60p

YOUR COMPUTER

MAY 1982

Vol.2 No.5

Aerial photographs interpreted

Joysticks on the Sinclair

BBC graphics

Vic tank battle

ZX cassettes tested

Win a Micro Gen joystick for the ZX-81

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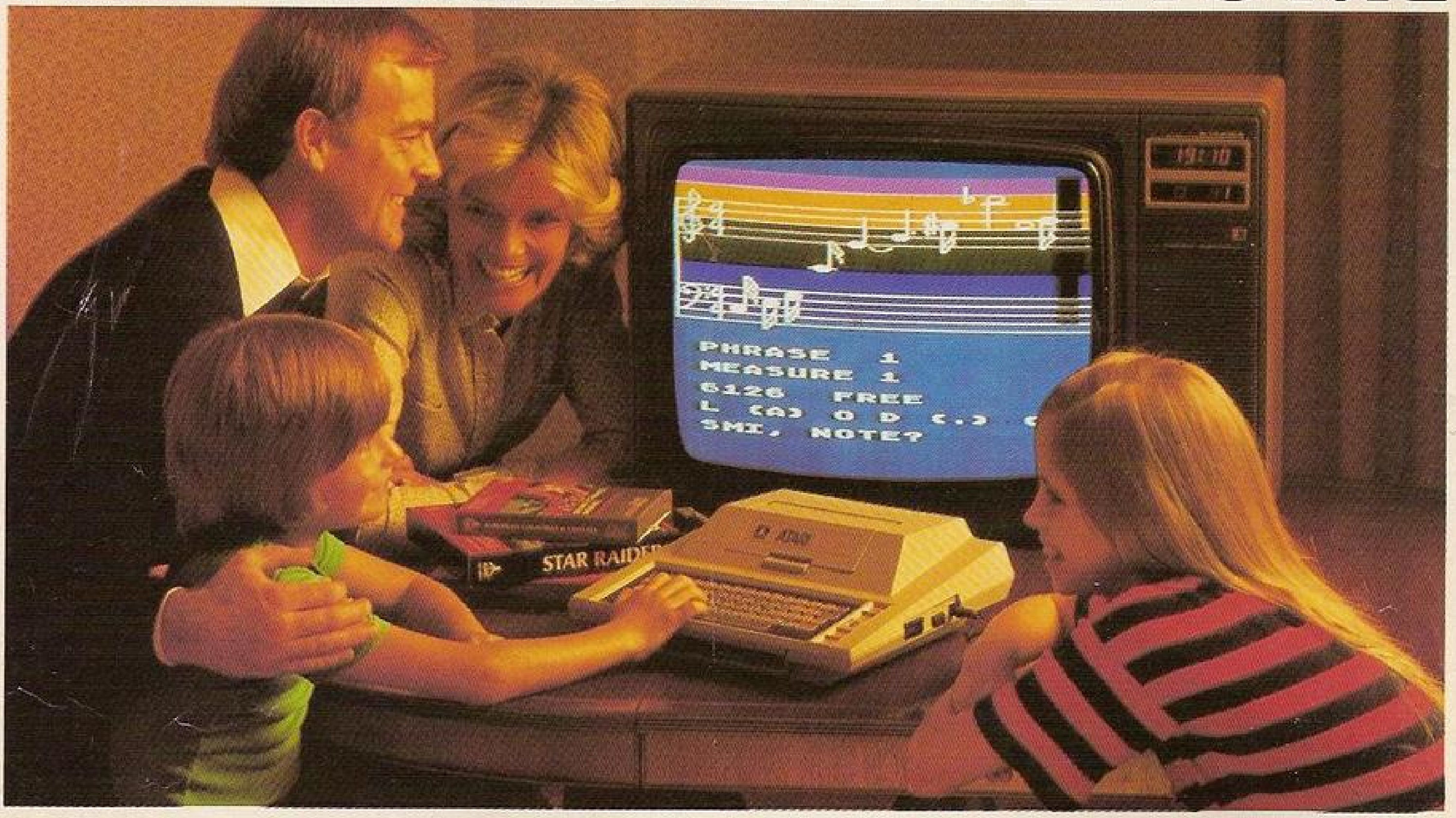

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Cover photograph by Stephen Oliver.

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EDITORIAL

NEXT MONTH, with ZX-81 software on flexidisc offered free with every issue, *Your Computer* is presenting a new idea in program storage to the micro market — an idea which could have a dramatic effect on the currently expensive business of buying software. The flexidisc method eliminates the time-consuming chore of entering a program line by line, and if adopted commercially could reduce manufacturing costs to such a point that micro users would benefit from a fall in program prices to one-quarter of their present levels.

The flexidisc is the size of the ubiquitous 7in. forty-five or single, and is made of pliable plastic. In its grooves, in the form of high- and low-frequency sine waves, it can contain the kind of program that would occupy one side of a conventional software cassette. You transfer the software that the flexidisc contains on to one of your own cassettes simply by playing the disc on your record player and recording it. Once the program is safely committed to cassette the flexidisc is stored away as the master copy, to be brought out only if you wish to record another duplicate. Of course, in next month's *Your Computer* there will be full step-by-step instructions on how to use the disc, plus a thorough account of its workings on the technical level.

When the micro enthusiast, hungry for novel applications for his machine, sets about buying new software it is clearly not the cassette itself that concerns him but the quality of the software it contains. Given that the cassette can satisfy the essential loading requirements, all that it becomes is a container for programs — and compared with the flexidisc, an expensive one at that. Reduce the cost of the container but not the quality of the product held in it, and very soon you find yourself on the brink of a software revolution.

For a better idea of the finances of manufacturing cassette software, we could cite one program-producer who recently revealed that a cassette which sells for £5 costs an estimated 22p to make. For that manufacturer to be able to obtain the same percentage profit margin, the selling price for a flexidisc would be 66p on a production price of 3p.

In the ZX-81's short 1½-year life, software prices for the machine have fallen considerably. Micro users look to commercial software for new ideas, and if the flexidisc means that software becomes even more affordable, new ideas will develop quickly and it will herald a breakthrough which will have an impact on both the user's pocket and the development of micro programming.

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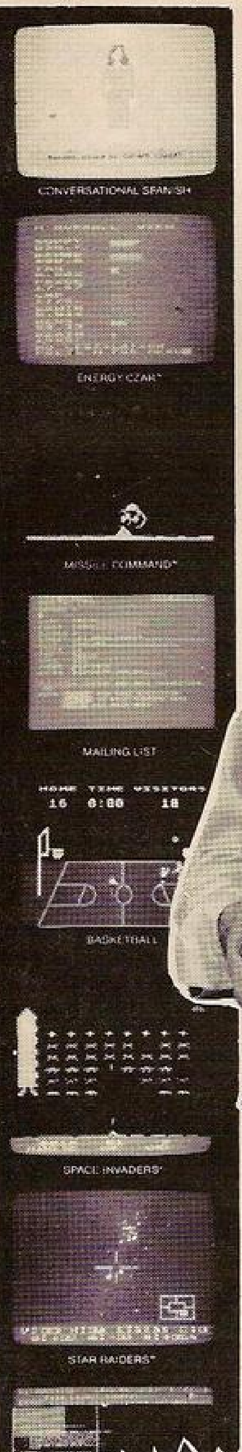

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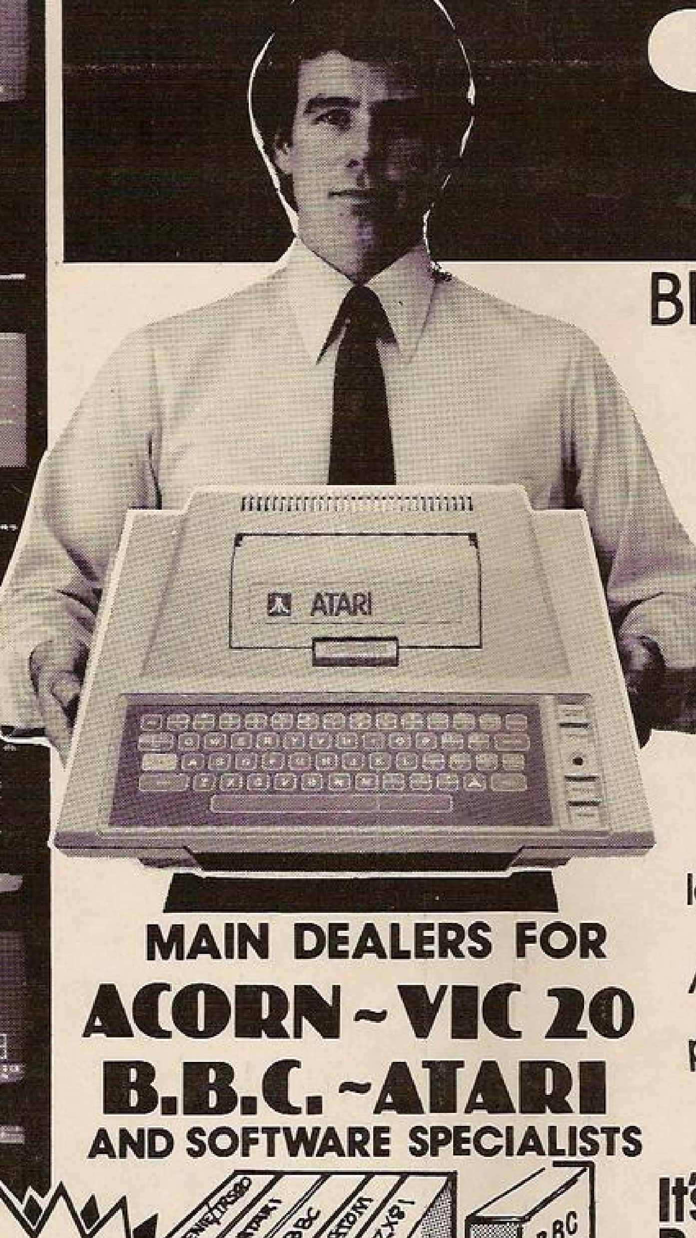

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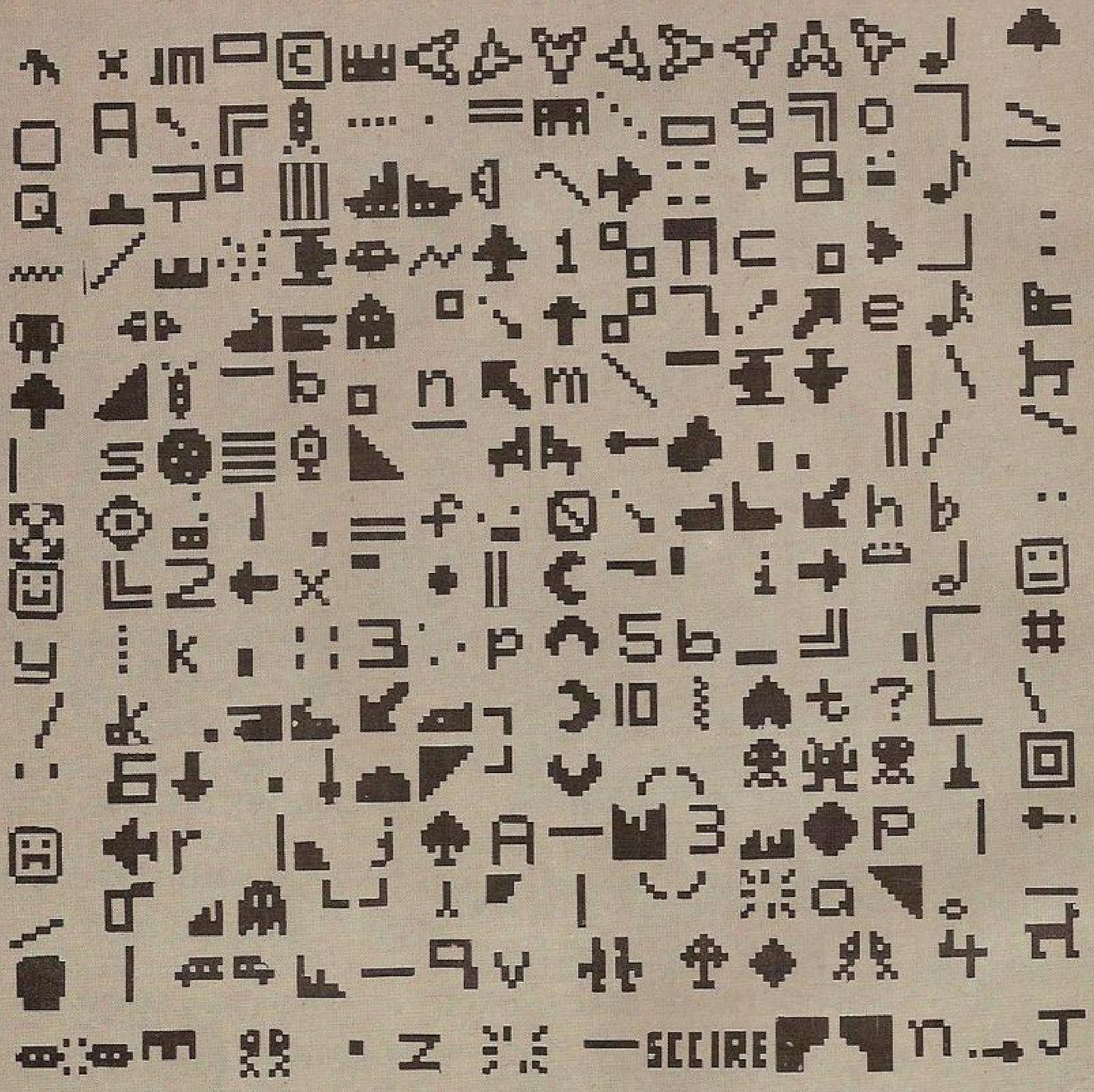

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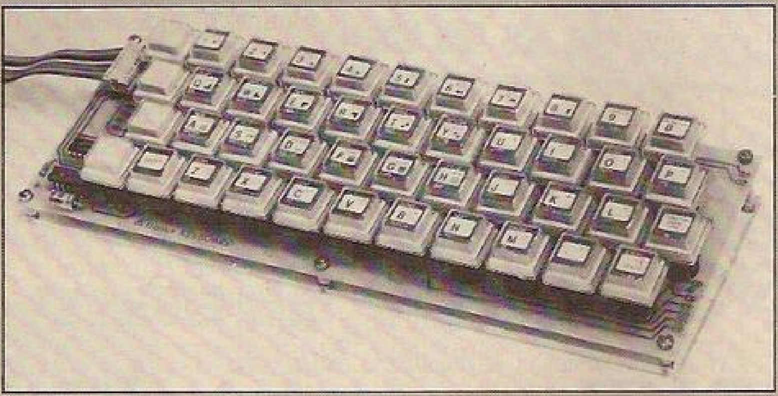

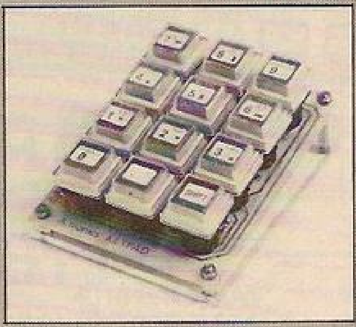

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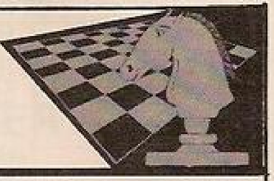

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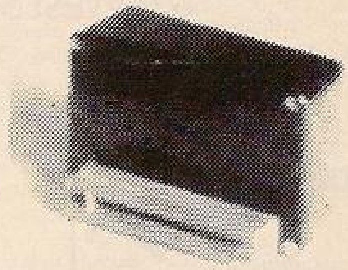

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YOUR LETTERS

DEAR AUNTIE

Once upon a time there was a friendly inventor who worked for Acorn. One day, his employer lent him to Auntie Beeb, who asked him to design a computer.

The inventor worked night and day, and eventually produced an enchanted machine. Everbody for miles around came to see the wonderful micro, and many people decided to buy one for themselves.

One such person was a little boy called Christopher. He ordered his computer in September 1981, and expected to receive it in time for that Christmas.

When December came, Christopher's mummy contacted Auntie Beeb on the magic number, 0536 - 84658, and she was told that the big bad Gremlin had moved into the factory where the computers were made. This naughty Gremlin had taken all the chips, and had eaten them for his supper.

Now, a very unhappy Christopher is still waiting for his computer. Can anyone lend Autie Beeb a fairy Godmother or a brave knight to slay the Gremlin? If it takes much longer, Christopher won't be able to afford it on his pension.

Christopher Horne,
Maidenhead,
Berkshire.

ZX REPLACEMENT

I am pleased to report that since my last letter published in Your Letters, April, about the faulty replacements I have received for my ZX-81, I have received a new ZX-81, the sixth, in which the various arithmetic faults of its predecessors have been corrected. It is good to know that ultimately Sinclair has honoured the guarantee to replace machines with arithmetic failings although regrettable that the company has made so many unsuccessful attempts since July, 1981.

Users, particularly teachers, requiring the ZX-81 for arithmetic work should check their machines using, for example, Sinclair's test, PRINT SQR 0.25 which in faulty units gives 1.3591409 instead of 0.5. Unexplained crashes in which lengthy programs may be lost remain, however , a problem.

H Hack,
Henley on Thames.

ATOMIC CLOCK

I could not help feeling just a tiny bit sceptical when I was reading Tim Hartnell's list of timings for a loop printing the numbers 0 to 1,000 in his review of the BBC Micro.

As my Atom was just by me, it took only a few seconds to write a program to do the job, and my timing was only 45.5 seconds. I then tried stretching the program by using full-length verbs and by giving every element a separate line number.

So far as I know, the Atom still remains the fastest Basic interpreter in a low-cost micro available today over the counter. What is more, the Atom is a fact — not just a promise!

R A Bolton,
Market Harborough,
Leicestershire.

M FOR MONSTER

P J Newbury, Software File, March, was quite right when he said "The lack of Read and Data statements in ZX-81 Basic can be most frustrating" even though you can save all the variables.

One of the many uses for Read and Data is to initialise string arrays, for instance monsters in an Adventure. However the trusty multi-purpose Rem statement can be used to this end:

```
240 DIM D$ (10,10)
250 LET DS = (PEEK 16425 +
    256*PEEK 16426 + 5)
260 REM ORC.TROLL.SAURON.
    BALROG.GECKO.GOLLUM.
    GOBLIN.*
270 DIM M$(7,6)
280 LET C0 = 1
290 GOSUM 9000
300 FOR X = 1 TO 7
310 LET M$(X) = D$(X)(TO 7)
320 NEXT X
330 STOP

9000 LET C$ = ""
9010 LET X$ = CHR$ PEEK DS
9020 IF X$ = "*" THEN RETURN
9030 IF X$ = "." THEN GOTO
    9070
9040 LET C$ = C$ + X$
9050 LET DS = DS + 1
9060 GOTO 9010
9070 LET D$(C0) = C$
9080 LET DS = DS + 1
9090 LET C0 = C0 + 1
9100 GOTO 9000
```

However this method is not ideal for large amounts of data since the transfer array becomes very large and wasteful. It is then better to read data in blocks of, say, 10, and use the counter C0, to place the data consecutively in one large array.

Also when a long Rem statement is being typed, an annoying delay between characters soon develops. It may be better then to split the data into separate Rem statements and set the value of DS using the NXTLIN variable — J Eade, Software File, January.

N Matthews,
Wallingham,
Surrey.

ROBINSON'S JAM

In reply to David Robinson's letter — Your Letters, March — I can assure him that my Vic-20 behaves in exactly the same way when using the Input statement. He himself suggests the easiest solution, which is to Print the prompt and then to Input just the variable, either as a separate line or after a colon.

```
10 PRINT "THE NUMBER OF
VOLTS AT A"
20 INPUT V
```

Or, alternatively

```
10 PRINT "THE NUMBER OF
VOLTS AT A": INPUT V
```

There is a much simpler solution to the problem of putting 255 characters into a string. The first line is:

```
10 A$ = "        "
```

Followed as necessary by:

```
20 A$ = A$ + "        "
30 A$ = A$ + "        "
```

Maurice Hill,
Walsall,
West Midlands.

SEVEN-DAY ITCH

I have been in computing a week now and, having almost worked my way through the ZX-81 instruction manual, decided to try some of the programs listed in software File. Out of the four programs tried, three crashed because of errors in the listings as printed.

With my limited experience I managed to de-bug the programs and even made some improvements. It has been a frustrating few days as my wife and children will testify — and I wonder if the submitted programs are checked by you for accuracy and operation.

It is, of course, possible that some corruption does occur in the process of printing and we can all appreciate the problems in meeting a deadline for publication.

I am not at all put off by the experience — in fact I know that I learnt a great deal from it — far more than if I had just plodded on and never bothered to get my feet wet. However, just a plea to all — please read the notes which head Software File before rushing in programs for publication.

Brian Burke,
Benson,
Oxfordshire.

REPEAT UNTIL

Having just read "ZX Repeat Until" in Your Letter, January 1982, I feel compelled to write.

A Repeat-Until loop is a loop with an If condition at the end, e.g.,

```
12 (beginning of loop)
14
16
18
20 IF (Condition) THEN GOTO 12
```

This is simplier and clearer and does not involve any calculations.

G L Watson,
Edgware,
Middlesex.

LADDERS UPDATE

After Typing in the Snakes and Ladders program for the ZX-81, by Brian Horsfield on page 37 of the March issue, I would like to point out that amendments should be made to the listing. Lines 1170 and 1180 are not required. Line 190 should read: GOSUB 1000. Line 240 should read: GOSUB 600 and line 450 should read:

```
PRINT AT L (Y−X),C(Y−X);CHR$
(INT((Y−X)/10) + 156); CHR$
(Y−X−10*INT((Y−X)/10) + 156)
```

In Response Frame on page 59 of the same issue, you say that after about 20 minutes the ZX printers output becomes unreadable, I have not experienced this problem. If you are having trouble with overheating it helps if the back of the computer is raised about 0.25 in. higher than the front, therefore allowing more air under the computer to cool the heat sink.

Robin Wyke-Holloway,
Salisbury,
Wiltshire.

STOP THAT RAG

I found your article on ZX-81 Music in March's *Your Computer* most interesting to read and use. I would like to suggest two improvements which I have made. First, to play a flat the program jumps to line 1500 and there performs seven or eight more lines than for one of the notes A to G. This causes a delay in the flats which gives the tune an unwanted syncopated flavour.

To correct this I have inserted a dummy For loop in lines 1041 and 1042. Secondly, I have found it useful to store the tune while I am correcting my errors. I can then call up the tune by simply keying in 1, 2 or whatever. The control for this is in my added lines 181 to 188, while the tunes are stored after the main program, starting at line 4000.

```
PROGRAM TO CORRECT SEMITONE TIMING

1039 REM ** TEST FOR SEMITONE **
1040 IF N>128 THEN GOTO 1500
1041 FOR T=1 TO 6
1042 NEXT T

DISPLAY FOR EDITING AND PLAYING TUNES

TYPE 1 TO RECORD TUNE 1,
TYPE 2 TO RECORD TUNE 2,ETC.
TO WRITE NEW TUNE TYPE 0,
THEN LIST 4000 TO SEE FORMAT:
 N$=NOTES (A-G, FLATS - INVERSE GRAPHICS)
 X$=OCTAVES (1-8)
 D$=DURATION OF NOTES (0-F)
WRITE NEW TUNE 10 LINES AFTER THE START
OF THE LAST ONE.
TO RECORD IT, GOTO 181 AND TYPE
NUMBER OF NEW TUNE.

PROGRAM TO STORE TUNES TO EDIT THEM

181 CLS
182 PRINT "TYPE 1 TO RECORD TUNE 1,
TYPE 2 TO RECORD TUNE 2, ETC. TO
WRITE NEW TUNE TYPE 0, THEN LIST
4000 TO SEE FORMAT
 N$=NOTES (A-G, FLATS - INVERSE GRAPHICS)
 X$=OCTAVES (1-8)
 D$=DURATION OF NOTES (0-F)
WRITE NEW TUNE 10 LINES AFTER THE START
OF THE LAST ONE.
TO RECORD IT, GOTO 181 AND TYPE
NUMBER OF NEW TUNE."
183 INPUT I
184 IF I>0 THEN GOTO 186
185 STOP
186 GOSUB 4000+I*10
187 GOSUB 1000
188 GOTO 181

4009 REM ** TUNE 1 = JINGLE BELLS **
4010 LET N$="EEEEEEEGCDEFFFFFEEEEEDDEDG
EEEEEEEGCDEFFFFFEEEEGGFDC"
4011 LET X$="5555555555555555555555555
555555555555555555555"
4012 LET D$="2242242221822212221122224 8
22422422218222122211 2222C"
4013 RETURN
4019 REM ** TUNE 2 = SONATINA IN G **
4020 LET N$="BCDBADGABCABGBAGABABCADBAD
GABGABCAGEDGBGD"
4021 LET X$="5555554555554554555555555
4554555544444444"
4022 LET D$="224444C22444411222222224444
A222222222222222F"
4023 RETURN
```

Michael Smith,
Fareham,
Hampshire.

The CPU 100 and 200 thermal printers are suitable for use with most microcomputers. Both models have full line buffering with bi-directional printing and a microprocessor which "looks ahead" to decide on the most efficient print direction for the next line. Text format is 40 characters per 4in. line on the 100 model, and 80 characters per 8in. on the 200 model. Graphics consist of 240 or 480 seven-dot print positions per line and work at 240 positions per second. A parallel TTI-compatible ASCII eight-bit interface permits the printers to ber interfaced with most microcomputers. An optionla "plug in and go" interface is available for the Apple, Pet, Sorcerer and TRS-80. The CPU-100 and 200 printers cost £236 and £325 respectively from CPU Peripherals Ltd, Rodd Industrial Estate, Govett Avenue, Shepperton, TW17 8AO. Telephone 98-46433.

Sound generator and joystick make Atom more friendly

A SOUND generator and an eight-way joystick for the Acorn Atom are available from R. Shillito, 5 Ingarfield Road, Holland, Clacton, Essex, CO15 5XA.

The sound generator is available with one, two or three AY-3-8910 sound chips, built-in amplifier and speaker and up to six eight-bit I/O ports.

The eight-way joystick plugs into one of the sound generator ports, or into a joystick port adaptor. Up to six joysticks can be used simultaneously with the largest sound generator. The standard power supply can be replaced by a 5V/5A supply which uses a toroidal transformer.

The sound generators are priced at £54.95, £64.95 and £79.95 for the one-, two- and three-chip models. The joystick costs £14.95 and the joystick-port adaptor costs £19.95. The standard power supply is sold for £44.95, or £49.95 with built-in mains suppression.

Tape storage

THE ZX-99 automatic tape drive controller plus software gives the ZX-81 both word-processing and data-retrieval capabilities. Handling up to four tape recorders at once, the ZX-99 enables you to use tape storage to hold data files as well as programs.

A full tape-to-tape copy program is evoked by a single USR command. The ZX-99 can also make directory listings of ordinary program storage tapes. In addition, the ZX-99 has an RS-232C serial output interface which is compatible with standard ASC11 printers.

The ZX-99 costs £62.90 form Data-assette, 44 Shroton Street, London, NW1 6UG. Telephone 01-258 0409.

You can bank on your ZX-81

A PERSONAL banking system for the ZX-81 which enables you to keep detailed records of your bank transactions has been introduced by J. Gibbons, 14 Avalon Road, Orpington, Kent, BR6 9AX. All standing orders, be they monthly, quarterly, six-monthly or yearly, are automatically included in your own statements on the correct dates.

The banking system includes a machine-code load/save routine which enables you to store your records in datafiles on cassette separately from the program. This routine saves and loads the program variables and allows the system to access separate add-on programs.

The personal banking system is available on cassette for £9.95, including a 12-page user manual, from J. Gibbons, or from Hilderbay Ltd, 8/10 Parkway, Regents Park, London, NW1 7AA. Telephone 01-485 1059.

Galactic Chess from Artic

ZX-GALAXIANS is a machine-code version of the popular arcade game. Suitable for the 16K ZX-81, ZX-Galaxians contains swooping attackers, full explosions, continuous-status reports and personalised high scoring routines. It is available on cassette for £6.50 from Artic Computing, 396 James Reckitt Avenue, Hull, North Humberside.

Artic has also introduced a new version of ZX-Chess II which can be used in conjunction with the Quicksilva character board to produce classical chess pieces on the screen. This program is available on cassette for £12.99. Alternatively, you can buy the program and Quicksilva characters board, motherboard and connector for £45 — a saving of £10.

Goto Luton — do not pass goto

ZX-81 MONOPOLY is a computer simulation of the popular board game. Produced by Work Force, 140 Wilsden Avenue, Luton, Bedfordshire, telephone 0582-418577, it is suitable for the 16K ZX-81 and is available on cassette for £8 including VAT and postage.

Work Force is currently working on a U.S. version of ZX-81 Monopoly and it should be available shortly.

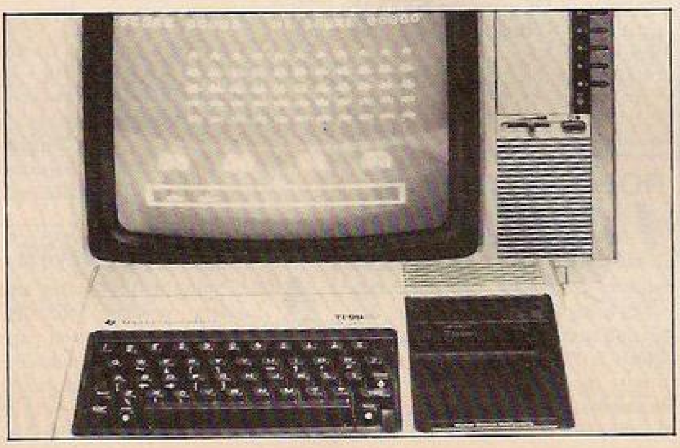
Tandy package offers total word processing

NEWSCRIPT is a word-processing package for the TRS-80 Model I and III which offers a range of facilities normally found on large mainframe computers.

A full-screen editor allows the user to move the cursor anywhere on the screen or file. Text can be added, deleted, replaced or inserted according to the user's demands. Newscript can also print multiple copies of one letter, or merge names and addresses from a mailing list into a standard letter. Other facilities include centring, page numbering, righ-justification and a mailing label option.

Newscript will support most matrix and daisywheel printers currently available. It requires 48K with at least one disc drive and costs £79 plus VAT and postage from E A International, 8 High Street, Meldreth, Toyston, Hertfordshire, SG8 6JU. The telephone number is 0763-60189.

Texas lone star destroys aliens as Yankee space games go home



TEXAS Instruments has introduced a Space Invaders module for its TI-99/4A home computer. The Invaders module is similar to the arcade game with the player trying to destroy the advancing aliens before they land.

There is a choice of two skill levels where the invading aliens are either "merely aggressive" or "downright nasty". The aliens come in various forms and are worth a different amount of points.

The plug-in TI Invaders module costs about £40 from Texas Instruments Ltd, Manton Lane, Bedford, MK41 7PA. Telephone 0234-67466.

Teach yourself electronics

SUPERKIT is designed to teach beginners the basics of digital electronics. The kit, which costs £19.90 including post and packing from Cambridge Learning Ltd, contains an instruction manual, seven LS TTL integrated circuits, a EuroBreadBoard and various light-emitting diodes, resistors and capacitors. No soldering is involved, but the user must provide a 4.5V battery or a stabilised 5V power supply.

The kit is supported by Cambridge Learning's courses in digitial computer logic, and electronics and digital design. The beginner has the chance to learn about fault-finding, improvisation and subsystem checking as well as Boolean logic, gating, shift registers and ripple counters.

Cambridge Learning is based at Rivermill Lodge, St Ives, Huntingdon, Cambridgeshire, PE17 4EP. Telephone 0480-67446.

Nascom toolkit

EXTENSION BASIC is a new software utility for the Nascom range of microcomputers. This program adds 30 additional statements to standard Microsoft 4.7 ROM Basic and includes extra program editing commands, debugging facilities and structured programming. It is fully compatible with standard Basic and can be used as an interpreter or as a toolkit.

Extension Basic is supplied with a 25-page manual, a relocator program and a demonstration program which includes the games Sweeper and Demon Driver. It is available on cassette for £15 or in ROM for £25 from Level 9 Computing, 229 Hughenden Road, High Wycombe, Buckinghamshire, HP13 5PG. Telephone 0494-26871.

Commodore's £1,500 competition

COMMODORE HAS launched a £1,500 softward competition for the Vic-20 and Pet 4000 series microcomputers. First prize consists of a Vic single-drive floppy-disc unit, printer and programmers' aid cartridge. Second prize is a disc drive and programmers' aid cartridge while the third prize is a printer and an aid cartridge. Runners-up will receive books, magazines and composite discs of the winning entries.

The competition is open to all individuals and schools resident in the U.K. and Ireland. To enter the competition, write a program for the Vic-20 or Pet 4000 series, using up to 32K RAM, and send it to Commodore Software Competition, Department YC, 35 Garway Road, London W2 4QD, by June 30, 1982. Multiple entries on cassette or disc are permissible.

Commodore is looking for programs which are both inventive and educational and that can be used in either primary, secondary or special schools, or in the home. Typical entries will range from physics and chemistry packages to gardening diaries and recipe files. Games programs can also be submitted, but preference will be given to programs that have some educational or practical use.

The judges will include Commodore's technical manager, and educational computer consultant and Mike Todd, chairman of the Vic users' group. The winners will be presented with their prizes at a formal ceremony in August.

Competition entrants will also be given the chance to benefit from their programs. Commodore plans to market some of the winning programs in association with the authors.

Vic Panic

LINE-UP 4 and Panic Driver are the first two games for the unexpanded Vic-20 to be released by Terminal Software, 28 Church Lane, Prestwich, Manchester, M25 5AJ. Telephone 061-773 9313. The two games are available on cassette for £4.99 including post and packing.

Terminal Software is planning to release more software for the Vic-20, including Reversi and Scramble.

Will the real ZX-82 please step forward

CLIVE SINCLAIR'S new micro-computer is due to be launched this autumn, according to a recent article in *The Sunday Times*. It claimed that the new computer would cost around £170 and would include colour graphics and a conventional typewriter keyboard. In addition, the computer would probably have a 32K memory and would be marketed under the name of Spectrum.

Clive Sinclair declined to comment on the article other than to say that *The Sunday Times* had the facts wrong: "I do not know where these rumours start", he said. Sinclair refused even to admit to the existence of a new microcomputer.

Speculation had been rife concerning a successor to Sinclair's enormously successful ZX-81. Some stories have hinted at a microcomputer incorporating Sinclair's flat-screen TV, due to be released later this year. Another possibility is a business-orientated microcomputer.

The exact format of the new microcomputer is uncertain. Only Sinclair knows for sure and he is not talking.

Datron Micro Centre's "Triple-Vision" multi-screen microcomputer display system allows you to run up to 12 different monitors from a Sharp MZ-80K or MZ-80B. The monitors will display high- or low-resolution graphics and computer-generated sound. The system can be used to display scores during chess or other tounaments, or to provide other information during conferences and lectures. A lower-cost Multi-Vision unit provides video and audio output for up to 12 different monitors fitted with audio play-back facilities. Triple-Vision costs £79 plus VAT while Multi-Vision costs £39 plus VAT. Both systems are available from Sharp Dealers and from the Datron Micro Centre, 2 Abbeydale Road, Sheffield, S7 1FD. Telephone 0742-585490.

TUG launch

THE TANGERINE Users' Group has launched two additional software packages for the Microtan 65. Forth is another version of an advanced language while Columbia is a business-orientated word-processing package. Columbia can be used with the Epson printer range and includes facilities for mail shots, mail merge and word-wrap.

Other software releases include Galaxians and a multi-purpose record files package. More details from the Tangerine Users' Group, 16 Iddesleigh Road, Charminster, Bournemouth, Dorset, BH3 7JR. Telephone 0202-294393.

Tangerine move

TANGERINE Computer Systems Ltd has moved from its Forehill Works base in Ely. The company's new address is The Science Park, Milton Road, Cambridge, CB4 4BH. Telephone 0223-60422.

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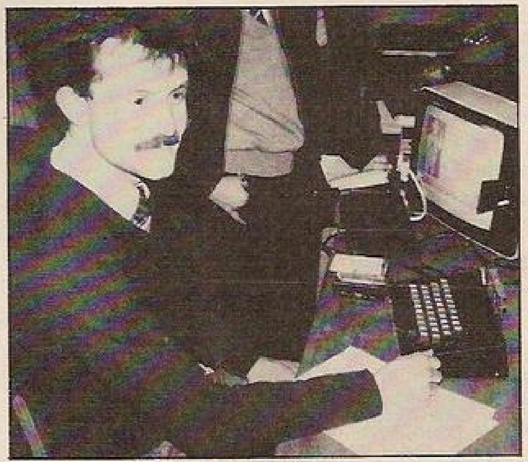
Computer Club is here to encourage you to start your own local computer club or, if one already exists, to join it and become involved. Each month we will devote the page to new ideas from local clubs. We would like to hear of anything which has made a club a success, or of any projects or programs you are developing.

Aylesbury's graphics made easy

Aylesbury's "gang of four" started meeting last August to talk about their Sinclairs. By January a fully-fledged computer club had formed with 30 people at their annual general meeting. Brendon Gore went to Aylesbury College, Buckinghamshire to find out how they were getting on.



"USING GRAPHICS on the ZX-81 is not difficult", in the opinion of Rod Clayton, chairman of the Aylesbury ZX Computer Club. "Even beginners can create quite sophisticated graphic displays using the Print At statement". Rod Clayton opened his talk on graphics for beginners by printing a character on a large TV screen hooked up to a ZX-81. A simple

FOR J = 1 TO 8 NEXT J

loop generated a row of eight characters on the screen. A comma and a semicolon were used to vary the positions of the printed characters.

Mobile display

A computer needs to know three things in order to print a character from one square to another. It needs to know the square to start printing the character, the square to stop printing the character and the direction in which the character will move. Given this information, it is relatively easy to write a program which will move a character across the screen. See listing 1.

If you input 0 for SX, 0 for SY, 21 for EX, 31 for EY, 1 for X MOVE and 1 for Y MOVE, the ZX-81 will print a line of stars diagonally across the screen, said Clayton. Making the Y MOVE input 0 will change the direction of the line to the horizontal, and changing the X MOVE input to 0 will result in a vertical line.

Converting the moving character display to an animated character display is quite simple, says Clayton. "All you have to do is print a character at one square, then blank it out, print the same character at the next square, blank it out and so on. This makes the character look as if it is moving".

For an animated graphics display add line 125 Print At Y,X:" " to the program. The space between the " " blanks out the * each time it is printed. But, says Clayton, you must remember to use the same number of spaces as there are characters in the program.

Finally, says Clayton, for a flicker-free display insert lines

123 FOR Z = 1 TO 10
124 NEXT Z.

This introduces a time delay into the program — the higher the second number in line 123, the longer the delay.

After the talk, club members were given the chance to put some of Clayton's ideas into practice. More advanced members joined the hardware and discussion groups or swapped notes on their latest programs. Younger members tended to play the available games software.

Specialist groups

The club's first annual general meeting was held in January this year with more than 30 people in attendance. The original "gang of four" were confirmed in their posts, Clayton as chairman, Nowotnik as secretary, Knight as treasurer and membership secretary and Cornhill as librarian.

The meeting set up three specialist groups: a beginners group for newcomers to microcomputers, a hardware group for electronics buffs and a machine code group for advanced programmers. George Avenell was selected as co-ordinator for the beginners' group, George Morgan was appointed head of the hardware group and Trevor Toms was put in charge of the machine code group.

The club also provides members with a monthly newsheet compiled by secretary David Nowotnik.

The club's subscription costs £5 a year for adults and £2.50 a year for under-17s and old-age pensioners. For further details send a SAE to Ken Knight, 22 Mount Street, Aylesbury, Buckinghamshire.

Listing 1.

```
MOVING CHARACTERS PROGRAM

1    REM "G"
30   INPUT SX              (STARTING X CO-ORDINATE)
40   INPUT SY              (STARTING Y CO-ORDINATE)
50   INPUT EX              (ENDING X CO-ORDINATE)
60   INPUT EY              (ENDING Y CO-ORDINATE)
70   INPUT X MOVE }        (DIRECTION OF MOVEMENT)
80   INPUT Y MOVE }
100  LET X=SX }            (SETS THE STARTING X,Y
110  LET Y=SY }             CO-ORDINATES)
120  PRINT AT Y,X; "*"     (PRINTS THE CHARACTER)
130  IF X=EX AND Y=EY THEN GOTO 1000 (IF THE END
                            SQUARE IS REACHED STOP)
140  LET X=X+X MOVE        (INCREMENT VALUES OF X
150  LET Y=Y+Y MOVE         AND Y)
160  GOTO 120
1000 STOP
```

Local society news

Gwent Amateur Computer Club

THIS CLUB, which caters for the South Wales area, meets regularly at St Mary's Church Hall, Stow Hill, Newport. For more information send a SAE to the club secretary Ian Hazel, 50 Ringwood Hill, Newport, Gwent, NPT 9EB.

Computer Users' Club

THE COMPUTER USERS' CLUB is designed mainly for BBC Micro users, but it will also benefit Video Genie/TRS-80 and Compucolor II users who wish to run BBC-based software and teletext/Prestel software. The club, which has been included in the BBC's referral scheme, provides a monthly printout of software ideas, programs and advice. Details of the club's activities are available from Tony Latham, 72 Sidmouth Road, Welling, Kent, DA16 1DS.

Cardiff Computer Club

A NEW ZX-81 users club has been formed in Cardiff. It aims to exchange information, help and advice between members. The club also hopes to build up a collection of original programs for members to borrow. Anyone interested in joining the club should contact M Hayes, 69 Morris Avenue, Llanishen, Cardiff, CF4 5JX.

As Sinclair sales head for half a million ZX software has become a lucrative market. New firms have sprung up to take advantage of the wider horizons offered by cheap 16K memories. John Deeson reviews the latest games and application programs for the Sinclair.

SURVEY ZX CA

As MORE and more companies enter the market, the quality of available material is rising fast and the prevailing trend seems to be towards applications software, as opposed to games. The second wave of programs from Sinclair Research has still not appeared, and when it is released it will be on to a market where software prices are falling slightly — £3 for a cassette of excellent material is not at all unusual.

The appearance of 16K memories for considerably less than the Sinclair price means that 1K owners, like their ZX-80 counterparts, will experience a dwindling service from the software suppliers. At the same time sales of memories greater than 16K are strengthening,

which will lead to formidable data-handling programs and adventure games which will soon no doubt benefit from colour and sound.

Our criteria for review are novelty, ease of use, clarity of instructions and neatness of graphics — in short, value for money.

Galaxy Invaders, from Bridge Software, is very good value at £3. It is a machine-code program, with Break blocked, which offers the usual ZX invaders game. There are 10 levels of play and your score is displayed with the highest and the previous score, and the number of bases remaining. The cassette is supplied with an adequate leaflet.

Serious ZX users will be pleased that a new version of Bridge Software's Multigraphics is available. It costs £4.50 but is even better than the original program praised in the January survey. It now has animation, paging, reveal and Save.

Steller Software's SAS Mission Impossible and Space Battle costs £4.95. SAS involves a randomly-generated embassy containing hostages to rescue, terrorists to kill and bombs to avoid. You have three minutes for your mission and you need it. You are armed with a load of grenades but each change of character position takes two seconds. Although this is a very slow Basic game like Space Battle it is more gripping despite the SAS's recruitment of the garden snail into its ranks. SAS is not easily beaten or crashed. It is original but not outstanding.

Abersoft's Basic adventure is over-priced at £10. This is text only and probably requires the usual million hours to untangle. It just fits into 16K and seems to be based on the classic Crowther Fortran version, with 140 locations to map and explore.

Michael Orwin's £5 Cassette Two is very good value. It contains 10 stolid well designed games which work, offer plenty of variety and choice, and are fun.

Improved quality

J K Greye has improved the quality of its 16K products. Games 2 contains the slow Basic Starfighter in which you shoot the enemy craft in your sights against the clock. It is slow and demanding on the arm muscles but presents a reasonable challenge. Pyramid is a nine-layer Tower of Hanoi implementation and Artist is even better than the beautiful 1K version.

Greye's Catacomb, Games 3, is described as a multi-level graphics adventure. The adventure approach is unexceptional and the graphics adequate. As one wanders through the catacomb one discovers more and more of the maze with its various attackers and rewards. The attacks are not under keyboard control so survival is a matter of luck. Each time you play, you are given a new layout.

Artic Computing, has three variations of adventure. Imaginatively called A, B and C, they are all neat, well-designed and fast-moving non-graphics adventures. Version A, at £7, puts the adventurer on an alien planet, and offers more than 100 commands.

Adventure B costs £9 and has auto-Run and, more important, the facility to Save at any stage. This time you have to rob an Inca temple.

In the £9 Adventure C, you are in space, escaping from an alien cruiser on a rather horrid mission. This is very like the others — text only, a good range of commands; and highly tormenting. It is a high-speed game because of its machine-code program, and its use of fast mode and Scroll.

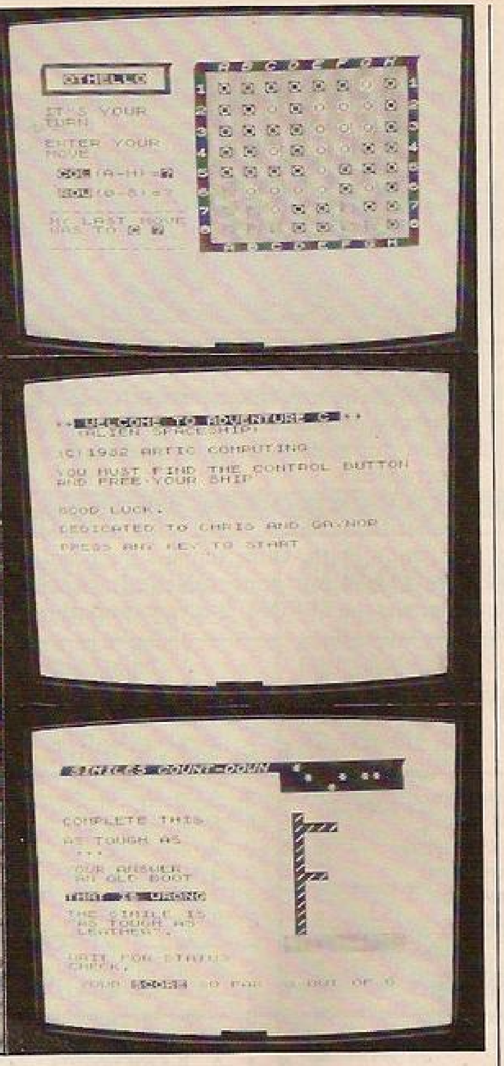
As the documentation warns, Artic's £3 Galaxy Warrior is at first rather difficult to control. It is a form of Star Trek, with galaxies to be searched through, stars to avoid and menacing Klingons. It is rather slow because it is mostly in Basic and is hard on the fingers. This is an appealing game with full scoring. Artic's Chess II — at £15 compared with £10 for version I — has seven skill levels, a best-move facility, save and copy, and a printout of the moves at the end. A version has been developed for the Quicksilva character board, overcoming the rather annoying use of alpha characters. It is easy enough to play, although the move-entry routines are rather confusing. ZX Chess II is fast, and plays well at all levels. The board display is enormous, leaving only just enough room for current and last moves. We could not make the move-recommend facility work, but otherwise found this game most impressive.

We had occasion to speak with some disdain in January about Can Of Worms, a cassette of "adult" 1K games whose source is now identified as Automata Cartography. At £3, Love And Death is another collection of disgusting programs. The target of this company's third cassette is God — the Bible costs £5 for 10 programmed blasphemies.

The games stakes

Cadsoft has also recently entered the 1K games stakes. Its Cassette AB is probably best value — £3 for 10 carefully-written programs. They include Coded Word-guess, Towers of Hanoi, Mastermind, Simon and Lander — the old standards, but none the worse for that.

Battle of Britain costs £4.95 and is one of the ZX-81 simulations from Microgame Simulations. The price includes an outline grid of South-East England which nine German



ASSETTES

bomber squadrons are approaching, and from which nine fighter patrols can be scrambled. This is a gripping text-only simulation. During the test, however only four British planes were downed compared with 74 German ones. Despite this patriotic bias, it is a useful simulation and a good game.

The same company's Asset Stripper and Kingdom of Nam are also very useful games for one player against the computer. They also cost £4.95 each and, although written in Basic, are adequately fast. Asset Stripper offers three levels: your task is to do as well as you can with a starting capital of £100,000. The program unfortunately crashes repeatedly with error 5 after a few pages. The simulation is well developed, however, and worthy of development.

The Mine of Information Othello, at £10, is recommended without reserve. It is a superb opponent, with nine skill levels, and is supplied in an attractive box with a superb accompanying booklet. Mine of Information offers a generous 30-day guarantee period if you have loading problems.

Video Software has released a tape called 1K Party Tricks. The game Shoot involves pressing a number key and hoping that the goal-keeper will not randomly stop the invisible penalty shot. Other programs include a good etch-a-sketch; a program to discover the day of a given date; and random weather forecasts. At £3.95 there is much to amuse your guests.

Significant lead

We assume that Micro-Gen's Amaze and Space Invaders are for use with the ZX-81 paddle; certainly, the keyboard does not operate with either. To market the first ZX paddle gives you a significant lead in a potentially large market, if you have good software.

A tape recorder for £18.50 from G J Henderson, 107 Mersey Road, E17, is sold with a cassette of poorly-recorded 1K games. The recorder is the Hong Kong-made Duette, which had the task of loading all the programs for this review and presented no problems at all. It is no better and no worse than the Waltham W-167, which is significantly cheaper, or the Sharp RD-620E, which is slightly dearer.

The three 1K programs are a neat Space Invaders using keys 8, 9 and 0 which is a nuisance; a think of a number game; and bingo.

Rose Cassettes, one of the longest-established and reliable suppliers of educational programs, has recently added to its range with Olmaths, a set of three formidable packages on different subjects. Each is menu-driven and authoritative. They are good value at £4.95, but lacking in sparkle.

AVC Software has significantly extended its range of full-graphics teaching programs. These products show the patience and novelty needed for software able to attract a rowdy class or a lone student. The Hangperson range for the nine- to 14-year-olds mentioned in January now has seven titles — two each in physics, biology and human biology for CSE or O level, and one in geography with 50 words and phrases on Britain.

Integral answers

As well as the original Tables, AVC's Countdown series now has first-year French vocabulary, a test on similies, and physics O-level problems. The problems and data are randomly generated each time but always have integral answers. All these programs cost £3.

The War Game costs £5 with a resource booklet and is an attempt to make the facts and feelings about nuclear weapons more real. Hiroshima data are analysed and the potential of modern bombs is explored interactively and graphically. It is not for the very young, who can stay with Atari's Missile Command — a horrifyingly realistic game.

Bridge Software has added a suite of versatile 1K statistics programs, with t and f tests, correlations, confidence limits, as well as the more usual mean/standard deviation. The main failing is the division into several programs, a fact of 1K life. A 16K package is, however, on the way and should be very good. The statistics program costs £3 with instructions; a very useful booklet costs another £2.

Parsons is a new company marketing index-driven Geography and Fun Learning, each offering six adequate programs. The map tests expect too much from ZX graphics. Among the others are rather weak hangman games on several themes and a vocabulary test.

Turner Consultants' two primary mathematics cassettes show a great deal of thoughtful hard work. They are fully bug-trapped, friendly and helpful. Primary level Division and Tables Test are £4.50 each.

In the miscellaneous section, 16K Art and Fun is a cassette of six index-driven programs from Parsons. The cassette has simple but adequate instructions and includes the pleasant, non-interactive Pattern maker as well as standard Sketches and Battleships. The £3 Madame ZX-81 from AVC Software is a relatively sophisticated astrologer, with outputs which include views of the client's zodiacal constellation and a randomly-accessed personality readout.

(continued on next page)

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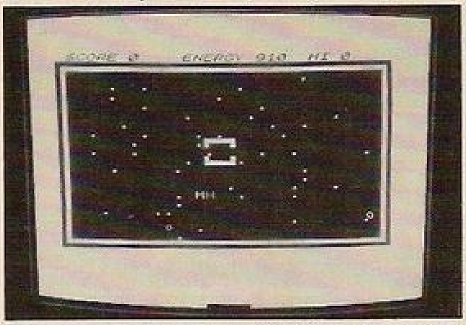
Artic Computing's impressive 4K ZX-Bug, a machine-code enterer/monitor, is very good value. A problem with such programs at the moment is their memory requirement. Artic has done well to minimise the size of this sophisticated product, but it is crashable and not as friendly as some would wish.

Picturesque also offers a machine-code monitor. Called ZXMC, this is a 2.5K product with a superb accompanying booklet. Picturesque has not, however, solved the problems of its duplication system — the copy sent was unloadable. If the program is as good as the booklet, it is first class. At £6.50, it could be very good value.

Resident routines

It is sad, too, that the Picturesque Screen Kit has the same barrier to cross. It costs £4.95, and consists of a set of resident machine-code routines which allow one to call on all kinds of glorious facilities. It, too, would not load. It features scroll in any of four directions to clear screen; instant clear screen or fill with any character; clear, border, invert



any rectangle from one space to whole screen; flashing cursor at any point; save and load at double speed.

We should see more in the future of firmware like Orme Electronics' Toolkit on ROM and Artic's Forth. Orme supplies the board, which is usable with printer and extra memory that carries the EPROM. It is very reasonably priced at £11.95, and gives a good range of routines, such as versatile Renumber and partial Delete, as well as a game of Life. Unfortunately, the board fitting is rather difficult when used with extra memory. One has to attach the whole board to a rigid sheet to prevent white-outs. The Toolkit occupies 2K.

Deluxe version

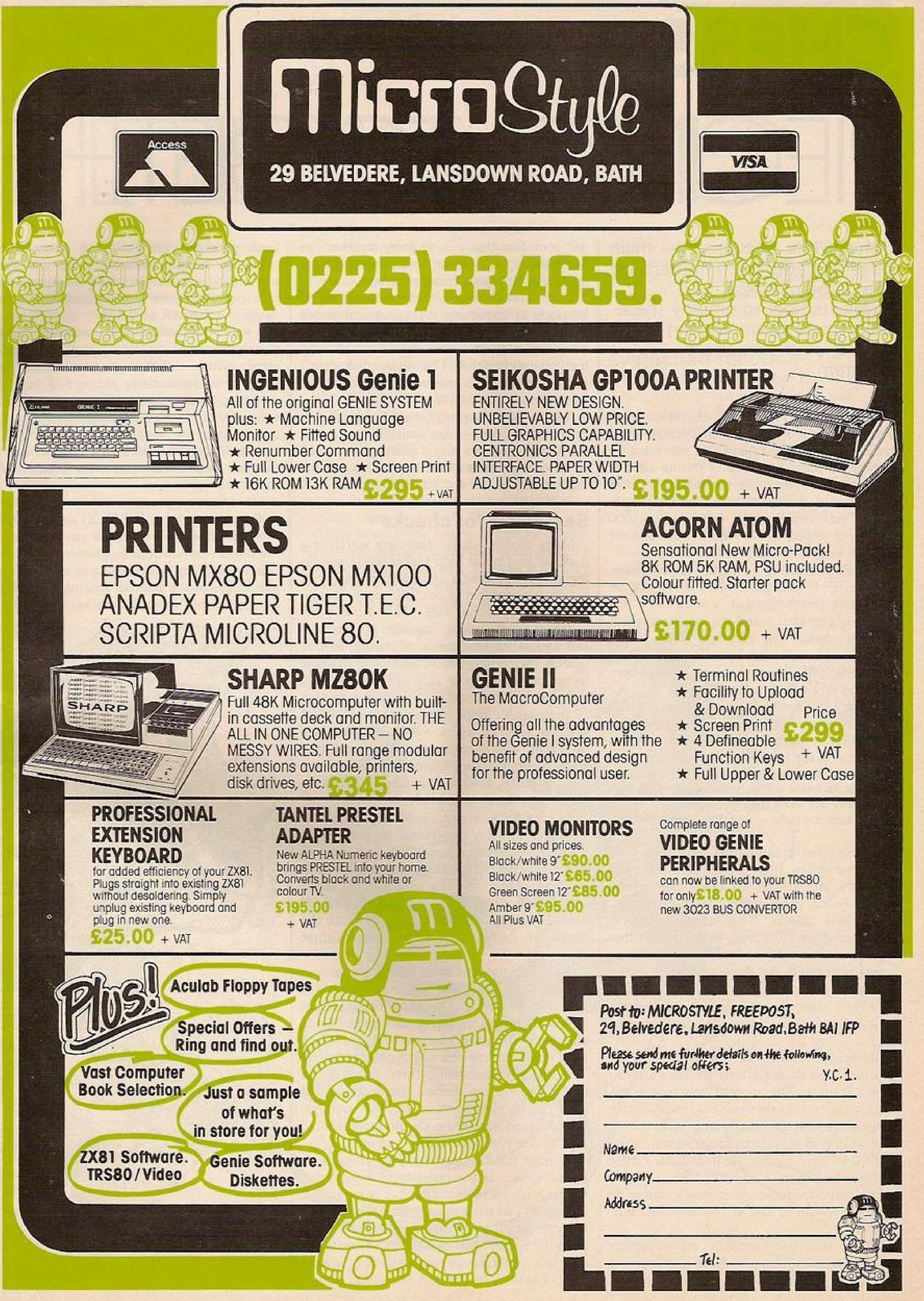
Video Software continues to extend its range of Basic utilities. As usual, each £7.95 cassette has a demonstration, a superb little book of notes and an audio-commentary. For £2 more you can buy the deluxe version in a smart box with spare cassette and planning charts. Video-Sketch lets you build up 12 pages of screen display, page through them as you wish, save, and amend them in use. It is very useful for teaching as well as for the shop window. Video-Ad is similar but offers a great choice in the rate and style of paging. Their main problem is slow creation speed. ■

Supplier	Program name	Description	A	B	C	D	E	F	G	H
			Assessment							
	Games									
2	1K Party Tricks	10 simple games	5	4	3	3	2	3	3	3
4	Galaxy Invaders*	Fast, 10 levels	3	5	5	5	4	4	5	2
5	Love and Death	Eight 1K crudities	3	5	2	2	—	3	2	5
5	The Bible	10 1K crudities	3	5	2	3	—	2	2	5
6	SAS Mission Impossible*	Embassy siege	3	5	2	3	3	2	3	4
7	Games 2*	Three games	3	5	3	3	4	3	4	3
7	Monstermaze*		3	0	—	—	—	—	—	—
7	Catacomb*	Adventure	2	5	4	4	4	4	4	3
8	Amaze*	Smash through	0	5	3	—	—	—	4	4
8	Space Invaders*	Standard	0	5	3	—	4	4	4	2
9	Cassette Two*	10 good games	3	5	4	4	4	4	4	4
10	Adventure*	Classical	2	5	2	2	5	4	—	1
11	Adventure A*	Adventure	3	5	2	4	4	5	—	2
11	Adventure B*	Adventure	3	5	2	4	4	5	—	2
11	Adventure C*	Adventure	3	5	2	4	4	5	—	2
11	Galaxy Warrior*	Star Trek	3	4	4	2	3	2	2	2
11	Chess II*	Good chess	3	5	3	3	5	5	4	3
12	Cassette AB	10 standard games	1	5	2	2	3	3	3	1
13	Battle of Britain*	Simulation	5	5	1	2	5	4	—	4
13	Asset Stripper*	Economy Simulation	4	5	1	3	4	3	—	4
13	Kingdom of Nam*	Social Simulation	4	5	4	3	4	3	—	1
14	Othello*	Powerful	5	0	2	4	5	5	4	3
	Education									
1	Olmaths*	Three programs	—	4	3	4	4	4	—	4
1	Family Quiz*	Three general programs	—	5	3	4	3	4	—	4
3	French Countdown*	Vocabulary test	—	5	5	3	3	3	4	5
3	Geography Hangperson*	British revision	—	5	5	5	4	4	5	5
3	The War Game*	Anti-nuclear	4	5	4	4	3	3	3	5
4	Statistics	Six 1K programs	5	5	2	2	3	3	—	2
15	Geography*	Map tests	2	5	3	3	3	3	4	4
15	Fun Learning*	Games	1	5	3	3	2	3	2	3
16	Division*	Drill and help	2	5	3	4	4	3	2	3
16	Tables Test*	Simple	2	5	4	3	3	4	—	3
	Miscellaneous									
2	Video-Sketch*	Economy Simulation	5	3	5	3	5	3	5	5
2	Video-Ad*	Economy Simulation	5	3	5	3	5	3	5	3
3	Madame ZX-81*	Economy Simulation	—	5	4	4	—	3	4	5
11	ZXbug*	Economy Simulation	3	5	2	4	4	5	—	2
15	Art and Fun*	Economy Simulation	2	5	3	3	3	4	3	4
17	ZXMC*	Economy Simulation	5	0	—	—	—	—	—	2
17	Screen Kit*	Economy Simulation	3	0	—	—	—	—	—	5
18	Toolkit — EPROM	Economy Simulation	3	—	—	3	3	3	—	5

Notes: **Supplier**: numbers refer to suppliers' list. **Program name**: asterisk shows 16K needed. **Assessment**: 0-5 scale: A, documentation; B, easy of loading; C, format, or screen layout; D, ease of use; E, functional value; F, programming quality; G, quality of graphics; H, novelty.

Suppliers and addresses

1. **Rose Cassettes** 148 Widney Lane, Solihull, West Midlands. Education, general.
2. **Video Software** Stone Lane, Kinver, Stourbridge, Worcestershire. Games, general.
3. **AVC Software** PO Box 415, Birmingham B17 0HD. Education, general.
4. **Bridge Software** 36 Fernwood, Marple Bridge, Stockport, Cheshire, Graphics, games, statistics.
5. **Automata** 65a Osborne Road, Portsmouth. Games.
6. **Stellar Software** 144 Pampisford Road, Purley, Surrey. Games.
7. **Greye** 16 Park Street, Bath, Avon. Games.
8. **Micro-Gen** 24 Agar Crescent, Bracknell, Berkshire. Games.
9. **Orwin** 26 Brownlow Road, London NW10. Games.
10. **Abersoft** 7 Maesafallen, Bow Street, Dyfed. Game.
11. **Artic Computing** 396 James Reckitt Avenue, Hull, Humberside. Games, general, utilities.
12. **Cadsoft** 24 St James Street, Cheltenham, Gloucestershire. Games.
13. **Microgame Simulations** 73 The Broadway, Grantchester, Cambridge. Simulations.
14. **Mine of Information** 1 Francis Avenue, St Albans, Hertfordshire. Game.
15. **Parsons** 23 Coxhill Gardens, River, Dover, Kent. Education, general.
16. **Turner Consultants** 3 Hillgarth Underbarrow, Kendal, Cumbria, Education.
17. **Picturesque** 6 Corkscrew Hill, West Wickham, Kent. Utilities.
18. **Orme Electronics** 2 Baripper Road, Camborne, Cornwall. Utilities on ROM.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CHESS

PIECING TOGETHER

John White discusses the main developments in computerising the game of chess, and suggests how to employ these techniques when you set about writing your first chess program.

SPEAKING IN 1949, the mathematician Shannon pointed out that an average chess game lasted 40 moves and that there are an average 30 move possibilities during each of those moves. There are, therefore, at least 10^{120} possible games of chess. To search these at the ridiculously high rate of 1,000,000 games per second would require a search time of 10^{108} years to exhaust all possibilities.

When constructing a program to play chess, it is certainly not possible to carry out an exhaustive search. Instead, a search of a few moves is considered and the position which arises is scored. The means of doing this is known as the evaluation function — EF — and the strength of a chess program depends very much on how effective the EF is.

Contary to popular belief, it is actually relatively easy to write a chess program. The real difficulty lies in constructing a program which meets the following requirements:

- Plays strong chess.
- Makes its move within a reasonable time — certainly not more than five minutes.
- Uses little memory — less than 32K at the outside.

Skilled chess programmers earn high fees, with good reason. It is generally true that good programs are written by highly-experienced machine-code programmers, rather than by good chess players. The mainframe world computer chess champion, Belle, was written by a non-chess player, and relies on brute strength to find its move rather than by making complicated positional assessments. However, some appreciation of good chess play is necessary to write a good program for a micro.

Before embarking on writing a chess program, you should clearly define what you expect from it. The amateur, working in his spare time, is unlikely to be able to produce a program capable of beating one written by a team of full-time, salaried professionals. Nor will the amateur have access to dedicated chess units for his program, and will have to rely on his domestic microcomputer which cannot be expected to run so fast as the dedicated unit would.

On the other hand, writing chess programs will give much pleasure and will also improve your programming skill. With practice, you will soon find that writing programs becomes much easier; you will not, for example, need to keep rewriting your move generator.

There are also many discoveries waiting to be made in improving evaluation and search procedures. Computer chess is essentially only 30 years old, and the alpha-beta pruning method only half that. The obvious "chopper" pruning mechanism entered commercial chess computers as late as 1981.

As a final inducement, I should mention that many of the chess games available on cassette for domestic micros play a feeble game which could easily be improved — think of the market for the Vic and the BBC Micro.

Searching for checks

Many modern chess computers search to a depth of four-ply at their higher levels, searching deeper for checks and captures. A ply of search is equivalent to one half move, that is, one move by either side. This dictates the choice of programming language. If a machine can choose its best move at one-ply in one second, then it will take 30 seconds to examine its opponent's reply to each of its moves, 900 seconds to examine its own responses to each of the possible opponent moves, and 27,000 seconds — 7.5 hours — to examine the opponent counter responses at the fourth ply. If the program takes 10 seconds to find its best one-ply move, than it will take 312 days to search to a depth of four-ply.

These figures assume a full search of the tree of moves which is constructed by considering all possible permutations of moves to a depth of four-ply. In fact, powerful pruning methods exist to reduce the size of the tree, and a program which can select its best one-ply move in one second can be made to search to a depth of four-ply in about two to three minutes.

To reduce the time spent selecting a move at one ply to 10 seconds or less, machine code or assembly is essential. Out of curiosity, I wrote two chess programs, one in interpreted Basic and one in compiled Fortran, to see how long they would take to run with a one-ply search. The Basic version took three minutes per move, the Fortran version five seconds, and both played ghastly chess due to a minimal EF. A good machine-code program should find its one-ply move within one second.

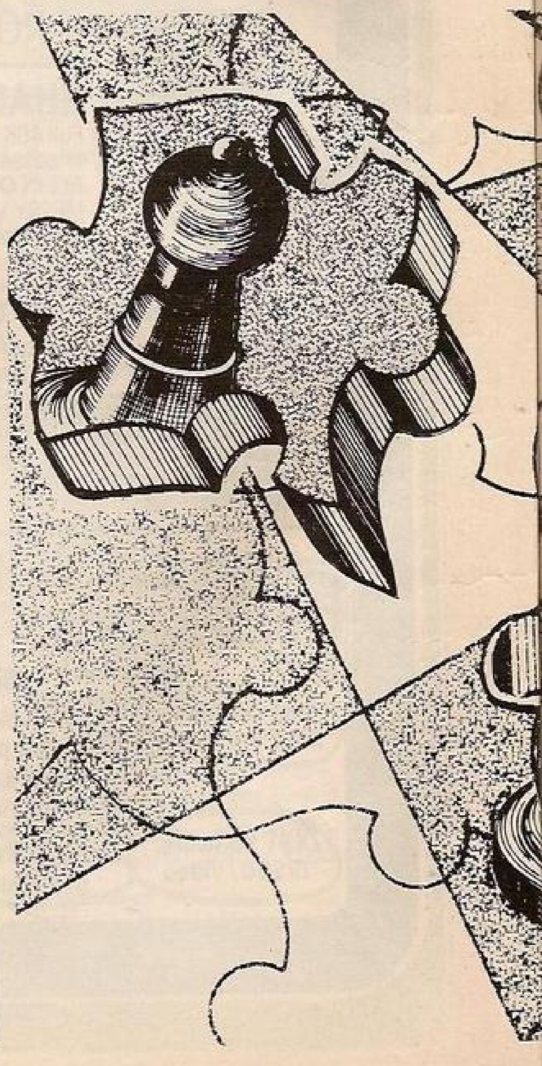
Another good reason for programming in machine code is the inability of many other languages, including Basic, to perform recursion. I do not know any way of enabling a Basic program to call itself more than once, since the Return statement bears no label. It is desirable to use, say, a move generator at each level of search, rather than to have to write a fresh generator for each and every level.

Finally, machine-code programs are more economical on space than other languages, and it is possible to write a reasonable program using less than 4K of RAM.

A variety of methods may be used to set up the chessboard. Simplest is a two-dimensional array, where different positive values are assigned to the machine pieces, and negative values to the opponent's. The values may be equated with the nominal value of a piece, so a queen could be assigned a value of 90, a bishop 32 and a knight 29. Loss of the king is fatal, so these are assigned very high values, say, about 5,000.

All moves to a position will then be subject to the constraint that X * (9−X) and Y * (9−Y) — where X and Y are the new co-ordinates on the board — must both be greater than zero.

It is common practice to put the 0th and ninth lines of the array to a number which is distinguishable from the pieces. This marks



THE BEST MOVES

the rim of the board and saves checking whether a project move has gone off the board.

Picture a rook moving down a file. It can either feel its way down cautiously or it can thunder down until it bounces off the rim. A second rim can also be added to check the legality of knight moves, which may hop over the first rim. Remember that the rim may have to change sign, in some implementations, according to which side is moving.

Separate table

It is also possible to devise chessboards in a one-dimensional array and even to use two two-dimensional arrays, so that all the pieces will appear to be moving in the same direction.

The position of major pieces can additionally be kept in a separate piece table, and this enables attacks on enemy pieces to be found very quickly. This method is used by all the major chess manufacturers.

The move generator simply calculates all the moves for the chess men. A queen is composed of a rook and a bishop. The generator can be written very easily, but remember to test for move legality. A piece can move on to a vacant square, on to an enemy-occupied square but not on to a friendly-occupied square. A piece cannot move through another piece, unless it is a knight.

En passant is also reasonably easy to cater for. A flag is set whenever a pawn makes a move enabling *en passant* by the opponent. Much more difficult is castling where the castling rook must not have been moved, the king must not have been moved, the king must not be in check and the king must not pass through check or settle in check.

A test to see if the king is in check is, therefore, essential and this can also be used to give priority to king protection. The test is done by making legal rook, bishop, pawn and knight moves away from the king, and testing to see whether the appropriate enemy piece is encountered. Testing to see if the moving piece is giving check is inadequate, since it may miss a discovered check. Incidentally, do not forget to allow for the possibility of double check.

Evaluation function

Two methods are available for working out which move a computer should make. The first is the EF, which assesses and scores a position arising after a piece has been moved. The second is the look ahead — search in depth — which considers responses to machine moves, counter responses, counter-counter responses and so on.

There is considerable debate in computing circles as to whether a chess program should use a sophisticated EF combined with a shallow search — but searching some forcing lines such as captures in greater depth — or

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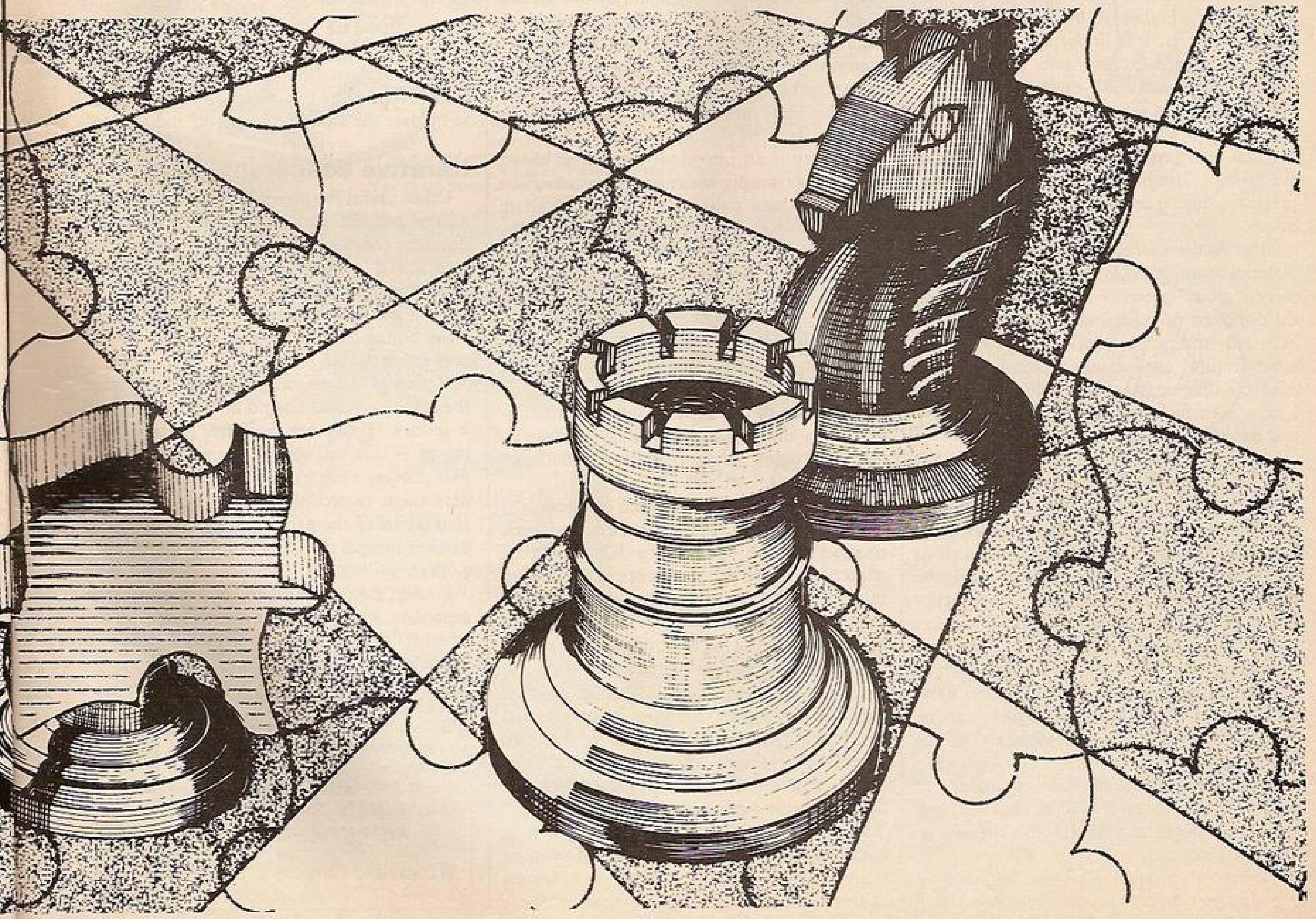

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should use a minimal EF with as deep a search as possible. Bearing in mind that the EF is called after every potential move, it must be kept as short — that is, as fast — as possible, particularly for a deep search, and will rarely contain more than 20 elements.

Devotees of the first method point out that a detailed search of only part of the tree, selected by a sophisticated EF, most closely mimics human chess play. David Levy is a believer in this approach, and his company's Philidor program uses special, still secret methods to attain a strong EF capable of considering even strategic factors. Another example is the German Shach computer which plays a respectable game with a look ahead of only one move, but with a very powerful EF.

Adherents of the second approach observe that programmers should concentrate on the computer's greatest strength — its ability to calculate rapidly. The Belle program makes its moves by calculation deep into the chess tree. It is also common to give great consideration to the EF at the first and second ply, but to reduce the EF at all subsequent levels, so as to spend less time searching.

Search routines

By convention, the score from an EF is taken as positive if favourable for the program, negative if unfavourable. An essential feature of any good EF is an evaluation of the number and quality of pieces bearing on any square, particularly in the centre. This is done as described for the search for check on the king, and the same routine can be used for both purposes. However, it is important to remember that for square control one piece hidden behind another may still exert an effect.

For example, a queen on the same diagonal as a bishop — with no intervening piece — will exert its own pressure on the same squares as the bishop. The bishop will exert the greater pressure, since it is more expendable than the queen.

Other features worth including in the EF are material count, attacks on king, queen or lesser pieces, pins, presence of doubled pawns, development of pieces, whether castling has occurred and advancement of pawns. Yet other features can be added, limited only by available time or imagination. Some examples I have seen include fianchettoing the bishop and doubling rooks along a file or row.

So far we have been considering only the evaluation of positions. An alternative method is to evaluate each move as it is made. This is significantly faster than evaluating positions, but unfortunately gives weaker results. It is not suited to chess programs, but could be used for draughts or other games where tactics are more important than strategy.

The ability to search moves in depth is a subject which would require as much space as all the rest of this article put together. Basic principles, with excellent examples, can be found in the references given at the end of this article.

Numerous techniques are available to reduce the size of the tree to be searched, and you should acquaint yourself with the following:

- Minimax is the name given to a full search of every permutation of moves, i.e., the whole tree, where the opponent tries to minimise the machine's score while the program tries to maximise it. This is the slowest type of search.
- Alpha-beta search is a method of pruning which gives the same result as minimax but in less time. The principle is that if any one response to a program move can be found that makes the move weaker than one previously considered, then the program need not waste time calculating other responses to that move.
- Hard pruning can be effected simply by eliminating all potential moves which fail to achieve a certain minimum score.
- Razoring makes use of the assumption that the opponent can always find a move that will make things better for him than if he had made no move.
- Chopper: sometimes the program has only one legal move. This can be made at once without need to calculate all the possible responses and counter responses.
- Killer heuristic makes use of the assumption that any response which cuts off part of the tree with alpha-beta pruning will also cut off another part at the same level.

The efficiency of many of these pruning methods, especially alpha-beta, can be greatly increased by sorting the moves into decreasing score order. This must not be done too often, or the time spent sorting exceeds the time saved, but can be very effective if carried out after each ply of search.

This leads us to iterative deepening which is used on virtually all the better chess machines now. All the moves are found at the first level. These are sorted into score order and searched to the second ply. These are sorted and searched to third ply and so on. By this means, the best move yet found is always available at each level of search, and this is normally constantly displayed. If a timer is employed, the thinking can be interrupted at any time and the best move becomes the machine's choice.

Mobility is an important concept in chess, and is most simply obtained by summing the number of legal moves made by the program and by the calculated responses to each of its moves. Pruning must not be carried out at the first and second ply or this method will not work.

Normal pruning

Mobility may also be assessed in a sufficiently sophisticated EF — for example, by modification of the square control routines — but slows the program noticeably. However, normal pruning is now permitted, which may compensate.

When the total material count of pieces falls below a minimum level, then extra end-game routines can be called. The EF should be adapted to make the king more active and to make the advance of pawns — especially as chains — more favourable. The depth of search can also be safety increased since less material is available to be moved.

As a guide, the powerful Morphy program enters its end-game routines when material equivalent to two kings, two rooks, two knights and seven pawns remains on the board, and the depth of search is roughly doubled at the higher levels.

Book openings are very useful for games of chess, enabling the program to avoid opening traps and permitting some non-obvious strategic moves to be made. For example, the black move C7-C5 is thematic in many queen's pawn openings, yet I know of no program which does this early in the game except as part of a book opening.

The only limit on the book is that of memory space, which is unlikely to trouble most owners of micros. The book should be held in an array, matched against move number, and not as part of an opening tree which will take a long time to search.

Random selection between moves of nearly equal merit is a very useful feature, making all games different, and is most simply done by adding a small random number in the EF to the score from each evaluation.

Counter moves

After completing its search, the program will come up with a series of moves and a series of counter moves. These can be stored, which is very expensive on memory but will enable the program — on request — to reject the best move in favour of the next best and so on. This facility is available on several of the programs from the software company Philidor, such as Pet Chess, Intelligent Chess and Chess Champion Mk V.

More commonly, the scores are compared with a store which is initially set at minus infinity, say, −10,000. If the score exceeds the store, the store level is set to the score and the moves creating the score are also stored. Thus the store is constantly upgraded until only the best move remains in the move storage area. For opponent responses, a second store is preset to plus infinity — say, +10,000 — and scores that are less than the store are exchanged with the score until the lowest-scoring, and so best, opponent response is stored. The same two stores can also be used to operate the alpha-beta pruning mechanism.

Iterative deepening

Other useful features which can be added to a chess program include the ability to set up a position, use of real-time clocks to record play length and a move counter. For programs using iterative deepening, the clocks can be used to interrupt the machine's thinking, and a halt button can also be made available for the user for the same purpose.

A prompt button can be used to reveal what the machine thinks should be your move, and a restore button can be used to take back moves — this will require memory storage of past moves. Printers can be interfaced for a permanent record, which may be had at the conclusion of the game on request, or as the game is played; the latter requires no memory storage.

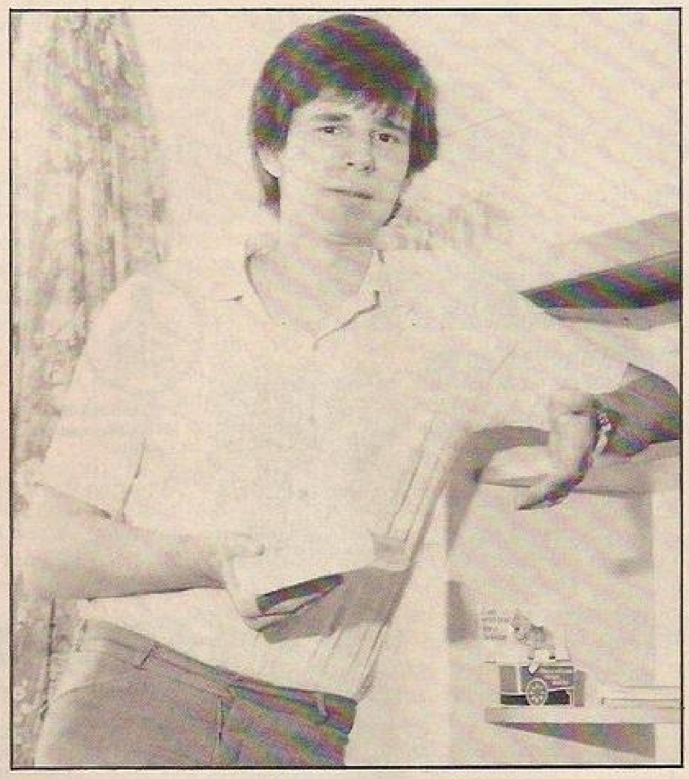
Finally, do not forget to couple your move generator with a routine which tests to see whether the opponent's proposed input is legal.

REFERENCES

- The following are essential reading for anyone writing a chess program:
- *Sargon — a computer chess program,* D and K Spracklen, Hayden.
- *Advances in Computer Chess* pages 89 to 97, J A Birmingham and P Kent, Pergamon Press.
- *Chess and Computers,* D Levy, Batsford.

Few face Richard Turner's choice of managing a thriving software firm or completing a degree. Brendon Gore finds out how this ex-champion hammer thrower runs Artic without stepping out of the university circle.

INTERVIEW
ONE DEGREE



RICHARD TURNER'S entry into the world of microcomputers was sheer accident, he says. Both he and fellow Artic director Chris Thornton went to Malet Lambert high school in Hull. In 1979 the school put on a computer course, using a time-sharing scheme on a big Honeywell computer. Chris Thornton signed up for the scheme almost immediately, but initially Richard Turner was not that keen.

"I did not want to go on the course because it meant missing a free lesson during the sixth form", says Turner. "But everyone else seemed to be signing up for the course so I thought I might as well hop on. Two weeks after the course started I was hooked".

This new-found interest in computers did not stop Richard Turner from picking up four A levels, mathematics, physics, chemistry and general studies, but it did persuade his parents to buy him a ZX-80 microcomputer for his 18th birthday.

Middlesbrough-based Linsac, one of the first ZX-80 software houses, was looking for programs to market. Richard Turner sent in a sample program which was accepted.

Richard Turner's partner in programming, Chris Thornton, also had a few months free before starting a degree in computer science at Hull University. Together they began writing programs for Linsac.

"We started writing programs in Basic, but Chris soon moved on to machine code. We didn't have a clue what machine code was about at first, but we got hold of a program from one of the computer magazines and managed to pick out a few of the instructions. This was not too successful so eventually we decided to buy a book on the subject. We got the whole set of instructions from it and started writing machine code".

The pair continued to write programs for Linsac, but found they had less time once their holidays ended. Richard Turner moved to Chelmsford for the first three months of his industrial year with Fords.

In January, 1980, Richard Turner and Chris Thornton decided to form a partnership and go into business for themselves. Artic Computing was born.

"The name comes from an anagram of the initials of our names", explains Richard Turner. "We thought of various different names, most of them terrible, but we settled for Artic. We had not even thought of the articulated lorry, but it became our logo".

For the first six months times were hard — the company made £21. With comparatively heavy spending on advertising, Artic found itself in debt. However the launch of ZXChess proved to be the turning point.

'I knew I would never go back if I took a year off'

ZXChess was extremely popular, partly because it was the first chess program for the ZX-81 to hit the market. It was also extremely difficult to write, taking over a year from the original idea to the finished product.

Looking back at Artic's formative months, Richard Turner says that their biggest mistake lay in selling programs too cheaply. "There's a snob element in the ZX-81 market. If you sell programs too cheaply they do not sell. I tested this out with one program called Zombies which we were selling in a pack of four programs for £2. I took the Zombies program out of the pack and sold it on its own for £3.50. Sales immediately took off, which is the reverse of most theories".

During this period Richard Turner moved to the Fords assembly plant at Dagenham, writing Adventure games in his spare time. He finished the control and subsidiary systems for the games while completing his year's industrial training at Enfield.

Originally, Richard Turner had intended to study at Liverpool University as part of his sponsorship deal with Fords. He now decided to switch to Imperial College, London.

Richard Turner is the first to admit that combining a university degree with running a business is not easy. He was offered a year's leave of absence from university to concentrate on running Artic, but turned it down. "I knew I would never go back if I took a year off".

The crunch will come in June with the first-year exams. If he fails he will probably work full-time on Artic, but he thinks he has done enough to pass.

Artic is currently producing 12 different games programs for the ZX-81. The best sellers, says Richard Turner, are ZXChess I and II, Adventure A, B and C, and Galaxians. "ZXChess is our biggest seller on the mail order side, but we have probably sold more Galaxians because we have just had a big order for 2,500 Galaxians cassettes from W H Smith".

The Galaxians program was written for Artic by William Wray, a Hull schoolboy who is currently doing his O levels at Cottingham grammar school. William Wray first visited Artic with a view to buying some of their programs, but he and Richard Turner started talking and William Wray ended up sending in one of his own programs. With a little help from Artic, Wray's Galaxians program was polished up and marketed under the Artic label.

The order from W H Smith resulted from the ZX Microfair in January. "I saw John Rowland, Smith's market development manager, at the ZX Microfair and told him 'This is a brilliant program, come and have a look'. He came over and his kids started playing it. That always works".

The Galaxians cassettes were only delivered to W H Smith on March 1, so it is still too early to say how well they are selling. But Turner is confident the Galaxians game will be successful and hopes to secure a big repeat order from W H Smith soon.

Artic's biggest problem has been the quality of its cassettes, says Richard Turner, though he is quick to emphasise that there is nothing wrong with their quality now. Initially, when orders were limited to two or three a week, Artic produced all its own cassettes.

A new tape recorder solved some of the problems, but the C10 cassettes supplied by local retailers were still very poor quality. Artic tried two different suppliers, both of whom produced good cassettes at first, but the quality soon faded.

A number of cassettes were returned by dissatisfied customers. At one point Artic was forced to replace 250 ZXChess cassettes because they were unusable. But, as Richard Turner points out, Artic did replace all the faulty cassettes even though it was a relatively expensive operation. In addition, Artic sent letters to all its customers who bought faulty ZXChess cassettes apologising for any inconvenience caused.

Cassette quality is no longer a problem. Artic found another supplier, Work Force of Luton, who produce consistently good-quality cassettes.

IN ARTIC

"I am also trying a little experiment with a tape-duplicating company which is producing the Galaxians and ZXChess programs for us", says Richard Turner. "The company seems very professional and I hope it will take tape production out of our hands".

Another potential problem, which affects Artic and all other software houses, is the vexed question of copyright. "It is a big problem", says Richard Turner. "You have to watch out for other companies trying to rip off your software. We try and protect our programs by making them self-executing, in machine code, so that no one else can break into them. But with a little bit of know-how you could just rewrite the load routine and fix it so that you could copy the program. One of the programs that we sell can actually be used to break into the rest of our programs".

'We would like to build a cheap computer'

No one has tried a software case in court yet, mainly because it would be extremely expensive, explains Richard Turner. Everyone is waiting for the test case.

Artic has not caught anyone trying to sell their software, yet, though a number of people have copied it successfully: "Most people are so pleased when they do manage to copy our programs that they write and tell us. We just warn them not to sell it".

One possibility which Artic has discussed with some of the other ZX software suppliers is forming a ZX-81 software-house user group to clamp down on any unscrupulous firms which infringe copyright. "If we found any cases of copyright infringement we could approach the computing magazines and threaten to withdraw our advertising unless they agreed to stop carrying advertisements from the offending company", says Turner.

Copyright is important because computer software is a lucrative business. Artic is not showing any mammoth profits on the balance sheet yet, because all the profits are being ploughed back into the company in the form of reinvestment, equipment and stock. Nevertheless, with Artic taking in about £300 an day in mail orders alone, the company is not doing badly.

The scope for profit will be even bigger when Artic starts marketing software for other microcomputers apart from the ZX-81. "At the moment all our machine-code programs are written on a Video Genie and converted to the ZX-81. In theory we could sell TRS-80 and Video Genie software as well.

"We are planning to move on to the BBC Microcomputer, if we can get hold of one. We are meant to be quite high on the list, but have still not seen any sign of one. If we do start writing programs for the BBC machine, which has a 6502 processor, there is no reason why we should not write programs for all the other 6502-based machines such as the Vic-20".

Artic is currently working on a Forth compiler on EPROM and hopes to bring out a prototype by the end of March. This will have a number of advantages for ZX-81 users, as Forth is 10 times faster than Basic as well as being a structured language. Turner hopes to produce a compiler that users will be able to plug into the back of their ZX-81s without taking out the ROM.

In addition, Artic is developing a board to link two 16K RAM packs together to give a total of 32K RAM. The idea behind the board is to help people with a 16K RAM pack who want to expand their ZX-81 to 32K RAM, explains Turner. At present those people have to buy a new 32K RAM pack and throw away the 16K pack. This board will enable them to keep the original 16K pack. To obtain 32K RAM they simply buy another 16K pack, which is cheaper than buying a new 32K RAM.

Looking a little further ahead, Richard Turner forecasts that Artic will remain essentially a software house. "We will obviously be moving on to better machines", he says. "Eventually we would like to build a cheap computer, but I do not know whether we will ever find enough capital".

Lest you think Richard Turner is some kind of ice-cool whizz kid with electrons coursing through his veins, it is worth recounting a story from his schooldays. At senior school in Hull Richard Turner was the county hammer champion. He competed in the English Schools Athletics Championships twice, but never finished higher than 13th despite being a potential medal winner. "The big occasion cracked me up", says Turner. "I could not throw properly because I was so nervous".

It is somehow refreshing to know that Artic's chairman can suffer from nerves. For all his machine-like competence, Richard Turner is human. ■

INTERPRETING AERIAL

The meaningless tiny dots that buildings and landmarks become when seen from the air can be given precise proportions with Michael Banks' program in Basic.

IF PHOTOGRAPHY is one of your hobbies, you may have tried your hand at taking aerial photographs, or perhaps you have attempted some shots from the observation deck of a tall building or some other high vantage point. If so, you will probably have wondered just how high you were when the photograph was made, or the size of objects on the ground in the picture.

This program gives you the answer to either of these problems, provided of course, you already know one of the variables. The program is written for the Acorn Atom. It makes use of the formula

$$H = \frac{OF}{I}$$

where H is the altitude of the camera when the photograph was taken; O the length of a known object on the ground; I the size of the known object as measured on the negative, and F, the focal length of the camera used.

All measurements should be in metric units. The focal length of most cameras is given in millimetres and so it is easier to measure the relatively small size of images on a negative in millimetres rather than in inches. Always measure images on the negative because you can never know exactly what proportion a print is of the original.

I originally designed this program for use with the Astrocam, a camera made to be carried by model rocket and designed by Estes Industries of Penrose, Colorado. I have found it to be invaluable for interpreting data quickly from the large numbers of aerial pictures I take.

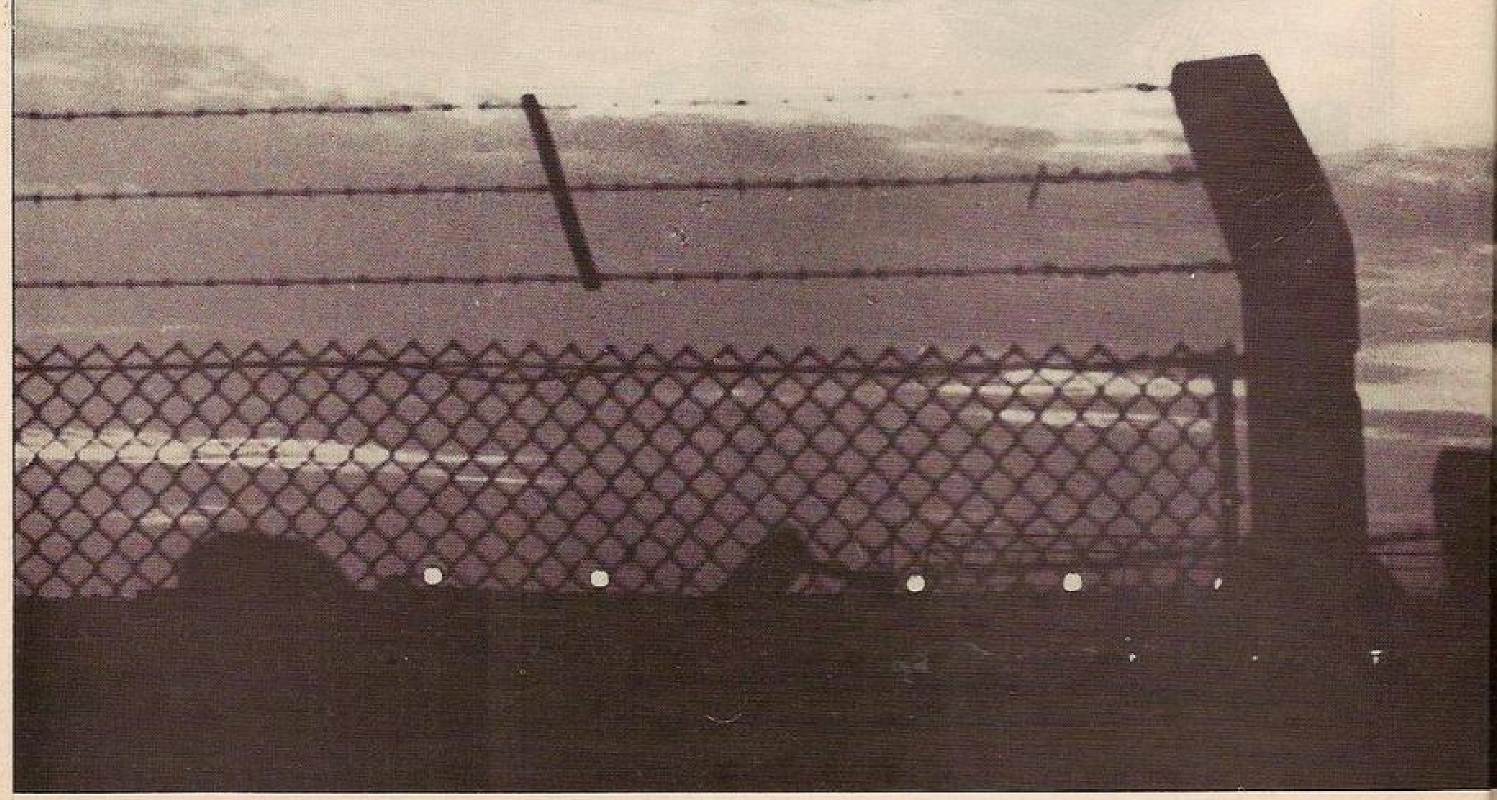
Since I use the program only with photographs made with the Astrocam, I substitute the 30mm. focal length of the Astrocam for F in lines 120 and 220. You can do the same, using the focal length of your own camera. If you wish to make this modification, be sure to delete lines 110, 210 and 211.

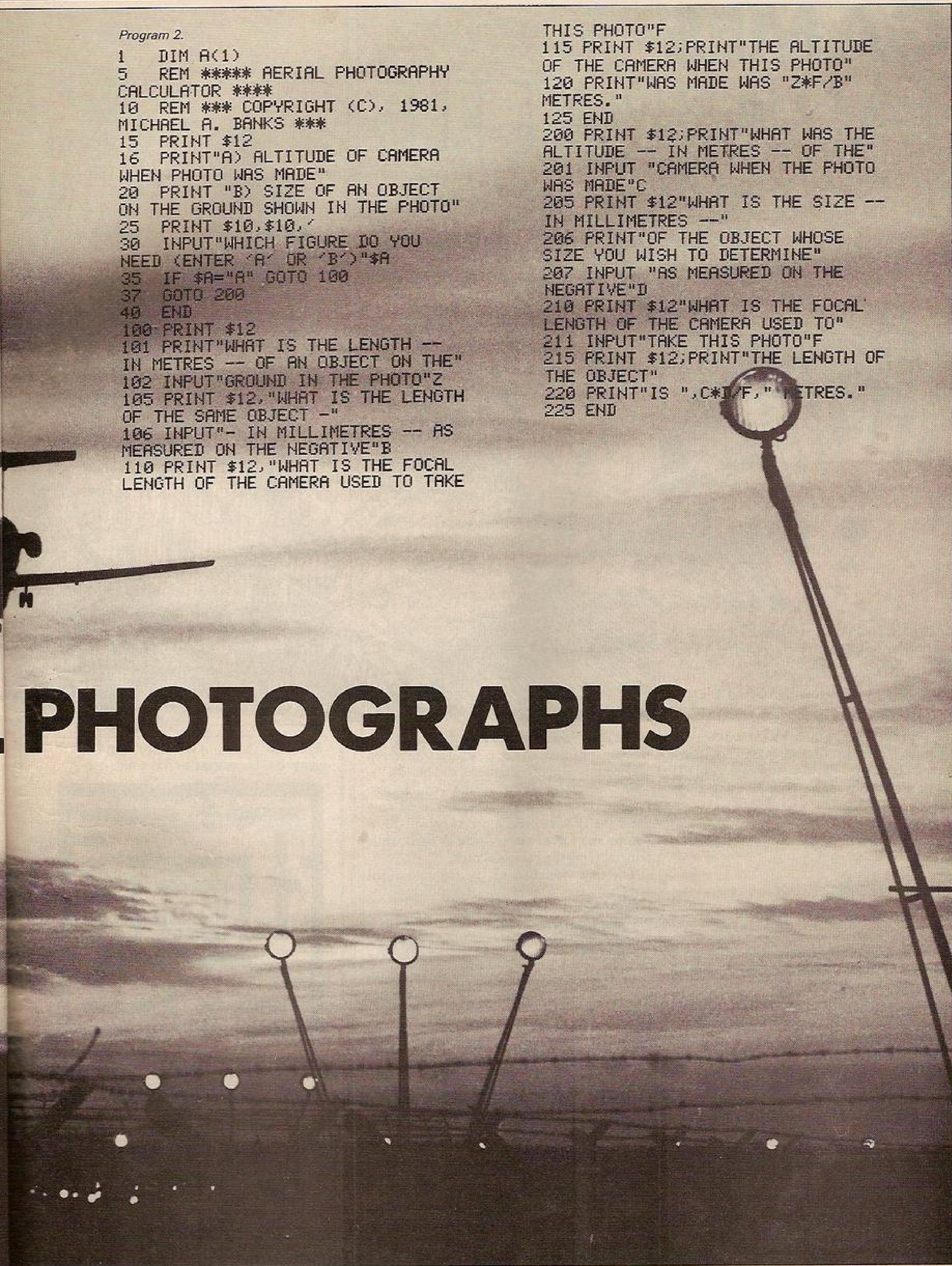
The program can be used to interpret data from standard horizontal shots, as well as from high-altitude ones. To use this program for horizontal photographs, substitute the distance to an object for the altitude when the program requests it.

If you are a stickler for detail and want the computer to address you properly when requesting information, make the changes given in program 1.

Program 1.

```
16  PRINT"A) DISTANCE OF CAMERA
FROM AN OBJECT IN THE PHOTO"'
20  PRINT"B) SIZE OF AN OBJECT IN
THE PHOTO"'
101 INPUT"WHAT IS THE LENGTH OR
HEIGHT OF AN OBJECT SHOWN IN THE
PHOTO"Z
105 PRINT $10;PRINT"WHAT IS THE
SIZE OF THE SAME"
106 PRINT "OBJECT -- IN
MILLIMETRES -- AS MEASURED"
107 INPUT "ON THE NEGATIVE"B
115 PRINT $12;PRINT"THE DISTANCE
OF THE CAMERA FROM THE"
120 PRINT"OBJECT WAS "Z*F/B"
METRES."'
200 PRINT $12
201 INPUT"WHAT WAS THE DISTANCE
FROM THE OBJECT TO THE CAMERA"C
215 PRINT $12;PRINT"THE SIZE OF
THE OBJECT"
```





Program 2.

```
1   DIM A(1)
5   REM ***** AERIAL PHOTOGRAPHY
CALCULATOR ****
10  REM *** COPYRIGHT (C), 1981,
MICHAEL A. BANKS ***
15  PRINT $12
16  PRINT"A) ALTITUDE OF CAMERA
WHEN PHOTO WAS MADE"
20  PRINT "B) SIZE OF AN OBJECT
ON THE GROUND SHOWN IN THE PHOTO"
25  PRINT $10,$10,'
30  INPUT"WHICH FIGURE DO YOU
NEED (ENTER 'A' OR 'B')"$A
35  IF $A="A" GOTO 100
37  GOTO 200
40  END
100 PRINT $12
101 PRINT"WHAT IS THE LENGTH --
IN METRES -- OF AN OBJECT ON THE"
102 INPUT"GROUND IN THE PHOTO"Z
105 PRINT $12,"WHAT IS THE LENGTH
OF THE SAME OBJECT -"
106 INPUT"- IN MILLIMETRES -- AS
MEASURED ON THE NEGATIVE"B
110 PRINT $12,"WHAT IS THE FOCAL
LENGTH OF THE CAMERA USED TO TAKE
THIS PHOTO"F
115 PRINT $12;PRINT"THE ALTITUDE
OF THE CAMERA WHEN THIS PHOTO"
120 PRINT"WAS MADE WAS "Z*F/B"
METRES."
125 END
200 PRINT $12;PRINT"WHAT WAS THE
ALTITUDE -- IN METRES -- OF THE"
201 INPUT "CAMERA WHEN THE PHOTO
WAS MADE"C
205 PRINT $12"WHAT IS THE SIZE --
IN MILLIMETRES --"
206 PRINT"OF THE OBJECT WHOSE
SIZE YOU WISH TO DETERMINE"
207 INPUT "AS MEASURED ON THE
NEGATIVE"D
210 PRINT $12"WHAT IS THE FOCAL
LENGTH OF THE CAMERA USED TO"
211 INPUT"TAKE THIS PHOTO"F
215 PRINT $12;PRINT"THE LENGTH OF
THE OBJECT"
220 PRINT"IS ",C*D/F," METRES."
225 END
```

PHOTOGRAPHS

GAMES
TANK BATTLE

David Prosser's Tank Battle is a game of skill and dexterity. The aim is to destroy your opponent's tank, before he destroys yours.

TANK BATTLE runs on a Vic-20 without any additional memory. It is a two-player game whose object is to destroy your opponent. To do this you may move around using these keys:

```
Left:
  E
S   D '3' to fire
  X
Right:
  @
:   ; '—' to fire
  /
```

As the game progresses, you will notice little green dots on the screen. Beware, these are mines. A shell fired from a tank will not affect them but if a tank should drive over one, it will explode. When this happens the second player's score is increased by one.

The second way to win, by destroying your opponent, involves driving your tank frantically around the maze. Once you press the fire button, a shell which is different for each tank will be fired in the last direction you moved. If this shell hits the wall of the maze, then you are allowed to fire again as your shell vanishes. You cannot, therefore, fire again while one of your own shells is in progress.

There are two versions of this game. Game B is the one I have just described; in game A every time either of the fire buttons are pressed, a block is plotted on the screen at a random position. After a while the screen may become full of both mines and blocks.

So, to restart the game while also remembering the scores, the user need only press the f1 key. Pressing the key will allow you to swap from either game A or B while remembering the present scores.

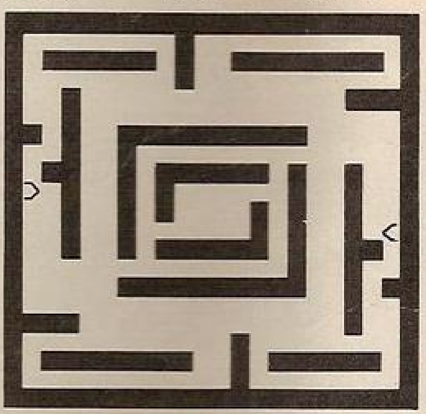
The time, which is on the top line of the screen, is the time it takes for either of the tanks to be destroyed.

When run, the program will produce a maze like the one shown in figure 1, assuming the same data is used. The > sign is the left player's tank and the < sign is the right player's tank. The score is printed at the top and in the middle, the time.

After each game, the bottom line of the maze will be replaced by the winner's name and the second line down will carry the question "Another go (Y/N)".

Figure 1

LEFT Ø　　0045　　RIGHT Ø



002:	this line sets the screen colour for the rest of the program which is a red border and red screen.
004:	here any key previously remembered in a Get statement is reset. As well as this, lines 4 and 5 produce coloured blocks at the top and bottom of the screen.
005 to 010:	this outputs the title page. Notice that in lines 6 and 8 there are 13 spaces after the Reverse On command.
011:	this sets the variables. S0, S2 and V are all to do with the sound controls on the Vic. S0 and S2 are the two sound-box locations and V is the volume control.
015:	notice that there is no need for semicolons in this line.
016:	to obtain this graphics symbol, hold down the Commodore key and press Y.

```
0 REM   D.PROSSER
1 REM SHELDON HEATH
2 POKE36879,42
4 POKE198,0:PRINT"■■":FORA=0TO21:POKE7680+A,160:POKE38400+A,(AAND7):POKE8164+A,
160
5 POKE38884+A,(AAND7):NEXT
6 PRINT"■■■    ■                 ":PRINT"    ■ TANK BATTLE ":PRINT"    ■
 "
7 PRINT"    ■     FOR      ":PRINT"    ■                  ":PRINT"    ■ V I C-2 0  "
8 PRINT"    ■               ■■":PRINT" BY DAVID  PROSSER■"
9 PRINT"    SHELDON HEATH ■■":PRINT"     ■ HIT A KEY "
10 GETA$:IFA$=""THEN10
11 S0=36877:V=S0+1:S2=V-2:D1=-22:D2=D1
15 PRINT"■"TAB(5)"TANK BATTLE"
16 PRINTTAB(5)"───── ──────■"
17 PRINT"  THERE ARE TWO GAMES TO PLAY.A & B.■":PRINT"GAME A":PRINT"──────"
18 PRINT"THE COMPUTER WILL PUT UP  OBSTRUCTIONS WHEN"
19 PRINT"THE 'FIRE'  BUTTON IS PRESSED.■":PRINT"GAME B":PRINT"──────"
20 PRINT"SAME AS ABOVE BUT HAS NO OBSTRUCTIONS.■■"
22 PRINT"■■PRESS 'A' OR 'B'":GOTO940
23 GETA$:IFA$=""THEN23
24 IFA$<"A"ORA$>"B"THEN22
26 GM=A$="B"
27 PRINT"■":RESTORE
28 READX,Y:IFX=-1THEN30
29 FORQ=XTOX+Y:POKE7724+Q,160:POKE8185-Q,160:NEXT:GOTO28
30 READX,Y:IFX=-1THEN40
32 FORQ=XTOX+22*YSTEP22:POKE7724+Q,160:POKE8185-Q,160:NEXT
33 GOTO30
40 DATA0,21,56,7,184,5,106,2,46,5,138,9,-1,-1
50 DATA0,20,31,2,91,8,206,1,133,0,178,0,160,5,-1,-1
70 BC=60:WC=62:B=7986:W=7923:J=0:K=0:POKEB,BC:POKEW,WC
86 PRINT"■LEFT"ZZ"■■■■■RIGHT"ZX:TI$="000000"
90 GETA$:PRINT"■■■■■■■■■■"RIGHT$(TI$,4)
91 IFK=1THENGOSUB220
92 IFJ=1THENGOSUB310
93 IFA$="-"ANDJ<>1THENB1=B:J=1:D4=D2:GOSUB500:GOSUB400:GOSUB310:POKEB,BC
94 IFA$="3"ANDK<>1THENW1=W:K=1:D3=D1:GOSUB500:GOSUB400:GOSUB220:POKEW,WC
96 IFRND(1)>.98THENGOSUB750
97 IFA$=""THEN90
98 IFASC(A$)=133THEN4
100 IFA$="E"THEND1=-22:GOTO109
101 IFA$="@"THEND2=-22:GOTO112
102 IFA$="S"THEND1=-1:GOTO109
103 IFA$=":"THEND2=-1:GOTO112
104 IFA$="X"THEND1=22:GOTO109
105 IFA$="/"THEND2=22:GOTO112
106 IFA$="D"THEND1=1:GOTO109
107 IFA$=";"THEND2=1:GOTO112
108 GOTO90
109 IFPEEK(W+D1)=32THENPOKEW,32:W=W+D1:POKEW,WC:GOTO90
110 IFPEEK(W+D1)=46THENPOKEW+D1,42:GOSUB800:GOTO356
111 GOTO90
112 IFPEEK(B+D2)=32THENPOKEB,32:B=B+D2:POKEB,BC:GOTO90
113 IFPEEK(B+D2)=46THENPOKEB+D2,42:GOSUB800:GOTO355
114 GOTO90
220 IFPEEK(W1+D3)=32ORPEEK(W1+D3)=87THENPOKEW1,32:W1=W1+D3:POKEW1,81:RETURN
221 IFPEEK(W1+D3)=160ORPEEK(W1+D3)=46THENPOKEW1,32:K=0:RETURN
222 POKEW1,32:POKEW1+D3,81:GOTO355
310 IFPEEK(B1+D4)=32ORPEEK(B1+D4)=81THENPOKEB1,32:B1=B1+D4:POKEB1,87:RETURN
311 IFPEEK(B1+D4)=160ORPEEK(B1+D4)=46THENPOKEB1,32:J=0:RETURN
312 POKEB1,32:POKEB1+D4,87:GOTO356
355 X$=" LEFT":GOTO360
356 X$="RIGHT"
360 POKES0,220
380 FORL=15TO0STEP-1:POKEV,L:POKEV+1,L:FORQ=1TO300:NEXTQ,L:POKES0,0:POKEV+1,42
390 PRINT"■■■■■■■■■■■■■■■■■■■■■■■"X$" CONTROLLER WINS";
391 IFLEFT$(X$,1)="R"THENZX=ZX+1:GOTO600
392 ZZ=ZZ+1:GOTO600
400 POKES0,200:FORQ=1TO100:NEXT:POKES0,0:RETURN
500 IFGM=-1THENRETURN
510 TY=RND(1)*417+7746:IFPEEK(TY)=32THENPOKETY,160
530 RETURN
600 POKE198,0:PRINT"■■■■■ANOTHER GO"
605 GOSUB900
610 GETA$:IFA$=""THEN610
620 IFA$="Y"THEN27
630 IFA$<>"N"THEN600
635 PRINT"■■                    ":FORQ=1TO500:NEXT
640 POKE198,0:PRINT"■■■■■CHANGE GAME"
645 GOSUB900
650 GETA$:IFA$=""THEN650
660 IFA$="Y"THENRUN
670 IFA$<>"N"THEN640
680 END
750 TY=RND(1)*417+7746:IFPEEK(TY)=32THENPOKETY,46:POKE30720+TY,7
751 RETURN
800 FORL=1TO15:FORQ=200TO220+L*2:POKES2,Q:NEXTQ,L:POKES2,0:RETURN
900 POKEV,15:FORA=1TO5:PRINT"■■■■■■■■■■■■■■■■■■?":POKES2,225:FORQ=1TO150:NEXT
910 POKES2,0:PRINT"■■■■■■■■■■■■■■■(Y/N)":FORQ=1TO150:NEXTQ,A:RETURN
940 POKEV,15:FORA=1TO5:PRINT"■■■■■■■■■■■A■■■■■■B":POKES2,225:FORQ=1TO150:NEXT:PO
KES2,0
950 PRINT"■■■■■■■■■■■A■■■■■■B":FORQ=1TO150:NEXTQ,A:POKE198,0:PRINT"■■":GOTO23
```

017 and 019: these two lines use the graphics symbol obtained by holding down the Commodore key and pressing T.

026: this line saves the use of an If-Then statement by using logic. If GM is set to −1 then A$ = "B", otherwise GM = 0.

027: the Restore is in case the f1 key is pressed while the game is in progress.

040 and 050: the two data lines are used to plot the maze. From screen location 7724, or the third line down, the screen is numbered from zero to 461. The first data number is from where the line starts, and the second one shows how long the line is to be. Line 40 is the data for all horizontal lines, and line 50, the data for all vertical lines. Both lines require rogue values of −1 at the end of the line.

070: this sets the screen positions and the values for the tanks. Anything with a W is for the left tank; B is for the right tank.

098: this line tests if the f1 key has been pressed.

380: this line outputs an explosion sound, while changing both the screen and border colours — V + 1 does this. They are returned to normal at the end of the line.

635: note that there are 20 spaces on this line after the cursor-down instruction.

750: after plotting a mine at a random position on the screen, the colour is changed to green.

900-950: these lines should be entered very carefully. They are mug traps which cause the keys to be pressed to flash on and off on the screen five times. During this a bleeping sound is output, the purpose of which is to draw the attention of the user to the correct responses.■

HOW TO IMPRESS WITH YOUR ZX-81

Wearied by a barrage of "What does it do?" questions from doting relatives and inquisitive friends, Charles Chambers turned his hand to writing a series of Basic routines which load quickly and are guaranteed to impress.

HOWEVER BRILLIANT a mathematical manipulation, however obscure your machine-code routine, however florid and devious your string handling, it will cut little ice with that uncomprehending uncle who has watched over your shoulder for half an hour and wants to know if your ZX-81 plays space invaders.

Faced regularly with this sitution, I quickly reached the conclusion that I had to write some programs which were short and immediately interesting.

These programs, I decided, must be graphic and fascinating — something that catches the eye and holds it for a reasonable amount of time.

It is much better to program in fast mode because the flash of the screen gives the necessary feedback to signal your key presses. Fast is also, by definition, faster for the machine. So, although not as pretty as slow mode, it is better for both watcher and watched.

My first program is a perfect example of what you can do with a short listing which can be put on the machine in a flash.

```
5 INPUT A$
10 INPUT X
15 FOR N=1 TO INT 672/(X+1)
20 PRINT A$;"space";
25 NEXT N
30 CLS
35 GOTO 15
```

It is an innocuous-looking program, but enter the name of that envious friend or endearing aunt, together with the number of letters in the string, and his or her name is printed in a never-ending cycle on the television screen.

This next program produces a fascinating pattern that at times can be almost three-dimensional. Enter three characters — a space in the string is usually a good ingredient, and fast mode adds an air of expectation.

```
10 INPUT A$
20 PRINT A$;
30 GOTO 20
```

The following program is one taken directly

(continued on next page)

Program 5.

```
1  LET X=1000
2  LET Y=0
3  LET C=1
10 LET Z=INT ((X-Y)/2)
15 CLS
18 PRINT AT 0,0;C
20 PRINT AT 11,10;"NO IS ";Z
30 INPUT R$
40 IF R$= CHR$ 19 THEN LET X=Z
50 IF R$= CHR$ 18 THEN LET Y=-Z
60 IF R$= "YES" THEN PRINT AT 11,10;"I THOUGHT SO"
70 IF R$= "YES" THEN STOP
80 LET C=C+1
90 GOTO 10
```

Program 6.

```
10 PRINT AT 11,15;"WAIT"
20 PAUSE (RND*4)*100
30 PRINT AT 11,14;"PRESS NEWLINE"
40 POKE 16436,0
50 POKE 16437,0
60 INPUT A$
70 PRINT (65792-(PEEK 16436+256* PEEK 16437))-5.14
```

(continued from previous page)

from the ZX-81 manual but has one slight modification:

```
10 FOR N=0 to 63
20 PLOT N, 22+20*SIN(N/32*PI)
30 NEXT N
40 SCROLL
50 GOTO 10
```

The main part of the program creates a full-screen sine wave. With the Scroll command, the wave builds on itself to produce an attractive and constantly moving display. If your machine has only 1K, the program will stop after a few minutes when the memory has filled.

Program 1 can be very impressive, though if you are running a machine with a 16K expansion it is best to detach it because, being Basic, it will run too slowly. With 1K it runs perfectly. When you have keyed it in, enter 0 as the string which will produce a ball bouncing around the screen. After you have watched that for a minute or two, add this to it:

```
6 INPUT G
```

and change line 50 to

```
50 IF Y=31-(G-1) THEN LET P=0
```

All you need to do to send a word, rude or otherwise, bouncing round the screen is to enter it together with the number of letters it contains. If you do not like to remove your expansion unit, the following modification to the program will compensate you for not having been able to run it fast enough before. First, drop line 80. You should be able to see why it will not work on a 1K ZX-81 and why it has a speed advantage over the original program. Add these lines.

```
3 LET K=1
85 IF K=250 THEN LET A$=CHR$
   (RND*12+127)
86 LET K=K+1
87 IF K=250 THEN LET K=1
```

Start by inputting any graphic character, which will then draw itself around the screen. After 250 cycles, the character will change into another and, because of the method by which the formula decides the direction of the character's progression, the whole screen will gradually fill.

Because the characters vary and the pattern fills in a rather non-standard way, delightful designs build up and change continually. While everyone watches it, you can go away and read *War and Peace* and still have time for a cup of coffee before they tire of it.

By experimenting with the tuner on your VHF radio, you should be able to pick up the buzz of the computer. If you now save the program, you will hear on the radio the screeching noises of the software being loaded on to the tape. It is even possible to save a program on tape from the radio. With the ZX-80 this can be very useful.

If you have loading problems or are loading a long program, by using a radio you can follow its progress and check that the computer has not missed it.

Program 2 is the first game: a number is displayed in the middle of the screen and you must press the equivalent numbered key before it counts on. This counting from one to nine gives the game a dimension of speed, forcing the player to fluster and to make mistakes. The game lasts for 30 numbers and your score is shown in the top left-hand corner.

If you want to make it a little harder, you can make X a random number between one and nine. This is how you do it:

```
25 LET X=RND*9
```

and drop line 35. This modification will make the program run somewhat faster, but unless you are used to the vagaries of the Sinclair touch-keys, then the first version is difficult enough.

The next program offers, perhaps, less entertainment value but fits the 1K machine with memory to spare and can be entered in a second. It turns a string into one of those magic triangles which read the word down two sides, usually associated with Abracadabra. Apart from peoples names, Abracadabra is about the best word to keep watchers interest, although the longer the word the better.

```
1 LET X=1
2 LET Y=1
10 INPUT A$
20 LET B$=A$(X TO Y)
30 LET Y=Y+1
40 PRINT AT 5+Y, 11; B$
50 GOTO 20
```

Program 3 will be of use to a primary-school child — it prints the multiplication tables, starting with the two-times on to infinity. For some reason a few always expect the computer to make mistakes and give the wrong answer. Mathematics at such an elementary level might be expected to bore everyone in a few seconds. Yet because the tables are produced by a computer, they suddenly take on a whole new significance for those unfamiliar with these machines.

Program 4 is a battle of logic. The computer picks a number from one to 1,000. All you have to do is to find the number by a process of guesswork and deductions from clues given by the computer. The computer gives you clues by telling you if your number is greater than or less than its. While this is in process, it counts the number of turns you have taken. Of course, if you want to make it more difficult, all you have to do is increase the possibilities of X, by increasing the limit of (RND*____).

In program 4, you discovered the computer's secret number, now it will discover yours. What is more, it will not go beyond its 11th guess without succeeding. Tell the computer if your number is greater than or less than the computer's guess, using the symbols provided. When it succeeds, type in "Yes". The listing is a little longer than program 4. Remember to enter it in fast mode. You may also find it quicker to Edit, for instance, line 40 into line 50, or line 2 into line 3.

Program 6 is a variation on that old chestnut that tests the speed of your reactions and it is accurate to 0.01 of a second. When you run it, "Wait" is displayed on the screen and after a random time, which can be as long as eight seconds, "Press Newline" appears. When you have done that, your time is displayed. Do not run this in fast mode as the pause command will create havoc. My best reaction time is 0:24 of a second. ■

Program 1.

```
1  LET X=0
2  LET Y=1
5  INPUT A$
10 LET P=2
15 LET N=2
20 PRINT AT X,Y;A$
25 LET X=X+N-1
30 LET Y=Y+P-1
40 IF X=21 THEN LET N=0
50 IF Y=31 THEN LET P=0
60 IF X=0 THEN LET N=2
70 IF Y=0 THEN LET P=2
80 CLS
90 GOTO 20
```

Program 2.

```
1  LET X=1
2  LET Y=1
3  LET B$="12"
4  LET T=0
10 PRINT AT 11,14;X
15 IF INKEY$<>""THEN LET B$= INKEY$
20 IF X= VAL(B$) THEN LET Y=Y+1
25 LET X=X+1
30 PRINT AT 0,0;Y
35 IF X=10 THEN LET X=1
40 LET T=T+1
50 GOTO 10
```

Program 3.

```
1  LET X=1
2  LET Y=1
9  FOR S=1 TO 12
10 PRINT X;" X ";Y; " = "; X*Y
20 LET X=X+1
30 NEXT S
40 LET Y=Y+1
50 PAUSE 300
60 CLS
70 GOTO 5
```

Program 4.

```
1  LET C=0
10 LET X=INT (RND*1000)
20 INPUT Y
30 IF Y=X THEN PRINT AT 11,15;"YES"
40 IF Y=X THEN STOP
50 IF Y>X THEN PRINT AT 11,15;CHR$ 18
60 IF Y<X THEN PRINT AT 11,15;CHR$ 19
70 LET C=C+1
80 PRINT AT 0,28;C
90 GOTO 20
```

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Space Invaders and almost all the other computer games have been condemned by everyone from the Archbishop of Canterbury to the National Union of Teachers. Rod Hyde believes that on-screen skirmishes with the chip have their own value, and presents his own ZX-81 game to prove the point.

VALUE OF THE

GAMES CAN be useful. Even the most despised arcade games develop co-ordination and familiarity with computer interaction.

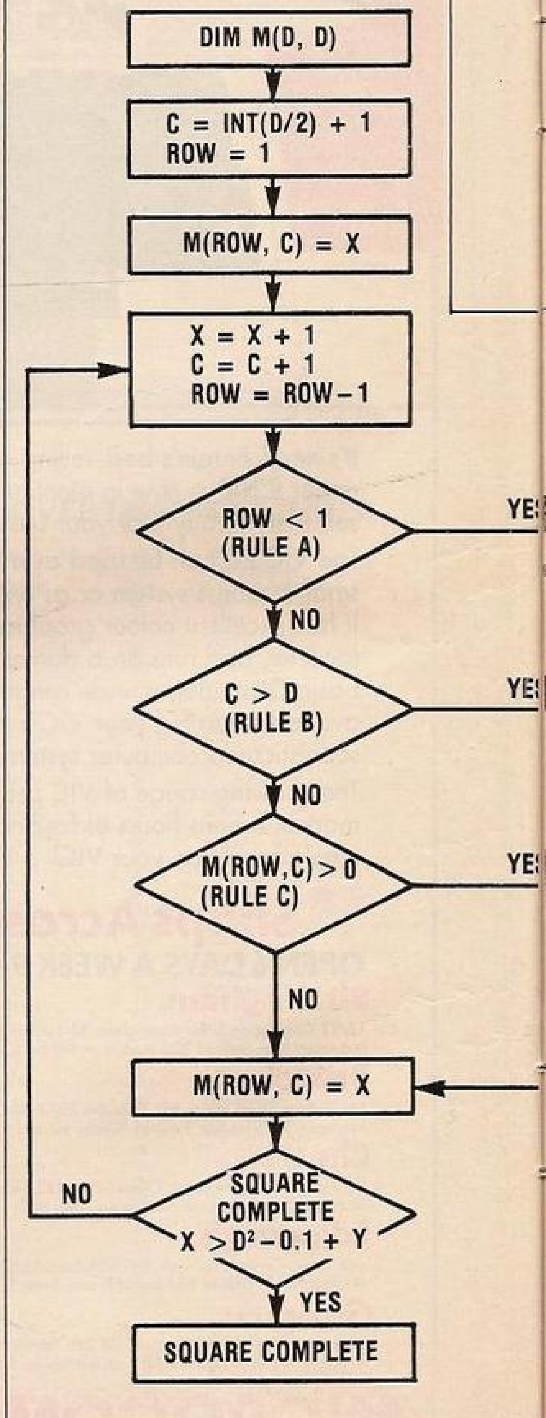
Educational programs are certainly useful but can also be fun when turned into games. Magic Squares is both educational and fun. The program is structured, as recommended by Eric Deeson in the February 1982 issue, so that it gives practice at the right level for everybody.

The program is based on magic squares. These squares have fascinated men for hundreds of years and were thought to have magic properties. Some claimed magic squares cured melancholy and others even used them as part of the paraphernalia of the occult.

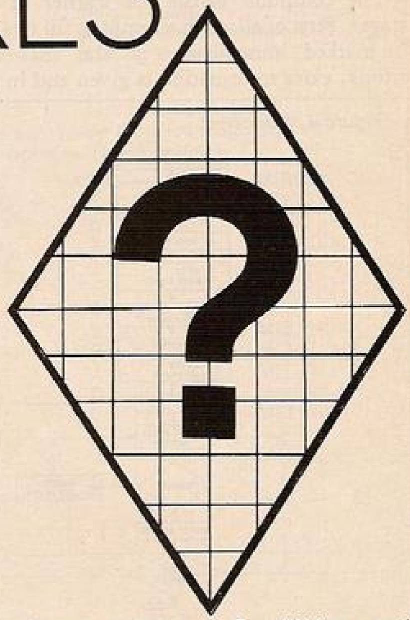
```
MAGIC SQUARES
1    SLOW
10   PRINT AT 0,6;"MAGIC SQUARES"
12   PRINT AT 2,14;"816"
13   PRINT AT 3,14;"357"
14   PRINT AT 4,14;"492"
16   PRINT AT 6,1;"IN THE MAGIC SQUARE SHOWN ABOVE"
17   PRINT AT 7,0;"EACH ROW, COLUMN AND DIAGONAL"
18   PRINT AT 8,0;"ADDS UP TO 15.  THERE ARE MANY"
19   PRINT AT 9,0;"DIFFERENT KINDS AND SIZES OF"
20   PRINT AT 10,0;"MAGIC SQUARES AND IN THIS GAME I"
21   PRINT AT 11,0;"CAN MAKE THEM WITH UP TO 49 NUM-"
22   PRINT AT 12,0;"BERS. ONCE I HAVE MADE A MAGIC "
23   PRINT AT 13,0;"SQUARE I WILL DISPLAY IT TO YOU"
24   PRINT AT 14,0;"WITH SOME NUMBERS MISSING. THE"
25   PRINT AT 15,0;"GAME IS FOR YOU TO FILL IN THE"
26   PRINT AT 16,0;"MISSING NUMBERS AS QUICKLY AS"
27   PRINT AT 17,0;"POSSIBLE. IF YOU ARE QUICK YOU"
28   PRINT AT 18,0;"WILL BE PROMOTED TO THE NEXT"
29   PRINT AT 19,0;"BIGGER SQUARE. IF NOT, I WILL"
30   PRINT AT 20,0;"EITHER LEAVE YOU OR RELEGATE YOU"
31   PRINT AT 21,3;" < PRESS RUN WHEN READY > "
32   IF INKEY$<>"R" THEN GOTO 32
35   CLS
40   PRINT AT 0,6;" < MAGIC SQUARES > "
42   PRINT AT 2,1;"THE AIM OF THE GAME IS TO GET"
43   PRINT AT 3,0;"PROMOTED AS HIGH AS POSSIBLE IN"
44   PRINT AT 4,0;"600 SECONDS. THERE ARE THREE"
45   PRINT AT 5,0;"DEGREES OF DIFFICULTY; START AS"
46   PRINT AT 6,0;"A BEGINNER. I WILL ADVISE YOU"
47   PRINT AT 7,0;"WHEN TO GO ON TO THE NEXT LEVEL."
49   PRINT AT 9,1;"EXAMPLE:"
50   PRINT AT 10,7;"MAGIC NUMBER IS 15"
51   PRINT AT 11,12;"████████"
52   PRINT AT 12,6;"ROW1█2+7+?█"
53   PRINT AT 13,6;"ROW2█9+5+?█"
54   PRINT AT 14,6;"ROW3█?+?+?█"
55   PRINT AT 15,12;"████████"
56   PRINT AT 16,0;"ROW1: 7+2=9; 15-9=6 ; SO ?=6"
57   PRINT AT 17,0;"ROW2: 9+5=14; 15-14=1; SO ?=1"
58   PRINT AT 18,0;"ROW3: 2+9=11; 15-11=4; SO ?=4"
59   PRINT AT 19,0;"ROW3: 7+5=12; 15-12=3; SO ?=3"
60   PRINT AT 20,0;"ROW3: 6+1=7;  15-7=8;  SO ?=8"
61   PRINT AT 21,3;" < PRESS RUN WHEN READY > "
65   IF INKEY$<>"R" THEN GOTO 65
70   CLS
80   PRINT AT 12,0;"TYPE IN THE DEGREE OF DIFFICULTY"
82   PRINT AT 14,15;"B FOR BEGINNER"
84   PRINT AT 15,15;"E FOR EXPERT"
86   PRINT AT 16,15;"I FOR IMPOSSIBLE"
88   LET D$=INKEY$
90   IF D$="B" OR D$="E" OR D$="I" THEN GOTO 95
```

(listing continued on page 42)

Figure 5. Setting up a magic square with an odd number of squares.



MAGIC SQUARES



A magic square is just a mathematical oddity. It is a set of numbers arranged in a square formation so that the total of each row, column and diagonal is the same.

Order of three

The order of a magic square tells us how many rows and columns there are. As an example, the square in figure 1 has an order of three. There are no magic squares of order two and there is only one third-order square — that is not counting reflections and rotations like the one shown in figure 2. After the third order, the number of magic squares increases astronomically; 880 squares of order four and more than 13 million of order five.

It is possible to make a magic square with an odd number of sides by following some simple rules. Start by putting the 1 in the middle of the top row as shown in figure 3 and then proceed by placing the next number in the square diagonally up and to the right. Sometimes this is not possible and other rules apply:

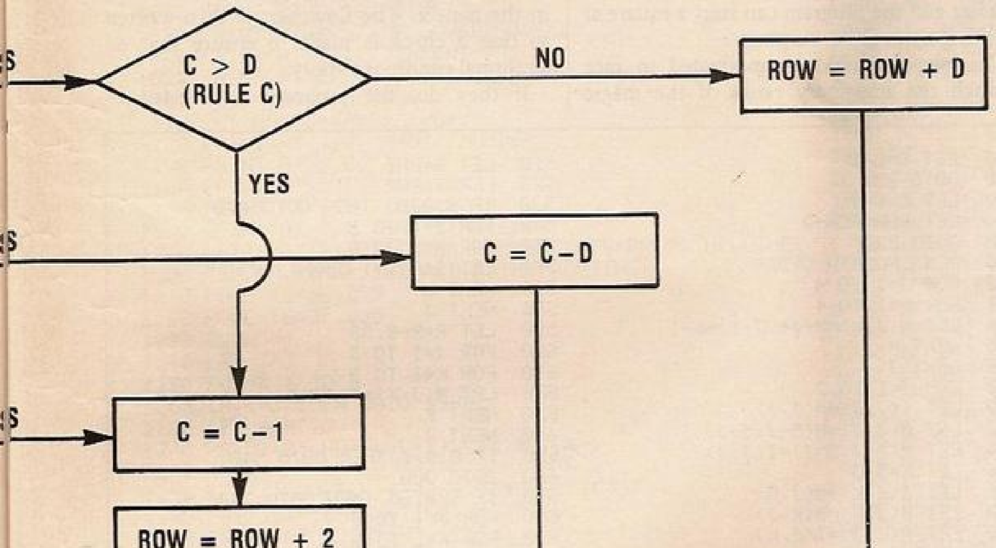
When on the top row, the next number goes to the bottom row but still one column to the right, e.g., 1 to 2.

When on the rightmost column, the next number goes on the leftmost column but still one row upwards, e.g., 3 to 4.

If the next square is blocked, go down one, e.g., 5 to 6. This also applies when on the top rightmost square.

I have not found such a convenient method for squares with an even number of rows and columns. The program works out a fourth- and sixth-order square using different methods. I like the sixth-order square formation particularly because it starts by joining up four third-order squares. I used this fact in the program.

After setting up one of the possible 3,000 magic squares, the computer displays it with some numbers missing. The game is to fill in the blanks as quickly as possible. You can do this by a mixture of addition and substraction, knowing that all the columns, rows and diagonals add up to the same magic number. Sometimes it is possible to notice a pattern in the numbers.



It may seem strange to use a number cruncher to play a mental arithmetic game. After all, what are computers for? However, we all need these mental skills, including pattern recognition, so that computers and calculators can be checked quickly.

Rank of grandmaster

There are three levels of difficulty: beginner, expert and impossible. Most people start as beginners and novices of the magic square. Success at each stage means promotion to larger squares and so to the ranks of challenger, expert, master and finally, grandmaster. You are allowed only 10 minutes.

Do not start to panic as the seconds tick away or your mind will go blank. If you complete a seventh-order square within the time limit, the computer will recommend you to go to the next level of difficulty. On the other hand, if you do not complete a square quickly enough, the computer will construct another square of the same order with slightly easier numbers. A still slower completion time will result in the computer making a square one size smaller as well as demoting you to the ranks.

The computer gives you prompts and hints.

(continued on next page)

ROW1	8	1	6		4	3	8
ROW2	3	5	7		9	5	1
ROW3	4	9	2		2	7	6

17	24	1	8	15
23	5	7	14	16
4	6	13	20	22
10	12	19	21	3
11	18	25	2	9

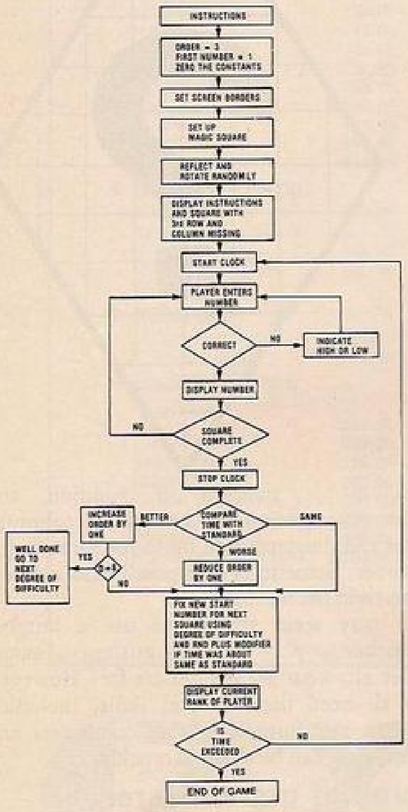
Figure 1, a third-order magic square, figure 2, a clockwise rotation of figure 1, figure 3, a fifth-order square.

(continued from previous page)

It indicates which number to attempt next. A correct answer is printed out. In the event of an incorrect answer, the computer indicates whether it is too high or too low.

The computer assists the learner in two stages. First of all, each attempt to fill in a gap is marked immediately. If the answer is wrong, extra information is given and in this way a forgotton borrow or carry might be remembered.

Figure 4. Flowsheet.



The computer will not move on to the next gap until a correct response is given. At first sight this might be considered a little tedious. However, it must be remembered that it is impossible for a player to stay for long at a level beyond his ability. Besides, even a difficult combination of numbers is usually solved after two or three attempts when hints are given.

Secondly, the difficulty of the next square set depends solely on the player's performance on the previous square. The primary objective of the program is to provide an enjoyable opportunity to practise mental arithmetic over a wide range of difficulty. As speed and accuracy are of the essence in mental arithmetic, it seems reasonable to use them when evaluating.

Rotate and reflect

So, a fast and, by implication, accurate response is reinforced by making the next square more difficult, whereas for a slower response the next square is the same type or easier depending on how slow the response happened to be.

A player automatically reaches his own level and even if the stays on the same square he will be presented with different arrangements of numbers. This is achieved by rotating and reflecting the squares randomly so that either the original square, or a horizontal or vertical reflection, is rotated up to three times. In addition, the square does not have to start at one. More difficult squares are obtained by increasing the first number and the program can start a square at anything up to 50.

The player should be motivated to race through the imaginary ranks of the magic squares. This provides the best kind of competition: against oneself, trying to improve on previous attempts. For the player stuck on one square, a bar — an acknowledgement of the distinction — is awarded for each attempt. On promotion and demotion the bars are lost and so even steady responses are encouraged.

Except for the simplest of programs, I always like to start with an overall flowchart showing in outline what I want the program to do. The magic square flowchart is shown in figure 4 beside the relevant statement numbers from the program listing.

Flowcharting is certainly a good method of clarifying thinking during programming, and clarified thought leads to efficient programs. Nevertheless, the final flowchart can nearly always be improved. Flowcharting was especially useful when converting the rules for making magic squares into a program. My attempt is shown in figure 5 and the meaning of the variables is given in figure 6. To make a magic square, all that is needed is the order, D, and the lowest number, X.

From all aspects, programming, printing and storage, it seemed best to arrange the number of the magic square in an array. I have used array M and an example is shown in figure 2. It can be seen that a particular slot can be defined by giving the row and column number. For instance, row 3 and column 2 is 7 and would be written M(3,2)=7.

Referring to figure 5, in the first box an array of two dimensions and size D by D is produced. In the second and third boxes, the row and column numbers for the first number are defined and the first number, X, is written in the matrix. The flowchart is then written so that a check is made to ensure that no abnormal conditions apply.

If they do, the program is diverted to

(listing continued from page 40)

```
91   GOTO 88
95   LET Y=0
96   LET PREV=0
97   LET B=0
98   CLS
99   FAST
100  LET D=3
101  FOR J=0 TO 31
102  PRINT AT 9,J;"█"
103  IF J>=9 THEN GOTO 105
104  PRINT AT J,15;"█"
105  NEXT J
109  REM  MAGIC SQUARE SETTING
110  LET X=1
120  LET ROW=1
121  FOR J=10 TO 20
122  PRINT AT J,0;"
123  NEXT J
124  FAST
125  DIM I(D,D)
130  DIM M(D,D)
140  IF D=4 THEN GOTO 350
142  IF D=6 THEN GOTO 400
144  GOSUB 150
146  GOTO 500
150  LET C=INT (D/2)+1
160  LET M(ROW,C)=X
170  LET X=X+1
180  LET C=C+1
190  LET ROW=ROW-1
200  IF ROW<1 THEN GOTO 260
210  IF C>D THEN GOTO 290
220  IF M(ROW,C)>0 THEN GOTO 320
230  LET M(ROW,C)=X
240  IF X>=(D**2-0.1+Y) THEN RETURN
250  GOTO 170
260  IF C>D THEN GOTO 320
270  LET ROW=ROW+D
280  GOTO 230
290  LET C=C-D
300  GOTO 230
320  LET C=C-1
330  LET ROW=ROW+2
340  GOTO 230
350  REM  FOURTH ORDER
352  FOR J=1 TO 4
353  FOR K=1 TO 4
354  LET M(J,K)=X+4*(J-1)+K-1
355  NEXT K
356  NEXT J
358  FOR J=1 TO 2
360  LET I(J,J)=M(J,J)
362  LET M(J,J)=M(5-J,5-J)
364  LET M(5-J,5-J)=I(J,J)
366  LET K=5-J
368  LET I(J,K)=M(J,K)
370  LET M(J,K)=M(K,J)
372  LET M(K,J)=I(J,K)
374  NEXT J
376  GOTO 500
400  REM   SIXTH ORDER
410  LET D=3
420  GOSUB 150
430  LET D=6
432  FOR J=1 TO 3
434  FOR K=1 TO 3
436  LET M(J,K+3)=M(J,K)+18
438  LET M(J+3,K)=M(J,K)+27
440  LET M(J+3,K+3)=M(J,K)+9
442  NEXT K
444  NEXT J
446  FOR J=1 TO 3
448  LET K=1
450  IF J=2 THEN LET K=2
452  LET I(J,K)=M(J,K)
454  LET M(J,K)=M(J+3,K)
456  LET M(J+3,K)=I(J,K)
458  NEXT J
500  REM  ROTATION AND REFLECTION
510  LET R=RND
520  LET S=RND
530  IF S>0.33 THEN GOTO 670
540  FOR J=1 TO D
550  FOR K=1 TO D
560  LET I(K,D+1-J)=M(J,K)
570  NEXT K
580  NEXT J
590  LET R=R-0.33
600  FOR J=1 TO D
610  FOR K=1 TO D
620  LET M(J,K)=I(J,K)
630  NEXT K
640  NEXT J
650  IF R>0.1 THEN GOTO 540
660  GOTO 800
670  IF S>0.66 THEN GOTO 740
680  FOR J=1 TO D
690  FOR K=1 TO D
700  LET I(D+1-J,K)=M(J,K)
710  NEXT K
720  NEXT J
730  GOTO 600
740  FOR J=1 TO D
750  FOR K=1 TO D
760  LET I(J,D+1-K)=M(J,K)
770  NEXT K
780  NEXT J
790  GOTO 600
800  REM   PRINT ROUTINES
810  LET VL=17-2*D
820  LET VR=17+D
830  LET HU=14-INT (D/2)
840  LET HL=16+INT (D/2)
850  FOR J=VL TO VR
860  PRINT AT HU,J;"█"
870  PRINT AT HL,J;"█"
880  NEXT J
890  FOR J=1 TO D
900  FOR K=1 TO D
```

complete the necessary special rule. Otherwise the slot is completed normally: that is the next square is one up and one to the right.

Once a flowchart for a complicated piece of logic has been completed, it should be tested. This is done by inventing data that will flow along all the lines of the flowchart and checking that you obtain the answer you would expect. Sometimes a trace table can be valuable.

Relevant data value

In these tables you record the value of all the relevant data at each program stage. If you do have a problem, a trace table will invariably show you where it is. For programs already in the computer, by introducing the correct print statement, you can make the computer draw up a trace table for you.

I checked my flowchart by using it to make up the magic square in figure 1 and it worked! Please see figure 7.

I can send you a cassette including some other mathematical games for £3.50. My address is 53 Holloway, Runcorn, Cheshire.

Figure 6. List of variables

A	attempt at completing square
B	number of bars awarded
C	column number
D	order of square
HU and HL	upper and lower horizontal border respectively for magic square
J	counter
K	counter
MN	magic number
PREV	time taken to complete previous squares
R	random number, degree of rotation
ROW	row number
S	random number, setting type of reflection
TIME	variable to produce time taken on present square
VL and VR	left and right vertical borders respectively for magic square
X	counter giving number in square
Y	one less than lowest number in square
Z	counter

array	
M(D, D)	contains the numbers for the magic square
I(d, D)	is used when reflecting and rotating the square.

Figure 7. Trace table for magic square formation — D = 3 and X = 1.

X	ROW	C	M(ROW, C)
1	1	2	M(1, 2) = 1
2	0	3	
	3		M(3, 3) = 2
3	2	4	
		1	M(2, 1) = 3
4	1	2	
	3	1	M(3, 1) = 4
5	2	2	M(2, 2) = 5
6	1	3	M(1, 3) = 6
7	0	4	
	2	3	M(2, 3) = 7
8	1	4	
	1	1	M(1, 1) = 8
9	0	2	
	3	2	M(3, 2) = 9

```
910  IF J=3 OR K=3 THEN GOTO 960
920  IF M(J,K)<10 THEN GOTO 950
930  PRINT AT HU+J, VL+1+(K-1)*3;M(J,K);"+"
940  GOTO 960
950  PRINT AT HU+J,VL+2+(K-1)*3;M(J,K);"+"
960  NEXT K
970  NEXT J
980  FOR J=HU TO HL
990  PRINT AT J,VL;"■"
1000 PRINT AT J,VR;"■"
1001 NEXT J
1005 PRINT AT 0,16;"TIME:"
1010 PRINT AT 2,17;"ALLOWED:600SECS "
1020 PRINT AT 1,17;"TAKEN   :"
1030 PRINT AT 1,28;"SECS"
1100 REM  MAGIC NUMBER
1110 LET MN=(D**3+D)/2+D*Y
1120 PRINT AT 1,2;"MAGIC NUMBER"
1130 PRINT AT 3,6;"         "
1140 PRINT AT 3,5;"IS ";MN
1150 PRINT AT 6,3;"THE CLOCK"
1160 PRINT AT 7,2;"HAS STARTED"
1170 PRINT AT 21,0;"ENTER NUMBER THEN PRESS NEWLINE"
1200 REM    TIMER SET AND ENTER ROUTINE
1210 POKE 16436,255
1220 POKE 16437,255
1230 SLOW
1240 LET J=3
1250 FOR K=1 TO D
1255 IF K=J THEN GOTO 1380
1260 LET A$="??"
1270 PRINT AT HU+J,VL+1+(K-1)*3;A$
1275 INPUT A
1280 LET TIME=PEEK 16436+256*PEEK 16437
1285 LET TOT=(65536-TIME)/45+PREV
1290 PRINT AT 1,25;INT (TOT)
1305 PRINT AT HU+J,VL+1+(K-1)*3;"  "
1310 IF A=M(J,K) THEN GOTO 1350
1320 LET A$="LL"
1330 IF A>M(J,K) THEN LET A$="HH"
1340 GOTO 1270
1350 LET Z=1
1360 IF M(J,K)<10 THEN LET Z=2
1370 PRINT AT HU+J,VL+Z+(K-1)*3;M(J,K);
1374 IF K=D THEN GOTO 1380
1376 PRINT "+"
1380 NEXT K
1400 LET K=3
1410 FOR J=1 TO D
1420 LET A$="??"
1430 PRINT AT HU+J,VL+1+(K-1)*3;A$
1435 INPUT A
1440 LET TIME=PEEK 16436+256*PEEK 16437
1445 LET TOT=(65536-TIME)/45+PREV
1450 PRINT AT 1,25;INT (TOT)
1465 PRINT AT HU+J,VL+1+(K-1)*3;"  "
1470 IF A=M(J,K) THEN GOTO 1510
1480 LET A$="LL"
1490 IF A>M(J,K) THEN LET A$="HH"
1500 GOTO 1430
1510 LET Z=1
1520 IF M(J,K)<10 THEN LET Z=2
1530 PRINT AT HU+J,VL+Z+(K-1)*3;M(J,K);
1534 IF D=3 THEN GOTO 1540
1536 PRINT "+"
1540 NEXT J
1550 PRINT AT 21,0;"                                 "
1560 PRINT AT 7,9;"OPP"
1600 REM  EVALUATION
1610 IF (65536-TIME)/45>D**3*2 THEN GOTO 1680
1620 IF (65536-TIME)/45<D**3 THEN GOTO 1660
1630 LET B=B+1
1640 LET X=INT (0.5*(RND*((CODE D$-38)**2+1)))+1
1645 LET Y=X-1
1650 GOTO 1710
1660 LET D=D+1
1670 GOTO 1690
1680 LET D=D-1
1690 LET B=0
1700 LET X=INT (RND*((CODE D$-38)**2+1))+1
1705 LET Y=X-1
1710 LET PREV=TOT
1720 IF D=8 THEN GOTO 1910
1730 IF D=2 THEN LET D=3
1740 IF D=3 THEN LET B$="    NOVICE  "
1750 IF D=5 THEN LET B$="    EXPERT  "
1760 IF D=6 THEN LET B$="    MASTER  "
1770 IF D=7 THEN LET B$="GRAND   MASTER"
1780 IF D=4 THEN LET B$="  CHALLENGER"
1790 PRINT AT 4,19;"YOU ARE A"
1795 IF D=5 THEN PRINT AT 4,27;"AN"
1800 PRINT AT 5,17;B$
1810 PRINT AT 6,18;"OF THE MAGIC"
1812 PRINT AT 7,17;"SQUARE-CLASS ";D$
1825 PRINT AT 8,16;"               "
1826 IF B=0 THEN GOTO 1835
1830 PRINT AT 8,19;"WITH ";B;" BAR"
1835 FOR J=1 TO 50
1836 NEXT J
1840 IF PREV<600 THEN GOTO 120
1850 PRINT AT 1,2;"END OF GAME"
1860 PRINT AT 3,3;"TYPE S TO"
1870 PRINT AT 4,4;"RESTART"
1890 IF INKEY$<>"S" THEN GOTO 1890
1900 GOTO 95
1910 PRINT AT 1,2;" EXCELLENT "
1920 PRINT AT 3,3;"TRY NEXT "
1930 PRINT AT 4,3;"DEGREE OF"
1940 PRINT AT 5,3;"DIFFICULTY"
1945 PRINT AT 6,3;"          "
1950 PRINT AT 7,2;" TYPE RUN "
1960 IF INKEY$<>"R" THEN GOTO 1960
1970 GOTO 70
```

■

THE ZX-81 UNDER

BUILD YOUR OWN

Joysticks give an added dimension to most games software. David Griffin shows how you can benefit through building your own joysticks for the ZX-81.

JOYSTICKS GIVE an extra novelty to games. Using them is easy compared with the player's usual confrontation with 40 rather meaningless keys. Most hardware additions such as joysticks are available only on larger, more expensive machines, and then only to those fitted with ports — so that would normally rule out the basic ZX-81.

The joystick I shall describe is eight-directional, but after connection to the ZX-81 only four of these directions can be obtained from Basic. If we want to use the other directions, we must resort to a very simple machine-code subroutine.

The joystick is very easy to construct, made from pieces of wood and metal — see figure 1. Cut a hole in the centre of a suitably sized sheet of metal. This hole should be slightly larger than the bolt being used. This sheet is the base of the joystick.

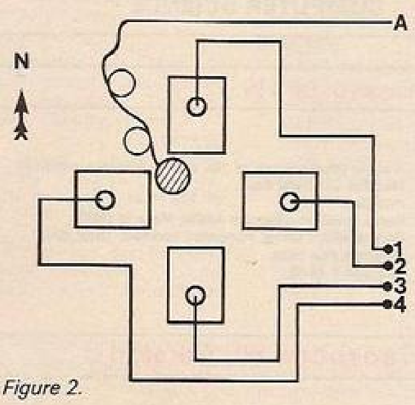


Figure 2.

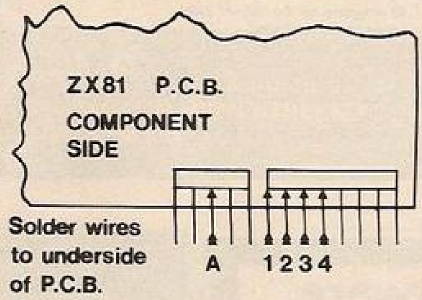
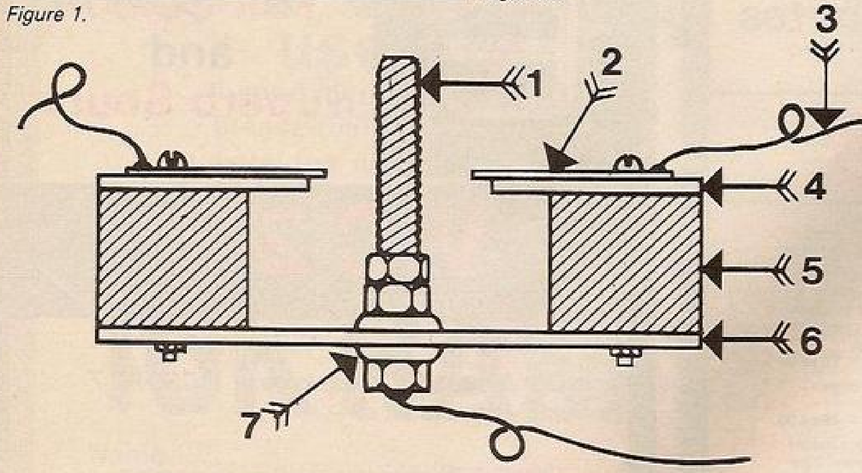


Figure 3.

Figure 1.



1 bolt
2 copper plate
3 wire soldered to copper
4 wood with a square hole cut from the centre
5 wooden block
6 metal sheet with a hole cut in the middle
7 old scalectric tyre, or a piece cut from rubber tubing.

Fit an old Scalextric tyre — or a piece cut from rubber tubing — around the bolt, and then into the hole. Screw two nuts around the tyre to hold the bolt in place to give a spring-like effect to the motions of the bolt in the hole. Then position wooden blocks around the bolt and metal sheet, as shown in figure 1. The copper plates can be obtained from old piping if you cannot find any in sheet form. Alternatively, use another good conducter in its place.

Arrange the plates as in figure 2. It will be necessary to use five wires to make the connections to your ZX-81; four of the wires should be soldered to the four copper plates, the fifth to the base of the bolt.

After the joystick has been made, attach it to your computer. To do this, the wires from the joystick must be soldered to the keyboard connections on the printed-circuit board. Remove the back from your ZX-81. If you find this difficult, first locate the three screws under three of the rubber feet supporting it. These feet are held in place by sticky tape and should pull off easily.

There is a ribbon cable joining the keyboard to the printed-circuit board. It is to the underside of these connections that the wires from the joystick will be soldered — see figure 3. The wire A from the bolt is to be soldered to one of the five connections on the left-hand terminal. The four wires 1, 2, 3 and 4 will be soldered to any of the eight connections on the right.

Ideally, a ribbon cable should be soldered to all of the connections, and then an edge connector soldered to the other end. Then, any additions such as the joystick should be fixed to a piece of Veroboard slotted into this connector. It is important that your keyboard is fully functional after these modifications.

The joystick works by connecting two wires of the keyboard terminals to give the same result as if a key had been pressed. Depending on which lines your joystick's wires were soldered to, different results will occur to the following:

```
10 SCROLL
20 PRINT INKEY$
30 GOTO 10
```

Type in this little program and run it, testing each position north, south, east and west to see the response. If you used the same positions as in figure 3 the results should be as follows:

3: north
8: south
E: east
D: west

As you will have discovered if you tried to push the bolt into one of the diagonals, no result will occur. The reason that the diagonals cannot be used in Basic is that two

JOYSTICK CONTROL

keys cannot be pressed at once to create a response on the screen — that is, except with Shift. The problem can be overcome with a little machine-code subroutine.

```
1 REM xxxxxx
POKE 16514,205
POKE 16515,187
POKE 16516,2
POKE 16517,68
POKE 16518,77
POKE 16519,201
```

This program calls a routine in ROM, which returns the value of the key being pressed. This is used in the statement Inkey$. It also registers when two, three or even more keys are pressed at once. This is of use for our purposes when two keys — the diagonals — are pressed at the same time.

To discover which values correspond to the connections on the printed-circuit board you have chosen, type:

```
1 REM . . . (machine code)
10 SCROLL
20 PRINT USR 16514
30 GOTO 10
```

and run it, testing each position of your joystick, and noting down the numbers for each. Let:

A = north value
B = north-east value
C = east value
D = south-east value
E = south value
F = south-west value
G = west value
H = north-west value

Substitute the letters in lines 120 to 230 of program 1 for these values. Program 1 allows you to draw on the screen. First, the ZX-81 asks for two inputs; the first is the x co-ordinate of the starting point — 0 to 63 — and the second is the y co-ordinate of the starting point — 0 to 43. Then proceed to draw in all the directions of the joystick. To rub out at any time, type W and continue to move in the usual directions. To draw again press Q.

If you have only 1K, you must erase lines 160 to 230, but you will be able to move only in the four main directions.

If you want, you can build a button. This can have many applications in games — for firing lasers, for example. This should be made from a keyswitch, like those used in keyboards. The two connections of this should be fixed to the keyboard terminals, one to each, left and right.

You could also construct an additional joystick. Connect the four wires from the copper plates to any of the connections on the right keyboard terminal. Solder the wire from the bolt to one of the connections of the left terminal. This must be a different one to that used by the first joystick. If you do not take this precaution you will find that the joysticks may register the same result when in certain positions. ■

Program 1.

```
1    rem ...(machine code)
2    rem program to draw
     pictures with the
     aid of joysticks
10   input x
20   input y
30   let z=0
40   plot x,y
50   unplot x,y
60   if z=1 then goto 80
70   plot x,y
80   let a$=inkey$
90   if a$="q" then let z=0
100  if a$="w" then let z=1
110  let q=usr 16514
120  if q=A then let y=y+1
130  if q=E then let y=y-1
140  if q=C then let x=x+1
150  if q=G then let x=x-1
160  if q=B then let x=x+1
170  if q=B then let y=y+1
180  if q=D then let x=x+1
190  if q=D then let y=y-1
200  if q=F then let x=x-1
210  if q=F then let y=y-1
220  if q=H then let x=x-1
230  if q=H then let y=y+1
240  goto 40
```

CONVERTING ATARI STICKS

Patrick Norris explains how you can convert Atari joysticks to work with the ZX-81.

AFTER READING an article by Ian MacLean in the January 1982 issue on interfacing the ZX-81, I conceived the idea of connecting Atari joysticks to the ZX-81. Construction costs are negligible and it took me only one evening to complete the project. Obviously either one or two joysticks are required. I chose Atari sticks because they are robust and, at £6.50 each, not too expensive.

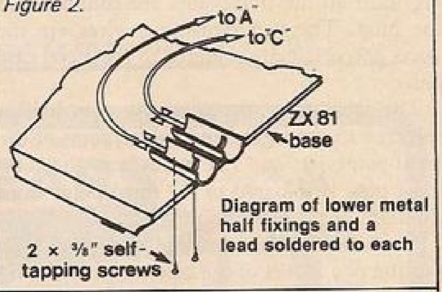
The constructor will require the joysticks, two male and two female in-line five-pin DIN plugs, and about 5ft. of multi-strand wire — the thin, plastic-covered type. Do not use single-strand wire because it is too brittle.

Perhaps surprisingly, the hardest part of the project is making the holes in the side of the ZX-81, to allow access to the male plugs. I achieved this by the judicious use of a wooden dowel, slightly smaller than the outside diameter of the plugs, with emery paper wrapped around it to file the holes to the required size.

There is just enough space to enclose the male plugs under the keyboard. Access to the plugs is on the right-hand side of the case.

Be very careful that the rearmost plug does not touch the printed-circuit board when the two halves of the ZX-81 case are put back together.

Figure 2.



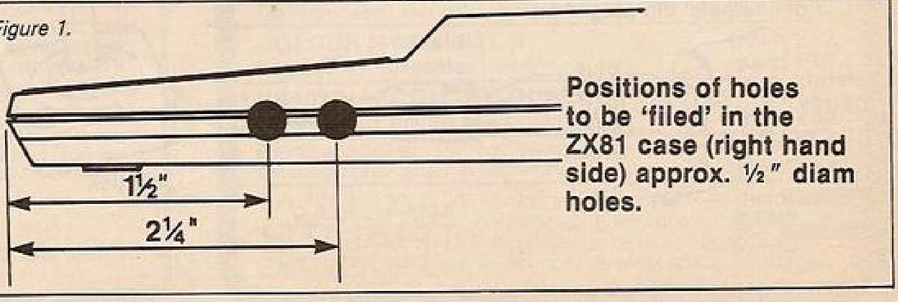
The lower halves of the metal sections of the male plugs were held to the base of the ZX with 3/8 in. self-tapping screws — see figure 2. Solder one wire to the rearmost metal half and one to the foremost.

The next stage is to wire up the two DIN plugs. Take a wire from pin 1 of one plug to pin 1 of the other, pin 2 to pin 2 and so on, until each plug is linked to the other by five wires. Then solder an extra five wires to the plug that will be in the rearmost position — one wire to pin 1, the second wire to pin 2 and so on.

At this stage you should have two plugs

(continued on next page)

Figure 1.



(continued from previous page)

wired together, five wires hanging from one of them and two wires soldered to the metal cases in the base, one wire to each half.

Now place the rearmost plug in its appropriate lower metal-case half, remembering that this plug has five extra wires on it, and place the foremost plug in its half. Put the upper halves of the metal sections in place and tack-solder the two halves of the metal cases together to stop any movement.

The next stage is where the fun starts so be very careful. Before going any further make sure that the soldering iron that you are using is earthed. If it is not then find one that is or you will damage the chips in the ZX-81.

With the base in front of you, the plugs in place, take the main section of the ZX-81 containing the keyboard, and place it to the right-hand side of the base with the main section upside down. You should now be looking at the underside of the printed-circuit board.

On the front left-hand side of the board, as you look at it, will be a neat row of eight solder points running from left to right. Next to this row, slightly to the right will be another five solder points. This is where the main connections will be made.

Using the earthed soldering iron, solder the wire from pin 1 of the rearmost plug to the right-hand solder point of the five solder-point section. Solder the pin-2 wire to the next point to the left, the pin-3 wire to the next left and so on, until all the five points are connected to the plug. The two remaining wires are the wires you originally soldered to the metal case halves.

The wire from the rearmost case half is soldered to the right-hand solder point of the eight-point section. The wire from the foremost plug is soldered to the third point from the right of the eight-point section.

All connections are now complete. Carefully put the two halves of the case together but do not screw it together. Connect up the ZX-81 and test the keys on the keyboard. If nothing happens on the screen, then you have a short in your wiring that will have to be rectified. If everything is satisfactory screw the two halves of the case together and place it to one side. This section is now complete.

When you buy the joysticks, ensure that they are tested because you will have to cut the plugs off the ends and so you will not be able to return them if something is wrong. The same applies if you have an Atari video game; the joysticks will not be able to plug into the game again.

When you have cut off the plugs on the joysticks, pare back the sleeving and you will see six coloured wires.

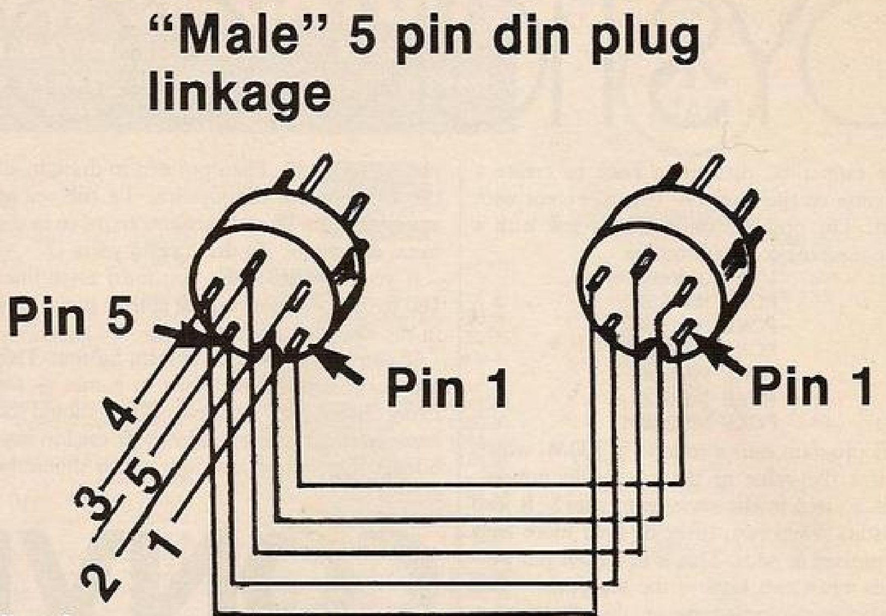


Figure 3.

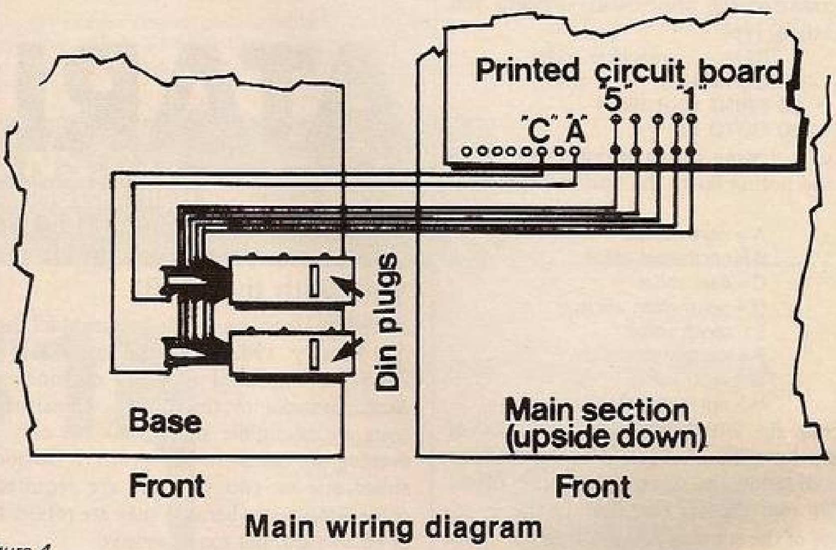


Figure 4.

Take one female section of the five-pin DIN plug and remove the plastic sleeve. Push this sleeve on to the lead connected to the joystick. If you do not do this at this stage, you will regret it later. You are now left with a female five-pin DIN plug insert and two halves of the metal case that encloses it.

Solder the green lead to the pin 1 socket — see figure 5 — white to pin 2, blue to pin 3, brown to pin 4 and orange to pin 5. At this stage solder the black lead to one half of the metal case. Put the plug together and slide the plastic sleeve over the whole assembly to keep it together. Now you see the point of putting the plastic sleeve on first.

The joystick plugs into the rearmost male plug that was fitted in the case of the ZX-81.

If you have followed these instructions exactly, the configuration is as follows:

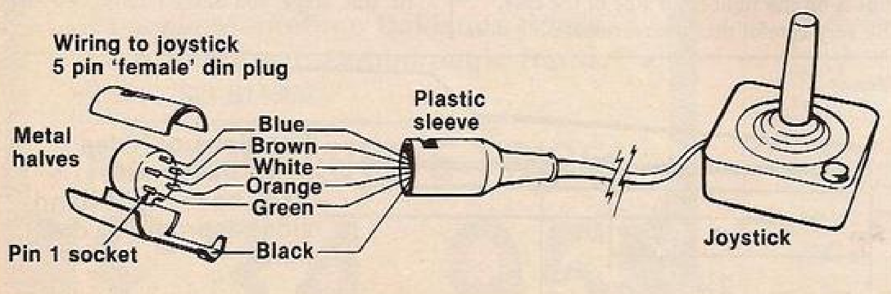
Stick left:	equivalent of key 6 pressed
Stick up:	key 7
Stick down:	key 8
Stick right:	key 9
Fire button:	key 0

If you wish to add the second joystick, the wiring is slightly different. Solder the orange wire to the pin 1 socket, brown to pin 2, blue to pin 3, white to pin 4, green to pin 5 and once again the black lead goes to the metal case. For the second joystick the configuration is:

Stick left:	equivalent of key 1
Stick up:	key 2
Stick down:	key 3
Stick right:	key 4
Fire button:	key 5

This second stick plugs into the foremost male plug. ■

Figure 5.



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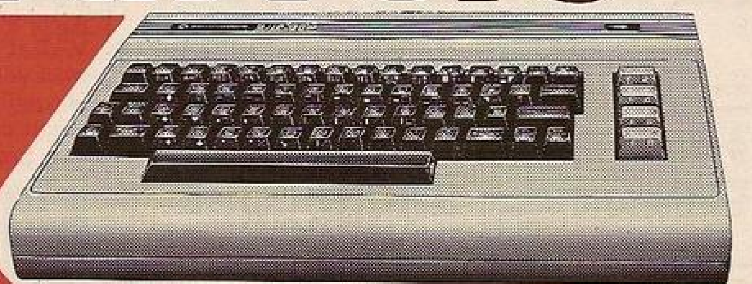

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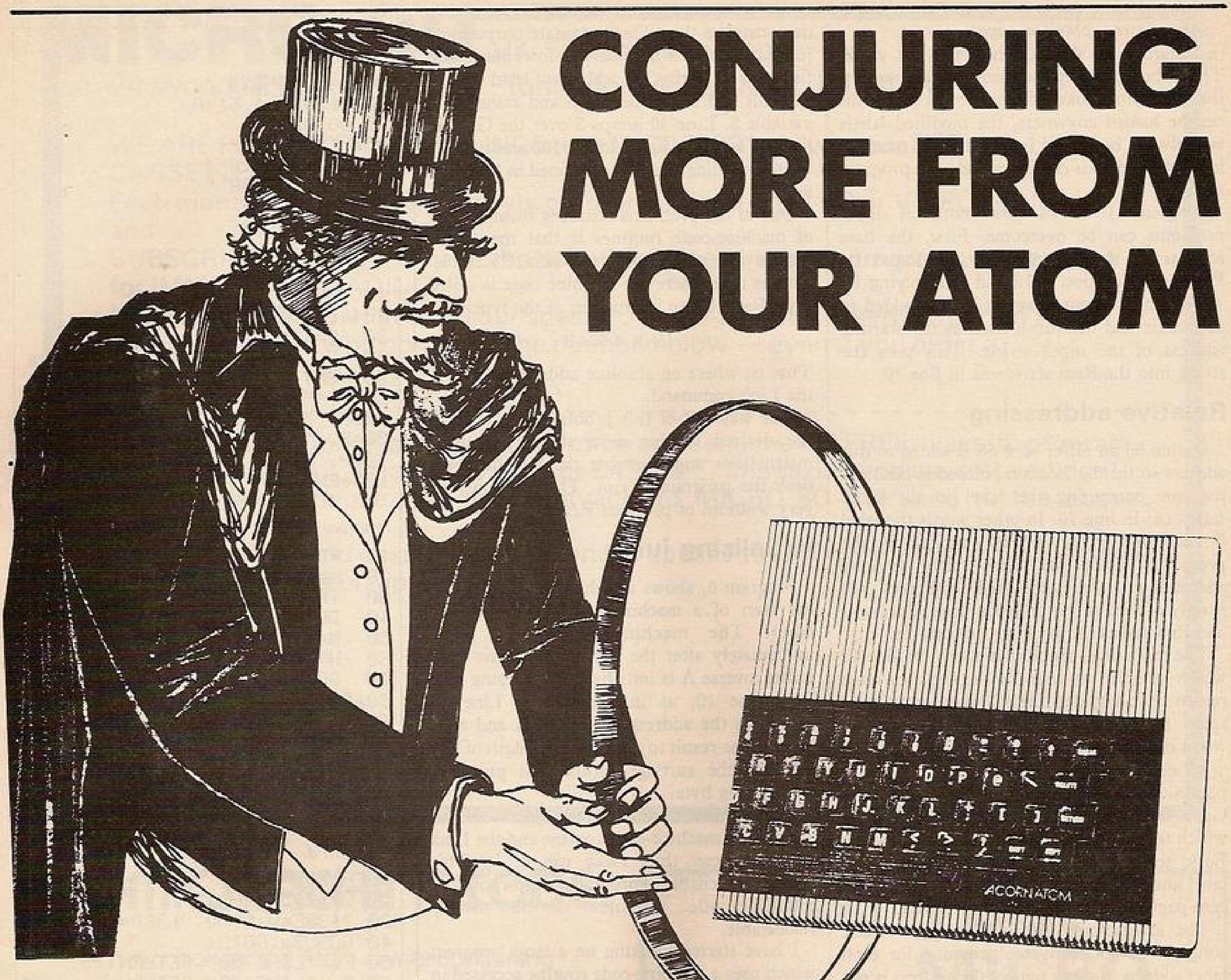
CONJURING MORE FROM YOUR ATOM



Do your Atom programs consist of pages of standard If statements? David Berry uses computed Goto to make those problems disappear before your very eyes.

COMPUTED GOTOS are standard commands; Fortran has one, so do many Basics, including the Atom dialect. However, one problem with the Atom system is that if you prefer the tidiness of using labels rather than line numbers, this facility is not readily available.

One of the useful things about interpreters is that line n+1 is not read until line n has been interpreted. This allows the program to make a calculation in line n, convert this to a label code, and Poke the code into any succeeding line.

Label codes

The only other point you need to know before we can write our computed Goto is that the ASCII codes for the labels start at #61 for inverse A and end with #7A for inverse Z.

Program 1 gives an example. In it, line 20 calculates the value to be Poked into line 30. Incidentally, the best way of finding the address of the location into which to Poke the label is to type the program as far as the label with dummy characters inserted into the Poke address. Then print &Top and replace the dummy characters with the value of Top-2. You can then finish entering the program normally.

To see the effect of the program, run it a few times and after each run, list it. You will notice that the label after the Goto in line 30 changes each time the program is run.

Anyone who doubts the value of the computed Goto should consider how many standard If statements are necessary to achieve the same effect. In program 1, three would be needed to branch to all four labels, and if the program was extended to use the 26 labels available, 25 If statements would then be necessary. Compare this with the two lines needed by the computed Goto.

Programs which use menus often require a series of If statements to direct the sequence of jumps in response to the menu entries selected. It would be much simpler to enter the actual target label and plug this into a Goto.

It would also be useful if a whole string of menu selections could be entered and the program directed to each in turn — program the program so to speak. Program 2 does exactly that.

A string of labels is input by line 20 and stored in the program at line 10 where each character replaces one of the spaces. The 13 spaces are essential to make the positioning right for the Poke in line 40, which changes the label after the Gosub.

The Do loop in the same line moves the pointer S along the stored string so that the Gosub labels are changed in the same sequence as the string characters. In this example, the string can be up to 13 elements long and can use the labels inverse A to inverse D in any combination — more if you add more lines — but must terminate with inverse E.

The two problems

There are, however, two problems with this approach and if you list the program after a run you will find the first of them — the program will have gained an extra line or even two. This is because the string you have input terminated in a carriage return and the Atom therefore interpreted the two bytes following it as a line number. If you do not delete the lines formed in this way, there should be no problems in running the routine, but it is very untidy programming.

The second problem also applies to program 1: neither of the two programs we have considered so far is relocatable. If you load them into any part of the memory other than

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that starting at # 2900, they will not work. This is because they use absolute addresses for the modifying Pokes. So, while the programs can be loaded anywhere, the modified labels will always be Poked into the same memory location, and thus can be outside the program text.

Program 3 shows how both of these problems can be overcome. First, the base address of the program can be found by Peeking at location # 12 and multiplying by # 100. In program 3, seven is then added to this value and the result used as the starting address of the input string. This puts the string into the Rem statement in line 10.

Relative addressing

In line 60 an offset of # 68 is added to this address so tht the location pointed at becomes the one containing the label in the Goto statement in line 70. In other words the label in the Goto is the # 6Fth character in the program. Thus we now have relative addressing — the required addresses are simply offsets of the program base address — and this makes the program relocatable.

The extra lines problem is solved by line 40 which simply replaces the string's carriage return with a space; line 120 then looks for a space in the string and terminates the run when one is found.

Labels on the Atom are simply markers placed within the text of the program. When a Goto or similar command is encountered which uses a particular label for the first time, Basic searches through the text to find the label and then stores its address in an area of zero-page RAM from # 38D to # 3C1.

The arrangement of this storage is quite simple: two locations are provided for each label address, the low byte of the address is put in the first of the pair and the high byte in the second. Thus the address of label inverse A occupies # 38D — low byte — and # 38E; inverse B occupies # 38F and # 390, and so on. Knowing this enables us to do two things: find the address of a label — and I will show how this can be useful — and change the address of a label.

Look now at program 4. This program solves the problem of using up labels when addressing a large number of lines. To keep this demonstration simple I have reverted to absolute addressing and kept all the lines from 50 to 80 the same length.

The variable A

Line 20 calculates the address for the label based on the location of the space following the line number 50 — # 2951 — the length of the lines 50 to 80, which is 23 characters, and the variable A, which randomly chooses which line will be branched to.

Variable Q then contains the address to which control will be sent when the command Goto inverse A is executed. Line 30 Pokes this address into the two bytes of zero-page RAM associated with label inverse A. Basic is thus fooled into believing that a label inverse A appears on one of the lines 50 to 80.

Because we can now read the position of a label, we can use labels for marking the start of a set of data stored in a program. Program 5 demonstrates this. The seemingly purposeless jump in line 10 is necessary to force Basic into finding and storing the address of label inverse A. This address is then read and assigned to variable S. Line 30 jumps S over the Goto in line 90, and over line number 100 and is ready to start reading the data contained in lines 100 to 170.

One of the problems resulting from the use of machine-code routines is that they often render the whole program non-relocatable. This is true where the machine code is called from Basic by an instruction of the type:

LINK # 89AB

That is, where an absolute address is used in the Link command.

One way out of this problem is to include the desired routine as a set of assembler instructions and assemble the routine every time the program is run. This is, however, very wasteful of precious RAM.

Initialising jump

Program 6, shows a technique for marking the start of a machine-code routine with a label. The machine code must start immediately after the end of the Basic text. Label inverse A is initialised by jumping to it from line 10, as in program 5. Line 50 calculates the address of inverse A and adds eight to the result to cater for the length of line 90 plus the carriage return and program-terminating byte.

This resultant value is the address of the start of the machine-code routine and the Link command can thus make use of it. This technique enables programs incorporating machine-code routines to be totally relocatable.

I have started working on a large program which uses a machine-code routine accessed in the way I have described. I soon became very frustrated, however, because every time I changed a line or character in the Basic segment of the program, I would either overwrite or fall short of the machine-code routine and consequently would have to re-assemble it all.

Terminator file

This is because the monitor shuffles the program text only as far as the Basic terminator byte # FF, and the machine code following this was therefore not moved.

So, include the machine-code routine as a part of the Basic program as follows. Find the location of Top. Top-1 contains the terminating # FF and Top-2 contains a return # 0D. Replace the # 0D with # 3B, which is a semicolon, then assemble the routine starting at Top-1 thus overwriting the # FF.

Note the location of the final byte of the machine code from the listing produced as the routine is assembled. Poke # 0D into the next location and # FF into the one following that.

The monitor now treats the machine code as part of the Basic program and moves it with the rest of the text following insertions and deletions. Listing the program can produce strange results depending on the characters the monitor finds when it reaches the machine code. It is, therefore, probably best to list only as far as the last line number. ■

Program 1.

```
10fA=ABSRND%4
20 ?#2928=( 61+A)
30 GOTOa
40aP."SALT "
50bP."MUSTARD "
60cP."VINEGAR "
70dP."PEPPER "
80eP.';GOTOf
```

Program 2.

```
10  GOTOf;<13 Spaces>
20f INPUT"$=‘$#200A
30  S=#2909
40  DO S=S+1;?#2953=?S;GOSUBa
50  UNTIL 0
60AP.'"SUBR a";RETURN
70bP.'"SUBR b";RETURN
80cP.'"SUBR c";RETURN
90dP.'"SUBR d";RETURN
100eEND
```

Program 3.

```
10  REM <20 Spaces>
20  m=?#12*#100+7;N=M
30  IN.$M
40  DO M=M+1;U.?M=#D;?M=#20
50  M=N
60 xN?#68=?M
70  GOTOa
80aP.'"AT a";G.z
90bP.'"AT b";G.z
100cP.'"AT c";G.z
110dP.'"AT d";G.z
120zM=M+1; IF?M<>#20 G.x
130 END
```

Program 4.

```
10FA=ABSRND%4
20 Q=#2951+(A*23)
30 ?#38E=Q/#100;?#38D=Q%#100
40 GOSUBa;GOTOf
50 P.'"LINE 50";RETURN
60 P.'"LINE 60";RETURN
70 P.'"LINE 70";RETURN
80 P.'"LINE 80";RETURN
```

Program 5.

```
10   GOTOa
20bS=?#38E*#100+?#38D
30   S=S+LENS+3
40   DO
50   P.$S
60   S=S+LENS+3
70   UNTIL $S="STOP"
80   END
90a  GOTOb
100  THIS
110  IS
120  ONE
130  WAY
140  TO
150  STORE
160  DATA
170  STOP
```

Program 6.

```
10 GOTOa
20b< Programme text >
30 < Programme text >
40 < Programme text >
50 L=(?#38E*#100+?#38D)+8
60 LINK L
70 < Programme text >
80 < Programme text >
90aGOTOb <cr><#FF>
   < Machine code routine >
```

Memotech's New Memory System for the ZX81

It grows as you progress

Memopak 16K Memory Extension

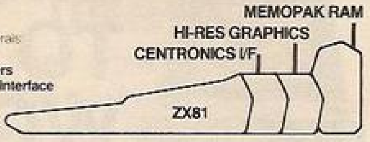
- £39.95 incl.VAT

It is a fact that the ZX81 has revolutionised home computing, and coupled with the new Memopak 16K it gives you a massive 16K of Directly Addressable RAM, which is neither switched nor paged. With the addition of the Memopak 16K your ZX81's enlarged memory capacity will enable it to execute longer and more sophisticated programs, and to hold an extended database.

The 16K and 64K Memopaks come in attractive, custom-designed and engineered cases which fit snugly on to the back of the ZX81, giving firm, wobble-free connections. See below for ordering information.

Coming Soon...

A complete range of ZX81 plug-in peripherals:
Memotech Hi-Res Graphics
Centronics Interface and Software Drivers
Memotech Digitising Tablet **RS232 Interface**



All these products are designed to fit 'piggy-back' fashion on to each other, and use the Sinclair power supply. WATCH THIS SPACE for further details. We regret we are as yet unable to accept orders or enquiries concerning these products – but we'll let you know as soon as they become available.

How to order your Memopak.

By Post: Fill in the coupon below and enclose your cheque/P.O./Access or Barclaycard number.

By Phone: Access/Barclaycard holders please ring Oxford (0865) 722102 (24-hour answering service).

Memopak 64K Memory Extension

-£79.00 incl.VAT

The 64K Memopak is a pack which extends the memory of the ZX81 by a further 56K, and together with the ZX81 gives a full 64K, which is neither switched nor paged, and is directly addressable. The unit is user transparent and accepts basic commands such as 10 DIM A(9000).

BREAKDOWN OF MEMORY AREAS

0–8K . . . Sinclair ROM

8–16K . . . This section of memory switches in or out in 4K blocks to leave space for memory mapping, holds its contents during cassette loads, allows communication between programmes, and can be used to run assembly language routines.

16–32K . . . This area can be used for basic programmes and assembly language routines.

32–64K . . . 32K of RAM memory for basic variables and large arrays.

With the Memopak 64K extension the ZX81 is transformed into a powerful computer, suitable for business, leisure and educational use, at a fraction of the cost of comparable systems.

Unique 3 month trade-in offer!

When your programming needs have outgrown the capacity provided by 16K RAM, and you find it necessary to further extend your ZX81's capacity, we will take back your 16K Memopak and allow a discount of £15.00 against your purchase of our 64K model.*

**We reserve the right to reject, for discounting purposes, units which have been either opened or damaged in any way.*

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Please debit my Access/Barclaycard* account number

*Please delete whichever does not apply

SIGNATURE ____________ DATE ________

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64K RAM, Assembled		£79:00	
		Postage	£2.00
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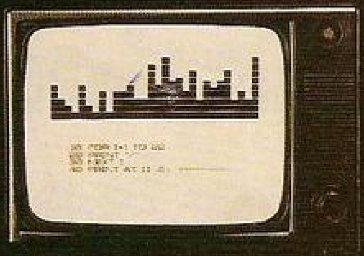


Sinclair ZX81 Personal Comp

the heart of a system that grows with you.

1980 saw a genuine breakthrough – the Sinclair ZX80, world's first complete personal computer for under £100. Not surprisingly, over 50,000 were sold.

In March 1981, the Sinclair lead increased dramatically. For just £69.95 the Sinclair ZX81 offers even more advanced facilities at an even lower price. Initially, even we were surprised by the demand – over 50,000 in the first 3 months!

Today, the Sinclair ZX81 is the heart of a computer system. You can add 16-times more memory with the ZX RAM pack. The ZX Printer offers an unbeatable combination of performance and price. And the ZX Software library is growing every day.

Lower price: higher capability
With the ZX81, it's still very simple to teach yourself computing, but the ZX81 packs even greater working capability than the ZX80.

It uses the same micro-processor, but incorporates a new, more powerful 8K BASIC ROM – the 'trained intelligence' of the computer. This chip works in decimals, handles logs and trig, allows you to plot graphs, and builds up animated displays.

And the ZX81 incorporates other operation refinements – the facility to load and save named programs on cassette, for example, *and* to drive the new ZX Printer.

New BASIC manual

Every ZX81 comes with a comprehensive, specially-written manual – a complete course in BASIC programming, from first principles to complex programs.

Kit: £49.95

Higher specification, lower price – how's it done?
Quite simply, by design. The ZX80 reduced the chips in a working computer from 40 or so, to 21. The ZX81 reduces the 21 to 4!

The secret lies in a totally new master chip. Designed by Sinclair and custom-built in Britain, this unique chip replaces 18 chips from the ZX80!

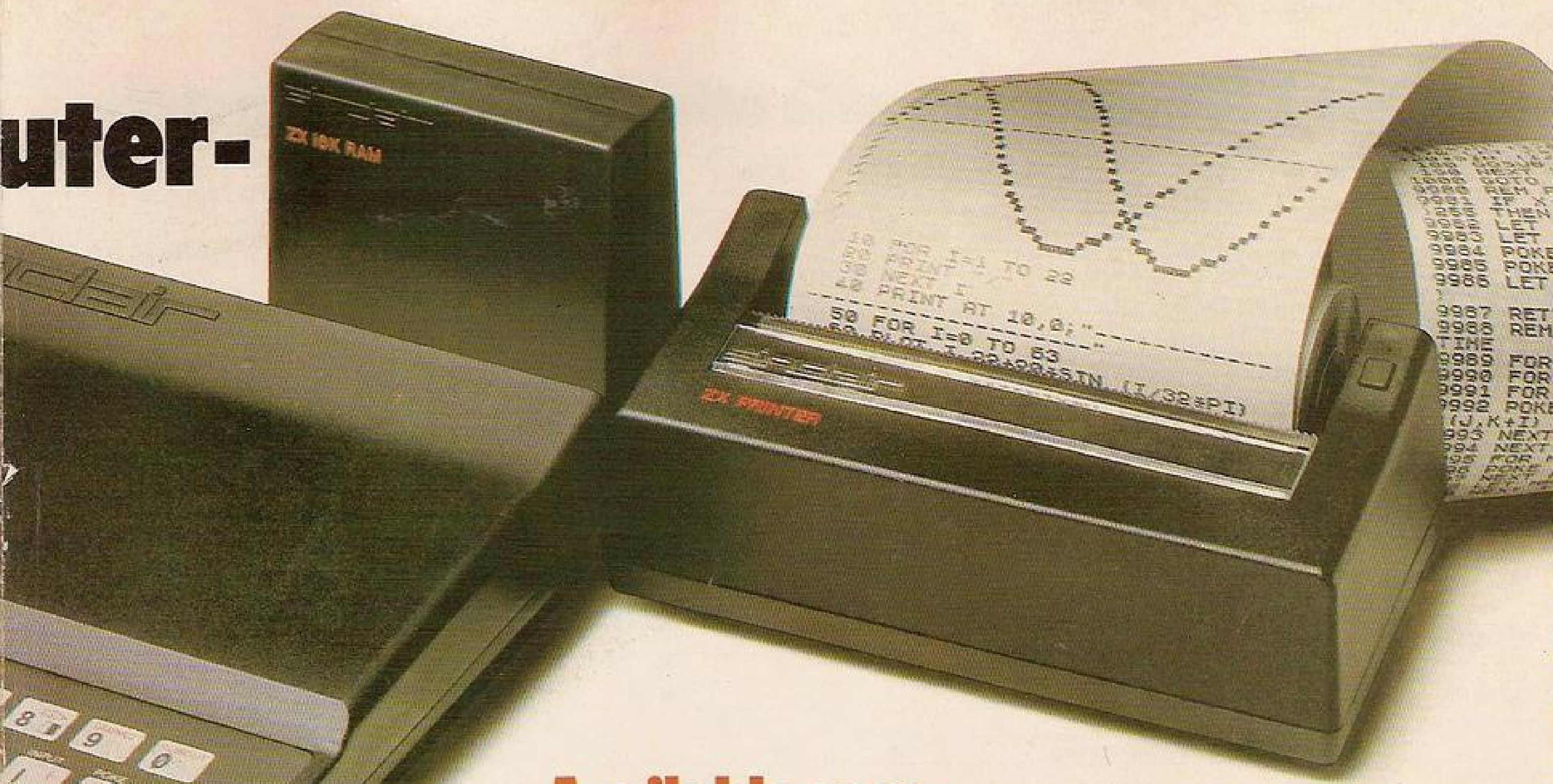
New, improved specification
- Z80A micro-processor – new faster version of the famous Z80 chip, widely recognised as the best ever made.
- Unique 'one-touch' key word entry: the ZX81 eliminates a great deal of tiresome typing. Key words (RUN, LIST, PRINT, etc.) have their own single-key entry.
- Unique syntax-check and report codes identify programming errors immediately.
- Full range of mathematical and scientific functions accurate to eight decimal places.
- Graph-drawing and animated-display facilities.
- Multi-dimensional string and numerical arrays.
- Up to 26 FOR/NEXT loops.
- Randomise function – useful for games as well as serious applications.
- Cassette LOAD and SAVE with named programs.
- 1K-byte RAM expandable to 16K bytes with Sinclair RAM pack.
- Able to drive the new Sinclair printer.
- Advanced 4-chip design: micro-processor, ROM, RAM, plus master chip – unique, custom-built chip replacing 18 ZX80 chips.

Built: £69.95

Kit or built – it's up to you!
You'll be surprised how easy the ZX81 kit is to build: just four chips to assemble (plus, of course the other discrete components) – a few hours' work with a fine-tipped soldering iron. And you may already have a suitable mains adaptor – 600 mA at 9 V DC nominal unregulated (supplied with built version).

Kit and built versions come complete with all leads to connect to your TV (colour or black and white) and cassette recorder.

uter-



Available now- the ZX Printer for only £49.95

Designed exclusively for use with the ZX81 (and ZX80 with 8K BASIC ROM), the printer offers full alphanumerics *and* highly sophisticated graphics.

A special feature is COPY, which prints out exactly what is on the whole TV screen without the need for further intructions.

At last you can have a hard copy of your program listings–particularly useful when writing or editing programs.

And of course you can print out your results for permanent records or sending to a friend.

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 computer – using a stackable connector so you *can* plug in a RAM pack as well. A roll of paper (65 ft long x 4 in wide) is supplied, along with full instructions.

16K-byte RAM pack for massive add-on memory.

Designed as a complete module to fit your Sinclair ZX80 or ZX81, the RAM pack simply plugs into the existing expansion port at the rear of the computer to multiply your data/program storage by 16!

Use it for long and complex programs or as a personal database. Yet it costs as little as half the price of competitive additional memory.

With the RAM pack, you can also run some of the more sophisticated ZX Software – the Business & Household management systems for example.

How to order your ZX81

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, Access, Barclaycard or Trustcard.

EITHER WAY – please allow up to 28 days for delivery. And there's a 14-day money-back option. 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 ZX81 Personal Computer kit(s). Price includes ZX81 BASIC manual, excludes mains adaptor.	12	49.95	
	Ready-assembled Sinclair ZX81 Personal Computer(s). Price includes ZX81 BASIC manual and mains adaptor.	11	69.95	
	Mains Adaptor(s) (600 mA at 9 V DC nominal unregulated).	10	8.95	
	16K-BYTE RAM pack.	18	49.95	
	Sinclair ZX Printer.	27	49.95	
	8K BASIC ROM to fit ZX80.	17	19.95	
	Post and Packing.			2.95

☐ Please tick if you require a VAT receipt TOTAL £______

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

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

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How the ZX81 compares with other personal computers

SYSTEM IDENTIFICATION		ZX81	ZX80	ACORN ATOM	APPLE II PLUS	PET 2001	TRS 80 LEVEL I	TRS 80 LEVEL II
ROM		8K	4K	8K	8K	14K	4K	12K
GUIDE PRICE	Basic unit – inc. VAT	£70	£100	£175	£630	£435	£290	£375
	Unit plus 16K RAM (*12K RAM)	£120	£150	£285*	£630	£530	£360	£375
COMMANDS	LIST, LOAD, NEW, RUN, SAVE	●	●	●	●	●	●	●
STATEMENTS	PRINT, INPUT, LET, GOTO, GOSUB/RETURN, FOR/NEXT IF/THEN	●	●	●	●	●	●	●
	STEP	●		●	●	●	●	●
	TAB	●			●	●	●	●
ARITHMETIC	ABS, RND	●	●	●	●	●	●	●
FUNCTIONS	INT	●			●	●	●	●
	ATN, COS, EXP, LOG, SGN, SIN, SQR, TAN	●			●	●		●
	ARCSIN, ARCOS	●						
STRING	CHR$	●	●		●	●		●
FUNCTIONS	LEN	●		●	●	●		●
	ASC(CODE), STR$, VAL, INKEY$	●				●		●
NUMBERS	FLOATING PT $\pm 10^{\pm 38}$	●			●	●	●	●
	INTEGERS		●	●	●	●		●
NUMERIC	A-Z			●			●	
VARIABLES	AA-ZØ				●	●		●
	An-Zn, n=any alphanumeric string	●	●					
STRING	A$ & B$						●	
VARIABLES	A$ to Z$	●	●	●				
	An$ to Zn$ n=any alphanumeric character				●	●		●
NUMERIC	SINGLE DIMENSIONAL		●	●			●	
ARRAYS	MULTI DIMENSIONAL	●			●	●		●
DISPLAY	ROWS	24	24	16	24	25	16	16
	COLUMNS	32	32	32	40	40	64	64
	LOW RES GRAPHICS (<7000 pixels)	●	●	●	●	●	●	●
	HI RES GRAPHICS (>40000 pixels)			●	●			
SPECIAL	USR (CALL, LINK)	●	●	●	●	●		●
FEATURES	PEEK, POKE (OR EQUIV)	●	●	●	●	●		●

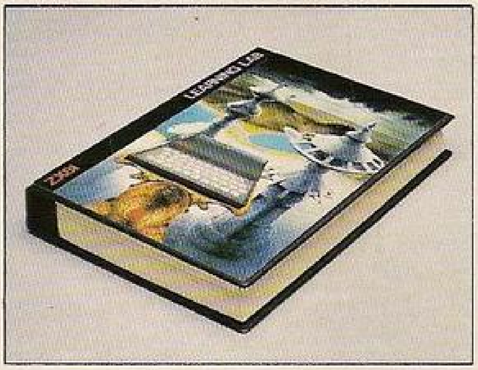
Sinclair software on cassette.

The unprecedented popularity of the ZX Series of Sinclair Personal Computers has generated a large volume of programs written by users.

Sinclair has undertaken to publish the most elegant of these on pre-recorded cassettes. Each program is carefully vetted for interest and quality, and then grouped with others to form single-subject cassettes.

Software currently available includes games, junior education, and business/household management systems. You'll receive a Sinclair ZX Software catalogue with your ZX81 – or see our separate advertisement in this magazine.

The ultimate course in ZX81 BASIC programming.



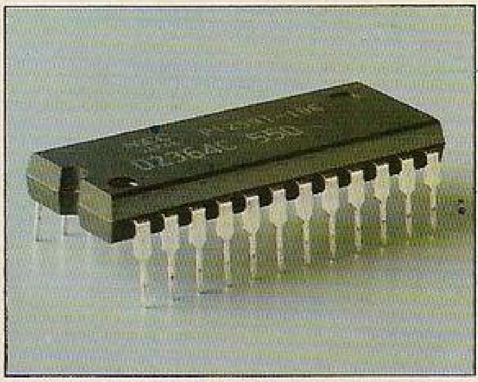
Some people prefer to learn their programming from books. For them, the ZX81 BASIC manual is ideal.

But many have expressed a preference to learn *on* the machine, *through* the machine. Hence the new cassette-based ZX81 Learning Lab.

The package comprises a 160-page manual and 8 cassettes. 20 programs, each demonstrating a particular aspect of ZX81 programming, are spread over 6 of the cassettes. The other two are blank practice cassettes.

Full details with your Sinclair ZX81.

If you own a Sinclair ZX80...



The new 8K BASIC ROM used in the Sinclair ZX81 is available to ZX80 owners as a drop-in replacement chip. (Complete with new keyboard template and operating manual.)

With the exception of animated graphics, all the advanced features of the ZX81 are now available on your ZX80 – including the ability to drive the Sinclair ZX Printer.

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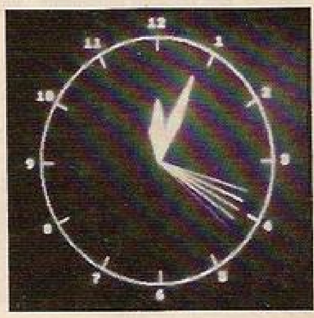
BBC BOOSTS GRAPHICS

Until recently micro users could only display information on screen in crude diagrams. Brian Smith reveals a way which will lead you out of the realm of fuzzy bar charts.



INEXPENSIVE high-resolution computers such as the BBC Micro have made it possible to create new, graphic ways of communicating facts, figures, trends, and results.

These graphics can also be used to portray two- and three-dimensional images, to manipulate those images and to hint at ways in which you can produce useful graphics routines of your own, to fit in with your own problems. After all, it is not nearly as much fun creating graphics just for its own sake — far better to begin to use the computer as a tool, possibly even a creative partner, in your work or other activities.

Phenomenal capability

Supplied with the BBC machine is the *User Guide.* Probing into this substantial volume reveals that the graphics capability of the computer is phenomenal. The commands Move and Draw are the simplest ways of moving to a point or drawing a line; but they are just duplicates, for ease of use, of two of the many graphics commands, more generally referred to by words such as Plot, Mode and VDU.

Plot, for example, can have one of 256 codes following it, though some are reserved for future expansion. VDU presently has 32 ways of working, some of which need another eight pieces of information.

Though this may seem over-complex, I believe that you will only rarely require more than a small proportion of these, as the machine's designers anticipated with their use of Move and Draw to duplicate Plot 4 and Plot 5. The great power of the machine stems from the fact that you can, if you want, superimpose a window on the graphics screen, or link the text and graphics cursors — the graphics cursor allows you to plot text of any colour anywhere on the screen.

The screen resolution is referred to by plotting up to 1,280 points horizontally and up to 1,024 vertically, though this is scaled down automatically to resolutions between 160 by 256 and 320 by 265. The model B, with more memory, goes up to 640 by 256, which means it really needs a monitor rather than a television. My machine is rock-steady on a monitor, and quite passable on an poor-quality, colour television — it can drive both, and an RGB colour monitor, simultaneously.

Finally, mention should be made of the programmable function keys. There is no reason why you should not, after a little careful programming, draw circles, for example, by pressing one key, and boxes with another.

The photographs show the results of the programs Clock and Photo from the BBC *Welcome* pack.

Program 1 runs on the BBC machine, though it was first written on a 380-Z. Its purpose is to show a matrix of information as a kind of contoured landscape. The original aim was to show heights, taken from points on a flat map, and give a rough idea of what the countryside looked like, but it can, of course, be used to present any information which is of equivalent form.

The result is to show a kind of slice through the landscape, which should really be at a 45° angle on one corner. If, however, you want that, you must also turn your TV on its corner, too!

Line 100 sets the resolution and line 110 the colour. Lines 140 to 160 produce random values for the matrix, but of course you could enter your own data via Read-Data or a series of input statements. The program draws many little lines at 45°, making their length proportional to the value they represent. Then the grid is laid over them, and distorted to fit these lines. Lines 330 to 350 merely make the visible edges neater.

Endless possibilities

Try inputting values, instead of random information. That will generate different types of landscape. Alternatively you could generate them mathematically — the possibilities are endless.

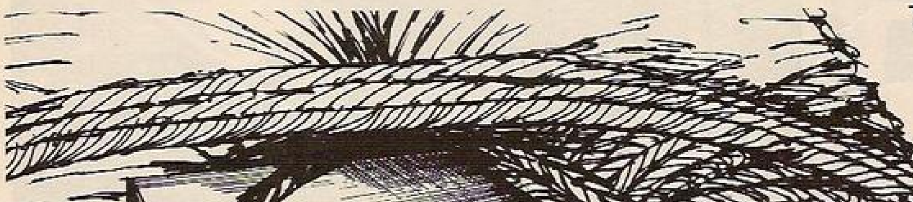
For those with other machines, remember that Move goes to a point without leaving a trace; Draw leaves a line. For those with lower resolution screens, reduce every value of 100, in the program, to 15 or so, and change the 80, in line 150, to 10.

Over the next months, I shall be encouraging you to produce programs which can be of benefit to other users, as well as fitting into the broad theme of this column. ■

Program 1.

```
100 MODE 5
110 GCOL 0,7
120 H=8: V=8: REM ......OR SO
130 DIM X(H,V),Y(H,V),D(H,V)
140 FOR I=1 TO H:FOR J=1 TO V
150     D(I,J)=RND(80)
160 NEXT J:NEXT I
170 FOR I=1 TO H:FOR J=1 TO V
180     MOVE 50+I*100*H/(H-1),J*100*V/(V-1)
190     X(I,J)=(50+I*(100*H/(H-1)))-D(I,J)
200     Y(I,J)=(J*(100*V/(V-1)))+D(I,J)
210     DRAW X(I,J),Y(I,J)
220 NEXT J:NEXT I
240 REM NOW CONNECT UP POINTS STORED IN X()&Y()
250 FOR I=1 TO H:FOR J=1 TO V
260     IF J=1 THEN MOVE X(I,J),Y(I,J) ELSE DRAW X(I,J),Y(I,J)
280 NEXT J:NEXT I
290 FOR I=1 TO V:FOR J=1 TO H
300     IF J=1 THEN MOVE X(J,I),Y(J,I) ELSE DRAW X(J,I),Y(J,I)
320 NEXT J:NEXT I
330 MOVE 50+100*H/(H-1),100*V/(V-1)
340 DRAW 50+H*100*H/(H-1),100*V/(V-1)
350 DRAW 50+H*100*H/(H-1),V*100*V/(V-1)
360 END
```

Untying the strings from Basic dialects



Tony Edwards reveals the essential features of those string-handling commands which form such a powerful weapon in the Basic armoury. On the surface they appear to be different in each dialect, but after a little study you should find you are able to translate most programs to run on your own micro.

STRINGS PLAY a most important part in many programs, be they for games or commercial use, and the differences from dialect to dialect are not great. The $ sign is almost universally used as a suffix to denote a string variable so there should be little difficulty in identifying strings in program listings, although $ is also occasionally used for other functions.

In many Basics, variables can be declared as string variables using the statement

```
DEFSTR A,B,C
```

or

```
DEFSTR A-C
```

both of which cause all variables whose names begin with A, B or C to become string variables even though they may lack the $ suffix. If your machine does not have these functions, add $ to all those variables to be used as strings, but beware of redefinition with Defint, Defsng or Defdbl or by suffixes such as % , ! or #.

Strings have limited length, but that length is variable depending on the interpreter used. At least 16 are usually permissible, but some computers, such as the BBC Microcomputer, allow up to 255 characters. If a program uses very long strings take care that your machine can handle them. Sometimes the program will crash but, more dangerously, it may simply ignore the extra characters and you will never know — until, that is, the program fails to produce the expected results.

If you run into this problem, the over-long strings must be broken into smaller ones. I would advocate the use of a string array large enough to hold the whole of the oversize string in bits and having the same name.

Program 1.

```
10 C = P/N
20 C$ = STR$(C)
30 FOR I = 1 TO LEN(C$)
40 IF MID$(C$,I,1)<>"."THEN 70
50 PRINT LEFT$(C$,I-1);"POUNDS";
   MID$(C$,I+1,2);"PENCE"
60 I=LEN(C$)+1
70 NEXT I
```

Program 2.

```
10 C = P/N
20 PO = INT(C)
30 PE = C-PO
40 PE = INT(PE*100)
50 PRINT PO;"POUND";PE;"PENCE"
```

Reserved words

String names must not contain reserved words — that is, words the interpreters use to identify internal functions. Different machines have different reserved words so learn those relevant to yours and keep an eye open for them when translating. The rules for the use of reserved words also differ.

My machine and the BBC Microcomputer have the reserved word Val but the latter allows the string name Revalue$ and mine does not. The BBC Microcomputer only forbids reserved words at the start of a word and in upper case. This is a most elusive problem and should always be investigated as the cause of a syntax error in an apparently correct line.

Some computers, such as the Hewlett-Packard HP-83, require the reservation of string space before use. This should not be a problem as you should know if your system requires it, but watch out for an unnecessary Dim(A$) statement. A Pet user may recognise this as an array dimension statement when in reality on the Pet it is an unnecessary string dimension. Dimensioning unnecessary string arrays is a good way to run out of space.

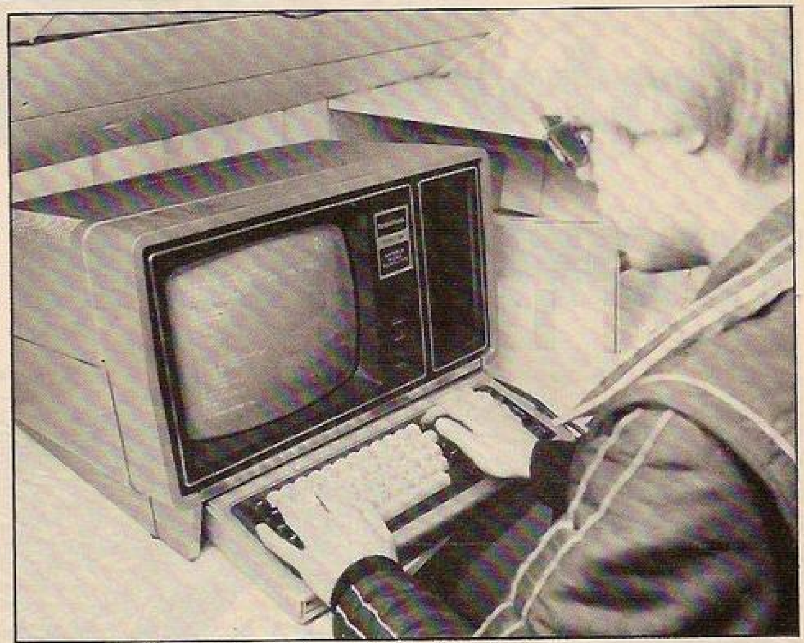
Clear statement

Other computers provide for reserved string storage space with a Clear statement which is often implicit in a Run. The default value is usually 50 bytes but it can be as high as 200 and so may need redefining with Clear(200). The Clear statement sometimes has the unrelated function of clearing terminal or output buffers.

Many Basics use Fre(A$) to identify remaining free space for strings, but do not confuse

(continued on next page)

Beware of unnecessary Dim statements on the Pet.



On the TRS-80 CHR$(26) is a line feed, not Clear Screen.

(continued from previous page)
this with the also common Fre(0) or Free(0) which returns the total amount of free memory remaining — it is similar to the Mem statement.

Equivalent functions

If your Basic dialect has string-manipulation functions, you should recognise the equivalent functions of other dialects without difficulty. Len; Left; Right; and Mid, sometimes with the "$", are common. One point to watch, however, is the BBC Microcomputer's statement Mid$(A$,n) which appears to be a parameter short; it is not.

On this computer Mid$(A$,n,m) acts as would be expected; it returns m characters starting with the nth, but Mid$(A$,n) returns all the characters starting with the nth. This could be simulated with the complex function

RIGHT$(A$,LEN(A$)-(n-1))

Some Basics have additional string functions. A common one is Cha$, Char$, or more rarely Chr. This retrieves the ASCII character having the value of the argument. For standard ASCII symbols this will not cause problems but values outside the usual ASCII range are non-consistent. For instance, on the UK101 Chr$(26) clears the screen but on the TRS-80, it is a line feed. Whenever you write to us, enclose, on a separate sheet, a list of the special Chr$ calls for your machine. When I have enough, I will reproduce a reference list for your use.

Program 3.

```
10  DIM A$(12)
20  LET A$="[A]A[B]BC[D]D[E]EF[G]G"
30  LET T=??(the number of semitones of
    transposition)
40  INPUT B$
50  FOR N=1 TO LEN B$
60  LET P=CODE B$(N)
70  IF P>45 THEN GOTO 300
80  LET P=(P-37)*2
90  IF P=6 OR P=8 OR P=10 THEN LET P=P-1
100 IF P>10 THEN LET P=P-2
110 LET P=P+T
120 IF P>12 THEN LET P=P-12
130 PRINT A$(P)
140 NEXT N
150 PRINT
160 RUN
300 LET P=P-165
310 IF P>=2 THEN LET P=P+P/2
320 GOTO 110
```

An irregularity which will cause translation trouble is the BBC Microcomputer's ability to use only the least significant byte of n in Chr$(n).

Another common extra string function is String$(n,m) which returns n characters of ASCII code m. This is often used to assist graphics output. If you do not have this function, look up m in the ASCII Code list and Print n of them. Alternatively, assign n of them to a string variable and Print that variable. A special case of this is found on the TRS-80 and Video Genie where Chr$(n), if n is above 191, returns a string of blanks which is useful for formatting.

Formatting statement

The pair of functions Str$(n) and Val(n) do not exist in all dialects. Str$(n) converts a variable to a string, so that it can be used in string manipulation, and the Val(n) converts it back again. If you do not have these functions, you must use arithmetical manipulation. For instance, programs 1 and 2 are identical.

In this case the arithmetical manipulation is easier, but the example serves as a comparison. In practice, it would be achieved better with a formatting statement, if you have one.

Here is a short test. In our December issue J F Vincent gave the useful program reproduced as program 3 to transpose music from one key to another. Can you translate it for use on your machine?

Worth the effort

This translation is not easy, but it is worth the effort both for the practice and for the program. The main problem lies with line 60 because you will have to guess its non-standard meaning. The [A] [B] etc., in line 20 represent inverse characters. If you have completed the translation and it still will not work, remember it was written for integer Basic so recheck your translation of line 310.

Next month, we shall look at the new BBC Microcomputer's dialect to identify statements which may cause trouble in translation, and to find some equivalents to non-standard functions. ■

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ASIMOV: WORD PROCESSOR IN MACHINE CODE

Playwrights, journalists, hoteliers, doctors and candlestick makers are all using word processors for their own purposes. John Dawson decided to build his own.

WORD PROCESSORS are one of the phenomenal growth areas of microcomputing. The term "word processing" was coined by IBM in 1964 to describe all automatic equipment that helped in the preparation of text.

There is much evidence to indicate that word processors increase the productivity of people who use them and a report by the Central Policy Review Staff — the Government's think-tank — concluded that the use of word processors instead of conventional typewriters results in consistent productivity gains in excess of 100 percent.

Such an increase in productivity may be achieved without socially unacceptable side-effects; one organisation trebled its workload by the introduction of word processors without any change in the number of people employed. In three other cases, however, there were serious reductions in the number of clerical staff employed by the companies.

As usual, the jargon term "word processors" covers a diversity of different uses and needs. A typist in an office may require fast access to any one of hundreds of standard paragraphs or letters in the production of personal but standard mail.

Another secretary in the same organisation may spend the majority of the time typing and then correcting draft reports — she will have only one document in hand at a time and the prime requirement that she will have is flexible editing and extensive print options. Someone else may need to sort a mailing list according to certain criteria for advertising purposes.

In the beginning

When I started to design Asimov I had about two years experience of using dedicated, commercial word processors and that period of information systems analysis saved time; I knew very largely what I wanted the program to do.

Cassettes are satisfactory for bulk storage if the computer has sufficient RAM to hold the whole of a document, or a convenient subsection of it, in the machine at one time. If you can manipulate a book chapter, or the whole of an article without waiting for a slow floppy disc, why not use fast RAM as virtual disc memory; with a full TanRAM of 40K connected to the system, the Microtan computer will hold between 7,000 and 8,000 words of text.

Asimov loads text from tape at rather more than 1,000 words a minute. Two minutes at the start and end of a writing session is acceptable for storing and retrieving a document.

Like most programs, Asimov is a combination of top-down ideas and bottom-up programming. I started with the concept that I wanted a word processor built as a series of modules so that as the program developed a new function would consist eventually of a series of subroutine calls to earlier, more primitive, sections of machine code.

Asimov took about six months to write and although I started using the Tangerine assembler in X-Bug, it would have been impossible to complete the program without the ability to store source code on tape for subsequent editing and modification.

So, about one-third of the way through I rewrote several hundred lines of code using the Microtanic Software two-pass assembler and then continued to complete the program in slightly less than 3,400 lines, about 33K of source code. The assembled machine code is just over 7K in length.

The dialogue design is vitally important in a program of this kind, where it must become an extension of the writer's thoughts. Plain English messages are displayed at the top of the screen throughout Asimov. For example, when you want to write a text the program asks you first:

DESTROY old text? <Y>

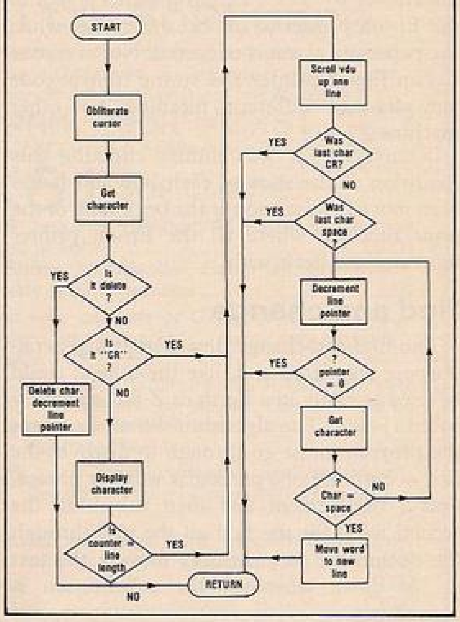
Because the decision is important, you must press Y or y — it makes no difference — rather than the reflex action of pressing the Return key. Then you can write new text by typing on to the screen. Whenever the program needs an unusual response to do something, the correct key entry is shown on the top line of the screen.

In the course of editing a document you have to move the cursor all over the screen and you should be able to do so by pressing one key for one movement. The place to which your finger has to travel should correspond as closely as possible to the direction you would point to move the cursor on the screen.

The cursor can be moved and positioned over the whole screen using the cursor controls illustrated in figure 1.

The effects of pressing the keys on the numeric keypad are: left; right; down one line; up one line; scroll display up one line; scroll display up 15 lines; cursor to start of next line; cursor to top-left corner of screen; return cursor to start of document.

Word wrap.



The full stop in a circle is a command to search the text for a Control W character and then display the next page of text.

There is nothing unusual about this layout. Indeed, it would be a bad sign if there were. However, using the program I think that the functions performed by the 7 key are correct but could have been allocated elsewhere. It would be useful to have a key available to return the cursor to the start of the previous line.

The rate at which a cursor blinks is important and the Human Sciences and Advanced Technology Unit at Loughborough University suggests that the blink rate should be between two and four times a second. Ideally, the user should be able to stop the cursor flashing.

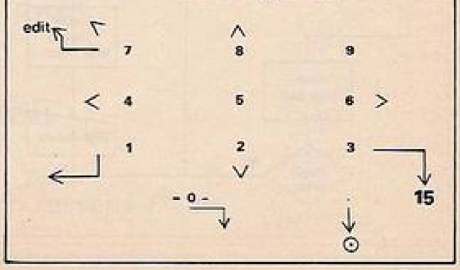
The three flowcharts illustrate some of the problems that have to be overcome in designing a system which will take the burden of computer operating away from a writer. The word-wrap flowchart was part of an article in Tansoft Gazette and is less complex than the final program as it relates only to word-wrap on the bottom line of the screen. The final version of Asimov prevents broken words anywhere on the VDU.

The printer-control flowchart demonstrates how easy it is to overlook tiny details; the first decision in the flowchart is "? single sheet". If

(continued on next page)

Figure 1.

The numeric key pad and cursor movements



(continued from previous page)
the answer is "Yes", a control signal is sent to the Epson printer to inhibit the buzzer when the paper-out alarm is triggered. Not everyone has an Epson printer and so the control code may have a different meaning for other machines.

In any case, it was clumsy checking this condition at the start of each line and it has been moved to a section at the beginning of the print function where all the Epson printer functions are dealt with.

Find and change

The find-and-change flowchart is a general-purpose algorithm and, like the others, could be used as easily in a Forth or Z-80 assembler-based system. The algorithm shows the stages the program must go through to discover the first occurrence of a particular word or phrase, find a replacement and then substitute the second word for the first all the way through the document, automatically moving the text up or down whenever the substitution is carried out.

The Find command will accept a word or phrase up to 20 characters long. Comparison starts at the beginning of each word and a full stop will match with any other character to allow the automatic correction of sections of words.

For example: ......tion will match with "automation" and "correction". Dates can be changed automatically by finding ../../79 and changing that date to 01/11/83 or 15th March 1984. You can save a good deal of effort in typing a document by using an identifiable code such as XXX every time you need to write "Information Technology Year 1982" or "Trichophyton equinum schonleinii", and then automatically replacing the code with the phrase.

The core edit commands that any word processor must have also include: Delete character, word, sentence or paragraph. Insert text anywhere in an original document. Overwrite the existing text. Move paragraph to a text buffer and bring the paragraph back To the cursor position, once or as many times as you wish. Kill the remainder of the text. Print from the cursor position. Continue writing from the end of the text. All of these are single keystroke commands.

Tape functions allow a user to: Store text on tape. Documents are stored with the printer Layout codes to format the text when it is retrieved. Retrieve text from tape. Text name on tape may be up to 25 characters long and all the characters are significant when Asimov is searching a tape for a document. Append a text from tape to a document already in the computer.

Print commands

Each document on the tape is stored with a comment section so that you can record the stage that a draft document has reached or the date when something was completed without the information forming part of the text itself. The tape speed can be altered simply by typing "T".

The Print commands include: page Layout which can be controlled by setting:

Right margin
Left margin
Line spacing
Page length
Form length
Single sheet or continuous stationery

Automatic page numbering is available starting from page 1, or another number that you set. Alternatively, Asimov will leave the first page for a main title and will then number the subsequent pages.

Up to 20 tabulator stops can be set and these are displayed graphically on the layout screen.

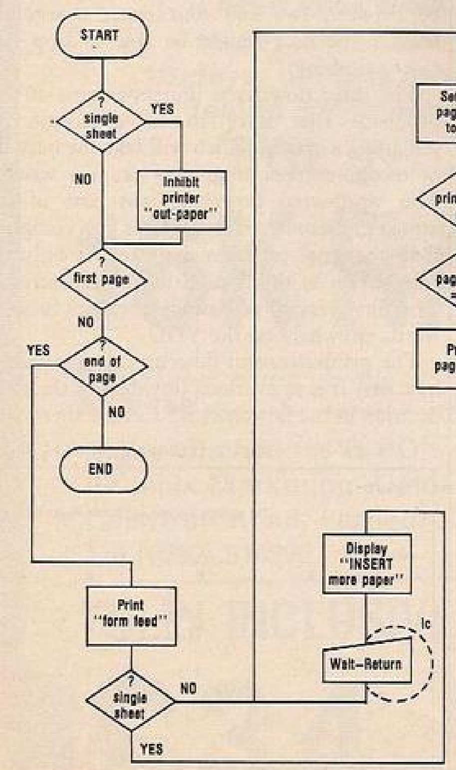
Condensed or emphasised type-styles can be set for the whole document and these can be varied by embedded commands inside the text.

Other instructions allow you to centre a line of text or indent the text by variable amounts to improve the presentation of a document. It is possible to put marginal notes into the left-hand margin and to number paragraphs.

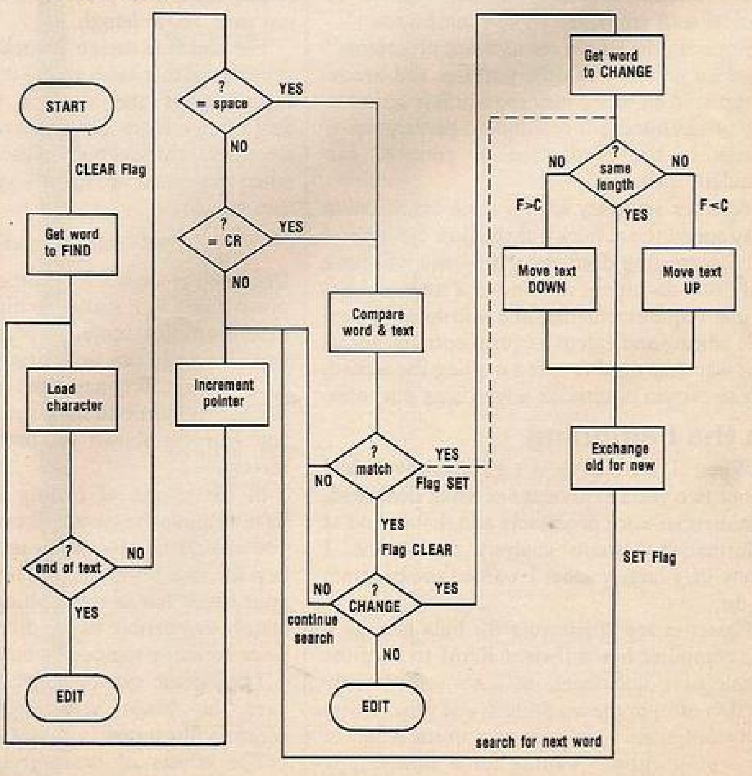
CONCLUSIONS

- Once you have used a real word processor for writing it is very difficult to settle for anything less. However, the "real" needs some emphasis.
- If your first experience of carpentry is a screwdriver with a wobbly handle or a badly-sharpened rule which makes ragged, off-centre holes no matter how careful you are, then you are unlikely to persist in your attempt to become a neat, skilled craftsman.
- Good tools are not flashy, they just do the job. In the same way the dialogue between a computer user and the machine should be unobtrusive and something of which the user is hardly aware.
- The documentation could be made more comprehensive and include additional functions for, say, telecommunications and macro printer commands. Nevertheless, Asimov works well and it is unobtrusive and enormously helpful.
- One further function even counts the number of words in an article — a huge labour-saving benefit. ■

Printer control.



Find and change.



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ACORN STRING

■Could you please help me? I used to have a Sinclair ZX-81 and have now purchased an Acorn Atom but there does not seem to be an equivalent to the Inkey$ function. Could you tell me what to do?

Lee Shields,
Shelf, Halifax.

THERE ARE a number of routines for reading the Acorn Atom keyboard. One way is Peeking into address # B005 which usually has the value 255 stored in it. If you press the CTRL key, this value changes to 191, and when Shift is pressed it changes to 127. So if you want a variable such as A to increase when you press CTRL and to decrease when you press Shift, you could include the lines:

```
100 IF ?# B005 = 191 A=A+1
110 IF ?# B005 = 127 A=A−1
```

Another way, which reads the Shift and Repeat keys, is to use the routine

```
100 IF ?# B001 & #80 = 0 A=A+1
110 IF ?# B002 & #40 = 0 A = A−1
```

KIT CATASTROPHE

■Attempts to reach technical staff at Sinclair Research result in a firm but polite refusal and the person to whom I have been referred in the company has no technical knowledge. I built my ZX-81 from a kit and have had problems with the keyboard. Apart from this, the circuit appears to be working. How can I further test my keyboard, to get greater stability under operating conditions?

W J Norman,
Alton.

YOU COULD TEST the keyboard circuit further by connecting a wire to one of the eight keyboard lines. Then tap on one of the KBD0-4 lines, thus imitating the keyboard switch. This will produce at least a keyword on the screen. The lack of stability you mention could be caused by one of two things. One possibility is the floppiness of the edge connection. This can be cured by expanding the printed-circuit board of the ZX-81 by applying solder to the expansion connector. The other is power: mains fluctuations — people pulling out plugs, devices drawing large amounts of power switching off and on nearby — can affect memory. Sometimes this can be caused by people outside your own house. Someone we know has problems at Romford, Essex when the Ford works at Dagenham switches over its power supplies. The shrinking RAM and white-out seem to be due to the same cause. If at any time the RAM loses power, all its bits reset themselves to zero. Then when the ROM draws from the RAM the next place to go, it resets itself, thus starting a RAM-check program. This RAM check sets the RAMtop variable, so if the power is not there until it reaches 11K then that is what it will consider the top of memory to be. If you wish to check all the component integrated circuits before inserting them on the board, may we recommend the ITT data book on TTL integrated circuits for pin connections and truth tables.

LOST LOADER

■ I recently bought a Sinclair ZX-81 in the hope of gaining some working knowledge of computers. Everything went fine until I tried to load a program into it and here I encountered some difficulty. The problem is that after going through the specified procedure for loading, the TV set gave a picture with light diagonal lines as the Newline key was pressed. The program lines appear as expected, but when the program finishes, the diagonal lines come back, and the only way to get the computer back to normal is to press the Break button. I tried everything, including various tape recorders, checking leads and the like, but to no avail. As a beginner at this, who built the unit from a kit, I thought I had a possible fault, so I sent the complete unit back to Sinclair for checking and repair if found necessary. I then received what looks like a new unit, but no explanation as to whether there was a problem, or if I was at fault. The new unit was set up, but on trying to load a program the same situation arose — diagonal lines. I have even tried the loading procedure without connecting the tape recorder input, but still obtain diagonal lines. I am now at a complete loss. The unit appears to save programs, according to the manual. The program I was trying to load was supplied by Sinclair. I hope you can give me some guidelines as to where I may be going wrong.

I M Hamilton,
Glasgow.

THERE IS one procedure that we know of to discover the most likely set-up for successful loading on the ZX-81. Discard, for the moment, the Sinclair tape. Buy a C-12 from a computer store, clean and, if you can, demagnetise the recording heads, and always clean them before use. Make sure the leads from the computer to the recorder do not cross the power supply line. Write a very short — say, two-line — program, and save that. Then, after pressing New then Newline, enter

```
LOAD ""
```

with nothing between the quotation marks. Making sure the tape is about half a second before the program starts, start the tape rolling, then quickly press Newline. The program should load — or not, as the case may be — within a few seconds. If you are unsuccessful, move the volume control up a notch, and try again. Do it over and over again, changing the volume slightly each time, until you achieve success. Once you have done so, mark the point where the volume control is, and always put it on exactly this point when loading. If you manage to load a program from the Sinclair tape in due course, immediately make a copy on your own tapes, as you will find it much easier to load programs recorded on your own machine than you would those recorded on other machines. Either cut out the capacitor across the tone control, or fix the tone control at maximum. You may also like to try adjusting the azimuth of the head while playing the Sinclair tape until you make the tape sound at maximum brightness. This should improve matters.

WHICH COMPUTER

■Could you possibly help me decide between the Acorn Atom and the Microtan/Tanex system? I have pondered for months on each one's merits and failings, and have failed to reach a conclusion. I am impressed by the low starting price of the Microtan 65, but not by the outlay necessary to reach Basic standard. I have experience in Basic already and do not, therefore, require a beginners' course. Nevertheless, my knowledge of assembler or machine code is virtually non-existent, which makes buying the basic Microtan 65 a risk.

The Atom appeals because it constitutes a simple route to a Basic microcomputer, although it lacks the built-in I/O ports available on the Microtan for future experimentation in control of external devices. Also there is no problem in deciding which box or power supply to buy.

Paul Stacey,
Oldham.

THIS IS A variation of the old "which is the best computer to buy" question. There is no simple answer and the longer you delay, the more you will deprive yourself of the delight of owning a machine. You have, anyway, more or less answered your own question. You say you know Basic, would like a machine which allows you to use Basic, and that the Atom has it. Although Atom Basic is non-standard, Atom users find it a delight once they grow used to it. As well, you will be able to upgrade your Atom to BBC Basic. If you want to know more about the Tangerine system, write to Bob Green at the Tangerine Users' Group. Almost any computer you buy nowadays will give you a great deal of satisfaction. Every month, every machine becomes a little closer to being obsolete. There will never be the "right" time to purchase. Why not take the plunge now and buy a machine? Then, in a year or so, use the experience you have gained in looking for your next computer.

PROS AND CONS

■Please could you tell me if it is true that a special cassette deck is needed for the Vic? If so, could you tell me why it is so special, or is it another way for the manufacturer to take money from enthusiasts? Why has this important subject been neglected from your reviews and other literature?

M Reddy,
Merseyside.

YES, YOU NEED a special cassette recorder, costing £40 to £50. It is a digital cassette recorder, storing information which is different from that stored by a normal audio recorder. Perhaps the reason it is not mentioned is because — as you suggest — it could deter people from buying the machine. On the positive side, the digital recorder offers much more reliable Loading and Saving than a domestic recorder.

SINCLAIR ON BBC

■I am considering buying a BBC Microcomputer. I have a number of ZX-81 programs, as well as books of programs written in Microsoft Basic. Will these run on the BBC machine?

Max Harris,
Dagenham, Essex.

PROGRAMS ACTUALLY saved from another computer will not load directly into the BBC machine, but many of them will be relatively easy to convert. Apart from a couple of things, such as the use of the query for Peek and Poke, and P. instead of ? as an abbreviation for Print — the BBC Basic is almost completely standard. It also shows considerable thought. To generate random numbers, for example, in the range one to six, many Basics insist you enter

```
LET D = INT(RND(1)*6) + 1
```

whereas on the BBC machine — as on the ZX-80 and the Tandy Colour Computer, but on very few, if any, other microcomputers — the line

```
D = RND(6)
```

will produce integers in the range one to six. ■

FINGERTIPS

Fingertips is our regular calculator column covering calculator news, programming hints and examples of unusual applications. The column is written and compiled by calculator enthusiast David Pringle who is glad to hear of any of your ideas. *Your Computer* pays £6 for each of your contributions published.

THE PACE AT which the top-of-the-market calculator firms modify and improve their products is stupendous and more than a little disconcerting for those of us who have a small bank balance, or a middle- to lower-end of the market calculator. For any of you in either or both of these categories, forgive me for dangling the following bait in front of you.

To review the past six months of developments I would precis the big three of up-market calculators as follows: Casio, Hewlett-Packard and Texas Instruments. I have kept you abreast of Casio's new range of 500, 600 and 700 series, but what of Hewlett-Packard's peripherals? These must be of interest not only to Hewlett-Packard fans, but to all of us who are interested in seeing how the personal programmable calculator is to develop into the portable pocket computer.

The Hewlett-Packard interface loop (HP-IL) — available in the United States since January — centres on a device which lets the HP-41 control and communicate with other machines and computers. This loop would, for instance, allow someone to gather data in the field and pump it into a larger mainframe computer at a later stage, or vice versa.

The HP-IL is Hewlett-Packard's standard for serial interfacing of its devices, including the 41-C, in a loop and allowing the serial transmission of data around that loop. A staggering number of 981 devices may be attached with maximum data transfer rates of 5,000 bytes per second.

With an HP-41 in the loop, the data transmission rate falls to the order of 200 bytes per second because, for serial transfer, the rate of transmission will be determined by the slowest component in the loop. Bank managers will groan when they hear that none of Hewlett-Packard's old peripherals appear compatible with the loop, and so a whole new series has been developed.

The most exciting is the digital cassette drive which has 128K of memory capacity with 13-second average file access time. This rectifies, admittedly in an expensive manner, a long-standing deficiency of the Hewlett-Packard armoury.

Other peripherals include a 101-character wide thermal printer with parsing and formatting, and a high-resolution video interface. One interesting facility of the loop is the ability to "wake up" any particular peripheral from a power-saving standby mode.

Lowering ourselves to slightly less expensive planes, Hewlett-Packard has introduced a new extended function memory module. This provides an extra 127 registers of X-RAM and 47 new functions including a programmable Size command and improved assignment and flag-clearing instructions. The most interesting new peripheral, though, is the 82182A timing module which gives several options for alarms, a stop-watch capable of storing up to 319 split times in RAM and a timing resolution of 10ms.

While the machine is turned off, the clock still receives enough power to run and can wake the calculator at any specified time. I must admit that I have not seen the last two in action but they are on general release.

I am absolutely delighted that someone has conceived a useful application for Casio's musical ability. I hand over to Dave Newman of Auld Reekie.

Program P2 — see figure 1 — splits a number in the display into its constituent digits, putting them in memories 09 down to 01, with the exponent and its sign in memories 12 to 14. Numbers are always output in scientific notation. If the number is negative —1 is stored in memory 09 and the eight most significant digits of the number in memories 08 to 01. Memory 12 stores the sign of the exponent; —1 for negative, —2 for positive.

Subroutine P4 then converts these numbers into note codes spread over the whole scale of notes played by the calculator. These 12 notes correspond in increasing pitch +, —, 0, 1, 2, 3, 4, 5, 6, 7, 8, and 9. Figure 2 shows the note codes calculated from the number 1.23456789E+00.

In use, when a calculation has been completed the user presses P2, with the cassette adaptor switch in the Cal position. After allowing some time for the note codes to be calculated, the user switches the adaptor to music and presses PO to output these notes to a tape recorder. He will hear nine tones for the number followed by a pause and then three tones for the sign and value of the exponent. PO can be pressed again if the user is not sure of the number. Afterwards the adaptor has to be switched to Cal before continuing calculations.

Figure 2.

```
MEMORY LIST
M00-19,F-1F 512steps
FILE :   HEAR

M00=            0.
M01= 37.24504366
M02= 44.59041297
M03= 53.38441663
M04= 63.91275051
M05= 76.51745464
M06= 91.60802527
M07= 109.6747185
M08= 131.3044772
M09= 188.2025695
M0F=            1.

M10=            0.
M11=            0.
M12=  225.319384
M13=       157.2
M14=       157.2
M15=           0.
M16=           0.
M17=           0.
M18=           0.
M19=           0.
M1F=           0.

       -1.23456789
       -1.23456789e 00
```

Figure 1.

```
PROGRAM LIST
M00-19,F-1F 512steps
FILE :   HEAR

*** P0
MR09
MR08
MR07
MR06
MR05
MR04
MR03
MR02
MR01
MRF
MR12
MR13
MR14
AC
          ...015steps

*** P2
Min14
9 Min00
2 +/-Min12
MR14 x>=0 GOTO0
x1 +/-Min09 m+00=
Min14
LBL0
log INT MinF +/- 10^x
x MR14
LBL1
- INT IND Min00 = x
10 =
DSZ GOTO1
MRF x>=0 GOTO2
x 1 +/- Min12
LBL2
÷10 - INT Min13 =x
10 = Min14
9 Min00
LBL3
IND MR00
GSBP4
IND Min00
DSZ GOTO3
MR12
GSBP4
Min12
MR13
GSBP4
Min13
MR14
GSBP4
Min14
1 MinF
          ...078steps

*** P4
x.18+/- = e^x x  157
.2=
          ...015steps
```

A slow tempo is set in memory F. As the user becomes familiar with the tones, he can speed up the output by changing the last line of the program to put higher numbers into memory F.

While learning the tones, program P1 may be useful — see figure 3. To use enter a single-digit number, e.g., 4, then press P1 and wait until it has had time to calculate the note code. Then change the adaptor switch to the music position and press Exe, whereupon the tone corresponding to 4 is recorded on tape or heard on a monitor earphone.

Note that this program uses all the memories on an FX-501P or 601P, so anything in these memories will be lost on calling P2. If numbers in these memories are needed later, they have to be saved on cassette before listening to a result.

For the FX-502P and 602P, other programs must use memories 10,11 and 15 onwards to keep numbers which are wanted after hearing a result.

On the FX-501P and 601P calculators the programs P0 and P2 must be written with the calculator connected to an FA-1 or FA-2 adaptor with the switch in the Music position — but run with this in the Cal position. Thus Min 12 is written Min.2, etc. The memory 1F used in P1 can be changed to any convenient memory.

It would be interesting to hear from any blind people who succeed in using this program.

Paul Stockwell of Andover asks why there are no programs for the Commodore PR-100. Well, here is his to make up for it.

The purpose of this program is to find the point of intersection of two straight lines; one is in the calculator's linear regression function, and the other is the user's program.

The program requires only two cartesian (x,y) co-ordinates for each of the lines. Two or more sets of co-ordinates may be entered into the linear regression function, as described in the instruction manual, for the first line which may be of positive or negative slope. The second line can then be entered in memory. Only two co-ordinates may be entered and these are entered in memories 0-3 as shown in table 1. Note this second line must be of negative slope.

When the program is started it will run briefly to evaluate the slope and intercept of the second line and will

```
PROGRAM LIST
M00-19,F-1F 512steps
FILE :   HEAR

*** P1
GSBP4
MIN1F
HLT
MR1F
AC
          ...006steps
```

Figure 3.

stop to display 0. The value of the first increment is then placed on the display. This is both to speed up the program and to allow the required degree of precision to be set.

If the intersection value was 1, for example, and the increment was 0.001 then the machine would do 1 ÷ 0.001 = 1000 loops. If the increment were, say 0.1 then it would do only 10 loops.

This means that a substantial speed increase can be obtained by allowing progressively smaller increments to be entered. This program allows this, and increments from 1 down to 0.0000001 can be entered. The second number is the lower limit of accuracy.

If the increment is greater than the intersection value, it will display 0; if not, it will display the most accurate

(continued on next page)

Memory No	Contents
0	value of 1st x ordinate
1	value of 1st y ordinate
2	value of 2nd x ordinate
3	value of 2nd y ordinate
5 to 9	linear regression

Table 1. Memory contents before first run

Memory number	Contents
0	slope of second line m
1	constant of second line c
2	value of x intercept Xi
4	value of increment
5 to 9	linear regression

Table 2. Memory contents after first run.

(continued from previous page)
value of the intersection's x ordinate it can find in the increment range.

The program will also pick the best straight line through a selection of points if they are entered into the linear regression function, before finding the intersection. The no-operation step, number 54, is entered by placing the calculator's three-position switch in the clear mode and pressing the step key once before returning to load mode.

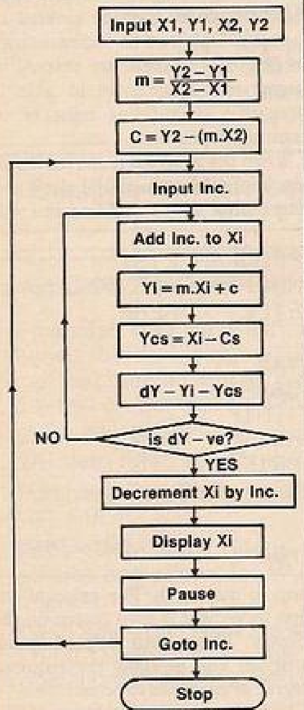

Figure 4. Flowchart for intersection program.

Figure 5. Intersection program.

STEP NO.	REMARKS	KEY NO.	PNTR.	KEY FUNCT.
1	recall Y2	52	00	MR
2		81	01	1
3	subtract	85	02	–
4	Y1	52	03	MR
5		83	04	3
6	divide	75	05	÷
7	result by	64	06	(
8	X2 – X1	52	07	MR
9		91	08	0
10		85	09	–
11		52	10	MR
12		82	11	2
13		65	12	)
14	gives m	95	13	=
15	store in	51	14	M
16	memory 0	91	15	0
17	recall X2	52	16	MR
18		82	17	2
19	multiply	74	18	X
20	by m	52	19	MR
21		91	20	0
22	subtract .	85	21	–
23	from Y2	52	22	MR
24		83	23	3
25	exchange	55	24	X – Y
26	registers	95	25	=
27	store c	51	26	M
28		81	27	1
29	clear M2	91	28	O
30		51	29	M
31		82	30	2
32	pause for	13	31	R/S
33	Inc.	51	32	M
34		71	33	4
35	recall	52	34	MR
36	Inc.	71	35	4
37	add Inc.	21	36	F
38	to Xi	84	37	M +
39	in M2	82	38	2
40	recall Xi	52	39	MR
41		82	40	2
42	multiply	74	41	X
43	m	52	42	MR
44	= m.Xi	91	43	O
45	add c	84	44	+
46	recall c	52	45	MR
47		81	46	1
48	Yi = mXi + c	95	47	=
49	subtract	85	48	–
50		64	49	(
51		52	50	MR
52	recall Xi	82	51	2
53	Ycs	44	52	Cs
54	1	65	53	)
55	No Op.	99	54	step
56	Yi – Ycs	95	55	=
57	If – ve	15	56	SKIP
58	skip to	14	57	GOTO
59	60	83	58	3
60	Yi = Yi + Inc	71	59	4
61	If Yi – Ycs	52	60	MR
62	decrement	71	61	4
63	Xi	21	62	F
64		85	63	M –
65		82	64	2
66	display Xi	52	65	MR
67		82	66	2
68	pause	13	67	R/S
69	input new	14	68	GOTO
70	Inc.	83	69	3
71	value	81	70	1

If 2nd line to be +ve slope then insert key X↔Y in location 55.

If the exchange-registers key is entered into location 54 instead, the machine will find the intersection for a second line with a positive slope only. If the increments entered are smaller than one another by a factor of 10 each time then there will be no more than 10 loops each successive run. If there are too many, try a larger increment, and if this does not work then the lines may not cross.

Finally, a novel attempt at analysing the solution of December's four-dot problem comes from Alan Stevens of Alvaston. To refresh your memory, the problem is: starting at a side dot, what is the expected, or average number of moves to traverse to the dot on the opposite side gives:

Prob. → Left 2 or 3 = Prob. ← Right 2 or 3 = ½
Prob. → Left 1 = 1
Prob. → Right 4 = 1

· · · ·
1 2 3 4

It is a pleasing problem, he writes — simply stated, but requiring careful thought. Unfortunately, I discovered an analytical solution. This made it seem somewhat pointless trying to perform the numerations to within 10^{-6} on the calculator However, I thought it would be interesting to write a program to perform a Monte Carlo simulation of the problem, using the pseudo random number generator on any Texas Instruments TI-59 calculator.

To run the program store a seed in 09 and the number of simulations to be run through in 06, then press RST and R/S. ■

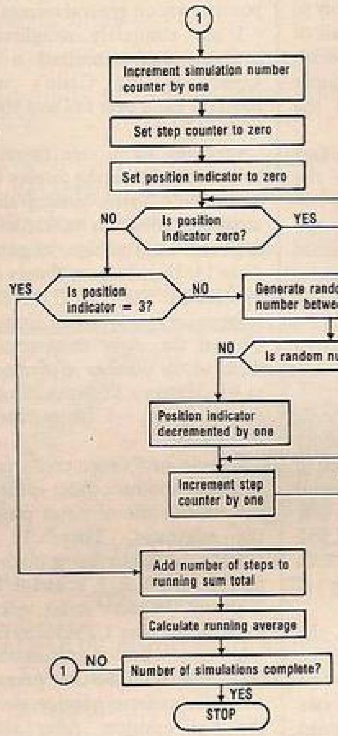

Figure 6.

```
Op   21        x>=t 036
CLR            Op  33
STO 02         GTO 038
STO 03         Op  23
RCL 03         Op  22
x=t 036        GTO 007
RCL 03         RCL 02
-              SUM 00
3              RCL 00
=              ÷
x=t 043        RCL 01
Pgm 15         =
SBR D.MS       STO 04
-              Prt
.5             Dsz 6 000
=              R/S
```

STOre	Contents
00	The cumulative sum of all the steps taken.
01	The number of trials performed so far.
02	The number of steps so far in a given trial.
03	The current position. (The dots are numbered 0 to 3).
04	The latest average.
06	Number of trials decremented to zero.
09	Random number seed.

Figure 7.

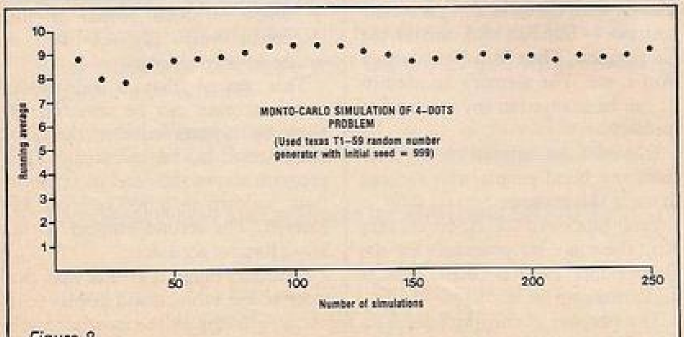

Figure 8.

Software File gives you the opportunity to have your programs, ideas or discoveries published. We will accept contributions for any personal computer and will group programs for like machines together in the file. Please double-check your listings before sending them, and specify the memory they require. Mark your letter clearly for *Your Computer.* We will pay £6 for each contribution published.

High resolution

David Rees,
Weybridge,
Surrey.

VIC-20

THE UNEXPANDED Vic is supplied with coarse graphics. To remedy this, I used a fresh approach to user-definable graphics. Instead of presetting the graphics characters, they are filled directly from the program as it calculates pixel co-ordinates. Using these programs 27,024 or more graphics modes are available, depending on the amount of Vic screen your television can display.

The first part of the program, lines 10 to 40, clears the screen and fills it with character 208, so that the screen does not suddenly fill up with pixels if character 32 is Poked during the program.

A grid of characters is then Poked on to the screen. The example programs give a grid of 16 characters by 10 and gives a resolution of 128 by 160.

```
HIGH RESOLUTION GRAPHICS PLOTTING

10  PRINT"CLR HOME"
20  FOR N=0 TO 505
30  POKE 7680+N,208
40  NEXT N

50  FOR A=1 TO 16
60  FOR N=1 TO 10
70  POKE 7682+22*N+A,N+10*A-11
80  NEXT N
90  NEXT A

100 POKE 36867,27:POKE 36869,253

110 M=5120
120 FOR N=0 TO 2559
130 POKE M+N,0
140 NEXT N

150 FOR A=160 TO 2560 STEP 160
160 FOR N=7 TO 0 STEP -1
170 Y=INT((A-159)/20-N+8)
180 H=PEEK(M+A-Y)
190 F=2↑N+H
200 IF F>255 THEN F=H
210 POKE M+A-Y,F
220 NEXT N
230 NEXT A

150 FOR A=160 TO 2560 STEP 160
160 FOR N=7 TO 0 STEP -2
170 Y=SIN(((A-159)/20-N+8)/15)*60+80
180 H=PEEK(M+A-Y)
190 I=PEEK(M+A-Y-1)
200 F=H+2↑N+2↑(N-1)
210 G=I+2↑N+2↑(N-1)
220 IF F>255 THEN F=H
230 IF G>255 THEN G=I
240 POKE M+A-Y,F
250 POKE M+A-Y-1,G
260 NEXT N
270 NEXT A

150 A=0:B=0:C=7
160 B=B+160
170 Z=(COS(((B-159)/20+8-C)/15)+0.5)*4
180 X=INT((COS(((B-159)/20+8-C)/15)+0.5)*4)
190 N=INT((Z-X)*8)
200 C=C-1
210 A=X*(-160)
220 IF A>1120 OR A<-1120 THEN 160
230 Y=INT(SIN(((B-159)/20-C+8)/15)*60)+80
240 H=PEEK(M+A-Y+1440)
250 F=2↑N+H
260 IF F>255 THEN F=H
270 POKE M+A-Y+1440,F
280 IF C<0 THEN C=8:GOTO 160
290 IF B<2560 THEN 170

300 INPUT R$
310 POKE 36867,46:POKE 36869,240
```

Screen and character generator parameters are set by lines 50 to 90. To use the programs to their fullest, the functions of the first four control registers must be known.

Control register 1 is located at 36864 and controls the horizontal position of the screen. 12 is the normal Poke value. Subtraction from this value results in the screen moving to the left by the length of one graphics character each time. Addition results in movement of the screen to the right. Above 24 the screen becomes distorted.

Control register 2 is located at 36865 and controls the vertical position of the screen. 38 is the normal Poked value. Addition lowers the screen and subtraction raises the screen by the height of one pixel each time.

Control register 3 is located at 36866 and has a normal Poke value of 150. The range from 128 to 158 is useful. With each addition, the line length of the display is increased by one character, from 0 to 29 characters in length.

Control register 4 is located at 36867 and has a normal Poke value of 46. The register controls the number of rows of display area, and whether eight-by-eight or eight-by-16 characters are displayed. With each increase of two in the Poke value, the number of rows is increased by one. Even numbers give eight-by-eight characters and odd numbers give eight-by-16 characters.

Registers 1, 2 and 3 are mainly used with resolutions of extreme length or height. In this program, eight-by-16 characters will be used as they give access to a greater amount of memory and screen area — line 100.

Register 6, located at 36869, controls the location of the character generator. Its normal value is 240; 253 starts the character generator at location 5120 in the user RAM.

Next, the character memory is cleared for plotting lines 110 to 140. By bypassing this subroutine, composite patterns of different functions may be drawn. Now the parameters for point plotting are set up and the graph is drawn — lines 150 to 230.

Line 150 switches progressively from one column of characters to the next. Each column is 160 pixels high — 10 characters with 16 rows each. Line 160 regulates the production of individual pixels from left to right in each byte. Line 170 is the function which is being plotted. In this case it will produce a sloping line. ((A−159)/20−N+8) is the variable from which pixel positions are calculated and so should not be changed. Functions should be built around it. If the height of resolution is changed, use the following guide to produce the new variable:

((A − resolution minus one)/resolution divided by eight−N+8)'

Lines 180 to 210 Poke in new pixels while leaving the display intact. To produce larger pixels use alternative A together with the lines previously listed up to 140.

By adjusting the length of step, number of lines Peeked and Poked and adding 2 (N−2), 2 (N−3) etc., pixels ranging from two by two to eight by eight may be created. If step is not consistent with length of the pixels they will overlap.

The last type of program that may be needed is one to plot one function with

(continued on next page)

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change in another. The alternative B program produces circles or ovals for which sine functions have to be plotted with cosine functions. Lines 10 to 140 are as listed previously.

Lines 170 and 180 contain the horizontal equation. The fractional part of the result is used to calculate N, or the portion in the character byte where the pixel is to be plotted. The whole number, X, is the number of character squares across from the starting position where the value is to be Poked. If the horizontal function will be both negative and positive, it is best to have the base Poke position midway across the screen.

A separate set of variables is used to calculate the values of the functions, otherwise plotting would give the same values each time a similar horizontal or vertical point is reached.

Finally, for convenience, the following lines may be added to any of the programs so that after viewing the resulting graph, you may easily return to normal mode by pressing return.

```
300 INPUT R$

310 POKE 36867,46:POKE 36869,240
```

Using these programs, the maximum mode possible on an unexpanded Vic is 128 by 192, by starting the character generator at 4096 and Poking from character 32 onwards or after the program memory space finishes. On an expanded Vic, the maximum possible mode is 128 by 256. I prefer the example mode as it has a memory safety buffer against accidental Poking and for extra program material.

```
BLOCK GRAPH

10  POKE 36879,127
20  G=8126:H=0
30  DIM A(11),B(11)
40  PRINT "CLR INPUT DATA FOR:-"
50  INPUT "JAN";A(0)
60  INPUT "FEB";A(1)
70  INPUT "MAR";A(2)
80  INPUT "APR";A(3)
90  INPUT "MAY";A(4)
100 INPUT "JUN";A(5)
110 INPUT "JUL";A(6)
120 INPUT "AUG";A(7)
130 INPUT "SEP";A(8)
140 INPUT "OCT";A(9)
150 INPUT "NOV";A(10)
160 INPUT "DEC";A(11)
170 L=A(0)
180 FOR J=0 TO 11
190 IF A(J)>H THEN H=A(J)+1
200 IF A(J)<L THEN L=A(J)
210 NEXT J
220 M=(H-L)/20
230 PRINT
240 FOR B=H TO L STEP-M
250 PRINT (INT(B*10))/10:NEXT
260 PRINT "SQQQQQQQQQQQQQQQQQQQQQQ
    ______________________"
270 PRINT "      JFMAMJJASOND"
280 FOR J=0 TO 11
290 B(J)=INT((A(J)-L)/M)
300 R=6
310 IF J=0 OR J=2 OR J=4 OR J=6
    OR J=8 OR J=10 THEN R=2
320 FOR S=0 TO B(J)
330 POKE G,160:POKE G+30720,R
340 G=G-22
350 NEXT S
360 FOR S=B(J) TO 0 STEP-1
370 G=G+22
380 NEXT S
390 G=G+1
400 NEXT J
410 GET A$:IF A$="" THEN 410
420 FOR S=0 TO 11
430 X=X+B(S)
440 NEXT S
450 X=INT(X/12)*22
460 G=8126
470 FOR S=1 TO 12
480 POKE G-X,45:POKE G-X+30720,5
490 G=G+1
500 NEXT S
510 GET A$:IF A$="" THEN 510
999 END
```

Block graphs

Jenny Dodsworth,
Aldfield,
North Yorkshire.

VIC-20

HERE IS a small program for the Commodore Vic. It will draw block graphs on monthly data, automatically adjusting the scale. After the graph has been displayed, press any key to find the average.

Not St George's day

P Watson,
Hartlepool,
Cleveland.

ZX-81

IN THIS GAME for the 16K ZX-1 the user acts the part of St George. His mission to reach the damsel at the top of the screen. His task is, however, complicated by the dragons which appear from random positions.

Every time he completes his task he has to start again — this time, with one more dragon. There is a maximum of 12 dragons which can be altered if desired.

The dragons are shown by the £ signs and St George and the damsel by G and * respectively. The player moves by using the arrow keys 5 to 8.

```
10 REM  ST GEORGE BY P. WATSON
20 REM       18\2\82
30 DIM M$(20,30)
40 DIM R(12)
50 DIM Q(12)
60 LET Z=1
70 POKE 16418,0
80 FAST
90 CLS
100 PRINT " [32 x ■ ] "
110 PRINT AT 0,6;"THERE AREs";Z;"sDRAGONS"
120 REM  SET UP LANDSCAPE
130 FOR I=1 TO 20
140 FOR H=1 TO 30
150 LET M$(I,H)="s"
160 IF INT(RND*10)>7 THEN LET M$(I,H)="▒"
170 NEXT H
180 PRINT "■";M$(I);"■"
190 NEXT I
200 REM  POSITION GEORGE
210 LET GY=19
```

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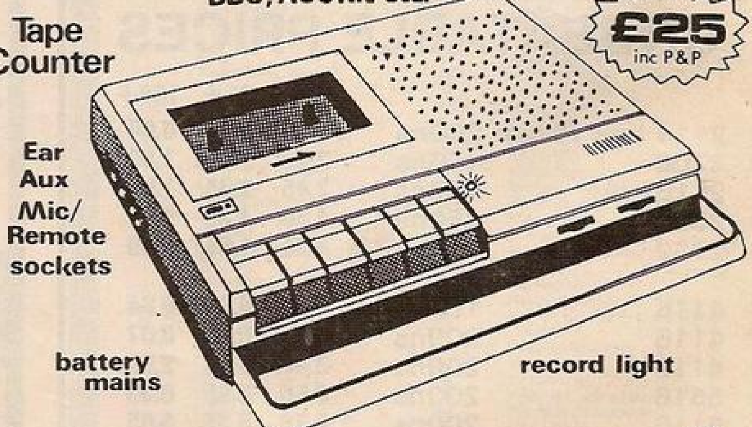

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(continued from page 76)

```
220 LET GX=INT(RND*20)+5
230 LET M$(GY,GX)="s"
240 REM  POSITION DRAGONS
250 FOR I=1 TO Z
260 LET R(I)=INT(RND*10)+5 .
270 LET Q(I)=INT(RND*20)+5
280 NEXT I
290 REM  MAKE ROOM FOR DAMSEL
300 FOR I=2 TO 4
310 FOR H=15 TO 17
320 LET M$(I,H)="s"
330 NEXT H
340 PRINT AT I+19,0;" [32 x ■ ] ";AT
    I,1;M$(I)
350 NEXT I
360 LET N=0
370 LET S=0
380 SLOW
390 PRINT AT GY,GX;"G";AT 3,16;"*"
400 REM  GET PLAYER'S MOVE
410 LET Y=0
420 LET X=0
430 LET X=X-(INKEY$="5")+(INKEY$="8")
440 LET Y=Y-(INKEY$="7")+(INKEY$="6")
450 IF X=0 AND Y=0 THEN GOTO 430
460 REM  IS THE POSITION EMPTY
470 IF M$(GY+Y,GX+X)="▩" THEN GOTO 610
480 REM  CARRY OUT MOVE
490 PRINT AT GY,GX;"s"
500 LET GY=GY+Y
510 LET GX=GX+X
520 PRINT AT GY,GX;"G"
530 REM  IS HE HOME
540 IF GY=3 AND GX=16 THEN GOTO 850
550 REM  TIME FOR A DRAGON?
560 LET S=S+1
570 IF S/5 <> INT(S/5) OR N+1>Z
    THEN GOTO 610
580 LET N=N+1
590 LET M$(R(N),Q(N))="s"
600 REM  MOVE DRAGONS
610 FOR I=1 TO N
620 LET A=0
630 LET B=0
640 LET A=A-(GY<R(I))+(GY>R(I))
650 IF A <> 0 AND M$(R(I)+A,Q(I)) <> "▩"
    THEN GOTO 710
660 LET A=0
670 LET B=B-(GX<Q(I))+(GX>Q(I))
680 REM  IS POSITION VALID
690 IF M$(R(I),Q(I)+B)="▩" THEN GOTO 760
700 REM  CARRY OUT MOVE
710 PRINT AT R(I),Q(I);"s"
720 LET R(I)=R(I)+A
730 LET Q(I)=Q(I)+B
740 PRINT AT R(I),Q(I);"£"
750 REM  IS GEORGE CAUGHT
760 IF R(I)=GY AND Q(I)=GX THEN GOTO 800
770 NEXT I
780 GOTO 390
790 REM  ST GEORGE IS CAUGHT
800 PRINT AT 21,5;"GEORGY BOY...YOU ARE DEAD"
810 PRINT AT 23,5;"YOU KILLEDs";Z;"sDRAGONS"
820 PAUSE 3000
830 STOP
840 REM  HOME SAFE
850 PRINT AT 21,1;"NICE ONE GEORGE YOU ARE A HERO"
860 IF Z=12 THEN GOTO 930
870 LET Z=Z+1
880 PRINT AT 22,0;"BET YOU CANT SLAYs";Z;"sDRAGONS"
890 PRINT TAB(5);"PRESS ANY KEY TO START"
900 IF INKEY$ <> "" THEN GOTO 80
910 GOTO 900
920 REM  ALL DRAGONS SLAIN
930 PRINT AT 23,1;"YOU HAVE KILLED ALL 12 DRAGONS"
940 GOTO 820
's' means space
```

```
RESISTOR FINDER

1   REM ***RESISTOR FINDER***
2   REM ***BY I.WEEKS***
3   REM *** 1982 ***
5   DIM A$(9),B$(9),C$(9)
10  FOR I=0 TO 9
11  READ A$(I):B$(I)=A$(I):C$(I)=A$(I):NEXT
15  PRINT CHR$(12)
20  PRINT TAB(165)"RESISTOR COLOUR CODE":PRINT
30  INPUT" 1ST COLOUR";A$
40  INPUT" 2ND COLOUR";B$
50  INPUT" 3RD COLOUR";C$
60  GOSUB 220
100 D=((A*10)+B)*C
110 IF D<1000 THEN 150
120 IF D<1000000 THEN 160
130 PRINT:PRINT" VALUE= "D/1000000"M.OHMS"
140 GOTO 190
150 PRINT:PRINT" VALUE = "D"OHMS"
155 GOTO 190
160 PRINT:PRINT" VALUE ="D/1000"K.OHMS"
190 PRINT:PRINT"Press 1 to repeat"
195 GET Z
196 IF Z = 1 GOTO 15
199 END
220 FOR I =1 TO 9
230 IF A$ =A$(I) THEN A =I
240 IF B$ =B$(I) THEN B =I
250 IF C$ =C$(I) THEN C =10↑I
260 NEXT
270 IF A$ ="BLACK" THEN A =1
280 IF C$ ="GOLD" THEN C =.1
290 IF C$ ="SILVER" THEN C =.01
300 RETURN
310 DATA BLACK, BROWN, RED, ORANGE, YELLOW,
    GREEN, BLUE, VIOLET, GREY, WHITE
```

Resistor finder

I D Weeks,
Prescot,
Merseyside.

MICROTAN

THE MICROTAN 65 program is for calculating the value of resistors from their colour-code bands, and occupies about 0.75K. There should be no problems in running it on other machines except for

15 PRINT CHR$(12)

which is to clear screen.

The program could easily be converted to find the values of polyester and tantalum capacitors which use the same colour bands, but in picofarads instead of ohms.

Hot pursuit

S A Nicholls,
Keynsham,
Bristol.

ZX-81

THE PROGRAM is entirely in machine code with just line 3 in Basic to run it, and it will just fill the 1K ZX-81 including display. The program also makes use of most of the 33 spare bytes from address 16444.

It is a simple version of a maze chase. The display occupies 18 lines by 17 columns and consists of five overlapping squares with a row of inverse zeros in the last line for the score.

Five minus signs are then placed in the maze and one £ sign. The minus signs will

(continued on next page)

```
16514   01 00 FF FF ] RANDOM
        12 00 EE FF ] DIRECTION DATA
        2B            DEC HL
        06 07         LD B,7
        23            INC HL
        36 08         LD (HL),8
        10 FB         DJNZ-5
        11 12 00      LD DE,18
        06 06         LD B,6
        19            ADD HL,DE
        36 08         LD (HL),8
        10 FB         DJNZ-5
        06 06         LD B,6
        2B            DEC HL
        36 08         LD (HL),8
        10 FB         DJNZ-5
        06 06         LD B,6
        ED 52         SBC HL,DE
        36 08         LD(HL),8
        10 FA         DJNZ-6
        C9            RET
16556   11 11 00      LD DE,17
        06 11         LD B,17
        3E 80         LD A,128
        D7            RST 10
        10 FD         DJNZ-3
        3E 76         LD A,118
        D7            RST 10
        1B            DEC DE
        7A            LDA,D
        B3            OR E
        20 F1         JRNZ-15
        06 11         LD B,17
        3E 9C         LD A,156
        D7            RST 10
        10 FD         DJNZ-3
        3E 76         LD A,118
        D7            RST 10
16584   2A 0C 40      LD HL,(16396)
        11 14 00      LD DE,20
        19            ADD HL,DE
        22 3E 40      LD (16446),HL
        CD 8A 40      CALL 16522
        11 08 00      LD DE,8
        19            ADD HL,DE
        22 40 40      LD (16448),HL
        CD 8A 40      CALL 16522
        11 44 00      LD DE,68
        19            ADD HL,DE
        22 42 40      LD (16450),HL
        CD 8A 40      CALL 16522
        11 44 00      LD DE,68
        19            ADD HL,DE
        22 44 40      LD (16452),HL
        CD 8A 40      CALL 16522
        11 08 00      LD DE,8
        19            ADD HL,DE
        22 46 40      LD (16454),HL
        CD 8A 40      CALL 16522
16637   3E 3E         LD A,62
        32 3C 40      LD(16444),A
        21 00 19      LD HL,1900h
        22 48 40      LD (16456),HL
        2A 0C 40      LD HL,(16396)
        11 16 01      LD DE,278
        19            ADD HL,DE
        22 54 40      LD(16468),HL
16658   11 7D 00      LD DE,125
        ED 52         SBC HL,DE
        36 25         LD(HL),37
        06 0A         LD B,10
        16 30         LD D,48
        1B            DEC DE
        7A            LD A,D
        B3            OR E
        20 FB         JRNZ-5
        7E            LD A,(HL)
        3D            DEC A
        77            LD(HL),A
        10 F4         DJNZ-12
        36 80         LD (HL),128
16681   2A 48 40      LD HL,(16456)
        11 00 00      LD DE,0
        ED 52         SBC HL,DE
        22 48 40      LD(16456),HL
        2B            DEC HL
        7C            LD A,H
        B5            OR L
        20 FB         JRNZ-5
        2A 56 40      LD HL,(16470)
        23            INC HL
        22 56 40      LD(16470),HL
        CB 45         BIT 0,L
        28 78         JRZ +120
        2A 0C 40      LD HL,(16396)
        11 43 01      LD DE,323
        19            ADD HL,DE
        7E            LD A,(HL)
        3C            INC A
        FE A6         CP 166
        20 05         JRNZ +5
        36 9C         LD(HL),156
        2B            DEC HL
        18 F5         JR -11
16726   77            LD(HL),A
        3A 3C 40      LD A,(16444)
        32 69 41      LD(16745),A
        32 9D 41      LD(16797),A
        C6 0C         ADD A,12
        32 6D 41      LD(16749),A
        32 A1 41      LD(16801),A
        2A 00 40      LD HL,(40XX)
        ED 5B 00 40   LD DE,(40XX)
        36 08         LD(HL),8
        E5            PUSH HL
        2A 32 40      LD HL,(16434)
        ED 4B 33 40   LD BC,(16435)
        09            ADD HL,BC
        22 32 40      LD(16434),HL
        7C            LD A,H
        E6 06         AND 6
        C6 82         ADD A,130
        6F            LD L,A
16771   26 40         LD H,64
        4E            LD C,(HL)
        23            INC HL
        46            LD B,(HL)
        79            LD A,C
        BB            CP E
        28 03         JRZ +3
        83            ADD A,E
        28 E3         JRZ -29
        E1            POP HL
        09            ADD HL,BC
        7E            LD A,(HL)
        FE 80         CP 128
        28 D2         JRZ -46
        FE 0C         CP 12
16792   28 6C         JRZ +108
        36 16         LD (HL),22
        22 00 40      LD (40XX),HL
        ED 43 00 40   LD (40XX),BC
        3A 3C 40      LD A,(16444)
        3C            INC A
        3C            INC A
        32 3C 40      LD (16444),A
        FE 48         CP 72
        20 A8         JRNZ -88
        3E 3E         LD A,62
        32 3C 40      LD (16444),A
16820   18 06         JR +6
        76            ]
        00            ]
        02            ] LINE '2 REM'
        92            ]
        00            ]
        EA            ]
16828   2A 54 40      LD HL,(16468)
        36 0C         LD(HL),12
        CD BB 02      CALL 'KEY ?'
        7D            LD A,L
        2F            CPL
        6F            LDL,A
        E6 81         AND
        28 05         JRZ +5
        11 12 00      LD DE,18
        18 1D         JR +29
        7D            LD A,L
        E6 18         AND 24
        28 05         JRZ +5
        11 EE FF      LD DE,-18
        18 13         JR +19
        7D            LD A,L
        E6 60         AND 96
        28 05         JRZ +5
        11 01 00      LD DE,1
        18 09         JR +9
        7D            LD A,L
        E6 06         AND 6
        CA 29 41      JPZ 16681
        11 FF FF      LD DE-1
        2A 54 40      LD HL,(16468)
16880   36 08         LD (HL),8
        19            ADD HL,DE
        7E            LD A,(HL)
        FE 08         CP 8
        28 06         JRZ+6
        FE 80         CP 128
        20 0A         JRNZ+10
        ED 52         SBC HL,DE
        36 0C         LD(HL),12
        22 54 40      LD(16468),HL
        C3 29 41      JP 16681
16902   2A 0C 40      LD HL,(16396)
        11 33 01      LD DE,307
        19            ADD HL,DE
        36 B8         LD(HL),184
        23            INC HL
        36 A8         LD (HL),168
        23            INC HL
        36 B4         LD (HL),180
        23            INC HL
        36 B7         LD(HL),183
        23            INC HL
        36 AA         LD (HL),170
        06 0B         LD B,11
        23            INC HL
        7E            LD A,(HL)
        FE 9C         CP 156
16929   20 04         JRNZ +4
        36 12         LD(HL),18
        10 F6         DJNZ-10
        11 25 00      LD DE,37
        01 21 01      LD BC,289
        2A 0C 40      LD HL,(16396)
        23            INC HL
        7E            LD A,(HL)
        FE 76         CP 118
        28 FA         JRZ-6
16950   C6 81         ADD A,129
        77            LD (HL),A
        0B            DEC BC
        78            LD A,B
        B1            OR C
        20 F2         JRNZ -14
        01 00 03      LD BC,0300h
        0B            DEC BC
        78            LDA,B
        B1            OR C
        20 FB         JRNZ-5
        1B            DEC DE
        7A            LDA,D
        B3            OR E
        20 DF         JRNZ -33
16971   C9            RET (TO BASIC)

BASIC:
1 REM  308 Ø's
2 REM  144 Ø's
3 RAND USR 16556
```

(continued from previous page)

then move at random around the maze attempting to corner and land on the £ sign. The £ sign is controlled by the player and moves at twice the speed of the chasing minus signs. Any key in the top row of the keyboard will move you up — any key in the bottom row, except shift, will move you down. Any right-hand side key in the middle two rows will move you right and any left-hand side key in the middle two rows will move you left.

The movement of the minus signs is not entirely random, for once moving in a certain direction they will continue to do so until they meet a cross-over at which point they will choose a random change of direction but not return on their original path. Each move of the minus signs will increase the score which gives an indication of the time you have survived in the maze.

Once your £ sign is captured, the game ends with a spectacular flashing screen, where the display runs through the ZX-81 graphics and inverse video set in about three seconds, and ends with your score displayed.

Built into the game are five levels of play that can be accessed in the following way:

The basic game as listed.

A game that does not allow you to reverse direction, i.e., it erases the maze as you travel but leaves a trail which the minus signs can follow to rebuild the maze. Just type Poke 16881, 155 as a direct move.

As game 1, but with speed constantly increasing after each move.

POKE 16881,8 direct command
POKE 16685,5 direct command

As game 2, but the speed increasing

POKE 16881,155 direct command
POKE 16685,5 direct command

To change the constant speed of the game in options 1 and 2 Poke address 16644 with any value from 1 to 100. A value less than 25 will make it run faster and greater than 25 will run slower. Anything greater than 100 is really too slow to play.

For anyone who has not tried loading a machine-code program do not be put off by the listing or the time taken — the end program justifies this extra time and care. To start loading the program you will need to work in the fast mode. If you have the 16K RAM then set RAMtop to 1K, as the program will not work with a display file ready set up. Then enter line 1 Rem followed by 308 zeros then line 2 Rem followed by 144 zeros. Unfortunately, the ZX-81 will not accept a single Rem statement with 452 zeros.

As a double-check to ensure that you have the correct number of zeros in the Rem statements type:

PRINT PEEK 16822 direct command

This should give an answer of 118, showing line 1 is correct. Then

PRINT PEEK 16825 direct command

This should give an answer of 146 showing line 2 is correct.

Then, still in fast mode, enter the following hexadecimal-loader program:

```
10 LET X = 16514
20 LET A$ = ""
30 IF A$ = "" THEN INPUT A$
40 IF A$ = "S" THEN STOP
50 POKE X, 16 * CODE A$ + CODE A$ (2) —
   476
60 PRINT AT 11,7 ; X ; "SPC" ; A$ (1 to 2)
70 LET X = X + 1
80 LET A$ =        A$ (3 to)
90 GO TO 30
RUN (IN FAST)
```

You can now enter the hexadecimal codes as in the listing, either in pairs or blocks i.e., 01 newline — 00 Newline — FF Newline or 0100FFFF1200EEFF Newline and so on. Remember there are no spaces between the codes. The hexadecimal-loader program will give a display of the last address and code entered so that you can check the listing as you enter it.

I prefer to run in fast mode because the screen flicker does give an indication that an entry has been made without having to look up from the list to check.

After the last entry, at address 16971, enter S to end. Now type the only line of Basic necessary:

3 RAND USR 16556

and delete lines 10 to 90 as these are no longer required.

The program is best saved at this point, before running, just in case any incorrect entries have been made, which may result in loss of program when run. Should the program fail to run, reload it and check each address using the following Basic:

```
10 FOR X = 16514 to 16971
20 LET A = PEEK X
30 LET B = INT (A/16)
40 LET C = A — B * 16
50 PRINT X ; "SPC" ; CHR$ (B + 28) ; CHR$ (C
   + 28)
60 NEXT X
GO TO 10
```

Then, by the use of Cont, you can check through the listing for errors, but remember, if correcting an error then Poke the address with the decimal value of the hexadecimal code. Conversions are at the back of the Sinclair manual.

Millikan

John Lewis,
Hillend,
Perth.

BBC

THIS PROGRAM is a simulation of Millikan's experiment, for which he received a Nobel prize in 1923. It is very difficult to set up in practice and yet it is a standard topic in A-level and university physics.

An oil drop charged with a random number of electrons is balanced between two plates across which is a variable voltage. When the correct voltage has been achieved, the experiment is stopped and the correct values should be substituted in the equation

$$Q = mgd/v$$

where Q is the charge on the drop in coulombs, mg is the drop mass, d is the plate separation and V is the balancing voltage.

A blast of X-rays then changes the charge on the drop, the drop must again be balanced and the charge calculated. The experiment must be repeated many times — Millikan did it hundreds of times. The charge on one electron is the smallest interval found between the results for the charge on the drop. The accepted value for the charge on an electron is 1.6E —19 coulombs.

```
MILLIKAN

10   MODE 4
20   VDU 28,0,5,39,0
30   P. : P.: P. "R....RAISES VOLTAGE"
40   P. " L.... LOWERS VOLTAGE"
50   P. " S.... STOPS EXPERIMENT"
60   P. " PRESS S AND <RETURN> TO START "
70   INPUT A$
80   IF A$<>"S" THEN GOTO 30
90   MOVE 0,800: DRAW 580,800 : MOVE 620,800:
     DRAW 1279,800 : MOVE 0,100 : DRAW 1279, 100
100  Y = 799
110  A = 0
120  Q = (1.6E-19) * RND(10) : V=INT (1.54E-14*9.81 * 5E-3/Q)
130  Z = INT ( 10000/ABS (A-V))
140  GCOL 0,1: GOSUB 250
150  FOR X = 1 TO Z : NEXT X
160  GCOL 0,0 : GOSUB 250
170  IF A<V THEN Y=Y-2 ELSE Y=Y+2
180  IF Y>= 800 OR Y<= 100 THEN GOTO 270
190  P=INKEY(1)
200  IF P=82 THEN A=A+50
210  IF P=76 THEN A=A-50
220  IF P=83 THEN GOTO 280
230  IF A<0 THEN A=0
240  VDU 12 : P.: P.: P.: P.A;"V": GOTO 130
250  MOVE 597, Y+3 : DRAW 603,Y-3: MOVE 603, Y+3:DRAW 597,Y-3
260  MOVE 600, Y-5: DRAW 600, Y+5: MOVE 595, Y: DRAW 605,Y:RETURN
270  P.: P.: P. " EXPERIMENT FAILED!" :END
280  P.: P.: P. " MASS = 1.54E-14KG " : P."SEPARATION = 5E-3 M" :
     P. " VOLTAGE =" ;A;"V"
290  P. " PRESS S AND <RETURN> TO RESTART"
300  INPUT A$
310  IF A$ <> "S" THEN GOTO 280
320  VDU 12 : P.: P.: P. " RADIATION ON - CHARGE ON DROP CHANGING
     TO NEW VALVE"
330  FOR I=1 TO 3000 : NEXT I
340  GOTO 110
350  END
```

Winning sequence

John Lewis,
Felinfoel,
Llanelli, Dyfed.

ZX-81

THIS PROGRAM imitates those number-sequence puzzles often found in intelligence tests. These usually follow the format: Find the next number in the series 6, 13, 34, 97, ?. But be prepared, this program produces a considerably more difficult puzzle.

The governing equation in line 115 is carefully designed to produce a sequence of random length, and not only puzzles of differing levels of difficulty, but also puzzles

(continued on page 83)

```
1    REM  SEQUENCE  BY JOHN M. LEWIS, 1981
2    PRINT "COMPLETE THE SEQUENCE OF NUMBERS YOU ARE ABOUT
     TO SEE"
3    SLOW
4    PAUSE 200
5    CLS
10   LET B=INT (RND*10) +1
20   LET C=INT (RND*10) +1
30   LET D=INT (RND*10) +1
100  FOR A=0 TO INT (RND*6)+4
110  PRINT B
115  LET B=B+(B+C)-D*B
120  NEXT A
125  FAST
130  INPUT X
140  IF X=B THEN PRINT AT 12,8;" CORRECT, IT WAS ";B
150  IF X<>B THEN PRINT AT 12,8; "WRONG, IT WAS ";B
160  GOTO 3
```

(continued from page 81)

which sometimes consist of all positive numbers, and sometimes mixed negative and positive numbers.

Program operation is simple. After running, complete the randomly-generated sequences. If you complete the sequence incorrectly, the computer will print the correct answer. For maximum frustration, all sequences should be attempted mentally.

Colour and sound

Eric Deeson,
Harbourne,
Birmingham.

BBC

THE BBC MICRO is a beautiful machine with a delightful Basic and great flexibility. The provisional user guide is, however, hard to follow and incomplete. Here is a program that has impressed all users, children and adults, and that will help to make sense of the user guide pages together.

It is developed from the remarkable four-line program in the *Welcome* booklet, but utilises colour and sound to great effect.

The syntax for Sound is that it is followed by four numbers. For simple sound, keep the first channel set at 1. The others control loudness, frequency and duration. Note that a sound once specified continues for the set duration whatever else the computer may be doing. Note too that it is a simple matter to connect a superior speaker in the audio circuit provided.

```
A BBC PROGRAM

10  MODE 5                              (colour graphix
20  COLOUR 129                          (red background
30  COLOUR 2                            (yellow characters
40  CLS                                 (form red screen)
50  PRINT TAB(1,3);"what's your name";  (TAB gets away from edge
60  INPUT N$
70  COLOUR 130                          (yellow background
80  COLOUR 1                            (red characters
90  CLS                                 (form yellow screen
100 PRINT TAB(1,3);"Thanks, ";N$;"."
110 FOR A=1 TO 5000:N.                  (Pause
120 VDU 19,1,0,0,0                      (change characters to black
130 REPEAT
140 P.:P.:P.TAB(1);"Give me a number";"between 1 and 10."
150 B=1
160 *FX15,0                             (clear INPUT buffer
170 B=INKEY(400)-48                     (accept number within 4sec.
180 GOSUB 360                           ("chime"
190 UNTIL B<2 OR B>9                    (break out of loop
200 CLS
210 FOR A=1 TO 400
220 P.N$;                               (background pattern on name
230 N.
240 C=7
250 VDU 19,1,C,0,0                      (change background colour
260 CLS
270 FOR A=1 to 100
280 GCOL RND(3),RND(7)                  (random foreground
290 PLOT 85,RND(1280),RND(1024)         (random triangle
300 SOUND A,A,A,A                       ("concrete" music
310 FOR B=1 TO 1000:N.                  (delay
320 N.
330 C=C-1
340 IF C=-1 THEN G.20                   (restart
350 G.250                               (repeat colour/sound display
360 FOR C=1 to 8                        ("chime" sub-routine
370 FOR A=15 TO 25
380 SOUND 1,A,40,6
390 N.:N.
400 RETURN
```

Key options

G E Taylor,
Derby.

ATOM

THE ACORN Atom has three keys which may be checked directly by a program to see if they have been pressed. This program does not require a Return as in a normal Basic input. These keys are sufficient for games which only need right, left and a fire button as in example 1.

If, however you need more options, such as forwards and backwards, some other technique muste be used. The Atom Basic ROM contains a routine at location x FE71 which scans the keyboard once and returns the key number in the CPU's Y register — or 255 if no key is pressed.

A short assembler routine must be written to store the Y register at a convenient location for a Basic program to use, as in example 2. Some of the keys are well grouped for use with a computed Goto or Gosub, but do not forget to check first that the key number will result in a line number that will be valid.

Adding the statements of example 3 to example 2 makes it possible to detect the highest numbered key of the group IJKLM which is pressed. This is fine for one fingered use, but if you want to check for simultaneous multiple depressions then a combination of the two techniques must be used.

```
EXAMPLE 1
10 IF ?#B001 & 128 = 0 THEN PRINT "SHIFT"
20 IF ?#B002 & 64 = 0 THEN PRINT "REPEAT"
30 IF ?#B001 & 64 =0 THEN PRINT "CONTROL"
40 PRINT " "
50 GOTO 10
```

```
EXAMPLE 2
100 DIM KKO,P-1
110[
120:KKO JSR #FE71
130 STY #80
140 RTS; ]
150 LINK KKO : K = ?#80
160 IF K = 255 THEN 150
170 PRINT K'
180 GOTO 150
```

```
EXAMPLE 3
170 IF K < 41 OR K > 45 THEN GOTO 150
180 GOSUB (1000 + 100 * (K - 41))
190 PRINT " " ; GOTO 150
1000 PRINT "FORWARD" ; RETURN
1100 PRINT "LEFT" ; RETURN
1200 PRINT "FIRE" ; RETURN
1300 PRINT "RIGHT" ; RETURN
1400 PRINT "BACKWARD" ; RETURN
```

Fighter raid

C J Hall,
Kinlet,
Worcestershire.

VIC-20

WHEN THE program is run for the first time there will be a short delay which is due to the time it takes to load user-composed characters into the top 2K of Vic's RAM — the subroutine at line 600. If, after the first run, the program is wanted again, the delay can be omitted by typing (RUN2 RETURN)

The object of the game is to shoot down as many low flying fighter planes as you can with 100 rockets. To fire the rocket press any key excluding Ret., Shift, and Run/Stop.

In the listing

(CLR) = Shifted CLR Home key
(HOME) = CLR/Home key not shifted
(CTRL—) = CTRL and 4 key pressed together

```
FIGHTER RAID
1   GOSUB600
2   POKE51,255:POKE52,19:POKE55,255:POKE56,19
3   PR=8158:P=0:B=0:S=0:R=0:O=36877:M=O+2:N=O+1
9   PRINT"(CLR)":POKEM,8
10  FORA=8164TO8185:POKEA,102:NEXT
20  P%=RND(0)*12+5
21  PRINT"(HOME)(CTRL-4)HITS"S"OUT OF "R
22  POKE8180,102
30  P=7680+(22* P%)
35  FORA=0TO21
40  POKEP,130:POKEP-1,32:POKEPR,128:IFB=1THENPOKEPR+22,
    129:POKEPR+44,32
41  P=P+1:FORX=1TO70:NEXT
49  IFB=1THEN56
```

(continued on next page)

(continued from previous page)

```
50  GETA$:IFA$=""THENNEXTA:POKEP-1,32:GOTO20
55  B=1:R=R+1:IFR>100THENEND
56  POKEN,15:POKEO,170:PR=PR-22:IFPR-22=7696THENB=0:
    PR=8158:GOTO59
57  IFPEEK(PR-1)=130THEN500
58  NEXTA:B=0:POKEPR,32:PR=8158
59  FORZ=7696TO8136STEP22:POKEZ,32:NEXTZ:POKEP-1,32:
    POKEN,0:POKE O,0:GOTO20
500 POKEPR,42:POKEPR-1,42:POKEPR+22,42:POKEPR+44,42
501 POKEM,159
510 POKEO,220:FORL=15TO0STEP-1:POKEN,L
520 FORX=1TO200:NEXTX:NEXTL
530 POKEO,0:POKEN,0
535 S=S+1:R=R+1:B=0:PR=8158
536 POKEM,8
537 PRINT"(CLR)":GOTO10
600 FORI=0TO1024
610 POKE5120+I,PEEK(32768+I):NEXTI
630 FORI=0TO1024:READA
640 IFA=-1THEN700
650 POKE6144+I,A:NEXT
660 DATA16,56,56,56,124,124,124,84
680 DATA0,128,192,224,254,255,255,0,-1
700 POKE36869,253:POKE36866,PEEK(36866)OR128
710 RETURN
```

Status display

Paul Kaufman,
Ely,
Cambridgeshire.

THIS SHORT routine written in Tan-Forth gives a useful display of the current system status. All the required information is stored in location 00. The program checks each bit to see if it is set or not, and prints the appropriate message.

Temp is a variable used for temporary storage of the contents of 00. The routine Fetch reads 00 and stores it in Temp, and the eight subsequent routines test the individual bits of Temp. This is done by performing a logical And on the desired bit and using the result for the If statement. The final program is defined on line 2 of screen 2 and strings all the preceding routines together. To execute the program type the word Status.

This routine will work with Tangerine's disc or cassette versions of Forth.

```
SYSTEM STATUS

Serial Input  Off
Special Print Off
DC Flag       Off
External O/P  Off
Parallel O/P  On
Serial O/P    Off
Screen Dis    Off
BASIC Warm    On

Ok

SCR # 1
0  HEX 0 VARIABLE TEMP
1   : FETCH 0 C@ TEMP ! ;
2   : SERIP CR. " Serial Input " TEMP @ 1 AND 1 = IF. " ON"
3  ELSE ."  Off" ENDIF ;
4   : SPEPR CR." Special Print " TEMP @ 2 AND 2 = IF. " ON"
5  ELSE ."  Off" ENDIF ;
6   : DCFLG CR." DC Flag       " TEMP @ 4 AND 4 = IF. " ON"
7  ELSE ."  Off" ENDIF ;
8   : EXTOP CR." External O/P  " TEMP @ 8 AND 8 = IF. " ON"
9  ELSE ."  Off" ENDIF ;
10  : PAROP CR." Parallel O/P  " TEMP @ 10 AND 10 = IF." ON"
11 ELSE ."  Off" ENDIF ;
12  : SEROP CR." Serial O/P    " TEMP @ 20 AND 20 = IF." ON"
13 ELSE ."  Off" ENDIF ;
14  : SCNDS CR." Screen Dis    " TEMP @ 40 AND 40 = IF." ON    "
15 ELSE ."  Off " ENDIF ; -->

SCR # 2
0   : BASWR CR. " BASIC Warm  " TEMP @ 80 AND 80 = IF."  ON    "
1  ELSE ." Off " ENDIF ;
2   : STATUS FETCH CLS
3  . "          SYSTEM STATUS " CR  ."        -------------"
4  CR CR SERIP SPEPR DCFLG EXTOP PAROP SEROP SCNDS BASWR CR CR ;
5
6
7
8
9
10
11
12
13
14
15
OK
```

Sounds of alarm

Michael Trinder,
Sunningdale,
Berkshire

YOU WILL have noticed that if a program is saved with the TV sound turned up, there is a tone generated through the TV speaker. It is that feature I have utilised to create the alarm in this program for the ZX-80.

```
10  PRINT "ALARM CLOCK  BY M.TRINDER"
15  PRINT
20  PRINT " TIME TILL ALARM GOES OFF"
21  PRINT "     (IN SECONDS)"
22  INPUT AL
23 CLS
24  PRINT "(V)ISUAL OR (S)OUND ALARM"
25  INPUT A$
26  IF A$ = "V" THEN  LET Z = 45
27  IF A$ = "S" THEN  LET Z = 44
28  LET A = 1
29  LET D = 75
30 CLS
31  PRINT "ALARM GOES OFF IN ";AL;" SECONDS"
32  IF Z = 45 THEN  GOTO 36
33  PRINT "TURN UP VOLUME ON TELEVISION"
34  PRINT "        TO HEAR ALARM"
35  PRINT " DISCONNECT TAPE-RECORDER"
36  PRINT
37  PRINT " -PRESS-NEWLINE-TO-START-"
38  INPUT A$
39  FOR B = 1 TO D
40  NEXT B
41  LET A = A + 1
42  IF A = AL THEN  GOTO Z
43  GOTO 39
44  SAVE
45  PRINT "  ALARM   BEEP-BEEP"
46  GOTO 45
```

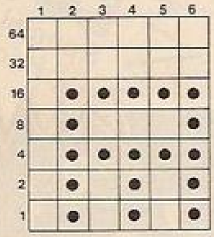
Cast the runes

P Horton,
Evesham,
Worcestershire.

PET

FANS OF J R R TOLKIEN may be interested in this program which reproduces runes on the Pet dot-matrix printer. Other readers will find it possible to adapt the program to produce their own characters.

Each character space consists of a six-by-seven grid, for example, the letter 'Y':



This is the same principal as the Vic character generator — demonstrated by Nick Hampshire in the October edition of *Your Computer*. Each of the six columns is assigned a value according to the number and position of the dots on the grid. For example, column 4 has the value

$$1+2+4+16=23.$$

The line-entering has been constructed using the Get command to enable the use of commas and colons. If they are entered as part of an input then the computer thinks that you are trying to input two different things and gives an 'extra-ignored' message.

The * command is used to break out of the program, but any other character could be substituted.

```
1000 PRINT"QQQTO TRANSLATE INTO RUNES TYPE IN THE "
1010 PRINT"'ENGLISH' A LINE AT A TIME "
1020 OPEN4,4
1030 DIMR(26,6)
1040 FORJ=1TO26:FORH=1TO6:READR(J,H):NEXTH:NEXTJ
1050 LN=LN+1:PRINT"LINE NUMBER"LN;" ";
1060 GETI$:IFI$=""THEN1060
1070 IFI$=CHR$(13)THEN1110
1080 L$=L$+I$:PRINTI$;"R ▒▌";
1090 IFI$="*"THENCLOSE5:CLOSE4:END
1100 GOTO1060
1110 PRINT" ":FORJ=1TOLEN(L$)
1120 C$=LEFT$(L$,1)
1130 A=ASC(C$):A=A-64:IFA>26ORA<1THENPRINT#4,
TAB(J),C$;CHR$(141);:GOTO1170
1140 FORH=1TO6:A$=A$+CHR$(R(A,H)):NEXTH
1150 OPEN5,4,5:PRINT#5,A$
1160 PRINT#4,TAB(J),CHR$(254);CHR$(141);:CLOSE5:A$=""
1170 C$="":L$=RIGHT$(L$,LEN(L$)-1):NEXTJ
1180 PRINT#4," ":L$="":GOTO1050
1190 DATA0,127,40,20,0,0,0,127,73 ,42,20,0,0,127,4,2,1,0,0,
62,20,8,20,62,0,127
1200 DATA32,24,32,127,0,127,20,116, 4,124,0,99,20,8,20,99,
0,127,40,20,10,127,0,0 ,0
1210 DATA127,0,0,0,0,0,127,0,0,0,127, 2,4,2,1,0,127,32,16,
8,0,0,127,80,32,80,127
1220 DATA0,32,16,127,4,2,0,127,72,36, 72,48,0,127,20,20,119,0,0,127,
2,127,40,16
1230 DATA0,127,68,68,42,17,0,124,4,8, 31,0,0,16,32,127,32,16,0,
63,16,8,4,3,0,63, 16
1240 DATA8,4,3,0,127,68,40,16,0,0,96, 16,127,16,96,0,31,20,23,20,
31,0,3,4,127,4, 3
```

Disassembling

Chris Lam,
Redhill,
Surrey.

ZX-81

EVER NEEDED a disassembler and found either it was too laborious to type in or the cassette costs too much? Here is one which disassembles on the first level. You can add this routine to a hexadecimal loader program, making it much more useful and powerful.

All the program does is ask for an address, finds what is inside that address, finds the hexadecimal of it and prints it, and goes round again. However, since this does take a long time it is best run in the fast mode . Use Cont to carry on scanning for the ZX-81.

```
DISASSEMBLER

5  REM DISASSEMBLER - CHRIS LAM 1982
10 PRINT "ENTER DECIMAL ADDRESS"
20 INPUT A
30 LET B=PEEK A
40 LET X=INT(B/16)
50 LET Y=B-X*16
60 PRINT A;"  ";CHR$(X+28);CHR$ (Y+28)
70 LET A=A+1
80 GOTO 30
```

```
0   REM                 ** DICE THROWER **
                        ** BY CHRIS TOLLEY **
                        ** (C)2 MARCH 1982 **
************************************************
10  LET U=1
20  LET T=U+U
30  LET F=T+T
40  LET S=F+T
50  LET X=S+F
60  LET Z=NOT U
70  PRINT "HOW MANY DICE? (MAX 3)"
80  INPUTN
90  IF N>T+U THEN GOTO 70
100 FOR M=Z TO N-U
110 LET D=INT (S*RND+U)
120 FOR A=U TO S+U
130 FOR B=U TO S+U
140 PLOT M*X+A,B
150 NEXT B
160 NEXT A
170 IF D/T<>INT (D/T) THEN UNPLOT X*M+F,F
180 IF D>U THEN UNPLOT X*M+T,T
190 IF D>U THEN UNPLOT X*M+S,S
200 IF D>U+T THEN UNPLOT X*M+S,T
210 IF D>U+T THEN UNPLOT X*M+T,S
220 IF D=S THEN UNPLOT X*M+T,F
230 IF D=S THEN UNPLOT X*M+S,F
240 NEXT M
250 FOR M=U TO S
260 SCROLL
270 NEXT M
280 PAUSE 4E4
290 GOTO X*X
```

Dicing with memory

Christopher Tolley,
Plaistow,
London E13.

ZX-81

THE WAY MY dice generator is written means that it will just squeeze into 1K, if you drop the Rem statement in line 0, and will draw up to three dice. Owners of ZX-81s with more than 1K RAM may change line 90 to draw more.

The point of interest in this program is the use of variables instead of numbers. I did this because numbers consume valuable space in an unexpanded machine. Most of these variables are assigned in lines 10 to 60. The dice are drawn in the loops from 120 to 160, as black squares. Depending on the value generated in line 110, certain of the points in these squares are unplotted in lines 170 to 270. Line 280 waits for you to press Newline before drawing a new set of dice.

The program starts at line 0. This line number cannot be directly entered without causing a syntax error. The way I did it was to enter the lines as 5 Rem and so on, and then use a direct command.

POKE 16510,0

which changes the line number to zero.

Any line number may be Poked in this way, but it is important to remember when dealing with numbers greater than 255 that they are stored with the more significant byte first — other addresses, such as in the system variables, are stored the other way round. ■

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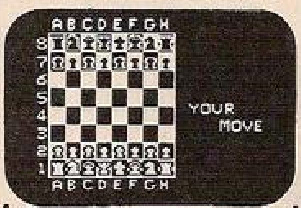

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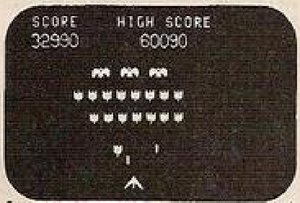

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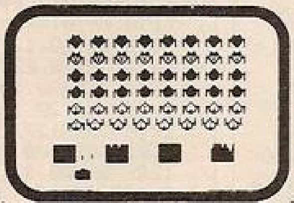

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LTRACE	DATA	RENUMBER X Y	IHEX
STEP	RESTORE	AUTO X Y	[illegible]
FIND	ELSE	CURSOR X Y	VECTOR
VAR	WHILE	BEEP X Y	ZERO
LVAR	ENDWHILE	KEY X	POP
DELETE X Y	DUMP	INKEY $X	STOP

[illegible]

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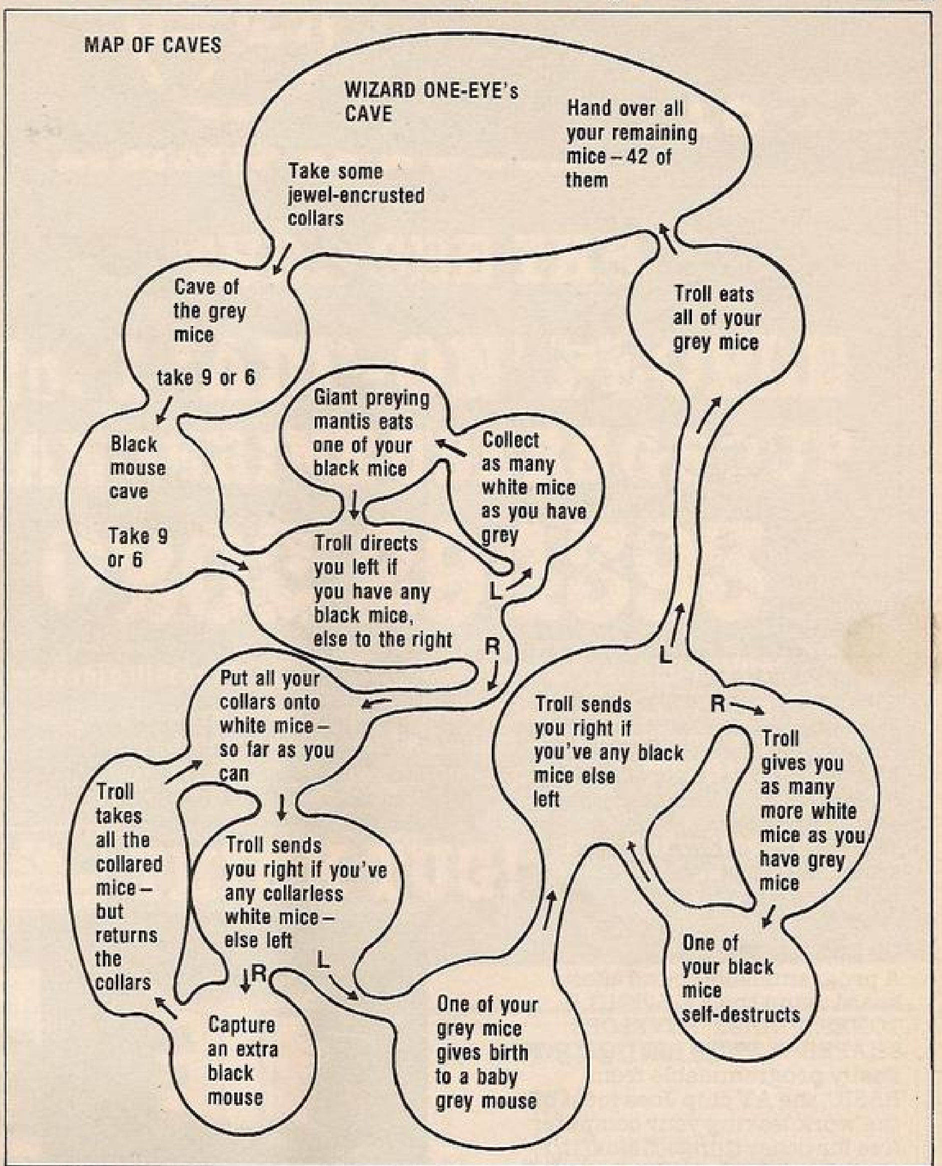
Rodent riddle

BY ANTHONY ROBERTS

THE WIZARD One-eye has been watching the *Hitch-Hiker's Guide to the Galaxy* with his trolls, while you were waiting on them all, hand and hoof. So you all know that the answer to life, the universe, and everything, is 42, and that the question is somehow computed from 9 and 6. The wizard promptly decides that if you do not solve the problem for him he will try turning you into a bowl of petunias — or perhaps a whale — and of course it is easy to solve.

You must, as usual, find your way through the trolls' cave system in which all passages are one-way. This time, as you enter, he offers you some jewel-encrusted mouse-collars as an inducement to succeed in emerging with 42 white mice as required. How many should you take? Here is the cave map.



Competition results

THERE WAS a slight reduction in the number of entries for the Vic-20 software competition in March. However, the standard of the entries was as high as ever, making the task of picking a winner extremely difficult. First place went to John Imrie, Flat C, 18 Jenner Road, Guildford, GU1 3PP, who completed the sentence "I need £100 of Vic-20 software because ..." with "my CPU runneth over with potential". £100 of Vic software is on its way.

Other suggestions which caught the eye included T Bradshaw's "My home-made Tardis won't run without it", G Veale's "I'll save a load on tapes" and F Diamond's "Vic's a big softy at heart". Miss L Meredith explained that "it changes a vastely ignorant computer into a very intelligent companion" while Paul Bywater proved himself a film buff with "it will help my Vic t'mature".

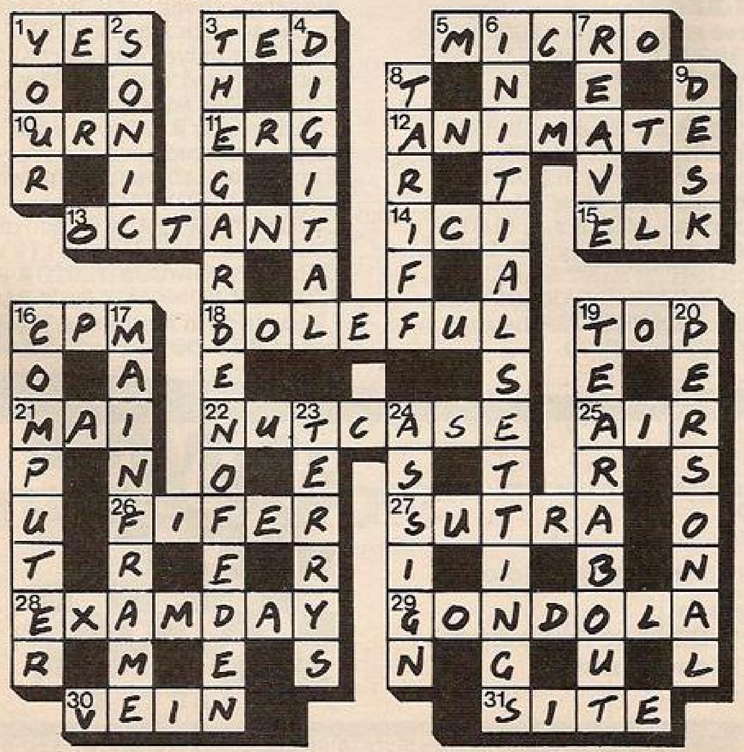
I Simmons of Welwyn Garden City added a touch of cynicism with "I can sell it for £80 and buy myself a ZX-81". B Zussman revealed that "Poking damages your wealth" while R Keating noted "a Vic program each day will keep the Apple at bay".

The Dire Straits competition included an error in the instructions. Each troll should go to sleep automatically after eating someone, allowing the next person to go through the cave untouched. The troll then wakes up and eats the third person to go through his cave.

The first person to spot this mistake in the puzzle was Andrew Scott, 55 Huntly Grove, Peterborough, PE1 2QW, who has been awarded the £15 book token.

The solution to the puzzle was 76 gems. The puzzle needed a program to model the cave system which would allow you to try each possible location for the six trolls. Troll 5 goes in the top cave, troll 6 in the bottom cave and trolls 3, 1, 2 and 4 in the middle four caves. This means that the fifth, eighth, 10th, 17th, 22nd and 24th men come out alive with 5, 35, 5, 5, 21 and 5 gems respectively for a total of 76.

Solution to the March crossword.



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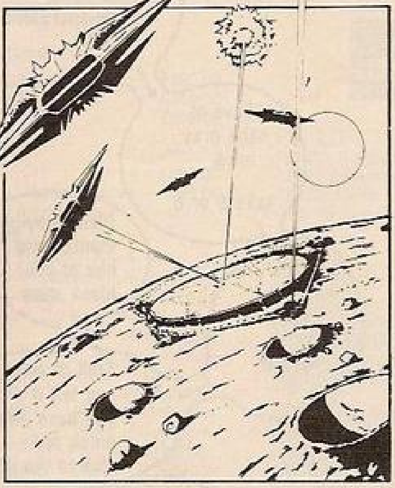
QS - LOWER CASE
abcdefghijklmnopqrstuvwxyz



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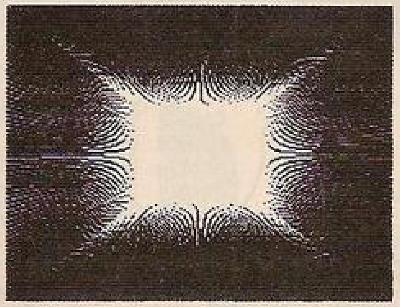

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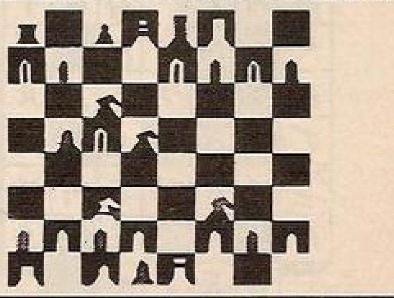

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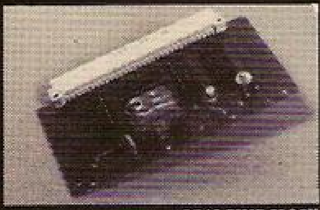

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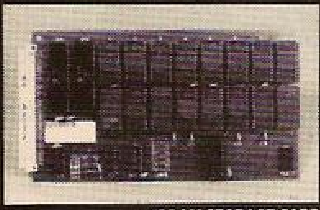

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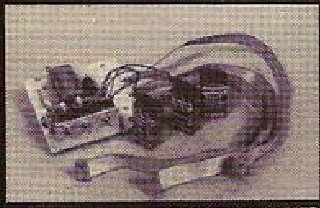

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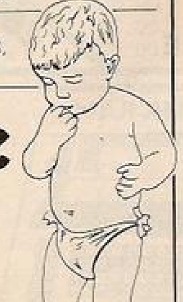

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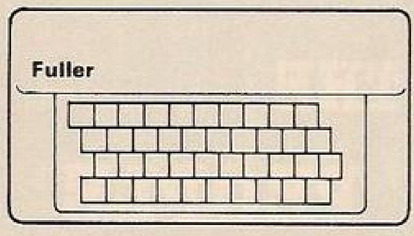

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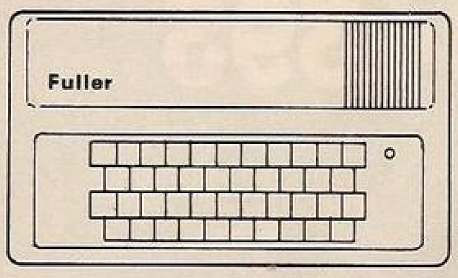

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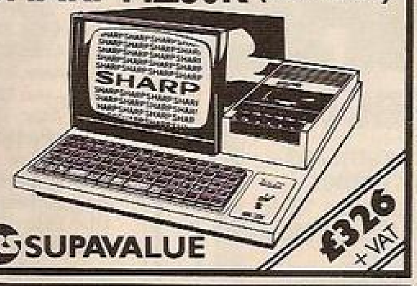

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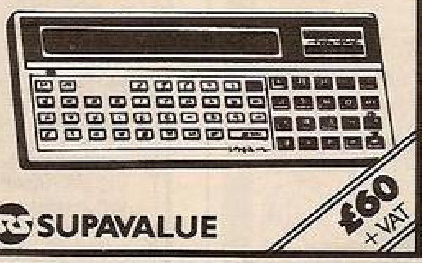

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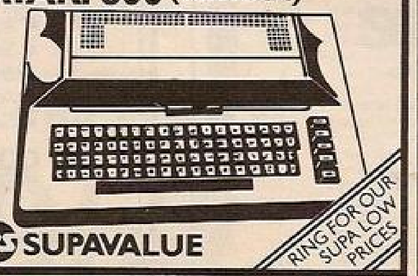

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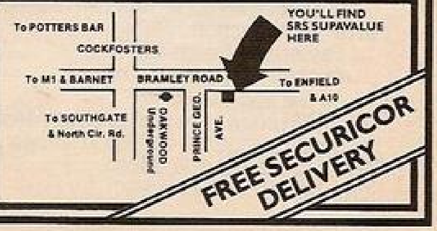

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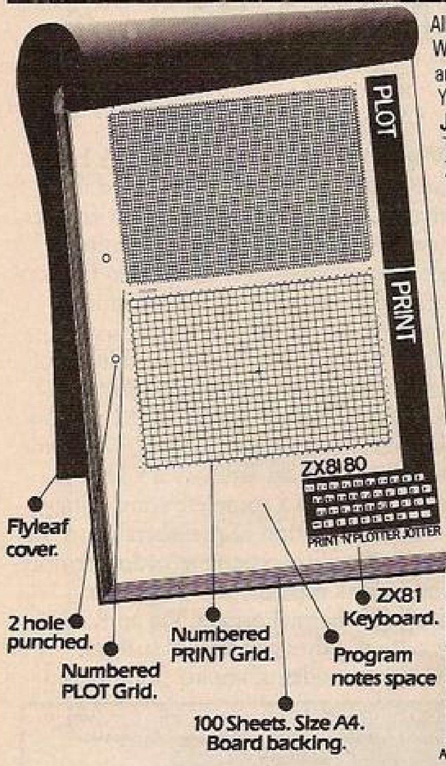

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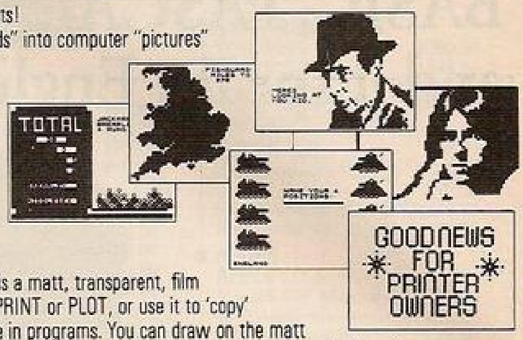

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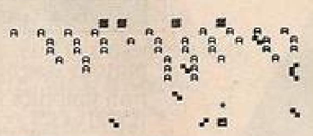

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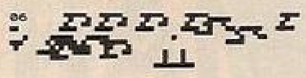

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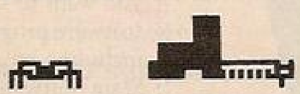

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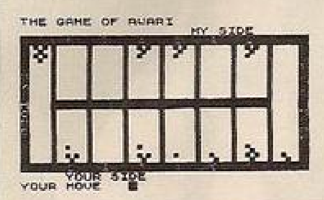

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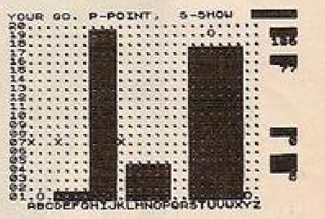

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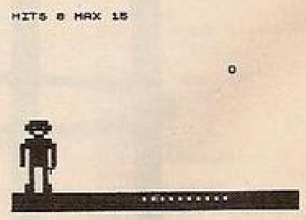

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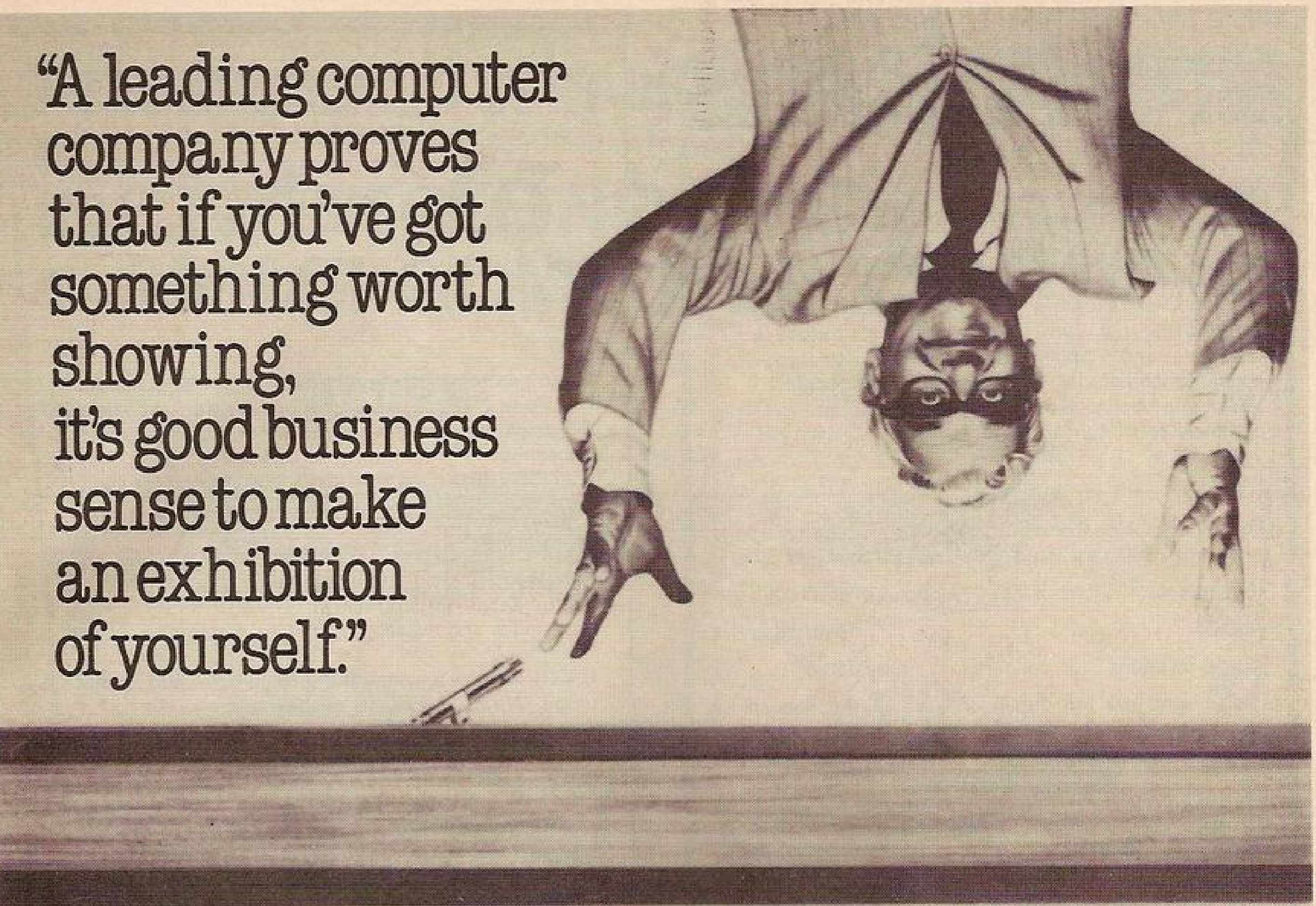

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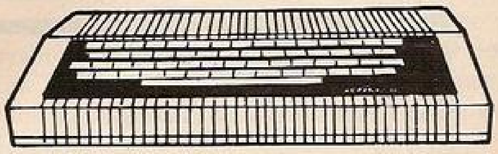

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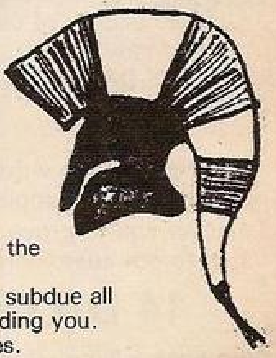

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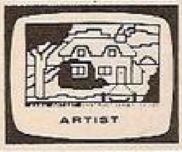

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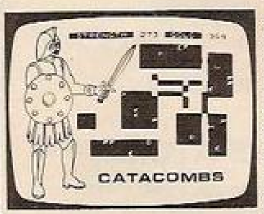

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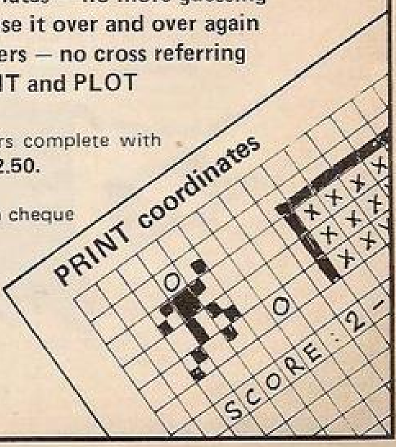

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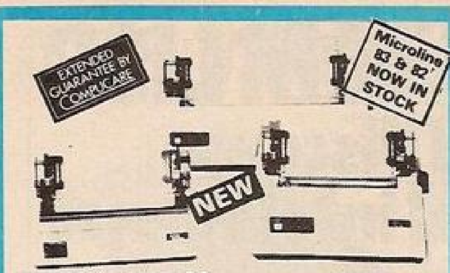

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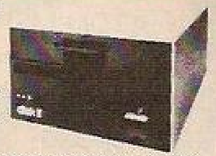

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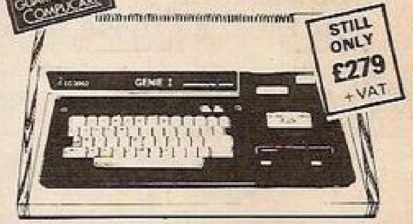

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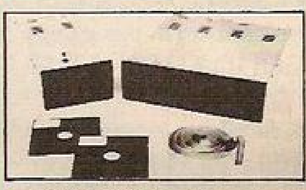

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