabetical listing.

```
Program conversions from ZX81
to SPECTRUM.
The following show a sample of
the suggested amendments to
make use of the INPUT command
on the SPECTRUM.
 620>INPUT "Add 1, Subst 2, Dele
te 3, Scroll 4, Return 5 ";y
 660 IF y=2 THEN GO TO 860
 670 IF y=3 THEN GO TO 1040
 685 IF y=5 THEN GO TO 1190
 700 INPUT "Enter Name of new It
em ";x$
 720 LET a$(1)=x$
 740 LET l(1)=LEN x$
 750 INPUT "Enter Amount of new
Item";a1
 770 LET a(1)=a1
 790 INPUT "Enter Cost of new It
em";c1


1260>INPUT "Add 1, Subst 2, Dele
te 3, Scroll 4, Return 5 ";y
1310 IF y=1 THEN GO TO 690
1320 IF y=2 THEN GO TO 860
1330 IF y=3 THEN GO TO 1040
1345 IF y=5 THEN GO TO 1190
```


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business computer
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RRP £2795 ex V

erve. The new 16 bit
ve today's executive.

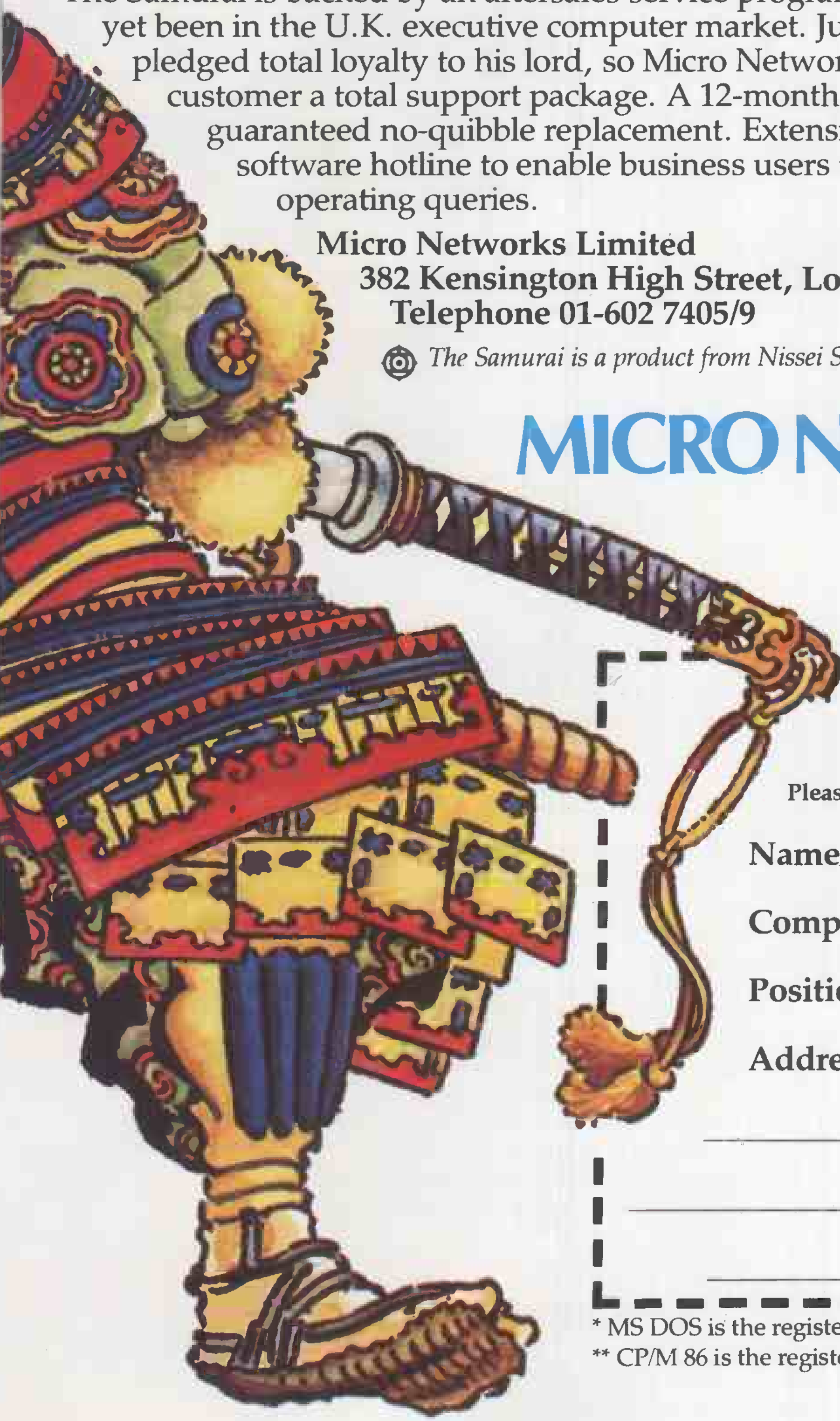
and printer interfaces all come as standard. And on top there is a superb range of options.

The software available to Samurai users is extensive. A full library has been developed by Peachtree the world's largest microcomputer software house, for MS DOS* and CP/M86** Samurai's operating systems. It all indicates that here's a machine that's built to work alongside you in the toughest business environment.

The Samurai is backed by an aftersales service programme, the like of which has not yet been in the U.K. executive computer market. Just as an ancient Samurai warrior pledged total loyalty to his lord, so Micro Networks pledges every Samurai customer a total support package. A 12-month guarantee of course, but also a guaranteed no-quibble replacement. Extensive training is available, and a software hotline to enable business users to get fast answers to operating queries.

Micro Networks Limited
382 Kensington High Street, London W14 8NL
Telephone 01-602 7405/9

The Samurai is a product from Nissei Sangyo which is a subsidiary of Hitachi.



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To: Micro Networks Limited
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Please send me more details of the 16 bit Samurai.

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* MS DOS is the registered mark of Micro Soft
** CP/M 86 is the registered mark of Digital Research

● Circle No. 111

Three from Texas

TEXAS INSTRUMENTS has entered the competitive desk-top business market with the TI Professional microcomputer. It is a 16-bit machine using the popular Intel 8088 CPU like the IBM Personal Computer. The oversized detached keyboard is more like the ones from Fortune and Wang.

The TI-P comes with 64K of RAM, expandable to 256K, and

one or more 320K floppy discs. It offers CP/M-86, Concurrent CP/M, MS-DOS and the UCSD p-system.

Meanwhile TI has also launched two further microcomputers, the TI-99/2 and CC-40, to strengthen its attack on the home and portable sectors respectively.

Contact Texas Instruments, Manton Lane, Bedford MK41 7PA. Telephone: (0234) 67466

ICL plumps for the Intel 8085

ICL HAS ANNOUNCED four new models of its micro, the Personal Computer, which is manufactured in the U.K. to a Rair design. Bottom of the range is the Model 15 with 64K of RAM and two 782K formatted floppies at £1,795. Top of the range is the Model 35 with 256K of RAM, a single floppy and built-in 10Mbyte hard disc at £5,125.

All the new models use the 5MHz Intel 8085 eight-bit processor, which can be simply upgraded to an 8088. The operating system supplied is either CP/M or MP/M for multi-user systems.

The Model 26 and Model 35 are fast enough for multi-user operation as they include 0.5 Mbyte of "virtual disc" or cache memory store. This allows very fast access to frequently used data without involving slow disc access.

Contact ICL, ICL House, London SW15. Telephone: 01-788 7272.

Canon's desk-top

THE FAMOUS Japanese camera and copier company, Canon, has launched a new 16-bit micro the AS-100. Apparently the label AS stands for "advanced station".

It comes in two versions, monochrome and colour. The AS-100 uses the Intel 8088 as its CPU and has 128K of RAM as standard, expandable to 512K. Two 5.25in. floppy discs are supplied, offering 640K of storage each; 1Mbyte 8in. discs are available as an option. There is a choice of operating system — CP/M-86 or MS-DOS may be specified.

Interestingly, a non-mouse knob-operated pointing device is available to plug into the detached keyboard to support the computer's normal graphics functions.

Contact Canon U.K. Ltd, Waddon House, Stafford Road, Croydon. Telephone: 01-680 7700.

Plug the Scullion into a Pet's User Port and the mains power supply, and up to six electrical devices can be switched on and off under program control using simple Peeks and Pokes from Basic. The Pet is fully isolated from the mains supply. The Scullion is suitable for stepper-motor control as well as turning on heaters, kettles and fish tanks, in fact anything drawing less than 10 amps. The unit costs £225. Further details from Mektronics Consultants, Linden House, 116 Rectory Lane, Prestwich, Manchester M25 5DB. Telephone: 061 798 0803.

Robot arm for the price of a toy

WOULD YOU SINCERELY like to get into robotics? If so, you could do a lot worse than invest in the Tomy Armatron at £30. There is nothing else even remotely near the price.

The arm traverses through 360°, as well as doing a 180° horizon-to-horizon swing. The claws, which are operated by knobs on the two control levers, are attached to a rotating wrist.

Tomy, a Japanese company, markets the Armatron as a toy. At the Earls Court Toy Fair, Tomy engineers admitted that it could quite easily be refabricated into something stronger and more durable. They also agreed it could be adapted to function under microprocessor control, especially a Z-80, for little more than the cost of the machine itself.

Where we disagree is with Tomy's reservation that it is suitable only for children over 12. The *Practical Computing* destruction testing team, aged six and three respectively, disprove that. After a weekend of Robot-arm wrestling, the Armatron was still functioning on the set of batteries it came with.

For further information contact Tomy on 01-661 1547

More news on page 24

● Circle No. 113

IBM profits near $4.5 billion

IBM HAS DECLARED a profit for 1982 of $4.409 billion on sales of over $34 billion.

IBM sales are thus running at around £85 million per working day, with profits of £11 million a day.

If IBM had sold its PC in the U.K. in 1982, and sold 200 a week for an annual turnover of £36.4 million, this could have increased profits by 0.1 percent. Wonder why it didn't?

CPS to import Winchesters

AUTHORISED IBM PC dealers CPS Data Systems are now importing PC-compatible Winchester hard discs from Tallgrass Technologies in the U.S. The TG-3012 is a 12MByte disc with integral tape back-up.

CPS also sells the Megaplus add-on board with 512K of RAM, three extra ports, and an interface which supports Tallgrass and Corvus hard discs.

Contact CPS at Arden House, 1102 Warwick Road, Acocks Green, Birmingham B27 6BH. Telephone: 021-707 3866.

Nominal ledger U.K.-style from Peachtree

U.K. VERSIONS of Peachtree's accounting systems and office-productivity systems packages are already available for the IBM PC. Now Peachtree has added the nominal ledger, which has been Britished by Peachtree International in Maidenhead, under contract to IBM.

As well as this, the basic accounting system includes Sales Ledger, Purchase Ledger and Inventory Management suites. The payroll package is expected to arrive in April with the new statutory sick pay facilities.

The office-productivity tools include Spelling Proof Reader, List Manager, Peachcalc financial modelling and Colour Graphics.

Later, Peachtree will start releasing its business management systems, written in Micro Focus Cobol.

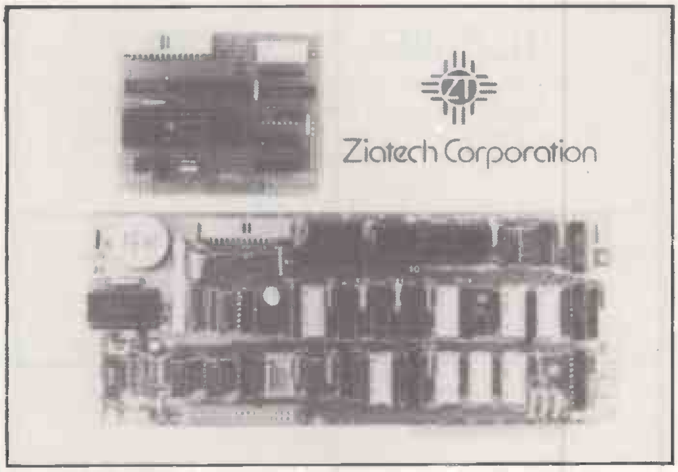
Contact Peachtree Software International Ltd, 43-53 Moorbridge Road, Maidenhead, Berkshire SL6 8LT. Telephone: (0628) 32711.

Three-function card saves space

ONE PROBLEM with the IBM PC is that it only has five expansion slots, which are quickly filled. Multifunction cards are therefore a useful development. Data Translation is offering the Ziatech 448 compatible card which fills one slot but has three complete separate functions. They are:

- GPIB controller — for daisychaining up to 14 GPIB compatible devices
- clock/calendar — with two-year battery back-up
- socket for multimode I/O board, with many available from various manufacturers. Examples are analogue I/O, maths processors, speech-synthesis chips, disc controllers and a second GPIB controller.

Contact Data Translation Ltd, 430 Bath Road, Slough, Berkshire SL1 6BB. Telephone: (06286) 3412.



Best-selling database manager for PC

A TOP-SELLING Apple program, DB Master, has been rewritten and expanded for the IBM PC. The new version has a 3,000-character record instead of 1,020. The database also has an Array Search feature to select records with multiple entries, and a Browse mode. Hardware requirements are a minimum of 192K of RAM and two 320K disc drives.

DB Master is from Stoneware Inc in California, and costs £349 from Pete & Pam, 103-5 Blegborough Road, London SW16 6DL. Telephone: 01-769 1022.

Mellow out the Easy way

THE EASY series of programs from Information Unlimited Software of Sausalito, California is now available from Pete & Pam Computers. The best-known offering is Easywriter II, which costs £225. It can be combined with Easyspeller, which costs £125 extra. The other two are Easyplanner, £125, and Easyfiler, £249.

Contact Pete & Pam Computers, New Hall Hey Road, Rossendale, Lancashire BB4 6JG. Telephone: (0706) 227011.

Comart peripherals

COMART LTD the microcomputer manufacturer and distributor, has signed an exclusive marketing agreement with Tecmar Inc to distribute the PC-Mate range of IBM PC compatible peripherals. They include Winchester hard-disc subsystems, memory and communications interfaces, analogue/digital converters and industrial control modules.

Comart's service division, Microserve, will be providing on-site maintenance for IBM PC users. Other Comart group members, including the Byteshop and Xitan Systems, will also be supporting the IBM PC.

Contact Comart Ltd, Little End Road, Eaton Socon, St Neots, Cambridgeshire. Telephone: (0480) 215005.

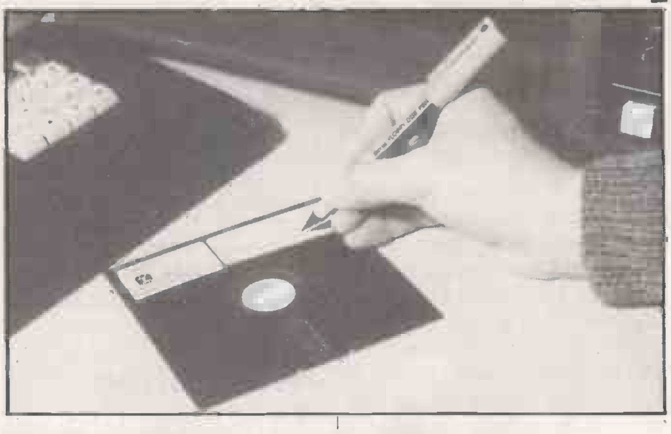
Appropriate Technology — Aptec for short — has launched a dual-language version of the IBM PC. The system includes the Arabstar word processor and a printer which can provide output in English, Arabic, or a mixtue of the two. The two languages can be mixed on the same screen — even on the same line — and Aptec's managing director Ali Baghdadi says they are working on further software. Contact Aptec Ltd at 2-4 Canfield Place, London NW6. Telephone: 01-625 5575 or 5134.

Berol disc pen

ORDINARY PENS can damage discs and — even worse — cause loss of data which may be priceless and irreplaceable. Now Berol has launched a specially designed pen which is suitable for writing on floppy-disc labels. It has a unique safety tip that will bend before the floppy is damaged if the user presses too heavily.

The Berol is a well-designed British-made pen suitable for many types of fine writing and figure work, for flowcharting and for use with stencils. It is available in black, blue, green and red at a retail price of 45p.

For further information, contact Berol Ltd, Oldmeadow Road, King's Lynn, Norfolk. Telephone: (0533) 672705.



Midland Fair

THE COMPUTER FAIR has been a great success in London and Manchester. Now it is paying its first visit to the Midlands. It will be held at Bingley Hall in Birmingham on April 28-30. The Fair aims to display the widest possible range of home and personal micros, small business systems, games and other software.

By special arrangement with British Rail, low-price tickets are available from many stations. For example, you can travel from Berkshire or Gwent for only £10, or from Derbyshire and Leicestershire for only £5.50. These prices include the £2 admission charge to the exhibition, and children under 16 are half-price. For the cost from your local station contact British Rail at 021-643 2711.

The Computer Fair is sponsored by *Practical Computing* and *Your Computer* magazines — see the advertisement which is on page 186 of this issue.

Rair's 3/60S runs MP/M-86

RAIR has launched another 16-bit micro to accompany the recent Rair 16. It is a new version of the old Black Box, designated the 3/60S. It features an Intel 8088 CPU, 256K of RAM and both floppy and hard discs. The floppy is 1Mbyte and the hard disc 19Mbyte, both unformatted. The operating system is MP/M-86.

The 3/60S is intended for multi-user, multi-tasking systems and will be sold both by Rair and by OEMs. Contact Rair by telephoning 01-836 6921.

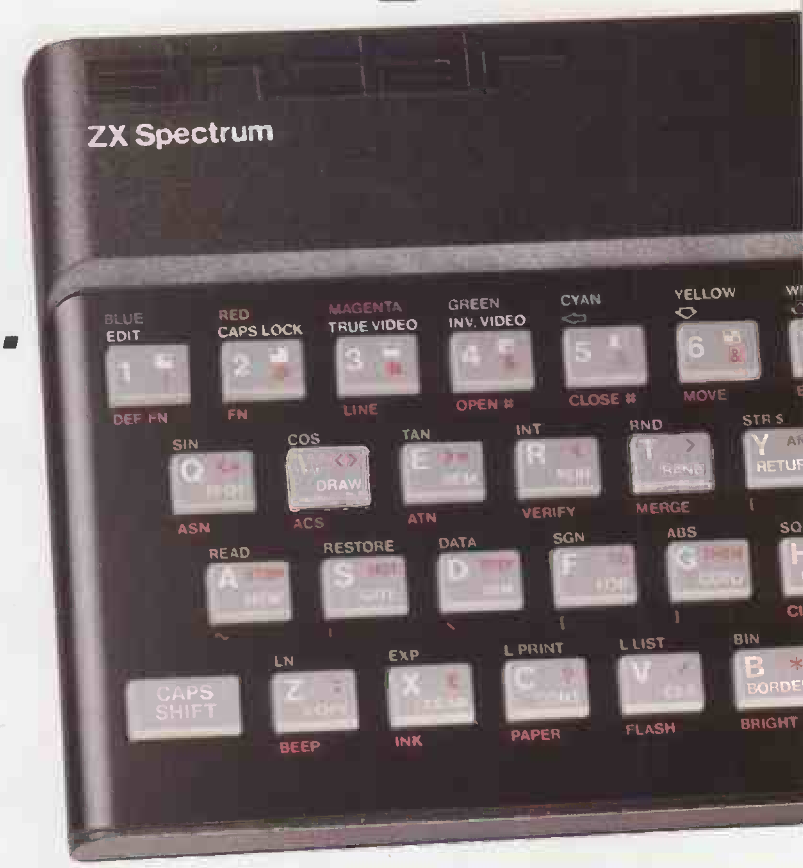
More news on page 29


ZX Spectrum
BLUE EDIT 1 ! DEF FN
RED CAPS LOCK 2 @ FN
MAGENTA TRUE VIDEO 3 # LINE
GREEN INV. VIDEO 4 $ OPEN #
CYAN 5 % CLOSE #
YELLOW 6 & MOVE
WHITE 7 ' ERASE
8 (POINT
GRAPHICS 9) CAT
BLACK DELETE 0 _ FORMAT
SIN Q <= PLOT ASN
COS W <> DRAW ACS
TAN E >= REM ATN
INT R < RUN VERIFY
RND T > RAND MERGE
STR$ Y AND RETURN [
CHR$ U OR IF]
CODE I AT INPUT IN
PEEK O ; POKE OUT
TAB P " PRINT ©
READ A STOP NEW ~
RESTORE S NOT SAVE |
DATA D STEP DIM \
SGN F TO FOR {
ABS G THEN GOTO }
SQR H ↑ CIRCLE
VAL J - VAL $
LEN K + LIST
USR L = LET ATTR
ENTER
CAPS SHIFT
LN Z : COPY BEEP
EXP X £ CLEAR INK
LPRINT C ? CONT PAPER
LLIST V / FLASH
BIN B * BORDER BRIGHT
IN KEY$ N , NEXT OVER
PI M . PAUSE INVERSE
SYMBOL SHIFT
BREAK SPACE

Sinclair ZX Spectr

16K or 48K RAM... full-size moving-key keyboard... colour and sound... high-resolution graphics...

From only £125!



First, there was the world-beating Sinclair ZX80. The first personal computer for under £100.

Then, the ZX81. With up to 16K RAM available, and the ZX Printer. Giving more power and more flexibility. Together, they've sold over 500,000 so far, to make Sinclair world leaders in personal computing. And the ZX81 remains the ideal low-cost introduction to computing.

Now there's the ZX Spectrum! With up to 48K of RAM. A full-size moving-key keyboard. Vivid colour and sound. High-resolution graphics. And a low price that's unrivalled.

Professional power– personal computer price!

The ZX Spectrum incorporates all the proven features of the ZX81. But its new 16K BASIC ROM dramatically increases your computing power.

You have access to a range of 8 colours for foreground, background and border, together with a sound generator and high-resolution graphics.

You have the facility to support separate data files.

You have a choice of storage capacities (governed by the amount of RAM). 16K of RAM (which you can uprate later to 48K of RAM) or a massive 48K of RAM.

Yet the price of the Spectrum 16K is an amazing £125! Even the popular 48K version costs only £175!

You may decide to begin with the 16K version. If so, you can still return it later for an upgrade. The cost? Around £60.

Ready to use today, easy to expand tomorrow

Your ZX Spectrum comes with a mains adaptor and all the necessary leads to connect to most cassette recorders and TVs (colour or black and white).

Employing Sinclair BASIC (now used in over 500,000 computers worldwide) the ZX Spectrum comes complete with two manuals which together represent a detailed course in BASIC programming. Whether you're a beginner or a competent programmer, you'll find them both of immense help. Depending on your computer experience, you'll quickly be moving into the colourful world of ZX Spectrum professional-level computing.

There's no need to stop there. The ZX Printer–available now– is fully compatible with the ZX Spectrum. And later this year there will be Microdrives for massive amounts of extra on-line storage, plus an RS232 / network interface board.

Key features of the Sinclair ZX Spectrum

- Full colour–8 colours each for foreground, background and border, plus flashing and brightness-intensity control.
- Sound–BEEP command with variable pitch and duration.
- Massive RAM–16K or 48K.
- Full-size moving-key keyboard– all keys at normal typewriter pitch, with repeat facility on each key.
- High-resolution–256 dots horizontally x 192 vertically, each individually addressable for true high-resolution graphics.
- ASCII character set–with upper- and lower-case characters.
- Teletext-compatible–user software can generate 40 characters per line or other settings.
- High speed LOAD & SAVE–16K in 100 seconds via cassette, with VERIFY & MERGE for programs and separate data files.
- Sinclair 16K extended BASIC– incorporating unique 'one-touch' keyword entry, syntax check, and report codes.

um

ZX Spectrum software on assettes – available now

The Spectrum software library is rowing every day. Subjects include ames, education, and business/ ousehold management. Flight mulation…Chess…Planetoids… istory…Inventions…VU-CALC…VU-3D Club Record Controller…there is omething for everyone. And they all ake full use of the Spectrum's colour, ound, and graphics capabilities. You'll eceive a detailed catalogue with your pectrum.

ZX Expansion Module

This module incorporates the three nctions of Microdrive controller, local rea network, and RS232 interface. onnect it to your Spectrum and you can ontrol up to eight Microdrives, ommunicate with other computers, and rive a wide range of printers.

The potential is enormous, and the odule will be available in the early part f 1983 for around £30.

sinclair

inclair Research Ltd, Stanhope Road, amberley, Surrey GU15 3PS. el: Camberley (0276) 685311.

The ZX Printer – available now

Designed exclusively for use with the Sinclair ZX range of computers, the printer offers ZX Spectrum owners the full ASCII character set – including lower-case characters and high-resolution graphics.

A special feature is COPY which prints out exactly what is on the whole TV screen without the need for further instructions. Printing speed is 50 characters per second, with 32 characters per line and 9 lines per vertical inch.

The ZX Printer connects to the rear of your ZX Spectrum. A roll of paper (65ft long and 4in wide) is supplied, along with full instructions. Further supplies of paper are available in packs of five rolls.

The ZX Microdrive – coming soon

The new Microdrives, designed especially for the ZX Spectrum, are set to change the face of personal computing by providing mass on-line storage.

Each Microdrive can hold up to 100K bytes using a single interchangeable storage medium.

The transfer rate is 16K bytes per second, with an average access time of 3.5 seconds. And you'll be able to connect up to 8 Microdrives to your Spectrum via the ZX Expansion Module.

A remarkable breakthrough at a remarkable price. The Microdrives will be available in the early part of 1983 for around £50.

How to order your ZX Spectrum

BY PHONE – Access, Barclaycard or Trustcard holders can call 01-200 0200 for personal attention 24 hours a day, every day. BY FREEPOST – use the no-stamp needed coupon below. You can pay by cheque, postal order, Barclaycard, Access or Trustcard.

EITHER WAY – please allow up to 28 days for delivery. And there's a 14-day money-back option, of course. We want you to be satisfied beyond doubt – and we have no doubt that you will be.

To: Sinclair Research, FREEPOST, Camberley, Surrey, GU15 3BR. **Order**

Qty	Item	Code	Item Price £	Total £
	Sinclair ZX Spectrum – 16K RAM version	100	125.00	
	Sinclair ZX Spectrum – 48K RAM version	101	175.00	
	Sinclair ZX Printer	27	59.95	
	Printer paper (pack of 5 rolls)	16	11.95	
	Postage and packing: orders under £100	28	2.95	
	orders over £100	29	4.95	
			Total £	

Please tick if you require a VAT receipt ☐

*I enclose a cheque/postal order payable to Sinclair Research Ltd for £ ______

*Please charge to my Access/Barclaycard/Trustcard account no.

*Please delete/complete as applicable

Signature

PLEASE PRINT

Name: Mr/Mrs/Miss

Address

PRC 904

FREEPOST – no stamp needed. Prices apply to UK only. Export prices on application.

Sinclair ZX Spectrum–technical data.

Dimensions
Width 233 mm
Depth 144 mm
Height 30 mm

CPU/ memory
Z80A microprocessor running at 3.5 MHz.
16K-byte ROM containing BASIC interpreter and operating system.
16K-byte RAM (plus optional 32K-byte RAM on internal expansion board) or 48K-byte RAM.

Keyboard
40-moving-key keyboard with full upper and lower case with capitals lock feature. All BASIC words obtained by single keys, plus 16 graphics characters, 22 colour control codes, and 21 user-definable graphics characters. All keys have auto repeat.

Display
Memory-mapped display of 256 pixels x 192 pixels; plus one attributes byte per character square, defining one of eight foreground colours, one of eight background colours, normal or extra brightness and flashing or steady. Screen border colour also settable to one of eight colours. Will drive a PAL UHF colour TV set, or black and white set (which will give a scale of grey), on channel 36.

Sound
Internal loudspeaker can be operated over more than 10 octaves (actually 130 semitones) via basic BEEP command. Jack sockets at the rear of computer allow connections to external amplifier/ speaker.

Graphics
Point, line, circle and arc drawing commands in high-resolution graphics.
16 pre-defined graphics characters plus 21 user-definable graphics characters. Also functions to yield character at a given position, attribute at a given position (colours, brightness and flash) and whether a given pixel is set. Text may be written on the screen on 24 lines of 32 characters. Text and graphics may be freely mixed.

Colours
Foreground and background colours, brightness and flashing are set by BASIC INK, PAPER, BRIGHT and FLASH commands. OVER may also be set, which performs an exclusive–or operation to overwrite any printing or plotting that is already on the screen. INVERSE will give inverse video printing. These six commands may be set globally to cover all further PRINT, PLOT, DRAW or CIRCLE commands, or locally within these commands to cover only the results of that command. They may also be set locally to cover text printed by an INPUT statement. Colour-control codes, which may be accessed from the keyboard, may be inserted into text or program listing, and when displayed will override the globally set colours until another control code is encountered. Brightness and flashing codes may be inserted into program or text, similarly. Colour-control codes in a program listing have no effect on its execution. Border colour is set by a BORDER command. The eight colours available are black, blue, red, magenta, green, cyan, yellow and white. All eight colours may be present on the screen at once, with some areas flashing and others steady, and any area may be highlighted extra bright.

Screen
The screen is divided into two sections. The top section – normally the first 22 lines – displays the program listing or the results of program or command execution. The bottom section – normally the last 2 lines – shows the command or program line currently being entered, or the program line currently being edited. It also shows the report messages. Full editing facilities of cursor left, cursor right, insert and delete (with auto-repeat facility) are available over this line. The bottom section will expand to accept a current line of up to 22 lines.

Mathematical operations and functions
Arithmetic operations of +, –, ×, ÷, and raise to a power. Mathematical functions of sine, cosine, tangent and their inverses; natural logs and exponentials; sign function, absolute value function, and integer function; square root function, random number generator, and pi.
Numbers are stored as five bytes of floating point binary – giving a range of $+3\times10^{-39}$ to $+7\times10^{38}$ accurate to $9\frac{1}{2}$ decimal digits.
Binary numbers may be entered directly with the BIN function. =, >, <, >=, <= and <> may be used to compare string or arithmetic values or variables to yield 0 (false) or 1 (true). Logical operators AND, OR and NOT yield boolean results but will accept 0 (false) and any number (true).
User-definable functions are defined using DEF FN, and called using FN. They may take up to 26 numeric and 26 string arguments, and may yield string or numeric results.
There is a full DATA mechanism, using the commands READ, DATA and RESTORE.
A real-time clock is obtainable.

String operations and functions
Strings can be concatenated with +. String variables or values may be compared with =, >, <, >=, <=, <> to give boolean results. String functions are VAL, VAL$, STR$ and LEN. CHR$ and CODE convert numbers to characters and vice versa, using the ASCII code.
A very powerful string slicing mechanism exists, using the form a$ (x TO y).

Variable names
Numeric – any string starting with a letter (upper and lower case are not distinguished between, and spaces are ignored).
String – A$ to Z$.
FOR-NEXT loops – A-Z.
Numeric arrays – A-Z.
String arrays – A$ to Z$.
Simple variables and arrays with the same name are allowed and distinguished between.

Arrays
Arrays may be multi-dimensional, with subscripts starting at 1. String arrays, technically character arrays, may have their last subscript omitted, yielding a string.

Expression evaluator
A full expression evaluator is called during program execution whenever an expression, constant or variable is encountered. This allows the use of expressions as arguments to GOTO, GOSUB, etc.
It also operates on commands allowing the ZX Spectrum to operate as a calculator.

Cassette interface
The ZX Spectrum incorporates an advanced cassette interface. A tone leader is recorded before the information to overcome the automatic recording level fluctuations of some tape recorders, and a Schmitt trigger is used to remove noise on playback.
All saved information is started with a header containing information as to its type, title, length and address information. Program, screens, blocks of memory, string and character arrays may all be saved separately.
Programs, blocks of memory and arrays may be verified after saving to confirm successful saving.
Programs and arrays may be merged from tape to combine them with the existing contents of memory. Where two line numbers or variables names coincide, the old one is overwritten.
Programs may be saved with a line number, where execution will start immediately on loading.
The cassette interface runs at 1500 baud, through two 3.5 mm jack plugs.

Expansion port
This has the full data, address and control busses from the Z80A, and is used to interface to the ZX Printer, the RS232 and NET interfaces and the ZX Microdrives.
IN and OUT commands give the I/O port equivalents of PEEK and POKE.

ZX81 compatibility
ZX81 BASIC is essentially a subset of ZX Spectrum BASIC. The differences are as follows.
FAST and SLOW: the ZX Spectrum operates at the speed of the ZX81 in FAST mode with the steady display of SLOW mode, and does not include these commands.
SCROLL: the ZX Spectrum scrolls automatically, asking the operator "scroll?" every time a screen is filled.
UNPLOT: the ZX Spectrum can unplot a pixel using PLOT OVER, and thus achieves unplot.
Character set: the ZX Spectrum uses the ASCII character set, as opposed to the ZX81 non-standard set.
ZX81 programs may be typed into the ZX Spectrum with very little change, but may of course now be considerably improved. The ZX Spectrum is fully compatible with the ZX Printer, which can now print out a full upper and lower case character set, and the high resolution graphics; using LLIST, LPRINT and COPY.
ZX81 software cassettes and the ZX 16K RAM pack will not operate with the ZX Spectrum.

sinclair
ZX Spectrum

Sinclair Research Ltd, Stanhope Road, Camberley, Surrey, GU15 3PS. Tel: Camberley (0276) 685311.

● Circle No. 115

Computer of the Year, 1982

PRACTICAL COMPUTING has recently participated with *Chip* magazine in Germany in voting for the 1982 Computer of the Year. Other magazines involved were *Databus* from Holland, *Microsystems* from France, *Bit* from Italy, Chip from Spain and *Personal Computing* from the U.S.

One problem was that not all the different countries have the same micros. In particular our vote for the Sinclair Spectrum in the home computer class was wasted, as exports had not then started.

The results were: Home Computer of the year, the Vic-20, Personal Computer of the year, the Sirius 1. Incidentally, the Vic-20 is called the VC-20 in Germany as "vic" sounds extremely rude to German ears.

London Computer Festival

THE ASSOCIATION of London Computer Clubs is holding its annual Fair at the Central Hall, Westminster, from April 14 to 16. This year it will be part of the first London Computer Festival, sponsored by the GLC and other bodies, which runs from April 3 to 17. For further details contact B M Goddard at 55 The Chine, London N21. Telephone: 01-360 0021.

Vertical marketing

VERTICAL MARKETING is the name of the current micro sales game with packages for accountants, solicitors, doctors, race-horse trainers, vets, butchers, bakers and so on. Macro profits beckon those who manage to fill a particular niche.

A two-day bash, starting on March 25, is being held at the Crest Hotel, Heathrow, the intention being to fill a gaping vertical gap in the computer conference market. It is called Selecting a Profitable Microcomputer Market, and is aimed at micro dealers.

The attendance fee is £165 and further details are available from Christine White, Interco Business Consultants, 1 Lancaster Park, Richmond, Surrey. Telephone: 01-948 3111.

Texet TX-8000 colour micro

WHEN WE REVIEWED the Oric 1 for this issue, there was only one colour computer for under £100. Soon there will be two. Texet — it claims to have been the first U.K. company to produce a pocket calculator in 1971 — has announced the Texet TX-8000 Colour Computer. It is an 8K, eight-colour home micro costing £98, which is only £1.95 less than the 16K Oric. However, Texet offers an upgrade to 64K for only £52, which will undercut both the Oric and the 48K Spectrum.

The keyboard is "full size moving-key rubber", and the use of a single Shift key and single-key space-bar suggest it will be just like the one on the Spectrum. There is one major difference between the TX-8000 and the Sinclair rival: the TX-8000 uses a 6502, not the Z-80.

Contact Texet, Commercial Avenue, Stanley Green Trading Estate, Cheadle Hulme, Cheshire. Telephone: 061-486 9231.

Trade Show '83

PRACTICAL COMPUTING is sponsoring The Computer Trade Show '83, to be held at the Wembley Conference Centre from April 26-28. The conference will include a trade exhibition and a series of seminars designed to bring manufacturers face to face with sellers.

The show is aimed at dealers, distributors, retailers, independent sales organisations, OEMs, systems houses and software houses. The fee is £90 for one day, £170 for two days, plus VAT.

Contact the Computer Trade Conference, IPC Business Press Ltd, Surrey House, Throwley Way, Sutton, Surrey SM1 4QQ. Telephone: 01-643 8040.

Business Press

THE NAME OF *Practical Computing's* parent company has been changed from IPC Business Press Ltd to Business Press International Ltd. This change has been made to reflect the very wide range of markets covered by the 100 publications of the company, and to identify its prime position as the world leader of business publishing.

"There's nothing like matter of fact;
seeing is believing."
John Arbuthnot *History of John Bull*
"I never desire or find fault with that I see not: That Proberb is verified in me; What the eye seeth not, the heart rueth not."
Michel Eyquem de Montaigne *Essays.*
"One of the most untruthful things possible . . . is a collection of facts, because they can be made to appear so many different ways."
Karl Meninger *A Psychiatrist's World*

Stained-glass graphics

Seeing is believing — or is it, asks Boris Allan.

WHEN LITERACY was low it was impossible to explain things in writing, and until very recently any education a commoner might have was through pictures. There is a very old maxim which claims "Pictures are the books"; that is, painted windows in churches were the library of laymen. After the Norman conquest the telling of Biblical tales by such means became the norm.

Psychologists have tried to put a value to the extent to which people use their eyes to take in information, compared to the other senses. The precise value — though not so meaningful purely as a figure — differs but usually is such that the information from the visual sense far exceeds the information from all the other senses taken together. What has been confirmed is the common view that to be blind is more of a disability than to be deaf.

Though the eyes are the most important sense, they are nevertheless still untutored in many aspects: too frequently we take Arbuthnot's stance, that seeing is believing. The drawings of Escher capitalise upon this untutored sense. As with other visual illusions Escher's drawings depend upon us trying to make sense of what has no sense. The most common visual illusions are not those of psychology or of art but those of statistics, and diagrams which purport to present statistics.

It is true that a picture can be worth a thousand words, but most people are, perhaps surprisingly, far better equipped to analyse the meaning behind a thousand words than they are equipped to analyse the meaning of a pictorial presentation. The use of diagrams and pictures to present results is part of a trend away from words towards visual presentations. It is part of the trend away from analysis to the consumption of predigested gobbets of information.

I was recently at a presentation — the word is only too accurate — in which the presenter managed to dazzle and amaze by his slick use of the new video technology. Sound tracks, moving pictures and diagrams were interspersed with his eminently forgettable words and stirring music.

The presentation had a good deal in common with the use of graphics on television, usually computer-driven. *The Money Programme* on BBC2 probably makes more use of graphics to inform than any other, but the graphics are on our screen for such a short time that even to a person experienced in the analysis of such diagrams, time is still too short in many cases.

There is a distinction to be made for one use of computer graphics which does not have these problems, application is that of computer-aided design or CAD. My worries about the ability of the user to interpret the computer output are not relevant here: CAD is inherently a visual exercise, as is most design, and those who use CAD are experts in the interpretation of diagrams. The interpretation of plans and designs requires training and some experience, and that is why CAD is so commendable. The CAD computer is doing things more easily than a person could do but the computer output is not ambiguous.

Computer graphics, as used in the presentation of statistics and results also needs a person who is trained to interpret its output. The meaning of something as simple as a piechart — a very popular feature of most computer-graphics packages is not as self-evident as it seems. It is of the nature of computer graphics that each illustration is transient, like a sales presentation, so that, explicitly or not, one is unable to fully digest the impact of the illustration. This is where the hard copy, the book, the report, scores for the unwary user.

Consider, for example, figure 1a which shows a rapidly increasing cost of a commodity, as might be zoomed up on to the screen with perhaps no more than 15 seconds to view it. Then look at figure 1b, which plots the same data with a few slight modifications to the graph. The slight modifications are to the axes: the zero is shown on figure 1b and the years along the abscssa are plotted at equal distances. They are obvious if you have time to look. An extremely accessible introduction to some of the tricks which diagrams and other forms of presentation can be used to mislead can be found in Darrell Huff's *How to Lie with Statistics,* published by Penguin Books.

If, as has been suggested by some, computers should be used far more for graphical and pictorial presentations of results and information on television — not only in specialist programs, but the news and similar — then the public needs to be trained in the interpretation of graphical output. I am not suggesting where this training should be, or by whom, but if only for their self-preservation people ought to educate themselves in this way. That such knowledge is only dimly available is only too obvious, for even in cases where the graphics are in books or reports the lack of understanding seems low. At least you can

(continued on next page)

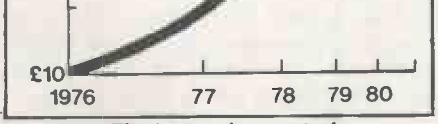


Figure 1a. The increasing cost of a commodity.

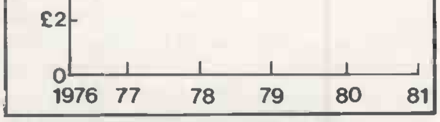


Figure 1b. Similar data with slight modifications to the presentation.

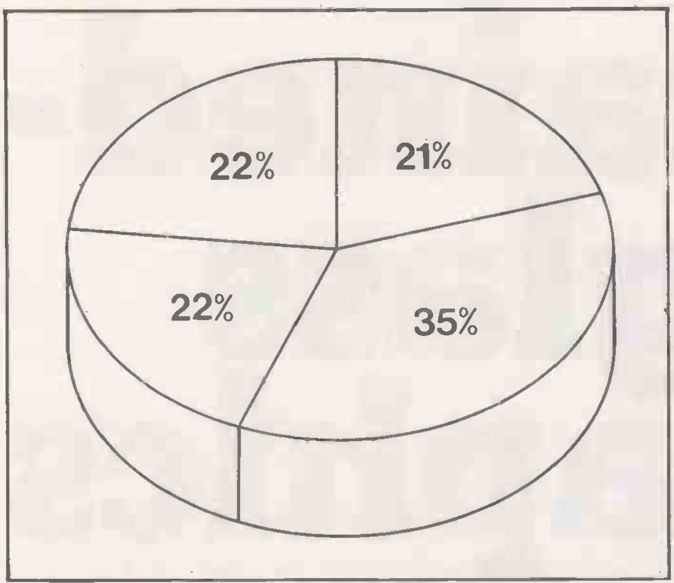


Figure 2. Solid pie chart drawn in perspective emphasises sectors in the foreground.

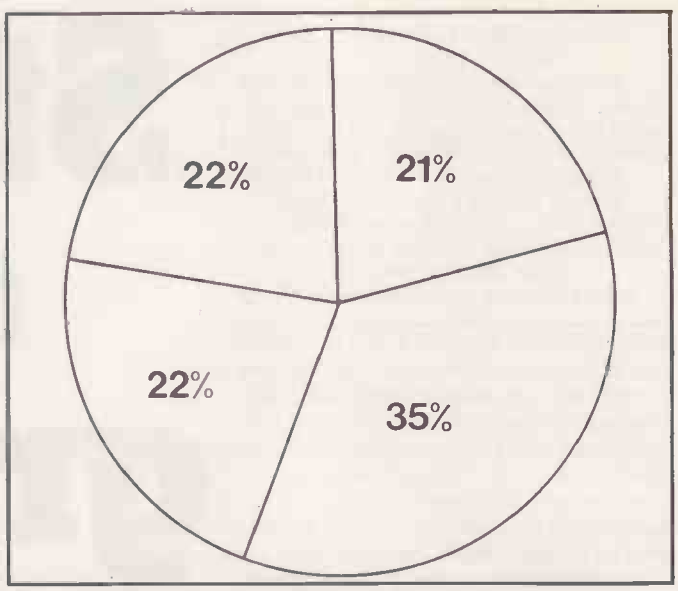


Figure 3. Ordinary pie chart where equality of three of the sectors is more obvious.

(continued from previous page)
study a report at leisure, without having to own a video recorder.

A report entitled *Information Technology: The management of change in the United Kingdom 1982* was recently published by Heidrick and Struggles in conjunction with the National Computing Centre. Both the report and responses to it indicate the lack of understanding which can only be heightened by snapshot computer graphics. Like many similar exercises, the report works on the Montaigne principle, "if you don't tell 'em they won't worry about it", and illustrates Meninger's worry about "facts" in general. Disraeli was the first to say "There are lies, damned lies, and statistics", when what he was actually commenting upon was levels of ignorance.

"Take a close look at a manager in your department. Is he male, British, about 44 years old, married with 2¼ children, probably got a degree?": so started one account of the report. The sentence I have quoted is obviously poking fun at statistics but it is already guilty of many of the errors which are compounded by the instant analyses produced using computer graphics. The number 2¼ is a mean number of children, and so to be consistent we should say that the average manager has half a degree — in fact 48 percent have a degree. Actually, the manager probably does not have a degree, and is certainly more likely not to have a degree.

The report finds that the average income of managers employed in what it termed the service sector was £23,500: it does not tell you how many managers there were in this category. Though it is possible to work it, this information would not be easily accessible in a computerised graphics system, especially one on television. There were responses from 26 percent of about 600 organisations, and of those, 18 percent were from the service sector. If you do the arithmetic it emerges that there were responses from about 28 managers in the service sector, mostly directors of management services or some equivalent. The average of £23,500 was, therefore, calculated on the basis of about 28 replies.

If the top 25 percent of income earners were taken and the average income then calculated for these people in the top 25 percent it comes to £39,000 for the service sector. Since 25 percent of 28 people is seven people, the value of £39,000 — the upper quartile mean salary is based on calculations on seven people. This information is totally disguised in the reports presentation, but can be disinterred from elsewhere in the report. If these results were shown on television, baldly, as they stand, without any information about the numbers involved, you would be likely to reach an erroneous conclusion. That many have made erroneous conclusions from the Heidrick and Struggles NCC report, even though the information was easily accessible, indicates the naivety of many commentators where statistics are concerned.

The report is well presented and has many block graphs, pie charts, and tables, just the type of display that you would expect from a computer-graphics package. The figures are attractive in the way that they often are in presentations.

But pretty graphics do not necessarily aid interpretation of data. Figure 2 shows an oblique, solid-looking, pie chart for Notice of termination of employment. A glance at the figures in each sector reveals that three sectors are almost identical at 22, 21 and 22 percent, though they do not appear so from the diagram. Figure 3 shows an ordinary piechart, and the equality of the sectors is far more obvious.

What is clear, therefore, is that in the analysis of graphical and statistical data there seems to be little expertise at even what one might term "more educated" levels. The increased use of computers for analysis of data by statistical and graphical means calls for an increased awareness and training in interpretation.

One benefit of learning to perform statistics by hand — and that is not to say it could not be replicated by using a computer — such as drawing graphs and calculating simple statistics, is that it can provide a feel for the potential of data, and the ways in which it may be presented, or misrepresented.

"Doing sums" may be tedious, but it can be a useful educational exercise. The computer can take away the tedium, but you have to be careful that the computer does not take away a feel for the data. Unless the computerised system is very carefully designed it will act as a sieve, strain only certain types of ideas.

What I find worrying, I suppose, is the attitude which says of a problem: "Do not worry, if you cannot do it we will remove it." That is, if you cannot understand simple statistics enough to be able to calculate them, do not worry, we will get the computer to do it for you. You will still not understand, but the graphs will have been drawn. At a conference, the World Congress on Books 1982, some members of Unesco suggested that illiteracy would cease to be a problem: because with the greater variety of devices for input and output to computers and similar devices, the status of writing might itself be altered. They thought that in the future cheap input/output devices to computer systems would be largely audio-based. So reading and writing would become unnecessary.

Because computers make the production of graphics so easy and the production of statistical results in untold quantities too easy, people would have to be more highly educated, not less, to be able to cope with this mass of information. Computer graphics, if they are our modern version of stained-glass windows, will have a similar impact on the pictorially illiterate. We will know the story, but will we understand what it means.

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HP joins High Street gang

Hewlett-Packard has always focused on the engineering and scientific market. Ian Stobie found HP set to fight for home and office sales.

FOR SOME TIME the Hewlett-Packard presence has been hovering expensively on the fringes of the volume personal-computer market. But a major TV advertising campaign and a two-day public exhibition at the Barbican Centre in London means that HP is moving beyond its traditional engineering and scientific base and pushing its personal computers into the rough and tumble of retail selling to ordinary consumers.

The TV promotion centres on the book-sized HP-75C portable computer, costing about £760 and described fully in *Practical Computing's* November 1982 issue and the January 1983 Portables special. Among the other HP hardware on show at the HP Personal Computer Event, as the Barbican exhibition was called, were the established Series 80 range of desk-top machines, the dual Z-80 based series 100 Model 20 micro launched at the end of last year, and the brand-new series 200 Model 16 16-bit micro.

The Model 16 is perhaps the most interesting machine. At the exhibition it was being demonstrated running the MBA package from Context, which integrates four standard applications — word processing, spread-sheet analysis, chart making and filing — into a single, data-compatible whole. With both Visicorp's VisiOn and Apple's Lisa due in the Summer, integrated software looks like being a major force in the microcomputer market this year. Although primarily aimed at engineering and scientific users, the Model 16 is a neat and compact machine, and with this type of software it may also prove attractive for use in a general office environment. HP has not yet finalised European arrangements for the Context package, but it could cost around £600 and be available almost immediately.

The main unit is very compact, measuring only 282mm. high by 315mm. wide by 488mm. deep. It houses the 9in. CRT display, a Motorola 68000 16-bit processor running at 8MHz and from 128K to 1Mbyte of RAM. The screen has 300-by-400 dot resolution, fully supported by the powerful HP Basic graphics features, and can display 25 lines of 80 characters text.

Use of the Motorola chip is a departure for HP, which usually builds around processors of its own design. The 68000 is a true 16-bit processor, moving data around in 16-bit chunks on the data bus and capable of addressing up to 16Mbyte of memory with its 32-bit wide address registers. To the user this means that the Model 16 is a fast machine, especially suited to calculation-intensive tasks.

The detached keyboard unit has a rotating knob mounted on the left, above the top row of keys. It is called simply the Knob, and can be used as a pointing device to move the cursor around the screen, to select menu options, for example, or to point to objects on the screen. Alternatively, it can control, via software, instruments attached to the Model 16. The Knob can be thought of as a simpler, one-dimensional version of the Mouse device used by the Lisa

and VisiOn. HP's concept was originally developed for instrument-control applications and has been used on a larger non-retail HP series 200 machines for such tasks as moving radar masts. It is fully supported by Basic, with the Knob function and the On Knob Goto, On Knob Gosub and On Knob Call statements added to the language.

Pricing follows the HP tradition — it is not low. A typical 512K RAM system with screen and keyboard is £3,889 plus VAT, without discs. The twin 3.5in. disc unit is another £1,351, and Basic costs £247, so it would cost £5,487 to put such a system on your desk.

Basic on HP machines is generally a much more powerful language than micro-computer users are accustomed to. A typical ROM-based Basic like Applesoft occupies 12K including the system monitor. HP Basic 2.0 as supplied for the Model 16 occupies 256K and uses a further 21K of RAM as workspace. It includes a full-screen editor, allowing you to scroll the whole program under the screen window as you do with a word processor, and comprehensive insert, delete and renumber facilities.

The Basic is semi-compiled to speed up execution. Errors are checked for line by line as the program is entered in the normal microcomputer way, but when you run the program the first thing the system does is compile a symbol table, and this can trap further errors before any damage is done.

HP Basic can handle very large and very small numbers, with exponents in the range of plus or minus 308, and can display them to 16 digits precision. Strings can be up to 32K in length, which is far beyond what most Basics can handle and is put to use when the system is being used for data capture. The syntax for substring manipulation differs from Microsoft-style Basic and is closer to the proposed ANSI standard, taking the form

A$[start position, finish position]

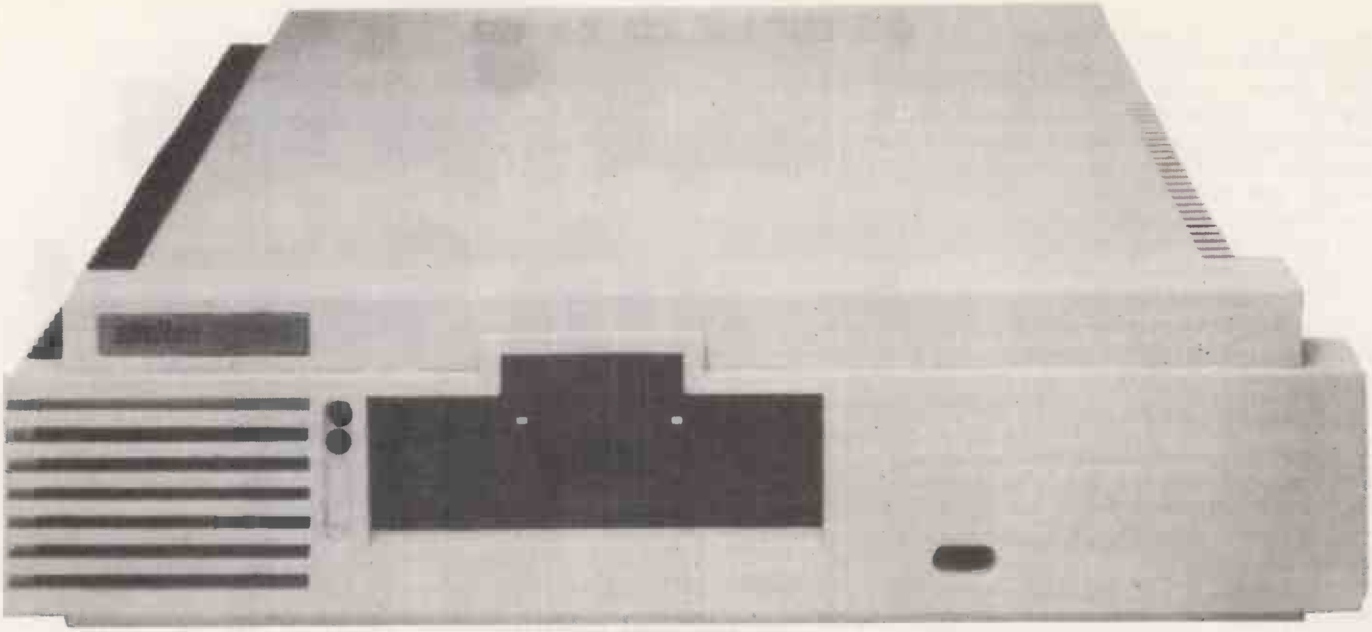
and

A$[start position; no. of characters]

Arrays can have up to six dimensions, and upper and lower limits can be set for array subscripts, which can be very large or even negative.

HP Basic is not a toy language and fully supports structured-programming techniques if you wish to employ them. Named subroutines can be defined and then called with a parameter list. They can be saved separately on disc and later merged into other programs, so you can simply build up libraries of reusable subroutines. Variables within subroutines can be specified as local to that subroutine or common to the whole program.

A full set of structured programming constructs is available, including Repeat-Until, Loop-Until, and Do-While. Case and Select as well as If-Then-Else-Endif are provided for selecting conditional actions. For selecting actions under the control of events in the outside world an On event Goto/Gosub/Call statement can be used with On Intr, On Timeout, On Key and On Knob. If HP Basic still does not seem adequate, there is a similar comprehensive implementation of Pascal available for the Model 16.



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Make way for the "People's Winchester"

I SUPPOSE that the vast majority of the readers of this magazine are never likely to want to build their own computer, and many still never need to know more about their hardware than the size of the RAM memory array. But before turning the page to find out more about the latest operating-system software, disc drives or games packs, spare a thought for the humble chip that made it all possible.

This column is dedicated to the chips which form the heart of all computers and many computer peripherals, and each month I will be lifting the curtain on that mysterious world of the electronic engineer and the computer designer by taking a closer look at the latest semiconductor chips, what they do and how they do it.

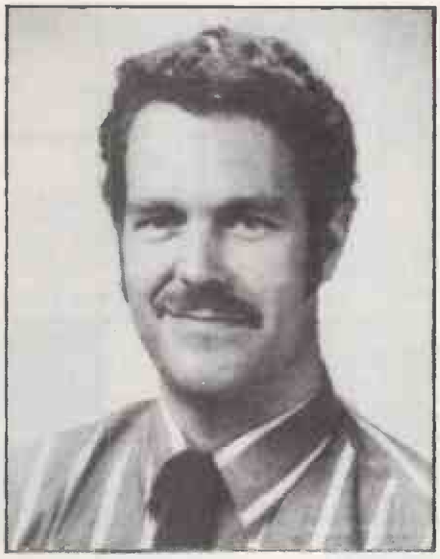
Even if you do not anticipate reaching for a soldering iron in the near future you should find it interesting; what's more you will steal a march on the readers of lesser magazines by gaining a shrewd idea of what to expect next from the microprocessor revolution. After all, today's chips will be used to make tomorrow's systems.

CP/M, as everyone knows, is *the* disc operating system for microcomputers. Is this because of its superior technical specification or the range of fancy features it offers? Alas no, it is simply because it has been around longer than most. It works with the 8080 and the Z-80 family of microprocessors, and most important of all there is a vast amount of software available at low cost to run under it.

Microcomputer users who do not have either the 8080 or the Z-80 in their machines sometimes go to extraordinary lengths to gain access to all that lovely CP/M software, as evidenced by the add-on Z-80 card available for the Apple and the 8080 emulator software available for the DEC PDP-11 family. Nothing, it seems, succeeds like success.

But technology marches on, and eight-bit microprocessors are soon to be replaced by the more powerful 16-bit devices like the Motorola 68000, and the Intel 8086. So is CP/M on its last legs? Thanks to CP/M-86 the latest verson of CP/M tailored to run on the Intel 8086 and its even more powerful offspring, the 80186 and the 80286 — the answer is no.

Of course competition is tougher now, and other operating systems for 16-bit machines such as the very elegant Unix will undoubtedly give CP/M-86 a run for its money. But my guess is that the no-frills CP/M will remain with us for a long time yet. Certainly Intel must be thinking along those lines, because it has put the CP/M-86 code on to a 16K ROM chip coded the 80150.



CP/M in any of its versions normally resides on a disc, and is loaded into RAM during system initialisation by a small ROM-based bootstrap routine. It therefore takes up disc space, takes up RAM space, and of course takes time to load. Having it available in a ROM is a big improvement.

by Roy Coles

Making up the 16K of firmware in the 80150 are three separate packages: the CCP or console command processor, the BDOS or basic disc operating system, and the BIOS or basic input/output sytem. The first two packages are pure CP/M-86 but the last has been developed by Intel to provide driver software for standard Intel peripheral devices such as the 8251 serial I/O controller, the 8255 parallel I/O controller, the 8275 CRT controller and, of course, the 8272 floppy-disc controller.

For most computer hobbyists bulk storage means cassette tapes or, for the lucky few, floppy discs. Yet the magnetic storage scene is changing fast, and before long even the humblest computer budget will find the funds for a low-cost micro-floppy drive or two.

The future lies with hard discs such as the Winchester, which consists of a rigid disc coated like a floppy and kept in a sealed container along with its associated read and write heads. The dust-free environment and the mechanical precision of the Winchester drive make it possible to pack much more information on to the floppy-sized magnetic disc, with the result that it is possible to pack tens of megabytes into the space previously required for hundreds of kilobytes.

Like all new developments, Winchester drives are expensive at the moment — but not for long, thanks to mass production and the omnipotent LSI chip. One device which will help to make the Winchester more attractive for use in low-cost personal computers is the μPD-7261 hard disc controller from NEC Electronics.

The 7261 is a 40-pin 5V operation NMOS chip. It is stacked to the pins with very clever circuitry, including an on-board microprocessor. The chip can handle as many as eight drives and under its own steam it can carry out the disc formatting, sector seek, read data and write data functions and so unload an otherwise onerus burden from the main processor. Data can be transferred to or from the chip at an incredible 12MHz rate, which puts it ahead of any current microprocessor. While it is reading the data it avoids mistakes by automatically detecting and correcting many errors by means of CRC or polynomial error-check codes generated during the write operation.

The on-board microprocessor is an eight-bit device with 64 bytes of RAM and 2.5K of ROM containing control code for the drive-management and data-transfer functions. The microprocessor makes the 7261 a "smart" chip which can be programmed to handle either of the two popular Winchester interface schemes, SMD or ST-506 — which are quite different in many respects. The microprocessor also acts as an interpreter of the hard-disc interface "language" which has 16 high-level commands such as Read Data, Write Data, Detect Error, and Seek.

Interfacing to the 7261 itself is made easier by the TTL compatibility of all the I/O lines, but some external logic is required between it and the drives. To take advantage of the high speed of the Winchester itself and the 12MHz transfer rate of the 7261 it will also be necessary to use a direct memory access, DMA, connection to the host microprocessor so that the whole disc sectors can be transferred without interruption.

With devices like the μPD-7261 becoming available, the "people's Winchester" cannot be too far away.

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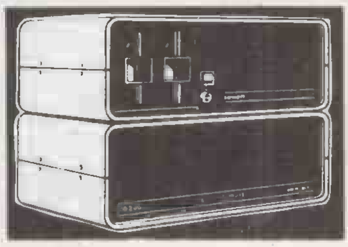

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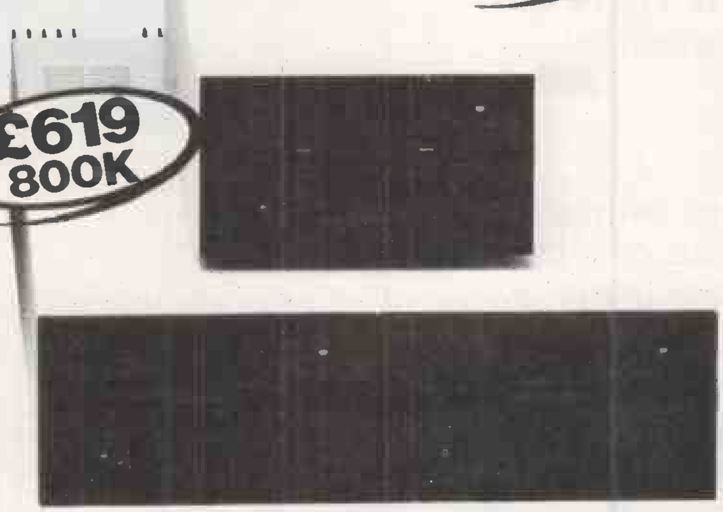

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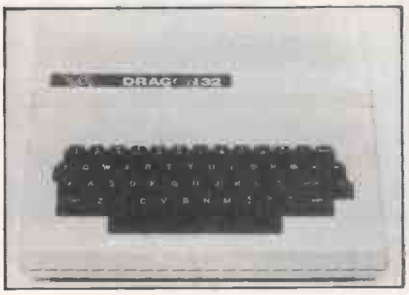

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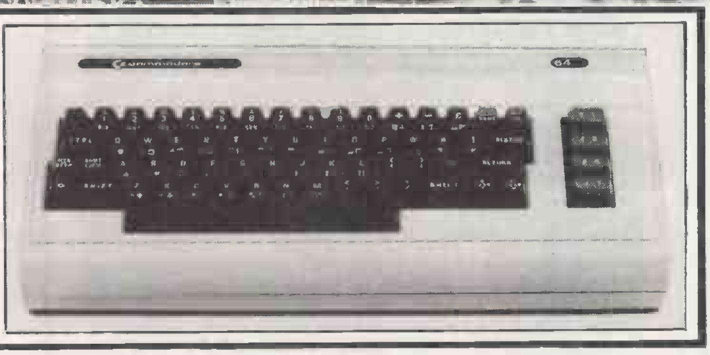

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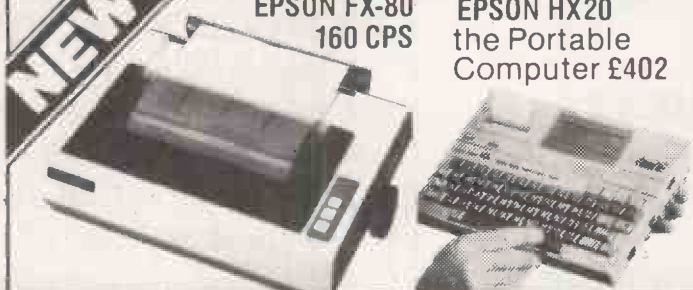

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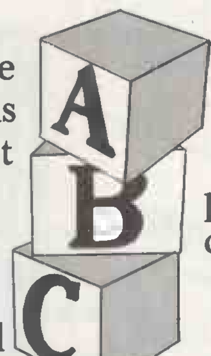

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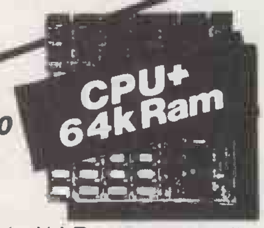

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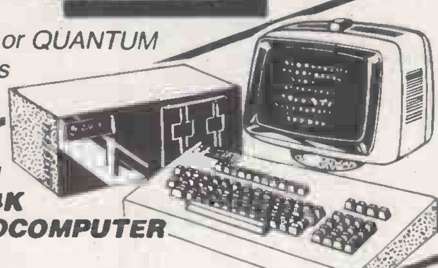

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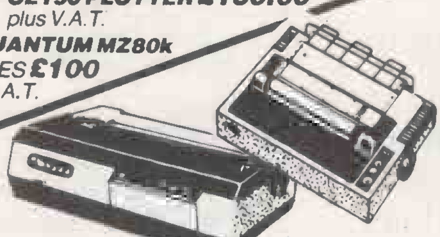

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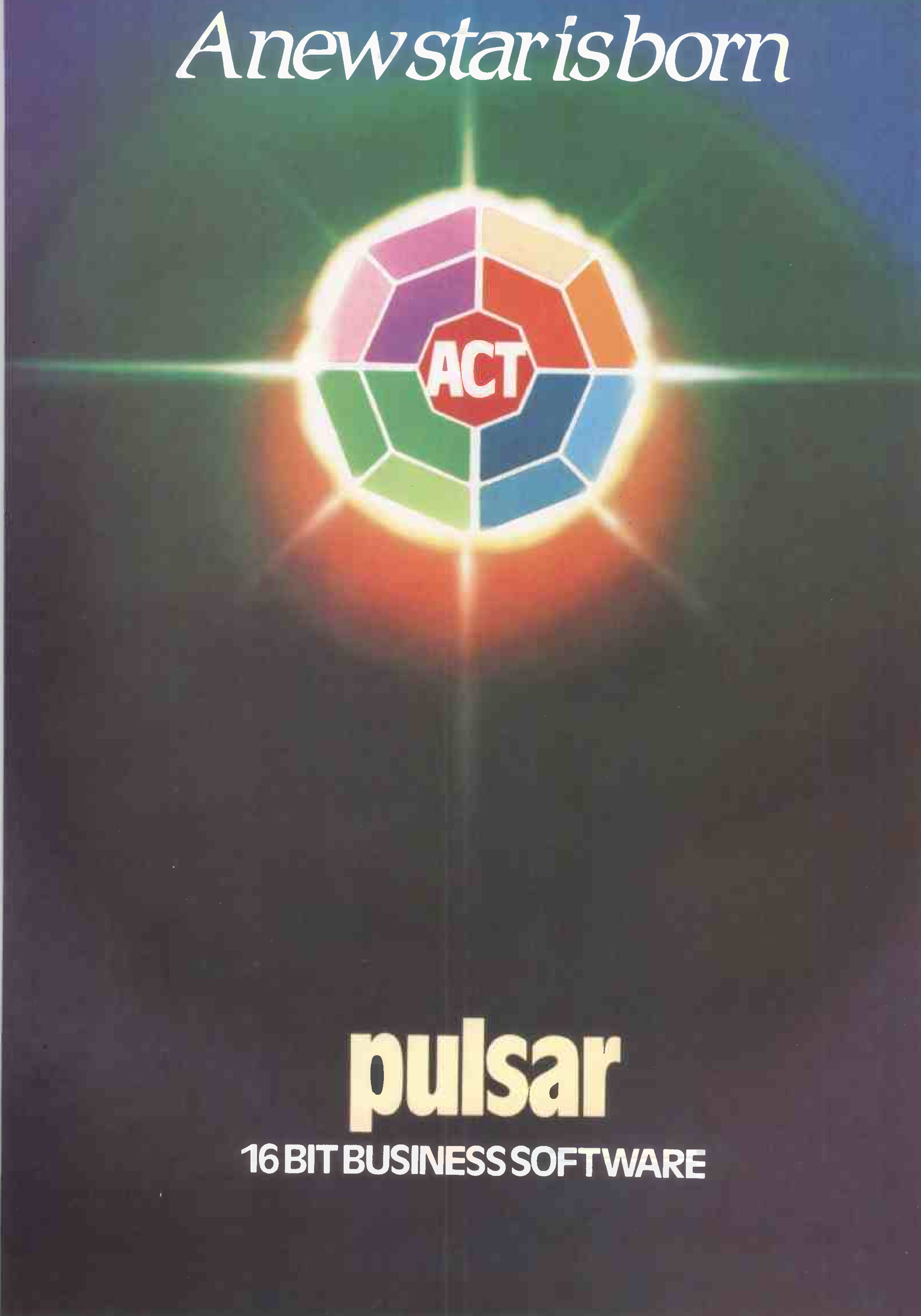
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OLIVETTI M-20

Jack Schofield tests this good-looking office micro built round the Z-8001 16-bit chip.

MOST COMPUTER MANUFACTURERS like to lead, or at least follow, the pack. Hence the proliferation of standard 64K CP/M micros over the last couple of years, and the current flood of 16-bit versions. At first glance the Olivetti M-20 looks as though it is designed to compete with the rest of the pack. On closer examination it looks individual, if not idiosyncratic. As one of the world's leading typewriter, word processor, computer and office-equipment manufacturers, Olivetti obviously feels it can go its own way. The danger is that it may end up going nowhere.

Equipment supplied for test was an L1 M-20 with two 5.25in. floppy-disc drives, black and white screen, and the PR-1450 80-column dot-matrix printer. All of it was made in Italy and to 220/240V standard.

Setting up is extremely simple. The main console includes both the drives and the keyboard. The tiltable VDU screen sits on top and is connected by only one cable, which also carries mains power. The printer is connected in the normal way but needs its own mains plug. Though they are not labelled each one only fits one port so there is no obvious way to connect them wrongly.

Turn on the power using the switch on the back and the M-20 beeps. After about five seconds it invites you to

Insert diskette and type Return

Hopefully even inexperienced users will know this is the key with a bent arrow.

You can insert the system disc in either drive as the M-20 checks both. This is fortunate as you can spend ages hunting through the documentation to find out which is which. As you learn from page 6 of chapter 10, Olivetti has not been boring enough to label the drives A and B, but 0 and 1. Drive 0 is the first drive — the one on the right. Drive 1 is the second drive — the one on the left. What a useful continental system this is.

Obeying instructions produces the systems information. In this case:

Total memory size: 160 Kbytes.
User memory size: 58390 Bytes.
Disk drive(s): 1 Ready.

This is not meant to imply the second drive is down, merely that it does not have a disc in it. It also provides the opportunity for some speculation. Where is the missing 100K?

Rather than equipping its machine with an obviously boring operating system such as MS-DOS, as on the IBM-PC, or CP/M-86 Olivetti has taken the trouble to write its own. Assuming it takes up about 40K, which would be reasonable, then where is the other 60K? Surely PCOS cannot take up 105,808 bytes. Looking at the files reveals PCOS.Sav at 73482 bytes, and PCOS loads Basic as well, incidentally there is a file called Edit. Abs at 19436 Bytes. A 19K editor? Whew!

Typing "basic" — all-lower-case commands are accepted — sends you instantly into PCOS Basic, which provides a user memory of only 34365. Note that this is a machine fitted with a 32K memory-expansion board, yet there is only 33.5K

(continued on next page)

Benchmarks

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Olivetti M-20	1.1	4.0	8.0	8.4	9.2	17.1	26.5	1.2
IBM PC	1.4	5.2	12.1	12.6	13.6	23.5	37.4	3.5
Sirius 1	2.0	7.4	17.0	17.5	19.8	35.4	55.9	42.5

The Z-8001 based Olivetti ran the Benchmarks noticeably quicker than competitive Intel 8088-based machines. Unfortunately we did not have 8086-based and 68000-based micros available for direct comparison, though we will run these tests for a future issue.

OLIVETTI M-20

(continued from previous page)

free to Basic. It certainly makes you wonder about the advantages of buying a 16-bit micro. The 128K version would leave you just 1,939 bytes free to play with, which is only a moderate advance on the ZX-81 and well under the massive 3.5K user RAM provided by the Vic-20.

Presumably Olivetti did not write PCOS for fun but because it could not take MS-DOS or CP/M-86 off the shelf. And Olivetti could not do that because instead of building its 16-bit micro around the popular 8086/8088 microprocessor, the designers chose the obscure Zilog Z-8001.

But starting from scratch has its advantages. Everyone agrees that CP/M is not user friendly and MS-DOS is only slightly less hostile. The way is open to produce something much better, and with 128K of RAM to play with surely the space is there.

Granting that PCOS ought to be wonderful, the actual result is disappointing. Instead of using a friendly, menu-driven system like that on certain home computers and some expensive business machines, PCOS is effectively just like CP/M, only different. In one respect it is better: it uses simple, memorable two-letter commands such as vr for VRename or Rename Volume and fc for FCopy or Copy file. In another respect it is worse — all the things you already know about CP/M become a positive disadvantage. You already know you want Dir, but you have to think of the Olivetti for it. Ah, vl for Volume List.

One of the worst things about CP/M is the error reporting. It tells you things like, to give a famous example,

BDOS ERROR ON B: BAD SECTOR

when it should really say "Close the drive door, dummy" Here again PCOS does not represent much of an improvement. It simply says Error 92. You look this up in the manual. Again it does not say "close drive door" but "command not found — an invalid keyword has been entered". This is annoying, as a valid instruction certainly has been entered — it is just not an error the designers have allowed for.

Anyway, the manual says there are 127 PCOS error codes, and though not all of them are used 28 are given in the manual. They range from Error 7, when the program is too big for the memory available, to Error 111, invalid device name. You can get some puzzling unutilised errors for which there is no explanation. In Basic, but not in PCOS, they are given the additional explanation "unprintable error", which is jolly useful as it saves you looking it up in the manual only to find it isn't there.

Olivetti has provided an extra facility for those users with masses of spare RAM. It is possible to PLoad the Eprint. Sav file, which takes up just over 1K, and which then becomes part of PCOS. This then has the function of adding a little comment to the error number, so you get

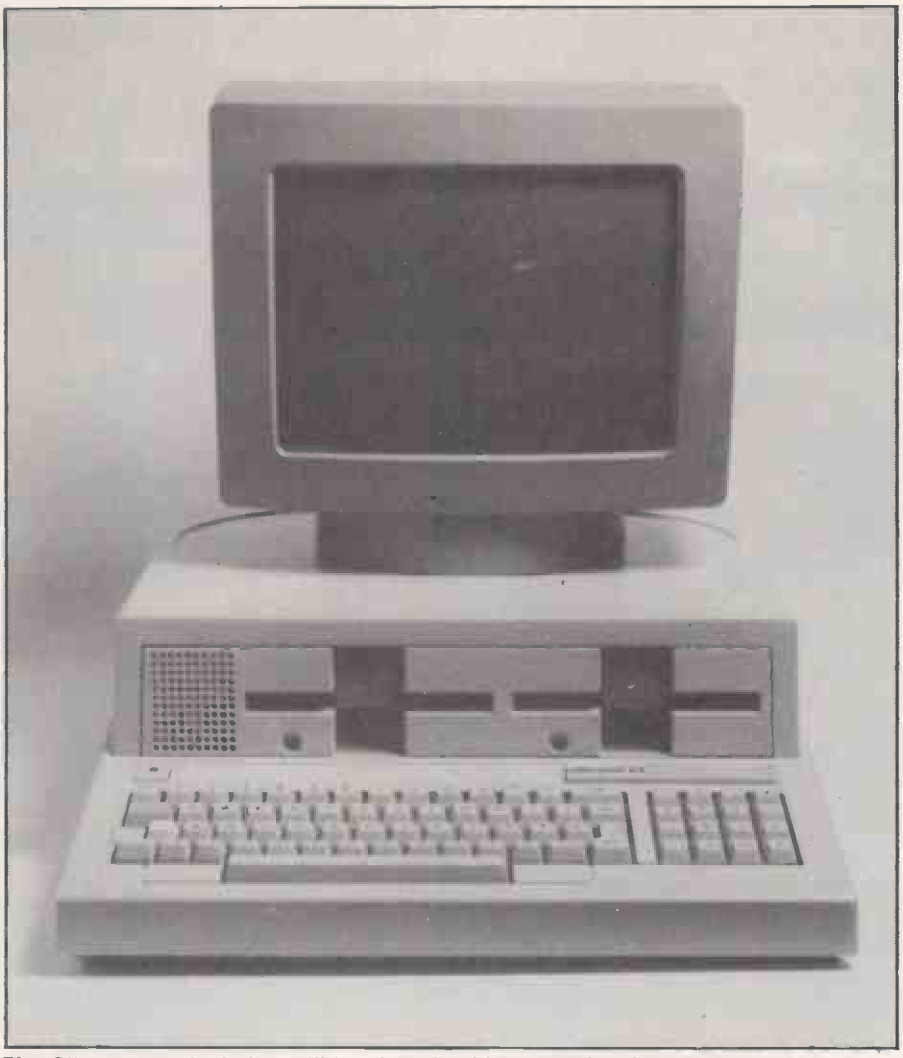
ERROR 92 — command not found

It is possible to type "he", for help, and then key in the error number. The PCOS system disc includes a large number of .Dat files which provide fuller explanations of the error codes without driving you back to the manual.

If all this were part of CP/M it would be wonderful. As part of PCOS it makes the system just about bearable, but in the end error numbers belong to 1979, not 1983.

PCOS does have some good points. For example, our vl will page all the files in order with the number of bytes, number of sectors used and allocated, and other information. Using vq provides a quick CP/M-type listing. Using va provides an alphabetical list — as long as the disc is not write-protected.

It also includes utilities that should prove valuable to the business user. The built-in password-protection scheme is an example. It is very simple to set up the parameters to control Olivetti printers, as you just need to type SForm then enter the parameters.



The Olivetti M-20 includes utilities that should prove valuable to the business user.

Specification

CPU: Z-8001 running at 4MHz
Operating system: PCOS
Memory: 128K RAM expandable to 224K with three 32K boards; as tested — 160K
Bus: five-slot expansion bus
Discs: two 5.25in. with 320K of unformatted storage each; transfer rate 250Kbit/s
Standard interfaces: parallel printer interface: RS-232C serial interface

KEYBOARD
Type: built-in with 72 keys, including 16-key numeric/cursor control pad
Features: auto-repeat on all keys; top row can be used as function keys; Basic language keywords optionally available on ASCII version

DISPLAY
Type: detached 12in. monochrome screen with brightness control
Displays: 64 characters by 16 lines, or 80 by 25 lines; 512 by 256 pixels
Colour: optional

DIMENSIONS
Basic unit: 430 × 519 × 155mm., weight 11kg.
Display: 334 × 310 × 260mm., weight 9kg.

The keyboard is typewriter style with a 16-key numeric keypad added and two curious extra Return keys S1 and S2.

For printer type you just give the number — though one wonders what happens with non-Olivetti models. PCOS provides good facilities for customising both the keyboard and the operating system by adding to it but not, unfortunately, by subtracting from it — so it is suitable for turnkey applications. All you need is an Init.Bas file on your program disc and the M-20 scoots through the system stuff, and Basic, and loads and runs this straight away.

Does the world need PCOS? No it does not, and if Olivetti wants to appeal to the general microenthusiast then the sooner it offers both a CP/M-80 emulator and CP/M-86 the better.

The M-20 is effectively a one-piece unit, though the screen is not actually attached to the top of the console. It is not particularly small, and monopolises a desk in a way that micros with detached keyboards do not.

The keyboard is typewriter style with a 16-key numeric keypad added. The keys have a nice feel and give a positive mechanical click when pressed.

At first the keyboard looks short of programmable function keys. However, the top 12 keys from 1 to ^ are effectively function keys when pressed with either the unlabelled orange Command key or the light-blue unlabelled Control key on the left of the keyboard. Templates can be fitted into two slots just above the keys. A template supplied with the Oliword program includes such functions as Forced Blank, Center and Decimal Tab.

The keys on the numeric keypad may also be programmed and in Oliword can be used for macros via the Learn/Execute utility, but then they can no longer be used as numbers. The 5 on the keypad is the centre of a logical cross-shaped cursor-control pad accessed using the shift key or Ctrl.

The oddest thing about the keyboard is the use of two extra Return keys labelled S1 and S2. They are really function keys and their use varies. In Oliword, S1 becomes Cancel and S2 an auxiliary key for special commands. It is a moot point as to whether this is more trouble than it is worth, as the use is not consistent from package to package.

The keyboard layout is standard English with a £ over the figure 3 and " over the 2. The colon and semicolon are on adjacent keys, which is quite useful. The most inconvenient thing is the lack of an Inst Del, Cancel or simple Backspace key. Deleting a letter means pressing Ctrl-H, which is not a particularly friendly idea.

The screen is very convenient and can be turned or tilted to suit. It has only one control, a brightness adjustment, but the contrast is excellent. The character set is very legible and program lines are well-spaced in Basic, which makes programming a pleasure.

The only flaw was that the cable connector was a loose fit and kept popping out of the console. Also, in certain positions, the fan inside the console would produce a vibrating resonance with the VDU — annoying, but curable by moving the VDU slightly. This is not a problem that has been noted on any other sample of the M-20, and could be due to the unit having been frequently transported.

A colour monitor is also available. It involves the use of one of the expansion slots, and reduces the amount of RAM that can be plugged into 192K.

The Basic-8000 Rev. 1.3 supplied on the system disc appears to be an Olivetti product. However, it is very close to the *de facto* MicroSoft standard — it could well be MicroSoft 5.2 — and offers the same type of string handling — Mid$, Left$ etc.

Commands include TROn and TROff, Auto for line numbering and Renum for renumbering. And it renumbers Gotos and Gosubs. Statements include Def FN, If-Goto-Else and If-Then-Else, Print Using, Swap, On Error Goto and While-Wend. For graphics and screen handling, statements include Circle, Color, Paint, Scale, Window and Close Window.

Scale enables you to switch between a display mode of 64 characters by 16 lines Scale 0,511,0,255, and 80 by 2 — Scale 0,479,0,255. Scale also enables you to set the screen according to your problem co-ordinates, so you can graph things without working out the number of pixels and translating each time.

The only bad thing about the Basic is the error-checking and report, which is only slightly better than PCOS. Errors are not picked up on line entry, and this is a facility which it is unpleasant to live without once you have become used to it. Error reporting is then on the level of

```
Syntax error in 35
```

— your problem, mate. You find it.

Editing is not bad, but not everyone will like it. When the program run throws up an error, the line number is reprinted at the end of the OK prompt. Pressing the space bar then prints out the line, so you can edit it. It saves retyping, but at this point Basic turns nasty. If you want to delete characters, use Ctrl-X; if you want to insert characters, that needs Ctrl-I, if you want to extend the line, that needs Ctrl-X.

If you want to delete the rest of the line then enter the Insert mode, use Ctrl-H — H for hack. And so on and so on, over five pages of the manual. Unfortunately you cannot simply use the cursor-control keys

(continued on next page)

OLIVETTI M-20

(continued from previous page)

to zip up the screen to insert that missing colon or whatever. You have to do it the hard way. It may be good for the soul but it is not good for the temper.

Standard benchmark tests reveal that the Basic is extremely fast at executing the trivial tasks they cover. In practical use, however, the Olivetti does not seem subjectively as fast as, say, the BBC Microcomputer, because disc access appears relatively slower.

The Olivetti supplied for review came with two standard packages: the Oliword word processor, and the popular Multiplan spreadsheet — thankfully not rechristened "Olicalc".

Oliword seems to be unique to Olivetti. Many people like it a lot, but this reviewer is not one of them. As with editing in Basic, it is tedious to actually do anything with it. It is somewhat like WordStar, and the editing is about as horrible as Apple Writer II.

On screen the top nine lines are normally devoted to instructions and function menus. The bottom five lines are devoted to mode, text and system information. This leaves a narrow strip of only nine lines across the middle where you can actually write. A word processor ought either to be as common and familiar as WordStar, or much better. Oliword is neither.

Multiplan seems to be the big software hit of 1983. Practically every major company is implementing this Microsoft program, including IBM, Wang, Apple, Philips and 20 others. It is easy to load by entering mp and pressing Return. After the Olivetti copyright — no mention of Microsoft — the blank spreadsheet appears.

To be different from VisiCalc, commands are entered at the bottom of the screen, using the first letter of any of the 20 options displayed. The initial grid is seven columns by 20 rows. And here is the worst thing about Multicalc: both the columns and rows are numbered, instead of one being numbered and the other lettered. This is because there are 63 columns and 255 rows but only 26 letters in the alphabet — a fact for which one cannot blame MicroSoft. Still, so many people confuse rows and columns anyway, a different notation would help.

One of the many nice things about Multiplan is that it continuously updates a "percentage free" total at the bottom of the screen, so you know when a model is becoming dangerously complex. It has many others, but they are not specific to the M-20, where the program — again, subjectively — does not seem to run quite as fast as on the Wang Professional micro.

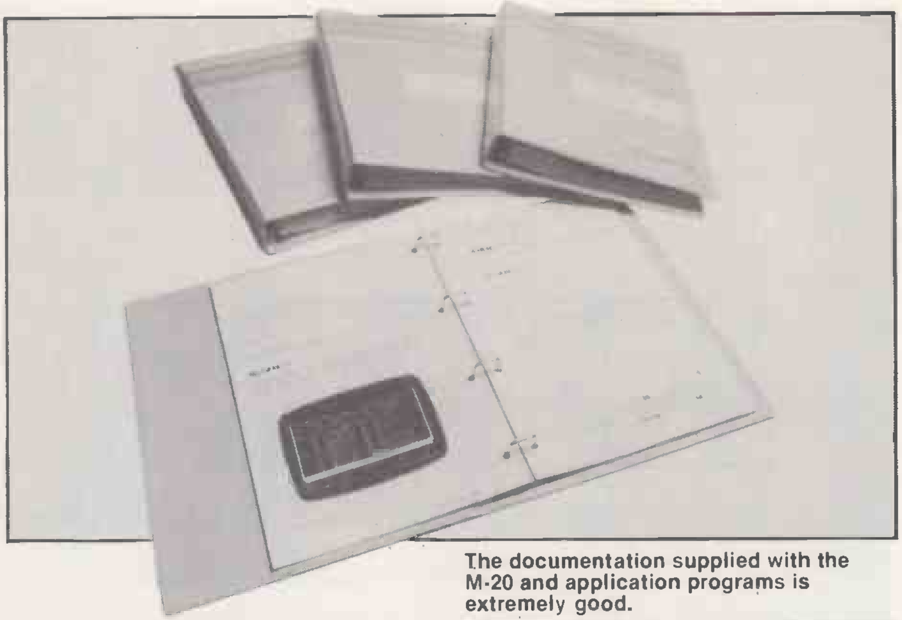
As with Oliword and PCOS, Multiplan comes with a template that slots in above the keyboard and makes it convenient to use the Ctrl and CMD function keys to use the top row as function keys. Functions offered include page movements, word and character movements, Delete and Recalc. Thus Olivetti has not simply implemented Multiplan, but has configured it to use the somewhat limited 72-key keyboard to the full.

Olivetti produces an application guide which lists a large number of other programs of various types. Many are general accounting packages, but some are specialised such as Hotel Billing, Kitplan and Kitcost for kitchens, Windows and DGlaze, Newdist for newsagents and QSuite for Quantity Surveyors. The Olivetti range includes Olientry for data entry, Olispec accounting, Olisort, Olistat, Olimaster and Olitutor. This last named is a self-teaching guide to the M-20 itself, and probably well worth having.

The documentation supplied with the M-20 and application programs is extremely good — certainly among the best there is. It is thorough, well laid out and reasonably accessible. It is aimed at the absolute beginner, which makes it slow and somewhat frustrating for the slightly more knowledgeable. The user who knows, say, CP/M or WordStar could really do with a quick summary of the essential differences without having to search through dozens of pages that explain, in great detail, what everything means.

Pocket reference guides are included with the main manuals, but they are not quite as accessible as the manuals themselves — which defeats the whole purpose of having them. The Oliword quick reference card is good; the Multiplan one incomprehensible. Fortunately Multiplan itself has a good Help facility.

In the main manuals, cross-referencing is excellent but of the four supplied, three lacked an index. With such massive and detailed manuals, an index is a real help.



The documentation supplied with the M-20 and application programs is extremely good.

Conclusions

- **The Olivetti L1 M-20 is attractively styled, solidly constructed and easy to install.**
- **It uses an idiosyncratic operating system, PCOS, which is not likely to prove a strong attraction either to complete beginners or to those familiar with CP/M. With CP/M-86 available and a CP/M-80 emulator it would become a more attractive system. Running only under PCOS it will not attract in numbers the business user who is also a computer enthusiast.**
- **The Basic is fast, but the amount of RAM free to Basic is disappointingly small. The advantages of having a 16-bit machine are by no means obvious from the M-20.**
- **The ergonomics are good and the screen display is excellent, but the built-in keyboard, while no disadvantage in a laboratory or factory, makes the machine intrusive on an office desk top.**
- **The documentation is excellent and makes the machine suitable for a complete beginner. However, a beginner would probably be better off, in the long run, learning on an industry-standard operating system such as CP/M-86 or MS-DOS.**
- **The M-20 could be very attractive to systems houses writing turnkey packages: Olivetti will sell the machine effectively and support the hardware but the software market will be less competitive than for more popular micros such as the IBM PC and Sirius 1. Any software will need to insulate the inexperienced user from the machine.**
- **At £2,395 plus VAT for the twin-floppy version, the price is competitive. A single-floppy and hard-disc versions are also available.**
- **The Olivetti L1 M-20 is distributed by Olivetti, Olivetti House, PO Box 89, 86/88 Upper Richmond Road, London SW15 2UR. Telephone: 01-785 6666.**

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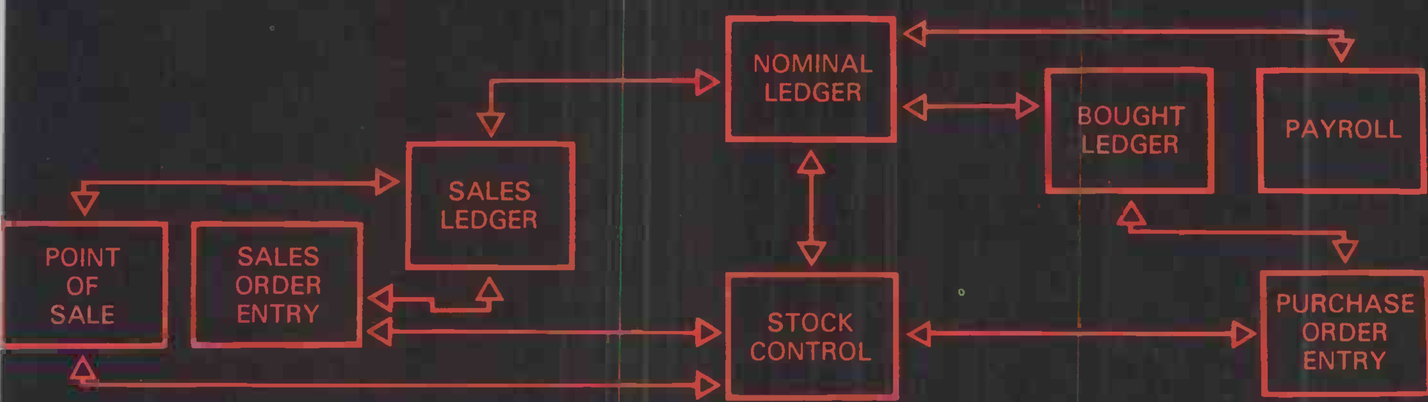

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PC

ORIC 1

Colour, good sound and a price of under £100 make the Oric an attractive beginners' micro.

THE LAUNCH of the Oric 1 comes at a watershed in the development of the micro industry's private subset of English, a language which is called computerspeak. Computerspeak — or if you're really on the ball, ComputerSpeak — has been developed by the people who write press releases, advertising copy and brochures.

It is a language where horrible grotty keyboards are described as "professional"; where £99 microcomputers can be used by businessmen; and where delivery in 28 days means we might get round to sending you a machine one day, but in the meantime we will hang on to your money.

To be fair to the grey faces behind the Oric, they didn't invent Computerspeak. They are, nevertheless, proficient in its use. The Oric looks horrible, which in Computerspeak translates as "superb styling". It does not have a proper keyboard, which is described as "professional". The "comprehensive" user manual is, in fact, impenetrable, and the review machine was supplied with a provisional manual which for a large part was actually wrong.

I could go on, but it would be unfair. Other micro manufacturers are just as bad, but the Oric tops them all by claiming to be "the real computer system". In fact it is a toy.

If the Oric is treated as the toy that it obviously is, it is terrific, except for one thing: the colour does not seem to work on the *Practical Computing* television. These "problems" will be ironed out, says Oric. In fact the new manual is already being sent out, and at least it is correct. Oric says that an adjustment has been made to the TV modulator — which incidently is unique in that it can be programmed — which will result in crisp, sharp pictures on U.K. television sets. A second sample we obtained did, in fact, give bright, attractive colours.

The Oric, though ugly, is very sturdy. It will be able to take the kind of thumping that is commonly associated with microcomputer games. The keyboard, though in no way professional, is vastly superior to that of the Spectrum, which is the Oric's nearest rival. The keys actually depress, but unlike those on the Spectrum they don't make your flesh creep when you touch them. The keyboard is laid out like a typewriter keyboard, with a space-bar and cursor controls in sensible places.

This means that a home computer user could use the Oric as a cheap word-processor, as long as he does not actually know how to type. The keys are more like buttons, and need a firm press. Also they are very small. However, they are suitable for use by a slow two-finger typist.

When each key is pressed it makes a loud blip. This very quickly becomes irritating but it can be turned off by pressing a control character.

There is a word-processor package for the Oric which is due to be released shortly. Designed by John Dawson, it should be usable by a student or a child learning about these matters, and suitable for limited home use.

Specification

Microprocessor: 6502
Memory: 16K or 48K
Keyboard: 57 push-button keys
Sound: three channels across six octaves plus games sounds
Colour: eight colours
Display: 40 characters by 28 lines; high resolution, 240 × 200 points
Ports: TV, RGB monitor, cassette/sound, printer, expansion port.
Price: 16K, £99.95; 48K, £169.95.
Manufacturer: Oric Products International, Coworth Park Mansion, Coworth park, London Road, Sunninghill, Ascot, Berkshire SL5 7SE.

There are four pads under the Oric, to stop the micro from scratching the kitchen table. They also stop it from sliding about.

In addition to a TV output on the rear of the Oric there is a monitor output. This is strange in two ways. First, it has non-standard pin-configuration. Second, who in their right mind would want to pay £200 for a colour monitor when their micro is only worth £99? There might conceivably be a point if the screen resolution warranted it, but that is not the case with the Oric.

Adding a monitor output costs the manufacturer very little, and so the machine might be no cheaper without it, but it is really only a cosmetic addition. Next to the monitor port is a cassette/sound output port. In fact the loudspeaker built into the Oric is loud enough on its own, but some music or sounds might be wanted for sound effects elsewhere.

Still, being able to take sound from the machine and store it in analogue form on tape just might be a good idea, and it does not cost the manufacturer much to add the facility. The main use of this port is for CSave and CLoad operations to tape. The Oric saves at 2,400 baud, with a 300 baud option for greater reliability. Saving the screen contents or machine-code routines is commendably straightforward.

Next to the cassette/sound port is a 20-pin parallel printer port. It should make adding a Centronics-type printer a comparatively simple task. The Oric does not have an

RS-232C compatible port and this is a shame. After all, RS-232 is a fairly standard serial port, and it would be more use than a colour-monitor output to the majority of users.

The bus expansion is 34-pin, allowing access to some of the 6502 bus lines. It is similar to that on the back of the Acorn Atom or the BBC Micro. No doubt this is where the Microdrives will plug in. There do not seem to be any disc-handling commands provided in Basic.

The case can be removed by taking out six screws. Five of them are obvious; the sixth is hidden beneath a sticker which warns that removing the back of the case will invalidate your warranty. Clearly, the maker does not want you to play around with the insides.

Inside the Oric is a 1W speaker, which can make a sound loud enough to wake the neighbours. The Oric really does have excellent games sound, and it should make a substantial difference to any game.

When an explosion really sounds like an explosion, and a zap sounds like a zap, you begin to realise that you are close to what microcomputers in the home are all about. It is one thing to spend an evening in front of a colour television giving yourself a backache and severe eye strain playing Space Invaders. Being able to go deaf to boot is something else.

In addition to the sound effects accessible from Basic — namely Zap, Shoot, Explode and Ping — there are three more music commands which are more powerful than any to be seen on cheap micros.

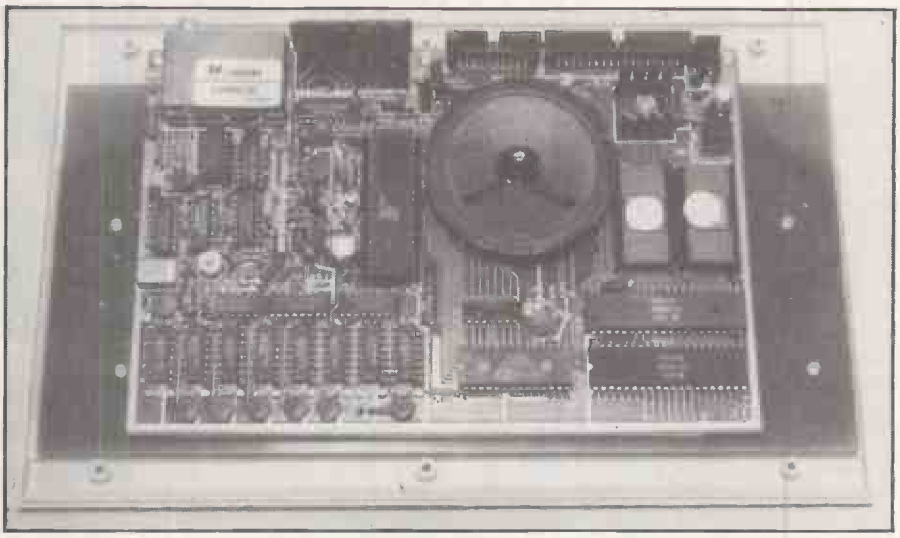
Sound is followed by three parameters: Channel, Period and Volume. There are three channels and they can have any value between 1 and 6: 1, 2 and 3 give pure, musical tones, while 4, 5 and 6 mix the tone channels with a dose of noise.

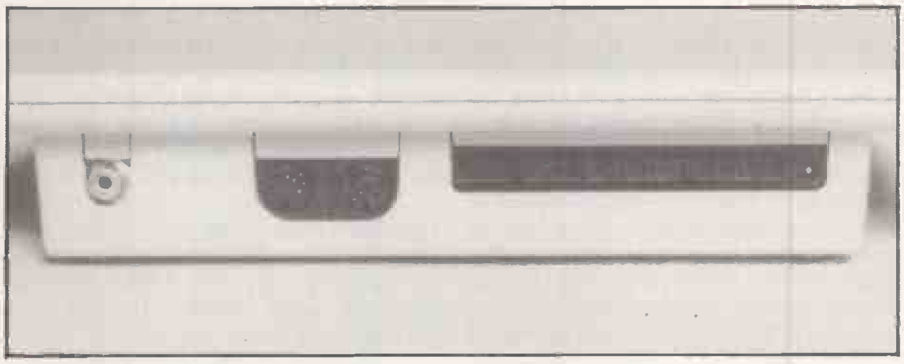
The command Music is used to create music of a sort, as opposed to mere sounds. The command allows you to set notes, their octaves and volumes. The Play command has an envelope parameter which allows some interesting sounds to be created easily. As a synthesiser system the Oric is a good, cheap introduction.

The graphics on the Oric were difficult to use, and the manual did not help much either. The difficulty may have something to do with Oric's Prestel adaptor origins. Although the graphics are fast, there is not much that can be done with them, and compared with other micros they are not very powerful.

In most respects the Tangerine Basic supplied with the Oric is of the standard Microsoft type. String handling uses the Left$, Right$ and Mid$ conventions, rather than string slicing. If-Then-Else is the only real extension to standard Basic.

The other extras are of the games and graphics type. As well as those already mentioned, colour and graphics commands include Draw, Fill, Pattern, Circle, Ink and Paper. As well as the standard text mode, you can have double-height, flashing characters and user-defined characters.





To reach the high-resolution mode, type Hires. It gives a screen 240 points across by 200 points down, with a three-line text window at the bottom. The similar four-line text window you can have with the Apple and Atari micros is easy to remove, but how it can be done with the Oric remains a mystery.

If you plan to stay in the text mode, typing Grab grabs some of the RAM reserved for high-resolution graphics. On powering up, the Oric claims to have 47,870 bytes free, on the 48K version, with 39,421 bytes free to Basic. Typing Grab provides an extra 7,167 bytes. The Oric's RAM figures are more honest than is now often the case.

The main problem with Basic is the editing, which is pathetic — so bad in fact that rewriting a line is often quicker. All that Control-A-ing becomes a bit much after a while. What is worse, once a change has been made it is impossible to just hit Return; you have to use Control-A again.

One moan about the final manual. It is insubstantial, illogical and lacks an index. It is better than the provisional manual, but it is still not much of a help, especially to people who know nothing about computing. And they are the people who are, after all, most likely to buy the machine.

Conclusions

- **The Oric is the cheapest home micro that offers colour and sound. The sound is far better than the Spectrum sound and one of the Oric's best points.**
- **The keyboard in not professional, and poor for word processing, but again it is better than the Spectrum's offering.**
- **While there is no software available, as the Oric uses the popular 6502 many games should soon be converted to run on it. The Spectrum has the advantage that masses of software already exists.**
- **The Oric is not suitable for business use. Because of the poor manual it is not as effective as it should be as a learning micro for beginners.**
- **It would appear that the main design criterion was price, and consequently an inferior machine has been produced. For a little more money, a joystick port — and perhaps an RS-232C port — would have been worth having.**
- **The Oric undercuts the Spectrum, and should give Sinclair Research a run for its money.**

CIFER SERIES 1

Cifer has planned and plotted a machine in a market of its own. Chris Bidmead investigates the degree of the designers' success.

CIFER SYSTEMS of Melksham, Wiltshire — not to be confused with Cipher Data Products Inc of Camberly, Surrey — has established a reputation for high-quality intelligent terminals. The series 1 range of microcomputers is a newish departure for Cipher — "newish", because over recent years Cifer-watchers have noticed the intelligence of the terminals increasing to the point where the production of a Cifer stand-alone micro was obviously becoming inevitable.

To all intents and purposes this point was reached at the beginning of 1982 with the introduction of the 2780 range. Yet with up to 256K of internal RAM, not one but three Z-80 microprocessors, an independent graphics board and 12Mbyte hard disc running CP/M, the 2780s were still only very, very intelligent terminals as far as Cifer's marketing department was concerned.

This reluctance to call a spade a bloody shovel had a purpose. Marketing Manager Stuart Gregory and his team have no intention of being caught up in the rush to produce more and more, cheaper and cheaper standard general-purpose micros. According to them it is only a matter of months before the Japanese will be shipping take-away dual-floppy machines to retail at around £500. Having successfully applied the old Harvard Business School adage to stay clear of the competition, by producing its own brand of up-market, customisable product, Cifer has been plotting its overt entry into micros with a good deal of caution.

The machine Cifer is at last officially describing as a micro has identifiable Cifer qualities. It is well made, well designed, immensely flexible — and expensive. If this combination reminds you of a certain trans-atlantic duo who made their name in calculators, the comparison goes deeper yet. For the Series 1 comes in a size described in marketing circles a Executive Desktop. It's small. The same sort of size as, dare we say, the current desk-top machines from Messrs Hewlett and Packard.

To be precise the case stands only 25cm. high, and takes up just 45cm. by 40cm. of desk space, with an extra 45cm. by 24cm. for the slim, detachable keyboard. Inside these lilliputian confines the Series 1 is able to cram all the hardware of the enhanced 2780 series as well as a Teac soft-sectored mini-floppy drive with a formatted capacity of 800K.

This compression is achieved in two ways. Firstly the screen is smaller than Cifer users have come to expect at 10in. diagonally rather than 12in., making room for two drives to the right of the screen and saving an enormous amount of volume at the rear of the tube. Secondly the component to air-space ratio, generous in the 2600 range of terminals, is pushed very tight, though the filtered fan seems to cope

adequately with cooling. It would be foolish to jump to conclusions, but personally I would feel easier with more air in the box.

The logical architecture is profoundly different from the run-of-the-mill CP/M micro. The Series 1 is really more a unified local area network than a single-processor machine. You will not be far off if you think of it as four separate subsystems: a screen, central processor and core memory, graphics, and the disc system. Each is autonomous and intelligent and capable of communicating with any or all of the others by way of the IEEE-488 bus which links them. Managing communication along the bus is the responsibility of an internal operating system called Ciops. Ciops is the true resident operating systems, CP/M being loaded in on top of it as a visitor.

The fifth and very important element is the package of CP/M utilities developed in-house by Cifer. They are .Com files — often with explanatory .Doc files — that are identified by names preceded with &. Their presence helps to make the Series 1 a system rather than just another micro.

The manual that arrived with the machine, intended for OEM's and development houses, is a formidable three days had study. Readability is not helped by it being an update, complete with insert pages and emendations, of the documentation for the 2680 range of machines. Like other Cifer documentation is it printed in dense dot-matrix format that suggests the rough draft of a Russian novel.

Overcome this initial impression and you will find the manual intelligently sectionalised, with detailed discussions under clear subheadings followed by tabulated data in appendices for subsequent reference. Tables of contents precede the sections and a comprehensive index brings up the rear. One section provides an overview of the CP/M manuals and offers some useful tips. For example, the standard CP/M utility Ed.Com requires the insert command i to be keyed as lower case, otherwise all subsequent text will be written to disc as upper case, however it looks on the screen. This is not made clear in Digital Research's documentation, so Cifer provides the warning. Would that all CP/M computer manufacturers knew the CP/M software environment this well.

However well the contents stand up to scrutiny, in practice you need three hands to hold it open. The whole 3kg. of manual bulges out of the standard Cifer floppy cardboard cover, its uncountable and unnumbered pages held together with a twopenny wire clip. I give it three for presentation, nine for content and a big round zero for star quality.

The hardware itself is a quite different proposition. It looks, feels and even smells like a star. The keyboard has a slightly soft touch that spells luxury, but might take a little getting used to, particularly if you have been brought up on the IBM layout.

I object to the arrangement for repeating characters by way of a separate Repeat key,

Some models include a 10Mbyte Winchester as well as floppies.

which is awkwardly placed between the right-hand Shift key and the Delete key, rather than just holding down any old character you want to machine-gun across the screen. There is a perfectly respectable reason why Cifer does it this way — it minimises the demands made on the central processor in multi-user environments — but if you are used to auto-repeat on every character key you will miss the facility. If you buy a Cifer, a separate repeat key is what you get, but keyboard design is important, at least until voice entry comes along and offices are filled with the sound operators shouting at their screens, trying to nudge cursors to the right position: "Left a bit, bit more, now down . . . "

On the positive side the Series 1 keyboard is very reconfigurable indeed. There are only three function keys as such, but the whole top row of 20 keys, dedicated to terminal functions like dumping to the printer, local screen editing, toggling graphics and so forth, can have alternative user functions downloaded into them, as can the right-hand numeric keypad and its associated cursor keys.

The display is a pale, rather acid green with clear, stable characters that are very easy on the eye, though the size of the screen struck users in this office as not really suitable for sustained use through the working day. Matters are not helped by a slight tendency for the image to jolt when the adjacent Winchester hard disc whirrs into action.

One very useful feature is the ability of the internal screen memory to hold seven screenfuls of text quite independently of the disc subsystem that drives it. You can scroll back and reread vanished data, or even edit it using the local edit keys and write it back to a file using Pip.

The screen allows several forms of highlighting: inverted, half-intensity, blinking, double-size, underlining and more; and these characteristics can be combined. For general use, in WordStar or the various CP/M Visiclones say, half-intensity in conjuction with inverted video makes a restful way of differentiating sections of the screen.

Additionally, protected fields may be set up that are immune to destruction by the cursor. Data-entry programs that call this feature will have to be specially written; ordinary commercial packages like DataStar have their own way of creating protected fields that do not depend on clever hardware.

Like the 2600 range of terminals — from which the Series 1's features are derived — the screen optionally displays an inverted, low-intensity 25th line that shows the status of the screen subsystem. It indicates such things as cursor position by row and column, data communication speed and protocol with the slave printer, whether the numeric keypad has been switched to its alternative function key mode, and so forth. Unlike the 2600 terminals the screen intensity can be changed through dialogue with the status line. A simple escape sequence directed at the screen is all that is necessary to dispose of this line, or replace it with a programmed message.

But this is only half the story as far as the screen is concerned because the physical display can also be driven simultaneously from the graphics board. Two games supplied to demonstrate this feature are downloaded from the disc system. The graphics is high resolution, smooth and fast, and can overlay pictures on the screen text quite independently from the disc subsystem.

The screen facilities are illustrated rather usefully by a Cifer program called &GClock, which sets and maintains a moving representation of an analogue clock-face. The intensity of the picture can be dimmed to background level and be left to tick away the seconds to the next coffee break while WordStar, directories or whatever go scrolling by.

The 256K of internal RAM on the main processor board presented somthing of a puzzle at first, as none of the software that came with the machine was able to access it. The documentation that arrived later explained all: Cifer has its sights on MP/M and CP/M 3, to be launched shortly by Digital Research as CP/M Plus.

Cifer's implementation of MP/M exists already, although we were not able to test it, and here the 256K of RAM is bank switched in 48K segments in the conventional way, with bank-identifying values being sent to a control port. In many respects the RAM behaves just as if it were so many separate S-100 boards. But the configuration is softer than this: a 256-by-eight static-RAM chip maps the memory area into 32 2K blocks, allowing software-changeable bank sizes and the possibility of write-protecting areas of memory.

There are five boards in all. A sandwiched pair comprise the disc subsystem that looks after the Teac and Rodime drives, and three other cards contain the screen system, the main CPU electronics and the graphics components.

There are a lot of chips — we counted 150 and then gave up. All those on the the main boards are socketed rather than soldered in, an expensive construction method adopted by manufacturers who take servicability seriously. I regard it as a mark of high-class merchandise. Other Cifer products show the same fondness for socketing.

The memories are state-of-the-art Texas

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CIFER SERIES 1

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4164 64K RAMs. The top graphics and disc boards have eight of them each making 64K, and the main CPU board has an impressive four-by-eight array of them, providing 256K in all. Zilog or Zilog second-source peripheral chips — Darts, SIOs, PIOs and DMAs — are used extensively. They support internal data transfer and external transactions though the single IEEE-488 socket for an additional Winchester drive, and the four 25-way D-type connectors at the rear of the machine. One of these, rather confusingly, is actually a Centronics parallel interface; the remainder are regular RS-232.

A fifth rear socket allows extra floppy drives to be daisychained on. As the ability to mix'n'match a very large number of different disc formats is an important feature of the machine, Cifer supplied us with external 8in. slim-line drives housed in a handsome, long black box to supplement the single built-in 5.25in. drive.

Head size on the 8in. drives means that in single-density mode they are only able to read, not write, and there is the obvious physical limitation that the drives require the discs to be soft-sectored. But within these constraints, aided by a Cifer systems utility called &SDef, the machine can handle combinations of 20 different disc formats, including IBM-standard single-density 8in., Superbrain and Televideo.

By tweaking variables in the interface between CP/M and Ciops, &SDef not only alters the disc parameters, but can also juggle with the logical-to-physical mappings. It is up to you, for example, whether drive A: is the hard disc or one of the peripheral 8in. discs.

Two features seem to be missing, however. There is no way of splitting the hard disc into a pair of logical drives — much the best way to handle a 12Mbyte Winnie for most ordinary applications — and there appeared to be no possibility of addressing the same physical drives as different formats under different CP/M drive names. On some systems, for example, the same pair of 8in. drives can be A: and B: and look like standard single density, or be C: and D: in which case they become double density. Format change always has to be made explicitly by way of &Set.

&SDef is one of a number of Cifer utilities that help the user to tap the power of the machine's unusual features. Another is &Veri, a file-compare program that takes the names of two files that may or may not be the same and hex dumps them to the screen a record at a time with the non-matching bytes highlighted; &MVeri is a multiple file-comparison utility that will look at a pair of drives and tell you whether files with the same name are, in fact, the same files — very useful for a fast check of updates and back-ups.

&Eraq works like MP/M's Eraq to provide rapid query and response erasure of families of files. &Form draws screen forms and stores them as text files, &FK simplifies the business of downloading functions into the keyboard, and &Backup in conjunction with &Restore is a Winchester disc back-up utility that is capable of splitting large files between floppies and joining them together again if the back-up needs to be reloaded.

&Set works a little like Stat in its IOByte mode, establishing linkages between logical I/O devices and their physical implementations. But it goes a lot further than the ordinary CP/M utility in offering many more linkage options and fanning out linkages. The LPT: device, for example, becomes two or even three output ports simultaneously, and &Set can change input and output protocols.

&Format, as you might expect, initialises blank discs for use with the system, but turned out to have an odd bug. When formatting a disc in drive B: — the internal floppy in the configuration we were using — this drive became drives A: and B: on existing from the program, and the Winchester could only be accessed by rebooting.

With this minor exception all the foregoing programs worked as documented, but I was not so lucky with &Xfer, which is designed to manage the transfer of text files between machines. I just could not get it to do anything. Cifer says that &Xfer is in its early version, although it is perfectly possible that the problems encountered were hardware bugs in the external non-Cifer equipment, or just stupidity on my part.

Cifer is following a route parallel to Televideo's, from smart terminals to stand-alone micros, but its software department has clearly been keeping abreast of things. With these additional &*.Com utilities Cifer's implementation of CP/M matches the very high quality of the hardware.

To balance my enthusiasm for the product as a whole I should list a number of minor dislikes about the machine. To start with the most trivial, although booting up is very flexible — W to boot on the Winchester; 0,1,2, or 3 to boot on the floppy drives; an empty Return to seek a system on each of the drives in turn, and ? for a Help screen to explain the booting procedure — there is a silly inconsistency: the W requires a Carriage Return.

The excellent Rodime drives occasionally give out a bright chirruping sound that would be good news from a canary, but sound to anyone with an ear for machinery as if a bearing is about to burn out. It isn't and doesn't, in fact, and the sound soon goes away again. I've noticed the same effect in other Rodimes in other machines, and I suppose it's no more than resonance in the casing.

My biggest, though still minor objection is that the clever "operating system within an operating system" idea slugs Winchester disc access time. Subjectively it seems to be something like twice to three times as slow as I have become used to on an almost identical Rodime drive in the Almarc Series 8. Admittedly the Almarc machine does not allow the sophisticated route mapping of the Cipher, but I would be inclined to trade speed for sophistication for the applications, which are mostly text manipulation, that go on in this office.

A partial answer is provided by Cifer in the shape of a number of alternative CP/M implementations of various sizes and smartnesses, offered as Sysgenable files. Only one of these smaller and faster alternatives supports the Winchester. It offers a 53.75K TPA as opposed to the 50.75K TPA of the full CP/M version, but sacrifices the ability to switch the disc formats or alter the external port baud rate. It also eliminates the Centronics port, and is still noticeably slower than the uncluttered Almarc implementation. But if you are used to floppies the Cipher is still very fast.

Series 1 systems

Model 1886: two 5.25in. floppies, 64K RAM, CP/M 2.2, price £2,795.

Model 1887: one 5.25in floppy, one 10Mbyte Winchester, 128K RAM, CP/M 3, IEEE-488 interface, price £4,995.

Model 1888: three 5.25in floppies, 64K RAM, CP/M 2.2, price £3,245.

Model 1889: as model 1887 with one extra floppy, price £5,395.

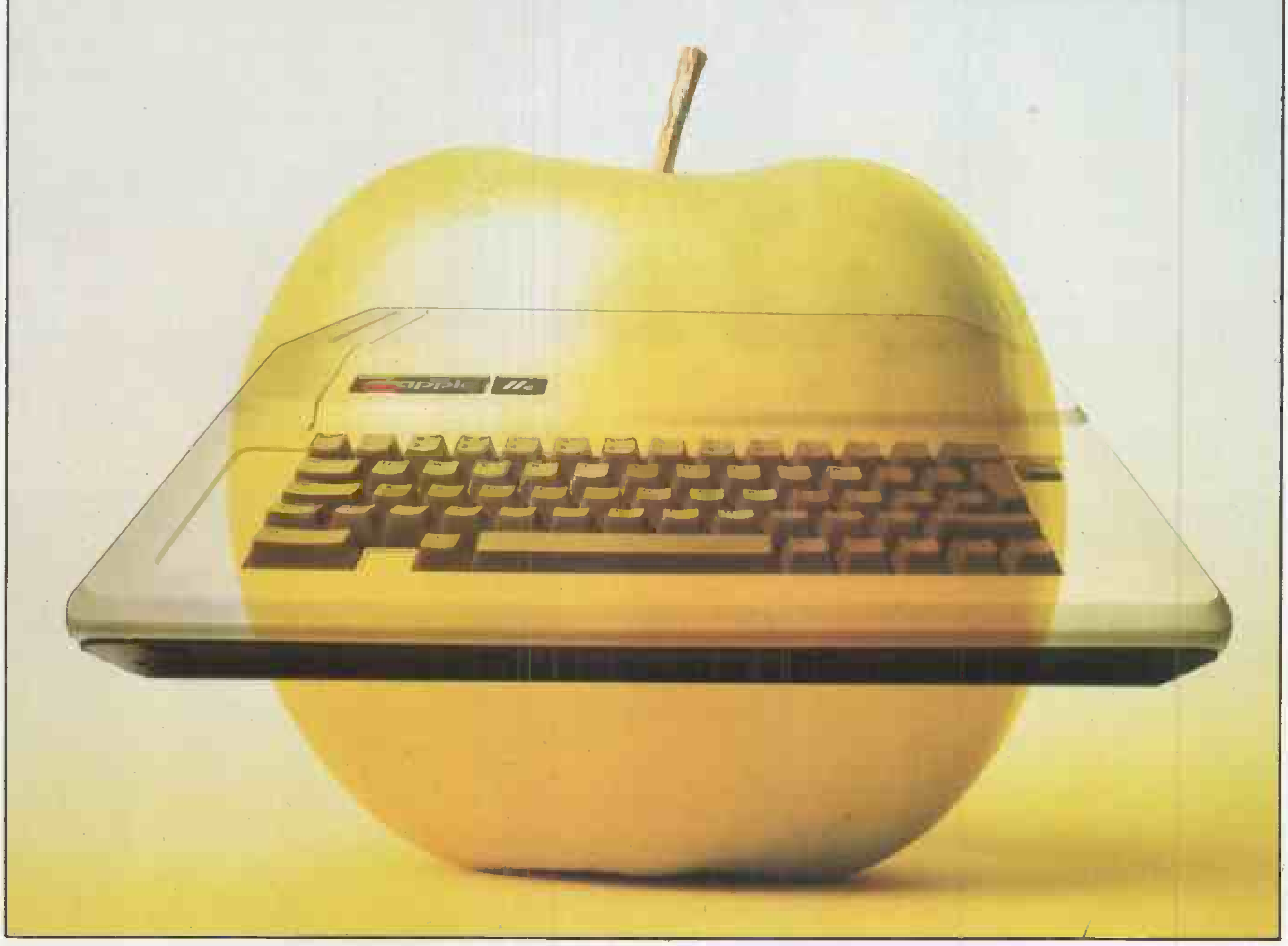
High-resolution graphics, extra RAM, MC-68000 processor, 21Mbyte Winchester, MP/M and Unix are all available as options at extra cost.

Conclusions

- **This computer is a very compact and extremely comprehensive eight-bit machine. The screen size is probably too small for day-long work, but outputs are provided to other terminals or to a video display.**
- **It comes with CP/M in several sizes, offering access to a great deal of commercial software. But essentially CP/M acts as the outer shell to the hardware-dependent Ciops operating system with some overhead in speed of execution.**
- **The provision to read and write to a variety of different disc formats makes it a useful machine for software houses. Unfortunately the configuration we tested was not able to write to 8in. discs in single-density format.**
- **It is made in the U.K. and Cifer is in a position to offer excellent support.**
- **The Cifer Series 1 is a beautifully made, beautifully designed eight-bit machine.**
- **For information contact Cipher Systems. Telephone: Bath (0225) 706361.**

APPLE IIe

The old workhorse lives on in a new incarnation. Roger Cullis put it through its paces.



DURING THE LAST year or so manufacturers have used developments in microcomputing technology to give us more powerful machines at the same price as a standard eight-bit, 64K computer. The ACT Sirius and the IBM Personal Computer and all its look-alikes, have been made possible by increased packing density and the increased complexity of chips. Apple, instead of jumping on the 16-bit bandwagon, has applied the improvements to a well-tried and successful formula. The result is the Apple IIe, best described as a state-of-the-art Apple II.

Over half-a-million sales demonstrate that Apple got it right the first time. The product spawned a whole satellite industry engaged in manufacturing peripherals and writing software for every conceivable application. Apple has proved convincingly that software sells hardware and will also sell peripheral hardware designed for special purposes. With a ready-made base of applications packages there was no reason to break new ground.

It is apparent that Apple has gone to great lengths to ensure that the new computer is compatible with its predecessor, even to the extent of perpetuating hardware compromises which are a legacy from the days when 4K RAM chips cost as much as 64K chips do now.

Apple has drastically reduced the number of chips, a factor which will both increase reliability and ultimately permit a significant reduction in the selling price. New features such as built-in diagnostics, lower-case text and extra cursor controls make the IIe even more attractive to the business user.

For the uninitiated, the Apple II is an eight-bit microcomputer based on the 6502 processor chip, which has a 64K addressing capability. It was originally launched in 1977 with a rather limited integer Basic interpreter. Subsequently it was replaced by Applesoft, a floating-point Basic written by Microsoft. Versions of the computer with Applesoft resident in ROM were known as the Apple II Plus. Since then there has been a whole range of internal revisions, transparent to the user as they do not affect his software.

A 16K RAM card means that additional RAM, mapped into the address space occupied by the interpreter ROM, permits an additional language to be loaded from disc. An alternative Basic to that present in ROM is provided as standard on the Systems Master Disc, but other languages such as UCSD-p and Fortran are also available.

A feature of the motherboard is the provision of a number of 50-way printed-circuit edge-connector sockets for expansion cards. The first available cards were produced by Apple and added disc controllers and serial/parallel interfaces. Independent manufacturers quickly devel-

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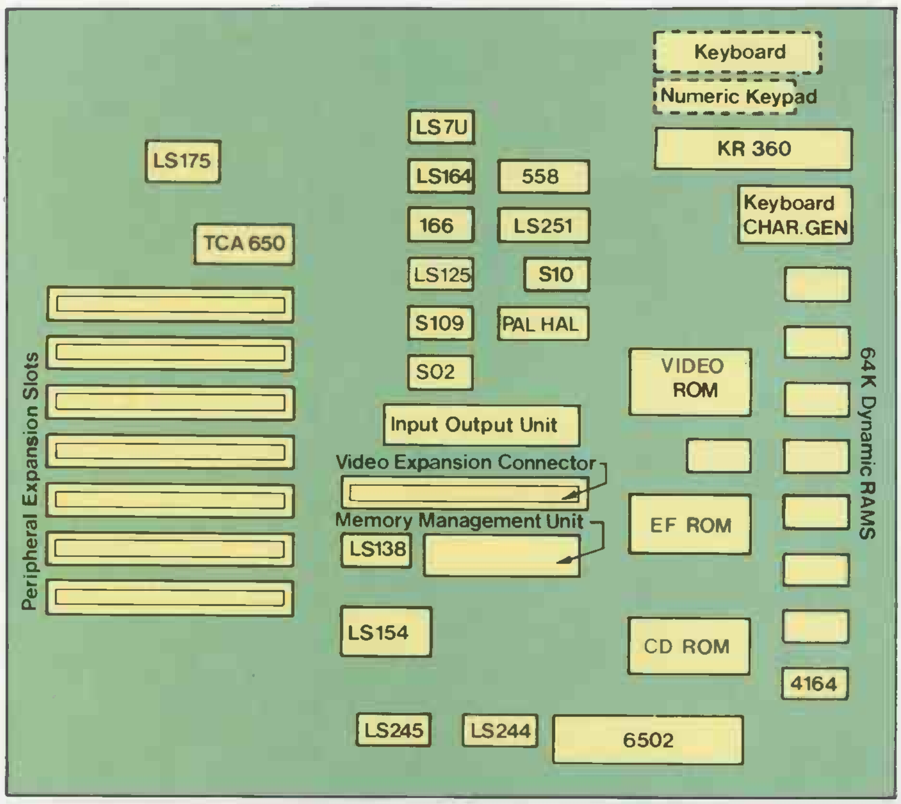

APPLE

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oped other devices — ranging from the esoteric exemplified by the Mountain Hardware Supertalker, the Heuristics Speech Recognition Card and the Alpha Syntauri synthesiser, to more general applications including Modems, buffered printer drivers and 80-column monitor display controllers. Several manufacturers have produced cards with alternative processor chips, using the Apple's 6502 for keyboard, I/O control and other house-keeping duties. The most significant of these are Z-80 boards, which enable Apple users to run the CP/M operating system and hence make available an extensive range of applications software.

From the outside the IIe could easily be mistaken for an Apple II. The case is the same both in size and shape, and the colour is virtually identical although the keyboard is lighter. It is the keyboard that provides the first indication that there is a different beast beneath the outer skin. The space bar is shorter and several new keys have appeared.

These perform mainly conventional functions such as Delete and Tab or provide ASCII characters like | and [, which were not present on the original Apple II, but two are unique.

At each end of a shortened space bar is a special key, the one on the left bearing an outline Apple symbol and the one on the right a filled apple. These keys are connected to one-bit game inputs and can be used as conventional games controls, say, to fire laser cannons or more mundanely in a custom graphics program to switch to an alternative mode, or make a back-up copy of a high-resolution screen.

When used in conjunction with the Control and Reset keys the open apple initiates a cold boot; the closed Apple starts a self-test using built-in diagnostics routines. If everything is functioning satisfactorily it responds with the message "Memory OK". During the cold boot routine the IIe carries out a partial memory wipe, a feature which has been introduced because many software vendors used it to protect programs run on the II Plus.

Cursor up and down keys have been added, although the Escape commands which perform those functions on the II Plus may still be implemented. The Apple II is gradually accumulating a proliferation of ways of moving the cursor, since the II Plus in turn had inherited four Escape commands for this purpose from the original II.

The Reset key has been moved to a less vulnerable position slightly away from the main bank of keys. It is lower and must be used in conjunction with the Control key to perform a warm boot, in contrast with the original Apple II where Reset could be, and frequently was, operated accidentally. In the later revisions of the II Plus the dual-key operation was an option selected by a switch on the keyboard encoder printed-circuit card.

Apart from the provision of additional characters many of the ancillary symbols have been moved. For example, the inverted commas and the apostrophe have deserted the 2 and the 7 and have joined forces on a new key next to Return, while the & is now to be found above the 7 instead of the 6. It will provide no difficulty for new users or those accustomed to the ISO standard keyboard layout, but owners of the II or II Plus will have to stop and think when they are using a IIe.

Although it is not difficult to make the change there may be mis-keying problems when the IIe is installed beside the old machine. Ergonomically it would be better if the IIe were a different colour, to provide a visual stimulus when changing from one to the other.

Apple could have made more use of the switch which it thoughtfully installed on the underside of the case for selecting the ISO standard or an alternative national keyboard. To cater for the requirements of different languages, there are some 22 different arrangements of the keys, the corresponding character set being defined by a ROM on the motherboard. It would presumably be a relatively simple matter to emulate the layout of the II Plus as the alternative character set.

The Repeat key has disappeared. All of the keys now have auto-repeat — a welcome improvement.

The previous Apple had a random array of ribbon cables, which meandered from cards in the expansion slots, through slits in the back of the case, to devices such as disc drives and printers which were in separate boxes. Moving the computer was an exercise in logistics, often requiring the removal of peripheral cards. Apart from the damage which could be sustained by the card, particularly those containing MOS chips, frequent removal and insertion of the cards sometimes causes hairline cracks in the motherboard printed circuit — with obvious results.

The IIe has overcome the problem with a new sheet-metal back punched with holes ready to take Cannon D-type and other connector sockets. Peripherals can now be plugged in at will using a robust sheathed cable. If a more permanent connection is desired it can be held in place with retaining screws, which prevent accidental displacement.

On opening the lid the first impression is one of emptiness. The motherboard indicates the changes in semiconductor device technology since the II was first launched. Although with 89 capacitors, six transistors and 43 resistors the discrete component count has not been changed unduly, a mere 40 integrated circuits have replaced the 85 or so chips on the old motherboard.

Nowadays memories are made of 64Kbit or larger dynamic RAMs, so the equivalent of an Apple II motherboard RAM and a 16Kbyte language card is to be found in the eight chips at the bottom edge of the printed circuit. Gone, too, are the D0, D8, E0, E8, F0 and F8 ROM which have been with us in various forms since the beginning.

In their place are three large 2364 ROM chips: the Memory Management Unit or MMU; the Input/Output Unit or IOU — no cracks about cycle stealing please; and Programmed Array Logic or PAL — not to be confused with the European standard colour TV circuits which are elsewhere; and two smaller ones, the keyboard decoder and the character generator. For the decoder a 2316 suffices, but for the character generator a 2332 has been chosen to permit straight-through bit-mapping for the graphics modes, but avoiding the need for additional switching circuitry.

The keyboard has no piggyback encoder PCB, but is connected directly to the motherboard via a ribbon cable and 25-way connector. A useful new feature is provision for the connection of a numeric keypad, an optional extra. With a basic microcomputer like the IIe, this increases the flexibility of the machine and is in keeping with the modular approach which Apple has adopted. Here it is particularly convenient because the keypad can be customised for a specific application, such as VisiCalc or word processing.

It is even feasible to plug in different keypads on different occasions, and we may expect to see peripheral suppliers including a keypad as well as a disc and expansion card with their applications packages. Full upper and lower case are present, but the Apple II can be emulated using the Caps Lock key.

The other internal change which is immediately apparent is the translation of slot 0 to a different position. In the process it has gained an extra 10 connections and has been renamed the video expansion connector. Slot 0 was the traditional home of the Apple language card, but since in the IIe the extra 16K is now provided in the motherboard RAM, its main purpose has disappeared.

Apple has made provision for an 80-column display by launching a new 80-column text card and an extended 80-column text card, either of which plugs into the video expansion connector. The two

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Specification

Microprocessor: 6502A eight-bit data, 16-bit address bus
Operating system: Apple DOS 3.3
Memory; 64K dynamic RAM, 16K bank-switched with ROM
16K ROM
additional 1K RAM with 80-column card
additional 64K RAM with extended 80-column card
Disc storage: single-sided, soft-sectored 143K per disc
two drive-controller card plugs into expansion slot.
Keyboard:
ISO standard with 63 keys
optional plug-in keypad
Display:
40 character x 24 lines text
80 character x 24 lines text with 80-column card
40 x 48 pixel 16-colour low-resolution graphics.
192 x 280 pixel six-colour high-resolution graphics
192 x 560 pixel six-colour high-resolution graphics with optional 80-column card
Dimensions: height × width × depth
100 × 385 × 450 mm
Prices:
Apple IIe with 64K RAM, £845
80-column card, £80
extended 80-column card, £180
disc drive with controller card, £345
dot-matrix printer, £425
daisywheel printer, £1,350

APPLE

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cards simply add 80-column text display and, unlike existing pripheral cards such as the Screen-Master 80 or the Comms-Master 4880 which plug into slot 3, do not support high-resolution graphics or terminal emulation.

When either of the 80-column cards is installed in the video expansion connector, it is not possible to use a peripheral card with on-board firmware in slot 3. In 80-column operation a high-resolution monitor with at least 14MHz bandwidth is needed to achieve a satisfactory performance; otherwise it functions in a similar manner to the 40-column text mode. Upper and lower cases in normal and inverse modes are available, but flashing characters are not implemented.

The IIe carries a Pal encoder together with a colour killer switch on the motherboard, which produces an unmodulated signal. To drive a television receiver it will be necessary to use an interface such as the Digitek modulator card, which can be mounted in slot 7 or adjacent to the keyboard ribbon-cable connector.

To achieve software compatibility the organisation of the IIe is very similar to its predecessor, even to the extent of adopting the same idiosyncratic memory map with the high-resolution screen buffers positioned in the middle of the user program space. The processor is a 6502A, clocked at the same rate as the 6502 of the II and II Plus. With an unchanged Applesoft interpreter the performance is identical, as the benchmark comparisons with the latest revision of the II Plus show. The differences lie within the tolerance variations to be expected in the clock crystals of individual machines.

The Monitor ROM has been completely rewritten, but the starting addresses of all the routines remain the same. It means that Basic and machine-code programs for the Apple II, which reference the monitor, will run satisfactorily on the IIe provided that they call the starting address of the subroutine. But if they jump to an address within the subroutine they will crash.

Provision of 80-column display capability carries with it the need to double the size of the text buffer, because the amount of information displayed on the screen is twice that of the 40-column mode. In the new 80-column card it is achieved by the provision of an auxiliary 1K RAM on the card. The extra RAM is mapped into the same address space, $400 to $7FF, as the existing text buffer Page 1, and is referred to as Text Buffer 1X — the necessary switching of the display being carried out by the MMU. If the relevant soft switch is toggled the 80-column display mode remains, but every other character disappears from the screen.

The extended 80-column card carries a complete 64K of additional RAM, which is mapped into the entire address space of the 6502. It provides a complete parallel memory which can be substituted for the main memory by soft switches in the I/O block, $C000 to $CFFF.

With the extended 80-column card it is possible to define an enhanced horizontal-resolution 560-dot high-resolution graphics mode. It uses an auxiliary high-resolution graphics buffer Page 1X mapped into $2000 to $3FFF in the auxiliary memory. Current DOS 3.3 and Applesoft do not support this mode — therefore it can only be used at present by machine-code programs.

For switching purposes, the memory map is divided into one small section and two large sections — stack and Page 0, $0 to $1FF; normal 48K RAM, $200 to $BFFF; and bank-switched memory, $D000 to $FFFF. As with current RAM cards, addresses $D000 to $FFFF support 16K banks of RAM. Two 4K sub-banks are mapped into $D000 to $DFFF and read- and write-enabled by soft switches.

As with the II Plus, In/Out functions are controlled by soft switches in the space $C000 to $C07F, but with the IIe certain addresses serve more than one purpose. It is important to distinguish between Read- and Write operations as the effect will be different. Expansion slots have their own dedicated addresses in the ranges $C080 to $C7FF and share the region $C800 to $CFFF.

The existence of two completely parallel sets of memory offers interesting

From the outside the IIe resembles an Apple II, though keyboard details suggest differences underneath.

possibilities for modular programming, but will have to be approached with great caution to ensure that the correct program segments are associated with the correct page 0 and stack. Routines have been provided in the new monitor to move blocks between main and auxiliary memory, and to transfer program control at the appropriate time.

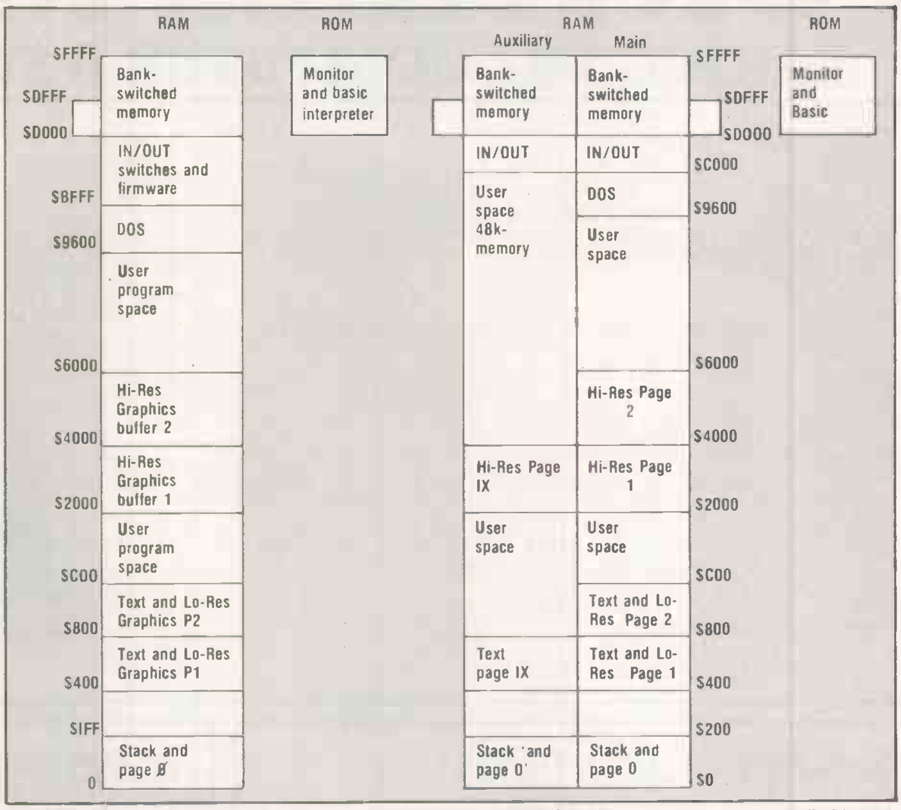
It has only been possible to perform superficial tests on software and peripheral devices. Pascal and CP/M run on the IIe as do a number of major machine-code packages such as VisiCalc. Applewriter II has been rewritten to accommodate the new 80-column cards, but the existing version works satisfactorily in 40-column mode, or with 80-column cards produced by other vendors when used in conjunction with a pre-boot disc.

VisiCalc takes advantage of the extra on-board memory to permit the construction of larger models. It also works equally well with a variety of other RAM cards, including 128K cards which take their refresh from the motherboard by plugging a ribbon cable into a socket previously occupied by a RAM chip. Apple has also introduced a special version of the multiplan spreadsheet for the IIe.

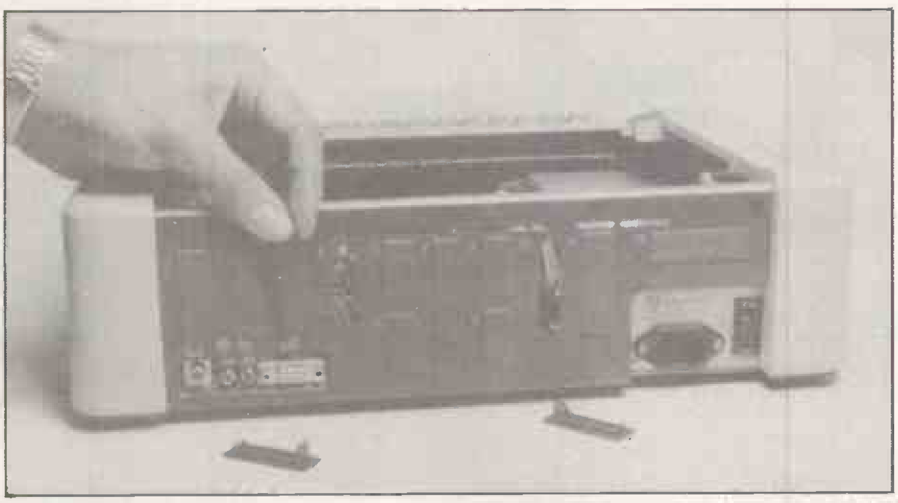
Conventional Applesoft programs function in exactly the same way as on the Apple II Plus and so do Speed Star compiled programs. Bit copiers such as Nibbles Away II work normally and I ran a program using UBI, universal boot initialiser, which is a non-standard fast-booting DOS. Graphics programs, both in Applesoft and machine code performed in a satisfactory way.

Turning to hardware, I drove an Epson MX-100 printer through a Super Printmaster III parallel interface card in text and graphics modes. A Screen-master 80-column card worked normally in slot 3 using 40- and 80-column text modes and high- and low-resolution graphics modes. A Z-80 Softcard booted up CP/M, but shortage of time prevented thorough exercising. The Double-Time printer which uses a special monitor ROM requires a firmware fix.

With the launch of the IIe Apple has re-evaluated the needs of its customers, whom it has encapsulated in the aphorism "The end-user is now at a lower level of understanding". As a result it will follow the lead of one of the independent peripheral-device manufacturers and supply a four-disc training pack and a single owner's manual, in place of the array of technical manuals which accompany the II Plus. The detailed manuals, which have in the past been one of Apple's great strengths, will be available as an extra. Since in the vast majority of cases users only read the instruction manual if all else fails, this approach will greatly simplify the instruction process.



The IIe has an entirely different memory structure (right) from its predecessor (left).

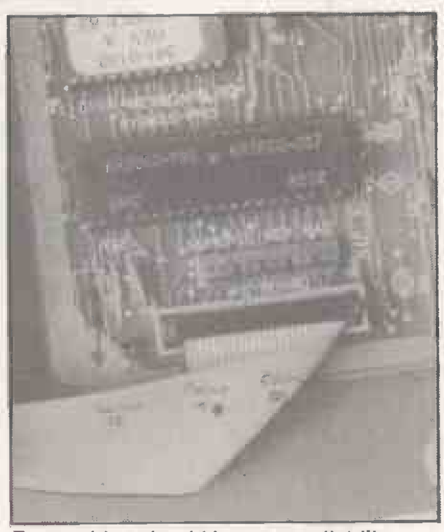

Holes punched in the back of the case can be fitted with connector sockets.

Conclusions

● **The Apple IIe is simply an Apple II with updated semiconductor technology. Existing users will be pleased to know that current software and accessories will function equally successfully on the new machine.**

● **It is clearly aimed at the bottom end of the business market, but at £845 its price includes a substantial premium for the software base. Although machines with an equivalent or better specification are available at less than half the price, without proven applications packages they are of value only to the computer enthusiast, for entertainment or educational purposes.**

● **Despite the fact that the basic design is now six years old and creaking at the seams — the first Apple IIs were shipped in June 1977 — the existence of countless firms writing software and manufacturing peripheral devices for specialist applications will ensure that the IIe is a best seller.**


Fewer chips should increase reliability and, ultimately, reduce price.

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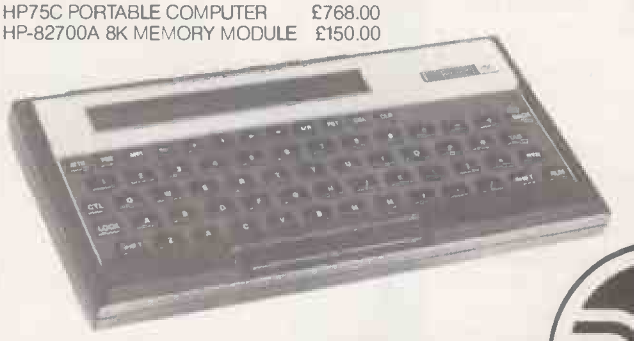

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● Circle No. 162

VIEW

How good a word processor can you squeeze into a 16K ROM? John Harris has been looking at Acorn's plug-in system for the BBC Micro.

RECEIVING Acornsoft's word processor View will doubtless have much the same effect on you as winning the pools. Having waited in vain for so long it comes as quite a shock to realise that it has finally turned up.

For your £59.80 you are supplied with a 16K ROM, a teaching manual called *Into View*, the View Guide reference manual which follows the now obligatory A5 spiral-bound format, and a function-key label card to fit under the transparent plastic strip.

Installing View allows an option: you can decide either to have your machine cold start straight into View, or into Basic as normal. There are five parallel ROM sockets on the BBC processor board, with the operating system sitting in the left-most, the disc-filing system — if you have one — in the next, Basic, View and spare. Whichever chip is in the right-most occupied socket is selected on powering-up, after which switching from one to another is done by prefixing the utility name required with an asterisk, as in *Basic or *Word.

View will operate in any mode, giving a maximum document size in memory of 25K in mode 7 down to 10K in mode 3. These two modes are the only ones of significance to word processing on the BBC: mode 7 gives 40 characters by 25 lines for use with a television or, for larger documents, mode 3 gives 80 characters by 25 lines, for use with a monitor and up to, say, five pages of A4 letter, which is a longer letter than most. Mode 0 provides 80 characters by 32 lines, but the extra seven lines visible costs almost half the remaining space.

In any mode the maximum document width is 132 characters, which falls well short of the maximum usable 240 or so on most 13in. printers operating in condensed mode. It will surely be frowned on by those easily peeved or with good reason to want the wider format. On hitting the right or left screen edge with the cursor, and being under the influence of a permissive ruler, the display will jump left or right to allow continued text entry on the current line.

Three command types exist on View. Command mode commands are reached from Text mode by pressing Esc, and give access to Save, Load, all DFS utilities, printing, word counting and Search and Replace options. Immediate commands are given in Text mode, which is in turn reached from Command mode by pressing Esc. They are accessed through the red function keys, and they generate different functions to their base functions if the Shift or Control keys are depressed at the same time to give 30 possible immediate functions, only one of which is not used. The third command type is the embedded print-formatting instruction, responsible for line and page formatting, header, footer and macro definition.

```
=>*HELP STORED

VIEW A1.4
  CE text                 RJ text
  DM xx                   EM
  PE (lines)              EP
  OP                      BM lines
  FM lines                HM lines
  TM lines                PL lines
  LM margin               LS lines-1
  FO 0/1                  HE 0/1
  HT type code            TS 0/1 margin
  SR r value
  DF /left/centre/right/
  DH /left/centre/right/

OS 1.00
```

CE text — Centre line against ruler
CM xx — Define macro labelled xx
PE (lines) — Page eject, if lines not left
OP — Odd page ejection
FM lines — Footer margin
TM lines — Top margin
LM margin — Left margin
FO 0/1 — Footers off/on switch
HT type code — Redefine highlight function
SR r value — Set register number; for example, SR P = P + 10 will skip 10 on page numbering
DF/left/centre/right/ — Define footer
DH/left/centre/right/ — Define header
RJ text — Right justify line against ruler
EM — End macro definition
EP — Even page ejection
BM lines — Bottom margin
HM lines — Header margin
PL lines — Set lines per page
LS lines-1 — Line spacing
HE 0/1 — Headers off/on switch
TS 0/1 margin — Two sided document off/on switch and margin

Table 1. View stored commands.

So, you are sitting looking at the empty screen page. What can be done with it? There is a default ruler with tabs every eight spaces and 74 characters wide, or 35 characters in mode 7. Together with the current ruler it can be copied, amended or reinvented from scratch. Up to 127 user-defined rulers may be added to it throughout the document.

The ruler which is active immediately precedes the cursor position and is duplicated on the top line of the screen. Besides allowing tabbing, the ruler defines the left and right margin for justification and formatting, which controls wrap-around at the end of each line. Both formatting and justification can be toggled on/off, and are indicated at the top left of the screen.

Six markers are known to the system. The first two are shown on the screen as inverse video, the remainder being invisible. They may be set individually, and the visible ones may be cleared together. The makers provide bounds for such activities as Save, Read, Count, Search, Change, Goto, and the Block Copy, Move, Delete and Format. The Read operation copies a file from disc or cassette into memory.

Putting text on the screen is a simple process. Once you have typed a few pages the cursor movement commands become significant. The arrow key moves the cursor to anywhere on the page, though if you press a character with the cursor beyond the bounds of the ruler, the toggle Release Margins determines whether it stays there or starts a new line. Shift Up and Shift Down pages through the document; Shift Left and Shift Right jumps words instead of characters. Commands available for cursor manipulation are Top and Bottom, for movement to top and to bottom of text; End of line and Go to marker; and the commands Search, with wildcard, an unselective Change, and Replace selective.

Character manipulation is available through Swap Case, Delete and Insert character, Delete to end of line, and the unusual Delete up to a given character. Lines may also be Inserted, Deleted, split and concatenated. An Insert mode toggle allows for continuous insertion or overwriting on amendment.

Continuous processing is an option for disc users only, and involves Editing from file 1 to file 2, requesting More as occasion demands and ending on Finish or Quit. It is a serial process and results in the original and

(continued on next page)

```
=>*HELP CMODE

VIEW A1.4
  LOAD file                SAVE file
  READ file (1)            WRITE file (1 2)

  EDIT filein fileout
  More (1)                 Finish
  QUIT

  SCREEN file1...n
  Print file1...n          SHEETS file1...n

  MODE                     COUNT (1 2)
  FIELD chr                FORMAT (1 2)
  PRINTER file             MICROSPACE spacing
  NEW                      OLD

  Search target (1 2)
  Change target result (1 2)
  Replace target result (1 2)

OS 1.00
```

(continued from previous page)

updated files being available on disc at the end. The size of files handled is limited only by the capacity of half a disc. It seems there is no provision for the input file to be resident on one drive and the output on another.

Printing is achieved in Command mode by typing Print or Sheets or Screen file list, where file list has one or more entries to a presumed maximum of around 90. Print is for continuous stationery and a full printout, Sheets for single feed or selective printing, and Screen will show you on the screen what would come out on the printer if you used Print.

The file list is a neat way round the limiting memory effect on document size if you do not want the operational inconvenience of continuous processing, as page and line counts, headers and footers continue as though file list were a single file. All printing operations are performed from cassette or disc only and not from the file in memory, the contents of which are unaffected.

The embedded print-formatting instructions allow line manipulation by way of centring and right justification. Page formatting is by page length, line spacing, margin specification at top, bottom, header, footer and left of page, and page ejection on all, odd or even pages. Line spacing varies from single space to one line per page. Single-line headers and footers may be defined, selected and deselected, and two-sided document margins are provided for.

Macros are areas of predefined text which can be duplicated and expanded at any point in the main text body by a macro call. The duplication and expansion takes place during printing. The macro once defined to the print process by being met in the text — though not printed at that point — remains in effect throughout file list, thereby allowing the printing files to be prefixed in file list by the required macro file libraries. Macros can, of course, also be embedded anywhere in the text itself.

Macros can be multi-line, with up to 10 parameters, and are identified by a two-character mnemonic which may not be an existing command code. A macro is called within the text by using the identifier as a command code itself and carrying the parameters on the remainder of the command.

Number registers are available for command arithmetic operations coded A to Z though not text ones; P is automatically maintained as the page counter and L the line counter. All may be amended at any point in the text and will be printed when prefixed by the split vertical ASCII 124.

When it comes to embedding printer control codes within the text body for highlighting, underlining, double width, condensed mode and so on, the quick-reference guide suddenly becomes very coy. What it says is: "The highlight codes give instructions to your printer to print text underlined (1), or in bold type (2) ... For other Highlight effects and use of the HT command, see the Technical Appendix to *Into View* booklet. Note: for Highlight commands to take effect, your computer must first be operating the correct 'driver' for your printer."

The HT command allows Highlight 1 and 2 to represent any printer function recognised by the printer driver. The driver which is needed to use them and the in-built highlight commands, however, is sold separately on cassette for an additional £9.95. It is a wicked con to say that View sells at £59.80; it costs £69.75 if you are going to use it properly, a tenner less if you are not too fussy.

Format block	F0
Top of text in memory	F1
Bottom of text in memory	F2
Delete to end of line	F5
Move to beginning of line	F4
Move to end of line	F5
Insert line	F6
Delete line	F7
Insert character	F8
Delete character	F9
Move block of text	Shift-F0
Swap case of character at cursor	Shift-F1
Release margins	Shift-F2
Delete up to character	Shift-F3
Start/end Highlight 1	Shift-F4
Start/end Highlight 2	Shift-F5
Go to marker	Shift-F6
Set marker	Shift-F7
Edit stored command	Shift-F8
Delete stored command	Shift-F9
Delete block	Control-F0
Next match for search or replace	Control-F1
Toggle format mode	Control-F2
Toggle justify mode	Control-F3
Toggle insert mode	Control-F4
Copy default ruler to current line	Control-F5
Split line at cursor	Control-F6
Concatenate lines	Control-F7
Mark line as ruler	Control-F8
Move left one character	Left Arrow
Move right one character	Right Arrow
Move up one line	Down Arrow
Move to beginning of last word	Shift-Left Arrow
Move to beginning of next word	Shift-Right Arrow
Move screen one page up	Shift Up Arrow
Move screen one page down	Shift-Down Arrow
Copy block	Copy
Copy current ruler to current line	Shift Copy
Toggle text and command modes	Escape
Delete last character typed	Delete
Insert a Tab and move to next stop	Tab

Table 2. View Immediate commands.

Conclusions

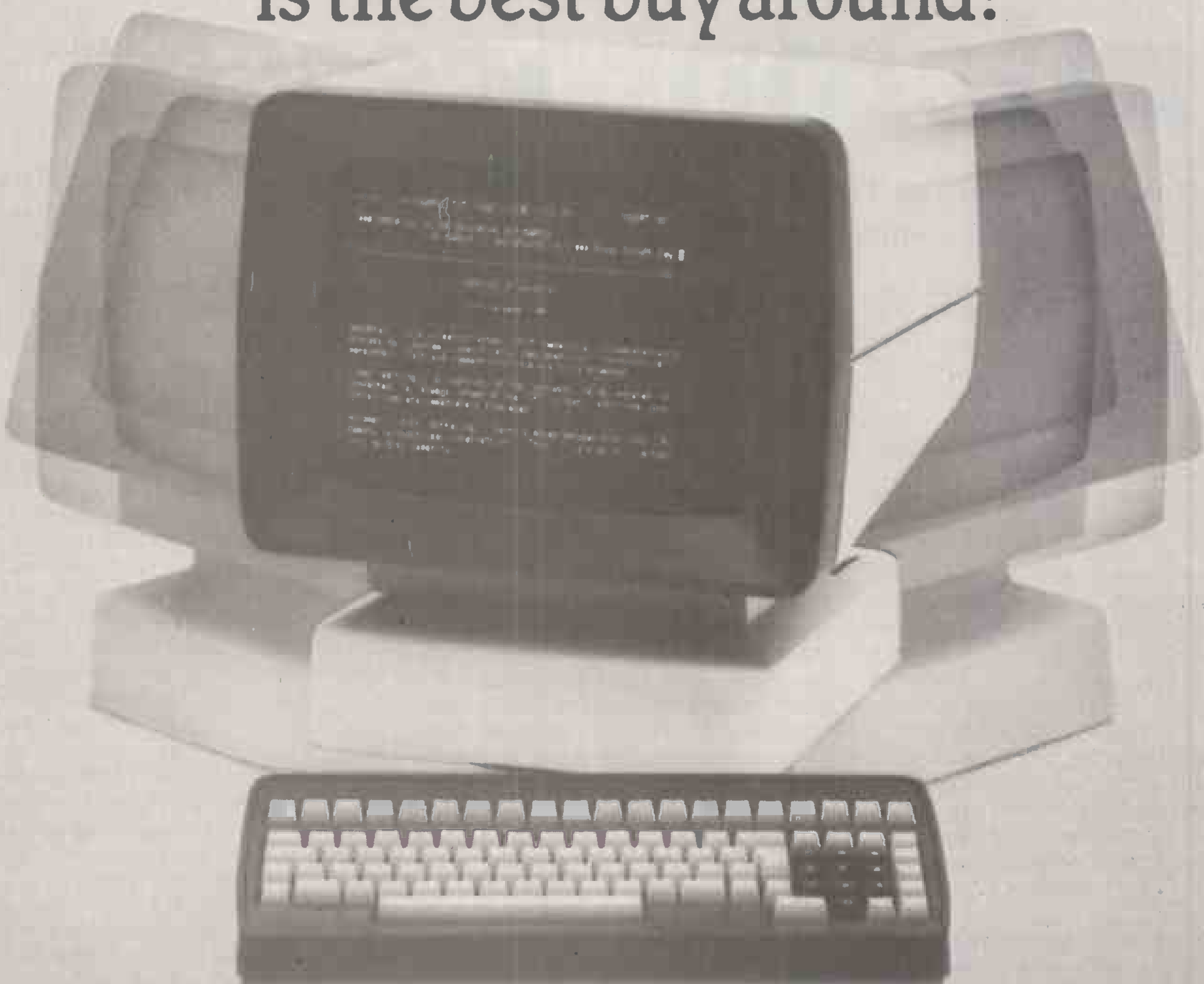
● The View package includes a 16K plug-in ROM, a teaching manual and a reference manual. It costs £59.80, including VAT.

● View operates in conjunction with a BBC Micro with the 1.0 operating system or later.

● To take full advantage of View a printer driver cassette is required, costing an extra £9.95, including VAT.

● View handles well, and is certainly the best word-processing system of its size, but it does lack certain features like the numeric Tab which are available on more expensive word processors.

The Big Screen Micro from KCB at under £1800 is the best buy around!



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● Circle No. 163

Programming the Z-80 microprocessor

Robert Simpson and Trevor Terrell explain the fundamentals of machine-code programming for the Sinclair Spectrum's Z-80A processor.

WHEN YOU WRITE programs in Basic your statements, functions and numbers have to be stored and subsequently translated to equivalent machine code by the ZX Spectrum interpreter and operating system. The Basic commands are interpreted so that the Z-80A microprocessor can fetch and execute the instructions. This is necessary because the Z-80A can only work with machine code, and therefore it only fetches and executes instructions in this form.

The interpretation process takes a finite time to implement. If this can be eliminated by writing programs in machine code rather than Basic, then a significant time saving is achieved. Time may be an important consideration in applications involving graphics or control of external peripheral devices. The number of memory bytes required for a program written in Basic is much larger than the number required for the equivalent machine-code program so a significant saving in memory requirements is also achieved by writing programs in machine code.

You can store a machine-code program in memory in the same area as your Basic program or in a separate area created for this purpose between RAMtop and user-defined graphics — see figure 1. To include machine code within a Basic program you may use an appropriate Rem statement.

From a practical point of view, the choice of where to place the Rem statement is governed by the necessity to know the address of the first byte of the machine-code program. When the Rem is the first line of your Basic program, the address of the first byte used for the Basic program is determined by Peeking into the system variable program. This may be achieved using:

```
10 LET x = PEEK 23635
15 LET y = PEEK 23636
20 PRINT "Address of FIrst Byte of
   BASIC"' " IS "; x + 256 * y
```

The address of the first machine-code byte will be the address obtained using the above program plus 5, because the line number and Rem token require four and one memory locations respectively. You will find that the address of the first byte of your Basic program is 23755, hence the address of the first byte of machine code will be 23760. If you place the Rem statement elsewhere in your program you will have to determine the address in RAM which can hold the first byte of the machine-code program, and this is not an easy task.

When using the Rem statement in the first line of your Basic program the number of characters between the Rem token and the Enter corresponds to the number of bytes that can be used for machine code. The method of entering machine code in a Rem statement uses a two-pass operation. In the first pass the Rem statement is used to reserve the required memory space for the machine-code program, and in the second pass the machine-code bytes are converted to their decimal equivalent code and Poked into the appropriate memory locations.

Consider for example, how to enter the following three bytes of machine code:

```
04 INC B
0D DEC C
C9 RET
```

The first pass operation to reserve the required three memory bytes is achieved by entering:

```
1 Rem bbb
```

where the three characters bbb correspond to the memory bytes for the machine code. The bytes of the machine code must now be converted to their decimal equivalent, that is

04 converts to 04,
0D converts to 13
C9 converts to 201.

The decimal values are subsequently Poked into memory addresses 23760, 23761 and 23762. On completing this two-pass operation your Rem statement line will be listed as

```
1 REM ?
```

When your machine code is included in a Rem statement it is part of a Basic program and is subject to all the Basic commands, such as Edit, List, Save, New, etc.

A machine-code program is linked to a Basic program using the USR function. The memory address of the first byte of machine code is the number used after the USR function. The hexadecimal equivalent of this number is loaded into the BC register pair of the Z-80A microprocessor, and after execution of the last machine-code instruction — the essential Return instruction, C9 — the content of the BC register pair returns to the USR function.

Consequently, to access and run the three-byte machine-code program once it has been entered, you can use

```
PRINT USR 23760
```

followed by Enter. The displayed result is 24015. Before the machine-code instructions are executed the values stored in the B and C registers of the Z-80A microprocessor are 92 and 208 since $23760 = (92 \times 256) + 208$. After executing the first instruction, INC B, the register contents are 93 and 208, and then after executing the second instruction, DEC C, the register contents are 93 and 207. After the Return instruction, RET, the USR function returns with the value $(93 \times 256) + 207$, or 24015. The USR function is used in a line of Basic program to access the machine-code program, and if you use

```
25 LET x = USR 23760
```

then, after executing the simple machine-code program, the value of x is set equal to 24015.

A Return instruction, RET, must always be included as the last op code in a machine-code program. Otherwise it is quite possible that your ZX Spectrum will fetch and execute the codes which exist in the RAM

The authors are from the Systems and instrumentation division of of Preston Polytechnic. This article is an edited extract from their forthcoming book, *ZX Spectrum User's Handbook*, to be published by Newnes Technical Books.

locations following the end of your machine-code program; since these are unspecified, a crash condition may then result. If that happens, the operating system loses control and the microcomputer becomes incapable of doing anything useful. For example, you will recognise this condition when you are unable to input control commands from the keyboard. The only way to deal with a crash condition is to momentarily disconnect the 9V power supply.

It is possible to store a machine-code program in an area which you create above RAMtop but below the user-defined graphics area. This is the area to be used when you do not wish to have your machine-code program erased by New. In the Spectrum the user-defined graphics area occupies the top 168 bytes of RAM, and RAMtop is normally the next address below this — see figure 1. In the 16K Spectrum RAMtop is normally at address 32599, whereas in the 48K Spectrum it is at 65367.

You can redefine the address of RAMtop by putting the desired RAMtop value in a Clear statement using the form

CLEAR Desired RAMtop value

The Clear command also clears all the program variables, the display file CLS, and Gosub stack, the latter being put at the new RAMtop; it also does a Restore, and resets the Plot position.

When you have redefined RAMtop to reserve sufficient memory bytes for your machine-code program above RAMtop and

(continued on next page)

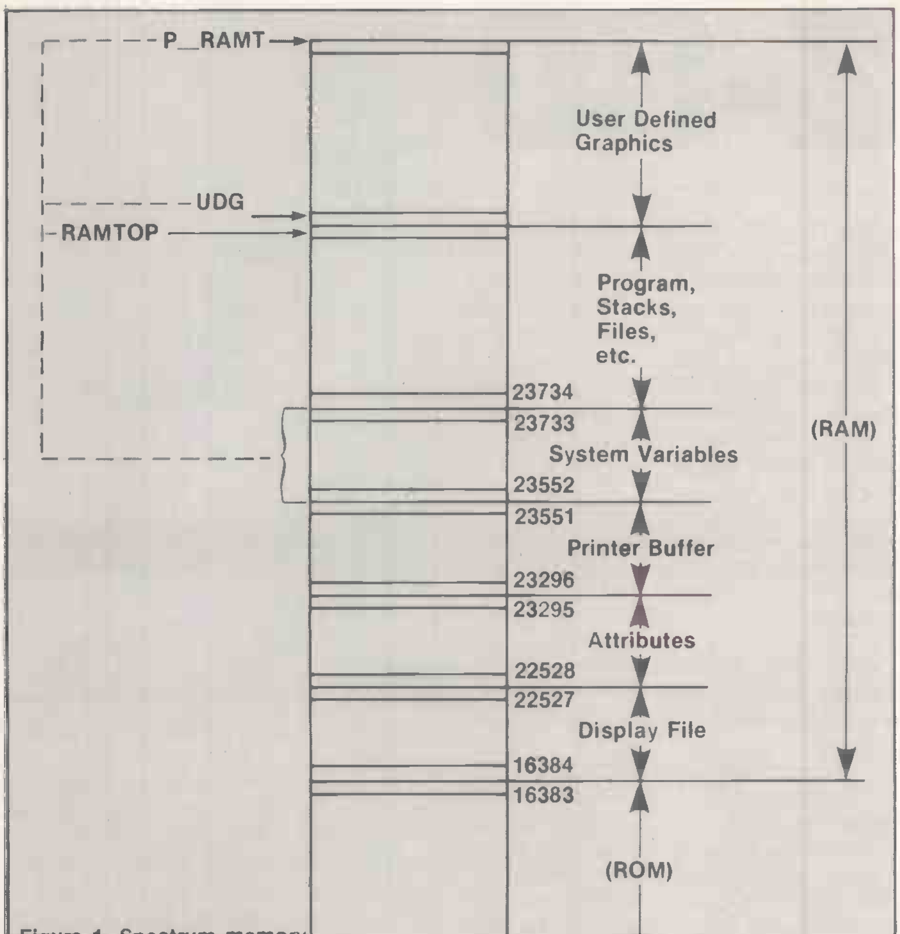


Figure 1. Spectrum memory map.

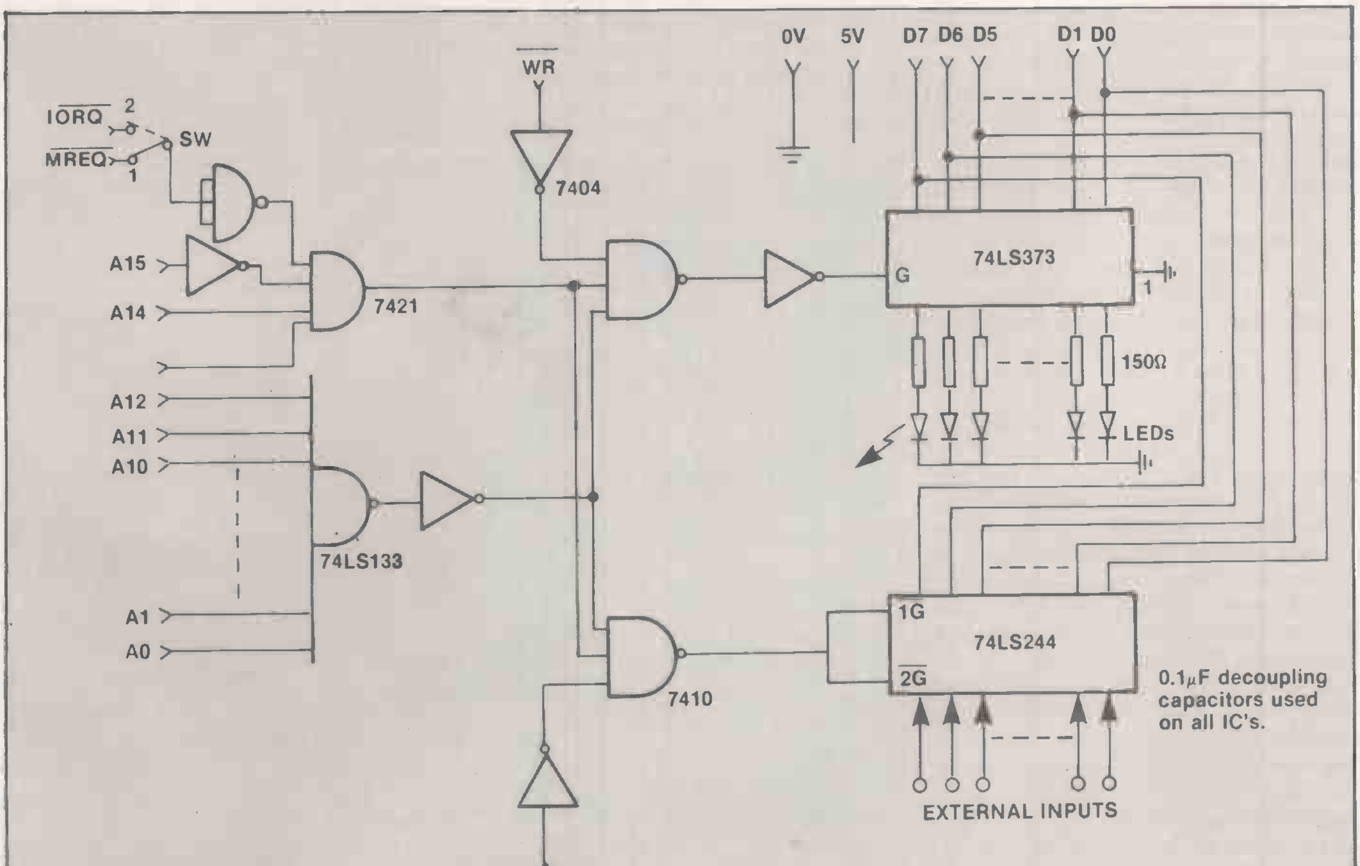


Figure 2. One-byte data interface.

Z-80

(continued from previous page)

below the user-defined graphics area, you may Poke your machine code into the available memory area. The machine-code program is then once again accessed by using the USR function followed by the start address of the machine-code program.

Consider using a 48K Spectrum to run the three-byte machine-code program, with the first byte of machine code stored at memory address 60001. You first redefine RAMtop by entering

```
CLEAR 60000
```

Next, convert the machine codes to their decimal equivalents, which in this case gives:

```
04 INC B
13 DEC C
201 RET
```

These values are then Poked into the memory addresses 60001, 60002 and 60003 respectively, and the program may be run by entering

```
PRINT USR 60001
```

This time the Spectrum displays 60256. Before the machine-code instructions are executed, the values stored in the B and C registers are 234 and 97, since 60001 = (234×256) + 97. After executing the INC B, DEC C and RET instructions the USR function returns with the value (235×256) + 96 or 60256. Remember that once you have redefined RAMtop it stays at the redefined value until you change it to a new value or remove the DC power supply.

You may store machine-code programs on cassette tape by using the Save statement in the form

```
SAVE "Program Name" CODE
RAMTOP + 1, Number of program bytes
```

The tedium of converting machine-code program bytes to their decimal equivalent and then Poking them into memory locations above RAMtop can be eliminated by using program 1. It requires you to input as a decimal number the value of RAMtop, whichis set using the Clear statement in line 75. You then input each byte of your machine-code program as two hexadecimal characters; they are stored in successive memory locations starting at the next address above the defined RAMtop. When the last byte of the machine-code program has been entered, enter Z to terminate the loading operation. To access and run the machine-code program use the USR function followed by the start address which is, of course, RAMtop + 1.

A machine-code programming example demonstrates how the Z-80A microprocessor may be used to implement a data byte In/Out operation at the machine-code level. It is implemented using the one-byte memory-mapped interface shown in figure 2. In this example the microprocessor is used to determine the number of bits in the input data byte set equal to 1, and it then outputs

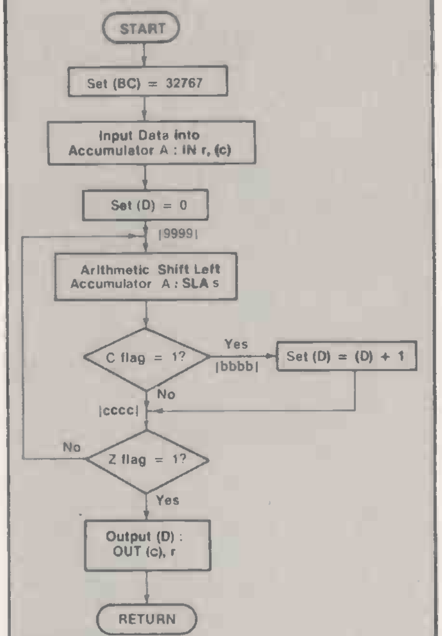


Figure 3.

the result as a binary number through the I/O port.

The flowchart for the program is shown in figure 3. The first part of the process involves setting the content of the BC register pair equal to the address of the one-byte memory-mapped interface, namely 32767. The next step in the process is used to input the interface data byte into accumulator A. Register D is used as a counter, and its initial value is set to zero.

The arithmetic shift-left instruction moves the contents of accumulator A one place left, with the most-significant bit of the data byte moving into the carry-bit position and the least-significant bit being set to zero. If this action sets the C flag to 1 the counter is incremented by one; otherwise the incrementing operation is skipped. When the content of the accumulator A is zero — none of its bits set to 1 — the shifting process is terminated and the binary count value held in register D is displayed using the interface light-emitting diodes.

Program 2 lists the machine code for this process. It is convenient to express the program memory addresses relative to RAMtop, RT and the general addresses given in the program have the following relative values:

aaaa	RT + 9
bbbb	RT + 20
cccc	RT + 14

For example, when RAMtop, RT, is made equal to 32300 the memory addresses are as follows:

	Decimal	Hexadecimal
aaaa	32309	7E35
bbbb	32314	7E3A
cccc	32320	7E40

For In/Out operations the interface selector switch, SW, must be set to position 2, see figure 2.

Program 1.

```
10 PRINT "Input Ramtop value"
20 INPUT RT
25 PRINT RT
28 LET A = RT
30 PRINT "Input Byte or machine code"
   or Z to STOP"
35 INPUT H$
36 PRINT H$
37 IF H$ = "Z" THEN GO TO 75
38 LET RT = RT + 1
40 LET x = CODE H$
45 IF x > 57 THEN LET x = x - 7
50 LET y = CODE H$(2)
55 IF y > 57 THEN LET y = y - 7
60 POKE RT,x * 16 + y - 816
70 GO TO 30
75 CLEAR A
```

Program 2.

Address	Memory byte	Mnemonic	Remarks
RT + 1	06	LD r,n	(B) = 7F (BC) = 32767
	7F		
	0E	LD r,n	(C) = FF
	FF		
	ED	IN r,(C)	(A) = Input data
	78		
	16	LD r,n	(D) = 0
	00		
aaaa	CB	SLAs	2*(A)
	27		
	DA	JP cc,nn	If C = 1 Jump to bbbb, otherwise continue
	bb	LO byte of Addr	
	bb	HI byte of Addr	
cccc	C2	JP cc,nn	If Z = 0 Jump to aaaa, otherwise continue
	aa	LO byte of Addr	
	aa	HI byte of Addr	
	ED	OUT (C),r	Output result
	51		
	C9	RET	Return
bbbb	14	INC r	(D) = (D) + 1
	C3	JP nn	Unconditional jump to cccc
	cc	LO byte of Addr	
	cc	HI byte of Addr	

Big fish caught in small pond

When William Green was sold a faulty micro he demanded his money back. The supplier refused, so he went to court.

EARLY IN 1982 I bought one of the popular low-price personal computers. I will not name it, suffice to say it do not live up to the claims made for it in the advertisements. After trying unsuccessfully to get a machine that worked I decided to demand my money back.

I think it is a good rule to keep copies of correspondence about any relatively expensive purchase — memory is not always adequate. Accordingly I had kept a record of the symptoms of the faults I had experienced. I had written to the supplier describing these symptoms and had exchanged parts of the machine found to be faulty. I had kept copies of all my letters and the supplier's replies.

Memory is not always adequate.

Having decided to recover my money I wrote to the supplier explaining that I was not satisfied with the machine and asking for my money back. At the same time I returned the machine. A mistake — because in so doing I passed all the actual evidence of a faulty machine to the supplier. In the event it made no difference, although it might have done with a less scrupulous supplier.

The supplier's reply was as expected. It claimed that policy prevented refunds except within a short period of purchase. Since it was not known to me when I bought the computer it was not binding on me. I wrote back pointing this out and promising that should my money not be refunded within a fortnight I would sue. I sent the letter by recorded delivery to avoid any doubt that my threat to sue had been received. I sent the letter to the company's registered address, the official address of the company.

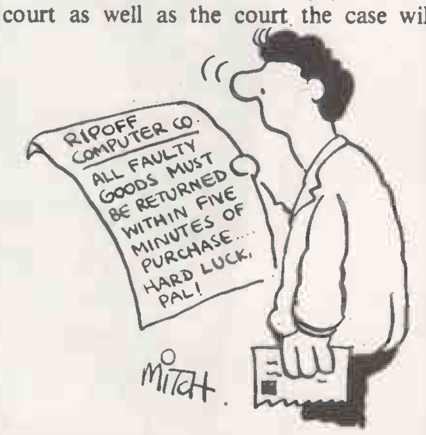
Some years earlier I had successfully sued for a small sum of money in the Small Claims Court and so decided to try that court again. The refund I wanted was under £200 and therefore well within the limits for the Small Claims Court. The Small Claims Court is a branch of the County Court, and not to be confused with a Magistrates Court.

In the Small Claims Court legal and other costs and expenses are limited. The person doing the sueing is asking only for a limited sum of money and will not face possibly high legal costs. An opponent has less opportunity to frighten a poorer adversary by the use of ostentatious, expensive legal assistance. For small amounts it is a very useful way of fighting against a relatively rich opponent. In my case my opponent was a rich company, in another court I might well have faced the possibility of very heavy costs were I to lose. In the Small Claims Court solicitors are not necessary. On the previous occasion I had done without a solicitor and I decided to do so again.

There is a free booklet called *Small Claims in the County Court*. It is revised from time to time and it is important to use the latest version. A copy can be obtained from any County Court. It is written in plain language and explains how to use the Small Claims Court without a solicitor. It does however deserve careful reading. The booklet explains that the person sueing is the plaintiff, the sued is the defendant. It is not essential, but using "plaintiff" and "defendant" in the various papers in the case saves continually writing out names and addresses.

To sue the defendant it is necessary to issue a summons. It saves time if the summons is issued by the correct court. The country is divided into court districts. The correct court is the one in the defendant's district. The booklet explains this. In my case, the correct court was about eight miles away from my home — not too far. It is sometimes possible to arrange to have the case dealt with by a court in another district. Usually it can be arranged only with the defendant's permission.

I confirmed the choice of court by a visit to the office of the Chief Clerk of the Court. The people in that office are available to advise about procedure but cannot advise about the case itself. A word of warning is necessary here: as in all occupations, some of those in the Chief Clerk's office have more enthusiasm than knowledge. If doubtful about the advice obtained consult the offices of two courts, say your local court as well as the court the case will proceed in. My first experience of the Small Claims Court included wrong advice about which court to use. However, should you issue the summons through the wrong court, only time is lost, the court will help you correct the error.



Policy prevented refunds except within a short period of purchase.

There are two kinds of summons, an ordinary summons and a default summons. I was advised by the Court Office that for my case the correct summons would be a default summons.

Another visit to the local County Court was needed to collect a Form of Request, the form that enables the summons to be issued. At the same time I found out what fee would be payable for serving the summons. In 1982 the minimum fee was £4, the maximum £29.

The case had now to be written, in plain language as simply as possible, giving the main facts and details of what I claimed. It is referred to as the particulars of claim. In preparing the particulars of claim do not be tempted to use legal language. Legal people understand English — use it.

I took the particulars of claim, with the Form of Request and appropriate fee to the court. I had to supply in addition a self-addressed envelope in which the court sent me, about a week later, the plaint note, which is both notice that the case has commenced and a receipt for the fee paid. The court issues the summons after receiving the Form of Request, particulars of claim and fee. The case is given a number, the plaint number. All papers to do with the case must be labelled with the plaint number. The plaint number is used in the court office for filing the papers in the case. No plaint number, no papers, no case! The plaint number is given on the plaint note.

My case was one of those for which arbitration was considered appropriate. Aribitration is the alternative to a full court procedure. The smallest claims are automatically subject to arbitration, in other cases the the plaintiff can ask for arbitration. In this case the arbitrator was a Registrar of the County Court. A court Registrar is second

I found it difficult to hear the Registrar.

only to a judge and is one of the more qualified and experienced people in the legal profession. With arbitration there is first a pre-trial review. At the review the plaintiff and defendant appear, and arrangements about the conduct of the trial itself are made. Either party to the case can take up matters which seem important. For example, in my case I tried to get an immediate judgment in my favour.

I failed. What had happened was that the defendant had not put forward a defence until three weeks after the issue of the summons. From reading the notice informing me that the summons had been served, it seemed to me that unless the defence was put up within a fortnight of the summons being issued the plaintiff was entitled to judgment. The Registrar thought differently.

The pre-trial review was something of a shock in other respects. On the previous occasion I had used the Small Claims Court the pre-trial review was held in a small room containing a small table, some quite ordinary chairs and the Registrar, myself and the defendant — a very quiet, informal occasion. That was in another district and at another time.

On this occasion the venue was a real court room. At the front was a dais containing a real judge's chair, complete with the Royal Coat of Arms. Here sat the Registrar. In front of him was the Clerk of the Court behind a bench. In front of his bench was the bench for lawyers, labelled plaintiff at one end and defendant at the other. That was not all. The court was full of people — all the plaintiffs and defendants in that afternoon's cases were there, all talking among themselves.

Those involved in each case had to talk to the Registrar and each other behind the lawyer's bench while the hubbub continued. When my case was finally reached I found that the defendant had sent a solicitor. He had been present in the court almost as long as I had, but did not report his presence to the Clerk until the last minute. It had the effect of delaying my case by a good hour. I found it difficult to hear the Registrar, who spoke very quietly while looking down at the case papers. Most of the time in fact I was not sure what was happening. The defendant's solicitor introduced himself, but while I was trying to say who I was the Clerk was standing between me and the Registrar. I am sure the Registrar never heard me. At one stage I believe the Registrar thought I was a solicitor representing another company.

The solicitor asked for permission to use an expert's report. The Registrar agreed because, he said, computer cases can become technical. The solicitor then asked for disclosure, which is in effect a request to be told of papers possessed by the other side, in this case me, which might be relevant. The request is not always as innocent as it sounds: sometimes papers not disclosed cannot afterwards be used in court, therefore it is wise to include everything you might want to use. Solicitors know this, most other people do not. In this case the relevant papers in my possession were only the letters between me and the defendant, and the advertisement which led to my buying the computer.

The Registrar asked for an estimate of how long the case might take; I had no idea. The solictor shouted: "two hours". The Registrar accepted this, made an Order for Disclosure and one expert's report on each side, and said the trial would be about 10 weeks from then. The whole process took about six minutes. As I left the court the defendant's solicitor advised me to use a standard solicitor's form for the Disclosure. I ignored the advice as I thought that to use a legal form might involve the wrong use of legal terms.

The Order for Disclosure duly arrived. It was a completely unreadable copy of an original — quite useless. I took it to the Chief Clerk's office where I was given a readable copy with an apology. The order required both the defendant and me to supply each other with a list of known relevant documents within 21 days of the date of the order. The poor copy I had been sent nearly caused me to overrun the time given. It had not been sent until nearly two weeks after the pre-trial review, the date of the order. I asked the Court Office if the list had to be sent direct to the defendant and was told I could send the list through the Court Office. This I did so as to avoid any risk that the defendant might not receive the list by the due time.

I never received a list from the defendants and I did not arrange for an expert's report or ask the defendant for a copy of his expert's report. According to the advertisement for the computer you did not need to be an expert to use it.

The date of the trial came and I attended the court. There I found that the trial was due to be held not in the court room where the pre-trial review had been held but in Chambers, in fact the office of the Registrar

Some patience is required.

who was to arbitrate. The Registrar was not the one who had presided at the pre-trial review. Neither the defendant nor his solicitor turned up. The Registrar, after asking me to briefly recount my case, made a judgment in my favour for the full amount I had claimed, plus the fee I had paid for the summons.

The order gave a date by which time the full amount had to be paid by the defendant into court. The court would then pay me. Should the defendant not pay by the due date the plaintiff can issue a warrant of execution. A standard form can be obtained from the Court Office for the purpose. A fee is payable, but advice on how to complete the form can be obtained from the Court Office. The fee is recovered, in addition to your claim, by the bailiff who executes the warrant. In my case, the defendant paid up just one day late. I was about to issue a warrant when the court told me the money I was owed had been paid in.

Ten languages

A LANGUAGE is a tool that aids communication. Human language is designed to expedite communication between humans. Though languages may develop and diverge in a number of ways they usually contain a central pool of vocabulary that is common to all the users of that language and a number of dialects.

Communication between computers is carried out by sending trains of electrical pulses along conducting links. At this level the signals are simply binary messages, either data or instructions. Yet the design concept of computers turns this simple phenomenon into the ideal communication tool.

Binary pulses and human spoken languages could not be more dissimilar. Their only common feature is that they are both ways of passing linear information between two or more information-processing centres. If humans and computers never interacted this would be fine, but unfortunately humans and computers do need to communicate with each other and it is the problems of this interface that bring about the need for computer languages.

Computer languages are a method of expressing the workings of a digital system in a way that we can understand, so that we can control them. People talk of a language being "high-level" to describe the extent to which it mirrors English. The higher the level the easier it is for non-specialists to program. There are many claims as to which is the highest-level language, and it is an interesting debate. Among the leading contenders must be the Xerox Smalltalk, which is both an operating system and a Language; Logo is another.

Logo is a stripped-down version of English with hardly any words at all. Smalltalk is an effort to get away from all conventional ideas about microcomputer languages and, if anything, mimics an office environment rather than having a linguistic form.

Both languages are included in the feature on the following pages, along with Basic, Cobol, C, Pascal, Prolog, Forth, Lisp and APL. Together they are the 10 most relevant languages for micro users. One other language deserving a mention is Comal, a structured Basic which lies between Basic itself and Pascal. It is widely used in Europe but is seldom seen in the U.K. outside educational institutions and our letters pages. It is, nevertheless, a language in its own right.

APL

BY ALMOST ANY yardstick, APL is the odd man out among modern programming languages. It uses symbols where others use words; it uses a workspace in preference to files; it makes no clear distinction between program and data. The reason is simple: APL was originally devised as a technical notation — computers had very little to do with it.

In the early 1960s a Canadian mathematician called Ken Iverson was wrestling with algorithms for sorting. He found it hard to express his thoughts in a notation which makes you write:

$$\sum_{n}^{i=1} v_i$$

to do something as basic as adding up a series of numbers. From his frustration grew the original notation he called A Programming Language, APL, though it bears little immediate resemblance to the computer version we know today.

The structure and concepts, however, have not changed. APL is still primarily concerned with simplicity, consistency and the effective communication of ideas. For the fact that computers as well as people now understand APL we must thank the pig-headedness of a small group within IBM.

The first APL interpreters were written in the early 1930s. From the start APL was conceived as an interactive language: you can walk up to any APL system, type 2 + 2, hit Enter, and the terminal will reply 4. After a slow start APL began to spread like wildfire within IBM, and it was soon made available on independent systems.

Eventually IBM had to let it out to customers, and I first met APL in 1977 on an ordinary IBM mainframe. At that time it was a rarity in manufacturing industry; today more than 50 percent of all major IBM users have it. Though this is impressive in its own right, I believe the real breakthrough is still to come.

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APL interpreters are rather large, say 100K, and pretty hard to write. APL systems usually need between 100K and 1Mbyte of working storage. It is clear why APL has so far been kept off the eight-bit micros in anything but limited subsets.

Two factors have come on the scene to change this. The first is fast, cheap hard-disc storage, which has allowed micro-APLs to "go virtual". There are now systems on the market which give you an 800K workspace on a 64K machine. The second factor is the M-68000 chip. To any APL pro it is a revelation to run on a computer like the Sage with 0.5Mbyte of real memory. Already minicomputer manufacturers are routinely talking of megabytes of workspace, and suggesting that files may be a thing of the past.

The first aim of APL's inventors was to impose a simple, consistent structure on the familiar anarchy of mathematical symbols. Consider the following:

$2 + 2$
$\log_2 5$
$2e^{1.6}$
$|-5|$
$2-2$
$3+6\times 10$
$3\times 6+10$
$2-5-6$

$$\sum_{n}^{i=1} V_i$$

$$\prod_{n}^{i=1} V_i$$

Notational complexity is compounded by ambiguity and by arbitrary rules. Is the minus sign something that labels a negative number, or something that subtracts it? Why should you do times before plus?

Here are the first five examples again in APL:

```
2+2
2⍟5
2×*1.6
|−5
2−2
```

Functions such as "plus" act on data, which is presented to them either on both sides, as in "times" or on their right only, as in "exponentiation". Many functions can be used either way, for example ÷5 would simply be the reciprocal of 5. In effect it assumes a default value of 1 to its left. They also act in a strict right-to-left order — the sixth, seventh and eighth examples evaluate to 63, 48 and 3 respectively.

The second great simplification of APL is that these arithmetic functions act just as well on lists and tables. For example to convert a series of values from pounds to dollars, and round up to the nearest dollar:

DOLLARS←⌈1.58×1200×300 450.67 23.8

Finally, if you can't do quite what you want with the symbols on the keyboard you can always invent extra functions of your own:

10×MEAN 2 3 4 .... is 30

APL makes no distinction at all between its own "primitive" functions and those that you make up. Execution still proceeds strictly right to left, which is why expressions like:

MEAN AGE WHERE SALARY > 10000

or

TOTAL SARARY WHERE AGE > MEAN AGE

See *Practical Computing* August 1982 for details of Total, Mean and Where work in such a natural "English-like" way.

Of course you can still use brackets in the normal way if you want to:

(3+6) × 10 .... is 90
0.06 × TOTAL SALARY WHERE (MEAN AGE) < AGE

Typically both Salary and Age would be lists of several thousand numbers.

The next key concept in the structure of APL is the idea of an operator. This is a symbol which combines with a variety of functions to extend greatly the range of the language. A good example is reduction:

+/1 2 3 4 .... is 10

The symbol / is the operator; it combines with + to yield the new function of summation. To get cumulatives we use \, called "scan" as in:

×\2 3 4 .... is 2 6 24
⌈\4 6 4 2 .... is 4 6 6 6

and so on.

With half a dozen operators and 20 primitive functions there is precious little you cannot invent. Using that staff data again, how old do you have to be to earn 12,000 a year?

⌊/AGE WHERE SALARY > 12000

So far there have been only two syntactic elements to learn: functions and operators. There is one more, the use of square brackets to index from an array. Again an example will help:

'BRUTE '[5 4 6 4 3] .... is 'ET TU'

How to put it all together? The Tower of Hanoi seems to be a live issue at the moment, so here are a couple of versions in APL. The first uses the classic recursive approach — see M S Jackson's letter in January's *Practical Computing* for an explanation.

Classic recursive approach.

```
        HANTOWER DISCS;MOVES
        --------------------
    [1]  ⍝SET UP EMPTY ARRAY OF MOVES ....

    [2]   MOVES← 2 0 ⍴0

    [3]  ⍝WHICH IS UPDATED BY ....

    [4]   DISCS BRAHMA 1 2 3
    [5]   'MOVE A DISC FROM PEG : ',⍕MOVES[1;]
    [6]   '                TO PEG : ',⍕MOVES[2;]
       ∇
        N BRAHMA NEEDLES
        ----------------
    [1]  ⍝TOWER OF HANOI BY RECURSION
    [2]   →N↓0
    [3]   (N−1) BRAHMA NEEDLES[1 3 2]
    [4]   MOVES←MOVES,NEEDLES[1 3]
    [5]   (N−1) BRAHMA NEEDLES[2 1 3]
       ∇
    HANTOWER 4
 MOVE A DISC FROM PEG : 1 1 2 1 3 3 1 1 2 2 3 2 1 1 2
                TO PEG : 2 3 3 2 1 2 2 3 3 1 1 3 2 3 3
```

Boris Allan's sneaky non-recursive formulation on page 193 of the September 1982 issue goes very nicely into APL. It requires neither looping nor branching, and is entirely machine-independent. Personally I find it easier to follow — I never did feel at home with recursion and it is significantly faster for large numbers of discs.

APL started off as a sort of souped-up desk calculator for engineers and accountants. Any job which applies simple tasks to tables of data can readily be tackled. However as more and more data was stored people found they still needed files, and the early APLs rapidly acquired them.

The next thing to happen was that someone noticed that VDUs were two-dimensional. In APL they found a notation capable of handling screens as they appeared to the user instead of a line at a time. All sorts of little data-editing applications sprang up as people learned how easy it was to set up a screen and scroll it up and down their data.

The two areas of financial planning and data enquiry must still account for about 90 percent of APL usage world-wide. This will change, since both areas are highly susceptible to packaged solutions. The big expansion of APL is going to be into decision support and short-term planning.

Here you need fast prototyping and a flexible response to changing needs. The systems are a mixture of generic tools — text editors, data managers and statistical analysers — and system-specific one-offs. The APL functional structure allows you to build bottom-up as well as top-down. Faced with a new problem area you can start by automating the individual tasks. The way they link into a finished system will evolve as your own understanding improves. In fact the design may never be totally fixed, and you often need to pull a system apart and reassemble it in a different order.

As a notation APL is hard to criticise, but as a computer language it has a good many serious problems. The first and most obvious is the character set. You need specially adapted keyboards and printers, and even then there is a hitch. APL was chiselled from a standard IBM "Selectric" golf-ball which did not have enough different symbols available. Consequently many of the characters are actually overstrikes; ϕ is O backspace/. Fair enough on a Teletype, but overstrikes on a VDU?

The next big problem with APL lies in linking it to other computer systems. Most companies already have a huge investment in data conventionally structured as files and records. To turn it on end into collections of lists is a major overhead, but even so it may be better than ploughing through sequential files with an APL system. As long as the data is set up to its liking, APL is at least as efficient as a typical compiled language. If it is forced to process 10,000 records the interpretive cost goes through the roof and the efficiency is dreadful. Be warned!

APL needs a lot of working storage to run really well. Until recently this was a limitation on big mainframes, let alone on micros but some very clever people have now got APL going on 64K CP/M systems. The results are astonishingly effective, but real memory is still better and I doubt if there will be many home-computer APLs in the near future. The £5,000 hard-disc, 16-bit systems are a different matter.

For a long period APL flourished only within the confines of IBM. When it finally flew the nest it was already the well-rounded product APLSV. Soon it became the very similar VS APL which set a world standard for other APL systems.

The early eight-bit systems were simple subsets, and the new versions such as M-68000 APL and VIZ::APL for CP/M are entirely VS APL compatible except for the inevitable micro features. The main problem lies with the APL provided by the time-sharing systgems. IP Sharp Ass. and STSC inc., the two main vendors, have fallen over each other to provide all sorts of new and fancy features. At least they co-operated on their file systems, but they have recently diverged from each other on the idea of general arrays. These structures are a major upheaval in APL thinking — any array element can be another array, and so on *ad infinitum* — and to have incompatibility from the start must be a bad idea.

To make matters worse IBM has now announced a provisional APL-2 which almost follows STSC, but not quite. It will be followed soon by a Unix-based Dyalog APL for the 16-bit systems. This too has a variety of new features.

Incompatibility between file systems and screen handling was inevitable. You could easily cover for it by burying all the hardware-dependent bits in APL functions. But divergence in the basic notation is serious. If you do go the APL route, my advice is to avoid anything which strays far from the original VS APL standard. To the APL whizzkids VS APL may seem awfully backward, but it is still far more powerful than any other current language.

APL will never oust Basic as the *lingua franca* of the micro world; neither will it go away. As systems get ever more complex, the power of APL and other languages like it will be increasingly in demand.

Non-recursive approach.

```
     HANOI DISCS;MOVE;POS
     --------------------
  [1]  ⍝NON-RECURSIVE SOLUTION TO THE HANOI TOWER PUZZLE.
  [2]  ⍝
  [3]  ⍝FIRST SET UP THE MOVE NO'S IN BINARY FORM; ONLY THE
  [4]  ⍝TOPMOST <ONE> BEING LEFT ON:
  [5]  ⍝THE DISC TO BE MOVED IS GIVEN BY THE POS OF THE ONES.
  [6]  ⍝∘∘ SAVED ON  24/01/83  AT  12.51.

  [7]   MOVE←<\⌽⍉(DISCS⍴2)⊤¯1↓⍳2*DISCS

  [8]  ⍝MAKE ALTERNATE ROWS +/- TO FORCE DISCS TO
  [9]  ⍝CYCLE WITH OPPOSITE HANDEDNESS.
  [10] ⍝THE POSITION OF EACH DISC AT ANY TIME IS THE
  [11] ⍝CUMULATIVE OF THIS, BUT EXPRESSED IN MODULO-3.

  [12]  POS←1+3|+\MOVE×(⍴MOVE)⍴DISCS⍴1 ¯1
  [13]  'MOVE DISC    : ',⍕MOVE⌈.×⍳DISCS
  [14]  'TO PEG       : ',⍕⌈/POS×MOVE
      ∇

    HANOI 4

MOVE DISC    : 1 2 1 3 1 2 1 4 1 2 1 3 1 2 1
TO PEG       : 2 3 3 2 1 2 2 3 3 1 1 3 2 3 3
```

Basic

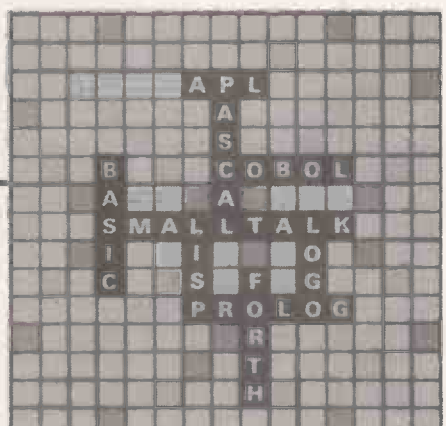
THE COLONY OF NORTH AMERICA, 1647: a New England province has enacted a law requiring towns of 50 or more householders to set up schools. The act embodies a spirit of popular education, preparing the nest in which the egg is to be laid. The egg is Basic.

The site of the nest was the small town of Hanover, sheltering among the maple trees between the White Mountains of New Hampshire and Green Mountains of Vermont. In 1769 it acquired, in accordance with the Act, a private institute of higher learning called Dartmouth College. The college in turn acquired, though some later, a mainframe computer and Fortran.

Fortran was widely used to introduce beginners to the world of programming, but it is oriented towards punched-card data entry and heavy number crunching and needs to be compiled. Such features classify it as a black art rather than a tool of popular education, or so, at least, thought two professors at the college, John Kemeny and Thomas Kurtz. In the early 1960s they introduced a new approach on the college's time-sharing terminals. They called it Beginners All-Purpose Symbolic Instruction Code, a mouthful that boils down to the useful and familiar acronym Basic.

The aim of Basic was to make it possible for non-experts to wring sense out of a computer terminal without committing themselves to a career as programmers. To this end the language was originally restricted to a handful of possible statements, and these statements were English-like.

Although this development certainly helped improve the readability of complete programs, line-by-line comparison with Fortran equivalents suggests that much of the anglicisation was achieved simply by stripping down the original idea. For



instance, Fortran's

```
Write (2,15) NUMBR1, NUMBR2,
NUMBR3
FORMAT 316
```

defines both the direction of the output — 2 is usually the user's console — and the format in which it is to be laid out — 15 is the line containing the format statement.

In the Basic it would become:

```
10 PRINT N1, N2
```

The formatting here is elementary: the

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variables are represented in a predefined manner according to their data types, and the comma represents a fresh start at the next tab field.

As Basic grew in size most of the dialects adopted a Print Using variant that included the format pattern in-line, as in Microsoft's:

```
10 PRINT USING "**$##.##"; CASH
```

Developments of this kind highlight both the strengths and weaknesses of the language.

Alongside anglicisation and its concomitant restriction of the instruction set, a second fundamental feature has made Basic addictively easy to use. In developing Fortran software the programmer writes a text file which then has to be processed by a kind of filter program called the compiler, and then possibly undergo a second process called linking before becoming executable code. Most Basics sweep aside this sometimes lengthy process by allowing the user to write a text file — usually in a line editor built into the language — and run it immediately, making it appear that the lines of instructions are being executed directly.

Although a standard is on the horizon there are too many existing varieties of the language to be definitive about what Basic is and what it is not. But the broad outline of how the language works can be seen by considering the way it handles data types and the three fundamental programming constructs of sequence, decision and iteration.

Basic can deal with two main types of data: character string and numeric. Most Basics subdivide numeric type into integer, single- and/or double-precision decimal values. Arrays of these data types can be created: string arrays are typically limited to a dimension of 2.

Values can only be stored in variables that match their type. The variables are known to the program by names made up of alphanumeric characters, the first of which must be a letter of the alphabet. In the simpler versions of the language, variable names can not be longer than one or two characters. More sophisticated dialects, like Microsoft's Extended MBasic and Digital Research's CBasic, allow names to be any length although the number of characters that are significant is still restricted to 40 for MBasic and 31 for CBasic.

Variable types are either declared in-line by using special characters in the variable name — for example, C$ indicates a string variable, C% an integer — or set up beforehand with some such construct as:

```
10 DEFSTR A-D
```

which declares any variable name beginning with the letters A, B, C or D to be a string variable.

Within these types there is no declaration of the variables themselves, as in Pascal. But arrays with subscriupts larger than a certain minimum value, usually 10, have space set aside for them in memory with the Dim statement. Most Basics for micros do not allow numeric arrays to be manipulated without breaking them down into their component parts, but matrix arithmetic by way of the Mat statement is often a part of Basics for larger systems.

Instructions in Basic code are written as a simple sequence of instruction lines. Each line must be numbered: instructions will be carried out in the order of the numbering, not the order the instructions have been entered. Any departure from numerical sequence as a result of decision or iteration has to be in reference to these line numbers.

Classic Basic has no way of calling a procedure by name. Functions, however, may be predefined out of line with the define function statement, thus:

```
5 DEF FNA(X,Y) = 2X/Y
```

and subsequently used in the program in a statement such as:

```
100 PRINT FNA(20,10)
```

which will produce the answer 4.

Basic uses an If-Then construction of the form:

```
100 IF X = Y THEN GOTO 120
```

On condition that the first part of the statement is true, X = Y, the second part of the statement, Goto 120, will be executed. If it is not true the next-highest numbered statement will be performed.

Most Basics allow adding an Else clause to define an alternative course of action, and usually If-Then-Else statements can be nested to cope with multiple-choice decision making. Classic Basic has no decision construct to match the Case statement of Pascal, but an On variable Goto construct appears in all but the simplest implementations.

Some of the more sophisticated Basics include constructs like While-Wend to continue looping while a particular condition remains true, and Repeat-Until to continue looping until a particular condition becomes true. Classic Basic has only the For-Next loop, which takes the form:

```
10 for N = 1 to 20
15 PRINT "PRACTICAL COMPUTING
   RULES OK"
20 NEXT N
```

A skilful programmer can work wonders with this simple idea, but so, unfortunately, can an unskilful one. If you enjoy debugging you will love the unpredictable boundary conditions that arise when you do computations or decisions inside the loop on the index variable that is counting the iterations.

The original idea of Basic as a *passe-partout* into the world of computing has been subverted by the proliferation of dialects. Often, as in Spectrum Basic, the language has been extended to address screen handling, colour graphics and the manipulation of special printers. The manufacturer delights in these hardware-dependent flourishes because they tend to lock customers into one upgrade path — his own. But the manufacturer has a fine excuse. Because Basic is gauche in the way it handles parameter-passing to procedures written by the user, it is much easier all round if specialist routines are prefabricated in the factory.

The few landmark dialects that are not machine dependent include Microsoft Basic, CBasic, XBasic and XTal Basic. They are outlined in the panel opposite, and all run under CP/M. The language turns up everywhere: Basic is currently running on giant multi-user mainframes and on palm-sized computer/calculators. I have only come across one operating system that does not support some form of Basic.

Compilers are designed to produce faster, compact code. In so-called interpreter systems like classic Basic the conversion to machine code takes place line by line, with two sometimes unwelcome side-effects. Routines will run a good deal slower — a factor of 10 is typical — and a proportion of the CPU's address space is filled by wadges of code hanging about like extras on the set of *Dark Crystal*: they may not be necessary for the day's work, but they had better be there in case they are suddenly needed.

For the learner the interpreter approach has very striking advantages. Basic throws your mistakes back at you when and where you make them, rather than obliging you to disentangle error messages later from a compiler printout. You can even try out instructions without having to write a program. Most versions of the language allow a Direct mode, in which single lines can be evaluated, so that if:

```
PRINT MID$("NEWHAMPSHIRE",3,4)
```

returns "Wham" you'll know that you and your Basic are in accord about the meaning of the Mid$—pronounced "mid-string"—function.

Common objections to the Basic include

If-Then-Else nesting leads to tangled coding where there are many choices to be made. Classic Basic has nothing resembling the Case statement of Pascal, which allows complex decision points to be coded with decent transparency.

It's not the fault of Basic that it has a Goto instruction — so, after all, do most other languages in some form or other. But the structural inadequacy of Basic means that programmers can too easily rely on Goto, and the result is "spaghetti" code whose execution paths become too entangled for the human observer to follow, and therefore to debug.

Some structuring is allowed for in the Gosub instruction, which returns the execution path to the point of departure. But the Return is not guaranteed: it is perfectly legal in Basic to include a Goto in the called subroutine that sends the program counter on a one-way ticket to somewhere else. Proper programming disciplines have to be brought in from outside to avoid this sort of thing. So in this sense Basic is teaching you nothing about programming.

Parameters cannot be passed to subroutines; Instead the basic programmer has to set global variables. You can picture this problem by imagining a boss in his office giving instructions to his staff. By picking up a telephone he can speak to each of them directly without risk of confusion. Without his telephone he has to throw open his office door and shout. Global variables used to send values to parameters are shouted Instructions.

According to Professor Kurtz, Basic is a moving target. The metaphor is revealing: in the language of business "targets" represent problems; a language should be a well-aimed arrow, a solution. Arrows converge on targets, whereas one of Basic's problems has been the divergence of dialects.

A forcible attempt at convergence is in progress. For nine years an ANSI committee has been sitting on the question of a standard for Basic, and the current proposed draft is due to be given a dry run this year. Some of the more far-reaching developments in the proposed version are:

- The standard comprises a mandatory core set of instructions and five optional modules relating to files, graphics, real-time applications, fixed decimal for money handling, and editing.
- The new version formally adopts on-line comments isolated from the code by !, 31-character variable names, floating-point arithmetic, and a larger set of geometric functions with a choice of degrees or radians.
- There is to be streamlining of the string-handling functions already provided in many dialects, and a Mat statement for handling one- or two-dimensional arrays.
- Iteration is enhanced with a versatile Do loop construct which may be written with the decision at the beginning or the end of the loop to emulate either the While-Wend or Repeat-Until construct. Multiple-choice decision points can be created with the Select-Case construct.
- Multi-line predefined functions, already allowed in some dialects, are now standard. In compiled versions of the language, parameter-passing to sub-programs is formalised, allowing local variables. Chaining to other programs is adopted — they need not be Basic programs. Argument lists may be passed.
- Print Using will be able to adopt either Fortran-type formatting where the picture is in a separate line, or the Microsoft-style statement that carries the picture in-line.
- Error-catching facilities extending the scope of Microsoft's On Error Goto family of statements will be included.

Microsoft Basic
Very widely used and richly endowed dialect. It can handle random files though rather awkwardly, and is also available as a stand-alone operating system. An almost compatible compiler called Bascom allows you to generate fast machine-code versions of successfully debugged programs. Sadly, support for versions that run under CP/M is currently taking second place to Microsoft's big push into its own 16-bit operating systems, MS-DOS and Xenix.

XBasic
A British engineering and maths oriented language with powerful matrix-handling features unusual in micro Basics. XBasic is designed to work closely with the CP/M family of operating systems, and understands CP/M user numbers. For multi-user systems special MP/M facilities like password handling are built in.

CBasic
Around the time of Microsoft's decision to cut loose from CP/M, Digital Research nipped in quickly and bought up this very popular pseudo-compiled Basic from Compiler Systems Inc. Now there's a true compiled version called CB-80, and a version for the new 8086/88 chips called CB-86. CBasic's most notable feature is to allow multi-line user-defined functions.

XTal Basic
Another British product, not to be confused with the XBasic. It was originally developed for the Nascom but has grown up into a sophisticated language with a choice of screen- or line-based editors. A specially interesting feature for those who know a little about Z-80 machine code is that you can easily extend the language yourself, adding up to 64 extra reserved words.

The BBC TV educational series on microcomputing and other sources of wisdom frequently suggest that Basic is valuable for teaching you about something called "computing", or more abstractly "computer literacy". In fact the language we have been calling classic Basic is really not much good for much more than teaching you Basic. The arguments for the educational value of Basic recall the discussion about the importance of teaching Latin in public schools. I suspect that there are parallel forces at work here: Basic is taught because it is eminently teachable.

Apart from the variety of specialist Basics used for handling particular peripherals like colour terminals, plotters and industrial process-control devices, Basic is ahead of Cobol as Europe's number-one business data-handling language for microcomputers. It remains to be seen whether the new standard will help pull together the variety of already established dialects, and enable Basic to hold its own in business and engineering against the encroachment of the newer structured languages like Pascal, C and ADA. But something better than Basic must start circulating around the schools before long. Educationally speaking, the Dartmouth college egg has hatched a cuckoo.

C

THE C PROGRAMMING LANGUAGE is a versatile, expressive, well-structured language that can produce very compact and efficient programs. It can also be baffling to look at, easy to mess up, and very tricky to learn. You either love it or hate it.

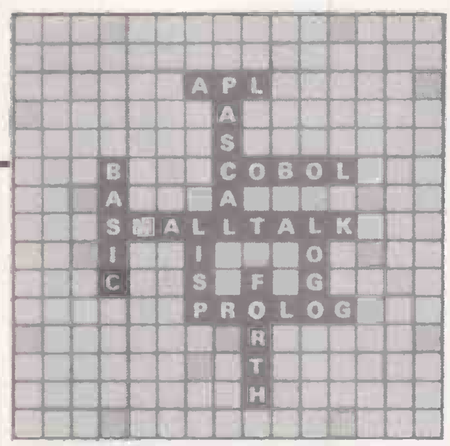
More and more programmers are taking the trouble to learn C. It is an ideal tool for system programming, that is for writing editors, utilities, interpreters, compilers and even operating systems.

The history of C is indeed closely linked to the Unix operating system. Bell Laboratories developed C as the means of implementing Unix on the Dec PDP-11. About 94 percent of Unix was written in C, as were many of its subsidiary utilities. C and Unix share many design rinciples and the early C compilers, themselves written in C, ran under Unix.

In spite of their close links, C is in no way tied to Unix. C compilers have been produced for dozens of operating systems and machines, especially micros. What's more, the different implementations of C are remarkably consistent, and you will find it far easier to transfer C programs from one system to another than you would with programs in Fortran, Basic or Pascal.

This portability is even more surprising when you consider that there is no formal standard for C. The language was largely specified by one man, Dennis Ritchie. The only reference book on the subject is *The C Programming Language,* published in 1978 by Prentice-Hall, which Ritchie wrote in collaboration with Brian Kernighan. This book is the C user's bible and is universally known as "K&R".

For the flavour of C, take a look at the listing. It is taken from K&R and shows a



routine for putting an array into ascending order by means of a shell sort. It is clear that C is hardly an English-like language. While the Pascal for incrementing a counter:

```
i: = i + 1
```

is fairly obvious, the same cannot be said of the C equivalent:

```
i++
```

Nor is it obvious that

```
a = i++
```

(continued on page 113)


TOMORROW'S OFFICE

(continued from page 111)

means set a equal to i, then increment i. Its meaning is quite different from

a = + + i

which increments i before setting a. Such subtleties make C a veritable minefield, and the beginner must go very carefully.

On the other hand, these same subtleties make C a very compact language. In many cases a single C statement may be used where two or three statements would be needed in Pascal or Basic. A good example of this is the For loop. In Basic, a For-Next construct only allows you to define a simple arithmetic progression for a control variable: you set its initial value, final value and increment. In C you may specify any type of initialisation for the loop, any condition to terminate the loop and any other action to be performed within each cycle. They need not all be concerned with the same variable nor with whatever statements, if any, are executed within the body of the loop

The shell-sort routine includes three nested For statements that illustrate the point. In Basic, you would probably need at least six statements to control the loop, rather than the three used here. But the Basic code would certainly be a lot clearer to the casual reader.

The same applies to C's other control-flow constructs. They include the familiar If-Else, which you can nest as deeply as you like, a While, and Do- While. There is also a Case- Switch, with a handy default label to take control if none of the switches applies. C even supports a Goto with symbolic labels, but K&R share the universal dislike for this statement and advise that it be used sparingly, if at all.

Another way in which C provides compactness is its rich set of operators. They include the usual arithmetic add, subtract, multiply, etc.; the relational equals, greater than, etc.; and the logical And, Or and Not. In addition, C has four less familiar types of operator: incremental, bitwise, assignment and conditional.

The incremental operator is found in the i+ + construct already mentioned. It is similar to the assignment operator, which enables a variable to be assigned a new value based on itself. An example is the statement:

gap / = 2

which halves the value of the variable Gap.

The bitwise operators provide a handy method of manipulating bits. They include a bitwise And inclusive Or, exclusive Or, ones complement, and left and right shifts. The conditional operator offers another example of C's brevity:

val = (a = = b) ? 1: − 1

This means that if a equals b, Val becomes 1, otherwise it becomes − 1.

What I badly miss in C is a set of operators for handling character strings, though C does at least provide a defined method of storing strings — unlike Pascal where it is left to the individual compiler to determine. But there is no easy way of moving strings around, concatenating them or comparing them. Neither is there anything like Basic's Left$, Mid$, etc.

Many of these standard functions are themselves written in C, and are accessible to the programmers — you can modify them and add to them. Most serious C programmers maintain their own function libraries which form the basis of all their programs. Each C program is a collection of functions ultimately controlled by a relatively short main section. The shell sort shown in the listing is an example of a function.

To find out what versions of C are available on miros I turned to the work of Jim and Gary Gilbreath, two Californian researchers who have collected benchmark tests on over 250 language implementations. The Gilbreaths identified 38 version of C, 12 of which were written for Z-80 based systems under CP/M.

One of the better ones turned out to be BDS C, which clocked 15.2 seconds in a standard prime-number benchmark. By comparison, the slowest C compiler, Tiny C, took 15 minutes for the same test. Fastest times for other languages were: Fortran, 13.9s.; Pascal, 19.0s.; compiled Basic 17.7s.; and interpreted Basic 24 minutes. There is also an interpreted version of Tiny C that took over an hour, but then nobody uses an interpreter in time-critical situations.

The Gilbreaths would be the first to admit that a simple prime-number routine cannot tell the whole story on a compiler's performance, but in other tests BDS C continued to score well. The total time needed for it to compile and link a small program was 20.7 seconds, against the slowest — Whitesmiths C — which took five minutes. In another benchmark, this time oriented towards input and output, BDS C came fourth, the fastest compiler being the Telecon Systems version of C.

BDS C supports most of the language elements described in K&R. Its main deficiency is the lack of a floating-point data type. The function library includes routines for communicating directly with CP/M via the operating system's BDos and Bios modules. There are also a number of plotting functions for memory-mapped video boards. The manual is well produced but I found it difficult to understand in parts, probably because my command of American slang is a bit rusty.

The main objection to BDS C — and the reason that I would not use it regularly — is the fact that the compiler does not produce standard relocatable object modules. This means that you cannot easily combine C programs with routines written in other languages. The compiler outputs its own relocatable format which is not compatible with Microsoft-type Rel files.

For this reason I normally use the Supersoft C compiler. It is distributed in the U.K. by Digital Devices of Tunbridge Wells at around £125. The Supersoft compiler generates assembler source code, which is then processed separately by a suitable assembler, such as CP/M's ASM or Microsoft's Macro-80. This means that you can "hand polish" the compiled program, an invaluable feature although perhaps not one that many programmers would use regularly.

Supersoft C lacks a number of language features such as static variables, initialisations and the Goto statement, but I have never felt hindered by these deficiencies. The function library is even better than the one supplied with BDS C, and the Supersoft manual is concise and easy to read.

Another compiler to consider is Whitesmiths C, although it is hard to see just why it is so popular. True, Whitesmiths is probably the most complete implementation of C on a micro. But the compiler is slow and difficult to use, and at around £320 it is not particularly cheap. What's more, Whitesmiths has chosen non-standard names throughout the function library, so to copy a string you have to call Cpystr, while most other C compilers use Strcpy.

C has recently started to become very popular — even something of a cult — and this is certain to continue. For the programmer who wants to do things that are simply not possible in Basic but who does not want the hassle of assembly-level languages, C is the answer to a prayer.

Though C is not the easiest language to master it is certainly worth the effort. It is compact, expressive and very portable. I would not necessarily choose C for programming a payroll or a sales ledger. But for any type of systems programming, for time-critical functions, for utilities, and for applications involving close interaction with the operating system or hardware, C would be my first choice every time.

Shell-sort routine.

```
shell (v,n)                     /*  shell sort, with acknowledgements
                                    to Kernighan & Ritchie            */
int v[], n;
{
        int gap, i, j, temp;

        for (gap=n/2; gap>0; gap/= 2)
                for (i=gap; i<n; i++)
                        for (j=i-gap; j>=0 && v[j]>v[j+gap]; j-=gap) {
                                temp=v[j];
                                v[j]=v[j+gap];
                                v[j+gap]=temp;
                        }
}
```

Cobol

EDSGER DIJKSTRA, that guru of programming proclaimed: "Teaching Cobol ought to be regarded a criminal act." Rather a damning statement you might say, and one that should not be taken lightly. A statement of that kind stimulates response; which is perhaps why Dijkstra made it.

In Cobol's case the response is a positive roar from the tens of thousands of Cobol programs and the similar number of Cobol programmers currently writing and maintaining them.

Cobol began life in 1959 as the brainchild of the U.S. Pentagon with a brief to design a *c*ommercial and *b*usiness *o*riented *l*anguage: It was trendy in those days to make languages oriented—Algol, Dibol, Snobol and Sol. Almost from its day of inception Cobol became the standard and most popular language utilised by computer users and software houses for building business software.

Systems of virtually unlimited complexity can be created easily by using Cobol's powerful overlay-handling capability. Standard file definitions, record definitions and procedures can be named and stored in a centralised library and included in just those programs which require them. For special applications a Cobol program may link to assembler code, but for most business uses this is unnecessary.

Within Cobol, data management is simplified because sequential, direct and indexed sequential file handling, together with sorting, is built into the language. Any type of record can be brought into memory by a single Read operation, and from then on processing is simple. All its fields are immediately available within the record area, just as if they had been coded as part of the program. Special string-handling functions are not required since individual fields or contiguous groups can be processed by simple Move statements.

By avoiding "expensive" constructs such as dynamic arrays and dynamically sized string variables the run-time environment necessary to support Cobol is simplified. In consequence, Cobol programs often execute up to 10 times faster than similar tasks programmed in the more trendy languages. Thus Cobol is usually the choice where efficiency is important — either to process large files as quickly as possible on a mainframe or, increasingly, to squeeze the very last ounce of performance out of a business micro.

Many attempts have been made over the years to dislodge Cobol from its position of pre-eminence. Notably IBM's launch of PL-1 in the late 1960s — deemed a failure — and a total failure in the all-important American market. PL-1 was popularly known in those days as IBM's friendly elephant, no doubt because of its size, slowness and the length of its memory. PL-1 was newer, better, covered both commercial and scientific programming, and over the years became more efficient, but Cobol withstood the challenge.

All languages, notably Basic and already Pascal, suffer from the wide range of dialects and variants which emanate from computer manufacturers seeking to offer the market that little bit extra. Cobol has its variants, but the degree of difference has remained remarkably small. The powerful figure of Captain Grace Hopper, USN has been influential in maintaining the original standard. A programmer trained in one version of Cobol can easily assimilate differences in another version and quickly become productive — a factor on which most of the world's software houses trade for the benefit of their clients and their own profits.

Cobol has also lead the way in showing how a programming language should develop. It should not be done by endlessly making dramatic changes to the language — although the American standards committee currently has caused a furore by proposing some major enhancements. Much better to leave the language largely alone and improve it by introducing separate programs — optimisers, meta languages, decision-table preprocessors and report generators.

Detractors say Cobol was designed for mainframes and has not progressed to microcomputers. The microcomputer manufacturers whose job is to define what the market requires would have it otherwise; hence their adoption of Cis-Cobol, Cobol 80, RM/Cobol, and BOS Software's MicroCobol, for example. Some say it has been done so that mainframe Cobol programs can be downloaded on to micros or micros can be used as program builders for mainframes. Yet no system builder worth his salt would defend this argument. Different system techniques must be used for micros and mainframes. Cobol compilers are available for micros because of the incessant demand for Cobol on micros for micros.

I forgive Dijkstra for his comment, and commend any interest taken in providing computer training in schools. Starting with a sound knowledge of computing a competent Cobol programmer can be trained in a matter of weeks and become productive soon after. It is for this reason that most in-house company programming training courses use Cobol as their chosen language. Cobol has long ceased to attract the interest of the academic community but when it comes to cutting commercial code quickly and competitively, Cobol is still out in front.

Forth

THE CHIEF WAY in which Forth differs from conventional languages is that you develop it yourself as you use it. It grows with you and it grows on you. What you are developing is not just programs but the language itself.

I cannot do better than quote Charles Moore, the inventor of Forth, in his foreword to a recent book: "I developed Forth over a period of some years as an interface between me and the computers I programmed. The traditional languages were not providing the power, ease or flexibility that I wanted. I disregarded much conventional wisdom in order to include exactly the capabilities needed by the productive programmer. The most important of these is the ability to add whatever capabilities later become necessary."

Moore was an astronomer at Kitt Peak observatory in the United States, and Forth was developed to control the observatory. The incentive to write this language — as it turned out to be — was the inadequacy of Fortran for the purpose. Forth is therefore unique in that it was written by a user, as distinct from a computer theoretician. Surprisingly, although Forth was written for a special purpose, it is not a special-purpose language. It would be as much at home handling the observatory accounts and records as it is in controlling the telescope and instruments.

The ability of Forth to grow so as to meet a user's needs is more important than its well-known speed advantage. The language is based on a dictionary of words which are referred to as verbs because when they are invoked from the keyboard something happens. Such a facility is not unknown in other languages. Basic, for example, has a handful of reserved words for performing certain operations, but the whole of Forth consists of such words.

Forth words are not reserved, and the development of the language consists of words which you yourself define. These words take their place in the dictionary and are equal in importance with the words initially provided by the system. The dictionary is not arranged in alphabetical order but in chronological order. A word at a given location in the dictionary may be either a primitive, which is defined directly in machine code, or else a secondary defined by means of words deeper down.

How may I define a word? Suppose for example I type

TESTING

and press Return. Forth responds by repeating the word followed by a ?, which means "never heard of it". However, if I now type

: TESTING ;

and press Return Forth will ever after greet "TESTING" with a cheeful OK. The word is now legitimate and resides in the dictionary, but it is a dummy with no action.

By means of the colon/semicolon combination you can define words with a specific action. You have to be careful, since a Forth word consists of any set of characters which can be typed from the keyboard, but just like the words of this article they must be separated from other words by at least one space. A colon is such a word and semicolon another.

If I type VList the dictionary is displayed and I see, among others the word Key. When I try this one nothing much appears to happen, but the system hangs up. It is waiting for me to press a key. I do so, choosing the letter A, and I immediately get the OK which is Forth's response when it likes what you do. The system is alive again. If I now type . the machine responds by displaying 65, which is the ASCII code for the letter A. The word Key will return the ASCII code for any key pressed. The code was tucked away somewhere waiting to be displayed by the . character usually called Dot.

There is also a word Emit which could be used instead of Dot, but it returns the actual character instead of the number. You could have some fun with it by intercepting the code and altering it before it is put out to the screen. You could, say, add 3 so that D is emitted when you type A. If you now put this in a repetitive loop a crytogram results.

You need a loop structure, so define a word Cypher thus:

: CYPHER BEGIN KEY 3 + EMIT AGAIN ;

If you now type Cypher, all the instructions which follow in this definition will be executed:

- BEGIN starts a loop performing the commands which follow until Again is reached.
- KEY waits for a key to be pressed and stores its ASCII code.
- 3 + adds 3 to the ASCII code.
- EMIT writes to the screen or terminal device.
- AGAIN causes an unconditional jump to Begin and hence to Key, and so on.

The only way to stop this cycle is to use the Break key or switch off the machine.

Cypher can be thought of as a small program which is run by simply typing the word and hitting Return. After doing that everything will be in cypher. For example.:

CYPHER JRRG£PRUQLQJ

is simply "good morning".

With this simple application there are a number of disadvantages. The space bar returns a £ and the Return key does not work. Non-alphabetic keys should be allowed to work normally, so you have to employ conditionals. First test to see if the key struck is alphabetic by asking if the ASCII code is greater than 64. This is done by means of

64 >

which tests the stored value against 64 and returns a True flag if it is. However, the number storage used is temporary and any test of the stored number removes it. So you have to duplicate it before testing. This is done by

DUP 64 >.

Dup does the trick.

With a simple sequence it is not necessary to use a defined word, but as an illustration you can:

: ALPHA? DUP 64 > ;

Anyway it will prevent you forgetting the Dup. The Forth word If looks for the flag and executes the code which follows if it is true. The syntax is:

: CYPHER BEGIN KEY ALPHA? IF 3 + ENDIF EMIT AGAIN ;

There is still the possibility that the addition of 3 will take you past Z. You could subtract 26 if this were the case to

(continued on next page)

Figure 2.

```
: DISENCRYPT   3 -  ;
: TOO-SMALL?   DUP   65 <  ;
: ADJUST2      26 +  ;
: DECYPHER
     BEGIN  KEY  ALPHA?
        IF   DISENCRYPT   TOO-SMALL?
           IF   ADJUST2  EMIT
           ELSE          EMIT
           ENDIF
        ELSE             EMIT
        ENDIF
     AGAIN
```

Figure 1.

```
: TOO-BIG?   DUP   90 > ;
: ADJUST   26  -  ;
: ENCRYPT   3 +   ;
: CYPHER
  BEGIN   KEY   ALPHA?  ( is it alphabetic? )
     IF ( if true ) ENCRYPT     TOO-BIG? ( has it now gone over the top? )
        IF ( if it has )   ADJUST   ( bring it back ) EMIT   ( and print it )
        ELSE ( if it hasn't )  EMIT ( print it )
        ENDIF
     ELSE  ( or was it non-alphabetic? )  EMIT   ( print it )
     ENDIF ( that key's done one way or another )
  AGAIN  ( go round again for the next key )
```

Figure 3.

HEX AND ACII DUMP ' DECYPHER NFA 38 DUMP

4AF9	88	44	45	43	59	50	48	45	.DECYPHE
4B01	D2	E5	4A	BE	E	D4	A	AB	REJ>.T.+
4B09	4A	32	9	18	0	C4	4A	D9	J2...DJY
4B11	4A	32	9	A	0	EF	4A	EC	J2...0JI
4B19	E	13	9	4	0	EC	E	13	.....I..
4B21	9	4	0	EC	E	13	9	DE	...I....
4B29	FF	37	C	4	44	55	4D	50	7..DUMP

(continued from previous page)

achieve wrap-around. It needs nesting using syntax shown in figure 1. Notice the free use of comments, which may be placed anywhere in the text but must be enclosed in brackets. The space after the left bracket is essential. For completeness you can now decypher — see figure 2.

In use this produces as an improvement on the previous application:

CYPHER JRRG PRUQLQJ
DECYPHER GOOD MORNING

There are obviously many more loop structures available such as:

BEGIN (do this) (test) WHILE (do that) REPEAT
BEGIN (do this) (test) UNTIL

The first of these carries on until the test fails, the second till it succeeds.

N1 N2 DO (do this) LOOP

repeats from the value N2 until the value N1 is reached.

Temporary storage is achieved by means of a parameter stack, which will usually hold about 60 16-bit integers, the most accessible number being the last entered. An operator removes the operands and replaces them with the result. Much cunning footwork can be performed on the stack by means of operators which manipulate the order in which the contents are arranged.

Forth is fast and flexible, and it is not easy to achieve both these qualities in one language. Assembler is faster in execution but much less flexible and much more expensive in program development time. The reason is that Forth uses two stages of interpretation. In the first of these, which is called compilation although it does not produce directly executable code, the addresses of the code of the constituent words of a definition are collected in sequence in the parameter field of the defined word ready for interpretation and execution at run time. These addresses are of course 16-bit numbers.

The word structure can be seen in the core dump shown in figure 3. The Forth word ' operates on Decypher to return its parameter field address. This is converted to the name field address by the word NFA, and Dump puts out 56 bytes of memory, starting at the NFA, in eight-byte blocks.

The 16-bit numbers on the left are the starting addresses of each row. The rows of bytes which follow are the contents of consecutive addresses. On the right is an ASCII conversion of the bytes. All numbers are hexadecimal. The first byte 88 is the character-length of the word. The seventh bit is set by convention. The next eight bytes form the actual defined word.

The byte pairs which follow are addresses. The first of these, 4AE5, is contained in the link field address, LFA, of Decypher and is the address of the name of the preceding dictionary entry. The next address is the execution address or code field address, CFA, which is where the action starts. It points to the inner interpreter. After this there is a succession of addresses of the code field of the constituent words in the definition.

This describes what is meant by compilation in Forth. No names or code of constituent words are found here, but only pointers to code. It is referred to as indirect threaded code, IDC.

Forth is portable and is available for almost all micros. There are a number of implementations of FigForth which may exhibit minor differences, and there are some similar threaded languages such as Stoic and IPS.

Forth interest groups flourish in several countries, the parent body being in the U.S. The address of the secretary of FIGUK is: K C Goldie-Morrison, 15 St Albans Mansion, Kensington Court Place, London W8 5QH.

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Lisp

LISP LISTINGS are instantly recognisable by the liberal smattering of brackets — or, to be correct, parentheses. It has been suggested that Lisp stands for "lots of irritating single parentheses". This is because Lisp has a feature which it shares almost uniquely with machine code — the programs are in the same form as data.

A single item of Lisp is called an atom, and the simplest type of atom is the integer. Most Lisps handle the standard integer range of −32,768 to +32,767. However, it is not uncommon, even on micros to find a Lisp which will handle "infinite-precision" integers which means that numbers can grow as large as they like, up to the RAM limit of the machine. This feature often goes with rational numbers, which allow the computer to deal with fractions like 36/419 completely accurately by storing them as infinite integers. Real numbers tend to take second place in Lisp, as it is used more for mathematics than for calculations.

The most interesting type in Lisp is the character atom. It is a little like a variable in Basic, but with some interesting twists. A character atom has a name — John, for example, and a value. The Lisp program fragment.

```
(SETQ JOHN 3)
(PRINT JOHN)
```

is equivalent to the Basic

```
100 JOHN = 3
110 PRINT JOHN
```

Both give John, the value 3 and then print it out.

You can continue a Lisp program like this quite correctly:

```
(SETQ JOHN 'ASTRING)
(PRINT JOHN)
```

which is equivalent to

```
120 JOHN = "ASTRING"
130 PRINT JOHN
```

Basic programmers will have spotted that line 120 will give an error, because John is a numeric variable not a string variable. In Lisp a character atom can have a value of any type at all.

Lisp character atoms are more flexible than Basic variables in two other ways. Firstly, the name of the variable is a perfectly good character string and Lisp programs can print it out and usually manipulate it. Secondly, Lisp character atoms can have extra values called properties. By using the Lisp line:

```
(PUT, 'JOHN 'FATHER 'FRED)
```

you can add the fact that John's father is Fred without upsetting the value of John.

When you want to group data together in Lisp, you use a construct called a List. It looks just like a list of items surrounded by parentheses, for example:

```
(MILK 6 CHEESE LYMESWOLD CAR)
```

Both programs and data structures are built up and out of lists and lists of lists.

Lisp programs are based on functions, some of which like SetQ and Print, are predefined. Writing your own programs is a matter of adding new functions which you write yourself. A function in Lisp is more like a function in Pascal or subroutine in Fortran than a Basic subroutine. It has a name, you pass parameters to it, it returns a value and it does not interfere with variables used by other functions. This means that structured programming ideas can be applied to Lisp easily.

Suppose you want to define a new function to tell you whether a person has blue eyes. Assume you have a database of people who have the property Eyecolour defined. Listing 1 shows what you would type to define the new function Blueeyes. The initial Define says that you are defining a new function. Next comes the name, then a list of the parameters you are going to pass to Blueeyes. The program passes one parameter, which will be called Person. Last comes the definition itself.

Looking at this from the inside out

```
(GET PERSON 'EYECOLOUR)
```

retrieves the Eyecolour property for the person; Equal then compares the value of Eyecolour with Blue and returns T for true or Nil, which is Lisp for false. This value is returned as the value of Blueeyes. You can now use Blueeyes like this:

```
(BLUEEYES 'JOHN)
```

which will return true or false.

Lisp functions are usually more complex than this and often contain Cond, the Lisp equivalent of Basic's If. It is also very common for Lisp functions to be recursive, which allows them to deal with data whose complexity is not known in advance. For example, listing 2 counts all the atoms in a nested list L. When the program is run using:

```
(ATOMCOUNT '(CARROT ((ONION
  LEEK)SALSIFY) BEAN))
```

it returns the value 5.

Lisp is ready for the enormous artificial-intelligence research programs that are usually run on large mini or mainframe computers. On microcomputers, manipulation of algebraic equations is made possible by the Mu-Lisp/Mu-Simp package. Another application in the academic field is a formal logic theorem prover which has been implemented in owl Lisp on the Apple II. With supermini or mainrame power available, the range of applications for Lisp broadens to include most of artificial intelligence.

The greatest advantage of Lisp is its flexibility, which has led to it being compared with machine code. There is no need to reserve fixed-size arrays for data, allowing indefinite levels of nesting of lists and recursive function to process them. Programs can be generated to create or modify programs and immediately use them as subroutines. Lisp is often used like machine code to create a higher-level programming language, in which Lisp itself is hidden away.

Expert systems can encapsulate the accumulated wisdom of human expert, and Lisp can be used to create the structure into which the person's expertise can be slotted. Production systems allow you to program with a set of statements like

If x happens then do y

without worrying about how all the events interact; the Lisp structure can take care of that. For micros, Lisp has the advantage that it is possible to create a Lisp interpreter to fit in a small amount of available RAM.

On the minus side, Lisp data tends to take up more space than it does in Basic because of the structuring information that goes with it. There are problems using Lisp for real-time applications or even interactive games because Lisp makes regular "garbage collections" which can hold the program up for several seconds.

Current Lisp interpreters tend to concentrate on internal efficiency and leave out any input/output aids. For example, output formatting like Basic's Print Using and support for random access to disc are rare.

All of these are really problems of the implementation rather than of the language itself, however. Lisp is now available on Apple, Commodore, Acorn Atom, BBC Micro and CP/M machines and a growth in interest seems likely as the commercial exploitation of knowledge based systems grows.

Listing 1.

```
(DEFINE BLUEEYES (PERSON)
    (EQUAL (GET PERSON 'EYECOLOUR)
'BLUE))
```

Listing 2.

```
(DEFINE ATOMCOUNT (L)
(COND ((NULL L) 0)
      ((ATOM L) 1)
      (T (PLUS (ATOMCOUNT (HEAD L))
               (ATOMCOUNT (TAIL L)) )) ))
```

Logo

MORE THAN a computer language, Logo is also an idea, a philosophy of what a computer language ought to be like. Its inventor and prophet, Seymour Papert, describes himself as an educational utopian. He has held chairs in mathematics and education at The Massachusetts Institute of Technology and studied under the Swiss educational philosopher Jean Piaget. Logo reflects these influences. It is primarily used to introduce children to computing and is Piagetian in its approach.

For Piaget and his followers, learning is a process of exploration and discovery that should not be pushed faster than the natural stages of a child's development. In applying this guiding principle to a computer language, Papert and his colleagues have produced a procedural language which can be approached at a number of different levels. A child of eight or nine can use its graphics capabilities.

At the same time, Logo is a high-level language as powerful as Basic, Pascal or Forth. The Logo community's view of computing's place in an educational curriculum is totally different from that enshrined in the phrase "computer-assisted learning." Papert dismisses CAL: "The important thing is not to teach children mathematics, but to teach them to be mathematicians." Nor is he trying to provide a language, which can be taught in computer science classes like Basic.

Logo really requires hands-on experience, allowing a child to build up her or his own vocabulary of procedures, beginning from a relatively small set of simple commands. One of the first implementations of Logo, at Edinburgh University in the early 1970s, allowed children to drive wheeled drawing pens over large sheets of paper. These devices were known as turtles, and they can still be obtained from Terrapin Inc. in Boston or from Jessop Acoustics in Britain. In micro implementations of Logo, the turtle appears on the monitor screen as a stylised pictogram which is used to draw shapes on the screen, using the paddle to direct it if you like. Logo is best known for its graphics, and the label "turtle graphics" seems to have entered the language of microcomputing.

Programming in Logo is not unlike programming in Forth. Each program has to be broken down into a series of procedures — in Forth they are called words — each of which can be called by name. Another feature of Logo which is particularly dear to its inventors is that it is fully recursive. The best analogy for recursion is people standing between two mirrors and seeing themselves in an infinite series of images in either direction.

The educational philosophy standing behind Logo is best understood by reading Papert's book, *Mindstorms,* subtitled, "Children, Computers and Powerful Ideas". At a different level, you can catch some of the intellectual flavour of Logoland by reading Douglas Hofstadter's book *Gödel, Escher and Bach, An Eternal Golden Braid.* The ultimate accolade was accorded in August last year when *Byte* magazine devoted most of its annual languages issue to Logo, providing an invaluable source of current information.

Logo is a dialect of Lisp — named from List Processing — which has been a favoured language of the articial-intelligence research community in the United States since the late 1960s. They used powerful machines, and Lisp's drawback from the perspective of the microcomputer user is that it is very greedy in its use of memory. Research in this area at Edinburgh was slowed in the early 1970s because the government would not fund the purchase of a Dec 10.

During the last two years Logo has appeared as a language for microcomputers, with implementations for the Texas Instruments 99/4, Apple II and TRS-80. Logo Computer Systems Inc, LCSI, a company formed in Montreal to produce implementations of the language for different micros, is working on at least 14 more versions. Customers include Sinclair, Acorn and two or three Japanese companies.

LCSI Logo, on the other hand, has the potential to be a more powerful programming language. The dilemma is this: LCSI Logo is very accessible and extremely tolerant of error, but it expects the user to put in a large number of programming hours in order to explore the capabilities of the language, as an activity undertaken for its own sake. The best comparison of the two Apple implementations—Krell and Terrapin market the same MIT version with different frills — is to be found in Harold Abelson's *Logo for the Apple II,* from Byte Publications. A fuller bibliography is available from the British Logo User Group. Logo for the Apple II has been available commercially for little more than a year in its present forms. Users with prior experience of microcomputing seem to prefer the Terrapin and Krell Logo, with its fuller links to the rest of the world.

Radio Shack's Color Logo for the TRS-80 is the newest Logo offering. Its limitation is that it is designed only for graphics applications, and has none of the powerful programming features found in the Apple Logos. Unlike the other implementations, Colour Logo was not produced by members of the original MIT team. In Britain too, a completely different implementation has been produced by the Department of Artificial Intelligence at Edinburgh University for the Research Machines 380-Z. Ken Johnson of Edinburgh University, which can rightfully claim a worthy second place to MIT in the development of Logo, has produced *The Hitch-hiker's Guide to Logo* expressly for the 380-Z implementation.

Most people's choice of Logo implementation will be dictated by the microcomputer they already own. But if you own an Apple II you need to think carefully: the version produced by LCSI and marketed by Apple is the most powerful and it is also the first micro version to satisfy Papert, but it is a sealed black box. There is no provision for calling in machine-language routines; no obvious way of writing Rem statements into your programs; no way of using normal DOS commands; and no Trace feature for help in debugging your procedures. Instead of a nomal Trace command, the LCSI Logo tries to be helpful in its comments. For example, if you put :Rightangle instead of Right :Angle, Logo would have printed:

I DON'T KNOW HOW TO RIGHTANGLE

which is probably more comprehensible to a child than a trace procedure.

The version marketed by Krell Software and Terrapin Inc. overcomes some of these deficiencies but lacks some of the powerful features available in the LCSI Apple Logo. LCSI makes the user a prisoner of the system: its Logo is virtually user-proof, and fulfils the inventors' purpose of forcing you to explore the microworld of Logo in its own terms. It may well be best for school use, especially where children learn their computing through unsupervised, hands-on experience.

Putting his theories to the test, Papert last year joined the World Centre for Information Science and Human Resources in Paris. Although he fell out with the Centre's political patron, Jean-Jacques Servan Schreiber, and left within nine months, he helped a group of programmers from Senegal to implement a version of Logo in Wolof, the national language of Senegal and the Gambia. There are also implementations in French, German and Spanish.

Pascal

WHEN I WAS PREPARING this piece and the example program to go with it, a couple of people looked over my shoulder and asked what was I doing. I explained that I was writing a Pascal program to illustrate what one looked like, and then explained how the program worked. Both these people were Basic programmers, and when the Pascal program was shown and examined both thought that it seemed a sensible language — possibly more so, they pondered, than Basic.

Pascal is a computer programming language designed to be easily understood by those learning programming. As many will testify, the use of Pascal does make the teaching of programming much simpler, though perhaps more regimented.

Pascal is a language which has arisen from the flames of the funeral pyre for N Wirth's unsuccessful submission for a successor to Algol 60. Wirth's ideas were not very novel and were mainly designed to clarify and simplify; some of them were first seen in the form of Algol W, but the birth of Pascal was made public in 1971.

Portability is one of Pascal's strong points, and has always been one of the aspects which Wirth has emphasised. Unfortunately, the emphasis on portability and standardisation has a deleterious effect on the implementation of new features. What has happened is that Pascal has spawned many more specialised languages for specific purposes, rather than extending the language itself, for example, Pasqual, Concurrent Pascal and Modula.

Apart from standard Pascal there are at least three major versions. Pascal-P, which has a portable compiler written in terms of a hypothetical stack computer, which has its own hypothetical assembly language known as P code. Pascal-S, developed by Wirth to overcome problems with scheduling student batch jobs, has a restricted set of data structures and control structures, UCSD Pascal is probably the most popular version on microcomputers and is a P code implementation with additions, such as turtle graphics.

The best way to introduce Pascal to an audience which knows other languages is to approach it through examples. My main example is the number guessing game Hilo, for which Basic versions are legion. The computer chooses a number which you have to guess, with the computer telling you whether your guess is too high or too low.

Pascal is a procedure-based language, and even the main program is best seen as a procedure. The program starts with a heading and a name, together with the names of the files to be used. The name program is Hilo, and the files are Input, Output.

```
PROGRAM HILO (INPUT,OUTPUT);
USES APPLESTUFF;
VAR TRIES, CHOICE, NUMBER : INTEGER;
PROCEDURE REQUEST;
  BEGIN
    WRITE ('ATTEMPT ', TRIES,' ');
    READLN (CHOICE)
  END;
BEGIN
  RANDOMIZE; NUMBER : = RANDOM MOD
    100 + 1;
  TRIES : = 1;
  WRITELN ('HILO — A NUMBER GUESSING
    GAME');
  WRITELN ; WRITELN;
  REQUEST;
  WHILE CHOICE < > NUMBER DO
    BEGIN
      IF CHOICE < NUMBER
        THEN WRITELN ('GO HIGHER')
        ELSE WRITELN ('GO LOWER');
      TRIES := TRIES + 1;
      REQUEST
    END;
  WRITELN ('CORRECT IN ', TRIES)
END.
```

The program runs on an Apple II using a library of procedures called Applestuff; before you use the procedures you have to tell the program. The program uses three integer variables, Tries, Choice, and Number. Before you use them you have to tell the program to set space aside for them, otherwise the program will give an error message.

At various places in the main program a Request will be made for the user's guess; the request is turned into a procedure which has to be defined before it is used. The procedure does not have any variables particular to it, and so does not have any parameters or variable declarations.

The Write procedure does not go to a new line, and so when the value of Choice is read the input is on the same line, and ReadLN puts in a carriage-return so that the program output moves to next line.

After the end of the procedure the main program body begins. It Randomises — an Apple II special function — initialises, Tries the computer's number, prints a heading and requests the first value. While the choice is not equal to the computer's Number, the program does some printing; If the Choice is greater than Number it Then prints Go Lower or Else prints Go Higher. The number of Tries is incremented by 1, and it makes its Request. When the Choice equals the computer's Number it goes to the WriteLN, which tells you how many guesses were taken.

This program in no way does justice to the more powerful aspects of Pascal, which can be illustrated by reference to some well-known problems in Pascal. The first insecurity lies with the Pascal feature which allows the definition of Types. Consider the following:

```
TYPE A = ARRAY [1..20] OF INTEGER;
VAR M1 : ARRAY [1..20] OF INTEGER;
    M2 : A ;
```

which shows the definition of a new type of data structure called A, which is a 20-element array. The variable M1 is defined explicitly as such an array, whereas M2 is defined as being of type A,

(continued on next page)

Figure 1.

IFX=Y THEN IF W=Z THEN A:=1 ELSE B:=1;

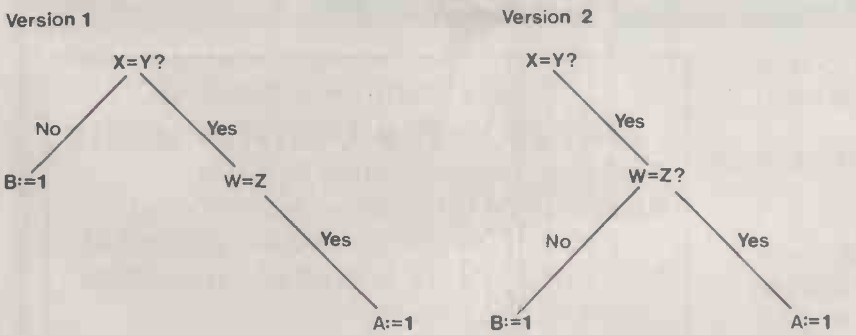
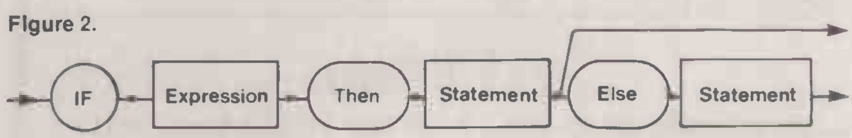


Figure 2.



THE IF STATEMENT: SYNTAX DIAGRAM

(continued from previous page)

which is implicitly an array. As far as Pascal is concerned, variable M1 and variable M2 are of two different types and cannot be equated. These definitions also point to another drawback of Pascal for scientific computing: the array bounds have to be constants and cannot be varied, so dynamic array parameters are not possible in library procedures.

A different kind of problem is presented by the dangling Else. The line

```
IF X = Y THEN IF W = Z THEN A: = 1 ELSE
   B: = 1;
```

has two distinct possible meanings — see figure 1. The interpretation given by Pascal comes from the syntax diagrams — sometimes called state diagrams — which indicate how the lines of Pascal are analysed.

Figure 2 is a syntax diagram for the If statement. It shows that when the Pascal translator comes to an If it then expects an expression, such as X = Y, to be followed by a Then which in turn is followed by another statement. But in the example the statement at that point is another If, so the procedure is followed yet again. This time the expression is W = Z, and the statement after the Then is A: = 1 and so the Else becomes operative with the statement being B: = 1. As the Else has been used by the second If there is no problem with the Else for the first If — there isn't one.

As a system-development language, Pascal has much to offer, though both Digital Research and Microsoft use other languages, but for constructive programming for mortals on microcomputers it is not particularly powerful. P J Brown notes that it is possible to adapt a batch language for interactive use, just as you can fit wheels to a ship so that it can travel on land; the results are not always satisfactory. Languages such as Forth and APL are also compiled and are designed to be interactive in use, though both have other disadvantages.

To be used to its best advantage Pascal needs large memory, good file handling and needs a sophisticated operating system. Apple is the only microcomputer manufacturer to have taken Pascal completely on board: its Lisa is a Pascal machine. Most manufacturers now offer Pascal but usually Basic is the prime offering. People need an interactive programming language, not a modified batch language.

Versions on microcomputers tend to be either variants on the UCSD Pascal system, which is adequate without being excellent — and contains bugs, I suspect, in the coding of floating-point routines — or programs which are offered as compilers on the same basis as other compilers. Recompilers, such as MTPlus and TRS-80, are sometimes very good in specific areas but frequently place restrictions on the version of Pascal used. UCSD Pascal is not only a variant of Pascal but also a complete system, and if Pascal is to be truly of use for programming then they will need to establish such environments.

Pascal is probably now at the peak of its popularity. It will not disappear, but will come to be seen as one among many other tools. With the advent of machines with much greater memory available — perhaps languages such as APL, Forth or more human versions will become the way forward. C A R Hoare, one of the key figures in Pascal, has just invented a new language. Called Occam, it has a very simple structure — like Pascal.

Pascal bibliography

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Microcomputer problem solving using Pascal, by K L Bowles; Springer-Verlag, 1977

Writing interactive compilers and interpreters by P J Brown; John Wiley, 1979

Structured Programming by O J Dahl, E W Dijkstra and C A R Hoare; Academic Press, 1972

"A generalisation of Algol", by N Wirth, *CACM* 6, 1963

"A proposal for a report on a successor to Algol 60" by N Wirth; *Report MR75* Mathematics Centre Amsterdam, 1965

"The design of a Pascal compiler, by N Wirth, *Software — Practice and Experience* 1, 1971

Prolog

MOST PROGRAMMING LANGUAGES are designed for easy calculation with numbers, and some also support string handling and complex file operations: Basic, Fortran, Cobol, Pascal all fall into this category. More sophisticated versions help if the task is more specialised: APL, for instance, when the numbers are in matrices; RPG-2 when the operations are writing a report. Some are also extensible and self-defining, such as Forth.

Like most AI languages, Prolog is not a number-file-processing language but a symbol-processing language. The program variables refer to symbols or structures of symbols rather than numeric, text, key fields and records. Instead of procedure calls or subroutine calls, a Prolog program is internally organised by inference steps in which logically related statements of the program are tried by the run-time system in computing a solution. Finally, the program statements are written in a simple logical form which, like APL for matrices of numbers, is particularly appropriate to symbolic processing problems.

Prolog has recently emerged as a promising candidate for building relatively more intelligent computer systems. Such systems are more flexible and need less specialised care and attention to create and maintain. They are capable of inferring appropriate responses on the basis of stored knowledge and rules of skill and they can communicate more fully with the users. These properties might not necessarily imply a natural-language interface — graphics interfaces are at least as likely — but they do mean that explanations are constructed rather than simple canned text ouputs, and that they directly reflect what the program is doing rather than some explicitly programmed and triggered message outputs.

Suppose you have a list of people:

Alan
Barbara
Cecil
Didcot
Eustace

All the information you have at present is that:

Barbara is the offspring of Alan,
Didcot Is the offspring of Alan,
Cecil is the offspring of Barbara,
Eustace is the offsprlng of Barbara.

How would a computer set about finding who are the descendants of Alan? A Prolog program for this problem would be as follows:

```
descendant (X,Y): — offspring (X,Y).
descendant (X,Z): — offspring (X,Y),
   descendant (Y,Z).
offspring (alan, barbara).
offspring (alan, dldcot).
offspring (barbara, cecil).
offspring (barbara, eustace).
```

First of all, you have to make it clear to the computer what "descended" means. You do so by giving it rules which state under which conditions it is true to say that someone is descended from someone else. If you are someone's offspring, then obviously you are descended from them, so Y is a descendant of X if Y is an offspring of X. The definition Prolog is

descendant (X,Y): — offspring (X,Y).

This is the first line in the program, which is a Prolog statement of "clause". On the left of the sign :— is what you want to be true; on the right the conditions for it to be true.

The second line of Prolog expands on the idea of "descended". It states what conditions must be met to be sure that a person is indeed descended from their grandmother or more remote generations.

descendant (X,Z) :— offspring (X,Y),
   descendant (Y,Z).

Its logic is: Z is a descendant of X if Y is the offspring of X and Z is descended from Y. In other words, you are a descendant of your grandmother if you are descended from your mother, who is the offspring of your grandmother.

Figure 1.

The last four lines of Prolog simply specify the known relations, for example

offspring (barbara, cecil)

which means, Cecil is the offspring of Barbara.

If you now want to ask the computer a question, it must also be in Prolog. In more sophisticated systems a parser would decipher some simple English sentences into the appropriate form by performing grammatical analysis to produce precise knowledge of the interrelationships between words in the sentence. From that, its consequent meaning is found with the aid of a dictionary.

In this example, the question to the computer must be coded:

?descendant (X, alan)

which means "what are all the instances of X who are descended from Alan" or "who are Alan's descendants?"

If the computer tackled the problem logically it would follow a path something like:

Well, I know that Barbara + Didcot also offspring of Alan because they told me so in the program, "offspring" is a word mentioned in rule 1, looking at it, Alan's offspring are also descended from hlm. Therefore X could be Barbara or Didcot. By rule 2, it seems that you can also be a desendant of someone if you are the offspring of a person already categorised as a descendant. If they told me Eustace + Cecil are offspring of Barbara, then they too are descendants of Alan.

This kind of logical thinking is made into a fixed, repeatable procedure by the resolution principle. If the computer publishes its result, a list

Didcot, Barbara, Cecil, Eustace

would be printed.

At some point, the computer used the fact that Barbara was descended from Alan, helping itself to information without being told to. There are no line numbers or instructions like Goto 260, or declarations like Let A$ = "alan". One way of representing the information in the program is an upside-down tree — see figure 1.

Prolog has been used in several expert systems developments with some very impressive results, for example at Edinburgh University. One particular system, called Mecho, makes skilful use of high-school mathematics methods to solve various exam-type physics questions. It does so by relying on logically phrased descriptions of small methods which it uses as steps in the problem-solving process. Further "meta" information guides its selection of methods and steps towards a solution of any problem given. This is much more economical and skilful than simply trying every possible alternative, for computers and humans both. Finally, it can describe what it is doing, why it is trying one or another line, and so on.

This higher-level window into the system can also mean that we may begin to instruct computers at higher levels by

(continued on next page)

Prolog directory

Programming in Prolog by W Clocksin and C Mellish; Springer-Verlag, 1982. A complete introductlon to Prolog.

Expert Systems Ltd, 34 Alexandra Road, Oxford: offers courses, publications, Prolog systems and consultancy.

Logic Programming Associates, 36 Gorst Road, London SW11 6JE: oifers Prolog, especlally a version called microProlog designed for use on Z-80 processors.

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suggesting plans or goals, rather than by typing programs and commands. Such facilities are built into all expert systems languages, but Prolog provides many necessary facilities usable directly as a low-level tool or for constructing more task-specialised expert-systems languages.

Prolog is a very general computing language, but it is certainly not the ultimate or only language to use inside AI or outside it. At least two other AI languages are distinguished and will probably be used for decades — U.S. Lisp and U.K. Pop-2. The new object-oriented and functional languages might well be as prominent as Prolog fifth-generation computers. These too are being seriously studied and developed by the Japanese for their own special properties, and a unified language may eventually emerge.

One general reason that the Japanese have chosen Prolog for the fifth-generation computers is that it has a very simple theoretical model — much simpler than Basic, Fortran, etc. Much theoretical work is now under way at Imperial College, London and elsewhere to enable analysis, specification, generation, modification, testing, documentation, etc. of Prolog programs to be performed entirely automatically. Prolog's special simplicity has meant that results are already being seen. This capability is important all along the route to the fifth-generation goal of computers which do not need an army of programmers, and can be used directly by end-users.

Prolog is also distinguished from other languages in having a declarative reading in the form of a purely logical description or specification. Normal languages are only procedural. You program a special software machine which does things — adding numbers, jumping, etc. — and the only way of understanding it is by following its sequence of actions. Prolog can also be understood procedurally, that is by tracing through the way the run-time system makes use of your Prolog program.

The declarative reading carries just the same information, but as a description of what is meant rather than how it is to be done. Among other advantages this means that Prolog programs, read as specifications, can be used to control many processors simultaneously and without placing any special burdens on the programmer. In other words, programs could go faster, or be more sophisticated, by using thousands of 1990s equivalents of Z-80s, rather than having to build a giant mainframe for the job.

Prolog also interfaces very easily with relational databases — it is actually a relational language. Relational databases provide a very simple and neat method of storing and using any kind of data in anticipated and unanticipated ways. Current-generation Japanese business microcomputers already contain simple file handlers of this kind, and the fifth-generation plan includes the use of these techniques for entire computer systems. Combined with Prolog, a very productive systems tool results.

The question must be asked: How will all this be used in practice? Will people be helped in jobs or put out of jobs? Will the wealth of nations increase, or only that of a few individuals? Will we teach or repress with our new systems? It is in application that the greatest questions are now to be found. In this area, the Japanese do not have a monopoly. We can consider what we do and do not want right now, for the "personal market" has a very considerable influence on what aspects of computing are developed most.

Prolog history

1965 J Robinson develops the resolution principle, essentially a method for deciding whether a given collection of formal, logical statements is consistent or self-contradictory. It has the special advantages that it can be implemented on a computer, and it can be shown always to give correct answers — if there are answers at all

1972 A Colmerauer develops the Prolog language. The name derives from its original purpose, programming in logic by resrictlng the kind of logic to which the resolution principle applies to a language in which programmers do some of the high-level work, formulating problems from which the Prolog system can infer answers.

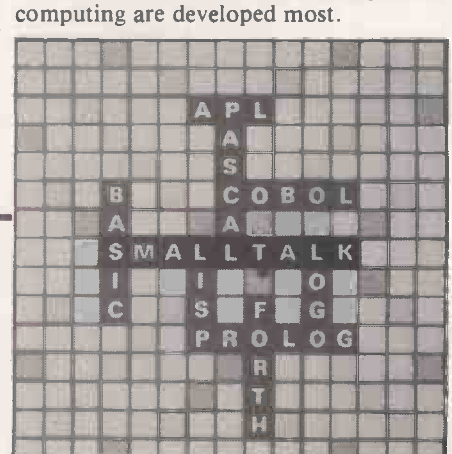
1976 R Kowalski develops logic programming. The new language is put on a firm theoretical footing, and ideas are developed of how logic can actually be used in programming difficult and useful tasks.

1977 D H D Warren develops a Prolog compiler allowing Prolog programs to be run approximately as fast as the fastest Lisp program doing the same kind of task. Thus major practical AI developments in Prolog become possible.

1979 Japan chooses logic programming for the next generation. The Japanese effort to design a fifth generation of computers has the published goals of making computers far more useful for wide-ranging industrial, commercial and social tasks, and for promoting international co-operation among nations. It is planned to do this using machines with much improved powers of storing and using complexly related knowledge; the starting point for the central co-ordinating language is Prolog.

1982 Prolog publically becomes available in the U.K.

Smalltalk



UNLIKE THE OTHER languages described in this issue, Smalltalk cannot be tried out by readers. It quite simply is not available in the U.K., nor even in the United States unless you have privileged access to Parc, Xerox Inc's Palo Alto Research Center, where the language was developed.

There are plenty of machines which could run Smalltalk, including Xerox's own Dandelion and ICL's Perq, which was built by engineers who left Xerox. The problem seems to be that Xerox cannot make up its mind how best to exploit an evidently hot property.

Those who have used Smalltalk like it very much, and ideas which originated with the Smalltalk project are appearing in new machines — Apple's Lisa is a prominent example and in advanced versions of Lisp. Xerox seems to be quite schizophrenic on the subject. It encouraged the wide publicity given to Smalltalk in a special issue of *Byte* magazine in August 1981 — which remains the most comprehensive source of information on Smalltalk; at the time it seemed as if the language would be made available, but unfortunately there was no follow up.

Subsequently, four companies in the United States, including Intel, Digital Equipment and Texas Instruments were provided with the source codes to allow them to build their own Smalltalks and to think through the hardware implications. But they were not licensed to distribute the language. So unless there is a well-guarded bootleg version, you can forget about using Smalltalk until Xerox makes up its corporate mind.

It might be worth bearing Smalltalk in mind when looking at Apple's Lisa. According to Apple's Larry Tesler, quoted in the same issue of *Byte*, the machine that best matches Smalltalk's strengths is a personal computer with a high-resolution display, a keyboard and a pointing device such as a mouse to point to objects on the screen and select the desired manipulation.

Tesler worked at Parc before moving to Apple and the philosophy of Lisa as expounded by Apple sounds very like Tesler on Smalltalk. The user interface, with a wheeled mouse moving a pointer on the high-resolution screen, seems to be identical. Probably the best hope of a relatively accessible Smalltalk would be for Xerox to license Apple to distribute it for use on the Lisa. The trouble with that fantasy is that Xerox, too, makes computers.

The most obvious external features of Smalltalk are multiple overlapping windows and the ability to deal with text, graphics, symbols and numbers in a uniform fashion. Smalltalk is often described as a "programming environment", in which all the information stored is accessible in a unified and co-ordinated fashion.

Like several of the other languages dealth with in this issue, an understanding of Basic does not get you very far in understanding Smalltalk. In the first place, Smalltalk is not a procedural language. It is object-oriented, meaning that Smalltalk does not distinguish between procedures and data.

The building blocks of Smalltalk are objects, which are grouped into subclasses, classes and superclasses. Objects which are members of a given class share properties, which in turn are objects and themselves form classes.

The idea of classes with particular properties comes directly from Simula. The user communicates with the system by sending messages to the objects, which also pass messages amongst themselves. To quote Dr Tim O'Shea, the only British expert on Smalltalk, message passing is the universal mechanism/metaphor for all operations in Smalltalk. The notion of message passing appears in the latest implementations of Lisp, and begins to give Lisp some of the characteristics of an object-oriented language.

A message contains two elements, a selector and an argument. The object requiring the message has two essential properties which allow it to act on the message: a list of private variables or other objects and a list of methods. The methods are, if you like, procedures, but they are proper to the receiver object, not to the message which calls the object.

The relationship between these four parts may be described by an analogy. Suppose I send a message to my local computer dealer and say: "Please sell me a computer (selector). I mostly need it for word-processing (argument)." The dealer can deal with my message in any way he likes. His private variables are computers in stock, software packages, programmers, alternative suppliers of other machines. His "methods" I leave to your imagination.

The message does not determine how an object will react, only the end result — I get a computer. This is extremely helpful in avoiding type mismatch, something which cannot happen in the Smalltalk environment. It is not a strongly typed language; in fact, it hardly seems to be typed at all.

I ought to stress that I have not laid my hands on a Smalltalk machine, and if I had Xerox would have sworn me to secrecy. But enough is known to say that Smalltalk is one of the contenders for the title of "the language of the next decade", and its intellectual parentage is therefore important.

Alan Kay, now with Atari but for years the presiding genius at Parc, was one of the founding fathers of personal computing in the United States. One of his visions of the future is the "dynabook", a high-performance, hand-held computer with access to large stores of data, equally at home with graphics or text, and using a high-resolution screen, making it as easy to read as printed text.

The Learning Research Group at Parc began to work with Alan Kay's idea, using a language called Simula, which was object-oriented to a degree but still retained Algol for some functions. Simula was developed in Sweden by a group including Kristen Nygaard and Graham Birtwhistle and was, as its name suggests, originally developed for simulating real-world events. Its object orientation came from this source, as the objects were allowed maximum flexibility in reacting with one another, giving results which could not necessarily have been predicted by the user of the program, much less by the programmer.

Smalltalk has been through at least four versions — 72, 74, 76 and 80 — each building on the lessons of the earlier implementations. It was originally implemented to run on the Alto, a hand-built 16-bit machine which is the lineal ancestor of the Xerox 1100 series, including the Dorado and the Dandelion, and also of the Perq.

Alan Kay provided another of the seminal ideas, overlapping windows, though the idea of different windows on the display screen was not itself invented at Parc. The originality was to allow the windows to be shuffled like papers on a desk. It is characteristic of Smalltalk that its features seem to derive from a world of paper and print rather than from a world of data processing.

The immediate examples are the idea of a dynabook, messages, and the editing commands Cut and Paste, and Copy and Paste. Two years ago when Xerox introduced its Smalltalk-influenced Star executive work station, it was presented in terms of a simulation of an executive's desk, complete with folders, correspondence and reports. The Lisa makes the same kind of pitch.

Smalltalk has been extensively tested with children but, unlike Logo, it is not easily accessible to the casual first-time user. You need some practice before the screens can be made to work their magic. According to the Lisa's champions, anyone can learn to use it in 20 minutes. But even if the Lisa's resident programming language turns out to be Smalltalk-like in structure, this does not mean that people will be able to cope with Smalltalk after 20 minutes.

One of the virtues claimed for Smalltalk is that you can forget modes for ever. No longer will you have to go from Edit mode to Entry mode to Execution, or from text to graphics to catalog.

All modes are one, which is clearly an aid to learning one's way around a system. Furthermore, it means that regularly used operations can easily be taught to a user of the machine. Even if the Lisa achieves something of the kind without Smalltalk, the intellectual inheritance is clear.

Computing gurus on both sides of the Atlantic believe that Smalltalk is an idea whose time has come. They point to the rather clumsy attempts of programmers in conventional procedural languages to produce integrated packages combining word processing, spreadsheets, database management and graphics. Context MBA was first in the field and is being followed rapidly by VisiCorp and VisiOn. VisiCorp's offering not available yet, but the Lisa knocks spots off Context MBA, which is hard to learn and very primitive by comparision. If Smalltalk, or at least the ideas lying behind it, can bring text, graphics and spreadsheets together, it will be a major advance, and the Lisa will not for long remain an expensive luxury for executives who cannot or will not type.

It seems almost inconceivable that Xerox will continue to drag its feet. At some point over the next two or three years Smalltalk will be upon us, either as a software product licensed to run on several different machines or as the principal programming language on some new personal computer offered by Xerox. It is still possible, I suppose, that Smalltalk will remain a seminal influence, its ideas reproduced and cannibalised by others.

Unless Xerox makes a move, the last scenario may best describe Smalltalk's fate. That would be sad, as the Learning Research Group at Parc clearly made a major contribution to the theory and practice of personal computing under the leadership of Alan Kay. It would be nice if the world could see their creation whole, not served up piecemeal by the agile entrepreneurs who have followed in their wake. Over to you Xerox.

Buyers' guide

Which languages run on which micro—and where to buy them.

CP/M Systems

ADA			
ADA	two-pass compiler	Software	£185
ADA	requires 56K	TCL Software	£350
Algol			
Algol-60	structured language compiler	Lifeboat Associates	£100
APL			
APL V80	large subset of APL/SV	Lifeboat Associates	
VIZ:APL	fullest eight-bit implementation	Inner Product	
APL	requires 56K	TCL Software	
Basic			
Basic 48	enhanced Basic for 8048 chip family	Small Systems Engineering	
Bazic	similar to North Star Basic	Xitan	
CBasic	Basic compiler	Microsoft	
KBasic	extended disc Basic	Lifeboat Associates	
MBasic	the standard Basic interpreter	MicroSoft	
Micro Business Basic	special implementation	Solitare Business Systems	
TCL Basic	10K interpreter	TCL Software	£55
XBasic	scientific Basic variant	Xitan	£175
Basic-80	standard interpreter	MicroSoft	£195
Basic Compiler	compatible with Basic-80	MicroSoft	£215
SBasic	8080 version	Software	£175
Xtal Basic	cassette or disc	Crystal Research	£40
BCPL			
BCPL Cintcode	compact systems programming language	Richards Computer Products	£150
C			
C'	developed from BDS C compiler	Tamsys	£470
Tiny-C	interpreter	Software	£90
Tiny-C Two	compiler	Software	£125
Whitesmiths C	requires 56K	TCL Software	£470
BDS C	requires 48K	TCL Software	£75
Cobol			
Cis Cobol	standard Cobol compiler	Xitan	£430
Cobol 80	standard Cobol compiler	TCL Software	£145
Nevada Cobol	fast version of the business language	ASRO Information Systems	£95
Bos Cobol	runs on almost any system	MPSL	£400
Comal			
Comal	a structured language	TCL Software	£145

16-BIT MICROS

BCPL			
BCPL	8086, Z-8000 and 68000 versions available	Richards Computer Products	
Basic			
CBasic/86	16-bit version of CBasic	Digital Research	£223
CBasic-16	CBasic for Unix	Digitial Research	
C			
C	for the DEC Rainbow 100	Digital Equipment	£335
Whitesmiths C Compiler	Unix version	Software	£565
C	two-pass Unix compiler	Software	£135
Cobol			
Level II Cobol	provides mainframe Cobol power	Micro Focus	£965
Cis-Cobol	CP/M 86	Micro Focus	£425
Bos Cobol	Sirius, IBM, etc.	MPSL	£400
Coral			
RCC 86	Coral 66 Compiler for the Intel 8086	Micro Focus	
Forth			
PicoForth	8086, 6800 version of Forth	Computer Solutions Ltd.	
Pascal			
Pascal/I	Z-8000, 68000, 8086 implementation	Hemingway Associates	
Pascal/MT + 86	CP/M 86 supports 8087 maths processor	Digital Research	£550

Forth			
Forth	powerful, fast micro language	Computer Solutions	
Forth	Supersoft Forth	Digital Devices	£140
Forth	requires 56K	TCL Software	£45-100
Stoic	non-standard version	TCL Software	
Z-80 Forth	in any format	Microprocessor Engineering	£45
Fortran			
Fortran 80	compiled scientific language	TCL Software	£220
		Software Ltd.	£180
Fortran	ANSI standard		
Ratfor	similar to Fortran 77	Software Ltd.	£70
Lisp			
Lisp 80	Lisp interpreter	TCL Software	£42
muLisp	7K interpreter, infinite precision	Lifeboat Associates	£120
Lisp	includes an editor	Software	£105
Pascal			
JRT Pascal	compiler and run-time interpreter	Lifeboat Associates	£130
Pascal/M	scientific Pascal	Lifeboat Associates	£235
Pascal/M +	extended version	Lifeboat Associates	
Pascal/Z	generates Z-80 code	Lifeboat Associates	£230
Pro Pascal	full implementation of standard Pascal	Prospero Software	£190
TCL Pascal	extension of standard Pascal	TCL Software	£120
UCSD Pascal	full development system	Lifeboat Associates	
MS Pascal	ISO standard Pascal compiler	Microsoft	
Tiny Pascal	subset of Pascal	Software Ltd	£65
Pilot			
Pilot	teaching language	TCL Software	
PL/1			
PL/1-80	commercial applications structured language	TCL Software	£325

ACORN ATOM

Turtle Talk	version of Logo in ROM	Baker	£18
Lisp	5.5K cassette-based interpreter	Acornsoft	£17.25
BBC Basic	with both ROM and RAM	Acornsoft	£49.95
Forth	interpreter, cassette based	Acornsoft	£17.25

APPLE

Tasc	Applesoft Compiler	Apple dealers	£99
TransForth	special Apple version of Forth	Pete and Pam	£60
Mickie	special-purpose query language	Systemics	£50
Pascal	complete language system	Apple dealers	£250
Apple Pilot		Apple dealers	£79
GraForth	Apple graphics language	Pete and Pam	£65
Business Basic	for the Apple III	Apple dealers	
Pascall III	UCSD for the Apple III	Apple dealers	
Transforth III	Forth for the Apple III	Pete and Pam	
Basic Compiler	for Apple II	Pete and Pam	
Cobol-80	business language	Pete and Pam	
Fortran-80	scientific compiled language	Pete and Pam	
App-L-isp	Lisp for the Apple II	Pete and Pam	
MuLisp	small implementation of Lisp	Pete and Pam Computers	

ATARI

Basic	included with 800	Maplin	£49.95
Basic A +	disc	Silica Shop	£48.95
MicroSoft Basic	more advanced	Maplin	£59.95
Pilot	on cassette or cartridge	Maplin	£54
Pilot (educator)		Maplin	£79.95
QS Forth		Maplin	£49.95
Tiny-C		Maplin	£64.95
InterLisp/65		Maplin	£87
Extended FigForth	full implementation	Silica Shop	£28.45
Pascal	requires two disc drives	Silica Shop	£35.95

BBC MICRO

Forth	cassette-based system	Acornsoft	£16.85
Lisp	5.5K machine-code cassette	Acornsoft	£16.85
BCPL	16K ROM	Acornsoft	
Cesil	cassette-based	Webb	£8
r q Forth	cassette-based	Level 9 Computing	£10
Logo II	graphics programming	Computer Concepts	£10
Forth	ROM-based system	HCCS Associates	£34.72

DRAGON 32

Dragon Forth	FigForth and Basic	Oasis Software	£18.95

COMMODORE VIC-20

VicForth	plug-in cartridge	Adda	£38.95
Forth	plug-in cartridge	Audiogenic	£24.95
BUTI	Extension to Basic	Audiogenic	£39.99

COMMODORE 64

Petspeed	Basic compiler	Oxford Computer Systems	£125

COMMODORE PET

Forth	FigForth with extensions	Kobra	£172
Petspeed	Basic compiler	Oxford Computer Systems	£125

RESEARCH MACHINES

Cobol	version of Cis Cobol compact	Research Machines	£325
Cobol	standard version	Research Machines	£425
Pascal	UCSD 8in. disc systems only	Research Machines	£180
TCL Pascal	for all disc systems	Research Machines	£120
Logo	includes turtle graphics	Research Machines	
Fortran IV	scientific language	Research Machines	£199
Z-80 Algol	structured language	Research Machines	£99
Cesil	interpreter	Research Machines	£14

TANDY TRS-80

Pilot	cassette-based interpreter	Molimerx	£12
Basic 80	disc-based CP/M interpreter	Molimerx	£195
Basic Compiler	full Basic compiler needs 32K	Molimerx	£115
Basic Compiler	works under TRS-DOS	Molimerx	£199
Basic Compiler	runs under CP/M	Molimerx	£199
Enhanced Basic	cassette or disc	Molimerx	£24/£27
Extended Basic	disc-based advanced language	Molimerx	£94.50
Fortran	disc-based compiler	Molimerx	£65
Pascal	compiler, requires two disc drives	Molimerx	£60
PL/B	highly structured Basic	Molimerx	£97.50
MicroCobol	business language	MPSL	£400
Tiny Pascal	models 1 and 3	Tandy dealers	£14.95/£12.95
Logo	ROM pack for color Computer	Tandy dealers	£29.95
Logo	disc-based	Tandy dealers	£49.95

Suppliers

Acornsoft Ltd 4a Market Hill, Cambridge CB2 3NJ
Adda Computers Mercury House, Hanger Green, London W5 3BA
Apple dealers — contact Apple Computer (U.K.) Ltd, Eastman Way, Hemel Hempstead, Hertfordshire HP2 7HQ. Telephone: (0442) 60244.
Audiogenic Ltd PO Box 88, Reading, Berkshire.
ASRO Information Systems Ltd. PO Box 159, Brighton, Sussex BN1 3LU. Telephone: (0273) 21979.
Baker 23 Dalford Court, Hollinswood, Telford, Shropshire.
Computer Concepts 16 Wayside, Chipperfield, Hertfordshire WD4 9JJ. Telephone: (09277) 62955.
Computer Solutions Treway House, Hanworth Lane, Chertsey, Surrey KT16 9LA. Telephone: (09328) 65292.
Crystal Research 40 Magdalene Road, Torquay, Devon. Telephone: (0803) 22699.
Digital Equipment Corp. PO Box 53, Reading, Berkshire. Telephone: (0734) 868711.
Digital Devices 134 London Road, Southborough, Tunbridge Wells, Kent. Telephone: (0892) 37977.
Digital Research Oxford House, Oxford Street, Newbury, Berkshire RG13 1JB
KobraMicro Marketing Farm Road, Henley-on-Thames, Oxfordshire.
Inner Product Eagle House, 73 Clapham Common South Side, London SW4 9DG.

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Level 9 Computing 229, Hughenden Road, High Wycombe, Buckinghamshire HP13 5PG. Telephone: (0494) 26871.
Lifeboat Associates PO Box 125, London WC2H 9LU. Telephone: 01-836 9028.
Microprocessor Engineering 21 Hanley Road, Shirley, Southampton SO1 5AP. Telephone: (0703) 775482.
Micro Focus contact Microcomputer Products International, 8/11 Cambridge House, Cambridge Road, Barking, Essex. Telephone: 01-591 6511.
Maplin PO Box 3, Rayleigh, Essex. Telephone: (0702) 552911.
Molimerx 1 Buckhurst Road, Town Hall Square, Bexhill-on-Sea, East Sussex. Telephone: (0424) 220391.
MPSL, 87-89 Saffron Hill, London EC1. Telephone: 01-831 8811.
Oasis Software Lower North Street, Chedder, Somerset. Telephone: (0934) 515265.
Oxford Computer Systems. Hensington Road, Woodstock, Oxford OX7 1JR. Telephone: (0993) 812700.
Pete and Pam New Hall Hey Road, Rossendale, Lancashire BB4 6JG. Telephone: (0706) 227011.
Prospero Software 37 Gwendolen Avenue, London SW15 6EP. Telephone: 01-785 6848.
Research Machines Mill Street, Oxford OX2 0BW. Telephone: (0865) 49866.
Richards Computer Products Brookside, Westbrook Street, Blewbury, Didcot, Oxfordshire OX11 9QA. Telephone: (0235) 850218.
Silica Shop 1-4 The Mews, Hatherley Road, Sidcup, Kent DA14 4DX. Telephone: 01-301 1111.
Small Systems Engineering 2-4 Canfield Place, London NW6 3BT. Telephone: 01-328 7145.
Software Ltd Duchess House, 18/19 Warren Street, London W1P 5DB. Telephone: 01-387 9927.
Systemics 21-23, The Bridge, Harrow, Middlesex HA3 5AG. Telephone: 01-863 0079.
Tamsys Pilgrim House, 2-6 William Street, Windsor, Berkshire SL4 1BA. Telephone: Windsor 849462.
TCL Software 59/61 Theobalds Road, London WC1X 8SF.
Xitan 23 Cumberland Place, Southampton SO1 2BB. Telephone: (0703) 38740.

Basic comparison

This chart compares 10 versions of Basic, the most popular microcomputer language, as found on a representative cross-section of micros. The Sinclair Spectrum, Dragon 32 and Atari 400 are basically home computers; the Lynx, the Atari 800, the BBC and Commodore 64 sit in the middle ground; and the Newbrain and Epson are portables, both with the powerful Basic normally associated with "serious" micros. The IBM PC is a 16-bit micro aimed more at the business user than the hobbyist and the Tandy model III is a fairly typical eight-bit micro. What is remarkable is not the differences between machines, but what they have in common. Remember that more commands does not necessarily mean a more powerful or easier to use system. A good example is the graphics commands on the Dragon 32 — there are a lot of them, but they are difficult to use.

	Sinclair Spectrum	Dragon 32	Lynx	Grundy Newbrain	Atari Basic	Commodore 64	BBC Basic	Epson HX-20	IBM PC	TRS-80 I and III
Variable name										
long	•				•		•	•	•	
short	•	•	1char	•	•	•		•		•
Numeric types										
integer						•	•	•	•	•
floating point	•	•	•		•	•	9 sig figs	•	•	•
double precision								•	•	•
Declarations										
DEF INT, SNG, DPL, STR								•	•	•
Arrays										
DIM	•	•	•	•	•	•	•	•	•	•
numeric	•	•	•	•	•	•	•	•	•	•
string	•	•		•		•	•	•	•	•
double precision								•		•
multi dimensional	•	•		•	2 max	•	•	•	•	•
OPTION BASE				•				•	•	
Arithmetic										
binary floating point	•			•				•	•	•
16-bit integer								•	•	
BCD floating point					•					
Operators										
arithmetic: *, /, +, –	•	•	•	•	•	•	•	•	•	•
relational: <, >, =	•	•	•	•	•	•	•	•	•	•
AND	•	•	•	•	•	•	•	•	•	
/ DIV: integer division							•		•	
XOR, EOR: exclusive Or							•	•	•	
NOT	•	•	•	•	•	•	•	•	•	
OR	•	•	•	•	•	•	•	•	•	
IMP: implication								•	•	
string concatenation	•	•	•	•	•	•	•	•	•	
string relational	•	•		•			•			•
Functions										
ABS: absolute magnitude	•	•	•	•	•	•	•	•	•	•
ACS, ARCCOS: arc cosine	•		•				•			
ADR: address of string					•					
ADVAL: analogue/digital conversion							•			
ALPHA: location of character			•							

	Sinclair Spectrum	Dragon 32	Lynx	Grundy Newbrain	Atari Basic	Commodore 64	BBC Basic	Epson HX-20	IBM PC	TRS-80 I and III
ANTILOG			●							
ARCSIN, ASN	●		●				●			
ARCTAN, ATN	●	●	●	●	●	●	●	●	●	●
ASC/CODE: ASCII code of first letter	●	●		●	●	●	●	●	●	●
BIN: binary number	●		●							
CDBL: convert to double precision									●	●
CHR$: character string	●	●	●	●	●	●	●	●	●	●
COS: cosine	●	●	●	●	●	●	●	●	●	●
DEG: radians to degrees			●		●		●			
DPEEK: two-byte Peek			●							
EXP: e raised to power	●	●	●	●	●	●	●	●	●	●
FACT: factorial			●							
FIX: transaction		●						●	●	●
FN: user-designed function	●			●		●	●	●	●	
FRE, FREE, MEM: remaining memory		●	●	●	●	●	●	●	●	●
FRAC: fractional port			●							
GETN, GET$, INKEY$: checks keys pressed	●	●	●	●	●		●	●	●	●
HEX$		●						●	●	
INF: simulates infinity			●							
INSTR: string-in-string search		●		●			●	●	●	
INT, CINT: integer part	●	●	●	●	●	●	●	●	●	●
LEFT$, RIGHT$: string slicing		●	●	●		●	●	●	●	●
LEN: length of string	●	●	●	●	●	●	●	●	●	●
LN, LOG: natural logarithm	●	●	●	●	●	●	●	●	●	●
LOG: base-10 logarithm			●				●			
MID$: string slicing		●	●	●		●	●	●	●	●
MOD: modulus							●	●	●	
NOT: returns 1 if x = 0, otherwise returns 0	●				●					
OCT$: octal conversion								●	●	
PEEK: look at memory byte	●	●	●	●	●	●		●	●	●
PI: 3.14159265	●		●	●			●			
POINT: look at pixel	●	●			●		●		●	●
POS: cursor position		●	●	●	●	●	●		●	●
RAD: degrees to radians			●		●		●			
RND, RAND: random numbers	●	●	●	●	●	●	●	●	●	●
SGN: sign determination	●	●	●	●	●	●	●	●	●	●
SIN: sine	●	●	●	●	●	●	●	●	●	●
SQR: square root	●	●	●	●	●	●	●	●	●	●
STR$: character to string	●	●		●	●	●	●	●	●	●
STRING$: copies string		●					●	●	●	●
TAN: tangent	●	●	●	●		●	●	●	●	●
TIME, TIMER: returns current time		●					●	●	●	●
UPC$: converts to upper case			●							
USR: machine-code jump	●	●			●	●	●		●	●
VAL: string to number	●	●	●	●	●	●	●	●	●	●
VAL$: number to string	●									
VAPTR: variable pointer		●							●	●
Control of program flow										
GOTO (line number)	●	●	●	●	●	●	●	●	●	●
GOSUB-RETURN	●	●	●	●	●	●	●	●	●	●
ON...... GOTO, GOSUB		●		●	●	●	●	●	●	●
GOTO (label)			●							
IF-THEN	●	●	●	●	●	●	●	●	●	●
IF-THEN-ELSE		●	●				●	●	●	●
WHILE-WEND			●					●	●	
PROC-ENDPROC			●				●			
FOR-NEXT-STEP	●	●	●	●	●	●	●	●	●	●
REPEAT-UNTIL			●				●			
CALL, EXEC, SYS		●	●			●	●		●	
STOP	●	●	●	●	●	●	●	●	●	
END		●	●	●	●	●	●	●	●	●
CONT, CONTINUE	●	●	●	●	●	●		●		●
PAUSE, WAIT	●		●			●			●	

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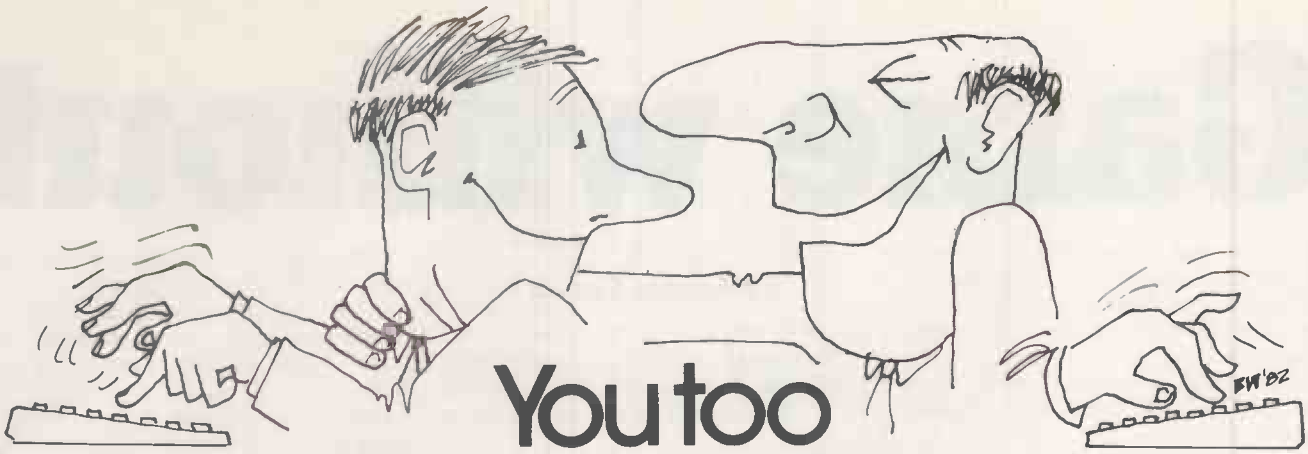
	Sinclair Spectrum	Dragon 32	Lynx	Grundy Newbrain	Atari Basic	Commodore 64	BBC Basic	Epson HX-20	IBM PC	TRS-80 I and III
EDIT: call editor	•	•							•	•
REM: comment line	•	•	•	•	•	•	•	•	•	•
RUN:	•	•	•	•	•	•	•	•	•	•
LIST:	•	•	•	•	•	•	•	•	•	•
NEW:	•	•	•	•	•	•	•	•	•	•
DEL, DELETE		•	•	•			•	•	•	•
RENUM: renumbers program		•	•				•	•	•	
AUTO			•				•	•	•	•
MON: calls monitor			•					•		
CLEAR: deletes variables	•			•			•	•	•	•
SYSTEM: return to DOS									•	•
BYE					•					
OLD							•			
ERASE: clear specific arrays								•	•	
Cassette commands										
BGET #, GET #: get byte						•	•			
BPUT #, PUT #						•	•			
APPEND			•							
LOAD, CLOAD	•	•	•	•	•	•	•	•		•
MLOAD: machine-code load	•	•	•				•	•		
SAVE, CSAVE	•	•	•	•	•	•	•	•		•
TAPE: alter baud rate			•							
VERIFY	•		•	•		•				•
MERGE	•			•				•		•
AUDIO		•								
EOF #		•					•	•		•
MOTOR: turns motor on		•						•	•	
SKIPF: skip to end of program		•								
INPUT #: input data		•				•	•			
PRINT #: write data		•				•	•			
OPEN #						•	•			
CLOSE #		•				•	•			
CHAIN							•		•	
Editing commands										
Abbreviations				•						•
AUTO			•					•	•	•
DEL, DELETE		•	•	•		•		•	•	•
EDIT	•	•							•	•
Multi-statement line	•	•		•	•	•	•	•	•	•
Screen Editor	•			•	•	•		•		
Line editor		•	•	•		•	•	•		•
RENUM, RENUMBER		•	•				•		•	
Listing device commands										
LLIST, LIST	•	•	•		•		•	•	•	•
OPEN: opens channel		•				•			•	
PRINT, LPRINT	•	•	•		•	•	•	•	•	•
LINK			•							
COPY: screen-printer dump	•							•		
LIST O: list option							•			
Disc Commands	Microdrive commands CAT CLOSE # DELETE ERASE FORMAT MOVE OPEN #			CLOSE GET # FILES INPUT # LINPUT # LOAD # LIST # MERGE # OPEN PRINT # PUT # SAVE # VERIFY #	CLOSE DOS LOAD NOTE OPEN POINT PRINT PUT SAVE STATUS XIO	CLOSE CMD GET # INPUT # LOAD OPEN PRINT # SAVE VERIFY	BGET # BPUT # CLOSE # EOF # EXT # INPUT # LOAD OPEN IN OPEN OUT PRINT # PTR # SAVE		BLOAD BSAVE CLOSE FILES GET INPUT # LINE INPUT # KILL LOAD MERGE NAME OPEN PRINT # PRINT # USING PUT RESET SAVE WRITE #	CLOSE CMD GET # INPUT # OPEN PRINT # CVD CVI CVS CDBL CINT CSNG MKD$ MKI$ MKS$ EOF KILL LOF FIELD LSET RSET
Input/Output statements										
DATA-READ	•	•	•	•	•	•	•	•	•	•
RESTORE	•	•	•	•	•	•	•	•	•	•
RESTORE (line number)	•		•	•			•		•	
GET				•	•	•	•	•	•	
INPUT	•	•	•	•	•	•	•	•	•	•
LINE INPUT, LINPUT		•		•				•	•	•
KEYN: code of key pressed			•					•		
PRINT	•	•	•	•	•	•	•	•	•	•
PRINT AT, PRINT@	•	•	•							•
PRINT USING		•						•	•	•
TAB	•	•	•	•		•	•	•		•
WIDTH							•	•		

	Sinclair Spectrum	Dragon 32	Lynx	Grundy Newbrain	Atari Basic	Commodore 64	BBC Basic	Epson HX-20	IBM PC	TRS-80 I and III
SPC: Space						●	●	●		●
POS: returns cursor position			●	●	●	●	●	●		
CLS: clear screen	●	●	●				●	●	●	●
BRIGHT	●									
FLASH	●									
INK: ink colour	●		●							
INVERSE	●									
PAPER: background colour	●		●							
OVER	●									
CCHAR: defines cursor character			●							
CFR: set cursor rate			●							
OUT: byte to port	●		●							●
IN, INP: value of port	●		●							●
ROUND ON, ROUND OFF			●							
EVAL							●			
VPOS, CSRLIN			●				●	●		
VDU							●			
SCROLL	●							●		
COUNT: counts printed characters							●			
COLOUR							●		●	
LOCATE: position cursor									●	
WRITE									●	
Other Basic Statements										
LET	●	●	●	●	●	●	●	●	●	●
TROFF: trace off		●	●				●	●	●	
TRON: trace on		●	●				●	●	●	
CODE: stores hex			●							
ERROR: generates error code			●	●			●	●	●	●
EXT: allows for extensions			●							
RANDOM, RANDOMIZE	●		●	●					●	●
RESERVE: moves stack			●	●						
SWAP: swaps two variables			●						●	
ATTR: attribute	●									
SCREEN$	●									
ON ERROR GOTO				●			●	●	●	●
REPORT				●			●			
ERL: error line number				●			●	●	●	
LOCAL: local variable							●			
OPT: option							●			
DATE$								●	●	
DAY								●		
Machine language	PEEK POKE USR	DEFUSR EXEC PEEK POKE USR VARPTR	full machine-code monitor	CALL FREE GET PUT RESERVE TOP PEEK POKE	ADR PEEK POKE USR	PEEK POKE SYS USR	CALL HIMEM LOMEM PAGE TOP USR	CALL DEF SEG DEF USR PEEK POKE USR VARPTR	DEFUSR INP OUT PEEK POKE VARPTR	DEFUSR EXEC PEEK POKE USR VARPTR
Graphics commands	BORDER CIRCLE DRAW INK OVER PAPER PLOT	CIRCLE COLOR DRAW GET LINE PAINT PCLEAR PCLS PCOPY PMODE PRESET PSET PUT RESET SCREEN SET	DRAW INK MOVE PAPER PLOT WINDOW	OPEN COLOR DRAW DRAWBY MOVE MOVEBY TURN TURNBY CENTRE RANGE DOT ARC AXES FILL BACK-GROUND WIPE MODE	COLOR DRAWTO GRAPHICS SET COLOR LOCATE PLOT	Peek and poke only PLOT VDU	CLG COLOUR DRAW GCOL MODE MOVE PRESET POINT PUT SCREEN	CIRCLE COLOR DRAW GET LINE PAINT PSET	SET RESET Peek and pokes	GRAPHICS COLOR SCREEN LINE PSET PRESET
Sound commands	BEEP	PLAY SOUND	BEEP SOUND	need additional hardware	SOUND	Peek and Poke only	ADVAL ENVELOPE SOUND	BEEP SOUND	additional hardware	SOUND
Sensing world	IN OUT	JOYSTK	INP OUT	GET and PUT	PADDLE PTRIG STRICK STRIG	Peek and Poke	ADVAL	COM ON COM ON PEN GOSUB ON STRIG GOSUB PEN STRIG OUT INP STICK	IN OUT	Peek and Poke requires extra hard-ware



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Game without

"It's just like a big game," Carshalt said, "all those empty ships floating around the North Atlantic. Like chess, only played for higher stakes. And may the best silicon chip win."

Henley ignored this statement. "It's been rumoured," he said, "that they've invented a new super-weapon."

"Oh, what kind of weapon?" Carshalt asked cheerfully. The game needed livening up.

"The rumour doesn't say. We don't know anything about it, except that it seems to work."

"Overcomes jamming, I expect," Carshalt opined flippantly. Henley looked sad.

"No, it's better than that. Not electromagnetic at all: can't be stopped. We can't even detect the damn thing."

"Probably uses a different wavelength," Carshalt said. "There are a few bands considered so useless that we never bothered with them."

Henley shook his head. "Not EM at all," he repeated.

Well, why not? Carshalt thought. They had exhausted that line of research. Nevertheless, the news disturbed him a little. Secure in their laboratories with their computers and their simulated weapons, the scientists were out of touch with the realities of the game. Carshalt could barely conceive of this war as being real, could not picture the real ships which the computers moved about the sea.

To widen his horizons, he had read about the wars of the past, incredulously picturing soldiers running at one another with swords or bayonets. He read with disbelief the learned theses designed to prove that nuclear war would be final. But most homes had a fallout shelter now, and men no longer served in modern war machines. Strategic nuclear weapons had never been used anyway.

War held no horrors for Carshalt; it was all unreal, no less than the electronic drama of the present. They were civilised now. They played their games with computers.

Henley had left the room. Carshalt followed him to join Commander Finns RN, in the adjacent terminal room. Here one could watch the light move about on the large screen, following the computer-controlled movements of the fleet. Picturesquely, the enemy ships were indicated by red. There were few of them; nothing like the number which the simulations and previous wars had led the computer to expect. Their own ships were denoted by green and were steadily decreasing in number.

by Angela Cotton

"Something diabolical's going on," Henley muttered as another green light went out. "Something's disabling all those ships."

The spot where the ship had been was now showing yellow, indicating that an aircraft or another ship had picked up on its radar the inert hulk of metal.

"They're not hitting us with their missiles. Our computers just stop working," Finns accused Henley, who had helped to equip those ships and to program their computers.

Finns had been watching it all day as ship after ship found its computer system failing to operate.

"It's clever, I agree," said Carshalt. "First they disable them, then the big ships or the aircraft move in with their missiles." He noticed that one of the red lights had moved and was now closer to the yellow. In a while, a missile would be fired at the undefended ship, the yellow light would be gone and another ship sunk.

It would not take long: the ships were quite close together. Their separation was determined by that compromise which made a strike most difficult for the enemy at minimum cost to their own missile accuracy. Under normal circumstances it would mean deadlock, for the automatic attack and defence systems were evenly matched. It had always meant deadlock, until now.

"There's nothing we can do, they're just wiping us out one by one," Henley moaned. He reminded Carshalt of a chess player who was watching his opponent systematically removing his pieces from the board without regard to the rules of the game.

"I expect Command computer will recommend surrender at any moment now before we lose all our ships," Henley added. "Not to mention billions of pounds worth of equipment."

The stakes are higher than that, Carshalt thought. Aloud he asked, "What do the aircraft instruments show us of this 'super weapon'?"

"Nothing. Absolutely nothing except sea-clutter. There's just nothing there, either under the sea or above it."

"Then it's something your instruments can't detect," Commander Finns observed shortly. Henley reacted in anger to this criticism of his scientific work. "There's nothing there. We can detect a missile as short as this —" he spread his arms "— and there are none around. Not a single missile, torpedo or submarine."

"Then it isn't a missile, torpedo or submarine," Carshalt said mildly.

"How does it know where we are?" Henley demanded. "It isn't radiating, and it still homes in even when we're not radiating."

Carshalt turned away, thinking his own thoughts. They had expected this war — this game — to be like all the others, with the only losses those caused by faulty equipment, ending in stalemate. It had happened every time ...

A shout from Finns brought him back to reality. "Look at this, Henley."

"What? Oh, my God! I never thought it would ..."

Carshalt turned too, his eyes enquiring of Henley what had happened.

"Command computer recommended surrender, and the recommendation went through ... but they won't let us. They won't let us!" He was almost screaming it. Carshalt walked over to the printed message on Finns' terminal.

In the two relevant languages, it said: "Our Command computer regrets that surrender cannot be accepted at this stage. It is too late to alter our plans until 0900 GMT. We will, however, cease from sinking those ships which have been disabled."

"Nine o'clock!" Henley exploded. "Information travels at the speed of light, and they can't tell their ships to stop till tomorrow morning!"

"They aren't using EM radiation," Carshalt reminded him quietly.

"Dammit man, what are they using?" Henley rounded on him.

"I have an idea ... but it's too fantastic." He turned to Finns, "Can you get me some of the video tapes from aircraft fly-bys?"

Finns nodded and typed something on the keyboard in front of him. Unnoticed behind him, another green light winked out and became yellow. The yellow light did not go out.

"Why did we ever let it start?" Henley moaned. He was beginning to realise what it meant.

"We didn't start it," Finns said stiffly. "It was their inexcusable actions."

We didn't have to declare war just because of them occupying a petty little state like that ... "

We declared war, Carshalt mused, because it was the thing to do. Because we thought it would make our position clear; then the war would end in stalemate and we'd compromise and they'd water down their demands and nobody would lose face.

He stared at the TV monitor on which the video tapes were being displayed, pondering

rules

how sour the game had turned. Behind him, Finns and Henley were discussing the non-use of the nuclear option. It was one of the rules of the game that if you had pledged not to be the first to use strategic nuclear weapons, then you did not do so. Command computer had no doubt been programmed with that rule.

Ignoring the conversation, Carshalt watched the video. Daylight TV, low-light TV, thermal imager: he could take his choice, but it would do him no good. The quality of the tape was poor. It had been computer enhanced, and it was still poor. Better, but still poor. Useless for his purpose.

"Damn computer," Carshalt said. "It was programmed with what to expect, so that when the unexpected came it processed it right out of the picture."

"We thought we knew what to expect," Henley said. His team had produced the software for the video processing. "We knew all their electronic capabilities, just as they do ours. In the simulations —"

"Forget your simulations," Finns said. He turned to Carshalt: "What did you expect to see?"

"Until today, the same as Henley." Carshalt headed a research team, too. He was not blameless in the catastrophe that had befallen them. "Now I'm not sure. Something, maybe, so small that it's indistinguishable from the sea background, moving almost at random, so slowly that Doppler radar won't notice it, something using so little heat that it's effectively the same temperature as the sea."

"No such thing exists," Henley said. "You need power, a homing device, speed and manoeuvrability."

"It exists," Carshalt stated, "and it's knocking out our ships. Look."

They looked. The fleet had been decimated. Yellow lights, disabled ships, were dotted about the screen. As promised, they had not actually been sunk. Without the ships to protect them, the aircraft were being shot down. Command had ceased its reconnaissance flights, knowing they were useless against the invisible enemy.

A new message appeared on Finn's screen.

"The PM's personally offered to surrender," Henley read, "but their Command computer says it isn't possible yet. But we're still choosing not to go nuclear. Damn them, this'll cost a fortune to rebuild."

Carshalt changed the subject. He had lost interest in the game, but he wanted to understand the secret weapon: "Are there any unenhanced tapes available?"

"Of course not," Henley snapped. His thoughts still ran on the tramlines of the game. Too bad.

"Then tell Command to get one. I want an aircraft to fly as low as possible over any ship beginning to show computer malfunctions. Use every wavelength we can get, and I want the raw tapes. I don't care if we lose the plane."

"It's beyond my authority to order that," Finns said, but he typed his request on the console, and they waited.

Tapes came for Carshalt, and he viewed them while they waited. A message arrived, formally accepting surrender from 0900 and promising that an occupying force and machines would be sent in anticipation of that time.

Messages came from their allies, regretting the situation but reaffirming that no aid could be sent. The country had started the war alone, and alone she must face the consequences.

As nine o'clock approached, Carshalt found what he was looking for. He knew now why the computer couldn't find the secret weapon. Programmed with the rules of the game, it failed to recognise the pattern of the weapon and subtracted it with the noise from any sensor on which it registered. The computer was blind to it.

The scene showed on daylight TV. Carshalt replayed it, adjusting the contrast and brightness, marvelling at the daring of it. They almost deserve to win, he thought, if they can make a scheme like this work.

He called Henley and Finns over, and replayed the tape. It was a beautiful shot, catching the secret weapon in the act of destruction. In spite of himself, Carshalt smiled. They might have lost the game, but at least they knew the weapons that had beaten them.

Then he smiled again at the expressions on the other two faces as they realised what he was showing them. Henley was incredulous; Finns' stern face cracked into an expression of horror, then almost amusement. "Why, it's barbaric — how could they dare?"

"Wars always used to be barbaric," Carshalt reminded him. "Why should it be different now, just because we do it in a civilised way with electronics and computers?"

Carshalt froze the replay and let them look at the scene more closely.

The man stood on the edge of the ship, barely holding the rifle with which he had systematically sabotaged the entire computer network. Below him, barely in view, was the vessel in which he had rowed, or perhaps earlier sailed, to reach the ship. His companion waited for him.

Carshalt released the Freeze button and let the tape play on to its end, watching without sorrow as the small boat suddenly keeled over, and the man with the rifle swayed and lost his balance and slipped into the sea. Seconds later the scene exploded as the undefended aircraft, which had recorded the scene guided only on this kamikaze course, was hit by a missile.

Alone now, the dead ship floated uselessly, at the cost only of two expendable enemy lives.

"Just a simple game," Carshalt muttered, "a game without rules." But only one side had been playing the game. It was nine o'clock and they had lost for real.

Beyond him, out in the street, screams were heard as the first enemy tanks rolled into London.

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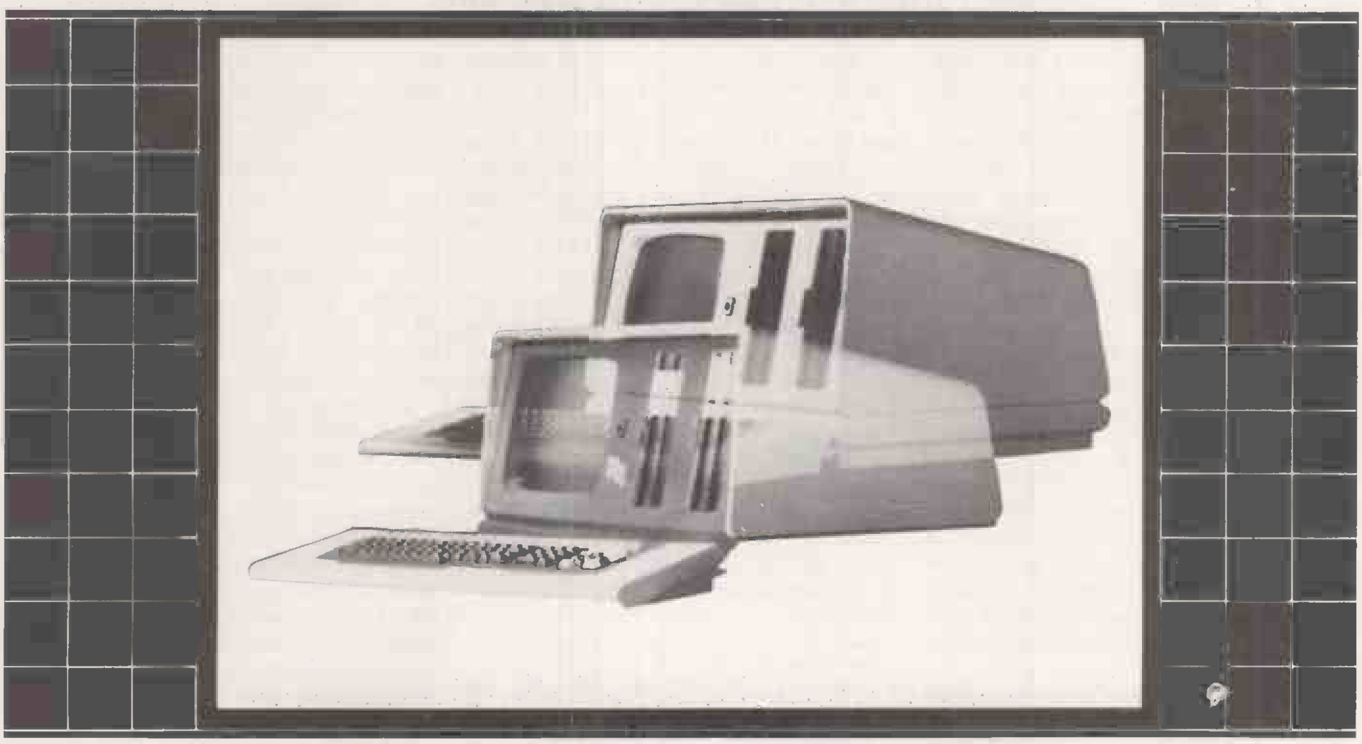

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Know your sort

Andrew Featherstone completes his survey of simple sorting methods with the shuttle, delayed-exchange and shell sorts.

THE FIRST ARTICLE in this series — March issue, page 120 — examined four linear sorting methods. Starting from the simplest way to sort a list of items it worked through a sequence of refinements of the initial method, leading to a point at which a new approach appeared to be needed. This article examines the two further methods which result, and an additional technique that could be applied to any of the six preceding methods.

Instead of repeatedly scanning up and down, the method can be altered to move down through the list, taking each key in turn and lifting it up up through the keys above it until a lighter key is encountered. Then the key which was originally the one below it is examined, and so on. There is then only one downward scan and a number of upward scans. The result is a sorted sequence, which grows downwards from the top of the list, consisting of those keys which have been examined and moved up as far as necessary. This is called the shuttle sort.

The algorithm for this method is shown in figure 1. The variables are as before except for the disappearance of PB, PP, PF, PT and the appearance of two new variables:

FP — forward pointer, marking the element reached on the downward scan.
BP — backward pointer, marking the element reached on the upward scans.

It is quite possible that statement 5

Repeat - Until BP ≦ 0 ∨ K$ (BP + 1) ≧ K$(BP)

could cause problems. If the language used does not supply the Repeat-Until construct the facility has to be provided manually. At the end of the statements in the loop would have to be written

If BP > 0 ∧ K$ (BP + 1) < K$ (BP) Then go to beginning of loop.

Different systems will treat this statement in different ways. Economical systems will use the result of the first simple condition to decide whether or not the second simple condition needs to be evaluated in order to determine the outcome of the compound condition, and so will not bother to evaluate the rest if BP = 0. Pedantic systems will want to evaluate both simple conditions before establishing the truth of the compound condition by using the logical operator. Such systems will come unstuck if BP = 0 in attempting to access K$(0).

If the manual Repeat-Until is being used, the way round this is to replace the And with a Then If. Otherwise, the way out is to use the sentinal technique. Declare K$ such that it includes an element K$(0), to which K$(FP) is moved before the inner Repeat-Until commences, and drop BP ≦ 0 and the Or from the termination condition. If the language you are using does supply the Repeat-Until construct but does not allow array subscripts to be other than positive, then the loop will have to be implemented manually as if the construct were not provided.

Assuming that such problems have been resolved it is possible to consider the working of the algorithm. Those comparisons which are made on the downward scan are termed primary comparisons and are represented by → ; those made on the upward scan are termed secondary comparisons and are represented by ← . This method does not work by means of passes so it is shown in stages, where each completion of an upward scan is regarded as the completion of a stage.

First stage

I S O R T K E Y S

Second stage

I O S R T K E Y S

Third stage

I O R S T K E Y S

Fourth stage

I K O R S T E Y S

Fifth stage

E I K O R S T Y S

At the end of the fifth stage the keys are in the following order:

E I K O R S S T Y

The downward scan has reached the end of the list and so the sort is complete; in terms of the algorithm FP > NK. The total number of comparisons is

$$3+2+6+6+4=21$$

and the total number of exchanges is

$$1+1+4+6+2=14$$

The new method has in this case reduced the number of comparisons by four, though the usual analysis again does not show this increased efficiency.

The minimum number of comparisons occurs when the list is ordered. In that case no secondary comparisons result from any of the N − 1 primary comparisons, so the minimum number of comparisons is N − 1.

The maximum number of comparisons occurs when the list is reversed, when each of the N − 1 primary comparisons results in a number of secondary comparisons as follows. The primary comparison at key K results in K − 2 secondary comparisons; K takes the values 2,3, . . . N so that the total number of secondary comparisons is $(N-2) * (N-1)/2$. Together with the N − 1 primary comparisons the maximum number of comparisons is $N * (N-1)/2$.

The minimum number of exchanges occurs when the list is ordered: none of the comparisons results in an exchange so the minimum number of exchanges is 0. The maximum number of exchanges occurs when the list is reversed: each of the comparisons results in an exchange, so the maximum number of exchanges is $N * (N-1)/2$. These figures are the same as before, so the new method does not appear to have made any improvement. However, in the general case the new method does lead to a satisfactory reduction in the number of comparisons.

There is still room for improvement, though to the number of exchanges rather than the number of comparisons. Suppose there is a key which has to be moved several places up the list. It is done by comparing the key with its predecessor, exchanging them, comparing it with its new predecessor, exchanging them, and so on.

The trouble is that an exchange has to be made by extracting the offending key from the list, moving the preceding key down one place, and inserting the extracted key into the space vacated by its erstwhile predecessor. The key which is moving up will repeatedly be replaced and removed before it reaches the right position, but it would be better not to replace the key until the right position has been found.

Figure 2 describes this new procedure. As before, statement 6

Repeat - Until BP ≦ 0 ∨ T$ ≧ K$(BP)

could cause problems. It might appear that it will be a trifle difficult to count the exchanges made by a method which does not actually seem to make exchanges as such. It can be done, though. An exchange entails removing a key, moving down its predecessor and replacing the key — three distinct data transfers or moves. These three moves are all present in the improved method so the exchanges can be counted by counting each of these moves as one-third of an exchange.

Figure 1.

(1) FP: = 2
(2) repeat (3) BP: = FP − 1
(4) if K$(FP) < K$(BP)
then (5) repeat (6) T$: = K$(BP + 1)
(7) K$(BP + 1): = K$(BP)
(8) K$(BP): = T$
(9) BP: = BP − 1
until BP ≦ 0 ∨ K$(BP + 1) ≧ K$(BP)
(10) FP: = FP + 1
until FP > NK

Figure 2.

(1) FP: = 2
(2) repeat (3) BP: = FP − 1
(4) if K$(FP) < K$(BP)
then (5) T$: = K$(FP)
(6) repeat (7) K$(BP + 1): = K$(BP)
(8) BP: = BP − 1
until BP ≦ 0 ∨ T$ ≧ K$(BP)
(9) K$(BP + 1): = T$
(10) FP: = FP + 1
until FP > NK

Figure 3.

(1) I: = 2 * * INT(LN(NK − 1)/LN(2))
(2) repeat (3) CALL SORT (NK,K$(NK),I)
(4) I: = I/2
until I < 1

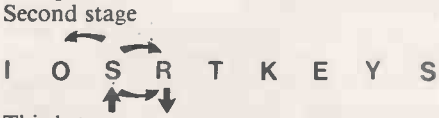
```
1500 REM SHUTTLE SORT
1501 LET FP=2
1502 LET BP=FP-1
1503 IF K$(FP)>=K$(BP) THEN GOTO
 1509
1504 LET T$=K$(BP+1)
1505 LET K$(BP+1)=K$(BP)
1506 LET K$(BP)=T$
1507 LET BP=BP-1
1508 IF BP>0 THEN IF K$(BP+1)<K$
(BP) THEN GOTO 1504
1509 LET FP=FP+1
1510 IF FP<=NK THEN GOTO 1502
1511 RETURN

1600 REM DELAYED EXCHANGE SORT
1601 LET FP=2
1602 LET BP=FP-1
1603 IF K$(FP)>=K$(BP) THEN GOTO
 1609
1604 LET T$=K$(FP)
1605 LET K$(BP+1)=K$(BP)
1606 LET BP=BP-1
1607 IF BP>0 THEN IF T$<K$(BP) T
HEN GOTO 1605
1608 LET K$(BP+1)=T$
1609 LET FP=FP+1
1610 IF FP<=NK THEN GOTO 1602
1611 RETURN

1700 REM SHELLSORT
1701 LET I=2**INT (LN (NK-1)/LN
2)
1702 GOSUB 1800
1703 LET I=I/2
1704 IF I>=1 THEN GOTO 1702
1705 RETURN
```

The illustration of the working of the new procedure shows a sequence of events very similar to those which occurred last time. However, each exchange is now reduced to a move, the moving down of a key. Each set of secondary comparisons implies just two further moves, the removal of the key to be moved up at the start and its replacement at the end, of the set of secondary comparisons.

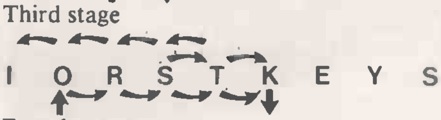
Using ↓ to represent the removal of a key, → to represent the moving down of a key and ↑ to represent the replacement of a key, the sequence of events is as follows:

First stage

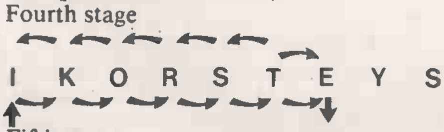
Second stage



Third stage



Fourth stage



Fifth stage

At the end of the fifth stage the keys are in the following order

E I K O R S S T Y

(continued on next page)

Table 1. Performance of sorts given ordered, reverse ordered and random lists.

	(1)	(2)	(3)	(4)	(5)	(6)
List: A B C D B E F G H I J K L M N O P Q R						
comparisons	153(271)	17(59)	17(59)	17(59)	17(59)	17(59)
exchanges	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
List: R Q P O N M L K J I H G F E D C B A						
comparisons	153(271)	153(87)	153(83)	153(83)	153(69)	153(69)
exchanges	153(21)	153(21)	153(21)	153(21)	153(21)	62(21)
List: C M O N Y B M O J F H W Y X A J Q Q						
comparisons	153(271)	150(134)	125(125)	114(96)	79(74)	79(74)
exchanges	64(23)	64(23)	64(23)	64(23)	64(23)	30(20)
List: F K U F S M B R G E N M Q E O S A U						
comparisons	153(68)	153(68)	137(68)	95(68)	83(68)	83(74)
exchanges	68(21)	68(21)	68(21)	68(21)	68(21)	32(19)
List: P T S V P B X O I H K B U M E N A C						
comparisons	153(27)	153(142)	151(127)	140(119)	122(81)	122(81)
exchanges	107(30)	107(30)	107(30)	107(30)	107(30)	45(26)
List: F A G Z S I T J C D I S E R N U S T						
comparisons	153(271)	125(113)	98(108)	90(104)	68(79)	68(79)
exchanges	52(26)	52(26)	52(26)	52(26)	52(26)	27(23)
List: P U V R S A F I C E E Y J C X J N V						
comparisons	153(271)	138(119)	117(105)	114(97)	90(76)	90(76)
exchanges	74(25)	74(25)	74(25)	74(25)	74(25)	34(23)
List: M I O L C G G F I R G U O Y A K V X						
comparisons	153(271)	150(134)	117(117)	86(102)	69(75)	69(75)
exchanges	55(25)	55(25)	55(25)	55(25)	55(25)	27(22)

(1) straight exchange sort; (2) ripple sort with logical flag; (3) ripple sort with integer flag; (4) shaker sort; (5) shuttle sort; (6) delayed exchange sort. The figures in brackets refer to algorithms run with the shell sort technique.

Know your sort

(continued from previous page)

The downward scan has reached the end of the list and so the sort is complete; in terms of the algorithm FP > NK. The total number of comparisons is 21 and the total number of exchanges is 8. The improved method has in this case reduced the number of exchanges by six, and this increase in efficiency is reflected in the usual analysis.

The minimum and maximum numbers of comparisons are the same for this method as for the shuttle sort, for exactly the same reasons. So the minimum is N – 1 and the maximum is N – 1 + (N – 1)* (N – 2)/2 = (N – 1)* N/2.

When the list is ordered, none of the primary comparisons results in any moves or secondary comparisons. So the minimum number of exchanges is 0. When the list is reversed, each of the primary comparisons results in three moves: extract the current key, move down its predecessor, insert the key when the top of the list is reached. Each of the secondary comparisons results in one move: move down the next key up. So the maximum number of exchanges is N – 1 + 1/3* (N – 1)* (N – 2)/2 = (N – 1)* (N + 4)/6.

In the general case, the number of exchanges is reduced by about one-half in the new procedure. There seems to be little room left for improvement to this much improved basic sort, but there is a device which can further reduce the number of comparisons and exchanges. It is not so much another sorting procedure as a technique which could be used in conjunction with any of the six procedures already described.

All the methods, except for the first, perform much better with an ordered list than with a reversed one. Similarly, a list which is fairly well ordered, with few keys far from their final position, will result in fewer comparisons and exchanges than a list which is badly ordered. Obviously, the further a key is from its proper place, the greater the number of comparisons and exchanges necessary to move it there.

The problem is that it is adjacent keys which are compared and exchanged. This is just right for keys which are only misplaced by one position, but very slow for keys which are misplaced by, say, 10 positions. By comparing and exchanging keys which are not adjacent it would be possible to make some kind of coarse adjustment, resulting in a list which is less badly ordered and so more amenable to the fine adjustment of comparing and exchanging keys which are adjacent.

This is just what the shell sort does. Given a list of N keys, it starts by finding the largest power of 2 which is less than N — P, say — and runs through the list comparing, and exchanging if necessary, keys which are P positions apart.

It then divides P by 2 and repeats the process. It continues with successively smaller values of P until P is equal to 1, when it is comparing adjacent keys. The difference between this method and that of comparing and exchanging only adjacent keys is somewhat analogous to that between the binary and serial search techniques.

The algorithm for the shell sort is shown in figure 3. The variables are:

NK — number of keys
K$(NK) — list of keys
I — Increment: comparisons are to be made between keys I positions apart
Int — an intrinsic function which yields the largest integer less than or equal to its arguments
LN — an intrinsic function which yields the natural logarithm of its argument
Sort — an external subroutine which performs a sort given NK, K$(NK) and I.

Step 1 sets I to the largest power of 2 which is less than NK. Step 3 calls a sorting procedure such as any one of the six procedures already described, to sort keys that are I positions apart. Some small alterations are necessary to render the sorting algorithms suitable for use within the shell sort algorithm.

In the straight exchange sort the following steps are changed to:

(3) PP: = I + 1
(5) If K$(PP – I) > K$(PP) Then . . .
(7) K$(PP): = K$(PP – I)
(8) K$(PP – I): = T$
(10) PB: = PB – I
(2) Repeat . . . Until PB < I + 1.

In the ripple sort with logical flag the following steps are changed to:

(4) PP: = I + 1
(6) If K$(PP – I) > K$(PP) Then . . .
(8) K$(PP): = K$(PP – I)
(9) K$(PP – I): = T$
(12) PB: = PB * PF – I (2) Repeat . . . Until PB < I + 1

In the ripple sort with integer flag the following steps are changed to:

(4) PP: = I + 1
(6) If K$(PP – I) > K$(PP) Then . . .
(8) K$(PP): = K$(PP – I)
(9) K$(PP – I): = T$
(12) PB: = PF – I
(2) Repeat . . . Until PB < I + 1

In the shaker sort the following steps are changed to:

(1) PT: = I + 1
(7) If K$(PP – I) > K$(PP) Then . . .
(9) K$(PP): = K$(PP – I)
(10) K$(PP – I): = T$
(13) PB: = PF – I
(17) If K$(PP – I) > K$(PP) Then . . .
(19) K$(PP): = K$(PP – I)
(20) K$(PP – I): = T$
(23) PT: = PF + I

In the shuttle sort the following steps are changed to:

(1) FP: = I + 1
(3) BP: = FP – I
(6) T$: = K$(BP + I)
(7) K$(BP + I): = K$(BP)
(9) BP: = BP – I
(5) Repeat . . . Until BP ≦ 0 ⌄ K$(BP + I) ≧ K$(BP)

In the delayed exchange sort the following steps are changed to:

(1) FP: = I + 1
(3) BP: = FP – I
(7) K$(BP + I): = K$(BP)
(8) BP: = BP – I
(9) K$(BP + I): = T$

Assessing the efficiency of this technique is no easy matter. Given an ordered list, it causes more comparisons to be made than would be made without it because it passes more than once through the list. Given a reversed list, it greatly reduces the numbers of comparisons and exchanges — except when used with the straight exchange sort, when the number of comparisons is increased.

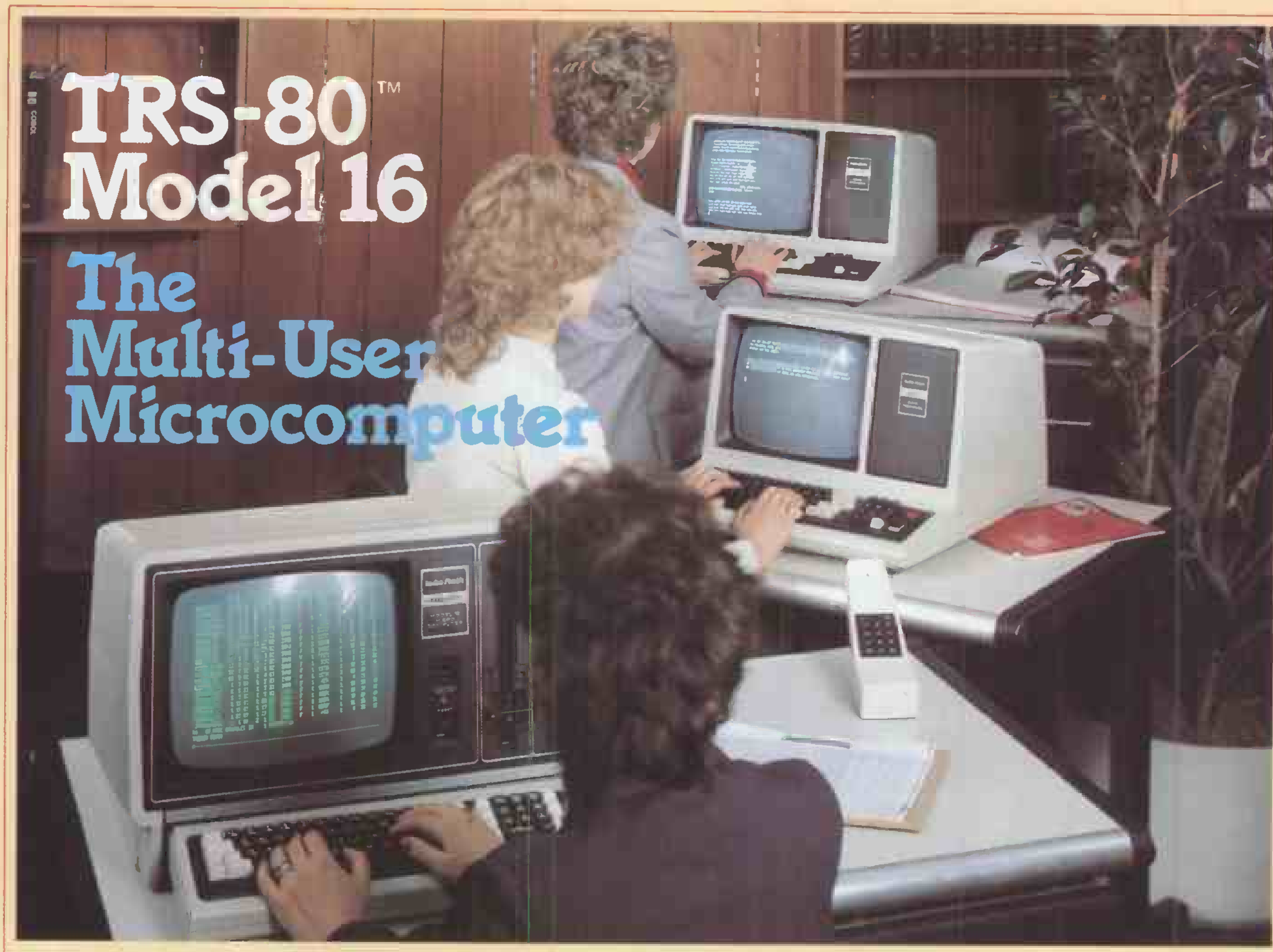
Given a random list, it seems invariably to reduce the number of exchanges made by each of the six sorts, and usually to reduce the number of comparisons, except when used with the straight exchange sort.

The efficiency of the technique depends to an extent on the increments used. For instance, suppose that the first increment is almost as large as the number of keys. It is not really likely that the list is so badly ordered that the keys at the bottom should be at the top. Much work has been done to try and find the best increments. It turns out that decreasing powers of 2 are rather poor. According to Knuth, the best way to choose the increments is to let $h_1 = 1$, $h_{s+1} = 3h_s + 1$, and stop at h_t, when $h_{t+2} \geqq N'$. This gives the sequence 1, 4, 13, 40, 121, . . .

For example, if you have 100 keys, use an increment of 13 on the first pass, 4 on the next one, and 1 on the last. Using these increments certainly improved performance, although the shell sort remains inefficient when used on a list which is to any degree ordered.

All the algorithms were run on their own and with the shell sort technique, to arrange a list of 18 letters in alphabetical order. Table 1 demonstrates the performance of the sorting methods in terms of the number of comparisons and number of exchanges needed. The most efficient method is the delayed exchange sort.

More complex sorting methods have been devised, such as C A R Hoare's Quicksort. *The Art of Computer Programming; Volume III: Sorting and Searching* by D E Knuth is a very comprehensive book, though somewhat difficult to follow, providing unstructured algorithms and detailed analyses of the methods discussed. The comprehensive *Sorting and Sort Systems* by H Loring, provides exceptionally lucid discussions of methods.



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Recursive Kalman filters

What do the steel rolling mills, the Space Shuttle and Exocet missiles have in common? Bill Hill explains.

THE KALMAN FILTER is, in essence, a filter for removing noise. It is a recursive algorithm on a digital computer which estimates the values of the variables of a stochastic system from measurements which contain randomly fluctuating noise. In many cases the estimates are needed to control the system. For example, an Exocet missile skimming across the waves contains equipment to measure its height above the surface and keep it at a steady level. With lots of little wavelets superimposed on the ocean swell, together with electrical noise in its circuits, the measurements it receives may look something like the pattern in figure 1. To control the height of the missile it is necessary to estimate the height with the noise filtered. A Kalman filter provides such an estimate, which would look something like the dashed curve shown in figure 1.

A Kalman filter can also be used to estimate variables which are not even directly reflected in the measurements made on the system. For example, a power station's boiler only has a few thermocouples placed in strategic positions. Suppose an engineer needs to know what the steam temperature or pressure is elsewhere, perhaps in some totally inaccessible part of the boiler? Using the few available measurements, a Kalman filter can be used to estimate the otherwise inaccessible variables.

R E Kalman, an American academic, formulated the filter algorithm in the early 1960s. His contribution was to construct a recursive algorithm which decreases the computational burden at each time step, and consequently makes real-time estimation a practical proposition. Previously mathematicians and control engineers had tried to solve the estimation problem using complicated mathematical techniques. Although there are plenty of military uses for Kalman filters they are also used extensively in industry as well.

When asked to make the best possible estimate of a variable from noisy measurements, your first question should be: best with respect to what criterion? Once the criterion is defined, your subsequent estimates can be said to be optimal estimates based on that criterion. The Kalman filter provides optimal estimates of the time-dependent variables of a stochastic system subject to Gaussian random noise, based on the least squares criterion. These time-dependent variables can be called state variables, or just states.

The filter algorithm produces state-variable estimates which are calculated so as to minimise the mean-squared error of the estimates from the time when the filter begins to work. The Kalman filter uses the mean-squared error criterion rather than the mean error criterion because, in a series of positive and negative errors, the positive and negative values would tend to cancel each other out for the mean error criterion. The mean-squared error criterion, however, will make all values positive, so the filter can concentrate on keeping the magnitude of the estimation error as small as possible in all

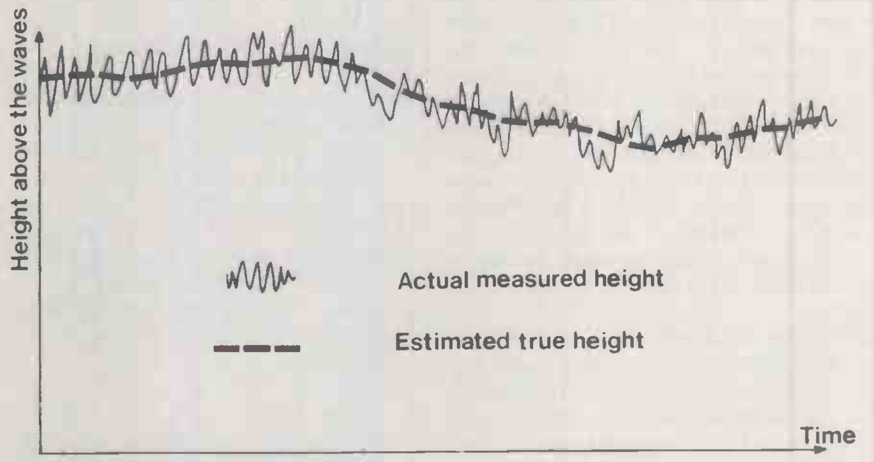


Figure 1. Typical noisy signal.

System equation:

$$\frac{d}{dt}(\underline{x}) = A\underline{x} + B\underline{u} + \underline{w}$$

Measurement model equation:

$$\underline{y} = C\underline{x} + \underline{v}$$

where: $\underline{x}$ is a vector of state variables; $\underline{y}$ is a vector of measurements made on the system; $\underline{u}$ is a vector of inputs to the system; $\underline{w}$ is a vector of Gaussian random noise in the process itself; $\underline{v}$ is a vector of Gaussian random noise in the measurements; A, B, and C are matrices with constant coefficients. The covariances W and V of the noises are assumed to be known. Covariance is defined as:

$$W = E\,(\underline{w}\underline{w}')$$

$$V = E\,(\underline{v}\underline{v}')$$

The covariance is the expected — that is, the mean — value of the product of the vector and its transpose. It is therefore the equivalent of the mean-square in the single-variable case.

Figure 2. Linear multivariable system equations.

cases. Those familiar with statistics will know the term mean-squared error by the name "variance"; the Kalman filter minimises the variance of the estimation error.

The Kalman filter provides optimal estimates for linear systems only. Such a system which can be modelled accurately by differential or difference equations which do not contain cross-products or powers of the state variables. Extensions of the Kalman filter are required for non-linear systems.

Figure 2 gives the general form of the equations for a linear multivariable system with noise present in both the process itself and in the measurements. The problem is to estimate the values of the state variables in the state vector $\underline{x}$ from the measurement values of $\underline{y}$. The relationship between the measurements and the state variables is called the measurement model.

There need not be as many measurements as there are state variables and not all the measurements need be directly coupled to all the state variables. Care is needed here because it is possible to choose measure-

(continued on next page)

Recursive Kalman filters

(continued from previous page)

ments in such a way as to make it impossible to estimate the state vector x at all. The system is then unobservable and unless you can specify different measurements you will not be able to use a Kalman filter. But the majority of cases are observable, and there is a test to check that they are.

Rather than consider the multivariable filter, it is easier to look at the single-variable or scalar case. The extension of the scalar filter equations to the multivariable case is quite straightforward. Figure 3 gives the model equations for a scalar stochastic system. The covariances referred to in figure 2 are just the multivariable equivalent of the scalar variance. Although you do not know the values of the process and measurement noises directly, you must have some idea of the magnitude of the noises in order to use a Kalman filter and so you must know what the noise variances are. In many practical cases the variances of the noises are not known exactly, but educated guesses or values taken from past experiments often suffice.

Most applications of Kalman filters are on digital computers, so it is necessary only to consider what is called discrete filtering. Both the model and filter equations are given in terms of equations rather than differential equations, because a computer will have to sample the measurements at discrete intervals, and then perform any calculations between the intervals. The system itself can still be a continuous process of course, while the filter works in discrete jumps.

If you have a continuous model of the process in terms of a differential equation you will have to rewrite the differential equation as a difference equation. If the sampling interval is small, it is usually sufficient to use the approximation for dx/dt:

$$dx/dt \simeq (x_{k+1} - x_k)/\delta t$$

where δt is the sampling time, that is the time between sampling intervals k and k+1. Thus for example, $dx/dt = 10x + u$ could be written as:

$$(x_{k+1} - x_k)/\delta t = 10x_k + u$$

which rearranges to:

$$(x_{k+1} = 10\delta t + 1)x_k + \delta tu$$

So if $\delta t = 1$ second, for example, then:

$$x_{k+1} = 11x_k + u$$

which can be written as:

$$x_{k+1} = \Phi x_k + \Delta u$$

where $\Phi = 11$ and $\Delta = 1$. If the model is not a first-order differential equation but of higher order the higher-order differential equation can be written as a group of simultaneous first-order differential equations, though that again is a multivariable case.

A block diagram of the discrete Kalman filter is shown in figure 4. It shows how the filter uses a model of the process internally. This model consists of equations like those in figure 3, but without the noise, since the exact noise values are not known. The filter's internal model is thus a deterministic model of the stochastic system; deterministic means exact, and not governed by the laws of probability.

The circumflex accents above the symbols in figure 4 signify filter estimates, as opposed to the actual system values. The plus and minus signs in brackets show whether the estimates are based on all the measurements made so far (+), or all the measurements apart from the latest one (−). This effectively means that $\hat{x}_k(-)$ is a prediction of x_k based on k−1 measurements, whereas $\hat{x}_k(+)$ is an updated

Φ	0.383
Δ	0.025
C	1000.0
variance of input noise	8.0
variance of measurement noise	0.0025
Initial value of the state variable	10.0
initial value of the estimate	0.0
initial value of the variance of the estimation error	10E + 06
upper screen value	40
lower screen value	0

Table 1. Typical values to be used with the Kalman filter simulation program for the thermocouple example given in the text.

System equation:

$$\frac{dx}{dt} = Ax + Bu + w$$

Measurement model equation:

$$y = Cx + v$$

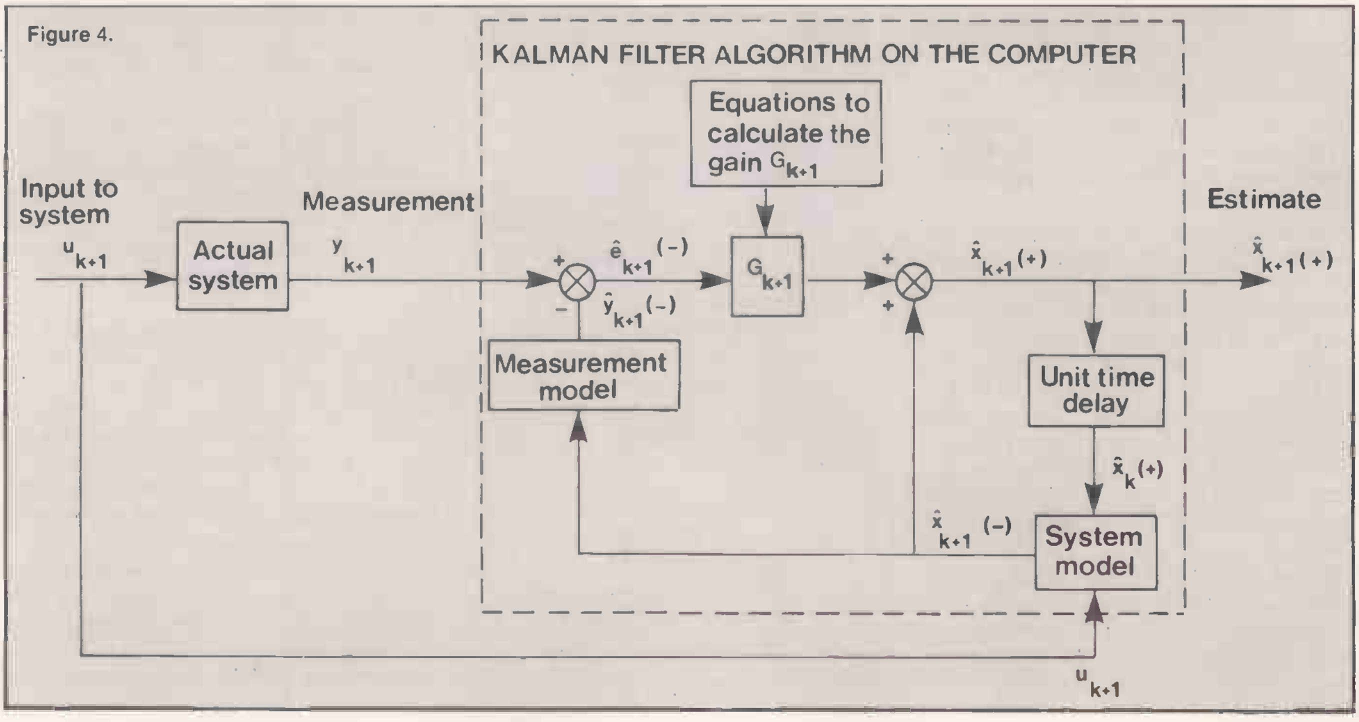
where: x is a single variable, called the state variable; y is a scalar measurement made on the system; u is a scalar input to the system; w is a scalar Gaussian random noise in the process itself; v is a scalar Gaussian random noise in the measurement; A, B and C are scalar coefficients. The variances W and V of the noises w and v are assumed known. (Variance is defined as:

$$W = E(w^2)$$
$$V = E(v^2)$$

The variance is the expected — that is, the mean — value of the squared noise.

Figure 3. Linear single-variable system equations.

Figure 4.



prediction of x_k, that is the latest estimate of x_k based on k measurements.

If you examine figure 4, you will see that the filter evaluates the error between the measurement of the process and the measurement as predicted by the model of the process on the computer. The error is then fed to the model in order to control the error in the state-variable estimate. The whole technique is thus in effect a feedback loop, and hence self-compensating. It is actually recursive, and draws on the past estimate in order to compute the present estimate.

The recursive feature means that past trends are automatically taken into account in the evaluation of the latest estimate, so the technique is vary fast. Figure 4 shows how the predicted measurement error $\hat{e}_{k+1}(-)$ is multiplied by a weighting factor, or gain, G which is recursively calculated from the Kalman filter equations, which are given in figure 5. The filter equations are quite straightforward, and because of their recursive nature do not require storage of previous values of the gain G or previous values of the state variable estimate $\hat{x}$.

If you have an analogue-to-digital converter interfaced to your micro, you could use the Kalman filter to estimate an unknown state variable of some process from a noisy measurement. You will have to model the process mathematically first. It is possible to use the computer to simulate both the sytstem and the filter to show how the Kalman filter works without actually needing the hardware for on-line measurements of a system. The simulation given here is based on thermocouple readings of the temperature of air flowing through a duct. Turbulence in the air stream makes the temperature fluctuate randomly about a mean value, and there is also some electrical noise generated by the thermocouple and amplifier circuit.

The thermocouple can be modelled as a first-order system. If it is placed in the duct and the temperature of the air is suddenly changed, then the voltage output from the thermocouple amplifier looks like that shown in figure 6. The voltage rises steeply before the output settles to a steady state which is modified by random fluctuations.

The model equations for this system are given in figure 7. The first-order differential equation is converted to a difference equation for use in the discrete filter. The air temperature acts as an input to the system, and random fluctuations in air temperature are strictly speaking input noise rather than process noise. This distinction is reflected in changes to the filter equations — see figure 8. The variance in the input noise has been calculated as approximately 8, and the variance of the measurement noise as 0.0025: the main source of the noise is therefore from the air-stream temperature fluctuations.

The problem here is to estimate the thermocouple voltage v_k from the noisy measurement voltage y_k. Once you know v_k then you can, if you wish, calculate the air stream temperature using the relationship for this particular type of thermocouple:

$$t_k(\text{in } ^\circ C) = 25v_k\,(mV)$$

An Applesoft program is given in the listing which will perform a filter simulation for a general first-order system. The program asks for the parameters Φ and Δ of the dynamic equation which describes the system and uses these values for the filter model. Next you have to input the noise variances, the initial values of the actual

(continued on next page)

The discrete version of the linear equations in figure 3 are:

$$x_{k+1} = \Phi x_k + \Delta u_k + w_k$$

$$y_k = Cx_k + v_k$$

$W = E(w_k^2)$ and $V = E(v_k^2)$ are the noise variances, which are known; w_k and v_k are assumed not to be totally independent of each other. The recursive filter estimation equation is:

$$\hat{x}_{k+1}(+) = \Phi\hat{x}_k(+) + \Delta u_k + G_{k+1}[y_{k+1} - C(\Phi\hat{x}_k(+) + \Delta u_k)]$$

The recursive filter gain equations are:

$$G_{k+1} = (Cp_{k+1}(-) \div (C^2p_{k+1}(-) + V)$$

$$p_{k+1}(-) = \Phi^2 p_k(+) + W$$

$$p_k(+) = [1 - G_kC]p_k(-)$$

with the initial condition

$$p_o(-) = E[(x_o - \hat{x}_o)^2]$$

Figure 5. The Kalman filter equations for a scalar system like that given in figure 3.

```
10  TEXT
20  HOME
30  PRINT "PROGRAM TO DEMONSTRATE THE KALMAN FILTER"
40  PRINT "FOR A FIRST ORDER SYSTEM"
50  PRINT : PRINT : INPUT "INPUT PHI   ";PH
60  PRINT : INPUT "INPUT DELTA  ";DE
70  PRINT : INPUT "INPUT C     ";C
80  PRINT : PRINT : INPUT "INPUT THE VARIANCE OF THE INPUT NOISE   ";VI
90  PRINT : PRINT : PRINT "INPUT THE VARIANCE OF THE MEASUREMENT"
100  INPUT "NOISE   ";VM
110  HOME
120  PRINT "INPUT THE INITIAL VALUE OF THE"
130  INPUT "STATE VARIABLE  ";X
140  PRINT "INPUT THE INITIAL VALUE OF THE"
150  INPUT "STATE VARIABLE ESTIMATE  ";XE
160  PRINT : PRINT
170  PRINT "INPUT THE INITIAL VALUE OF THE"
180  INPUT "VARIANCE OF THE ESTIMATION ERROR  ";PM
190  PRINT
200  PRINT "NOW DEFINE SCREEN MATHEMATICAL SPACE"
210  PRINT : INPUT "INPUT UPPER VALUE ";UV
220  PRINT : INPUT "INPUT LOWER VALUE ";LV
230  HOME
240  PRINT "IN THIS DEMONSTRATION THE FILTER GAIN IS"
250  PRINT
260  PRINT "BEING CALCULATED ON LINE AT EACH TIME"
270  PRINT
280  PRINT "INTERVAL, BUT NOTE THAT IT WILL CONVERGE"
290  PRINT
300  PRINT "TO A STEADY STATE AFTER ONLY A FEW TIME"
310  PRINT
320  PRINT "STEPS"
330  PRINT
340  PRINT "FOR THIS DEMONSTRATION THE GAMES PADDLE"
350  PRINT
360  PRINT "(0) IS USED AS THE INPUT. AND NOISE IS"
370  PRINT
380  PRINT "ADDED TO THIS IN ORDER TO SIMULATE THE"
390  PRINT
400  PRINT "ACTUAL PROCESS"
410  PRINT : PRINT
420  PRINT : INPUT "PRESS RETURN TO BEGIN";A$
430  HOME
440  HCOLOR= 3
450  HGR
460  VTAB 21
470  REM  CALCULATE AND PRINT INITIAL KALMAN GAIN
480 G = PM * C / (C ^2 * PM + VM)
490  PRINT : PRINT "FILTER ESTIMATE SHOWN ABOVE ACTUAL VALUE"
500  PRINT "FILTER GAIN= ";G
510  REM  PLOT INITIAL STATE & STATE ESTIMATE
520 K = 0
530  HPLOT K, INT (159 * (1 - X / (UV - LV)))
540  HPLOT K, INT (159 * (1 - XE / (UV - LV)) - 60)
550 K = K + 4
560  REM  GAMES PADDLE SIMULATES INPUT
570  REM  U CAN HAVE A VALUE BETWEEN 0 & 255
580 U =  PDL (0)
590  REM
600  REM  SLOW DOWN THE PROGRAM TO SEE HOW GAIN CHANGES
610  FOR I = 1 TO 500: NEXT I
620  REM  GENERATE GAUSSIAN RANDOM NOISE VARIABLES
630  REM  V IS THE NOISE IN THE MEASUREMENT
640  REM  W IS THE NOISE IN THE INPUT
650 V = 0:W = 0
660  FOR I = 1 TO 50
670 V = V +  RND (1)
680 W = W +  RND (1)
690  NEXT
700 V =  SQR (12 / 50) * (V - 25) *  SQR (VM)
710 W =  SQR (12 / 50) * (W - 25) *  SQR (VI)
720  REM
730  REM  ADD NOISE TO INPUT
740 U = U + W
750  REM  UPDATE ESTIMATION ERROR VARIANCE
760 PP = (1 - G * C) * PM
770 PM = PH ^2 * PP + DE ^2 * VI
780  REM  CALCULATE KALMAN GAIN
790 G = PM * C / (C ^2 * PM + VM)
800  PRINT : PRINT "FILTER ESTIMATE SHOWN ABOVE ACTUAL VALUE"
810  PRINT "FILTER GAIN= ";G
820  REM  CALCULATE STATE
830 X = PH * X + DE * U
840  REM  CALCULATE NOISY MEASUREMENT
850 Y = C * X + V
860  REM  CALCULATE STATE ESTIMATE
870 XM = PH * XE + DE * U:XE = XM + G * (Y - C * XM)
880  REM  PLOT STATE
890  HPLOT K, INT (159 * (1 - X / (UV - LV)))
900  REM  PLOT ESTIMATE
910  HPLOT K, INT (159 * (1 - XE / (UV - LV)) - 60)
920 K = K + 4
930  IF K   = 279 THEN  GOTO 580
940  REM  IF SCREEN IS FULL CLEAR IT
950  HGR
960 K = 0
970  GOTO 580
```

Recursive Kalman filters

(continued from previous page)

process state variable x_k and the state variable estimate $\hat{x}_o$. The program then asks for the initial value of the estimation error variance $p_o(-)$, and finally for the maximum and minimum values you wish the screen vertical axis to represent.

In practice, the initial values of the state-variable estimate and the estimation error variance are not known, so the initial estimate is a pure guess. Consequently the initial estimation error variance must be set to a high value, 10E06 for example, in order to tell the filter that you have little confidence in the initial guess. Of course in this simulation you do know what the actual initial state variable value is because you are also simulating the system itself. You can set x_o and $\hat{x}_o$ to the same value if you like, or use different values to see if the filter estimates converge to somewhere near the system values.

The program makes use of the Apple II high-resolution graphics screen to plot the system state variable and the filter's estimate of it, with the time axis of the filter estimate shifted 60 lines above the actual state-variable time axis for clarity. They should, of course, be plotted on top of each other, but on a black and white monitor it would be difficult to distinguish estimate from actual state. Because the RND function in Applesoft Basic has an approximately flat probability-distribution profile the program incorporates a small routine to generate roughly Gaussian random variables in order to simulate the Gaussian white noise present in the measurement and input.

The input to the system is simulated using the games paddle 0; turning it to a different position will cause the state to converge to a different steady-state value. The filter estimate should follow suit within a couple of time steps. Moving the games paddle to a new position is equivalent to changing the air temperature in the thermocouple simulation. The filter gain G_k is printed below the high-resolution screen after every time step.

The gain converges to a steady value after a few time steps even if the system itself is unstable and the state variable increases exponentially with time. The recursive filter equations are often dispensed with, and the constant gain is pre-computed and used instead in the recursive filter estimation equation in figure 5. All the other recursive filter gain equations in figure 3 then become unnecessary. Try running the simulation and note the value that G converges to. Then alter the program so that this is used from the beginning, and run it again. There is very little difference in the filter performance.

If you use the thermocouple model parameters in the simulation program summarised in table 1, then the program produces a plot like that given in figure 9. The filter estimate of v_k is good. Remember that the filter is estimating v_k purely from the noisy measurement y_k. In this case the filter is not being taxed much since the measurement noise is low, and so the measurement is a good indicator of the actual value of v_k.

The Kalman filter really becomes useful when the measurement noise level is higher and you want to filter out the measurement noise to get a good estimate of the state variable. Try rerunning the simulation, but this time pretend that the measurement noise is higher by specifying a larger measurement-noise variance. The filter estimate is still very good, even for much higher measurement noise variances.

This model is based on an actual thermocouple consisting of two wires of NiCr and NiAl of 0.114mm. diameter.
The dynamic equation describing the thermocouple is:
$dv/dt = 9.59v + 0.39(T + \text{random noise})$
where v is the potential difference produced by the thermocouple in mV, T is the temperature of the air in the duct. The random noise which is added to the temperature varies about a mean of zero.
The measurement model is given by:
$y = 1000v + \text{random noise}$
The amplifier gain is 1,000
The discrete version of this equation for a time step of 0.1s is:
$v_{k+1} = 0.383v_k + 0.025(T + \text{random noise})$
and
$y_k = 1000v_k + \text{random noise}$
The variances of the noises in the temperature and the measurement are:
variance of temperature noise = 8.0
variance of measurement noise = 0.0025

Figure 7. The dynamic model of the thermocouple temperature measurement system for the hot-air duct example.

Recursive filter estimation equation stays exactly the same, since noise is not taken into account by the deterministic filter model of the system.
One of the gain equations is slightly altered:
$p_{k+1}(-) = \Phi^2 p_k(+) + \Delta^2 W$
where W is now the variance of the input noise of the following system.
$x_{k+1} = \Phi x_k + \Delta(u_k + w_k)$
where w_k is the input noise.

Figure 8. Modifications to the Kalman filter equations if the noise is produced in the input rather than in the process itself.

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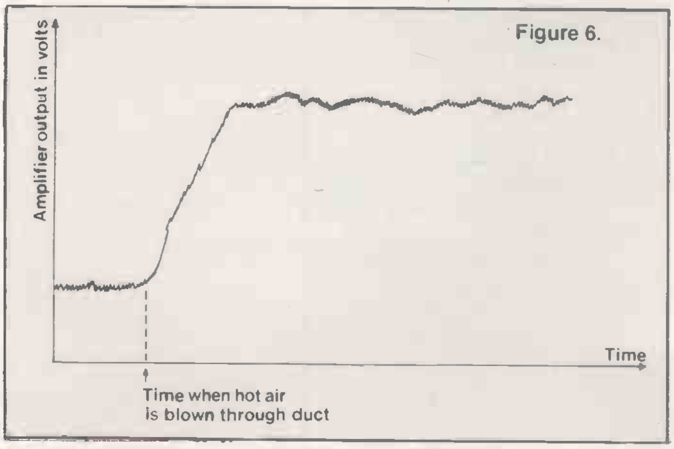


Figure 6.

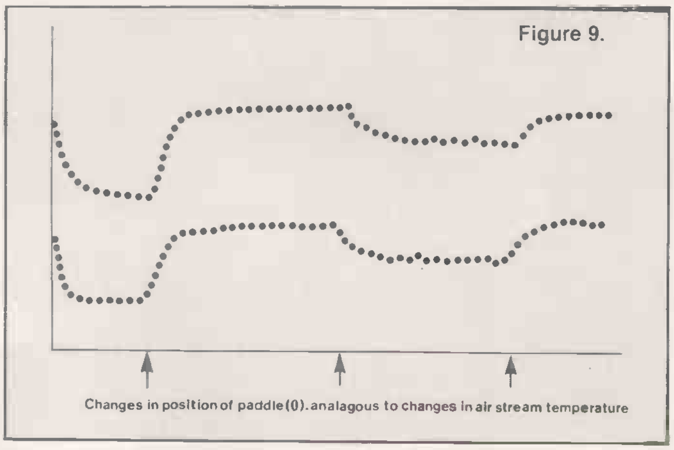
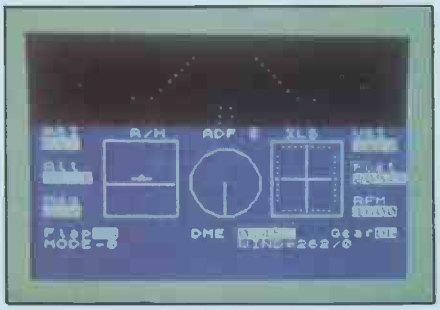


Figure 9.

Flights of fancy

Jack Schofield gives his fantasies free rein with an assortment of simulation games.

SIMULATION is one of the most interesting aspects of computing, and advanced graphics techniques have been pioneered commercially by flight-simulation experts such as Rediffusion. Many personal-computer owners can also "learn" to fly using a simulation program, though the actual aim is entertainment rather than instruction. To establish the range of the field I tried three: Nightflight for the Sinclair Spectrum, Jumbo Jet Pilot for the Atari, and MicroSoft's flight simulator for the IBM Personal Computer.



Nightflight on the Spectrum.

Nightflight comes on cassette and loaded on the third attempt — about par for the course with the Spectrum. It presents a menu of options including two demonstration modes, take-off and landing modes, and flying by two different types of navigation.

Graphically the simulation is about as good — or as bad — as you would expect: it is rather primitive, but not bad considering the limitations of the Spectrum. The cockpit view is a narrow strip at the top of the screen. As this is a night flight, it is plain black most of the time. There's also a map screen you can switch to, but it is confusingly presented.

The cockpit controls are also hard to follow, and the poor instruction sheet lacks a diagram. The blurb says Nightflight was written by a pilot. I believe it. He should have got a total ignoramus to write the instructions and so explain the stuff to the rest of us who aren't. As usual, the Spectrum sound is pathetic. However, the light plane is quite responsive, and that makes the weaknesses acceptable.

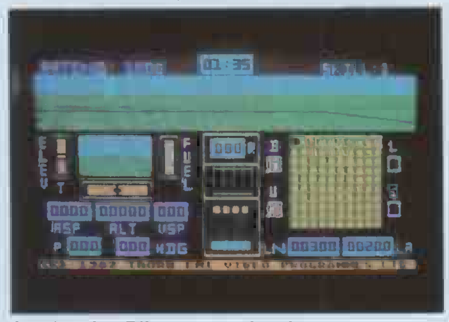
Jumbo Jet Pilot from Thorn EMI is a very different effort. Being written for the more powerful Atari 400 and 800 micros, the graphics are vastly superior. The simulation itself is also far more detailed, and the controls far more complicated. For example, elevating the flaps lifts the nose and this registers, along with a change in cockpit view, before it starts to affect altitude. There is also a map mode, which is simple but perfectly adequate.

Jumbo Jet Pilot comes on a plug-in ROM, so loading is simplicity itself. Control is partly by the keyboard, but also uses a standard joystick which makes it much more user-friendly.

The problem with Jumbo Jet Pilot is that it is unbelievably tedious to play. The plane is not responsive to the controls: you need 10 minutes to take off and about an hour to fly to the destination airport. It's almost as though the simulation was in real-time. I'm surprised you don't have to queue on the runway or get delayed by strikes.

I tried two flights. The second time I didn't bother with the runway — you can take off anywhere. I did not spot any landmarks between the two airports so the landscape appears uniformly green and boring, and the night-flight option is the same. The sound is also unimaginative.

Incidentally, the instructions are very poor compared with those for Atari's own games. They do at least contain a tiny diagram of the controls, labelled from a to p, but are hardly easy to read.



Jumbo Jet Pilot on an Atari.

The IBM PC's Flight simulator includes 10 built-in flight modes.

Flight-simulator specifications

	Nightflight	Jumbo Jet Pilot	Flight Simulator
Type: real-time flight simulation with colour graphics and some sound			
Format:	cassette tape	plug-in ROM	5.25in. floppy disc
System:	48K Spectrum	Atari 400 or 800 with joystick	IBM PC with colour-graphics adaptor
Manufacturer:	**Hewson Consultants,** 60A St Mary's Street, Wallingford, Oxfordshire OX10 OEL	**Thorn EMI,** Thorn EMI House, Upper St Martin's Lane, London WC2	**MicroSoft,** Bulbourne House, Gossoms End, Berkhamsted, Hertfordshire
Price:		£34.95	$50
Rating:	10/20	12/20	19/20

MicroSoft's flight simulator is awesome. It simulates flying in a little Cessna 182 with astonishing accuracy. In the absence of a joystick the keyboard controls are finnicky — especially as the full game uses about 45 different keys — but nonetheless the plane is incredibly responsive and a joy to fly.

This simulator was designed by Bruce A Artwick, who wrote his Master's thesis on "A Versatile Computer-Generated Dynamic Flight Display" before joining the Hughes Aircraft Corporation. He left to start his own company, Sublogic, and launched the A2-FS1 flight simulator for the Apple II. The IBM PC version from MicroSoft is, apparently, a huge advance on this.

The best thing about it is that fully half of the screen is devoted to a full three-dimensional colour display. You can also switch to sideways, downwards and backwards views, so you really can fly past a building and then look back at it. The IBM redraws the frames without benefit of any special graphics techniques, but quickly enough to present the illusion of continuity — it's almost as good as a movie on video.

The controls are amazing. It is claimed that the display meets full FAA specifications. The control panel is a faithful, detailed replica of the Cessna. You can even control the carburettor heat and the magneto switch.

There are 10 flight modes, including a demonstration mode and an Easy Flight mode. You can also fly in different kinds of weather, or in Advanced mode where the ailerons and rudder are controlled independently. Wind and weather then have more effect.

You set the mode on a two-screen menu which allows you to set all the other parameters, from the barometric pressure and the amount of cloud to the season of the year. You fly in a 24-hour format, so obviously dawn and dusk come at different times in the different seasons. There are 40 spare modes so you can, using the parameter settings, create your own and save them to disc for reuse later.

On booting up you always start at Meigs airport between Chicago Heights and O'Hare airports. You do not have enough fuel to fly across the U.S. but you can switch to start near Los Angeles, Illinois or Seattle. The database includes major buildings and geographical features so you can, flying visually, see where you are.

Finally the documentation is excellent. The disc comes with a book of about 100 pages. The instructions are comprehensive, helpful, and written in good English. There are excellent diagrams, including airplane drawings to show how the ailerons and rudder work.

In sum, the MicroSoft Flight Simulator is fantastically detailed, incredibly versatile, and a truly remarkable graphics program. Every IBM Personal Computer owner should have one.

The Hobbit

THIS IS an impressively packaged Adventure game which makes good use of the Spectrum's colour graphics to draw little pictures of the main locations. The cassette is boxed and comes complete with a copy of Tolkien's novel of the same name, plus a helpful 20-page instruction book.

You are Bilbo and make your way through Middle Earth, meet Gandalf and liberate the Dragon's treasure. Well, more likely you get eaten by a troll, but that's the idea. The interaction with other characters is limited, but above average for an Adventure game. This makes the action turn out slightly differently in each game.

The input routines accept instructions that are closer to English than usual, and you can enter several together. For convenience you can enter simple directions as single letters, or use the cursor-control keys, unshifted. The back of the instruction book contains a list of the 68 dictionary words the game understands — which saves endless hours of trying every word you can think of in the hope that something will work.

If you stop entering commands, after a while you get a wait entry, and the game goes on without you. For example, "You wait. Time passes. Gandalf closes the round green door." Later, "You wait. Time passes. Gandalf gives the curious map to you. Thorin waits." And later, "You wait. Time passes. Gandalf goes north." "You wait. Time passes." You wait. Time passes. Thorin says 'Hurry up!' "

The Hobbit was written by Philip Mitchel and Veronika Megler, with Alfred Milgrom and Stuart Ritchie, over a period of 18 months. They have not only produced one of the best games for the Spectrum, but given everyone else a lesson in good game design. Only one criticism: it's a pity the trolls do not spell better.

Specification

Type: Adventure game, text with some colour graphics and real-time components.
Format: cassette
System: 48K Spectrum
Manufacturer: Melbourne House, 131 Trafalgar Road, London SE10
Price: £14.95
Rating: 16/20

Defender

IT'S VERY HARD to review Defender, mainly because it's very hard to stop playing it. It is one of those games that, while luck plays a part, recognises and rewards skill. You just know you can get a better score next time. "Just one more go" can keep you up half the night.

Like many of Atari's best games it is readily available in the arcades, so if you are one of the unfortunate few who is not familiar with it, go and look now. Take a couple of pounds, because it is not easy to get the hang of it. First you have to learn the controls, then adopt a Zen attitude of detached tranquility and blast everything on sight.

The Atari version is played with a joystick instead of a lever and Thrust and Reverse buttons. Moving the joystick left or right sends your Defender left or right. To fire, press the joystick button. The smart bomb is operated by the space bar, and you jump through space by hitting any other key except Shift, etc.

In other respects, the Atari Defender seems to be a nearly exact copy of the arcade game. Movement on the Atari version is faster and smoother, but of course the screen is smaller. In particular, mutant humanoids are more vicious, but you soon learn how to deal with them ...

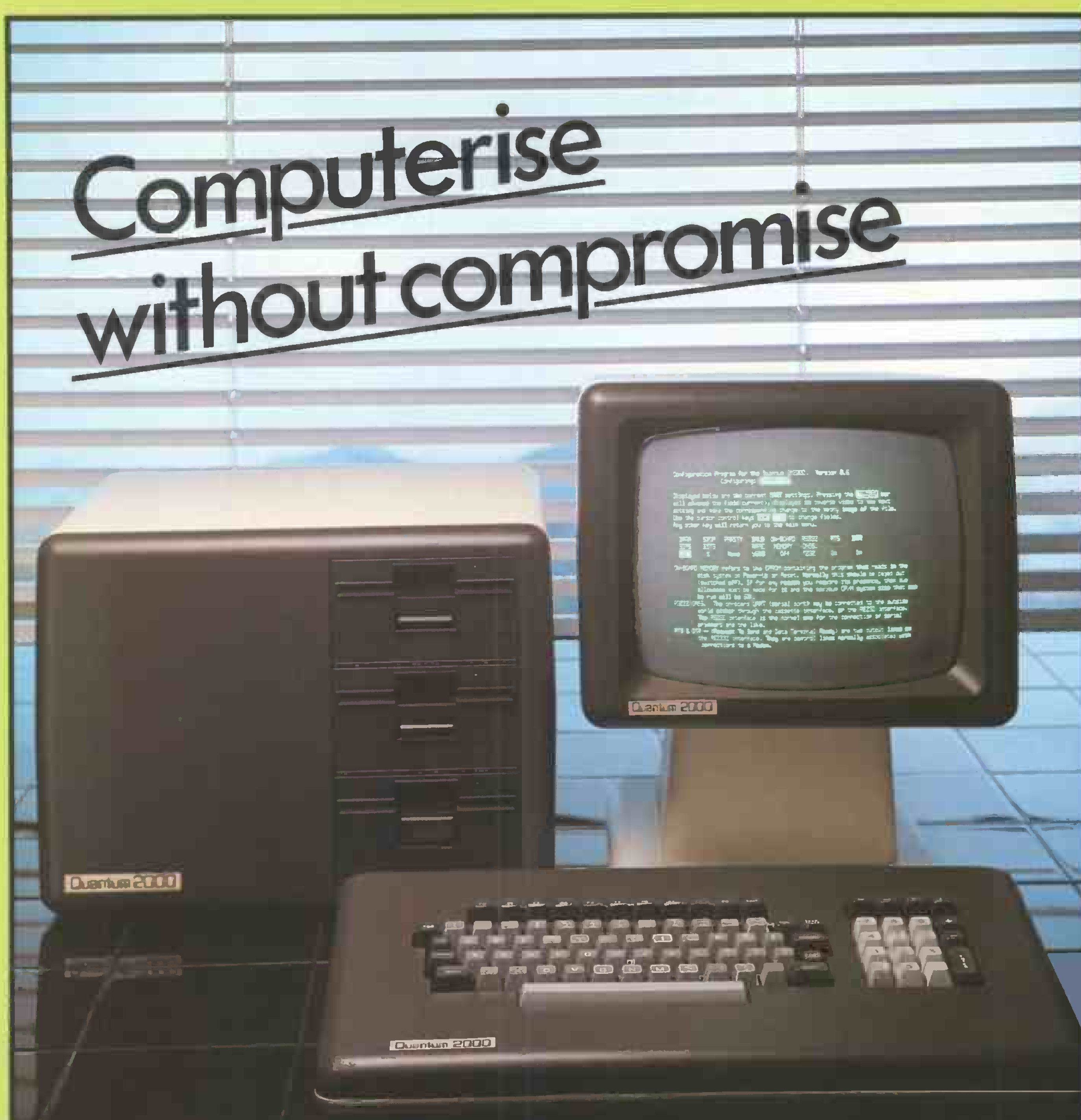
Unlike the arcade game, however, the home-computer version offers three different levels of play — easy, normal and hard. I only tried easy. Two-player versions and a demonstration mode are also included.

There is only one thing lacking: the computer does not record your highest score, let along best today or best of all time. This may be because it is not possible to fit more than 16K into a cartridge, and there just is not room for it.

Even so, Defender is outstanding, and could the the second-best home computer game ever written — after the immortal Star Raiders, of course.

Specification

Type: Real-time arcade game with outstanding colour and sound.
Format: Plug-in ROM pack CXL-4025
System: Any Atari 400 or 800 plus joystick
Manufacturer: Atari
Price: £34.95
Rating: 18/20



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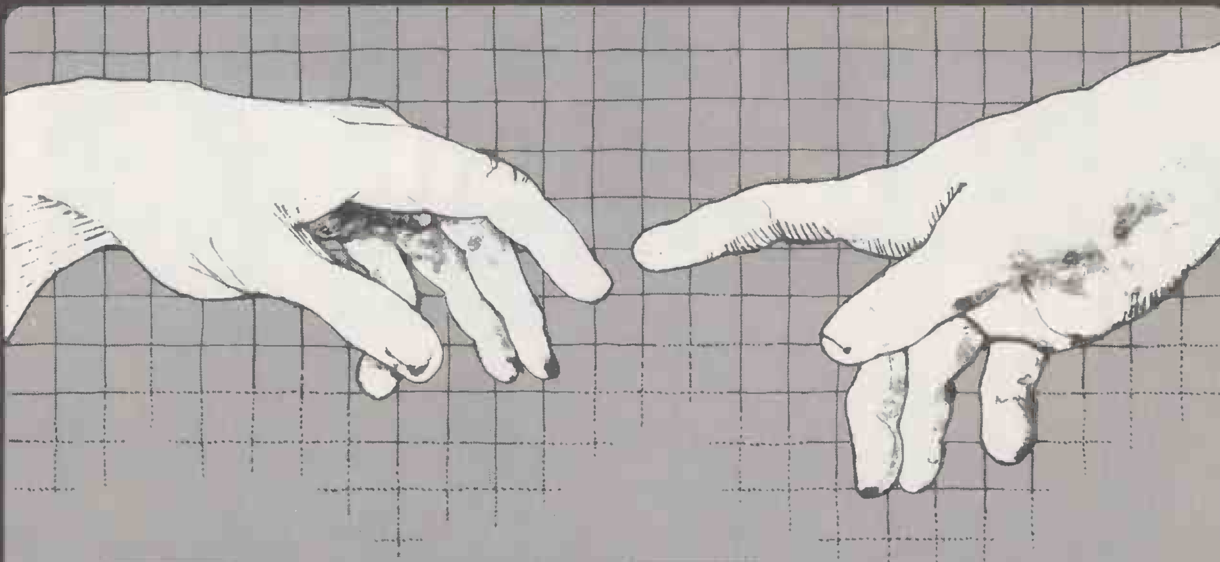

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Open File

This regular section of *Practical Computing* appears in the magazine each month, incorporating Tandy Forum, Apple Pie, Sinclair Line-up and other software interchange pages.

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Guidelines for contributors

Programs should be accompanied by documentation which explains to other readers what your program does and, if possible, how it does it. It helps if documentation is typed or printed with double-line spacing — cramped or handwritten material is liable to delay and error.

Program listings should, if at all possible, be printed out. Use a new ribbon in your printer, please, so that we can print directly from a photograph of the listing and avoid typesetting errors. If all you can provide is a typed or handwritten listing, please make it clear and unambiguous; graphics characters, in particular, should be explained.

We can accept material for the Pet, Vic and Sharp MZ-80K on cassette, and material for the larger machines can be sent on IBM-format 8in. floppy discs.

COMMODORE CORNER

by Mike Todd

Flipping Screen

THE FIRST three programs this month are simple utilities. Although all three reside in the second cassette buffer they are all fully relocatable. You could put them in any unused and protected area of memory just by changing the start address which appears in line 1000.

The first of the utilities, from Miss Bunn of Stourbridge, West Midlands, is a screen flip, which has a variety of uses. It swaps the contents of the screen with the contents of the top 1,000 bytes of memory and it is so fast that it effectively gives you a second screen.

The routine is actually written for an 8K Pet and stores the screen image from location 7192 onwards. If you want to use a 16K or 32K Pet then the 16th byte, at the end of line 2000 in the program, needs to be changed according to the table.

It is also necessary to protect the top 1,000 bytes from being overwritten by Basic, and this is done using:

```
POKE 52,A: POKE 53,B: CLR
```

at the very start of your program, where the values A and B are found from the table.

This routine will work on all 40-column Pets, although for very early old-ROM Pets you should Poke locations 134/135 instead of 52/53. Every time you want to flip to the alternate screen, just use Sys826.

Popping out

Many micros have a Pop command which allows you to remove the last Gosub entry from the stack. It can be useful if you want to abort a subroutine without returning to the calling statement.

Christopher Carter of Formby in Merseyside has sent an equivalent routine for the Pet which is designed for use on Basic 2/3 Pets, but could be used on others by changing the two subroutine calls according to the table.

It is called with Sys826 and will produce a

(continued on next page)

Flipping screen.

```
1000 S = 826
1010 READ A: IF A>255 THEN 1030
1020 POKE S,A: C=C+A: S=S+1: GOTO 1010
1030 IF A<>C THEN PRINT"CHECKSUM ERROR"
2000 DATA 169,  0,133,  0,169,128,133,  1,169, 24,133, 48,133, 52,169, 28
2010 DATA 133, 49,133, 53,160,  0,169,  0,177,  0,133, 50,177, 48,145,  0
2020 DATA 165, 50,145, 48,200,208,241,230,  1,230, 49,165,  1,201,132,208
2030 DATA 231, 96
2040 DATA 5517
```

```
033A A9 00      LDA #$00
033C 85 00      STA $00
033E A9 80      LDA #$80
0340 85 01      STA $01
0342 A9 18      LDA #$18
0344 85 30      STA $30
0346 85 34      STA $34
0348 A9 1C      LDA #$1C
034A 85 31      STA $31
034C 85 35      STA $35
034E A0 00      LDY #$00
0350 A9 00      LDA #$00
0352 B1 00      LDA ($00),Y
0354 85 32      STA $32
0356 B1 30      LDA ($30),Y
0358 91 00      STA ($00),Y
035A A5 32      LDA $32
035C 91 30      STA ($30),Y
035E C8         INY
035F D0 F1      BNE $0352
0361 E6 01      INC $01
0363 E6 31      INC $31
0365 A5 01      LDA $01
0367 C9 84      CMP #$84
0369 D0 E7      BNE $0352
036B 60         RTS
```

Popping out.

```
1000 S = 826
1010 READ A: IF A>255 THEN 1030
1020 POKE S,A: C=C+A: S=S+1: GOTO 1010
1030 IF A<>C THEN PRINT"CHECKSUM ERROR"
2000 DATA 162,255,133, 71, 32,170,194,154
2010 DATA 201,141,240,  3, 76,232,199,104
2020 DATA 104,104,104,104,96
2030 DATA 2879
```

```
033A A2 FF      LDX #$FF
033C 85 47      STA $47
033E 20 AA C2   JSR $C2AA
0341 9A         TXS
0342 C9 8D      CMP #$8D
0344 F0 03      BEQ $0349
0346 4C E8 C7   JMP $C7E8
0349 68         PLA
034A 68         PLA
034B 68         PLA
034C 68         PLA
034D 68         PLA
034E 60         RTS
```

(continued from previous page)
Return Without Gosub error message if there is no Gosub entry on the stack. Purists may say that there should be no need for such things in a well-structured program — but I'm sure someone will find a use for it.

Selective restoration

Also from Christopher comes a selective Restore routine which allows a Read statement to start at a given line of data. This would otherwise have to be done with a For-Next loop to search for the start of the desired data, which can be long and tedious.

The routine is called by using Sys826, X where X is the line number at which you want to start reading. If the line number does not exist, or if there is no Data statement on it, the routine just ignores the instruction.

This routine is also for Basic 2/3 Pets, but can be converted using the table.

Skill and judgement

Are you a competition nut? Do you enter every multiple choice competition that you see? You know the sort, "using your skill and judgement, arrange the following attributes into order and win ..." If you do, then Nick Higham of Eccles has produced a program to help you.

Most of these competitions allow multiple entries and, having chosen the preferred order of entries, permuting these to produce an entry can be very tedious. This program simplifies it all and after telling it how many

(continued on page 157)

Selective restoration.

```
1000 S = 826
1010 READ A: IF A>255 THEN 1030
1020 POKE S,A: C=C+A: S=S+1: GOTO 1010
1030 IF A<>C THEN PRINT"CHECKSUM ERROR"
2000 DATA  32,112,  0, 32,139,204, 32,210
2010 DATA 214, 32, 44,197,144, 33,160,  4,177
2020 DATA  92,240, 27,200,201,131,208,247
2030 DATA 165, 17,133, 60,165, 18,133, 61
2040 DATA 136,152,166, 93, 24,101, 92
2050 DATA 144,  1,232,134, 63,133, 62, 96
2060 DATA 5493
```

```
033A 20 70 00   JSR $0070
033D 20 8B CC   JSR $CC8B
0340 20 D2 D6   JSR $D6D2
0343 20 2C C5   JSR $C52C
0346 90 21      BCC $0369
0348 A0 04      LDY #$04
034A B1 5C      LDA ($5C),Y
034C F0 1B      BEQ $0369
034E C8         INY
034F C9 83      CMP #$83
0351 D0 F7      BNE $034A
0353 A5 11      LDA $11
0355 85 3C      STA $3C
0357 A5 12      LDA $12
0359 85 3D      STA $3D
035B 88         DEY
035C 98         TYA
035D A6 5D      LDX $5D
035F 18         CLC
0360 65 5C      ADC $5C
0362 90 01      BCC $0365
0364 E8         INX
0365 86 3F      STX $3F
0367 85 3E      STA $3E
0369 60         RTS
```

Flipping screen table.

	8K	16K	32K
16th byte	28	60	124
Poke 52,A	24	24	24
Poke 53,B	28	60	124

Popping out table.

BASIC2/3	BASIC1	BASIC4
C2AA	C2AC	B322
C7E8	C7D8	B86B

Selective restoration table.

BASIC2/3	BASIC1	BASIC4
CC8B	CCA4	BD84
D6D2	D6DA	C92D
C52C	C522	B5A3

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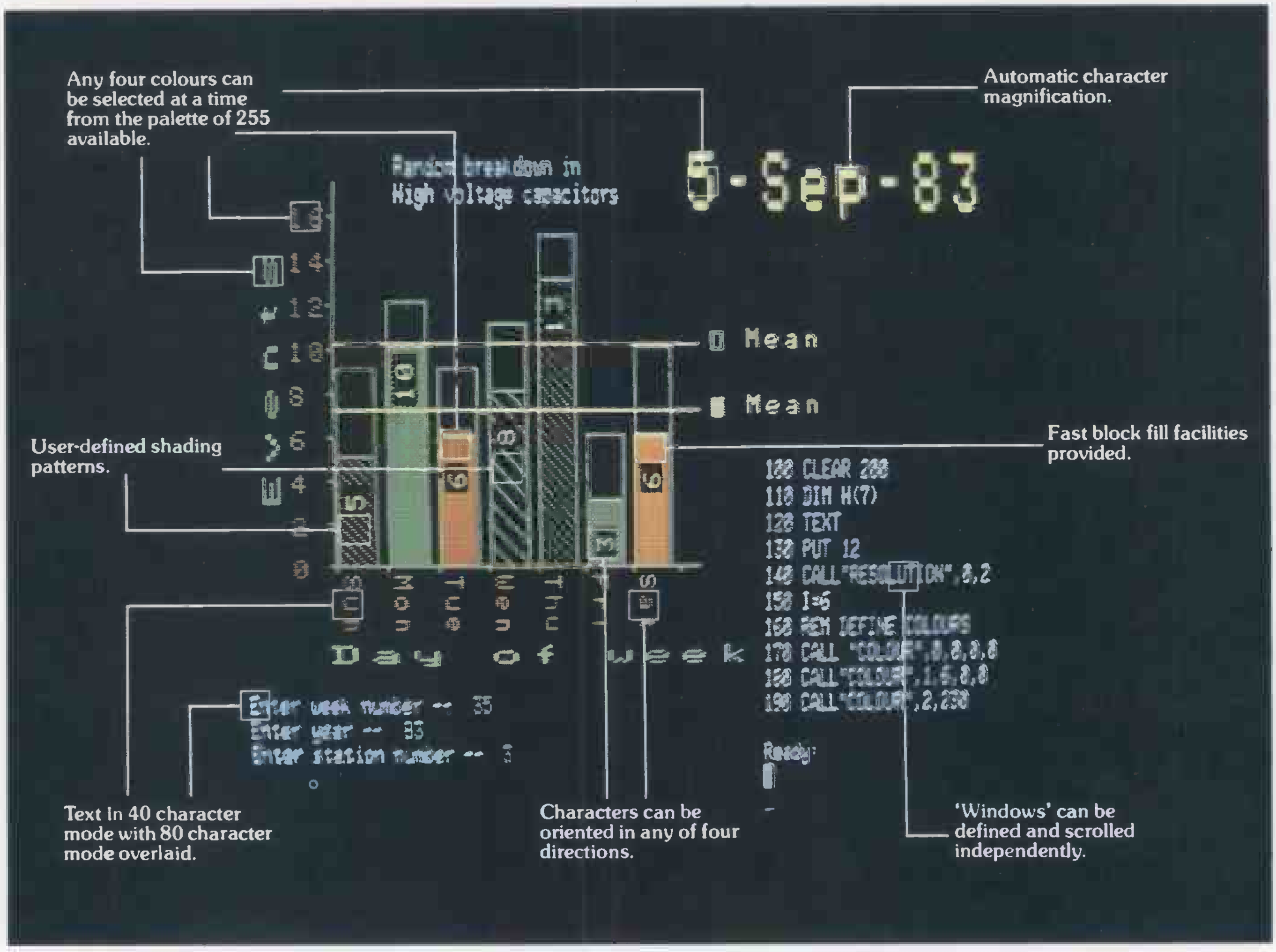

A picture may be worth a thousand words but it still tells only half the story about graphics on the 380Z.

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It is also worth noting that 380Z graphics are equally effective in monochrome — for 'colour' just read 'shades of grey'. Again there are 255 shades available, and there's also a very useful facility for fading up and down throughout the grey scale.

There are also the special effects — such as moving between graphics 'pages' for pseudo-animation, or the ability to produce 'instant' graphics by drawing them with the colour 'switched' off and then 'switching' on.

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(continued from page 152)
letters, are being used, each letter corresponding to an attribute, and the number required it asks you to assign a weighting from 1 to 100 for each letter. The higher the weighting, the greater the likelihood of the letter being chosen.

The program is self-explanatory, although there are three subroutines at the end, which may be worth noting as they could be useful in your own programs. Lines 8000 to 8010 simply wait for any key to be pressed, although it is a rather over-complex way of doing things.

The Poke 158,0 clears any spurious characters from the keyboard buffer, in case you may have pressed a key before the program is ready, and the Wait 158,1 simply waits for a key to be pressed. The Poke 216,25 forces the next Print statement to be placed on the bottom line of the screen. Lines 8500 to 8540 form a routine which simply flashes a question mark on the screen while waiting for any character, except Return, to be pressed and exits the routine with Z$ holding the character.

The Return CHR$(13) is detected in line 8530 using the ASC function. The Z$ + "" in the brackets is used to avoid an Illegal Quantity error if Z$ does not contain anything. The routine at lines 9000 to 9070 flashes its own cursor and acts like an Input statement, except that cursor movements other than Delete are not allowed, and Z$ contains the typed characters when Return is pressed.

It is a very useful bomb-proof replacement for Input and could be used on a Pet or Vic, provided that the Poke 158,0 in line 9000 is either omitted or changed. If you want to use the program on any Pet other than Basic 2, 3 or 4 Pets, then the Pokes and Wait will have to be changed as in the table. Unfortunately, the program does not write a tie-break slogan for you.

Hardware

Normally Open File covers software and not hardware, but here are some comments from P A Ramsdale of Swindon which may help those who wish to feed the vision signal from one of the new 12in. screen Pets to a monitor.

The user port provides a video, pin 2; vertical sync, pin 9; and horizontal sync, pin 10. They can be combined to produce a composite video signal suitable for a monitor. For old 8in. screen Pets, there are various circuits available to do the combination, but with the new 12in. Pets the signals have been inverted and the line timings have been changed. The line timing, which is about 100ms. rather than the standard 64ms., means that normal monitors will not lock. Fortunately these Pets use a programmable video controller MC-6845, and it is possible to reduce the line time sufficiently for the monitor to synchronise by:

POKE 59520,0 : POKE 59521,X

where X = 62 for 80 columns and X = 59 for 40 columns.

It is also necessary to move the line-sync pulse position so that the lines start at the left-hand side of the screen:

POKE 59520,2 : POKE 59521,Y

where Y = 47 for 80 columns and Y = 49 for 40 columns. The reduction in line timing results in a squeezing of characters on the Pet's screen, but they will appear normally on the monitor. It is also possible that some adjustment of the line-sync pulse width may be needed using:

POKE 59520,3 : POKE 59521,Z

Z starts off at 15 and the pulse can be adjusted by increasing this value.

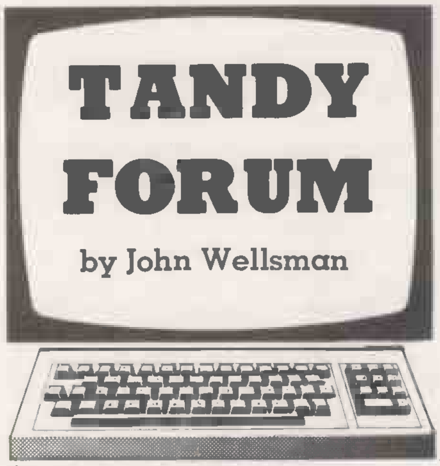
Whenever the screen mode is altered for instance using Print CHR$(142), all the values in the video controller are reset, and so these Pokes are required whenever it is done. The video combining unit used with the 8in. Pets requires inversion of the video and horizontal signals. The user-port signals could be applied directly to the inputs of a 4066 quad analogue switch to produce a suitable video output.

Skilled judgement table.

Basic 2/3/4	Basic 1	Vic
POKE 158,0	POKE 525,0	POKE 198,0
WAIT 158,1	WAIT 525,1	WAIT 198,1
POKE 216,25	POKE 245,25	POKE 214,22

Skilled judgement.

```
10 REM** AWARD EACH LETTER A WEIGHTING FROM
20 REM** 1-100 AND THE COMPUTER WILL
30 REM** CHOOSE AN ORDERING OF THE LETTERS
40 REM** BASED ON THE WEIGHTINGS ASSIGNED.
50 REM** BUT WITH A RANDOM FACTOR.
80
100 PRINT"■■■■■■■■■■■MULTIPLE CHOICE■"
110 PRINTSPC(10);"■COMPETITION ENTERER■"
120 PRINT"■■HOW MANY LETTERS TO CHOOSE FROM? ";:GOSUB9000:X=VAL(Z$):PRINT
130 PRINT"■HOW MANY LETTERS SHALL I CHOOSE? ";:GOSUB9000:N=VAL(Z$):PRINT
140 DIMA$(X),A(X),C(X),B(X)
150 PRINT"■■ENTER THE LETTERS ONE AT A TIME, EACH"
160 PRINT"■FOLLOWED BY IT'S RELATIVE WEIGHTING"
165 PRINT"■ON A SCALE 1-100 INCLUSIVE."
170 GOSUB8000
180 PRINT"■■LETTER";SPC(5);"WEIGHTING■":PRINT"------";SPC(5);"---------"
190 FORI=1TOX:PRINT"   ";:GOSUB9000:A$(I)=Z$:PRINTSPC(10);
200 GOSUB9000:A(I)=VAL(Z$):PRINT:NEXTI
220 GOSUB7500:GOSUB8000
230 GOSUB7000
250 PRINT"■■■WHICH COMBINATION NUMBER WOULD YOU LIKE "
252 PRINT"TO CHANGE? - (HIT 'RETURN' IF NONE) ";
255 GOSUB9000:PRINT
260 IFZ$=""GOTO300
265 C=VAL(Z$)
270 PRINT"CHANGE ";A$(C);" TO ";:GOSUB9000:A$(C)=LEFT$(Z$,1)
280 PRINT" AND ";A(C);" TO ";:GOSUB9000:A(C)=VAL(Z$):GOSUB7500: GOSUB7000
290 GOTO250
300 GOSUB7500
310 PRINT"■■■"
350 FORI=1TOX:C(I)=I:NEXTI
360 FOR I=1TOX:B(I)=A(I)*RND(1):NEXTI
400 FORI=1TOX-1:FORJ=1TOX-1
410 IFB(J)>=B(J+1)GOTO430
420 T=B(J):B(J)=B(J+1):B(J+1)=T:T=C(J):C(J)=C(J+1):C(J+1)=T
430 NEXTJ:NEXTI
450 PRINT"SELECTION:-":PRINT"----------■
500 FORI=1TON:PRINTA$(C(I));" ";:NEXTI
550 PRINT:PRINT"■■■■S■  FOR ANOTHER SELECTION."
560 PRINT"■■D■  TO DISPLAY TABLE AND/OR
570 PRINT"    CHANGE WEIGHTINGS.
580 PRINT"■■E■  TO END.":PRINT"■
600 GOSUB8500:PRINTZ$;
620 IFZ$="D"GOTO230
630 IFZ$="E"THENPRINT"■":END
635 GOTO310
640 PRINT"■";:GOTO600
6999
7000 PRINT"■";:PRINT"■LETTER";SPC(5);"WEIGHTING■"
7005 PRINT"------";SPC(5);"---------":PRINT
7010 FORI=1TOX:IFI<10THENPRINTI;:GOTO7015
7012 PRINT"■";I;
7015 PRINT" ";A$(I);SPC(10);A(I):NEXT
7020 RETURN
7500 FORI=1TOX-1:FORJ=1TOX-1:IFA(J)>=A(J+1)GOTO7530
7510 T=A(J+1):A(J+1)=A(J):A(J)=T
7520 T$=A$(J+1):A$(J+1)=A$(J):A$(J)=T$
7530 NEXT:NEXT:RETURN
7999
8000 PRINT"■":POKE158,0:POKE216,25:PRINTTAB(7)"■■PRESS ANY KEY TO CONTINUE■"
8010 WAIT158,1:GETZ$:RETURN
8500 POKE158,0:ZC=1
8510 T=TI
8520 IFTI-T>20THENPRINTMID$("? ",ZC,1)"■";:ZC=3-ZC:GOTO8510
8530 GETZ$:IFZ$=""ORASC(Z$+" ")=13GOTO8520
8540 RETURN
8999
9000 POKE158,0:ZC=1:Z$="":ZL=0
9010 T=TI
9020 IFTI-T>20THENPRINTMID$("■ ",ZC,1)"■";:ZC=3-ZC:GOTO9010
9030 GETZZ$:IFZZ$=""GOTO9020
9040 ZA=ASC(ZZ$):IFZA=13THENPRINT" ";:RETURN
9045 IFZA=20ANDZL>0THENPRINTZZ$;:ZL=ZL-1:Z$=LEFT$(Z$,ZL):GOTO9020
9050 IFZA>140ANDZA<158GOTO9020
9060 IFZA>13ANDZA<31GOTO9020
9065 IFZL>254GOTO9020
9070 ZL=ZL+1:Z$=Z$+ZZ$:PRINTZZ$;:GOTO9020
```



Commas for Gotos

In the January issue, I described how it is, under some circumstances, possible to use a comma instead of Goto and Then. P V Bamfield of Brighton has written to point out that while this does work, if you use a utility program to renumber the program you are likely to run into difficulties.

Mr Bamfield says that with two renumbering utilities he had error messages. I tried this myself with the Newdos and Ldos routines, and though I got no error messages and superficially correct renumbering I found that the lines numbers after the commas had not been changed. My apologies for not having checked this earlier.

Race 2000

R S Powell of Coventry sent in a game program which he calls Race 2000. Instructions for the game, which is a racing-car obstacle course rather than a race, are included in the listing, which is in Tandy level 2 Basic. It also includes a machine-language sound routine in the last eight lines.

The machine code is string-packed, avoiding the necessity of reserving any memory. The Put (X,Y) commands in the listing call the sound routine to produce a variety of engine noises. To hear them you have to plug in your cassette lead and connect the large grey jack to an amplifier. The £ signs between quotes represent spaces wherever they occur — except in line 1080, which tells you that the car is represented by a shifted 3 CHR$(35).

Basic insert

This routine was sent in by Mark Emery of Orpington, Kent. It enables you to insert a line of Basic into a program while it is still running, and without losing any variables except those used by the routine. Although the inserted line in this program is the last line of the program, it can be anywhere, and be defined as the variable Lin with a separate input.

The listing is for level 2 or DOS 48K machine. For a 16K machine two addresses in line 40 must be changed: —8192 becomes 29952, and —12288 becomes 28672. Line 45 should be changed to

DATA 33,0,112,205,192,27,201,0,0,0".

This program is not unlike Andrew Parsonage's program in last month's Tandy Forum. If you are interested to know how the computer handles Basic, a close study of this sort of program is both helpful and interesting.

On Run the first thing that a computer must know is the location in memory of the program. The start address of any Basic program is stored in addresses 16548/9, the least-significant byte being stored first and most-significant last. These two addresses are in an area of RAM which is reserved for housekeeping items like this. So the expression

PEEK(16548) + PEEK(16549) * 256

will give the starting address of a resident Basic program. By Peeking at and above this address it is possible to see how the computer stores a Basic program.

Type in the test program exactly as shown without any spaces in the first three lines. If you do not have a printer, for line 130, substitute

PRINT PEEK(P + Y);

and read from the screen.

Make sure that the printer is on line and loaded and then Run. The output is a column of figures followed by a line of dots on which you can write notes. Write on the top line the figure given by line 105 in the

(continued on page 160)

Race 2000.

```
1 CLEAR 100:DEFINTA-Z:GOSUB
1000:GOTO 3000:
5 GOTO 100
20 FOR I=0 TO 18 STEP 2
30 SET(X+I,Y):NEXT:RETURN
50 FOR I=8 TO 26:RESET
(I,25):NEXT:RETURN
80 GOTO 5
100 CLS
110 PRINT@66,"*R A C E   P R A C T
I C E *";
120 PRINT@130,"=======* 2 0 0 0
*=======";
130 PRINT@258,"* S P E E D *£££* C
O U N T *";
140 PRINT@450,"* T E M P . *£££££*
O I L *";
150
PRINT@514,"L";:PRINT@526,"H£££E";:P
RINT@542,"F";
160 PRINT@642,"D I S T A N C E :";
170 PRINT@116,"F U E L :";
180 PRINT@504,"P I
T";:PRINT@568,"S T O
P";:PRINT@632,"A R E A";
190 PRINT@952,"*START*";
200 FOR Y=0 TO
47:SET(0,Y):SET(1,Y)
210 SET(64,Y):SET(65,Y):SET(127,Y)
220 NEXT
230 FOR X=0 TO 64
240 SET(X,47):SET(X,10):SET(X,34)
250 SET(X,19):SET(X,28):SET(X,0)
260 NEXT:FOR Y=10 TO 27:FOR X= 1
TO 2:
270 SET(31+X,Y):NEXT X,Y
280 FOR X= 110 TO 127:SET(X,47)
290
SET(X,17):SET(X,35):SET(X,40):SET(X
,0)
300 NEXT:FOR X=100 TO
110:SET(X,47)
310 SET(X,10):SET(X,0):NEXT
320 FOR Y=0 TO 10:
SET(100,Y):SET(101,Y):NEXT
330 FOR Y=10 TO 47:
SET(109,Y):SET(110,Y):NEXT
340 FOR Y=42 TO
47:SET(100,Y):SET(101,Y):NEXT
350 FOR Y=21 TO 32: SET
(100,Y):SET(101,Y):NEXT
360 X=8:Y=26:GOSUB 20
370 X=39:GOSUB 20
380 X=104:Y=8:GOSUB 20
385 REM ------------INITIAL
SETTING AT LINE 390-----------
390
A=50:F=122:C=0:D=0:T=7:O=57:V=16244
:M=64:B=0
400 FOR X=39 TO
57:SET(X,25):SET(X+65,7):NEXT
410
PUT(200,255):PRINT@824,"(READY)";:P
OKEV,35:FOR I=1 TO 500:NEXT
420
PUT(100,175):PRINT@824,"-*SET*-";:F
```

(listing continued on page 160)

(continued from page 158)
program. The actual addresses will vary according to your system and memory size though their relationship will be the same, so I will give the values from my own machine.

My program starts at 27206 and the first two numbers are 83 and 106; the third and fourth are 10 and 0 — and will be the same in your printout if you have copied the program exactly. The first two are the least- and most-significant bytes of the address of the next line, line 20, of the program. In this case it is 83 + 256*106 = 27219. The second pair are the least- and most-significant bytes of the program line number.

These two pairs of numbers are followed by the text of the program line. The command words such as For, Next, and so on are not stored as words but as tokens or single bytes, and in the example the first number following the line pair 10,0 is 129, which is the token for For. It is followed by 88, the ASCII code for X and then 213, which is the token for the function of equality — not to be confused with the character =. Then 49, ASCII 1; 189, the token for To; followed by 49,48,48, for 1,0,0. Finally there is an end-of-line indicator, 0.

(continued on page 162)

(listing continued from page 158)
```
OR I=1 TO 500:NEXT
430 PUT(50,75):PRINT@824,"*-GO-*";
435 REM -----------MAIN PROGRAM
STARTS HERE ---------
440 IF A=<0 THEN
A=0:PRINT@327,"100";:GOTO 460
450
S=(52-A)*2:PRINT@327,STR$(S);"£";
455 S=50/A
460 C=C+1:PRINT@343,STR$(C);:IF A
<50 THEN A=A+B ELSE IF B =-5 THEN
A=A+B
470 POKEV+M,32:POKEV,35:I=0
480 I=I+1
481 IF S=0 THEN PUT(1,1) ELSE
PUT(S,1)
490 PRINTCHR$(15);:K$=INKEY$:IF
K$<>"" THEN 590
500 IF I<A THEN 480
510 V=V-M: IF V<15360 THEN POKE
V+M,32:V=V+1088:GOTO 810
520 IF PEEK(V) <> 32 THEN 940
530 IF RND(3)>1 THEN 440
540 IF RND(2)>1 THEN 570
550 X=RND(15)+32:Y=RND(15)*64
560 FOR I=0 TO
RND(2):PRINT@Y+X+I,"+";:PUT(10,5):N
EXT:GOTO 440
570 Y=RND(15)*64:FOR I=33 TO
48:PRINT@Y+I,"£";:NEXT
580 GOTO 440
590 IF K$="8" THEN M=64:GOTO 440
600 IF K$="7" THEN M=65:GOTO 440
610 IF K$="9" THEN M=63:GOTO 440
620 IF K$="5" THEN B=-5: GOTO 440
630 IF K$="2" THEN B=0:GOTO 440
640 IF K$="." THEN B=10:GOTO 440
650 IF K$="1" THEN IF INKEY$=""
THEN 650 ELSE 440
660 IF K$<>CHR$(13) THEN 500
670 X=V-15360:Y=X/64:X=X-(Y*64)
680 IF X<52 OR X>54 THEN 500
690 IF Y< 6 OR Y>11 THEN 500
700 PRINT@770," * R E - F U E L I
N G *";
710 IF F<122 THEN F=F+1:SET (F,7)
715 PUT ((130-F)*8,20)
720 IF O=57 THEN IF F=122 THEN 770
ELSE 470
730 O=O+1:SET(O,25)
740 T=T-RND(T-7):A=50:GOSUB 50: IF
T<7 THEN T=7
745 FOR I= 7 TO T:SET(I,25):NEXT
749 I=0
750 I=I+1
752 IF INKEY$=CHR$(13) THEN 790
755 IF I>O THEN 710
765 'PUT(255,255)
770 PRINT@770," * T A N K S  F U L
L *";
772 PRINT@835,": PRESS ENTER TO
CONT. *";
780 PRINT@312,"£FULL££";:IF
INKEY$<>CHR$(13) THEN 780
790 PRINT@770,"
  ";' <-- 24 spaces
791 PRINT@834,"
  ";' <-- 24 spaces
800 PRINT@312,"£££££";
810 N=S/100:I=-1
820 I=I+1:IF I>N THEN 850
830 RESET(F,7): IF F> 103 THEN
F=F-1:GOTO 820
840 PRINT@312,"*EMPTY*";:GOTO 960
850 IF F<110 THEN
PRINT@312,"RE-FUEL";:'PUT(10,10)
860 D=D+1:PRINT@660,STR$(D);:C=C+1
870 IF (D+1)/2=INT((D+1)/2) THEN
RESET (O,25):O=O-1
880 IF O=38 THEN PRINT@770," O I L
 E M P T Y";:PUT(2,20):GOTO 960
885 'PUT (2,20)
905 IF RND(5)>1 THEN 930
910 SET( T,25):T=T+1
920 IF T>19 THEN PRINT@770," O V E
R  H E A T I N G
";:PUT(30,70):GOTO960
925 'PUT(30,70)
930 GOTO 440
940
PRINT@V-15360,"BANG";:PUT(10,87):PU
T(46,63):PUT(65,01):PUT(99,28):PUT(
34,25):PUT(34,25)
950 PRINT@770, "YOU HAVE HIT AN
OBSTACLE...!";
960 PRINT@898,"PRESS < ENTER > FOR
A NEW GAME. ";
970 PRINT@834,"Y O U  H A V E  L O
S T !";
975 K$=INKEY$
980 K$=INKEY$:IF K$="" THEN 980
990 IF K$=CHR$(13) THEN 5 ELSE END
1000 CLS
1010 PRINTTAB(12)"WELCOME TO RACE
PRACTICE 2000"
1015
PRINTTAB(12)"=====================
======="
1020 PRINT
1030 PRINT"YOU HAVE TO COMPLETE AS
MANY LAPS AS POSSIBLE!"
1040 PRINT"BUT WATCH OUT FOR THOSE
OBSTACLES - THEY CAN POP ANYWHERE"
1050 PRINT"ALONG THE ROAD!"
```
(listing continued on page 162)

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(continued from page 160)

From the first number to the end of line, there are 13 numbers. Using my starting address, 13 + 27206 equals 27,219 which is the 14th line and brings you to the start of the second line where again you find two pairs of numbers, the first two being the LSB and MSB of the beginning of the third line, and the second pair being the LSB and MSB of the current line number.

In line 120 of the test program above I have only Peeked into the first 29 addresses, covering the first three program lines. You could increase this number and look at the rest of the program which does the Poking and Peeking.

If you do not have a table of command tokens it should be quite easy to construct one by writing dummy programs using all the commands, reading them out as described and then decoding the listing.

May I enter a plea to those who send in programs. Please, never, ever use I or O for subscripting variables. Many people use I especially in this way, but A(I) and A(1) can be so easily confused when typing in programs, so please use something else. O is just as bad, though is used less often. There are 24 other characters which can cause no confusion.

(listing continued from page 160)

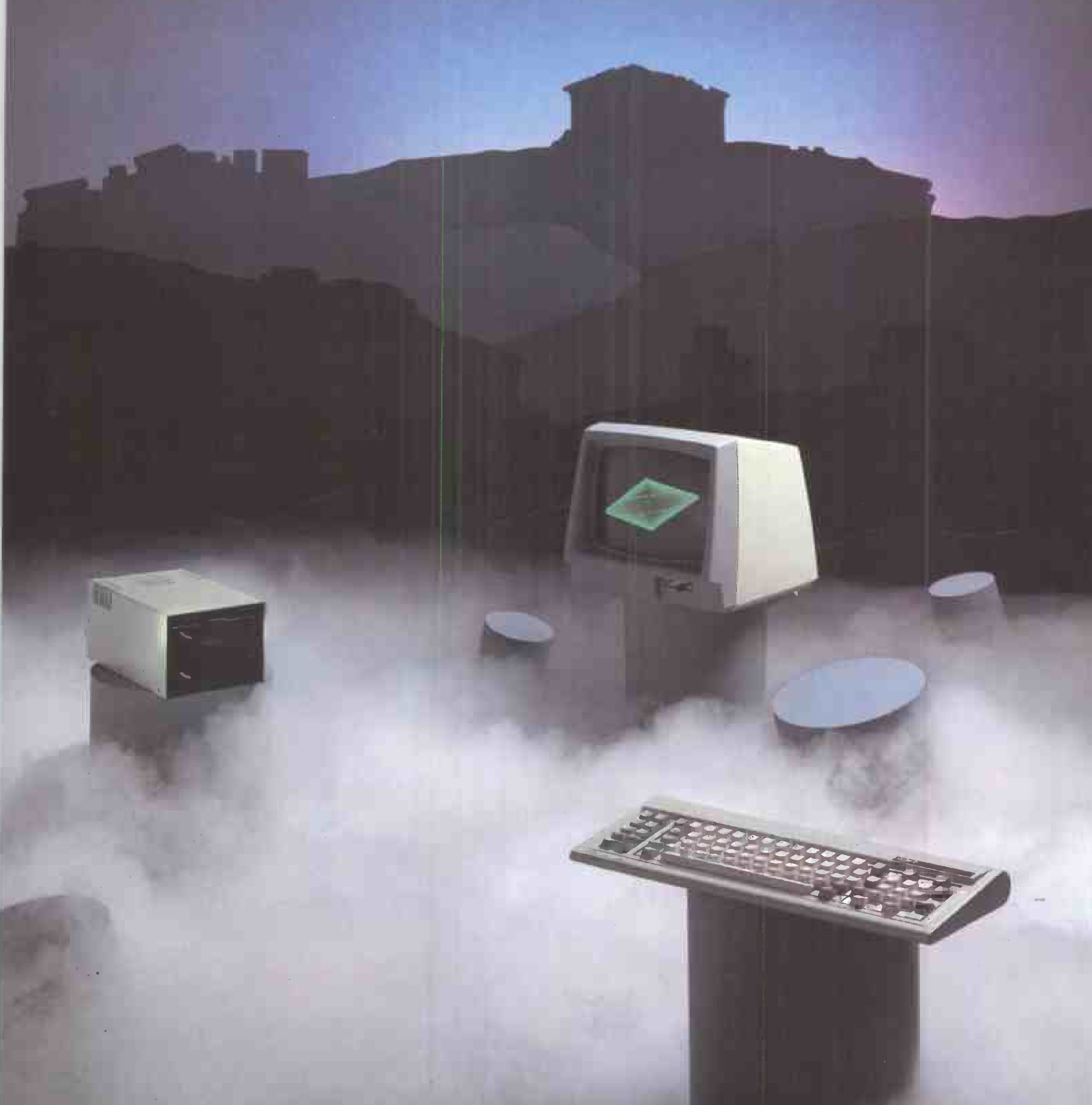
```
1060 PRINT"ALL THE INFORMATION
REQUIRED IS DISPLAYED, SO BE
OBSERVANT."
1066 PRINT"THE INFORMATION
INCLUDES:"
1067
PRINT"SPEED":PRINT"COUNT":PRINT"DIS
TANCE":PRINT"TEMPERATURE":PRINT"FUE
L":PRINT"OIL":
1070 GOSUB 1180:CLS:PRINT
1075 PRINTTAB(10)"THE CONTROLS ARE
AS FOLLOWS :"
1080 PRINT"'£'.....IS THE CAR"
1090 PRINT"'7'.....GO LEFT"
1100 PRINT"'9'.....GO RIGHT"
1110 PRINT"'8'.....GO UP"
1120 PRINT"'5'.....TO ACCELERATE"
1130 PRINT"'.'.....TO DECELERATE"
1140 PRINT"'2'.....TO KEEP SPEED
CONSTANT"
1150 PRINT"'1'.....TO FREEZE"
1160 PRINT"'0'.....TO CONTINUE"
1170 PRINT"'ENTER'.TO
RE-FUEL/CONTINUE
1175 PRINT:PRINT:PRINT"THE GAME
START WITH 'READY' - 'SET' -
'GO!'"
1176 GOTO 1192
1180 '
1190 PRINTTAB(15)"PRESS ANY KEY TO
CONTINUE"
1191 GOTO 1200
1192 GOSUB 1180::CLS:PRINT"ONE
LAST NOTE:- SOUND FOR THIS PROGRAM
IS PLAYED THROUGH THE CASSETTE
PORT AND MAY BE OBTAINED BY PUTING
SOME SORT OF AMPLIFIER ON";
1193 PRINT" THE CASSETTE
OUTPUT.":PRINT:PRINT:PRINTTAB(15)"-
---** PRESS ANY KEY TO START
**----"
1200 IF INKEY$="" THEN 1200 ELSE
RETURN
2999 REM ==MACHINE CODE ROUTINE
LOADER==
3000 CLS:MX$="........MACHINE CODE
ROUTINE STORED IN THIS
VARIABLE..........."
3020
C=VARPTR(MX$)+1:LO=PEEK(C):HI=PEEK(
C+1):POKE 16771,LO:POKE16772,HI
3030 LO=256*HI+LO
3040 FOR I=LO TO
LO+41:READA:POKEI,A:NEXT:GOTO 3080
3050
DATA197,207,40,205,28,43,71,197,207
,44,205,28,43,193,79
3060
DATA197,207,41,193,197,193,197,62,1
,211,255,16,254,193,197
3070
DATA62,2,211,255,16,254,193,13,32,2
35,193,201
3080 GOTO 5
60000 GOTO 60000
60023 SAVE"RACEPOWE/002:1
```

Basic insert listing 1.

```
1 CLS:CLEAR 5000
2 LIN=9999
5 GOSUB 150:REM FIND BEGINNING OF
  LINE LN
10 PRINT"ENTER THE LINE TO BE
PLACED AT";LIN
20 LINEINPUT")";F$
25 F$=F$+":REM "
30 FOR T=1 TO  LEN(F$):
M$=MID$(F$,T,1):
POKE-12288+T,ASC(M$):NEXT
40 DEFUSR1=-8192:FOR T = 0 TO
 7:READ D:POKE-8192+T,D: NEXT
45 DATA 33,0,208,205,192,27,201,
 0,0,0
50 A=USR1(0):X=16551
60 X2=PEEK(X)+PEEK(X+1)*256
70 FOR T=0 TO 255
80 IF PEEK(T+X2)=0 THEN 120
90 POKE RL+T,PEEK(T+X2-1)
100 NEXT
120 PRINT"DONE":LIST 9999
150 ST=PEEK(16548)+PEEK(16549)*256
170 A1=PEEK(ST):A2=PEEK(ST+1):
A3=A1+A2*256
180 SU=PEEK(ST+2)+PEEK(ST+3)*256:
   IF SU<>LIN THEN ST=A3:GOTO 170
190 RL=ST+4
200 RETURN
9999 ..............................
...................................
...................................
...................................
...................................
................
```

Basic insert listing 2.

```
10 FORX=1TO100
20 Z=X+2
30 NEXT
100 P=PEEK(16548)+PEEK(16549)*256
105  LPRINT"PROGRAM STARTS  AT";P;"
IN RAM":
120 FOR Y=0 TO 28
130                          LPRINT
PEEK(P+Y);"..............":
140 NEXT
```



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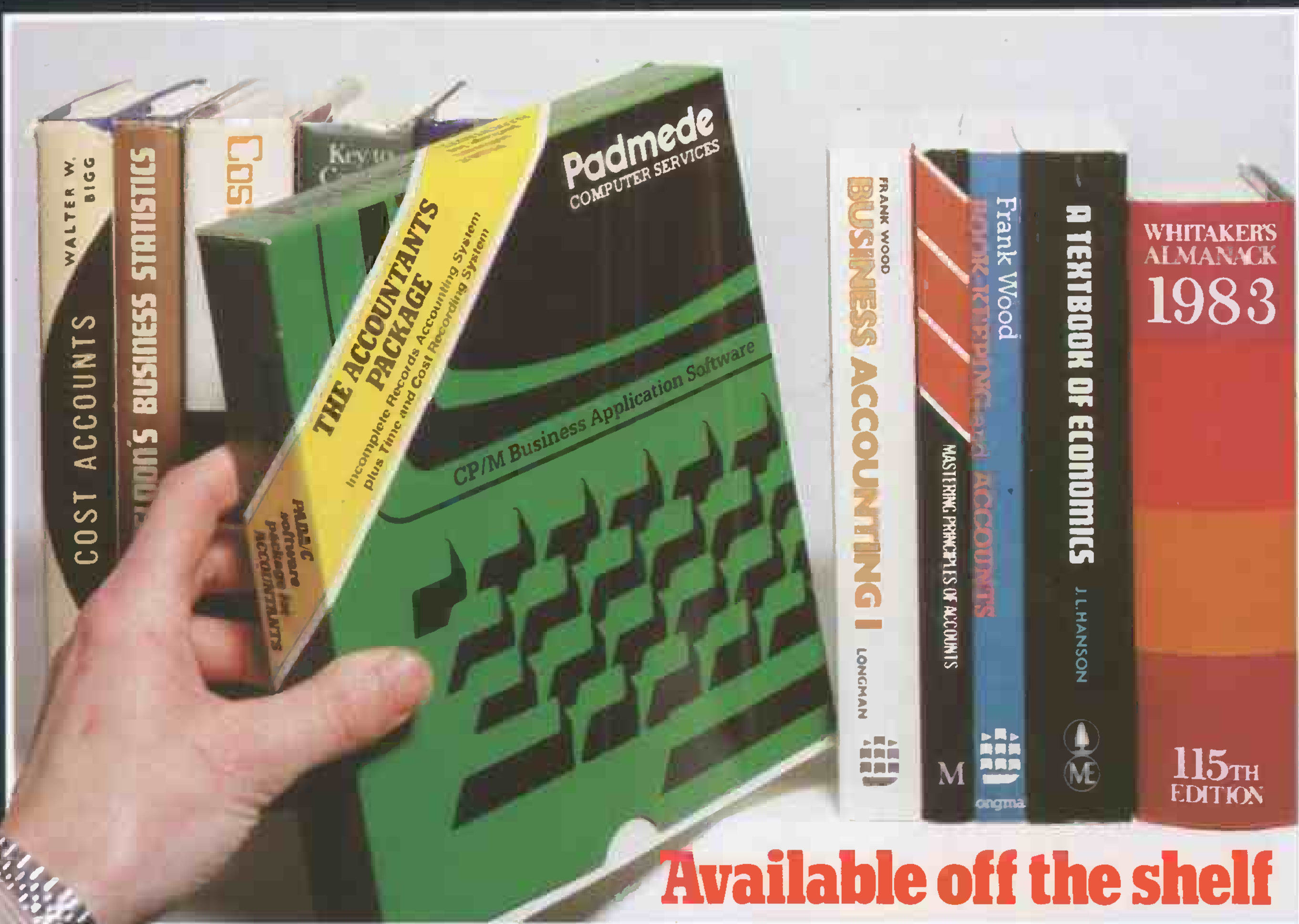

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Space Invaders

The Space Invaders program by P Mclean in the BBC Bytes column on page 141 of the February issue contains a keying error on line 400, which should read

400 FOR Q = 1 TO NI

The program runs as far as screen 6 before blowing up with the subscript error because the variable I, which I mistakenly substituted for NI when keying in the listing, can never exceed NI + 1; the For statement on line 100 keep it within this limit. NI, the number of invaders, reaches 7 on screen 6 giving a maximum value of I of 8, which exceeds the maximum dimensions for X%( ) and Y%( ) for the first time.

Normally we not only proof read BBC Bytes programs back to the original hard-copy version submitted by contributors, but also test the program through all visible pathways before publishing. Because I couldn't react fast enough to get past screen 2, I never met the bug which has given more expert players such a frustrating time.

When testing a tax or stock-control program there is a logical pathway to be followed; testing games requires that the tester is capable of playing the game to a satisfactory standard. Apologies all round, and thanks to the many readers who wrote in to point out the bug.

Graph

We have been sent two graph-plotting programs and fittingly, since graph plotting is an academic pursuit, the two contributors both have an academic background. Ann Kitchen of Stockport Grammar school comes from the teaching side, and A P Walker of Hayling Island, Hampshire from the taught.

Mrs Kitchen has written her program around the capabilities of the Tandy four-colour pen graphic printer. The printer sells for under £150, so true graph plotting is now affordable within school budgets. The program is designed to handle either cartesian or parametric equations, the Eval facility enabling both limits and equations to be entered while the program is running. The exercise remains under the control of the program operator from start to finish.

Both equation and limits are input and

(continued on next page)

Graph 1 by A P Walker.

```
>REM /////////// THIS IS THE
>REM LISTING FOR GRAPH (1)
>REM BY A.P.WALKER
>LOAD"A.APW2"
>LIST
   10 MODE7
   20 PROCINTRO
   30 MODE1
   40 PROCINTRO2
   50 ON ERROR GOTO1190
   60 DIMA$(15):XBOT=-20:XTOP=20:YBO
T=-20:YTOP=20:@%=&100030A:A=0
   70 *KEY 10 OLD:M RUN!M
   80 MODE1
   90 PROCLETTERS
  100 PROC_INPUT:PROCDRAW:GOTO100
  110 DEFPROCDRAW
  120 CLS
  130 REM********** DRAW AXIS ******
****
  140 VDU29,PX;PY;
  150 VDU5
  160 MOVE-PX,0:DRAW1280-PX,0
  170 MOVE0,-PY:DRAW0,1024-PY
  180 REM********** CALCULATE WHERE
NOS. ********************** SHOULD BE
 *************
  190 IF TY=2 THEN T1X=0:TESTXO=1E-1
0
  200 IF TX=2 THEN T1Y=0:TESTYO=1E-1
0
  210 IF TY=2 AND TX=2 THEN TESTXO=0
  220 IF TY=1 THEN T1X=1012-PY:TESTX
O=0
  230 IF TX=1 THEN T1Y=1140-PX:TESTY
O=0
  240 IF TY=1 AND TX=1 THEN TESTXO=X
TOP
  250 IF TX=0 THEN T1Y=140-PX:TESTYO
=0
  260 IF TY=0 THEN T1X=-PY:TESTXO=0
  270 IF TY=0 AND TX=0 THEN TESTXO=X
BOT
  280 REM****PUT ON NOS. AND REFEREN
CE LINES*********************
  290 FOR X=XBOT TO XTOP STEP XRANGE
/8
  300 GCOL0,1
  310 IF X<>0 THEN MOVEX/XRANGE*1000
,1000*YTOP/YRANGE
  320 IF X<>0 THEN DRAWX/XRANGE*1000
,1000*YBOT/YRANGE
  330 GCOL0,3
  340 FOR XCOUNT=1TOLEN(STR$(X))
  350 MOVEX/XRANGE*1000,T1X
  360 PLOT0,0,69*SGN(ABS(ABS(SGN(TY-
2))-1))+SGN(ABS(SGN(TY)-1))*(LEN(STR
$(X))+1)*32+SGN(ABS(ABS(SGN(TY-1))-1
))*20-(XCOUNT*30)
  370 IF X<>TESTXO THEN PRINT;CHR$(1
79+ASC(MID$(STR$(X).XCOUNT,1)))
  380 NEXT:NEXT
  390 FORY=YBOT TO YTOP STEP YRANGE/
8
  400 IF Y<>0 THEN GCOL0,1:MOVE1000*
XBOT/XRANGE,1000*Y/YRANGE
  410 IF Y<>0 THEN DRAW1000*XTOP/XRA
NGE,1000*Y/YRANGE
  420 GCOL0,3
  430 IF TY=1 AND Y=YTOP THEN O=0 EL
SE O=1
  440 IF TY=0 AND Y=YBOT THEN O1=1 E
LSE O1=0
  450 MOVET1Y-LEN(STR$(Y))*35*SGN(AB
S(ABS(SGN(TX-1))-1)),Y/YRANGE*1000+3
0*SGN(ABS(SGN(Y)-1))*O+O1*30
  460 IF Y<>TESTYO THEN PRINT;Y
  470 NEXT
  480 REM**********DRAW GRAPH
  490 I=0
  500 I=I+1
  510 TEST%=0
  520 GCOL0,2
  530 X=XBOT
  540 DEFPROCGRAPHY
  550 X=X+XRANGE/250
  560 Y=EVAL(A$(I))
  570 X1=X:Y=Y/YRANGE*1000:X1=X/XRAN
GE*1000:IF ABS(Y)<1000*YTOP/YRANGE A
ND Y>1000*YBOT/YRANGE AND TEST%=1 TH
EN DRAW X1.Y ELSE MOVE X1.Y:TEST%=1
  580 IF X<=XTOP THEN GOTO550
  590 GCOL0,3
  600 IF I<A THEN500
  610 WAIT=GET
  620 ENDPROC
  630 DEFPROC_INPUT
  640 REM***************INPUT SECTIO
N
  650 CLS:VDU4
  660 PRINTTAB(10,0);"INPUT SECTION"
  670 PRINTTAB(10,1);"============="
  680 PRINT''"To ENTER an equation j
ust press ""F1"".''"To DELETE an equ
ation just press ""F2"".''"To DRAW t
he graph just press ""F3"".'':IF A>0
 THEN PRINT"The present equations ar
e shown below:-"'
  690 IF A>0 THEN FOR PRI%=1 TO A:PR
INT;PRI%;". Y= "A$(PRI%)':NEXT
  700 IF INKEY(-114)<>0 THEN740 ELSE
 IF INKEY(-115)<>0 AND A>0 THEN710 E
LSE IF INKEY(-116)<>0 THEN750 ELSE 7
00
  710 INPUT "Delete equation number.
..      "nodelete:IF nodelete=0 OR no
delete>A THEN650
  720 FOR I=nodelete TO A:A$(I+1)=A$
(I):NEXT
  730 A=A-1:GOTO750
  740 A=A+1:PRINT:A;:INPUT". Y= "A$(
A)
  750 PRINTTAB(0,4)STRING$(158." ")
  760 INPUTTAB(0.5)"Is this equation
 O.K ".Y$:Y$=LEFT$(Y$,1):IFY$ "Y" T
HEN650
  770 PRINTTAB(0,7):STRING$(40," ")
  780 PRINTTAB(0,5):"Is the range O.
K :-
 "'" X:(":XBOT:" TO ";XTOP:") and Y:
(";YBOT:" TO ";YTOP:")";:INPUT.Y$:Y$
=LEFT$(Y$,1):IFY$="Y" THEN PROCTESTA
XIS:ENDPROC
  790 PRINTTAB(0.5);STRING$(80." ")

  800 INPUTTAB(0.5)"Bottom of 'X' ra
nge",XBOT
  810 INPUT"Top of 'X' range",XTOP
  820 IF XBOT>XTOP THEN TEMP=XTOP:XT
OP=XBOT:XBOT=TEMP
  830 IF FNTEST(XTOP-XBOT)=0 THEN790
  840 PRINTTAB(0,5):STRING$(80," ")
  850 INPUTTAB(0,5)"Bottom of 'Y' ra
nge".YBOT
  860 INPUT"Top of 'Y' range".YTOP
  870 IF YBOT>YTOP THEN TEMP=YTOP:YT
OP=YBOT:YBOT=TEMP
  880 IF FNTEST(YTOP-YBOT)=0 THEN840
  890 GOTO770
  900 DEFPROCTESTAXIS
  910 PX=ABS(XBOT)/(ABS(XBOT)+ABS(XT
OP)):TX=2
  920 IF XBOT>0 THEN PX=-XBOT/(XTOP-
XBOT):TX=0:GOTO940
  930 IF XTOP<=0 THEN PX=ABS(XBOT)/(
ABS(XBOT)+ABS(XTOP)):TX=1:GOTO940
  940 PX=PX*1000+140
  950 PY=ABS(YBOT)/(ABS(YBOT)+ABS(YT
OP)):TY=2
  960 IF YBOT>=0 THEN PY=-YBOT/(YTOP
-YBOT):TY=0:GOTO980
  970 IF YTOP<=0 THEN PY=ABS(YBOT)/(
ABS(YBOT)+ABS(YTOP)):TY=1:GOTO980
  980 PY=PY*1000+12
  990 YRANGE=FNRANGE(TY.YTOP.YBOT)
 1000 XRANGE=FNRANGE(TX.XTOP.XBOT)
 1010 ENDPROC
 1020 DEFFNRANGE(T.ITOP.BOT)
 1030 IFT=2 THEN RANGE=ABS(BOT)+ABS(
ITOP) ELSE IF T=1 THEN RANGE=ABS(BOT
-ITOP) ELSE RANGE=ITOP-BOT
 1040 =RANGE
 1050 DEFPROCLETTERS
 1060 VDU23.224,&00.&08.&08.&08.&08,
&08.&08,&08
 1070 VDU23,225.&00.&00,&00,&C0.&C0.
&00,&00,&00
 1080 VDU23,227.&00,&3E.&7F.&59.&4D,
&7F.&3E.&00
 1090 VDU23.228.&00.&40.&42,&7F.&7F,
&40,&40.&00
 1100 VDU23.229.&00.&42.&63.&71.&59.
&4F,&46,&00
 1110 VDU23.230.&00,&22.&63.&49.&49.
&7F.&36.&00
 1120 VDU23.231.&00.&18.&1C.&16.&7F,
&7F,&10.&00
 1130 VDU23,232,&00.&27,&67,&45,&45,
&7D,&39,&00
 1140 VDU23,233,&00.&3C.&7E.&4B.&49,
&79.&30,&00
 1150 VDU23.234,&00,&01,&71.&79,&0D,
&07,&03,&00
 1160 VDU23.235,&00.&36.&7F.&49.&49.
&7F,&36.&00
 1170 VDU23.236.&00.&06,&4F,&49,&49,
&3F,&1E,&00
 1180 ENDPROC
 1190 DEFFNTEST(DIFF)
 1200 PRINTTAB(0.5)STRING$(80," ")
```

(listing continued on next page)

One line-word processor.

```
>REM /////////// THIS IS THE ONE LINE WORD PROCESSOR MENTIONED IN GRAPH (1)
>WIDTH 36
>LOAD"A.APW1"
>LIST01
>LIST
    1 DIMA$(100):FORI=1TO100:PRINT;I
;:INPUT LINE A$(I):NEXT:PRINT"TURN O
N PRINTER":INPUT F:FORI=1TO100:PRINT
A$(I):PRINT:NEXT:END
```

(listing continued from previous page)

```
 1210 IF DIFF=0 THENPRINTTAB(0,5);"T
his range is not acceptable.":FORDEL
AYLOOP=1TO5000:NEXT
 1220 =DIFF
 1230 IF ERR=20 OR ERR=18 OR ERR=21
OR ERR=22 OR ERR=23 OR ERR=24 THEN P
ROCGRAPHY:GOTO100 ELSE GOTO100
 1240 DEFPROCINTRO
 1250 VDU23;8202;0;0;0;
 1260 PRINTTAB(15,9);CHR$141"GRAPH":
PRINTTAB(15,10);CHR$141"GRAPH":PRINT
TAB(27,15);"By A.P.Walker":FORI=1TO5
000:NEXT
 1270 ENDPROC
 1280 DEFPROCINTRO2
 1290 VDU23;8202;0;0;0:
 1300 CLS:PRINTTAB(15,0):"GRAPH":PRI
NTTAB(14,1);"======="
 1310 PRINT'"This program takes one
or more equations, and plots their g
raph .The equations   should be ente
red using the following:-"'" ""*"" f
or multiplication ."'" ""^"" for pow
ers ."'" ""/"" for division ."'" ""+
"" for addition ."
 1320 PRINT" ""-"" for subtraction .
"'"and ""("" and "")"" wherever nece
ssary ."''"All equations should be e
xpressed in    terms of 'X'"
 1330 PRINT"Multiplication signs can
't be ""assumed"".e.g:-"'"     '5X'
"'"should be written as:-"'"     '5*X
'"''"All 'trig' functions are in rad
ians ."''"To continue after the grap
hs have been  drawn ,just press any
key ,or 'BREAK'."
 1340 COLOUR1:PRINT'';"     PRESS AN
Y KEY TO CONTINUE":WAIT=GET
 1350 ENDPROC
```

Graph 2 by Ann Kitchen.

```
>REM THIS IS THE LISTING
>REM FOR GRAPH (2)
>REM BY ANN KITCHEN
>LOAD"A.KITCH"
>LIST
   10 REM  GRAPH PLOTTING ROUTINE
   20 REM  Copyright Ann Kitchen,198
2   Stockport Grammar School
   30 MODE7
   40 PRINT''"This program will plot
 curves on the    screen and also pr
int them on a TANDY   COLOR GRAPHIC
PRINTER if it is available"''
   50 PRINT"The curves may be either
 parametric or  cartesian in form an
d any limits may be selected. These
may be entered as 4*PI  or LN(4) if
desired but must be a"
   60 PRINT"recognised BASIC express
ion."
   70 PRINT''"PRESS ANY KEY TO START
"
   80 A$=GET$
   90 IF A$="" THEN 80
  100 CLS
  110 ERR=0
  120 CC=1
  130 MODE4
  140 XL$="-10":XH$="10":YL$="-10":Y
H$="10"
  150 TX$="T":TY$="T":Y$="X"
  160 TL$="0":TH$="4*PI"
  170 K$="M"
  180 PRINT"ARE COORDINATES CARTESIA
N OR PARAMETRIC C/P"
  190 C$=GET$
  200 PRINT"DO YOU WANT PRINTED OUTP
UT Y/N"
  210 P$=GET$
  220 PROCINIT
  230 IF C$="C" THEN GOTO 430
  240 IF C$="P" THEN GOTO 1190
  250 IF P$="Y" THEN VDU2:PRINT"H":V
DU1,17,10,10,10:VDU3
  260 PRINT"ANOTHER GRAPH Y/N"
  270 A$=GET$:IF A$="Y" THEN 180
  280 MODE7:END
  290 REM ***************************
********
  300 DEFPROCLIMX
  310 CLS
  320 PRINTTAB(0,2);"DO YOU WANT TO
CHANGE LIMITS "';XL$;"<X<";XH$,YL$"<
Y<";YH$;"   Y/N"
  330 A$=GET$
  340 IF A$="N" THEN 380
  350 CLS:PRINTTAB(0,2):"ENTER XL,XH
,YL,YH"'" WHERE XL<X<XH AND YL<Y<YH
":
  360 INPUT XL$,XH$,YL$,YH$
  370 CLS:GOTO320
  380 XL=EVAL(XL$):YL=EVAL(YL$):XH=E
VAL(XH$):YH=EVAL(YH$)
  390 XINC=(XH-XL)/400:YINC=(YH-YL)/
400
  400 XC=1/XINC:YC=1/YINC
  410 ENDPROC
  420 REM ***************************
********
  430 REM ROUTINE FOR CARTESIAN GRAP
H
  440 PROCLIMX
  450 CLG
  460 PROCAX
  470 CLS:PRINTTAB(0,3);"DO YOU WISH
 TO ALTER THE EQUATION Y=";Y$;"  Y/N
"
  480 A$=GET$:IF A$="N"THEN500
  490 PRINT"ENTER EQUATION Y=";:INPU
T Y$
  500 K$="M"
  510 X=XL
  520 ON ERROR GOTO 600
  530 Y=EVAL(Y$)
  540 I=INT((X-XL)*XC):J=INT((Y-YL)*
YC)
  550 IF J>400 THEN J=400:K$="M" ELS
E IF J<0 THEN J=0:K$="M"
  560 PROCDR
  570 IF P$="Y" THEN PROCPR
  580 IF J=400 OR J=0 OR I=400 OR I=
0 THEN K$="M" ELSE K$="D"
  590 GOTO610
  600 IF ERR=180R ERR=20 HEN K$="M":
GOTO610 ELSE REPORT:GOTO250
  610 X=X+XINC*4:IF X<=XH THEN 530
  620 ON ERROR OFF
  630 IF P$<>"Y"THEN700
  640 VDU2
  650 PRINT"Q1"
  660 PRINT"S0"
  670 PRINT"R";30-10*CC;",0"
  680 PRINT"PY=";Y$
  690 PRINT"Q0"
  700 VDU3
  710 CLS:PRINT"Y=";Y$
  720 PRINT XL$;"<X<";XH$,YL$;"<Y<";
YH$
  730 PRINT"ANOTHER CURVE ON THESE A
XES Y,N":R$=GET$
  740 IF R$="N" THEN 820
  750 IF P$<>"Y" THEN 490
  760 CC=CC-1:IF CC<0 THEN CC=3
  770 VDU2
  780 PRINT"C";CC
  790 PRINT"H":VDU3
  800 CLS
  810 GOTO490
  820 CLG:CLS:PRINT"H":VDU3:GOTO250
  830 REM ***************************
**********
  840 DEFPROCINIT
  850 IF P$="Y" THENVDU2:VDU1,18:PRI
NT"M0,-400":PRINT"I":PRINT"C0":VDU3
  860 VDU24,0;0;800;800;:VDU28,0,5,3
9,0
  870 ENDPROC
  880 REM ***************************
**********
  890 DEFPROCAX
  900 XAX=INT((-XL)*XC)
  910 IF XL>0 THEN XAX=0
  920 IF XH<0 THEN XAX=400
  930 YAX=INT((-YL)*YC)
  940 IF YL>0 THEN YAX=0
  950 IF YH<0 THEN YAX=400
  960 IF P$="Y" THEN VDU2:PRINT"M0,"
;YAX:PRINT"D400,";YAX:PRINT"M";XAX;"
,0":PRINT"D";XAX;",400"
  970 MOVE 0,YAX*2:DRAW 800,YAX*2
  980 MOVE XAX*2,0:DRAW XAX*2,800
  990 IF P$="N"THEN1060
 1000 PRINT"S1"
 1010 PRINT"M0,";YAX-15:PRINT"PX";XL
$:PRINT"M400,";YAX-15:PRINT"PX";XH$:
PRINT"M";XAX;",0":PRINT"PY";YL$:PRIN
T"M";XAX;",400":PRINT"PY";YH$
 1020 PRINT"H"
 1030 PRINT"C3"
 1040 CC=3
 1050 VDU3
 1060 ENDPROC
 1070 REM ***************************
************
 1080 DEFPROCDR
 1090 IFK$="M" THEN MOVE I*2,J*2
 1100 DRAW I*2,J*2
 1110 ENDPROC
 1120 REM ***************************
************
 1130 DEFPROCPR
 1140 VDU2
 1150 PRINTK$:I;",";J
 1160 VDU3:PRINTTAB(0,0);"
                              ";TAB(0,0)
 1170 ENDPROC
 1180 REM ***************************
************
 1190 REM ROUTINE FOR PARAMETRIC CUR
VES
 1200 PROCLIMX
 1210 PROCLIMT
 1220 PROCAX
 1230 K$="M"
 1240 CLS:PRINTTAB(0,5);"DO YOU WISH
 TO ALTER THE EQUATIONS"'" X=";TX$;"
  Y=";TY$;" Y/N"
 1250 A$=GET$:K$="M"
 1260 IF A$="N" THEN 1290
 1270 CLS:PRINTTAB(0,5);"X=";:INPUTT
X$
 1280 PRINTTAB(0,6);"Y=";:INPUTTY$
 1290 T=TL:ON ERROR GOTO1380
 1300 X=EVAL(TX$):Y=EVAL(TY$)
 1310 I=INT((X-XL)*XC):J=INT((Y-YL)*
YC)
 1320 IF J>400 THEN J=400:K$="M" ELS
E IF J<0 THEN J=0:K$="M"
 1330 IF I>400 THEN I=400:K$="M" ELS
E IF I<0 THEN I=0:K$="M"
 1340 PROCDR
 1350 IF P$="Y"THENPROCPR
 1360 IF J=400 OR J=0 OR I=400 OR I=
0 THEN K$="M" ELSE K$="D"
 1370 GOTO1390
 1380 IF ERR=18 OR ERR=20 THEN K$="M
":GOTO1390 ELSE REPORT:GOTO250
 1390 T=T+TINC:IF T<=TH THEN 1300
 1400 ON ERROR OFF
 1410 IF P$<>"Y" THEN 1470
 1420 VDU2
 1430 PRINT"Q1":PRINT"S0":PRINT"R";3
0-10*CC;",0"
 1440 PRINT"PX=";TX$;"  Y=":TY$
 1450 PRINT"Q0"
 1460 VDU3
 1470 CLS:PRINT"X=";TX$,"     Y=";TY
$:PRINTXL$;"<X<";XH$,YL$"<Y<":YH$:PR
INTTL$;"<T<";TH$
 1480 PRINTTAB(0,4);"ANOTHER CURVE O
N THESE AXES Y/N";:R$=GET$
 1490 IF R$="N" THEN 1550
 1500 CC=CC-1:IF CC<0 THEN CC=3
 1510 VDU2
 1520 PRINT"C":CC
 1530 PRINT"H":VDU3
 1540 GOTO1240
 1550 CLG:CLS:PRINT"H":VDU3:GOTO250
 1560 REM ***************************
***********
 1570 DEFPROCLIMT
 1580 CLS:PRINTTAB(0,2):"DO YOU WISH
 TO ALTER THE LIMITS OF T"'" TL=":TL
$;"   TH=";TH$;"  Y/N"
 1590 A$=GET$
 1600 IF A$="N" THEN 1630
 1610 PRINTTAB(0,5):"TL=";:INPUT TL$
:PRINT"TH=";:INPUT TH$
 1620 CLS:GOTO1580
 1630 TL=EVAL(TL$):TH=EVAL(TH$):TINC
=(TH-TL)/100
 1640 ENDPROC
 1650 REM ***************************
***********
```

(continued from previous page)

evaluated, after which axes are drawn and the curve plotted. Further equations may then be superimposed on the same axes, or new axes selected. Each curve on the graph will have a different colour — though they start to repeat after the fourth — and its equation is printed alongside. The end values of the axes are also output to the plotter and printed horizontally or vertically, as appropriate.

In order to overcome the error interrupt generated on division by zero, the main line of the program has been kept free of procedure calls and ForNext statements, both of which invalidate the error-trapping On Error facility which is used to allow, for example, the function $Y = 1/X$ to be plotted through $X = 0$.

Mr Walker's program is for the screen only, and is an exercise in superimposition. Up to 10 equations may be input, amended and deleted, the resulting graphs plotted on selected axes, limits amended and the whole repeated as often as required. The VDU23 character-define command is used to provide axis labelling on screen both horizontally and vertically, and the whole screen is used to give the greatest definition to the result.

The two programs complement each other, each having a separate purpose. I recall spending entire evenings with pencil and graph paper attempting to answer curious arithmetic homework questions; I suppose those of even greater antiquity would have looked askance at my slide rule.

Mr Walker not only wrote his letter and program description on his machine, he also wrote the word processor to do it with, and sent a copy of it to supplement his main contribution. It is very brief, very effective, and for anyone with a printer and no text editor it might prove invaluable.


THE NASCOM NETWORK HAS BEEN UP & RUNNING SINCE LAST SUMMER

Graphics input

A SHORT GRAPHICS PROGRAM to run on the Research Machines 380-Z comes from S M Roach and G M Bush of Weston-super-Mare, Avon. It enables the user to draw a diagram or picture on to the screen by means of a movable point, controlled via the keyboard. When the program is run the instructions are displayed, and then the computer asks the user to input the position on the screen at which he wishes to begin, that is the X and Y co-ordinates.

When these values have been input, the computer will recognise that point as the origin. This means the final diagram can be moved to any point on the screen. The point selected as the origin will then flash, and the user can move the dot seen on the screen to the desired position. Pressing A will draw a line from the first selected position to the position where the dot is present. The user can then move the dot to another position and draw a line from that point to the last point, and so on.

If, however, the user presses B instead, a line will not be drawn, but a point will be plotted to which the following line will be drawn. If a mistake is made in drawing a line, pressing the Delete key will erase it. When the picture is complete, pressing Z will ask the user to input a file name, and the picture will then be saved under that name.

When saving is complete, the screen will be cleared and the diagram that has been saved will be redrawn on the screen and the user will then be asked if they wish to continue: if so the computer will reopen the file and flash the original again, but the point will move from where it left off before. The next line will be drawn to the origin, unless the point is plotted instead. When completed, the new picture will be saved under the same name as before.

These picture files can be accessed during any program by:

DimQ(500)Z(500)
K — x co-ordinate to change origin
L — y co-ordinate to change origin
B$ — filename

and copying lines 610 to 730 from the program. The program does not allow for simply seeing what is on a file, but this can be done by typing 610, instead of copying lines 610 to 730.

The main features of the program are:

Lines 10-310 set up the program and give Instructions.
Line 320 flashes the origin.
Lines 340-500 move a point and save desired points in arrays of Q and Z. A line will be drawn from point to point unless -999 is found in the array, in which case a point will be plotted instead.
Lines 510-9999 are used as the End of File marker.
Lines 520-600 saves all the points in the arrays of Q and Z.
Lines 610-730 are the routine for displaying the contents of the file on the screen, noting the origin, and the plot markers from the file.
Lines 740-860 are a routine to reopen file and move to the End of File marker, erase the marker and continue the drawing, leaving the file open to save the rest of the picture when the user has fininshed.

Graphics input.

```
10 REM *****************  GRAPHICS PROGRAM EXTRA-ORDINAIRE  *****************
20 REM
30 REM                              WRITTEN BY
40 REM
50 REM +++++++++++     S. ROACH        AND             G. BUSH    +++++++++++++
60 REM                /+/+/+/+/+                       /+/+/+/+/+
70 REM ***********************************************************************
80 ON BREAK GOTO 870
90 ?CHR$(31):PUT27,"=1C"
100 CALL"RESOLUTION",0,2
110 ?:?:?"     THIS PROGRAM ENABLES YOU TO DRAW A PICTURE ON THE SCREEN USING A"
120 ?:?"                              MOVING POINT."
130 PUT27,"=0C"
140 ?:?:?TAB(10);"I = UP-LEFT"TAB(30);"P = UP"TAB(50);"@ = UP-RIGHT"
150 ?:?TAB(10);"L = LEFT"TAB(50);"; = RIGHT"
160 ?:?TAB(10);", = DOWN-LEFT"TAB(30);". = DOWN"TAB(50);"/ = DOWN-RIGHT"
170 PUT27,"=1C"
180 ?:?:?"              WHEN YOU WISH TO DRAW A LINE "CHR$(34)"A"CHR$(34)" MUST BE
 PRESSED"
190 ?:?"              IF YOU WISH TO MOVE WITHOUT DRAWING PRESS ":CHR$(34);"B";CHR
$(34)
200 ?:?"                  "CHR$(34)"Z"CHR$(34)" WILL END THE DRAWING SESSION"
210 A$=GET$(0):A$=GET$()
220 CLEAR2000
230 DIM Q(500),Z(500)
240 CALL"RESOLUTION",0,2
250 ?CHR$(31):?:?:?:?"FIRSTLY INPUT THE COORDS OF THE FIRST POINT"
260 ?:?:?"      1st VALUE  - 0 ( VALUE ( 319
270 ?:?"      2nd VALUE  - 0 ( VALUE ( 191
280 ?
290 INPUTK,L
300 IFK(0ORK)321ORL(0ORL)191THEN250
310 CALL"OFFSET",-K,-L
320 PUT12:FOR LOOP =1 TO 10:CALL"PLOT",0,0,0:FORDEL=0TO100:NEXT:CALL"PLOT",0,0,3
:FORDEL=0TO100:NEXT:NEXT
330 IFD$="Y"THEN?"YOU CAN CONTINUE NOW!!!"
340 X1=1
350 REM *************  ROUTINE TO MOVE POINT  ***************
360 A$=GET$(0):A$=GET$()
370 IFA$="Z"THEN510
380 IFA$="P"THENY=Y+1:CALL"PLOT",X,Y-1,0
390 IFA$="."THENY=Y-1:CALL"PLOT",X,Y+1,0
400 IFA$=";"THENX=X+1:CALL"PLOT",X-1,Y,0
410 IFA$="L"THENX=X-1:CALL"PLOT",X+1,Y,0
420 IFA$="O"THENX=X-1:Y=Y+1:CALL"PLOT",X+1,Y-1,0
430 IFA$="@"THENX=X+1:Y=Y+1:CALL"PLOT",X-1,Y-1,0
440 IFA$="/"THENX=X+1:Y=Y-1:CALL"PLOT",X-1,Y+1,0
450 IFA$=","THENX=X-1:Y=Y-1:CALL"PLOT",X+1,Y+1,0
460 CALL"PLOT",X,Y,3
470 IFA$="A"THENQ(X1)=X:Z(X1)=Y:CALL"PLOT",Q(X1-1),Z(X1-1),3:CALL"LINE",X,Y,3:X1
=X1+1
480 IFA$="B"THENQ(X1)=-999:Q(X1+1)=X:Z(X1)=-999:Z(X1+1)=Y:CALL"PLOT",X,Y,3:X1=X1
+2
490 IFA$=CHR$(127)THENQ(X1-1)=-999:Z(X1-1)=-999:Q(X1)=X:Z(X1)=Y:CALL"PLOT",Q(X1-
2),Z(X1-2),0:CALL"LINE",X,Y,0:X1=X1+1
500 GOTO360
510 Q(X1)=-9999
520 REM **************   CREATE AND WRITE TO FILE   ****************
530 IFD$()"Y"THEN?"INPUT THE FILENAME":INPUTB$
540 IFD$()"Y"THENCREATE#10,B$
550 IFD$()"Y"THENOPEN#10,B$
560 FORX1=1TO500
570 PRINT#10,Q(X1)
580 PRINT#10,Z(X1)
590 NEXT
600 CLOSE#10
610 REM ***************  DISPLAY DIAGRAM ON FILE  ******************
620 OPEN#10,B$:CALL"CLEAR":PUT12
630 CALL"OFFSET",-K,-L
640 ONEOFGOTO730
650 CALL"PLOT",0,0,0
660 FORX1=1TO500
670 INPUT#10,Q(X1)
680 INPUT#10,Z(X1)
690 IFQ(X1)=-999THENINPUT#10,Q(X1+1):INPUT#10,Z(X1+1):CALL"PLOT",Q(X1+1),Z(X1+1)
,3:X1=X1+1:GOTO720
700 IFQ(X1)=-9999THEN730
710 CALL"LINE",Q(X1),Z(X1),3
720 NEXT
730 CLOSE#10
740 REM ****************  ADD TO FILE OPTION  ****************
750 ?:?:?:?:?"DO YOU WISH TO CONTINUE"
760 D$=GET$(0):D$=GET$():IFD$()"Y"ANDD$()"N"THEN760ELSEIFD$="Y"THEN770ELSEEND
770 OPEN#10,B$
780 RENAME"A:NEWFILE",B$
790 OPEN#10,"A:NEWFILE
800 CREATE#10,B$
810 ONEOFGOTO850
820 INPUT#10,Z:IFZ=-9999THEN850
830 PRINT#10,Z
840 GOTO820
850 ERASE"A:NEWFILE"
860 GOTO320
870 PUT27,"=0C"
```

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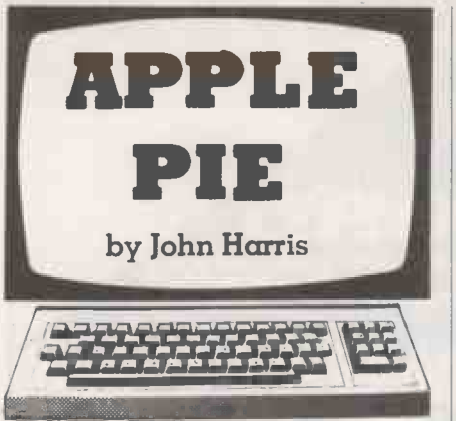

Simon

THE GAME of Simon is available commercially, though not necessarily on a computer. It is essentially a memory test, with the program playing a sequence of notes to which it adds one more each time you demonstrate your retention of what has gone so far.

Running the program by J Bamford of Wells, Somerset, I have reached 15 but Mr Bamford, possibly optimistically, has set the game to push on as far as 100 before admitting defeat. Mr Bamford claims that line 430 contains three embedded Control-G characters; it would take a better man than I to prove him wrong.

Enhanced File indexing

In November 1982 this column carried a File Index utility by Mr A Hourd of *(continued on page 173)*

Enhanced file indexing.

```
10 ONERR GOTO 9900
20 GM = 0
100 TEXT : HOME
110 HTAB 3: PRINT " ************
    *********************"
115 HTAB 3: PRINT " *
                          *"
120 HTAB 3: PRINT " *    MASTER C
    ATALOGUE OF DISKS     *"
130 HTAB 3: PRINT " *
                          *"
140 HTAB 3: PRINT " ************
    *********************"
150 VTAB 10: HTAB 4: PRINT "CHOO
    SE FROM :-": VTAB 12: HTAB 1
    0
160 PRINT "1. MAKING A CATALOGUE
    "
170 PRINT : HTAB 10: PRINT "2. R
    EADING A CATALOGUE"
172 PRINT : HTAB 10: PRINT "3. C
    ATALOG"
175 PRINT : HTAB 10: PRINT "4. Q
    UIT THE PROGRAM."
180 PRINT : PRINT : PRINT "PRESS
     1-4 ";
190 GET A$:AC = VAL (A$)
192 IF AC < 1 OR AC > 4 THEN 190
195 IF AC = 3 THEN GOSUB 12000:
    RUN
200 ON AC GOTO 1000,4000,100,146
    0
1000 REM ************************
     **
1010 REM *** DISK FILE INDEX DOS
     3.3 ***
1020 REM ************************
     **
1030 HIMEM: 34000
1040 TEXT : HOME : PRINT
1050 HTAB 8: PRINT "************
     ************"
1060 HTAB 8: PRINT "*** DISK FIL
     ES INDEX ***"
1070 HTAB 8: PRINT "************
     ************"
1080 VTAB 20: HTAB 8: PRINT "PRE
     SS SPACE WHEN READY.";
1090 GET AN$: IF AN$ < > " " THEN
     1090
1100 PRINT
1110 BA = 34500:TR = 1:FA = 0:EF =
     0:AD = 768:IO = AD + 9:TW =
     2
1120 REM *** NAMES OF FILES IN N
     A$() DIMENSIONED FOR 500 FIL
     ES ***
1130 REM ************
1140 DIM NA$(500)
1150 S3$ = "000"
1160 TEXT : HOME
1170 PRINT "PUT FIRST DISK IN,EN
     TER ITS I.D.": PRINT
1180 PRINT : INPUT "(ONLY 4 CHAR
     S PLEASE)  ";DN$
1190 IF LEN (DN$) < 4 THEN DN$ =
     DN$ + " ": GOTO 1190
1200 IF LEN (DN$) > 4 THEN 1180
1210 PRINT : PRINT : FLASH : PRINT
     " WORKING....PLEASE WAIT ": NORMAL
     : PRINT
1220 EN = 0
1230 GOSUB 1480
1240 REM ***SHELL-METZNER SORT
     ***
1250 HOME : VTAB 10: PRINT CHR$
     (7)"NOW WAIT WHILE ";EN;" FI
     LES ARE SORTED.": PRINT : FLASH
     : PRINT " DO NOT INTERRUPT..
     .......": NORMAL
1260 GOSUB 2310
1270 PRINT CHR$ (7) CHR$ (7) CHR$
     (7)
1280 REM *** END OF SORT ROUTI
     NE ***
1285 EF = 0
1290 GOSUB 2100
1295 EF = 1
1300 HOME : PRINT : PRINT "HARD
     COPY ?(Y/N)"
1310 GET Z$: IF Z$ = "N" THEN 14
     50
1320 IF Z$ < > "Y" THEN 1310
1330 HOME : VTAB 5: PRINT " MAKE
     SURE A PRINTER IS CONNECTED
     !": PRINT "THEN PRESS SPAC
     E TO GO ON."
1340 GET AN$: IF AN$ < > " " THEN
     1340
1350 PRINT : PRINT CHR$ (4)"PR£
     1"
1360 REM *** COULD NEED 'PRINT
     CHR$(9);"80N" FOR SOME PRINT
     ERS ***
1370 PRINT : PRINT SPC( 15);"MA
     STER CATALOGUE   PAGE1": PRINT
1380 FOR X = 1 TO EN
1390 PRINT SPC( 10); LEFT$ (NA$
     (X),1); SPC( 2); MID$ (NA$(X
     ),2,20);
1400 PRINT SPC( 2); MID$ (NA$(X
     ),22,3); SPC( 2);"DISK "; RIGHT$
     (NA$(X),4)
1410 IF X / 55 = INT (X / 55) THEN
     PRINT CHR$ (12): PRINT : PRINT
     : PRINT SPC( 15);"MASTER CA
     TALOGUE     PAGE "; INT (X /
     55) + 1: PRINT
1420 NEXT
1430 PRINT : PRINT CHR$ (4);"PR
     £0"
1440 PRINT CHR$ (7) CHR$ (7) CHR$
     (7) CHR$ (7) CHR$ (7)"FINISH
     ED"
1450 IF GM < > 1 THEN GOSUB 21
     00
1455 VTAB 22: PRINT "PRESS SPACE
     TO GO ON"
1456 GET A$: IF A$ < > " " THEN
     1456
1457 RUN
1460 GOSUB 2270: HOME : PRINT "
     BYE FOR NOW."
1465 POKE 216,0
1470 VTAB 5: FLASH : PRINT " RET
     URNING TO DISK MENU ": NORMAL
     : PRINT : PRINT CHR$ (4)"RU
     NMENU"
1480 PO = 0:RS = 0:SC = 0
1490 REM *** RESET ALL PARAMETE
     RS FOR EACH DISK ***
1500 GOSUB 1950
1510 BP = BA - 256:NT = 17:NS = 1
     5
1520 REM *** MAIN LOOP FOR READ
     ING EACH DISK CATALOG ***
1530 BP = BP + 256
1540 POKE IO + 9, INT (BP / 256)
     : POKE IO + 4,NT: POKE IO +
     5,NS
1550 CALL 768
1560 GOSUB 2010
1570 IF EF = TR THEN 2030
1580 SC = SC + 1:NT = PEEK (BP +
     1):NS = PEEK (BP + 2)
1590 IF NT > 0 AND NS > 0 THEN 1
     530
1600 REM *** PUSH DATA INTO STR
     INGS ***
1610 FOR CS = 1 TO SC
1620 FOR SE = 1 TO 7
1630 RS = (BA - 256) + (CS * 256)
      + 11 + (SE - 1) * 35
1640 FT = PEEK (RS + 2)
1650 IF ( PEEK (RS) = 255) OR ( PEEK
     (RS + 33) = 0) THEN 1800
1660 EN = EN + 1: REM *** UPDATE
     NO. OF ENTRIES ***
1670 IF FT > = 128 THEN FT = FT
      - 128: REM *** IGNORE LOCKE
     D CODE ***
1680 IF FT = 0 THEN FT$ = "T": GOTO
     1730
1690 IF FT = 1 THEN FT$ = "I": GOTO
     1730
1700 IF FT = 2 THEN FT$ = "A": GOTO
     1730
1710 IF FT = 4 THEN FT$ = "B": GOTO
     1730
1720 FT$ = "?": REM *** ONE OF TH
     E UNUSUAL FILE TYPES,EG. 'R'
     ***
1730 FS = PEEK (RS + 33):FS$ = S
     3$ + STR$ (FS):FS$ = RIGHT$
     (FS$,3)
1740 NA$(EN) = ""
1750 FOR PO = 1 TO 20
1760 N$ = CHR$ ( PEEK (RS + TW +
     PO))
1770 NA$(EN) = NA$(EN) + N$
1780 NEXT
1790 NA$(EN) = FT$ + NA$(EN) + FS
     $ + DN$
1800 NEXT
```

(listing continued on page 173)

Simon.

```
100  REM  SIMON BY J.BAMFORD 1983

110  GOTO 1010
200  REM SUB ROUTINE TO PLAY NOTE
      AND DISPLAY KEY NUMBER
210  POKE 38377,128: HTAB (21): PRINT
     "4";: GOTO 260
220  POKE 38377,171: HTAB (20): PRINT
     "3";: GOTO 260
230  POKE 38377,203: HTAB (19): PRINT
     "2";: GOTO 260
240  POKE 38377,0: HTAB (18): PRINT
     "1";: GOTO 260
250  POKE 38377,64
260  POKE 38378,DR: REM  POKE DUR
     ATION
270  CALL 38379: REM  PLAY NOTE
280  HOME : REM  CLEAR SCREEN OF
     KEY NUMBER
290  RETURN : REM  END OF SUBROUT
     INE
400  REM GAME STARTS HERE
410  HOME : PRINT "HERE WE GO....
     ..";: FOR W = 1 TO 1000: NEXT
     W:K = 0: REM  CLEAR SCREEN,
     PRINT, WAIT, START NEW GAME
420 K = K + 1: REM  INCREMENT SEQ
     UENCE COUNTER
430  IF K > MN THEN  PRINT "YOU W
     IN.";: END
440 TABLE(K) =  INT ( RND (1) * 4
      + 1): REM SET KEY NUMBER FO
     R NEXT NOTE IN TABLE
450 DUMMY =  PEEK (49168): REM  C
     LEAR KEYBOARD STROBE
460  REM NOW PLAY NOTE SEQUENCE
470  FOR C = 1 TO K
480  ON TABLE(C) GOSUB 240,230,22
     0,210: REM PLAY NOTE
490  NEXT
500  FOR C = 1 TO K
510  GET A$:B =  ASC (A$) - 48: REM
     GET KEY AND CONVERT TO NUMBE
     R
520  IF B = 0 THEN  HOME : PRINT
     "BYE";: END
530  IF B < 1 OR B > 4 THEN 510: REM
     CHECK FOR SUITABLE KEY
540  IF B < > TABLE(C) THEN  GOSUB
     250: PRINT "YOUR SCORE WAS "
     K - 1" THAT TIME.";FLAG = 1:
     C = K: GOTO 560: REM IF WRON
     G KEY,END GAME,PRINT SCORE,E
     XIT CLEANLY FROM FOR LOOP
550  ON B GOSUB 240,230,220,210: REM
     PLAY NOTE
560  NEXT C
570  FOR W = 1 TO 1000: NEXT W: REM
     WAIT
580  IF FLAG = 1 THEN FLAG = 0: GOTO
     410: REM START NEW GAME
590  GOTO 420
1000  REM INITIALIZE MACHINE
1010  HIMEM: 38376: PRINT : PRINT
      CHR$ (4)"PR£0": NORMAL : HOME
1020 MN = 100: REM SET MAXIMUM NU
     MBER OF NOTES
1030  DIM TABLE(MN)
1040  REM POKE SUBROUTINE TO PLAY
      NOTES
1050  POKE 38379,173: POKE 38380,
     48: POKE 38381,192: POKE 383
     82,136: POKE 38383,208: POKE
     38384,5: POKE 38385,206: POKE
     38386,234: POKE 38387,149: POKE
     38388,240: POKE 38389,9
1060  POKE 38390,202: POKE 38391,
     208. POKE 38392,245: POKE 38
     393,174: POKE 38394,233: POKE
     38395,149: POKE 38396,76: POKE
     38397,235: POKE 38398,149: POKE
     38399,96
1070  REM PRINT INSTRUCTIONS
1080  PRINT "THIS PROGRAM PLAYS '
     SIMON'.": PRINT
1090  PRINT "SPEED (0-9) / ";: GET
     A$: PRINT A$;:SP =  ASC (A$)
      - 48: REM GET KEY,PRINT IT,
     AND CONVERT TO A NUMBER
1100  IF SP < 0 OR SP > 9 THEN  HTAB
     (1): GOTO 1090: REM IF VALUE
      UNACCEPTABLE. GET ANOTHER K
     EY
1110  PRINT : PRINT :DR =  INT (2
     50 / (10 ^ (SP / 9))): REM S
     ET DURATION OF NOTES
1120  PRINT "USE THE KEYS 1 TO 4
     TO ENTER YOUR NOTES.": PRINT

1130  PRINT "PRESS 0 WHEN YOU ARE
      READY TO START.": PRINT
1140  PRINT "PRESS 0 AGAIN WHEN Y
     OU WANT TO STOP.": PRINT
1150  PRINT "TRY THE KEYS 1 TO 4
     NOW.": PRINT
1160  GET A$:B =  ASC (A$) - 48: HOME
     : REM GET KEY.CONVERT TO NUM
     BER.CLEAR SCREEN
1170  IF B = 0 THEN 410: REM STAR
     T GAME
1180  IF B   I OR B   4 THEN 1160
      REM              CHECK FOR SU
     ITABLE KEY
1190  ON B GOSUB 240.230.220.210:
      REM PLAY NOTE
1200  GOTO 1160
```

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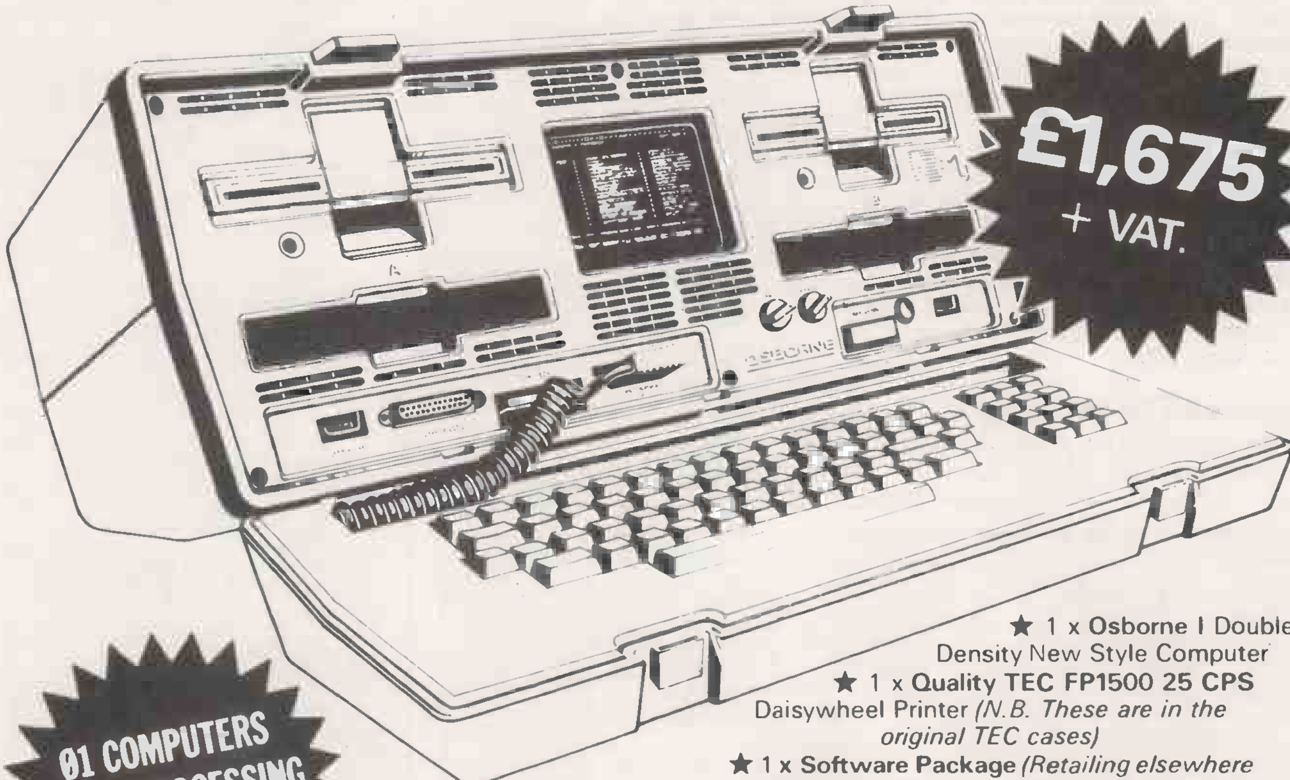

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(listing continued from page 171)

```
1810 NEXT
1820 X9 = FRE (0)
1822 HOME : PRINT : PRINT EN" FI
     LES READ SO FAR": PRINT
1830 PRINT : PRINT "ANOTHER DISK
     TO DO ?(Y/N)";
1840 GET AN$: PRINT AN$: IF AN$ =
     "N" THEN RETURN
1850 IF AN$ < > "Y" THEN 1830
1852 VTAB 5: PRINT "

1860 PRINT "FREE MEMORY = ";X9
1870 PRINT : PRINT "(LAST DISK R
     EF. WAS "$DN$" )"
1880 PRINT : PRINT "PUT NEXT DIS
     K IN,ENTER ITS I.D."
1890 PRINT : INPUT "(ONLY 4 CHAR
     S. REMEMBER!";DN$
1900 IF LEN (DN$) < 4 THEN DN$ =
     DN$ + " ": GOTO 1900
1910 IF LEN (DN$) > 4 THEN 1890

1920 PRINT : FLASH : PRINT " WOR
     KING......PLEASE WAIT ": NORMAL
     : PRINT
1930 GOTO 1480
1940 REM *** DISK READ SUBROUTI
     N AND PARAMETER TABLE ***
1950 RESTORE
1960 FOR X = 0 TO 29: READ Y: POKE
     AD + X,Y: NEXT : RETURN
1970 DATA 169,3,160,9,32,217,3,9
     6,0,1,96,1,0,17,15,26,3,196,
     134,0,0,1,0,0,96,1,0,1,239,2
     16
1980 REM *** ERROR CHECKING ROU
     TINE ***
1990 REM *** RETURNS ERROR CODE
     AS PAGE 97 OF DOS MANUAL (I
     BSTAT) ***
2000 REM *** IN DECIMAL, NOT HE
     X '': ***
2010 IF PEEK (IO + 13) = 0 THEN
     EF = FA: RETURN
2020 EF = TR: RETURN
2030 PRINT : CALL - 1052: CALL
     - 1052
2040 PRINT "ERROR NO. "; PEEK (I
     O + 13);" TRACK "#NT;" SECTO
     R ";NS
2050 PRINT : PRINT "YOU CAN TRY
     SAME DISK AGAIN OR PUT IN A"

2060 PRINT : PRINT "FRESH DISK W
     ITH A NEW I.D."
2070 PRINT : PRINT : PRINT "PRES
     S SPACE TO CONTINUE...";
2080 GET AN$: IF AN$ < > " " THEN
     2080
2090 GOTO 1820
2100 TEXT : HOME
2110 PRINT : PRINT "SAVE TO DISK
     ? (Y/N)"
2120 GET AN$: IF AN$ = "N" THEN
     HOME : PRINT "'BYE FOR NOW
     THEN": RETURN
2130 IF AN$ < > "Y" THEN 2120
2140 GM = 1:JW = 1
2150 D$ = CHR$ (4)
2160 PRINT : PRINT "TYPE IN THE
     NAME YOU WANT THIS FILE": PRINT
     "TO HAVE   ": INPUT FI$
2170 PRINT : PRINT D$"OPEN";FI$

2180 PRINT : PRINT D$"DELETE";FI
     $
2190 PRINT : PRINT D$"OPEN";FI$
2200 PRINT : PRINT D$;"WRITE";FI
     $
2210 PRINT EN
2220 FOR K = 1 TO EN: PRINT NA$(
     K): NEXT
2230 PRINT : PRINT D$;"CLOSE";FI
     $
2240 PRINT : PRINT D$;"LOCK";FI$

2250 TEXT : HOME
2260 PRINT CHR$ (7) CHR$ (7): PRINT
     : PRINT "FINISHED": RETURN
2270 TEXT : HOME : PRINT : PRINT
     "ANOTHER RUN ?(Y/N)"
2280 GET Z$: IF Z$ = "N" THEN RETURN


2290 IF Z$ < > "Y" THEN 2280
2300 RUN
2310 ZC = 0:ZS = 0:ZA = 1:ZN = EN
2320 IF 2 ^ ZA > ZN THEN 2350
2330 ZA = ZA + 1
2340 GOTO 2320
2350 ZF = 2 ^ ZA - 1
2360 ZF = INT (ZF / 2)
2370 IF ZF = 0 THEN RETURN
2380 ZD = ZN - ZF
2390 ZB = 1
2400 ZA = ZB
2410 ZE = ZA + ZF
2420 ZC = ZC + 1
2430 IF NA$(ZA) > NA$(ZE) THEN 2
     470
2440 ZB = ZB + 1
2450 IF ZB > ZD THEN 2360
2460 GOTO 2400
2470 ZS = ZS + 1
2480 ZT$ = NA$(ZA):NA$(ZA) = NA$(
     ZE):NA$(ZE) = ZT$
2490 ZA = ZA - ZF
2500 IF ZA < 1 THEN 2440
2510 GOTO 2410
4000 GOSUB 4340
4010 PRINT : PRINT CHR$ (4)"OPE
     N";FI$
4020 PRINT : PRINT CHR$ (4)"REA
     D"FI$
4030 INPUT N
4040 DIM N$(N)
4050 FOR K = 1 TO N
4060 INPUT N$(K): NEXT
4070 PRINT : PRINT CHR$ (4)"CLO
     SE"FI$
4080 TEXT : HOME : PRINT CHR$ (
     7) CHR$ (7)
4090 PRINT : PRINT "HARD COPY ?
     (Y/N)"
4100 GET Z$: IF Z$ = "Y" THEN 42
     20
4110 IF Z$ < > "N" THEN 4100
4120 TEXT : HOME : PRINT CH$
4130 PRINT
4140 POKE 34,2
4150 FOR K = 1 TO N
4160 PRINT LEFT$ (N$(K),1); SPC(
     2); MID$ (N$(K),2,20);
4170 PRINT SPC( 2); MID$ (N$(K)
     ,22,3); SPC( 2);"DISK "; RIGHT$
     (N$(K),4)
4180 IF (K / 18) = INT (K / 18)
     THEN GOSUB 4310
4190 NEXT
4200 POKE 34,0
4210 GOTO 4510
4220 PRINT : PRINT CHR$ (4)"PR£
     1"
4230 PRINT : PRINT SPC( 10);CH$
     : SPC( 6);"PAGE 1": PRINT : PRINT


4240 FOR K = 1 TO N
4250 PRINT SPC( 15); LEFT$ (N$(
     K),1); SPC( 2); MID$ (N$(K),
     2,20);
4260 PRINT SPC( 2); MID$ (N$(K)
     ,22,3); SPC( 2);"DISK "; RIGHT$
     (N$(K),4)
4270 IF K / 55 = INT (K / 55) THEN
     PRINT CHR$ (12): PRINT : PRINT
     : PRINT SPC( 15);CH$; SPC(
     6);"PAGE "; INT (K / 55) + 1
     : PRINT : PRINT
4280 NEXT
4290 PRINT : PRINT CHR$ (4)"PR£
     .0"
4300 GOTO 4510
4310 INVERSE : PRINT : PRINT : PRINT
     "PRESS SPACE FOR THE REST";:
     NORMAL
4320 GET Z$: IF Z$ < > " " THEN
     4320
4330 HOME : RETURN
4340 TEXT : HOME
4350 PRINT : PRINT SPC( 5);: INVERSE

     : PRINT " MASTER CATALOGUE F
     ILE READER ": NORMAL
4360 VTAB 5: HTAB 2: PRINT "IS D
     ATE REQUIRED ?(Y/N)"
4370 GET Z$: IF Z$ = "N" THEN MT
     $ = "":YN$ = "": GOTO 4430
4380 IF Z$ < > "Y" THEN 4370
4390 VTAB 5: HTAB 2: PRINT "ENTE
     R MONTH AS WORD       ": INPUT
     MT$
4400 IF MT$ = "" THEN 4390
4410 VTAB 7: HTAB 2: PRINT "ENTE
     R YEAR (EG. 1982)": INPUT YN
     $
4420 IF YN$ = "" THEN 4410
4430 PRINT : PRINT "TYPE IN A HE
     ADING THEN PRESS RETURN"
4440 INPUT CH$
4450 IF CH$ = "" THEN CH$ = "MAS
     TER CATALOGUE"
4460 CH$ = CH$ + "  " + MT$ + "
     " + YN$
4470 TEXT : HOME : PRINT : PRINT
     "ENTER NAME OF FILE TO BE RE
     AD": INPUT FI$
4480 IF FI$ = "" THEN 4470
4485 JW = 0
4490 TEXT : HOME : FLASH : PRINT
     : PRINT " READING ";FI$;" "
4500 NORMAL : RETURN
4510 PRINT : PRINT "READ ANOTHER
     FILE ? (Y/N)";
4520 GET Z$: IF Z$ = "N" THEN RUN

4530 IF Z$ < > "Y" THEN 4520
4540 CLEAR : GOTO 4000
9900 REM *** ERROR MESSAGES ***
9902 TEXT : HOME : PRINT CHR$ (
     7) CHR$ (7)
9905 ER = PEEK (222)
9910 IF ER = 255 THEN POKE 216,
     0: TEXT : HOME : PRINT CHR$
     (7)"YOU PRESSED CTRL-C": PRINT
     : PRINT : PRINT "'BYE FOR NO
     W": END
9915 IF ER = 4 THEN 11100
9917 IF ER = 5 THEN 11150
9920 IF ER = 6 THEN 11200
9925 IF ER = 8 THEN 11300
9930 IF ER = 9 THEN 11400
9935 IF ER = 10 THEN 11500
9940 IF ER = 11 OR ER = 16 THEN
     11600
9942 IF ER = 13 THEN 11700
9945 POKE - 16303,0: PRINT CHR$
     (7) CHR$ (7): PRINT "ERROR N
     O....": PEEK (222): PRINT "G
     ET HELP OR TYPE RUN TO TRY A
     GAIN.": END
10000 VTAB 23: HTAB 10: INVERSE
      : PRINT " PRESS SPACE BAR TO
      GO ON "
10005 NORMAL
10010 Z = PEEK ( - 16384) - 128
10020 IF Z = 32 THEN POKE - 16
      368,0: RETURN
10030 GOTO 10010
11000 REM ***** ERROR HANDLING R
      OUTINES ***
11100 PRINT : PRINT "YOU CANNOT
      RECORD ON THIS DISK! IT IS"
11110 PRINT "WRITE PROTECTED. RE
      MOVE THE TAPE ON THE"
11120 PRINT "RIGHT HAND SIDE OF
      THE DISK THEN TRY"
11130 PRINT "AGAIN."
11140 GOTO 13000
11150 PRINT : PRINT "THAT FILE D
      IDN'T EXIST ON THIS DISK,OR"
      : PRINT "ELSE IT DIDN'T HAVE
      ANY INFORMATION IN"
11155 PRINT "IT.": PRINT : PRINT
      "TRY AGAIN.": GOTO 14000
11200 PRINT : PRINT "THERE'S NO
      FILE/PROGRAM/PICTURE/DISPLAY
      "
11210 PRINT "OF THAT NAME ON THI
      S DISK. EITHER CHECK"
11220 PRINT "YOUR SPELLING OR TR
      Y ANOTHER DISK."
11230 GOTO 13000
11300 PRINT : PRINT "THERE'S AN
      INPUT/OUTPUT ERROR (I/O):"
11310 PRINT "THE COMMON CAUSES O
      F THIS ARE:-": PRINT "NO DIS
      K IN THE DRIVE"
11320 PRINT "DOOR OF THE DRIVE U
      NIT NOT CLOSED"
11330 PRINT "DISK NOT BEEN INITI
      ALISED"
11340 PRINT "USING A 13 SECTOR D
      ISK (USE 'MUFFIN'"
11350 PRINT "FROM THE APPLE MAST
      ER DISK TO CORRECT)
11355 PRINT : PRINT "SORT OUT TH
      E PROBLEM AND THEN CONTINUE.
11360 IF JW = 1 THEN JW = 0: GOTO
      13000
11365 GOTO 14000
11400 PRINT : PRINT "THERE IS NO
      T ENOUGH ROOM ON THE DISK"
11410 PRINT "TO SAVE THE CATALOG
      UE. FIND A DISK WITH"
11420 PRINT "ENOUGH FREE SECTORS
      ON IT CALCULATED BY ABOUT"
11430 PRINT "1/8TH OF THE NUMBER
      OF FILES SORTED."
11440 PRINT : PRINT "AT SOME STA
      GE DELETE THE FILE YOU JUST"

11450 PRINT "TRIED TO SAVE FROM
      THE FULL DISK SO AS"
11455 PRINT "TO AVOID COMPLICATI
      ONS ON THAT DISK."
11457 GOTO 13000
11500 PRINT : PRINT "THERE IS AL
      READY A FILE/PROGRAM/DISPLAY
      "
11510 PRINT "BY THAT NAME ON THI
      S DISK AND IT IS"
11520 PRINT "LOCKED. EITHER RENA
      ME YOUR FILE OR"
11530 PRINT "UNLOCK THE FILE AND
      TRY ANOTHER RUN."
11540 PRINT : PRINT "RENAME OR U
      NLOCK ?(R/U)    ";
11545 GET Z$
11550 IF Z$ = "R" THEN 13000
11560 IF Z$ < > "U" THEN 11545
11565 PRINT : PRINT CHR$ (4);"U
      NLOCK";FI$
11570 PRINT : PRINT FI$;" IS NOW
      UNLOCKED.": GOTO 13000
11600 PRINT : PRINT "THERE HAS B
      EEN A SPELLING MISTAKE AT"
11610 PRINT "LINE NUMBER "; PEEK
      (218) + PEEK (219) * 256
11620 PRINT : PRINT : PRINT "CHE
      CK THEN RUN PROGRAM AGAIN": END

11700 PRINT : PRINT "THAT FILE I
      S ON THE DISK BUT IT IS"
11710 PRINT "EITHER A BINARY FIL
      E OR AN APPLESOFT"
11720 PRINT "PROGRAM. YOUR FILE
      SHOULD BE A TEXT FILE."
11730 IF JW = 1 THEN 11750
11740 GOTO 14000
11750 PRINT "RENAME YOUR FILE AF
      TER PRESSING SPACE.": GOTO 1
      3000
12000 TEXT : HOME
12010 PRINT : PRINT CHR$ (4)"CA
      TALOG"
12011 PRINT : PRINT
12012 GOSUB 10000
12020 RETURN
13000 GOSUB 10000: TEXT : HOME
13010 IF EF < > 1 THEN GOSUB 2
      100: GOTO 1300
13020 GOSUB 2100: GOTO 1455
14000 GOSUB 10000: RUN
```

(continued from page 171)

Brundell, Norfolk. Since then enhanced versions based on this original have been sent in, with the intention of improving the sort — which, as Mr Hourd confessed at the time, was atrocious — and providing a hard-copy back-up to disc in case of printer failure during the final printing stage. It is silly to spend 10 minutes on a utility only to have to repeat the exercise from the beginning when you find the paper was mis-aligned, for instance.

One of these enhanced versions we are printing this month. It is admittedly very long, and not easy for those who keyed the original to merely type in modifications to what they have. Mr G Miles of Auchinleck Academy has provided a very thorough error-checking routine and a greatly enhanced sort. The resulting utility is a solid usable result which is worth printing in full, despite the apparent duplication of a previous submission.

DRAGON 32

High-resolution dump

A SHORT Basic and machine-code routine which allows high-resolution screen data to be dumped to a printer, comes from R A Shackleford of Hamilton, Strathclyde.

BASIC ROUTINE

Area under curve

THE PROGRAM by R Glynn Owens for calculating the area under a normal curve is one that is very useful and can be generalised to provide integration under other curves, writes M J Campbell of Southampton. This program is more specialised but gives a similar accuracy and is very much faster. Of course, whether you wait for 0.5 seconds or five seconds for the answer matters little if you are only running the program once, but if it forms part of a larger program — a simulation for example — where it may be run hundreds of times, the time element becomes important. The algorithm is based on one given by R A Lew in the journal *Applied Statistics,* (1981) 22, page 209.

If H(x) is the area between x and infinity and $h(t) = (2\pi)^{-\frac{1}{2}} \exp(-t^2/2)$, then H(x) is approximated by

$$0.5 - (2\pi)^{-\frac{1}{2}} (x - x^3/7)$$

for $0 \leq x \leq 1$, and by

$$(1 + x)h(x)/(1 + x + x^2)$$

for $x > 1$.

The area between two points a and b, $a < b$ is given by $H(a) - H(b)$. The layout is the same as that of Owens, except that 2π is calculated as 8* ATN(1). A further increase in speed would be obtained by putting $(2\pi)^{\frac{1}{2}}$ as 2.5066283.

BASIC ROUTINE

Recursive anagram

AN EXAMPLE of a problem which, in its general form, can only be solved by using a recursive procedure comes from A M Treder of Hounslow, Middlesex. The resulting program has quite powerful applications in many problems.

The program inputs a string and prints out all the possible permutations of the characters. If the string is entered with its characters in alphabetical or numerical order then the resulting permutations will also be printed in order.

Lines 100 to 140 set up the initial variables and counters. A$(X) stores the string available at a given depth of the recursion; LE(X) stores the length of that string; CO(X) stores the count which that level as reached; and R$(X) stores the character which has been chosen from the available string during this count at this level of recursion.

Line 150 is the main program and line 200 delimits the recursive process. Line 210 increments the counter for this level. Lines 220 to 240 select and remove a character from the available string before storing that as the available string for the next level.

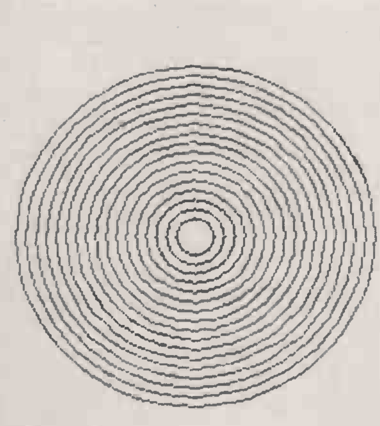
Line 250 stores the current counter, adjusts X for the next recursive step and proceeds to it. Line 260 is only reached after

High resolution dump.

```
1900 'BASIC SUBROUTINE AND DISASSEMBLED M/C CODE ROUTINE TO ALLOW SCREEN
1910 'DUMPING OF DRAGON 32 HIGH RESOLUTION GRAPHICS TO A TANDY LP VII.
1920 'FULL SCREEN TRANSFER TAKES ABOUT FIVE MINUTES"
1930 '
1940 ' BY  R A SHACKLEFORD
1950 '     7 CEDAR CRESCENT
1960 '     HAMILTON
1970 '     ML3 7LW
1980 '     5/NOV/1982
1990 '
2000 PRINT#-2,CHR$(18)
2010 FORI=0TO26
2020 FORJ=0TO31
2030 X=1536+224*I+J
2040 XH=INT(X/256):XL=X-256*XH
2050 POKE&H6F12,XH:POKE&H6F13,XL
2060 Z=USR0(Z)
2070 FORK=0TO7
2080 PRINT#-2,CHR$(PEEK(&H6F08+K));
2090 NEXTK,J:PRINT#-2,CHR$(13);:NEXTI:PRINT#-2,CHR$(30):RETURN
```

```
6F10   10 8E 1C DF    LDY    #1CDF
6F14   8E 6F 00       LDX    #6F00
6F17   C6 07          LDB    #07
6F19   A6 20          LDA     0,Y
6F1B   31 A8 20       LEAY   $20,Y
6F1E   A7 80          STA    ,X+
6F20   5A             DECB
6F21   26 F6          BNE    6F19
6F23   86 08          LDA    #08
6F25   10 8E 6F 08    LDY    #6F08
6F29   8E 6F 00       LDX    #6F00
6F2C   1C FE          ANDCC  #FE
6F2E   C6 07          LDB    #07
6F30   69 80          ROL    ,X+
6F32   66 20          ROR     0,Y
6F34   5A             DECB
6F35   26 F9          BNE    6F30
6F37   1A 01          ORCC   #01
6F39   66 A0          ROR    ,Y+
6F3B   4A             DECA
6F3C   26 EB          BNE    6F29
6F3E   39             RTS
```

```
30 'SAMPLE PROGRAM SHOWING OUTPUT TO PRINTER
40 '
50 DEF USR0= &H6F10
60 CLEAR200,25000
100 PMODE4,1:PCLS:SCREEN1,1
110 FORL=10 TO 90 STEP5
115 CIRCLE(128,96),L:NEXTL
120 GOSUB2000:END
```



a Return from line 330. Line 270 checks the counter and readjusts it if the end of the string has been reached, in which case it returns to the next higher level. Otherwise line 280 takes the program to where it chooses the next available character.

Lines 290 to 330 simply concatenate the chosen characters and print the resulting permutation. Line 330 then returns to line 260 to choose the next available character.

I have found that Clear 100 is sufficient space for a string of 10 characters. Obviously more can be cleared for longer strings. The program can be immediately rewritten into single-statement lines with the exception of line 270 which would require an extra If statement to return.

As an example of a non-crossword application consider line 320 replaced by Gosub 400 and include

```
400 for I = 1 to Y-1
410 X$ = LEFT$(R$,I): Y$ = RIGHT$(R$,Y-1)
420 X = VAL(X$): Y = VAL(Y$)
430 NEXT I
440 RETURN
```

The input to A$ must now be a purely numeric one. The program now yields in X and Y all possible pairs of numbers that can be formed by using all the digits given once and only once.

Area under curve.

```
100 PRINT CHR$(147)
200 PRINT"THIS PROGRAM CALCULATES THE AREA UNDER THE NORMAL CURVE BETWEEN "
300 PRINT"ANY TWO X COORDINATES, USING AN APPROXIMATION DUE TO LEW "
400 PRINT"PLEASE GIVE YOUR TWO X COORDINATES NOW,TYPING RETURN AFTER EACH ONE"
500 INPUT"X(1)";A:INPUT"X(2)";B:
600 X=A
700 GOSUB 10000
800 R=P: X=B
900 GOSUB 10000
950 AR=INT(1000*(R-P))/1000
1000 PRINT CHR$(135),"THE AREA ENCLOSED IS ";AR " OF THE TOTAL"
1100 STOP
10000 TP=8*ATN(1):C=SQR(TP)
10050 Y=ABS(X)
10100 IFY<=1 GOTO20000
10200 P=(1+Y)*EXP(-Y*Y/2)/(C*(1+Y+Y*Y))
10250 GOTO 20100
20000 P=0.5-(Y-Y*Y*Y/6)/C
20100 IF X<0 THENP=1-P
20200 RETURN
READY.
```

UK 101

Save/Load routine

THE PROGRAM by N V Davies of Haverfordwest, Dyfed, enables named Basic programs complete with all variables to be saved on cassette and then searched for and reloaded with auto-run. The program makes use of the 6850 ACIA's ability to generate a parity bit during the save operation and then check this bit during load to test for loading errors.

The program is located to suit an 8K machine and should be loaded from $1EDO to $1FFF. Basic's Memory Size should be answered by 7888 to give 7,119 bytes free. For machines with more than 8K of RAM the program may be relocated to the top of available RAM and Memory Size answered appropriately to protect the machine-code program.

The Pokes will then have to be changed to

(continued on next page)

Save/Load routine.

```
 10 0000          ;UK101 PARITY CHECK BASIC SA VE/LOAD
 20 0000          ;N.V.DAVIES SEPT. 1981
 30 0000          ES=$A187
 40 0000          ESH=ES/256
 50 0000          ESM=ESH*256
 60 0000          ESL=ES-ESM
 70 0000          ADDR=$00F0
 80 0000          SAVEF=$0205
 90 0000          LOADF=$0203
100 1ED0          *=$1ED0
110 1ED0 20A51F   ENTSVE JSR INITP INIT ACIA EVEN PARITY
120 1ED3 20F7FF          JSR $FFF7 SET SAVE FLAG
130 1ED6 206CA8          JSR $A86C OUTPUT CR/LF
140 1ED9 20BC00   LSTNME JSR $BC   GET NAME
150 1EDC F024            BEQ SNERR
160 1EDE 20EEFF          JSR $FFEE AND OUTPUT TO CASS.
170 1EE1 C95D            CMP #$5D  CHECK FOR END
180 1EE3 D0F4            BNE LSTNME MORE
190 1EE5 206CA8          JSR $A86C OUTPUT CR/LF
200 1EE8 20051F          JSR LSTART SET UP PROG START-VAR END
210 1EEB 202F1F          JSR SAVE SAVE POINTERS, PROG & VARIABLES
220 1EEE 201A1F          JSR LSTR SET UP STRING START-MEM END
230 1EF1 A000            LDY #0
240 1EF3 203A1F          JSR SAVE2 SAVE STRINGS
250 1EF6 206CA8          JSR $A86C OUTPUT CR/LF
260 1EF9 8C0502          STY SAVEF CLEAR SAVE FLAG
270 1EFC 20E91F   RESET  JSR INITN RESET ACIA
280 1EFF 4CBC00          JMP $00BC INCR MEM SCAN PTR & RTS TO BASIC
290 1F02 4C0CAC   SNERR  JMP $AC0C SN ERROR
300 1F05 A47A     LSTART LDY $7A
310 1F07 A679            LDX $79
320 1F09 D001            BNE LS2
330 1F0B 88              DEY
340 1F0C CA       LS2    DEX
350 1F0D 86F0            STX ADDR
360 1F0F 84F1            STY ADDR+1
370 1F11 A57F            LDA $7F
380 1F13 A480            LDY $80
390 1F15 85F2            STA ADDR+2
400 1F17 84F3            STY ADDR+3
410 1F19 60              RTS
420 1F1A A482     LSTR   LDY $82
430 1F1C A581            LDA $81
440 1F1E 85F0            STA ADDR
450 1F20 84F1            STY ADDR+1
460 1F22 A486            LDY $86
```

(listing continued on next page)

Recursive anagram.

```
10 REM********************************
20 REM Recursive Anagram Routine   *
30 REM********************************
40 REM
50 REM A. M. TREDER
60 REM
70 REM
100 CLEAR 100: PRINT CHR$(12)
110 INPUT A$: X=LEN(A$): Y=X
120 DIM A$(X),LE(X),CO(X),R$(X)
130 A$(X)=A$
140 FORI=1 TO X: LE(I)=I: NEXT I
150 GOSUB 200: END
160 REM
170 REM
180 REM Recursive Subroutine
190 REM
200 IF X=0 THEN 290
210 A=CO(X)+1
220 A$(X-1)=LEFT$(A$(X),A-1)
230 A$(X-1)=A$(X-1)+RIGHT$(A$(X),LE(X)-A)
240 R$(X)=MID$(A$(X),A,1)
250 CO(X)=A: X=X-1: GOSUB 200
260 X=X+1: A=CO(X)
270 IF A=LE(X) THEN CO(X)=0: RETURN
280 GOTO 210
290 R$="": FOR I=Y TO 1 STEP -1
300 R$=R$+R$(I)
310 NEXT I
320 PRINT R$
330 RETURN
```

(continued from previous page)

suit the new program location. When loaded at the location shown the entry point for the Save routine is at $1EDO, 7888 decimal, and the Load routine is at $1F45, 8019 decimal.

To save a Basic program start the cassette and enter:

POKE11,208:POKE12:30:X = USR(X):[NAME]

Name may be any number of characters which will fit the Basic line but must be enclosed in square brackets. To search cassette and load program enter:

POKE11,69:POKE12,31:X = USR(X):[NAME]

The cassette should then be started, and when Name is located this will be displayed. The program which follows is then loaded and run. If a parity error is detected, the word Error will be displayed. The cassette should then be rewound past the start of the program and a further attempt made at loading.

The first line of all programs must be arranged so that any following lines which dimension arrays or perform any other functions which would destroy the data loaded are skipped. Basic programs are saved in the form: Program "Name", Basic's memory and variable-table pointers from $0079 to $0086, contents of program and variable table RAM, contents of string-store RAM. Reloading is simply a reverse of this procedure.

Because the program is saved as a memory dump rather than lines of text, and is not displayed on the screen, no nulls are required and saving and reloading take less than half the time of the normal List-type Save. The speed at which programs may be saved is limited only by the cassette interface and recorder. With a high-speed interface and high-quality recorder, speeds up to 9,600 baud are possible.

No monitor subroutines, except those called via the indirect vectors, are used so the program should run with all monitors.

DRAGON 32

Simon

THIS PROGRAM by D Hojoff of Stanmore, Middlesex runs on a Dragon 32 home computer with standard 32K RAM. It uses 1.7K of memory. Four boxes are displayed on the screen and numbered 1 to 4. After a brief musical interlude a musical note is given, and at the same time one of the boxes flashes. You have to copy the sequence by pressing the keys 1 to 4 corresponding to the boxes that have flashed.

The sequence gradually becomes longer until a mistake is made, and a raspberry is emitted. You are given a grading at the end according to your ability.

You can continue by either trying the same sequence again, or attempting a new sequence. if you take too long to type your response you also get a raspberry. The sequence goes to a maximum of 32 characters.

(continued on page 178)

(listing continued from previous page)

```
 470 1F24 A685            LDX $85
 480 1F26 D001            BNE LSTR1
 490 1F28 88              DEY
 500 1F29 CA      LSTR1   DEX
 510 1F2A 84F3            STY ADDR+3
 520 1F2C 86F2            STX ADDR+2
 530 1F2E 60              RTS
 540 1F2F A00E    SAVE    LDY #$0E SAVE BASIC'S POINTERS
 550 1F31 B97800  LP1     LDA $78,Y
 560 1F34 20F41F          JSR CASOUT
 570 1F37 88              DEY
 580 1F38 D0F7            BNE LP1
 590 1F3A B1F0    SAVE2   LDA (ADDR),Y
 600 1F3C 20F41F          JSR CASOUT
 670 1F3F 20D41F          JSR INCAD
 680 1F42 90F6            BCC SAVE2
 690 1F44 60      BTB     RTS
 700 1F45 20A51F  ENTLD   JSR INITP INIT ACIA EVEN PARITY
 710 1F48 20F4FF          JSR $FFF4 SET LOAD FLAG
 720 1F4B 20BC00          JSR $BC
 730 1F4E C95B            CMP #$5B
 740 1F50 D0B0            BNE SNERR SN ERROR IF NO [
 750 1F52 A0FF    LOALP   LDY #$FF
 760 1F54 C8      LOALP1  INY
 770 1F55 AD0302          LDA $0203
 780 1F58 F0EA            BEQ BTB ABORT IF L.F. CLEAR
 790 1F5A 20EBFF          JSR $FFEB GET INPUT
 800 1F5D D1C3            CMP ($C3),Y CMP WITH [NAME]
 810 1F5F D0F1            BNE LOALP NOT NAME-TRY AGAIN
 820 1F61 20EEFF          JSR $FFEE DISPLAY TO VDU
 830 1F64 C95D            CMP #$5D END OF NAME?
 840 1F66 D0EC            BNE LOALP1 NO-GET NEXT LETTER
 850 1F68 A00E    RFLD1   LDY #$0E
 860 1F6A 20B01F  LOAD1   JSR GETCAS
 880 1F6D C90A            CMP #$0A  END OF NULLS
 890 1F6F D0F9            BNE LOAD1 SKIP NULLS
 900 1F71 20B01F  LOADA   JSR GETCAS GET BASIC'S POINTERS
 910 1F74 997800          STA $78,Y  AND RE-LOAD
 920 1F77 88              DEY
 930 1F78 D0F7            BNE LOADA
 940 1F7A 20051F          JSR LSTART
 950 1F7D 20981F          JSR LOAD2   LOAD PROG & VARIABLES
 960 1F80 201A1F          JSR LSTR
 970 1F83 20981F          JSR LOAD2  LOAD STRINGS
 980 1F86 8C0302          STY LOADF  CLEAR LOAD FLAG
 990 1F89 20FC1E  RFLD    JSR RESET  RESET ACIA
1000 1F8C 20A7A4          JSR $A4A7  SET MEM SCAN TO PROG START
1010 1F8F A9A5            LDA #$A5
1020 1F91 48              PHA
1030 1F92 A9C1            LDA #$C1
1040 1F94 48              PHA
1050 1F95 4C8EA4          JMP $A48E   RUN BUT NO POINTER RESET
1060 1F98 A000    LOAD2   LDY #0
1070 1F9A 20B01F  LOAD3   JSR GETCAS
1080 1F9D 91F0            STA (ADDR),Y
1090 1F9F 20D41F          JSR INCAD
1100 1FA2 90F6            BCC LOAD3
1110 1FA4 60              RTS
1120 1FA5 A903    INITP   LDA #$3 SET ACIA EVEN PARITY
1130 1FA7 8D00F0          STA $F000
1140 1FAA A919            LDA #$19
1150 1FAC 8D00F0          STA $F000
1160 1FAF 60              RTS
1170 1FB0 AD00F0  GETCAS  LDA $F000
1180 1FB3 4A              LSR A
1190 1FB4 90FA            BCC GETCAS
1200 1FB6 AD00F0          LDA $F000
1210 1FB9 2940            AND #$40 CHECK PARITY BIT
1220 1FBB D004            BNE ERR  ERROR IF SET
1230 1FBD AD01F0          LDA $F001
1240 1FC0 60              RTS
1250 1FC1 206CA8  ERR     JSR $A86C DISPLAY CR/LF ERROR CR/LF
1260 1FC4 A987            LDA #ESL
1270 1FC6 A0A1            LDY #ESH
1280 1FC8 20C3A8          JSR $ABC3
1290 1FCB 206CA8          JSR $A86C
1300 1FCE A2FE            LDX #$FE RESET STACK POINTER
1310 1FD0 9A              TXS
1320 1FD1 4C521F          JMP LOALP JMP TO REPEAT SEARCH FOR NAME
1330 1FD4 A5F1    INCAD   LDA ADDR+1 RETURN CARRY SET IF DONE
1340 1FD6 C5F3            CMP ADDR+3 OTHERWISE INCR. POINTERS
1350 1FD8 9008            BCC INCAD1
1360 1FDA D00C            BNE RINCAD
1370 1FDC A5F0            LDA ADDR
1380 1FDE C5F2            CMP ADDR+2
1390 1FE0 B006            BCS RINCAD
1400 1FE2 E6F0    INCAD1  INC ADDR
1410 1FE4 D002            BNE RINCAD
1420 1FE6 E6F1            INC ADDR+1
1430 1FE8 60      RINCAD  RTS
1440 1FE9 A903    INITN   LDA #$3 RESET ACIA TO NORMAL
1450 1FEB 8D00F0          STA $F000
1460 1FEE A911            LDA #$11
1470 1FF0 8D00F0          STA $F000
1480 1FF3 60              RTS
1490 1FF4 AA      CASOUT  TAX
1500 1FF5 AD00F0  CASLP   LDA $F000
1510 1FF8 4A              LSR A
1520 1FF9 4A              LSR A
1530 1FFA 90F9            BCC CASLP
1550 1FFC 8E01F0          STX $F001
1560 1FFF 60              RTS
```

(continued from page 176)

Simon.

```
10 PLAY"O3T4L4GE,L2G;L4GE;L2G;L4AGFEDEF;L8EF;L4GC;L8CC;L4C,L8DEF,L2G;L4GDDFED,L2C,L4;"
20 CLS:C$=""
30 PRINT@137,CHR$(49)
40 PRINT@150,CHR$(50):
50 PRINT@361,CHR$(51);
60 PRINT@374,CHR$(52);
70 G$=CHR$(143+48)+CHR$(143+48)+CHR$(143+48)
80 PRINT@104,G$;
90 PRINT@168,G$;
100 PRINT@136,CHR$(143+48);
110 PRINT@138,CHR$(143+48);
120 G$=CHR$(143+32)+CHR$(143+32)+CHR$(143+32)
130 PRINT@117,G$;
140 PRINT@149,CHR$(143+32);
150 PRINT@151,CHR$(143+32);
160 PRINT@181,G$;
170 G$=CHR$(143+16)+CHR$(143+16)+CHR$(143+16)
180 PRINT@328,G$;
190 PRINT@360,CHR$(143+16);
200 PRINT@362,CHR$(143+16);
210 PRINT@392,G$;
220 G$=CHR$(143+64)+CHR$(143+64)+CHR$(143+64)
230 PRINT@341,G$;
240 PRINT@373,CHR$(143+64);
250 PRINT@375,CHR$(143+64);
260 PRINT@405,G$;
270 FORI=1TO32:PRINT@223+I,CHR$(141);:PRINT@255+I,CHR$(139);:NEXTI
280 FORI=0TO15:PRINT@15+32*I,CHR$(139);:PRINT@16+32*I,CHR$(141);:NEXTI
290 PRINT@239,CHR$(137);:PRINT@272,CHR$(137);
300 IFC$="S"THENE=0:GOTO370
310 A$="":E=0
320 FORI=1TO32
330 B$=STR$(RND(4))
340 B$=RIGHT$(B$,1)
350 A$=A$+B$
360 NEXTI
370 FORN=1TO32
380 FORI=1TON
390 GOSUB480
400 NEXTI
410 FORI=1TON
420 GOSUB540
430 NEXTI
440 FORA=1TO1000:NEXTA
450 IFE=1THENN=32
460 NEXTN
470 GOTO610
480 B$=MID$(A$,I,1)
490 IFB$="1"THENPRINT@137,CHR$(143+48);:PLAY"C":PRINT@137,CHR$(49);:GOTO530
500 IFB$="2"THENPRINT@150,CHR$(143+32);:PLAY"E":PRINT@150,CHR$(50);:GOTO530
510 IFB$="3"THENPRINT@361,CHR$(143+16);:PLAY"G":PRINT@361,CHR$(51);:GOTO530
520 IFB$="4"THENPRINT@374,CHR$(143+64);:PLAY"B":PRINT@374,CHR$(52);
530 RETURN
540 TIMER=0
550 B$=INKEY$:IFTIMER>200THEN580
560 IFB$=""THEN550
570 IFB$=MID$(A$,I,1)THEN590
580 E=1:I=N:FORA=1TO32:SOUND85,1:NEXTA:GOTO600
590 GOSUB490
600 RETURN
610 IFI<9THENPRINT@448,"BEGINNER",:GOTO650
620 IFI<23THENPRINT@448,"AMATEUR",:GOTO650
630 IFI<32THENPRINT@448,"EXPERT",:GOTO650
640 IFI=32THENPRINT@448,"CHAMP";
650 PRINT@480,"DO YOU WANT TO CONTINUE (Y/N)?";
660 C$=INKEY$:IFC$=""THEN660
670 CLS
680 IFC$="N"THENEND
690 PRINT@32,"SAME SEQUENCE AGAIN = S"
700 PRINT@64,"PRINT THE LAST SEQUENCE = P"
710 PRINT@96,"TRY A NEW SEQUENCE = T"
720 C$=INKEY$:IFC$=""THEN720
730 IFC$="S"THENCLS:GOTO30
740 IFC$="P"THENCLS:PRINTLEFT$(A$,I-1):GOTO650
750 IFC$="T"THEN20
760 GOTO690
```

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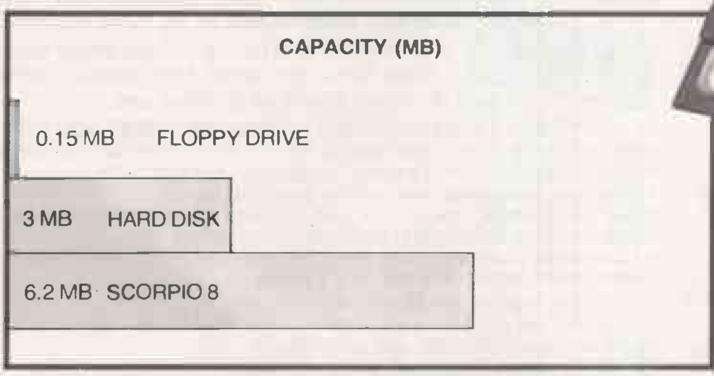

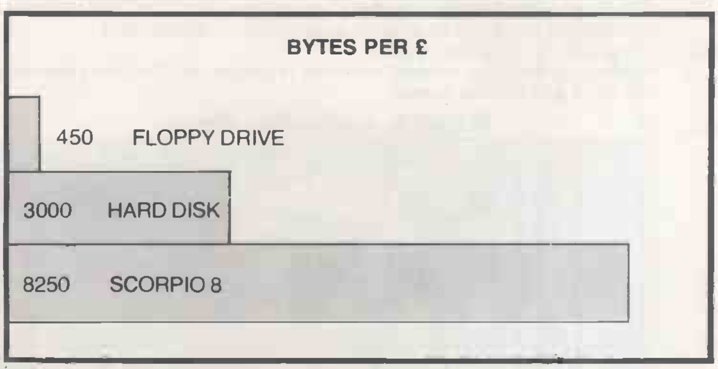

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* Specify formulae relating any row or column to any other.
* Enter your source data and have the results calculated.
* Save the results on tape (or disk – BBC) for later reloading and manipulation.
* Print the tabulated results in an elegant report format.
* Experienced users may access saved files and write their own reporting or graphics presentation programs for the results.

Some typical applications:–

* Small business accounting applications, e.g. profit and loss statements and cashflow projections, break-even analyses etc.
* Investment project appraisal – anything from double glazing to oil rigs!
* Comparing rent/lease/buy options
* Processing the results of scientific experiments or field studies
* Engineering calculation models
* In fact, anything that involves repeated re-calculation of results presented in tabular or spreadsheet format.

Program Availability Chart:–

	Database	Stock Control	Mailist	Invoices & Statements	Spread sheet Analysis	Cashbook Accounting	Word processor	Home Accounts	Commercial Accounts
Sinclair Spectrum 16k or 48k	●	●	●					●	●
Dragon 32k or 64k	●				●			●	
VIC20 (16k+)	●	●	●	●				●	●
Sinclair ZX81 (16k+)	●								
Grundy Newbrain	●								
Texas T199 4A	●								
Atari 400/800 or Osborne	●								
Sharp MZ80A	●	●	●	●				●	●
Sharp MZ80K	●	●	●	●				●	●
Sharp MZ80B	●	●	●	●				●	●
BBC micro model A or B 32K	●	●	●	●	●	●	●	●	●

Spectrum machine code

Bill Bennett searches for a good book on the subject — does such a thing exist?

WHAT BETTER WAY could there be of learning machine-code programming than on a Spectrum computer? It does not cost much, so if you do find mastering it too difficult then little is lost — you can always give the Spectrum to some kids. Logical deducation might lead you to think that because there are lots of books published about the Spectrum, there should be at least one good one about learning machine-code programming.

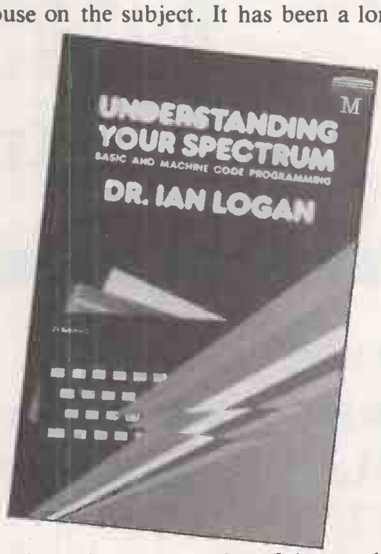
Unfortunately classical logic does not apply to the world of microcomputer publishing. We cannot rely on there being a decent microcomputer book on any subject. There are three books on the subject of machine-code programming for the Spectrum. Two of them I would not touch with a moving "professional" keypad.

However, there is one book on the subject that is both informative, enjoyable — yes an enjoyable book on machine code — and pitched at just the right level for programmers moving over from Basic. The book is *Introducing Spectrum Machine Code* by Ian Sinclair.

Ian Sinclair has nothing to do with Sinclair Research or with Clive Sinclair, and should not be confused wth the designer of the same name. He is a prolific writer with over 40 titles to his name; most of them, like this book, are pitched at the informed beginner. The reader is not thrown in at the deep end, but eased through the subject.

The major criticism of the book is that it comes to an end just when it gets interesting — a bit like *War and Peace* ending when the French invade Russia. However it just may be that Ian Sinclair is planning another volume. The book provides an excellent introduction to the topic, but it does need following up.

There are two books from Melbourne House on the subject. It has been a long time since I have seen such awful examples of the publisher's art. How anyone has the nerve to sell a book like *Spectrum Machine Language for the Absolute Beginner* is beyond me. At £6.95 the book is ridiculously over priced, and looks as though the text has been transferred directly from a cheap word-processor on to the page.



About one-third of the book is given over to the development of a machine code program, Freeway Frog, a version of the arcade game Frogger. I was pleased to see such an example of what can be done with machine code, but a few more examples would not have gone amiss. I would be embarrassed to have my name on the cover of this scruffy little item.

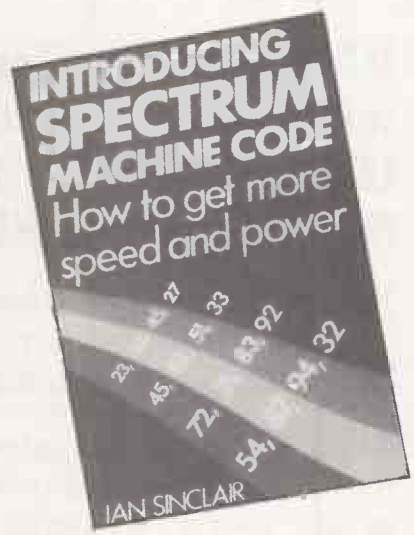
Spectrum Machine Language For the Absolute Beginner Edited by William Tang. Published by Melbourne House, 244 pages paperback, £6.95. ISBN O 86161 110 1

Understanding Your Spectrum by Ian Logan. Published by Melbourne House. 190 pages paperback, £7.95. ISBN 0 86161 111 x

Introducing Spectrum Machine Code by Ian Sinclair. Published by Granada, 151 pages paperback, £7.95. ISBN 0 246 12082 7

To be fair to Melbourne House, the public do not buy microcomputer books because they are well written or interestingly presented. I suppose this is why the publishers think they can get away with such sloppy presentation. But is the public going to pay the high price asked for such badly packaged merchandise?

Dr Ian Logan is well thought of in microcomputing circles. It is a pity that Melbourne House does not think highly enough of him to package his book *Understanding your Spectrum* as well as it deserves. From the design on the cover to the ink on the page, no corner has been left uncut in a sterling effort to minimise the cost of producing this book.



As far as the information inside is concerned it could be pure wisdom, but it is painful to look at. The book costs £7.95, but the extraordinarily high cost is warranted by the sheer amount of useful information within.

Understanding your Spectrum contains all the information an experienced machine-code programmer could need and will also be of great use to Basic programmers. It is in effect a supplement to the Sinclair manual. I cannot recommend the content too highly — it is a shame that a decent publisher has not signed Ian Logan up.

>NEXT MONTH

>MASS STORAGE AND DATABASES

The special section in the May issue is devoted to two of the most important growth areas in microcomputing. Important developments in mass storage include microfloppies of 3 to 3.5 inches, bubble memories, and video tapes and discs. Meanwhile the performance of floppies and hard discs is increasing dramatically.

The database programs needed to store, select, sort and access large amounts of information are making a big impact on the market. We're checking out the main developments in these vital fields

>ORION RISING

A leading office-equipment supplier was confident it could sell a new micro — so it commissioned one. The result is the new 16-bit Orion desk-top micro. We interviewed the designer to find out how he went about building it, and tested the machine.

>PICTURE THIS

The BBC Microcomputer offers exceptional colour-graphics facilities, but how can the average user exploit them to the full? The answer is to use a special graphics program designed to make painting and drawing simple. We tested three new packages to see how they perform.

>AND MUCH MORE!

Plus the May issue will include special articles on programming and using microcomputers, and the usual reviews and departments including the Open File pages of programs for popular micros, news and letters.

Practical Computing

On sale at W H Smith and all leading newsagents after April 13.

THE

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BY CAR Bingley Hall is situated close to the city centre and is within easy access to the M1, M5 and M6. Bingley Hall will be road signed by the AA.

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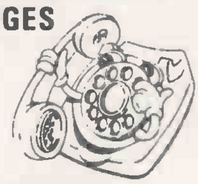

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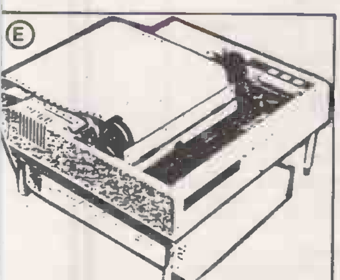

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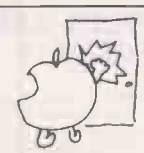

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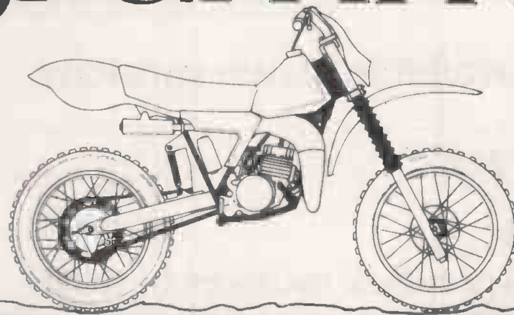

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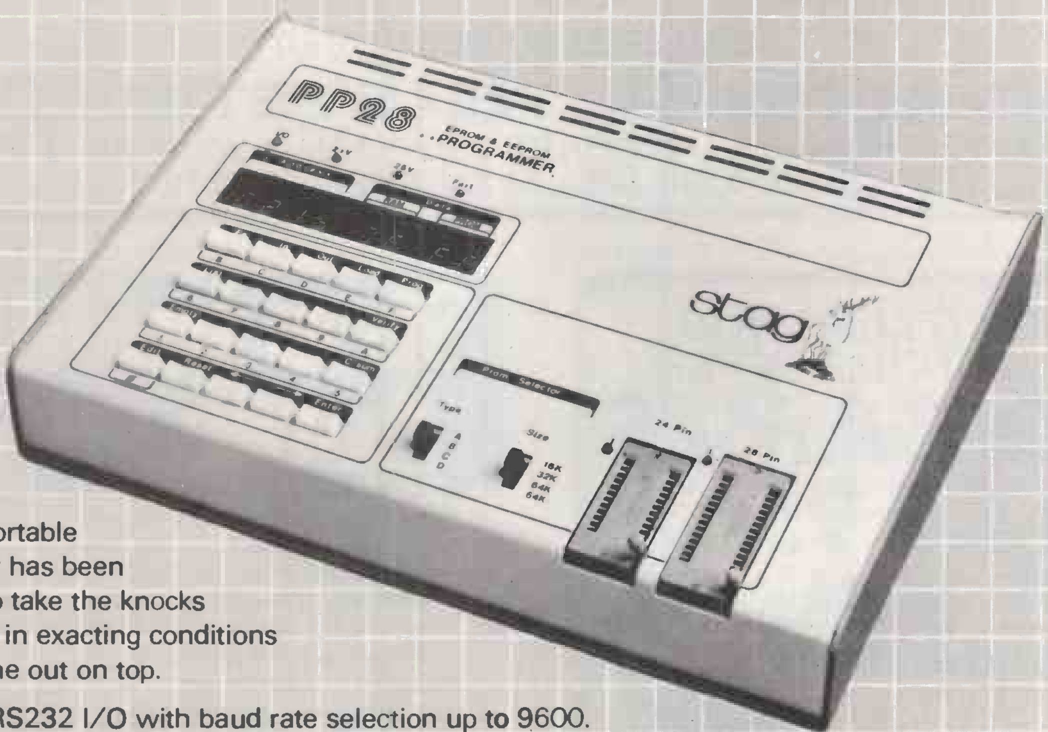

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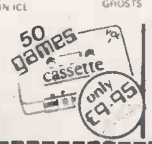

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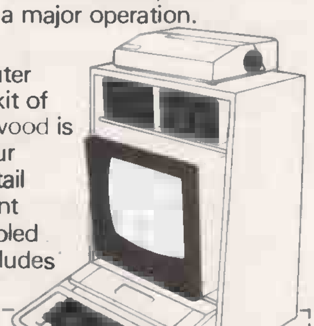

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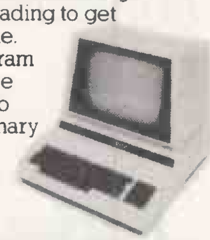

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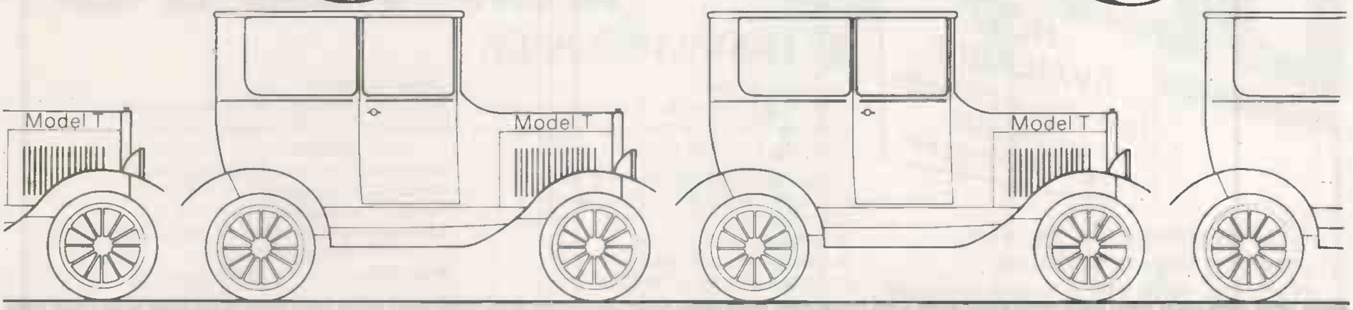

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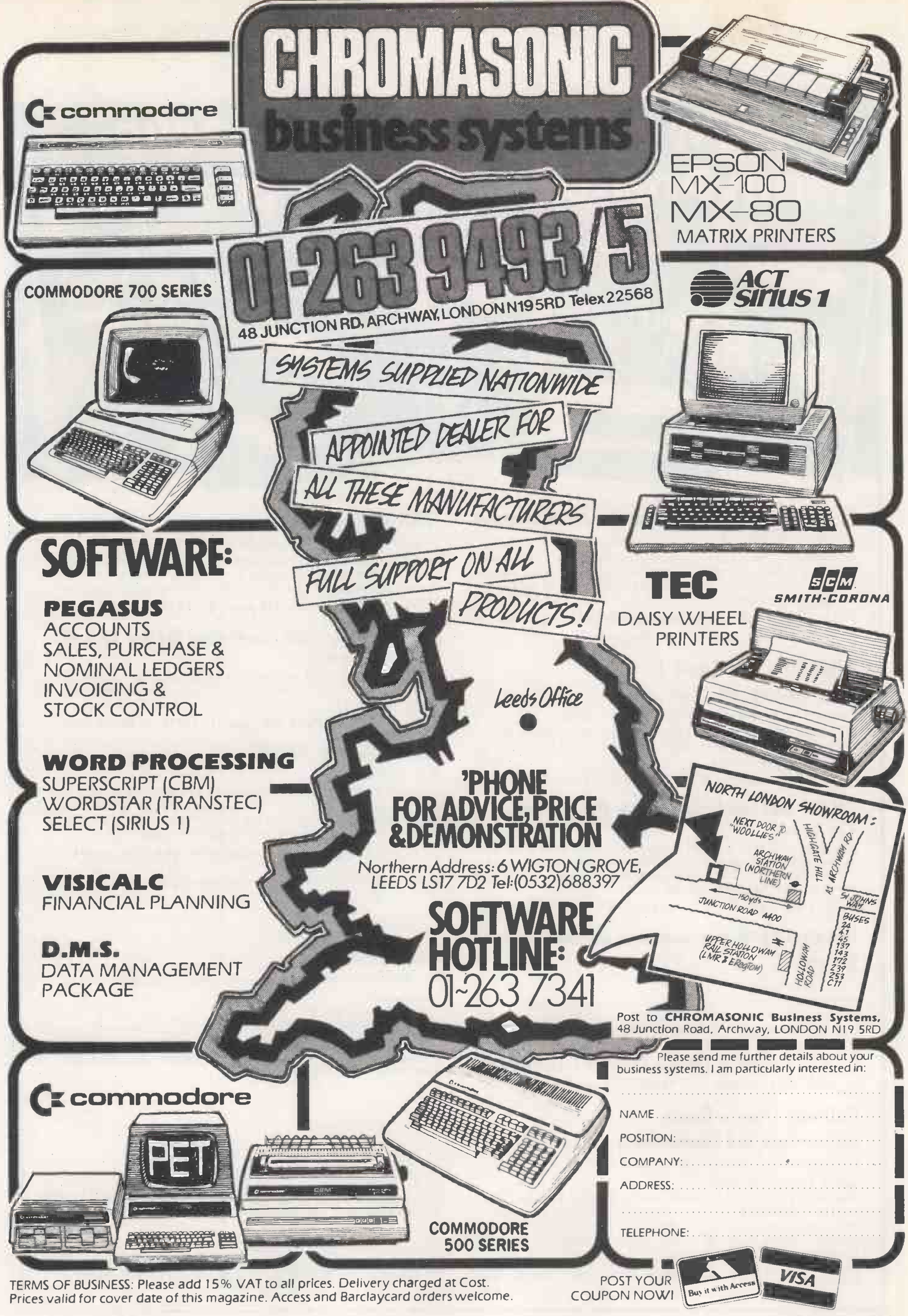

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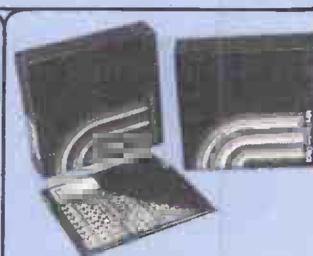

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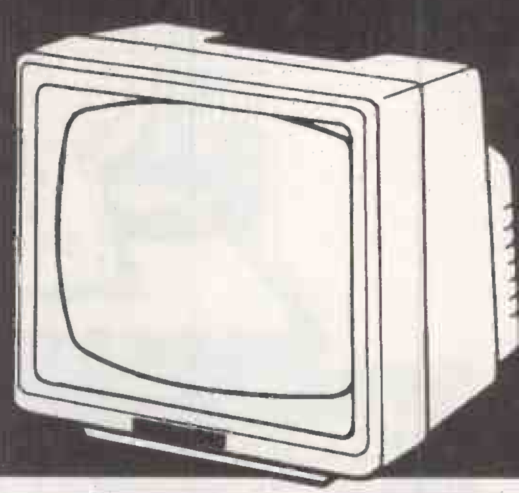

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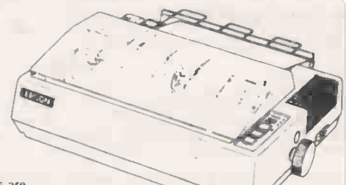

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