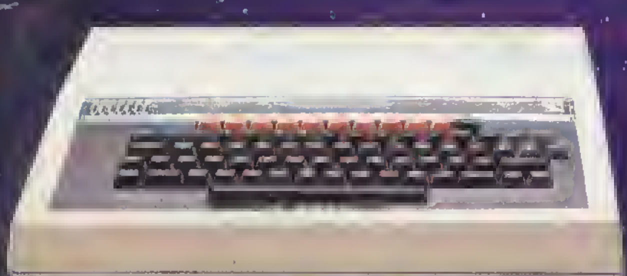
ACORN USER

BBC micro and Atom magazine

April 1983 £1

PRINTERS: layman's guide
BBC: Bach's music
DISCS: how fast?
ATOM: software reviews
BBC: interfacing
BCPL: new language

HEXANGLE
game for the BBC micro



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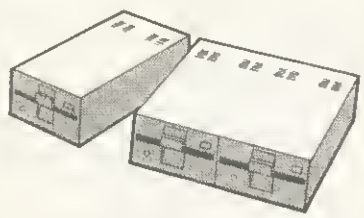

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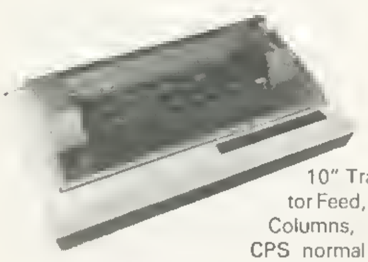

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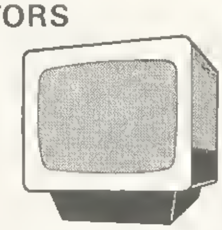

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For BBC SOFTWARE and BOOKS see our advert on Page 25 of this magazine.

ACORN ON THE KNIFE-EDGE OF TECHNOLOGY

DESIGNING and building the BBC micro is a difficult act for Acorn to follow. Their first computer to do so will be the Electron, a machine aimed at the home market with the same high-flying ambition as the Beeb.

The launch date is still not finalised, despite what many magazines have claimed. And the Electron is being kept very close to the company's collective chest. No more details have been released beyond what was said in last October's *Acorn User*.

The reason why is still the same as last October: 'Finalising the ULA is the dominant factor.' These words, issued by managing director Chris Curry say it all. Acorn is working at the forefront of technology – the largest logic array chips, the largest ROMs.

Acorn is trying to squeeze the utmost out of ULAs – and they are difficult to deal with. As director Andy Hopper who is in charge of chip design said: 'Manufacturing steps are fairly simple – but they take time. If a fault is found it can take months for it to be corrected.'

So when the latest iteration of the ULA comes in, Acorn holds its collective breath. Because if the ULA is tested and it works – Bingo. Acorn have their new worldbeater. And when it does, *Acorn User* will be the first to let you know.

Tony Quinn
Editor

APRIL 1983
NUMBER NINE

How to submit articles: You are welcome to send articles to the Editor of *Acorn User* for publication. *Acorn User* cannot undertake to return them unless a stamped addressed envelope is enclosed. Articles should be typed or computer written with double line spacing. Black and white photographs or transparencies are also appreciated. If submitting programs a cassette or disc is vital. Payment is £50 per page or pro rata. Please indicate if you have submitted your article elsewhere. Send articles, reviews and information to: The Editor, *Acorn User*, 53 Bedford Square, London WC1B 3DZ.

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CONTENTS

Coming soon in *Acorn User*:

● Musical style – how to analyse and reproduce it ● DIY interface box for the BBC micro ● DIY sound generator for the Atom ● Printers – what to do if it doesn't work ● ● Reviews – printers, software, books ● Teletext explained ● ● Graphics

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Who is this? Turn to page 5 for clues

BBC system goes worldwide

THE BBC computer literacy scheme, and with it Acorn's BBC micro, has now been launched overseas.

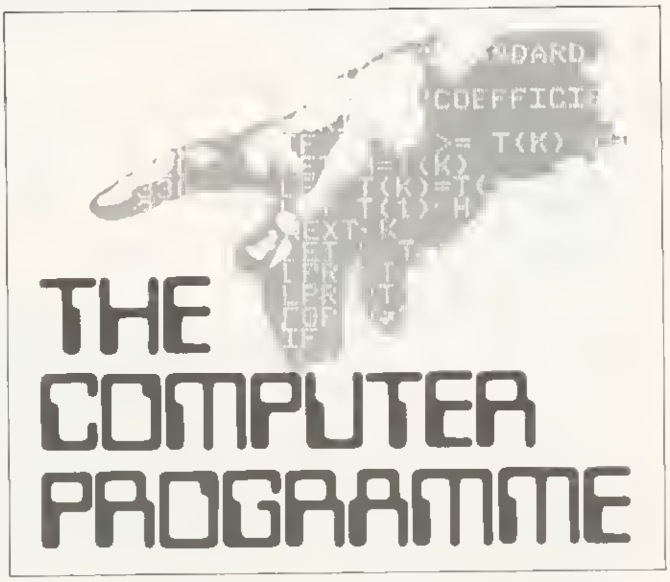
New Zealand saw the official announcement of the scheme on December 6, with *The Computer Programme* going out on national TV from the beginning of March. There are now estimated to be about 600 BBC micros in the country.

In Australia, the big launch took place on February 14 with the TV series starting in some states on May 13. The BBC micro has been available for about a year and more than 1500 are in use, mainly in schools. This is despite there being no direct government funding for micros in education, although individual states can give grants to buy equipment. This may soon change however as the country's elections have taken place Both major political parties have committed themselves to spending up to $20 million on micros for schools.

Meanwhile, across the Atlantic, the Public Broadcasting Service is showing *The Computer Programme* to the Americans from April 16. The BBC micro is not yet available, as major hardware changes have had to be made because the US television system has a different number of lines making up each screen. Acorn has a subsidiary in the US and a launch is planned for later this year. Advance machines are already undergoing trials in the US.

Australia is reported to be interested in setting up its own telesoftware service, under the auspices of the state-owned ABC TV. An Australian Education User Group has been set up for the Beeb in Melbourne, and Econet seems to be popular, with about 70 systems already in action.

Three groups are handling the literacy scheme: the BBC in Sydney, Acorn's distributor Barson's, and Pitman Publishing. Although 1000km separates these three, Siriol Giffney of the BBC described the launch as 'a successful and very co-operative venture.'



That famous hand again. . . symbol for TV series

Capital venue for Acorn User Show

A MAJOR new computer show will be launched this year by *Acorn User*.

The venue is the Cunard International Hotel, Hammersmith Broadway, London, and it will take place from August 25 – 28.

Many of *Acorn User*'s authors will be there for you to meet and there will be a special edition of the magazine.

The Cunard Hotel offers excellent facilities, with which we hope to overcome the crush associated with some computer exhibitions, and drab surroundings offered by others.

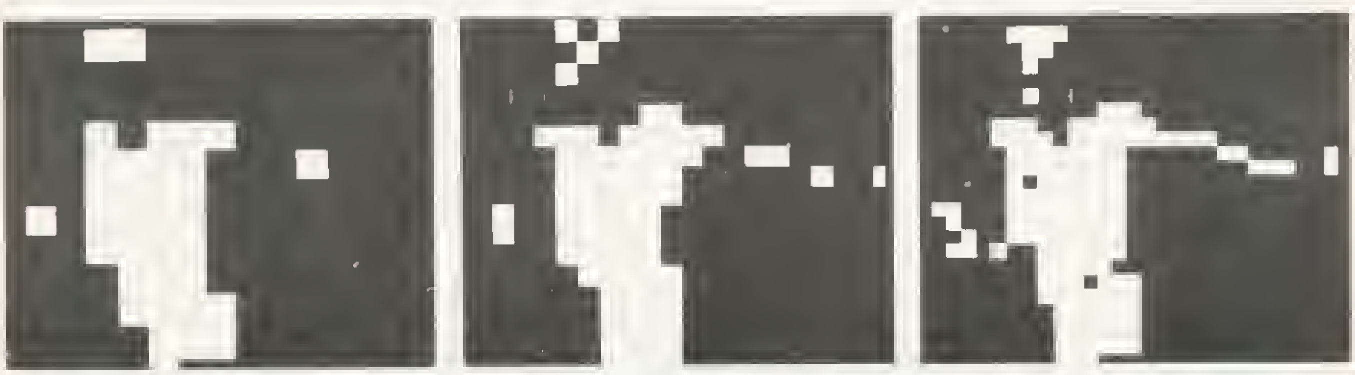
Acorn and other hardware suppliers will be on show with discs, printers, second processors, software, the BBC Buggy – not to mention the Electron, which will be making its first major public appearance.

There will be demonstrations of all new developments by and for the BBC microcomputer system – teletext, Prestel, Econet, new languages and graphics packages.

***Acorn User* will be sponsoring competitions with major prizes for the winners.**

So, whatever your plans in August, cancel the holidays and come along to the big family show. Look out for more details in future issues of *Acorn User*.

Computer Marketplace, the magazine's advertising agents have more details for exhibitors. Their address is 20 Orange St, London WC2 7ED. Tel:01-930 1612.



These pictures, provided by the BBC, show a sequence of digitised computer images. The first, on page 3, uses about 80 bits.

These three use 154, 320 and 616 bits. More clues on page 43 as to the identity of this world famous sportsman.

US voice chip set for new generation of micros

THE vocal harmonic trequency analysis device (VHFAD) – a new concept in voice chips – is expected to arrive from the US around Easter.

The chip relies on large scale integration, plus what the specifications refer to as a 'complete Analog-digital converter configured to reproduce any harmonic sound as an equivalent 32-bit word.' This means that over four billion harmonic sounds may be interpreted.

The VHFAD may be directly interfaced to a number of micros. To the BBC, the VHFAD looks like a standard I/O port, which occupies four locations in memory (hence 32 bits). Its internal circuitry allows the direct coupling of a line input from audio equipment or, via a suitable buffer (741 op amp), a microphone may be connected.

A third set of control lines is available for connection to the outside world via a block of eight DIL switches, which may be connected to pins 20 to 28.

The VHFAD is designed around the principle that when the human voice is supplemented by harmonics, as in forms of singing, or chanting, it develops linearity which transcends dialect, and in some cases nationality.

From tests in Silicon Valley, it transpires that every word or phrase produced during singing can be classified into one of eight variations.

This means it is possible to select a wide range of voice input so there will be no need to follow the old approach of repeating the few words which the micro is then trained to recognise. Instead, whole phrases and words could be stored in ROM, and once set by the switches to the correct vocal harmonic response, this would allow accurate analysis of the voice of any user, within the eight groups.

Table of switch settings

Pin no	Name	Vocal grouping
20	BM	Bass male
21	TV	Tenor voice
22	AU	Unisex alto
23	SS	Standard soprano
24	BS	Boy soprano
25	MV	Minstrel vocalist
26	NT	Not tuneful (dissonance)
27	CFC	Check finat consonant

With no training, the user could sing out his commands which would be decoded with an error of 0.001%, which represents the percentage of like-sounding words in the English language.

One expected use for this device has been found by the National Coal Board. A test site has been suggested in Wales, where it is hoped miners will be able to clock on orally, removing the disastrous effect of coaldust on the present mechanical apparatus.

Education users will find the inclusion of a dissonance (NT) switch will enable the device to be used with young children, who may occasionally appear tuneless, or with the older secondary pupil who may have difficulty with hymnal vocalisation.

Users should keep their eyes open for BBC add-ons incorporating the chip. One well known advertiser in these pages has christened their prototype unit the 'Beeb Sing-in', but Acorn should look out as Clive Simclair is rumoured to be considering using a VHFAD chip to replace the keyboard of his next micro.

However, Acorn joint managing director Chris Currie was adamant: 'If it comes to a shouting match, we'll win.'

Mr Simclair was keeping very quiet about it all, and not a whisper has been heard from him since very early in April.

Floppy disc pen – no kidding!

WHO says British companies are slow on the uptake? Berol appear to be first on the market with a floppy disc pen! The idea is that its 'unique safety tip' will automatically bend before a floppy disc can be damaged if the writer presses too heavily on its cover: 'Far better a bent nib which can soon be straightened,' say Berol, 'than a ruined floppy disc costing £5 or more, which may contain £100s if not £1000s worth of information!'

The Berol Floppy Disk Pen is available in four colours, 'including a special fade-resistant black for documents which need a long storage life'. The other colours are blue, green and red. It will cost 45p.

Official story on ROM exchange available from dealers

THE saga of operating system ROMs continues. We called four major Acorn dealers to get their side of the story, and found little evidence of any official policy. However, all the dealers said they will have stock of 1.2 ROMs by the time you read this.

Prices ranged from £10 (inc. VAT) to £12.50 (inc. VAT) for supply and installation. This will be done free of charge when replacing operating systems in EPROM, although one dealer said this only applied to the four-chip EPROM. The EPROMs are fitted into the PCB just under the keyboard on the right hand side (*User Guide* p498).

Dealers said they had no documentation on the 1.2 and didn't know if they would receive any.

We also asked if dealers had any information on the Basic II ROM. This is an updated version of BBC Basic containing a few extra commands, a slightly more economical use of memory and changes in some error messages. One dealer thought it would be available by the end of March/beginning of April; the others had no information.

So here is Acorn's official line. Dealers should have received 1.2 ROMs by the middle of March, with documentation arriving by April. The cost agreed with Acorn to fit and test the new ROM was £10 (plus VAT).

If you have the 0.1 system in EPROM, there will be four of them, so the 1.2 system change will be free (type *FX0). Only 1.0 systems were supplied in the form of two chips, which are on a 'carrier' – an extra piece of circuit board which fits into a ROM socket.

The differences between the 0.1 and 1.2 systems is that the second corrects bugs in the first (notably the cassette loading problem) and contains several new features. The reason people with EPROMs get a free exchange is that these chips are valuable, and can be re-used.

Now for Basic II. Contrary to what you may have read elsewhere, this does exist and is already in ROM. Acorn have not yet finalised distribution, but they are trying to arrange a minimum charge for supply and fitting. Watch this space – *Acorn User* will be carrying a major article on the new systems.

Error in article on building a lightpen

THE article in the March *Acorn User* on page 27 'Shine a light' on building a lightpen by Joe Telford contains a slight mistake.

Everywhere that 'pin photodiode' appears itshould read 'Schmitt receiver'. The RS Catalogue number is 303 270 and the cost is the same (£6.33). Stockists may exchange the part if you have already bought one, so check with them.

Basic program editor for Beeb

SCRED – a word processor designed for editing Basic programs already in memory as well as text – is available on cassette or disc.

Several special features are provided for program editing, as well as normal word processing facilities. A screen dump for the Epson is included, which can be tailored to other printers. Double-height screen characters and other effects are translated into print control codes automatically.

Scred will run programs up to 19k in size and operates in mode 7, with the top two lines for file name and commands. It occupies memory location &D00 to &3600 (&3500 to &7C00 for disc).

A BBC model B, or 32k A, is needed to run the software which costs £18 on cassette or £21 on disc. The makers will upgrade from tape to disc for £6.

Details from Stable Software, Barn Close, Compton St, Compton, Winchester, Hants SO21 2AT.

Micro database links to Prestel

MICRONET 800 – claimed to be the world's largest database for micros – should now be in action after a March 1 launch.

Subscribers who pay a £50 joining fee (for the first 10,000 applicants), plus £50 a year after that will have access to software, news and an electronic mall service through a telephone modem which links their micro to British Telecom's Prestel mainframe computers.

The modem is provided with software on cassette – and a personal password for the user. Once the modem software program is loaded, the user rings up the mainframe and puts the telephone handpiece in the modem which plugs into the micro's RS232 socket. Micronet then asks for the password and, if this is correct, opens up its files.

Micronet users can then scan through a library of programs and enter them into their micro's memory without the need to do any typing. This is known as 'downloading' software. Some programs will be free, while others have to be paid for.

micronet 800

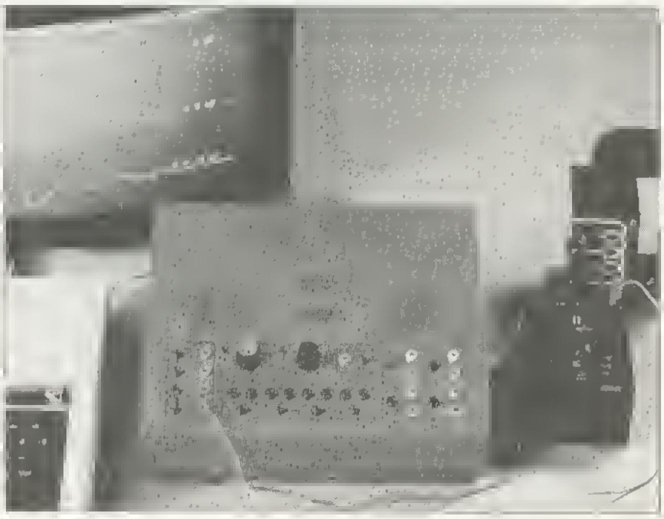
The system can also access all of the Prestel pages, although Prestel users will only be able to enter certain parts of Micronet and will not be able to download.

Initially, only six micros will be catered for, the BBC being one of them. Once connected up, a model B will have about 22k of memory left, the rest being used for the system software and screen display.

Subscription charges will be added to the user's phone bill, as will the cost of any software used and the normal connect charge. Fairly substantial programs should cost about £3 to £4, which should beat normal prices as software houses have no cassette, packing or distribution costs – apart from the charge for setting up the pages.

When the service was initially launched, its backers estimated there would be more than 100 free programs and 50 to pay for. User group pages have been set up with bulletin boards. The 250,000 Prestel pages, which have so far been mainly used for business, travel, news and entertainment information will also be open.

Versatile interface aimed at schools



THE Unilab micro interface detailed in the first issue of Acorn User is now available for £163.

This device was developed to link scientific experiments to micros and is only available initially for the BBC model B.

Uses for the interface include data capture or analysis, timing, signal generation and control. It connects to the 1MHz bus by a ribbon cable.

Unilab manufactures several devices which can be linked to the interface, including environmental and geophysical survey kits, signal generator, biological amplifier and radiation detectors.

The company appears keen to provide support for people using the interface, and included with the device are several cassette programs on applications to back up the manual.

Further, a software exchange will be set up whereby Unilab will distribute programs developed by users at cost price.

All sounds good stuff, and Unilab can give details on postage and VAT at Clarendon Rd, Blackburn, Lancs, BB1 9TA.

Price is up on Z80 board, but down on discs

ACORN has increased the price of the Z80 second processor by £100, to £295. This is justified in the new BBC microsystem brochure by the short phrase 'inc. software'.

The company has apparently negotiated a CP/M-compatible package of programs (version 2.2) to suit a small business. Details were not available, but an Acorn spokesman said it would be well worth the extra money.

The brochure (Information Sheet G3, February) gives initial delivery of all three second processors (6502, Z80 and 16-bit) as '2nd Qtr 83'. However, it is unlikely they will be available before the summer.

Meanwhile, the price of dual discs has fallen by £100 to £699 plus VAT.

Also, the invisible voice chips look set to appear. They were supposed to have been launched before Christmas, but this never happened. A deal is being sorted out whereby the charge for the two voice chips and fitting will include the plug-in cartridge socket (the infamous hole or 'ashtray' in early Beeb keyboards which has now been fitted with a cover).

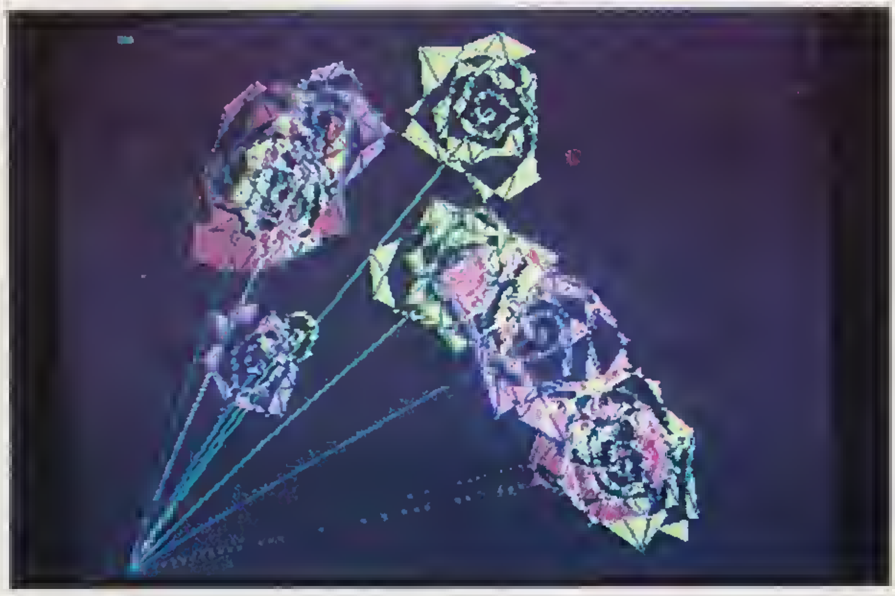
Manuals for the voice synthesiser and Econet are in preparation. Acorn has also produced a firm price list for Econet, and claims to be installing about ten of these networks a month in Britain.

FROM Robert Harding at Cambridge University comes *Stars and Stripes*. This was inspired by a trip he made to California in the company of a BBC micro.

The Americans were impressed with the Beeb's speed and graphics, and we feel the program is topical considering the launch of the BBC TV series over there, and Acorn's plans in the US.

```
10 REM *** STARS & STRIPES ***
15 REM   Model B, uses MODE 1
20 REM Written by Robert Harding
28 :
30 PROCinitplay
35 PROCplay(2)
38 :
40 REM table of COS for stars
50 DIM CS(12)
60 FOR I%=0 TO 12
70 CS(I%)=COS(RAD(30*(I%-1)))
80 NEXT
82 :
100 H=650: W=1.5*H :REM height, width
110 H1=300:     REM height of blue box
120 W1=1.5*H1: REM width of blue box
130 S=1.25 : REM OVERALL SCALE FACTOR
140 X0=100: Y0=100 : REM base corner
190 H=H*S: W=W*S: H1=H1*S: W1=W1*S
192 st2=W1/20: st1=st2/3
198 :
200 REM --- main shape ---
210 MODE 1: GCOL 0,3 : REM white
220 PROCbox(X0,Y0,W,H)
230 GCOL 0,1 : REM red stripes
240 FOR I%=0 TO 6
242 PROCplay(1)
250 PROCbox(X0,Y0+I%*H*2/13,W,H/13)
260 NEXT
270 VDU19, 2,4,0,0,0
280 GCOL 0,2 : REM blue background
290 PROCbox(X0,Y0+H-H1,W1,H1)
298 :
300 REM --- put in the stars ---
310 GCOL 0,3
320 REM 5 rows of 6 first
330 D=W1/6: E=H1/5
340 FOR J%=0 TO 4
350 FOR I%=0 TO 5
352 PROCplay(1)
360 X=D/2+I%*D: Y=E/2+J%*E
370 PROCstar(X0+X,Y0+H-Y,st1,st2)
380 NEXT
390 NEXT
398 :
400 REM --- inner stars ---
410 FOR J%=1 TO 4
420 FOR I%=1 TO 5
422 PROCplay(2)
430 X=I%*D : Y=J%*E
440 PROCstar(X0+X,Y0+H-Y,st1,st2)
450 NEXT
460 NEXT
470 END
900 REM  *** END OF MAIN PROGRAM ***
910 REM ============================
```

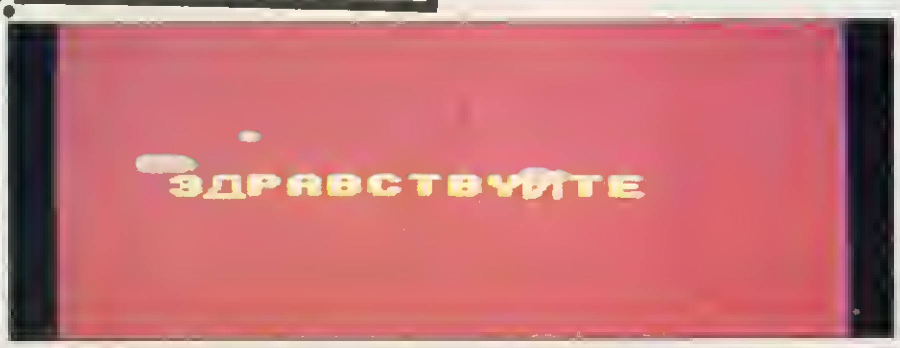
```
998 :
1000 REM --- 6 pt star ---
1010 DEF PROCstar(X,Y,A,B)
1020 LOCAL I%,CU,SU,CU,SV,CW,SW
1030 FOR I%=1 TO 11 STEP 2
1040 CU=CS(I%-1):SU=CS((I%+8)MOD12)
1050 CV=CS(I%+1):SV=CS((I%+10)MOD12)
1055 CW=CS(I%):   SW=CS((I%+9)MOD12)
1060 MOVE X,Y
1070 PLOT 0,A*CU,A*SU
1080 PLOT 85,X+A*CV,Y+A*SV
1090 PLOT 85,X+B*CW,Y+B*SW
1100 NEXT
1110 ENDPROC
1998 :
2000 REM --- rectangle ---
2010 DEF PROCbox(X,Y,A,B)
2020 MOVE X,Y
2030 PLOT 0,A,0
2040 PLOT 81,-A,B
2050 PLOT 81,A,0
2060 ENDPROC
2998 :
3000 REM -------------------
3010 REM play a few notes
3020 DEF PROCplay(NUM%)
3030 LOCAL I%,N%,T%
3040 IF NP%>=NNOTES% THEN ENDPROC
3050 I%=0
3060 REPEAT
3070 READ N%,T%
3080 IF N%<100 THEN 3082 ELSE 3088
3082 SOUND 1,V%,4*N%+33,T%:GOTO 3090
3088 SOUND 1,0,0,T%
3090 SOUND 1,0,0,1
3100 I%=I%+1: NP%=NP%+1
3110 UNTIL I%=NUM% OR NP%=NNOTES%
3120 ENDPROC
3138 :
3140 REM --------------------
3150 :
3160 REM initialise for tune.
3170 DEF PROCinitplay
3175 READ NNOTES%,V%
3180 NP%=0
3200 ENDPROC
8998 :
9000 REM  Data for JOHN BROWN
9010 DATA 77,-15
9020 DATA 7,12, 7,12, 4,9, 7,3, 12,9
9030 DATA 14,3, 16,9, 16,3, 16,9, 14,3
9040 DATA 12,12, 100,6
9060 DATA 9,12, 9,12, 12,9, 11,3, 12,9
9070 DATA 9,3, 7,9, 9,3, 7,9, 5,3
9080 DATA 4,12, 100,6
9090 DATA 7,12, 7,12, 4,9, 7,3, 12,9
9100 DATA 14,3, 16,9, 16,3, 16,9, 14,3
9110 DATA 12,12
9120 DATA 12,9, 12,3, 14,12, 14,12
9130 DATA 12,12, 11,12, 12,18, 100,6
9140 DATA 7,18, 5,3, 4,9, 7,3, 12,9
9150 DATA 14,3, 16,24, 12,21, 100,3
9160 DATA 9,18, 11,3, 12,9, 11,3, 12,9
9170 DATA 9,3, 7,24, 4,21, 100,3
9180 DATA 7,18, 5,3, 4,9, 7,3, 12,9
9190 DATA 14,3, 16,24, 12,12, 100,3
9200 DATA 12,9, 12,3, 14,12, 14,12
9210 DATA 12,12, 11,12, 12,24
```



One of our readers, B. Mitchell from Merseyside, is learning Russian. He wrote to tell us about an interesting little program for the BBC micro. This prints out 3DPABCTBYNE (ZDRAVSTVYEE) which is 'HELLO' in Russian. About 16 characters of the Russian alphabet need defining on an eight by eight matrix – the other 13 have English equivalents. Most Russian words will only need two or three characters being so defined.

Perhaps you could apply this to Chinese or Japanese!

```
10 MODE 5
20 VDU 23,224,62,34,34,34,34,66,
   66,255 : D$=CHR$(224)
30 VDU  23,225,134,138,138,146,
   146,162,162,194 : N$=CHR$(225)
40 PRINTTAB(3,16)"3";D$;"P";"A";
   "B";"C";"T";"B";"Y";N$;"T";"E"
50 END
```



THIS program is especially for Mother's Day. It draws random bouquets of roses in mode 1 on the BBC model B.

Lines 40 to 70 determine the colours, which are randomly selected for each flower by line 90. Lines 110 and 120 randomly select the centres for individual flowers.

Lines 170 and 180 produce a circle. Since the diameter (M) increases with the angle B, a spiral is being drawn. The number of revolutions is determined by the random variable F. To plot the rose flower leaves, the spiral radius is always changing in a random fashion (line 160).

Experimenting is worthwhile. Try substituting B/16 by B/15.7 in the line 180. B/14 produces exotic flowers. RND (10) in line 160 is worthy of study also.

Our thanks to Heinz Eipel for sending the program all the way from Germany.

```
   LIST
 10 REM ROSE BOUQUET
 20 CLS
 30 MODE 1
 40 VDU 19,0,0,0,0,0
 50 VDU 19,1,1,0,0,0
 60 VDU 19,2,5,0,0,0
 70 VDU 19,3,3,0,0,0
 80 FOR A=1 TO 12
 90 GCOL 3,RND(3)
100 MOVE 0.0
110 D=RND(800)+250
120 E=RND(800)+150
130 MOVE D,E
140 F=RND(200)+300
150 FOR B=1 TO F STEP 4
160 M=(B/(RND(10)+10))
170 X=M*5*SIN(B/16)+D
180 Y=M*5*COS(B/16)+E
190 PLOT 85,X,Y
200 NEXT B
210 NEXT A
220 GOTO 20
```

HEXANGLE

Peter Balch presents a game for two – you and your computer. It runs on a 32k BBC micro with either operating system (0.1 or 1.0). The listing has been dumped from cassette onto a printer to avoid any errors. Good luck.

Hexangle is a game of wits – yours against the computer. You both take turns to fill in the lines between the six yellow points; the computer draws red lines and you draw in white. The first one to draw a triangle of his or her own colour loses. However, only triangles with a point at each corner matter.

When the board is drawn, a flashing white line will appear – this is the cursor. You can move the cursor around by holding down the left and right arrow keys. When the cursor is in the position that you want, press return. On the first move of the game you can miss your turn by pressing the space bar.

The computer then makes its move. It considers each line in turn while moving the cursor around – then fills in one of them in red.

It is not possible to draw, and the computer plays a pretty mean game in the difficult mode – especially if you go first.

The procedure which decides which move to make is called CHOOSEMYMOVE. It tries a red line in each legal position and works out a 'Score'. This measures how good or bad that position is and is called a [illegible].

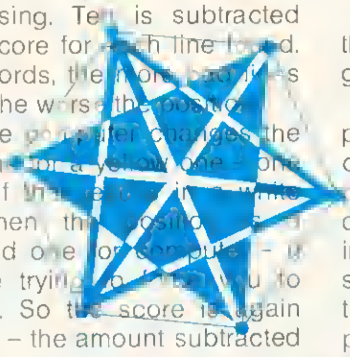
First, the routine checks whether the new red line would form a red triangle – if so this is a losing position and score is given a large negative value.

```
10  ENVELOPE 2,144,2,44,29,113,105,2
20,57,-25,-94,-42,123,57:SOUND 17,2,100
,255
20 REM HEX
30 REM COPYRIGHT (C) P.R. BALCH
40 REM ANALOGUE INFORMATION SYSTEMS
50 REM 1982
60 REM
70 REM ===========================
80
90 DIM PX(6),PY(6),VX(6),VY(6)
100  DIM LIN%(6,6)
110 PROCINIT
120 :
130 REM PRINT THE RULES
140 :
150 MODE 1
160 VDU 19,0,4,0,0,0
170 VDU 19,2,1,0,0,0,0
180 VDU 19,1,0,0,0,0
190 PRINT TAB(10,7);"H E X A N G L E"

200 PRINT TAB(10,8);"==============="

210 PRINT TAB(1,11);"Do you want the
Rules";
220 INPUT S$
230 VDU 23;8202;0;0;0;0
240 IF LEFT$(S$,1)="y" OR LEFT$(S$,1)
="Y" THEN PROCRULES
250 PRINT TAB(1,14);" (E:easy  I:inte
rmediate  D:difficult)"
260 PRINT TAB(1,13);"What level of di
fficulty";
270 INPUT S$
280 DIFF%=2
290 IF LEFT$(S$,1)="E" THEN DIFF%=0
300 IF LEFT$(S$,1)="I" THEN DIFF%=1
310 MODE 2
320 :
330 VDU 23;8202;0;0;0;0
340 :
350 REM START OF NEW GAME
360 :
370 REM DRAW THE BOARD
380 :
390 PROCDRAWBOARD
400 START%=0
410 FOR A%=1 TO 6
420  FOR B%=1 TO 6
430   LIN%(A%,B%)=0
440  NEXT
450 NEXT
460 GOTO 740
470 :
480 REM IF I HAVE WON
490 :
500 REM I WIN
510 PRINT TAB(6,3);"I Win     "
520  ENVELOPE 2,28,-108,-17,-19,61,76
,193,-63,-117,-1,-50,107,74:SOUND 17,2,
100,255
530 PROCDRAWTRIAN
540 MYSCORE=MYSCORE+1
550 GOTO 670
560 :
570 REM IF THE HUMAN HAS WON
580 :
590 REM YOU WIN
600 PRINT TAB(6,3);"You Win   "
610 ENVELOPE 2,1,4,-4,4,10,20,10,127,
0,0,-5,126,126:SOUND 17,2,100,255
620 PROCDRAWTRIAN
630 YOURSCORE=YOURSCORE+1
640 :
650 REM WRITE THE SCORE
660 :
```

Then it calls COUNTBADLINES to count how many 'bad' lines are left on the board. A bad line is one where the computer can't play without losing. Te[illegible] is subtracted from the score for [illegible]h line [illegible]d. In other words, the [illegible] bad [illegible]s there are, the w[illegible]rs[illegible] the posit[illegible].

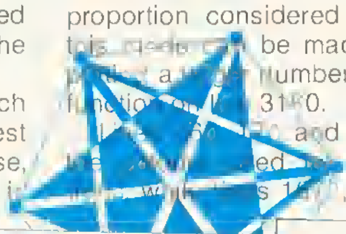


Next, the [illegible] changes the trial red lin[illegible] a yellow one [illegible] of yours. If [illegible] triangle then th[illegible] slightly bad one for [illegible] should be tryin[illegible] to play there. So t[illegible] score is again decreased – the amount subtracted depends on how far through the game we are.

The score obtained for each position is compared with the 'best score' obtained so far. If it is worse, that position is rejected. If it is better, the new position becomes the 'best score'. If the new score is the same as the best score then one is chosen at random.

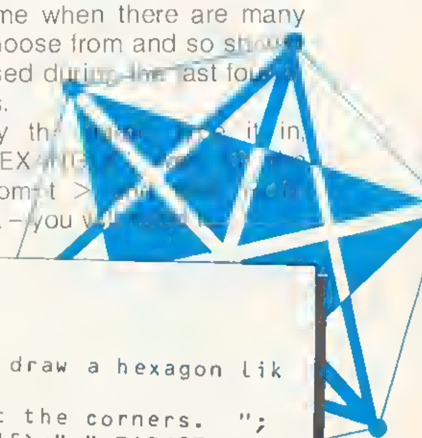
After looking at every legal move, the computer plays the line which gave the overall best score.

The computer has three levels of play – easy, intermediate and difficult. In the easy mode, it avoids playing in a losing position but otherwise plays at random. In the intermediate mode, it considers some lines in detail but doesn't think about the others. The proportion considered in detail in t[illegible] be made larger by [illegible] a [illegible] number in the RND f[illegible] 3140.



[illegible] and 180 specify [illegible]ed [illegible] the instruc[illegible] s 1[illegible], 1680, 1690 and 1940 specify the colours used for the game. You can alter these statements. Look up VDU 19 in the *User Guide*. This controls which actual colour a 'logical' colour is displayed as.

You may well want to try writing a better algorithm for the computer – a better version of CHOOSEMYMOVE. For instance, for each move that it considers, it could check what your response might be and then it's response and so on. This would take a long time at the start of the game when there are many lines to choose from and so sh[illegible] only be used du[illegible] last fo[illegible] five moves.



To play th[illegible] it in, LOAD "HEX[illegible] cursor prompt >[illegible] Good luck – you [illegible]

```
 670 IF YOURSCORE>MYSCORE THEN PRINT T
AB(3,30);YOURSCORE;" - ";MYSCORE;" to Y
ou"
 680 IF YOURSCORE<MYSCORE THEN PRINT T
AB(3,30);MYSCORE;" - ";YOURSCORE;" to M
e "
 690 IF YOURSCORE=MYSCORE THEN PRINT T
AB(3,30);MYSCORE;" Each               ";
 700 GOTO 350
 710 :
 720 REM DO THE HUMAN'S MOVE
 730 :
 740 REM YOUR MOVE
 750 PROCGETMOVE
 760 IF A%=0 THEN 810
 770 LIN%(A%,B%)=2
 780 PROCDRAWLINE(A%,B%,3)
 790 PROCTRIANGLE(2)
 800 IF WIN%=1 THEN 500
 810 START%=START%+1
 820 :
 830 REM DO MY MOVE
 840 :
 850 PROCCHOOSEMYMOVE
 860 PROCDRAWLINE(T%,U%,2)
 870 LIN%(T%,U%)=1
 880 PROCTRIANGLE(1)
 890 IF WIN%=1 THEN 600
 900 GOTO 740
 910 REM ============================

 920 DEF PROCRULES
 930 :
 940 REM PRINT THE RULES
 950 :
 960  CLS: PRINT TAB(0,1)
 970  ENVELOPE 2,20,25,5,-30,88,217,41
,67,-51,-2,-14,127,34:SOUND 17,2,100,25
5
```

```
 980  PRINT "I will draw a hexagon lik
e this with"
 990  PRINT "dots at the corners.  ";
 1000  PRINT TAB(14,15);"o";TAB(23,15);
 1010  PRINT"o";TAB(14,29);"o"
 1020  PRINTTAB(23,29);"o";TAB(9,22);
 1030  PRINT"o";TAB(28,22);"o"
 1040  GCOL 0,1
 1050  FOR I=1 TO 5
 1060   FOR J=I+1 TO 6
 1070   MOVEPX(I),PY(I):DRAWPX(J),PY(J)
 1080   NEXT
 1090  NEXT
 1100  A=INKEY(500)
 1110  PRINT TAB(0,4);"Then we will tak
e turns to draw in"
 1120  PRINT "the lines.  I will draw i
n Red and"
 1130  PRINT "you will draw in White."
 1140  GCOL 0,3
 1150  MOVEPX(5),PY(5):DRAWPX(2),PY(2)

 1160  DRAWPX(4),PY(4):DRAWPX(6),PY(6)

 1170  GCOL 0,2
 1180  MOVEPX(1),PY(1):DRAWPX(3),PY(3)
 1190  DRAWPX(4),PY(4):DRAWPX(1),PY(1)
 1200  A=INKEY(1000)
 1210  PRINT "The first person to draw
a triangle of"
 1220  PRINT "his or her own colour wit
h a dot at"
 1230  PRINT "each corner loses.  In th
is drawing,"
 1240  PRINT "I have a triangle and you
 haven't so"
 1250  PRINT "I have lost."
 1260  A=INKEY(1000)
```

I'M FREDDIE – FLY ME!

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If however, you are prepared to sit at your computer for literally hours on end getting to grips, and then give a considerable amount of effort and time into actually trying to solve it, then this is definitely for you.

Though F for Freddie is a flight simulator type of game, it is not one with simple operation and the ground appearing at the front of you, but is as accurate a simulation of not only flight, but preparation, take-off and the many more occurances associated with flying a tri-star jet as a 32K micro will allow.

Controls? A mind boggling 36 of them! And it is here where the logic and skill comes in, as everything must be done not only in the correct order but at the right time. Yes, it's in real time, with the clock ticking relentlessly away.

But the great asset of this 'game' is that every little piece of information you require is shown on the screen, nearly fifty in all, continuously being updated, with the colours being cleverly used to depict different, changing, situations.

Eventually you will master the take-off, then even manage to fly and at long last manage to land. But unlike all other games, at this stage you don't put it away for ever, for you have seven different destinations, all on different courses and distances...

There are plenty of instructions on the 36 controls and even a little advice, but as the whole thing is a colossal challenge, you are not told how to fly Freddie, this you have to discover entirely for yourself...

At times you will wish, as most certainly will your family, that you never bought the blasted thing!

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In Magic Adventure, Beth and David Guest have created a wonderland journey for children between 4 and 10.

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The scenes include the Talking Tree—who played a nasty trick on a friend so was punished by the Fairy. But if the Talking Tree helps later on, all with be forgiven...Poor mother rabbit needs help to count her babies...Dare the Cage be opened...what is in the Grassy Field... can the King's Spell Jar be found...what is the real colour of the Glasses...will the fairies dance......is the Castle locked...where does the Path lead...will the Fairy come...will there be a surprise...

With everything illustrated in colourful graphics, this is a delightful example of the programmers' art and refreshingly different from anything ever done before. Sound of course.

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```
1270  PRINT "Use the arrow keys until
the line you"
1280  PRINT "want flashes then press R
ETURN.  Press"
1290  PRINT "SPACE if you want me to g
o first."
1300  A=INKEY(10000): CLS
1310 ENDPROC
1320 REM ===========================
1330 DEF PROCINIT
1340 :
1350  REM INITIALISE VARIOUS THINGS
1360 :
1370  REM THE COORDINATES OF THE
1380  REM BOARD IN THE RULES
1390 :
1400  PX(1)=300: PY(1)=300
1410  PX(2)=464: PY(2)=526
1420  PX(3)=750: PY(3)=526
1430  PX(4)=908: PY(4)=300
1440  PX(5)=750: PY(5)=76
1450  PX(6)=464: PY(6)=76
1460 :
1470  REM THE COORDINATES OF THE
1480  REM MAIN BOARD
1490 :
1500  VX(1)=160: VY(1)=494
1510  VX(2)=416: VY(2)=844
1520  VX(3)=862: VY(3)=844
1530  VX(4)=1112: VY(4)=494
1540  VX(5)=862: VY(5)=140
1550  VX(6)=416: VY(6)=140
1560 :
1570  REM THE SCORES
1580 :
1590  MYSCORE=0
1600  YOURSCORE=0
1610 ENDPROC
1620 REM ===========================
1630 DEF PROCDRAWBOARD
1640 :
1650  REM DRAW THE MAIN BOARD
1660 :
1670  VDU 19,0,4,0,0,0
1680  VDU 19,2,1,0,0,0,0
1690  VDU 19,1,0,0,0,0
1700  COLOUR 3
1710 :
1720  REM DRAW THE DOTS
1730 :
1740  PRINT TAB(6,5);"o";TAB(13,5);
1750  PRINT"o";TAB(17,16);"o"
1760  PRINTTAB(6,27);"o";TAB(13,27);
1770  PRINT"o";TAB(2,16);"o"
1780 :
1790  REM DRAW THE LINES IN BLACK
1800 :
1810  GCOL 0,1
1820  FOR I=1 TO 5
1830   FOR J=I+1 TO 6
1840    MOVE VX(J),VY(J)
1850    DRAW VX(I),VY(I)
1860   NEXT
1870  NEXT
1880  ENDPROC
1890 REM ===========================
1900 DEF PROCGETMOVE
1910 :
1920  REM GET THE HUMAN'S MOVE
1930 :
1940  VDU 19,4,10,0,0,0
1950  PRINT TAB(6,3);"Your Move"
1960  ENVELOPE 2,24,15,29,34,19,37,194
,0,89,-78,-114,68,69:SOUND 17,2,100,255

1970  FOR J=1 TO 1000: NEXT
1980 :
1990  REM CYCLE THROUGH EACH LINE
2000  REM WHEN AN ARROW KEY IS PRESSED
2010  REM MEANWHILE FLASH THE CURSOR
2020 :
2030  A%=1: B%=1: I=1
2040  IF A%>=B% THEN 2190
2050  IF A%<B% AND LIN%(A%,B%)>0THEN 2
190
2060  D=3: E=10
2070  PROCDRAWLINE(A%,B%,D)
2080  IF INKEY(-26) THEN I=1: GOTO 216
0
2090  IF INKEY(-122) THEN I=-1: GOTO 2
160
2100  IF INKEY(-74) THEN 2310
2110  IF INKEY(-99) AND START%=0 THEN
PROCDRAWLINE(A%,B%,1): A%=0: GOTO 2310

2120  E=E-1: IF E>0 THEN GOTO 2070
2130  D=4-D: E=5
2140  GOTO 2070
2150 :
2160  PROCDRAWLINE(A%,B%,1)
2170  IF I=1 THEN ENVELOPE 2,23,19,37,
-70,178,245,232,-2,29,-10,-117,101,34:S
OUND 17,2,100,255
2180  IF I=-1 THEN ENVELOPE 2,135,-47,
74,66,240,43,136,-106,-17,-74,-62,121,7
0:SOUND 17,2,100,255
2190  B%=B%+I
2200  IF B%=7 THEN B%=1: GOTO 2230
2210  IF B%=0 THEN B%=6: GOTO 2230
2220  GOTO 2040
2230  A%=A%+I
2240  IF A%=7 THEN A%=1
2250  IF A%=0 THEN A%=6
2260  GOTO 2040
2270 :
2280  REM THIS IS THE LINE CHOSEN
2290  REM MAKE SURE A%<B%
2300 :
2310  IF A%>B% THEN C=A%: A%=B%: B%=C

2320  ENVELOPE 2,6,56,-15,-87,133,99,1
58,9,-20,-49,-50,123,79:SOUND 17,2,100,
255
2330 ENDPROC
2340 REM ===========================
2350 DEF PROCDRAWLINE(A,B,C)
2360 :
2370  REM DRAW THE LINE FROM A TO B
2380  REM IN COLOUR C
2390 :
2400 GCOL 0,C
2410 MOVE VX(A),VY(A)
```

```
2420 DRAW VX(B),VY(B)
2430 ENDPROC
2440 REM ============================
2450 DEF PROCTRIANGLE(C)
2460 :
2470  REM LOOK FOR A TRIANGLE
2480  REM OF COLOUR C
2490 :
2500  WIN%=0
2510  FOR A%=1 TO 4
2520   FOR B%=A%+1 TO 5
2530    IF LIN%(A%,B%)<>C THEN 2600
2540    FOR C%=B%+1 TO 6
2550     IF LIN%(A%,C%)<>C THEN 2590
2560     IF LIN%(B%,C%)<>C THEN 2590
2570     TA=A%: TB=B%: TC=C%
2580     WIN%=1
2590    NEXT
2600   NEXT
2610  NEXT
2620 ENDPROC
2630 ENDPROC
2640 REM ============================

2650 DEF PROCDRAWTRIAN
2660 :
2670  REM DRAW THE WINNING TRIANGLE
2680   REM IN AMAZING COLOURS
2690 :
2700  PROCDRAWLINE(TB,TC,C)
2710  PLOT 86,VX(TA),VY(TA)
2720  FOR I=1 TO 15
2730   FOR C=0 TO 7
2740    PROCDRAWLINE(TA,TB,C)
2750    PROCDRAWLINE(TA,TC,C)
2760    PROCDRAWLINE(TB,TC,C)
2770   NEXT
2780  NEXT
2790  PLOT 86,VX(TA),VY(TA)
2800 ENDPROC
2810 REM ==========================
2820 DEF PROCCHOOSEMYMOVE
2830 :
2840  REM CHOOSE MY BEST MOVE
2850 :
2860  PRINT TAB(6,3);"My Move    "
2870  IF START%>1 THEN 2990
2880 :
2890  REM MY FIRST MOVE IS RANDOM
2900 :
2910  T%=RND(5)
2920  U%=RND(6)
2930  IF U%<=T% THEN 2910
2940  IF LIN%(T%,U%)>0 THEN 2910
2950 ENDPROC
2960 :
2970  REM OTHER MOVES NEED MORE THOUGH
T
2980 :
2990  BEST%=-30000
3000 :
3010  REM CONSIDER EACH LINE IN TURN
3020 :
3030  FOR X%=1 TO 5
3040   FOR Y%=X%+1 TO 6
3050    IF LIN%(X%,Y%)>0 THEN 3470
3060     PROCDRAWLINE(X%,Y%,15)
3070     ENVELOPE 2,5,21,19,38,31,105,1
2,85,13,-35,-53,99,42:SOUND 17,2,100,25
5
3080     S%=0
3090 :
3100     REM TRY IT FIRST IN MY COLOUR
3110 :
3120     LIN%(X%,Y%)=1
3130     PROCTRIANGLE(1)
3140     IF WIN%=1 THEN S%=-10000: GOTO
3350
3150     IF DIFF%=0 THEN 3350
3160     IF DIFF%=1 AND RND(3)=1 THEN S
%=-1000: GOTO 3350
3170 :
3180     PROCCOUNTBAD(1)
3190 :
3200     REM IS IT BAD FOR THE HUMAN?
3210 :
3220     LIN%(X%,Y%)=2
3230     PROCTRIANGLE(2)
3240     IF WIN%<>1 THEN 3310
3250     S%=S%-9
3260     IF START%<4 THEN S%=S%-2
3270 :
3280     REM RED,RED,WHITE TRIANGLES
3290     REM ARE GOOD
3300 :
3310     FOR J%=1 TO 6
3320      IF X%=J% OR Y%=J% THEN 3340
3330      IF LIN%(X%,J%)+LIN%(J%,X%)+LI
N%(Y%,J%)+LIN%(J%,Y%)=3 THEN S%=S%+3
3340     NEXT
3350     LIN%(X%,Y%)=0
3360 :
3370     REM IF IT'S BETTER THAN THE
3380     REM BEST SO FAR THEN
3390     REM REMEMBER IT
3400 :
3410     IF S%<BEST% THEN 3460
3420     IF S%=BEST% AND RND(2)>1 THEN
3460
3430     BEST%=S%
3440     T%=X%
3450     U%=Y%
3460     PROCDRAWLINE(X%,Y%,1)
3470    NEXT
3480  NEXT
3490 ENDPROC
3500 REM ============================
3510 DEF PROCCOUNTBAD(F%)
3520 :
3530  REM COUNT THE NUMBER OF LINES
3540  REM THAT F% CAN'T PLAY
3550 :
3560  FOR G%=1 TO 5
3570   FOR H%=G%+1 TO 6
3580     IF LIN%(G%,H%)>0 THEN 3630
3590     LIN%(G%,H%)=F%
3600     PROCTRIANGLE(F%)
3610     IF WIN%=1 THEN S%=S%-1
3620     LIN%(G%,H%)=0
3630   NEXT
3640  NEXT
3650 ENDPROC
>
```

THE BEEB PLAYS BACH

As Jim McGregor and Alan Watt demonstrated last month, the BBC micro can produce some impressive music. Here, they take the theme further with Bach. Next month it's 12-bar blues. Roll over Beethoven!

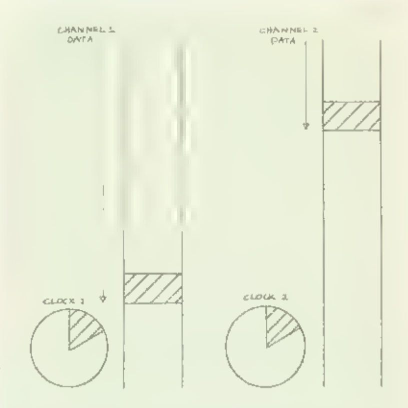

Figure 2. Clock for each channel

Although careful use of the envelope statement can produce moderately pleasing effects with a single voice (single sound statement), the sound generated is obviously from a fairly simple synthesiser. A lot of the resulting musical inadequacies can be overcome by using two or three voices or sound channels simultaneously. But to do this means solving some tricky queuing and synchronization problems.

Consider playing melodies simultaneously from parallel arrays or separate data streams containing, for each melody line, a pitch and duration value. We could fetch elements alternately from each melody array and send them alternately to two sound channels. A queuing problem arises whenever notes of different durations appear at corresponding points in each melody line – the usual situation in musical arrangements. To start with, consider the problem with two voices or channels. The example in figure 1 – should make things clear where a sequence of four minims is to be initiated in one channel at the same time as a series of quavers in the other channel.

We could attempt to play the melodies by fetching a note from the channel 1 data stream or array and sending it to the channel 1 queue. We then fetch a note from the channel 2 data stream and send it to the channel 2 queue etc. (By 'send' we mean execute a sound statement.) This approach would be perfectly satisfactory if there was a limitless queue associated with each channel. However, a channel queue can only hold a maximum of five requests (not four as stated in the *User Guide*).

By sending notes alternately to each channel, we have created the correspondence shown by the sloping lines in figure 1. The program will be held up when it attempts to send the seventh minim to the channel 1 queue as the first minim will still be sounding and the next five have filled the queue.

There are also five notes on the channel 2 queue but these are shorter and will be dealt with more frequently than the channel 1 notes. When the first minim on channel 1 has been played, four notes on channel 2 will have finished, leaving only two notes in the queue. The second minim on channel 1 now starts to play making room for the seventh minim in the queue. This enables one further quaver to be added to the channel 2 queue before the program is again held up on attempting to add the eighth minim to the channel 1 queue. Thus while the second minim is being played on channel 1, only three quavers are available to be played on channel 2.

To solve this problem, we must arrange in this particular case to execute sound statements for channel 2 more frequently than for channel 1. Once the sound statement for the first note on channel 1 has been obeyed, no further channel 1 sound statements should be obeyed until sound statements have been obeyed for the first four notes on channel 2. In general, we must keep the total duration of the notes for which channel 1 sound statements have been executed approximately equal to the total duration of the notes for which channel 2 sound statements have been executed.

We could order the notes manually when transposing the music for our program, but it is more convenient to keep the two lines of a melody separate and let a program decide on the order in which to execute the appropriate sound statements. To do this, we have to keep a 'clock' running for each voice of the melody (figure 2).

In general, the current note for each channel will be in a different position in the data streams. The clocks will tend to show equal elapsed times. Each time a sound statement is obeyed, the duration of the note is added to the clock associated with that channel. At

Figure 1. Queuing problem with two channels

each step we must obey a sound statement for the channel whose clock shows the least elapsed time. We require to repeat the following operation:

If clock1 > clock2 THEN obey SOUND statement for channel 1
ELSE IF clock2 > clock1 THEN obey SOUND statement for channel 2
ELSE obey SOUND statements for both channels and synchronise

The program then selects one out of these three courses of action and ensures the channels are not subject to interference from each other. Effectively we have removed the artificial connection in the parallel data streams between notes in different channels that have different duration values.

The above structure also synchronises the channels whenever the two clocks show equal elapsed time. If this was not done channels would drift apart because of the time taken by the sound generator to handle statements.

Another tedious task to be overcome before getting the machine to play arrangements is transposing from a musical score to a set of pitch numbers and associated notation. Transposing directly from the black dots to pitch numbers and durations in fractions of a second is tedious and error prone. You can write a graphics 'picking and dragging' program to input the music onto a screen stave, but we shall adopt a character convention, and list the music in data statements using figure 3. We use the North American notation for note durations because the first letters of their note names are all unique. *Remember that in this notation, a semibrieve is a whole note, a minim is a half note and so on.*

Note that there are notes that cannot be accurately represented at this tempo. For example a dotted 1/32 is 1.5 (only 1 or 2 can be used as a duration parameter in a sound statement). Similarly a 1/16 triplet is 4/3 per note, an 1/8 triplet 8/3 per note and a 1/4 triplet 16/3 per note.

Pitch values are represented using the convention shown in figure 3. We do not cater for a key signature, but insert sharps and

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```
  10 ENVELOPE 1,1,0,0,0,0,0,0,126,-4,0,-63,126,100
  20 ENVELOPE 2,1,0,0,0,0,0,0,63,10,0,-63,63,110
  30 ENVELOPE 3,1,0,0,0,0,0,0,126,-4,0,-63,126,100

  40 DIM pitch(3,100),duration(3,100),noofnotes(3),nextnote(3),clock(3)
  50 tempo=1
  60 PROCinitialise(1)
  70 PROCinitialise(2)
  80 PROCplaytwovoices
  90 END

 200 DEFPROCinitialise(voice)
 210 LOCAL note,pitch$,duration$,dur$,dur,notename$,position,prime$,octave
 220   READ noofnotes(voice)
 230   FOR note = 1 TO noofnotes(voice)
 240     READ pitch$, duration$
 250     dur$=RIGHT$(duration$,1) : dur =INSTR("tseqhw",dur$)
 260     duration(voice,note)=2^(dur-1)*tempo
 270     IF INSTR(duration$,"d") THEN
           duration(voice,note) = duration(voice,note) * 3/2
 280     notename$=LEFT$(pitch$,1)
 290     position=INSTR("C-D-EF-G-A-BR",notename$)
 300     IF position=13 THEN pitch(voice,note)=255
         ELSE pitch(voice,note)=1+4*position
 310     IF RIGHT$(pitch$,1) = "#" THEN
           pitch(voice,note) = pitch(voice,note) + 4
 320     IF RIGHT$(pitch$,1) = "b" THEN
           pitch(voice,note) = pitch(voice,note) - 4
 330     prime$ = "'" : octave = 0
 340     FOR j=2 TO LEN(pitch$)
 350       IF MID$(pitch$,j,1) = prime$ THEN octave = octave +1
 360     NEXT j
 370     pitch(voice,note) = pitch(voice,note) + octave*48
 380   NEXT note
 390 ENDPROC

 400 DEFPROCplaytwovoices
 410   nextnote(1)=0 : nextnote(2)=0
 420   clock(1)=0 : clock(2)=0
 430   finished=0
 440   REPEAT
 450     IF clock(1) > clock(2) THEN PROCsound(2,0)
         ELSE  IF clock(2) > clock(1) THEN PROCsound(1,0)
               ELSE PROCsound(1,&100) : PROCsound(2,&100)
 460   UNTIL finished=2
 470  ENDPROC
 480   UNTIL finished=noofvoices
 490 ENDPROC

 600 DEF PROCsound(voice,sync)
 610 LOCAL n,envelope
 620   nextnote(voice)=nextnote(voice)+1
 630   n=nextnote(voice)
 640   clock(voice)=clock(voice)+duration(voice,n)
 650   IF pitch(voice,n)=255 THEN envelope=0
                              ELSE envelope=voice
 660   SOUND sync+voice,envelope,pitch(voice,n),duration(voice,n)
 670   IF n=noofnotes(voice) THEN finished=finished+1:clock(voice)=2000000
 680 ENDPROC

1000 DATA 74, D'',q,G',e,A',e,B',e,C'',e,D'',q,G',e,R,e,G',e,R,e,E'',q
1010 DATA C'',e,D'',e,E'',e,F''#,e,G'',q,G',e,R,e,G',e,R,e,C'',q,D'',e
1020 DATA C'',e,B',e,A',e,B',q,C'',e,B',e,A',e,D',e,F'#,q,G',e,A',e,B',e
1030 DATA G',e,B',q,A',h,D'',q,G',e,A',e,B',e,C'',e,D'',q,G',e,R,e,G',e
1040 DATA R,e,E'',q,C'',e,D'',e,E'',e,F''#,e,G'',q,G',e,R,e,G',e,R,e
1050 DATA C'',q,D'',e,C'',e,B',e,A',e,B',q,C'',e,B',e,A',e,G',e,A',q
1060 DATA B',e,A',e,G',e,F'#,e,G',h,G,q
1070 DATA 38, B,h,A,q,B,dh,C',dh,B,dh,A,dh,G,dh,D',e,R,e,B,q,G,q,D',e,R,e
1080 DATA D',e,C',e,B,e,A,e,B,h,A,q,G,q,B,q,G,q,C',dh,B,e,R,e,C',e,B,e
1090 DATA A,e,G,e,A,h,F'#,q,G',h,B',q,C'',q,D'',q,D',e,R,e,G',dh
```

Program 1. Frere Jacques

code	musical convention		duration (for metronome 50)
t		1/32	1
s		1/16	2
ds	dotted	1/16	3
e		1/8	4
de	dotted	1/8	6
q		1/4	8
dq	dotted	1/4	12
h		1/2	16
dh	dotted	1/2	24
w		whole	32

Pitch values		*Pitch number*
C	(C below middle C)	5
C'	(middle C)	53
C"	(C above middle C)	101
C"'		149
C""		197
C'#	(middle C sharp)	57
C'b	(middle C flat)	49
R	rest	255

Figure 3. Character data convention **Pitch values**

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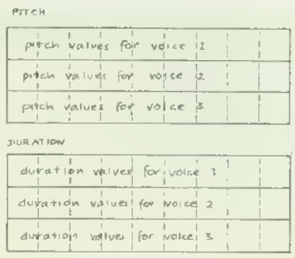

Figure 4. Two dimensional arrays

Figure 5. A round

flats explicitly. Program 1 is a complete program that can be used to play two voices of a melody where the two voices are supplied separately in data statements using the above notation. This and later programs use two two-dimensional arrays to hold up to three voices for an arrangement. These can be pictured as in figure 4. Only the first two rows are used in program 1. There are also three one-dimensional arrays used to record the number of notes in each voice, a count of the notes sounded for each voice and the 'clock' recording the total duration of the notes sounded for each voice.

You can arrange the voices yourself if you have sufficient musical knowledge. One intriguing form that is easy to transpose into a number of voices is the canon.

The simplest and most familiar form of canon is the round, and *Frere Jacques* is a common example. A theme (called the initiating voice or leader) enters. The second voice (identical to the theme in the case of a round) enters after a time interval, and the round is written so it harmonises with itself. Thus the theme performs two functions; first as a melody in its own right, and second as a harmony or counter point to itself (figure 5). Now because the follower is identical to the leader in the case of a round, or mathematically derivable from it, for canons, only one theme need be transposed into a program to play two or more voices.

Program 1 can be modified as indicated in program 2 to play *Frere Jacques* as a two voice round with a two bar delay. The procedure PROCround produces the two rows of our arrays necessary to play a round on two channels. In this procedure we effectively displace the follower by the delay where the delay is specified to the procedure in multiples of the smallest possible note (𝅘𝅥𝅯).

```
  40 DIM pitch(3,100),duration(3,100),noofnotes(3),nextnote(3),clock(3)
  50 tempo=2
  60 PROCinitialise(1)
  70 PROCround(1,2,64)
  80 PROCplaytwovoices
  90 END

 700 DEF PROCround(leader,follower,delay)
 710 LOCAL l,f
 720   pitch(follower,1)=255 : duration(follower,1)=delay
 730   f = 1
 740   FOR l=1 TO noofnotes(leader)
 750     f = f + 1
 760     pitch(follower,f)=pitch(leader,l)
 770     duration(follower,f)=duration(leader,l)
 780   NEXT l
 790   noofnotes(follower)=f
 800 ENDPROC

1000 DATA 32, F',q,G',q,A',q,F',q,F',q,G',q,A',q,F',q,A',q,B'b,q,C'',h
1010 DATA A',q,B'b,q,C'',h,C'',e,D'',e,C'',e,B'b,e,A',q,F',q,C'',e,D'',e
1020 DATA C'',e,B'b,e,A',q,F',q,F',q,C',q,F',h,F',q,C',q,F',h
```

**Program 2. Modified Frere Jacques.
Change these lines in program 1**

```
  40 DIM pitch(3,100),duration(3,100),noofnotes(3),nextnote(3),clock(3)
  50 tempo = 1
  60 PROCinitialise(1)
  70 PROCround(1,2,64)
  80 PROCround(2,3,64)
  90 PROCharmonise(3)
 100 END

 400 DEF PROCharmonise(noofvoices)
 410 LOCAL voice,slowest,sync
 420   FOR voice=1 TO noofvoices
 430     clock(voice)=0 : nextnote(voice)=0
 440   NEXT voice
 450   finished=0
 460   REPEAT
 470     slowest=1000000 : sync=0
 480     FOR voice=1 TO noofvoices
 490       IF clock(voice)=slowest THEN sync=sync+&100
           ELSE IF clock(voice)<slowest THEN slowest=clock(voice):sync=0
 500     NEXT voice
 510     FOR voice=1 TO noofvoices
 520       IF clock(voice)=slowest THEN PROCsound(voice,sync)
 530     NEXT voice
 540   UNTIL finished=noofvoices
 550 ENDPROC
```

**Program 3. Three voice round.
Change lines in program 1**

If the program doesn't sound right then you have probably made a mistake in typing the data. To check the tune through, play a single voice only using a FOR loop:

```
FOR note = 1 TO noofnotes
  SOUND 1,1, pitch (1,note),
  duration (1, note)
NEXT note
```

These three lines should replace the call of PROCplaytwovoices.

Contrasting envelopes can be used to effect, and we leave you to experiment with these (see *Acorn User* March). The theme in the above program is rather banal, but it is necessary to verify your program works.

Before moving on to more complex canons, we first present a procedure to synchronise music consisting of three separate voices. In program 3, PROCplaytwovoices is replaced with PROCharmonise which can organise three voices. It could be used to play more if we had further channels available. Each execution of the repeat loop in this procedure picks out the channel or channels that have fallen behind and issues sound statements for these channels, synchronising them if appropriate.

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Program 3 will arrange and play a three voice round using the same data as before.

One of the rarest forms of canon is the crab, or canon in retrograde motion, because it is so difficult to write. There is no delay, both themes enter simultaneously. The first voice plays the theme from the start and the second voice plays it backwards (figure 6).

Bach's No 9 canon from *The Musical Offering* is a crab canon. It contains a theme with long duration notes followed by a counterpoint. The theme is played against the reverse of the counterpoint, followed by the counterpoint playing against the reverse of the theme (figure 7). Program 4 includes a procedure to generate arrays for a crab and includes data for Bach's.

In mirror canons or canons in contrary motion, the follower is derived from the leader by inverting the intervals in the leader. This means that when the leader ascends the follower descends by exactly the same interval. A familiar tune that will work as a mirror canon is *Good King Wenceslas*. A time delay of half a bar is needed between the leader and the follower.

We now look at canon No 4 from *The Musical Offering*. This is a three part arrangement, a variation of the *Royal Theme* – centre piece of the work – providing the upper voice (figure 8). The higher canonic part enters first followed by its exact inversion half a bar later (delay = eight notes).

In a mirror canon there is a common note about which the reflection occurs. In this case it is Eb (the third degree of the C minor scale – the key of the work). Thus C in the leader becomes G in the follower and vice versa. If all that is a bit technical, bear in mind that it is just a rule for deriving the first note of the follower. Once the first note of the follower is fixed we derive the remainder by inverting the intervals in the leader. The leader in this case starts as a descending sequence of tone, tone, semi-tone, tone (figure 9). The follower then begins in the octave below – an ascending sequence of tone, tone, semi-tone, tone and so on. Program 5 generates the arrays for the inverted part together with the data for the *Royal Theme* and the canon.

```
50 tempo=1
60 PROCinitialise(1)
70 PROCcrab(1,2)
80 PROCharmonise(2)
90 END

700 DEF PROCcrab(voice,othervoice)
710 LOCAL n1,n2
720   n1=noofnotes(voice)
730   FOR n2=1 TO noofnotes(voice)
740     pitch(othervoice,n2)=pitch(voice,n1)
750     duration(othervoice,n2)=duration(voice,n1)
760     n1=n1-1
770   NEXT n2
780   noofnotes(othervoice)=noofnotes(voice)
790 ENDPROC

1000 DATA 90,C'',h,E'b,h,G',h,A'b,h,B,h,R,q,G',h,F',h,F',h,F',h,E'b,h,D',q
1010 DATA D'b,q,C',q,B,q,h,q,C',q,C',q,E'b,h,D',h,C',h,E'b,h,G',e,F',e,G',e
1020 DATA C'',e,B',e,E'b,e,D',e,F'b,e,F',e,G',e,A',e,B',e,C'',e,E'b,e,F',e
1030 DATA G',e,A'b,e,D',e,C'b,e,F',e,G',e,F',e,E'b,e,D',e,E'b,e,F',e,G',e
1040 DATA A'b,e,B'b,e,D'b,e,G',e,F',e,G',e,A'b,e,B'b,e,C'',e,D'',e,E''b,e,D'',e,A',e,F',e,C'',e,D'',e,E''b,e,C'',e,B'b,e,A'b,e,B',e,C'',e,D'',e,E'',e
1050 DATA F'',e,D'',e,B',e,D'',e,E'',e,D'',e,F',e,E'',e,F',e,E',e,G',q,G',q,E'b,q,C',q
```

Program 4. Procedure for crab canon with data for Bach. Change program 1

```
50 tempo=2
60 PROCinitialise(1)
70 PROCinitialise(2)
80 PROCinvert(2,3,+68,16*tempo)
90 PROCharmonise(3)
100 END

700 DEF PROCinvert(voice,othervoice,shift,delay)
710 LOCAL n1,next1,n2,lastpitchon1,lastpitchon2
720   IF delay>0 THEN
        pitch(othervoice,1)=255:duration(othervoice,1)=delay:n2=1
      ELSE n2=0  :REM n2 counts notes in other voice.
730   next1=1  :REM next1 is next note in voice.
740   REPEAT  :REM to copy restsat start and find first note.
750     IF pitch(voice,next1)=255 THEN
          n2=n2+1:pitch(othervoice,n2)=255:
          duration(othervoice,n2)=duration(voice,next1):next1=next1+1
760   UNTIL pitch(voice,next1)<>255
770   n2=n2+1
780   pitch(othervoice,n2)=pitch(voice,next1)+shift
790   lastpitchon1=pitch(voice,next1)
800   lastpitchon2=pitch(othervoice,n2)
810   duration(othervoice,n2)=duration(voice,next1)
820   next1=next1+1
830   FOR n1=next1 TO noofnotes(voice)
840     n2=n2+1
850     nextinterval=-(pitch(voice,n1)-lastpitchon1)
860     IF pitch(voice,n1)=255 THEN pitch(othervoice,n2)=255
        ELSE pitch(othervoice,n2)=lastpitchon2+nextinterval :
             lastpitchon1=pitch(voice,n1):lastpitchon2=pitch(othervoice,n2)
870     duration(othervoice,n2)=duration(voice,n1)
880   NEXT n1
890   noofnotes(othervoice)=n2
900 ENDPROC

1000 DATA 22, C'',q,E''b,q,G'',q,A''b,q,B',q,R,e,G'',e,F'',q,F'',q,F'',q
1010 DATA E''b,dq,D'',e,D''b,e,C'',e,B',e,A',s,G',s,C'',e,F',e,E''b,e
1020 DATA E''b,e,D'',q
1030 DATA 46,R,s,C'',s,B'b,s,A'b,s,G',s,F',s,E'b,s,D',s,C',s,R,s,C',s
1040 DATA D',s,F'b,e,A',e,R,e,G',e,C'',s,D'',s,C'',s,B'b,s,A',s,A,s,G,e
1050 DATA A,s,B,e,G',de,b,s,A,s,B,s,C',s,D',s,E'b,s,D',s,C',e,D',e,E'b,e
1060 DATA Ab,e,G,s,D',s,C',s,B,s,R,s,F',s,E',s,D',s
1070 DATA C',dq,B,e,E'b,s,C'',s,B'b,s,A'b,s,G',s,F',s,E'b,s,D',s,C
1080 DATA s,B,s,C',s,D',s,E'b,e,C'',e
```

Program 5. Mirror canon. Change program 1

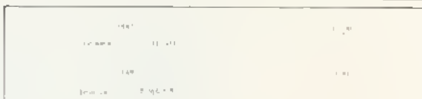

Figure 6. Crab canon

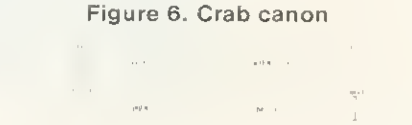

Figure 7. Crab with counterpoint

Figure 8. Three part canon

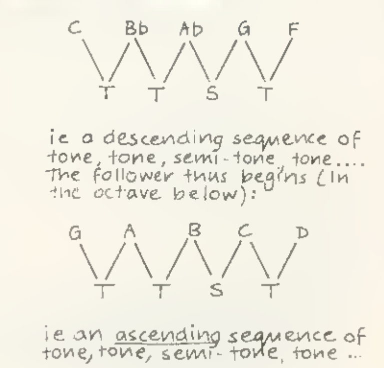

Figure 9. Mirror canon

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COWBOY SHOOTOUT (32K) £6.50
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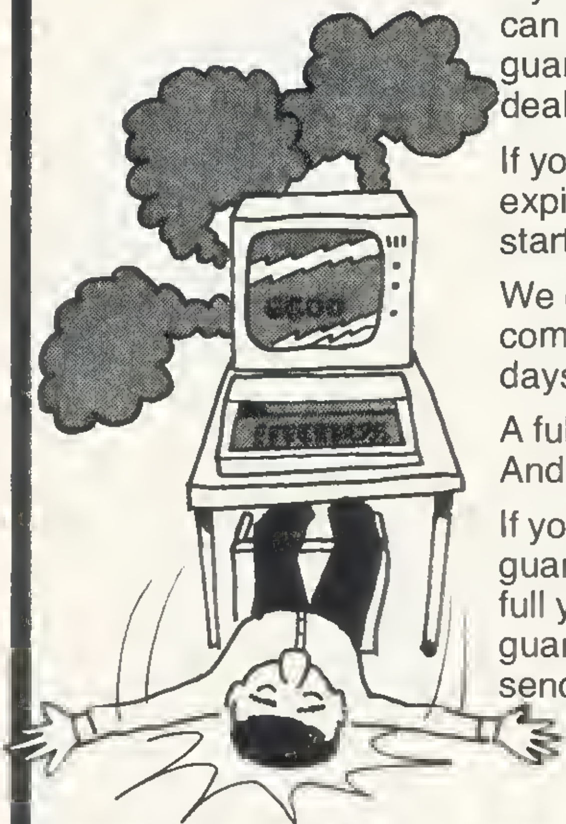

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HOW FAST CAN A DISC DRIVE?

Joe Telford follows up his article in January's issue with a review of Cumana's disc drives. He also establishes a set of bench tests

When our friendly Editor enquired whether I would review a pair of disc drives, I eagerly accepted – with the proviso that I could produce it in my usual style, of including routines which readers could develop. The discs were from Cumana, and I already use their single, 40-track drives.

First a session on jargon. There are two main types of disc drives: hard discs and floppy discs. Hard discs are faster and store more data than floppies. They are important to business users, but expensive. Floppy discs are usually the domain of the dedicated amateur, education and small businesses. Floppy discs and their drives come in two sizes: 5¼" discs (mini-floppies), and 8" (standard floppies). Most readers will meet the mini floppy variety, which are the subject of this article. Cumana provide drives in six configurations as shown in table 1.

Twin units are simply two single drives in one case. Single-side drives will only read from the underside (opposite the label) of the disc, while double-sided drives will read from both sides. The 40-track drives can store half as much data per side as 80-track drives.

The storage which a set of drives can access will vary depending on the three parameters: single or twin drives, single or double sided, and 40 or 80 track. Table 1 shows the amount of storage for each type as well as the price of Cumana's products at the time of writing (without VAT). Cumana drives are independent of the BBC micro for power – unlike the ones sold by the BBC. They are made by Teac in Japan.

In addition to the drives shown above, Cumana sell a 'drive to BBC' ribbon cable at £15. However, before buying discs, you must have a model B with the DFS upgrade (about £110).

On arrival, the drives lifted out of their packaging easily, and when shaken did not rattle (the first benchtest?). In addition to the drive unit, there was a connection lead, fitted with the correct BBC micro connector at one end and PCB connectors at the other. The warranty sheet and a sheet of instructions were included but no disc manual, or formatting disc. Both these items are vital for using discs. Cumana were unable to supply discs and manuals, but are writing their own manual and producing a disc containing a formatting program. Acorn sell copies of the manual and format disc (which come with BBC disc drives free of charge) for £30.

The casing of the Cumana unit matched the BBC micro's, as did the stippled finish. Two screws had to be removed from the casing to allow the lead to be connected at the drive end. This was simply a matter of pushing the connector firmly into place as per instructions.

Single unit, single side, 40 track	£199	100k	(25 pages of A4 approx)
Twin unit, double side, 40 track	£369	200k	(50 pages of A4 approx)
Single unit, single side, 80 track	£265	200k	(50 pages of A4 approx)
Twin unit, single side, 80 track	£495	400k	(100 pages of A4 approx)
Single unit, double side, 80 track	£345	400k	(100 pages of A4 approx)
Twin unit, double side, 80 track	£619	800k	(200 pages of A4 approx)

Table 1. Configuration and costs of Cumana disc drives

Unlike my original unit, no adjustment to the switches on either drive's circuit board was required. Nor was there any need to fit or alter a white terminating resistor block. On my 40-track drives, these tasks had taken some thinking through, though it would appear that the present drives are completely set up. Once the cover was replaced, a mains plug had to be fitted and the unit was ready for operation.

To test the unit in the same conditions as my older drives, it was pressed into daily service producing programs for the MEP primary software packages. This meant the unit was often working for over eight hours a day.

Benchmarking is the process of providing a set of standard tests to enable comparisons to be made between the performances of different devices. In our case we aim to compare disc drives, and suitable benchtests might be those which enable the comparison of speed of access and integrity of data transfer.

Benchtests of access time depend upon two main variables, the actual drive in use and the micro's software. In the case of the BBC micro this is the DFS software. There are a number of variations of the disc filing system (DFS) among our readers, varying from DFS 0.90, (the earliest system on general release) through DFS 0.97 and 0.9A, up to DFS 0.9E which is the latest recorded version (Jan 83). To thoroughly test the two discs, benchtests were carried out three times, using combinations of DFS0.97, DFS0.9A, DFS0.9E, OS1.00 0S1.20, Basic V1, and Basic V2.

When considering suitable benchmarks, we can separate them into two types: access times for saving – loading programs, and times for accessing data files in various ways ie, creating, writing and reading.

First, consider benchmarks for

page 30►

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* Processing the results of scientific experiments or field studies
* Engineering calculation models
* In fact, anything that involves repeated re-calculation of results presented in tabular or spreadsheet format.

Program Availability Chart:–

	Database	Stock Control	Mailist	Invoices & Statements	Spread sheet Analysis	Cashbook Accounting	Word processor	Home Accounts	Commercial Accounts
Sinclair Spectrum 16k or 48k	●	●	●					●	●
Dragon 32k or 64k	●				●			●	
VIC20 16k +	●	●	●	●				●	●
Sinclair ZX81 16k +	●								
Grundy Newbrain	●								
Texas TI99 4A	●								
Atari 400/800 or Osborne 1	●								
Sharp MZ80A	●	●	●	●				●	●
Sharp MZ80K	●	●	●	●				●	●
Sharp MZ80B	●	●	●	●				●	●
BBC micro model A or B 32K	●	●	●	●	●	●	●	●	●

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COMMERCIAL ACCOUNTS . . . £19.95
Compatible with most micros. See table. A gem of a program, all for cassette, with the following features:– Daily Journal. Credit Sales. Cash Sales. Credit Purchases. Purchases – other. Sales Ledger. Purchase Ledger. Bank Account. Year to date summary. A fully interactive program suitable for all businesses. Files can be saved and loaded and totals from one file carried forward to another on cassette. Particularly useful from a cash flow point of view, with an immediate accessibility to totals for debtors and creditors. Bank totally supported with entries for cheque numbers, credits and, of course, running balance.

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Compatible with most micros. See table. The program that everyone needs, the most valuable and versatile in your collection. Facilities include sort search, list print if required. Can be used in place of any card index application; once purchased you can write your own dedicated database to suit your particular needs with a limitless number of entries on separate cassettes.

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Compatible with most micros. See table. Dedicated software with all that's necessary to keep control of stock. This program will take the tedium out of stock control and save time and money. Routines include stock set up, user reference number, minimum stock level, financial summary, line print records, quick stock summary, add stock, delete/change record and more.

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► page 27

```
  1 REM Benchmark 1a  *SAVEing
  5 P."BM1A"
 10 TIME=0
 20 *SAVE"BM1A" 2000 4400
 30 PRINT TIME
 40 END
```

Program 1. Benchtest 1a

```
10*KEY9 P."BM1B":TIME=0:P.TIME|
   MSAVE"BM1B"|MP.TIME|M
```

Program 2. Benchtest 1b

```
10*KEY8 P."BM1C":TIME=0:P.TIME|
   M:*SPOOL"BM1C"|MLIST|
   M*SPOOL|MP.TIME|M
```

Program 3. Benchtest 1c

```
  1 REM benchmark 2a:
    *LOADing Memory
  5 P."BM2A"
 10 TIME=0:PRINTTIME
 20 *LOAD"BM1A"
 30 PRINTTIME
 40 END
```

Program 4. Benchtest 2a

```
10*KEY7 P."BM2B":TIME=0:P.TIME|
   MLOAD"BM1B"|MP.TIME|M
```

Program 5. Benchtest 2b

```
10*KEY6 P."BM2C":TIME=0:P.TIME:
  *EXEC"BM1C"|MP.TIME|M
```

Program 6. Benchtest 2c

accessing program files.

Benchmark 1a: SAVEing memory examines the time taken to save an amount of memory to disc. *SAVEing is normally done to save machine language programs or screen memory and a suitable program is shown as program 1. This will *SAVE &2400 bytes of memory to disc (9k) of memory.

If we replace line 20 with:

20 *SAVE"BM1A" 2000 3400

we can *SAVE 5k of memory. It is important to perform each benchtest with two separate amounts of memory, because we can apply some simple maths to find out two useful pieces of information about our discs, the save load timings per k of memory (or per record) and the time overhead involved before transfer can begin (this process will be explained in the next section). I decided to compare results based on 5k and 9k of memory because I had two programs of exactly those lengths.

Benchmark 1b was designed to test saving Basic programs (program 2). It is loaded as a Basic program and run and uses function key 9. Once this is done, the user loads a second basic program which is saved by pressing f9. The time to save this second program is the benchmark 1b.

Benchmark 1c is for *SPOOLing Basic programs and is also loaded as a Basic program. On running, it allocates function key 8. The user may then load a further Basic program. The time to *SPOOL this second program is benchmark 1c. Again this benchtest is run with 5k and 9k programs.

With *SPOOLing however, benchmarks depend upon yet another factor. This is because programs in memory are tokenised, so that reserved words are found as single bytes and also some numbers eg those in GOTO statements are found to have special encoded formats (User Guide, p483). During *SPOOLing a Basic program, the tokens and encoded numbers must be converted to ASCII, which is performed by the LIST command. The length of time for *SPOOLing thus depends upon frequency and expanded length of the tokenised keywords. In addition, because listing is effectively printing, the *SPOOL benchtest will be further slowed.

The second set of benchtests allows users to compare retrieval rates for programs, in their three forms: memory, Basic programs, and EXECuable programs.

Benchtest 2a uses program 4 and tests *LOADing memory. It *LOADS the section of memory *SAVEd in Benchtest 1a.

Benchtest 2b: LOADing Basic programs. Program 5 is loaded, then run. It allocates itself to function key 7. Pressing f7 will reload the Basic program saved in Benchtest 1b, and the time taken to do this is Benchmark 2b.

Benchtest 2c tests *EXECing Basic programs. It is based on program 6 which is loaded and run. It allocates itself to function key 6. Pressing f6 will EXEC the ASCII version of the Basic program *SPOOLed in Benchtest 1c. The time taken to do this is Benchmark 2c. As with benchtest 1c, this involves screen listing, as well as tokenising. This means we would expect it to run relatively slowly in comparison with 2a and 2b.

The second main area to examine is that of data transfer to and from files. Data files on the BBC micro may be sequential (serial) or random (direct) access. Serial files are encountered by users, as they are relatively easy to use, although access files are more flexible.

Benchtest 3a: writing to a serial file. Load and run program 7 to create the string R$ which is 254 bytes long. This will transfer to disc as 256 bytes, as each string is prefixed with a byte indicating it is a string, and a byte indicating the length of the string. In these datafile benchtests we will work to one record per sector (256 bytes). Line 40 creates the data file, and lines 50 to 70 write 100 records to the file. Line 80 closes the file, and completes the benchtest. The program can be rerun with line 50 altered to give 20 records, so we can again calculate overheads and transfer time per record.

Benchtest 3b: Writing records to a random access file. Program 8 does not create the environment of its data file. This can be done previously by either creating a serial file of the appropriate size, or by *SAVEing an appropriate amount of memory, with a suitable filename. This benchtest simply writes 100 records to that already created file. Each record may have a maximum length of 255 bytes. The program up to line 100 is similar to program 7, except that line 60 contains a reference to procedure 'putstring' defind in lines 110 to 170. It takes any string sent to it plus a start point in the file, and puts bytes from the string into the file sequentially from the start point. The value of using such a procedure 'putstring' defined in lines usable in applications programs and so gives a more realistic benchmark.

Line 50 can be altered to write 20 records, and the two benchmarks used to determine overheads and transfer time per record. Notice line 40 is an OPENIN command which is necessary in Version 1 of Basic. OPENOUT you will remember, initially destroys the named file.

Benchtest 4a: reading from a serial file. Program 9 reads 100 records from a previously created file (you could use a file created with program 7), and closes the file. if users create files which will fit into memory, then serial input may be used to improve access times – once the file is in core!

Benchtest 4b: reading from a random access file uses program 10 and is the last of the access time tests. It reads 100 records from a random access datafile. It is similar to the previous program except we replace INPUT# with the function of line 50. This function is defined after line 1100. The function has the start position in the fle of the required string passed to it, as well as the length of the string. The function gets bytes from the file of the required string passed position, and assembles them into a string, which it returns to the main body of the program. Users may find this function useful when accessing their own random access files.

As I have already mentioned, users can perform each benchtest with two different amounts of data or program to transfer. It would then be possible to compare results and to develop two formulae which model the disc access time.

For 9k:

disc overhead +9 x time per k = time for 9 k

and for 5k:

disc overhead + 5 x time per k = time for 5k

Reprèsenting this symbolically we get

$D + 9k = T1$
$D + 5k = T2$

Therefore:

$4K = T1 - T2$

and

$K = (T1 - T2)/4$ (Time per k less disc overheads.)

From this we can say

$D + 5(T1 - T2)/4 = T2$

and so

$D = T2 - 5(T1 - T2)/4$

or

$D = (9T2 - 5T1)/4$ (Disc overhead time.)

Similarly we can produce results for the time taken to write or read a record.

Transfer time per k is quite understandable, but the term disc overhead is not as easily followed.

Disc overhead refers to that part of the access time which is devoted to bringing the discs up to speed and finding the part of the disc allocated to the program to be loaded or saved.

The benchtest results following are all based on two different program or file lengths and using the above formulae the overheads and time per k are given.

To produce comparable results over the whole group of benchtests, the program was saved, and each file was written to a newly formatted disc. Thus the benchmarks are timings based on writing information to the beginning of a disc. Users may wish to compare these times with access to the middle tracks or final tracks.

There was also a problem in timing the benchtests, as over 10 repeats of any one benchtest the final time varied by 0.2s from the value entered into the tables. This means there is a small error in some calculations. A real time clock which could be connected to the BBC micro, and not be affected by disc access would be a boon to benchtesters.

The benchmarks in tables 2, 3, and 4 should allow users to make

```
10 PRINT'BM3A'
20 R$=STRING$(254,'?')
30 TIME=0:PRINTTIME
40 file=OPENOUT'BM3A'
50 FOR X%=1 TO 100
60 PRINT#file,R$
70 NEXT
80 CLOSE#file
90 PRINTTIME
```

Program 7. Benchtest 3a

```
10 PRINT'BM3B'
20 R$='3'+STRING$(254,'B')
30 TIME=0:PRINTTIME
40 file=OPENIN('BM3A')
50 FOR Y%=0 TO 99
60 PROC_putstring(R$,Y%*256)
70 NEXT
80 CLOSE#file
90 PRINTTIME
100 END
110 DEFPROC_putstring(A$,start)
120 LOCAL X%
130 PTR#file = start
140 FORX%=1 TO LEN(A$)
150 BPUT#file,ASC(MID$(A$,X%,1))
160 NEXT
170 ENDPROC
```

Program 8. Benchtest 3b

```
10 PRINT'BM4A'
20 TIME=0:PRINTTIME
30 file=OPENIN'BM3A'
40 FOR X%=1 TO 100
50 INPUT#file,R$
60 NEXT
70 CLOSE#file
80 PRINTTIME
```

Program 9. Benchtest 4a

```
10 PRINT'BM4B'
20 R$='3'+STRING$(254,'B')
30 TIME=0:PRINTTIME
40 file=OPENUP('BM3A')
50 FOR Y%=0 TO 99
60 R$=FN_getstring(Y%*256,255)
70 NEXT
80 CLOSE#file
90 PRINTTIME
100 END
1100 DEFFN_getstring(start,length)
1110 LOCAL X%,B$
1120 PTR#file = start
1130 B$='':FORX%=1 TO length
1140 B$=B$+CHR$(BGET#file)
1150 NEXT
1160 =B$
```

Program 10. Benchtest 4b

80 track	40 track
Wabash	Wabash
	Accutrack
Nashua	Nashua
	Maxell
	Control Data
	Inmac

Table 5. Types of discs used

comparisons between the two types of drive tested,as well as between variations of the BBC micro's operating system.

A range of discs were used with both types of drive, although I tried to match 80-track discs with the 80-track drive (rather than double density discs, which are also available). Table 15 shows a list of discs which were used with the two drives. All the discs have worked without failing, for up to six months, although I tend to use Wabash or Nashua regularly, and my oldest disc is from Inmac.

So, what do I like about the drives?

- Reliability, particularly after six months, hard use of the 40-track versions.
- Quietness of operation. The 80-track versions were particularly silent.
- Construction of the entry doors, with marked door locks.
- Facility to acccept auto boot on power on (more of an Apple standard).

However, what else do I dislike?

- Casing vents could let liquids, such as coffee, enter.
- The on/off switches were rather small and could be a source of trouble.
- Some drives (not Cumana) allow 40 to 80 track switching, which would be very useful.
- Although neat and well packaged, the drives are bulky, particularly for home use.

All in all a rather useful selection of disc drives, although I think disc usage is so important that the costs such as coffee, enter.

Next month: Our normal H&T format with a selection of applications for functions and procedures.

Benchtest	Description	5k or 20 records	9k 04 100 records	Disc overhead time	Time per k or per record
1a	*SAVE memory	1.7	2.1	1.2	0.1
1b	SAVE Basic program	1.6	2.0	1.1	0.1
rl1c	*SPOOL Basic program	12.8	22.4	0.8	2.4
2a	*LOAD memory	1.3	1.6	0.9	0.1
2b	LOAD Basic program	1.5	1.9	1.0	0.1
2c	*EXEC Basic Program	12.7	21.9	1.2	2.3
All records use 256 bytes of disc space. Benchtest 3a is used to create files for use in random access.					
3a	PRINT# a serial file	6.1	25.3	1.3	0.24
3b	BPUT# using PITR#	57.1	281.2	1.1	2.81
4a	INPUT- serially	5.3	23.4	0.8	0.23
4b	BGET# using PTR#	37.5	183.5	1.0	1.83

Table 2. Benchmarks for 80-track Cumana drives. BBC micro with DFS 0.9E, OS1.2, Basic V2

Benchtest	Description	5k or 20 records	9k or 100 records	Disc overhead time	Time per k or per record
1a	*SAVE memory	1.7	2.1	1.2	0.1
1b	SAVE Basic program	1.7	2.1	1.2	0.1
1c	*SPOOL Basic program	12.8	22.2	1.0	2.4
2a	*LOAD memory	1.5	1.9	1.0	0.1
2b	LOAD Basic program	1.5	1.9	1.0	0.1
2c	*EXEC Basic program	12.4	21.6	0.9	2.3
All records up 256 bytes of disc space. Benchtest 3a is used to create files for use in random access.					
3a	PRINT# a serial file	6.0	25.2	1.2	0.24
3b	BPUT# using PTR#	56.8	281.1	0.8	2.8
4a	INPUT# serially	5.3	23.6	0.8	0.23
4b	BGET# using PTR#	37.3	182.6	1.0	1.82

Table 3. Benchmarks for 40-track Cumanas. BBC micro with DFS 0.9E, 0S1.2, Basic V2

Benchtest	Description	5k or 20 records	9k or 100 records	Disc overhead time	Time per k or per record
1a	*SAVE memory	1.8	2.0	1.55	0.05*
1b	SAVE Basic program	1.7	2.1	1.2	0.1
1c	*SPOOL Basic program	12.8	22.2	1.0	2.4
2a	*LOAD memory	1.7	1.9	1.45	0.05*
2b	LOAD Basic program	1.7	2.1	1.3	0.075*
2c	*EXEC Basic program	12.2	21.4	0.7	2.3
All records use 256 bytes of disc space. Benchtest 3a is used to create files for use in random access.					
3a	PRINT# a serial file	5.9	25.3	1.0	0.24
3b	BPUT# using PTR#	57.0	281.3	1.0	2.8
4a	INPUT# serially	5.5	25.3	1.0	0.23
4b	BGET# using PTR#	37.4	182.6	1.0	1.82

The accuracy of these figures is open to question because of problems using the BBC clock.

Table 4. Benchmarks for 40-track Cumanas. BBC micro with DFS 0.97/9A, OS1.0, Basic V1

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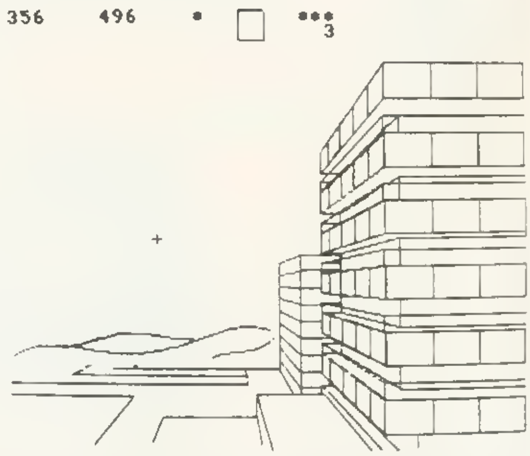

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BOTTOM OF FILE

Tony Shaw and John Ferguson round off their series on machine code by considering the powerful CALL statement

CALLING ALL MACHINE CODES

In an earlier article (December 1982) USR and CALL were used for transferring program control to a machine code program. Both were also used for passing information from the variables A%, X%, Y% and C% to the accumulator, X register, Y register and carry flag respectively. Furthermore, USR was shown to be capable of receiving data from these 6502 registers when control returned to Basic. The data is assigned to a variable defined when the machine code routine was called, eg to M% in the statement M% = USR(MCROUTINE).

When more information is required by the machine code program than can be directly passed via the registers, CALL must be used. The information to be passed is indicated by the variable names accompanying the CALL statement. For example:

CALL &2000, Q%, R%

The address of each parameter is passed in a parameter block starting at &0600. After a CALL statement has been executed the contents of the parameter block give the addresses of any variables supplied with the CALL statement (figure 1).

For string variables the parameter address points to a string information block containing:

- byte 1 low byte of string address
- byte 2 high byte of string address
- byte 3 number of bytes allocated to string
- byte 4 current length of string

The listings in figure 2 illustrate the structure of the parameter block by 'passing' two variables T% and A$ in the CALL to &FFEE. (The routine at &FFEE (OSWRCH) makes no use of this information.)

The first listing gives the contents of the parameter block:

- 2– number of parameters
- 50– address of T% (&0450)
- 4–
- 4– parameter type (4 – integer)
- C6– address of A$ information block (&0EC6)
- E–
- S1– parameter type (&81 – string variable)

One program follows up the pointer to T% revealing the current value of this integer variable (&00112233).

The other programs show that finding the string variable is a two-stage process – finding the string information block, and then the value of A$. Within the original program the value of A$ was changed to illustrate that the string information block is required for determining the current length of A$ as some of the previous version

0600 – number of parameters
0601 – low byte of address of first parameter
0602 – high byte of address of first parameter
0603 – code defining parameter type**
0604 – low byte of address of second parameter
0605 – high byte of address of second parameter
0606 – code defining parameter type etc **

**The codes used to define parameter type:
0 – 8 bit byte (eg ?X)
4 – 32 bit integer variable (eg X%)
5 – 40 bit floating point number (eg Y)
&80 – string at a defined address (eg $A)
&81 – string variable (eg A$)

Figure 1. Parameter block at &0600

```
100 T%=&00112233
110 A$="ABCDEFG"
120 A$="ABCD"
130 CALL &FFEE,T%,A$
140 FOR LOC=&600 TO &606
150 PRINT ~?LOC
160 NEXT LOC
170 END
>
>RUN
       2
      50
       4
       4
      C6
       E
      81
```

T%

```
200 POINT=&0450
210 FOR LOC=POINT TO POINT+3
220 PRINT ~LOC,~?LOC
230 NEXT LOC
>
>RUN
      450        33
      451        22
      452        11
      453         0
```

A$

```
200 POINT=&0EC6
210 FOR LOC=POINT TO POINT+3
220 PRINT ~LOC,~?LOC
230 NEXT LOC
>
>RUN
      EC6        CA
      EC7         E
      EC8         7
      EC9         4
```

```
200 POINT=&0ECA
210 FOR LOC=POINT TO POINT+6
220 PRINT ~LOC,~?LOC,CHR$(?LOC)
230 NEXT LOC
>
>RUN
      ECA        41A
      ECB        42B
      ECC        43C
      ECD        44D
      ECE        45E
      ECF        46F
      ED0        47G
```

Figure 2. Parameter block contents after CALL

```
100 REM OUTPUT BINARY VALUE OF INTEGER VARIABLE
110 OSASCI=&FFE3
120 DIM BINARY 200
130 FOR PASS=0 TO 2 STEP 2
140 P%=BINARY
150[OPT PASS
160        LDA &601      ;transfer pointer to page 0
170        STA &80
180        LDA &602
190        STA &81
200        LDY #3        ;Y counts through 4 byte integer
210.NBYT   LDA (&80),Y
220        STA LOC       ;store in temporary location
230        JSR BINO      ;output binary contents of LOC
240        DEY
250        BPL NBYT      ;get next byte ?
260        RTS           ;return to BASIC
270\
280\ Subroutine to output binary contents of LOC
290\
300.BINO   LDX #8        ;count through 8 bits
310.NBIT   ASL LOC       ;feed leftmost bit
                          into carry
320        LDA #&30      ;form ASCII for 0
330        ADC #0        ;forms ASCII for 1
                          if carry set
340        JSR OSASCI
350        DEX
360        BNE NBIT      ;get next bit ?
370        RTS
380]
390 REM USE LOCATION AT END OF PROGRAM
400 LOC=P%
410 P%=P%+1
420 NEXT PASS
425 REM
430 REM TEST WITH SOME DATA
440 FOR I=1 TO 3
450 READ NUMBER%
460 CALL BINARY,NUMBER%
465 PRINT NUMBER%
470 NEXT I
480 DATA 9,65536,-3
490 END
```

```
>RUN
00000000000000000000000000001001          9
00000000000000010000000000000000      65536
11111111111111111111111111111101         -3
>
>F%=379
>CALL BINARY,F%
00000000000000000000000101111011>
```

is still in memory the characters EFG.

Machine code routines that make use of the parameter block will probably transfer some or all of its contents to page 0 locations (&70 – &8F are safe to use). This enables indirect indexed addressing to be used for obtaining the current values of any variables required.

In program 1, the statement:

```
CALL BINARY, PARAM%
```

calls the machine code routine *Binary* which prints out in binary the value of the variable passed. It has only one parameter and transfers the pointer to it from the parameter block to locations &80 and &81.

The machine code routine *Square* in Program 2 behaves as an additional graphics command for drawing a square. It expects to receive three parameters that define the square:

```
CALL SQUARE,XCO_ORD%,
YCO_ORD%,SIDE_LENGTH%
```

The first two parameters are the horizontal and vertical components of the bottom left-hand corner of the square to be drawn. Subroutines are used by *Square* to check there are three parameters; that each is an integer variable; and that each parameter value is within a particular range. If an error is found control returns to Basic, printing out an error message on the way.

0080	–	low and high bytes of 'active' pointer
0081		
0082 (3)	–	start of copy of parameter block
0083	–	pointer to X co-ordinate
0084		
0085 (4)		
0086	–	pointer to Y co-ordinate
0087		
0088 (4)		
0089	–	pointer to length of square
008A		
008B (4)		

Figure 3. Locations &80 to &8B as used by 'Square'

The parameter block is transferred in its entirety to &82 – &8B (figure 3). Locations &80 and &81 are used by several of the subroutines as a pointer to the current variable of interest.

The square is formed by the equivalent of

```
PLOT 4, X, Y
PLOT 1, 0, L
PLOT 1, L, 0
PLOT 1, 0, –L
PLOT 1, –L, 0
```

These PLOT commands are accomplished by streaming the corresponding VDU command data through the operating system routine OSWRCH. A simple demonstration program runs after the program has been assembled. Alternatively, once assembled, squares can be drawn directly using any call of the form:

```
CALL SQUARE,I%,J%,K%
```

so long as the integer variables accompanying the CALL are assigned.

Program 2, page 38 ►

```
100 REM SQUARE COMMAND
110 MODE 4:REM DEMO PROGRAM RUNS IN MODE 4
120 OSWRCH=&FFEE
130 DIM SQUARE 300
140 FOR PASS =0 TO 3 STEP 3
150 P%=SQUARE
160 [OPT PASS
170 .SQUARE JSR TRANS      ;transfer parameter block
180         JSR TARGS      ;test arguments
190         JSR TPARMS     ;test individual parameters
200         JSR P4XY       ;Plot 4,X,Y
210         LDX #6
220         JSR POINT      ;point to L
230         JSR P10L       ;sequence Plot 1,0,L and Plot 1,L,0
240         JSR MINUS      ;form negative of value pointed to (L)
250         JSR P10L       ;sequence Plot 1,0,-L and Plot 1,-L,0
260         JSR MINUS      ;restore L to positive
270         RTS            ;back to BASIC
280 \
290 \ Subroutine to transfer parameter block to &82 onwards
300 \
310 .TRANS LDX #10         ;length of parameter block
320 .NBYT  LDA &0600,X
330        STA &82,X
340        DEX
350        BPL NBYT
360        RTS
370 \ Subroutine to set up &80 &81 to point to Integer variable
380 \ on entry X reg; 0-X 3-Y 6-L
390 \
400 .POINT LDA &83,X
410        STA &80
420        INX
430        LDA &83,X
440        STA &81
450        RTS
460 \
470 \ Subroutine to test each individual parameter value
480 \
490 .TPARMS LDX #0         ;point to X
500         JSR TPRAM
510         LDX #3         ;now Y
520         JSR TPRAM
530         LDX #6         ;and L
540         JSR TPRAM
550         RTS
560 \
570 \ Subroutine to test that there are 3 arguments
580 \  and that each is integer (4)
590 \
600 .TARGS LDA &82
610        CMP #3          ;check no. of args
620        BNE ERRR
630        TAX             ;set X and Y to 3
640        TAY
650        LDA #4
660 .TTYP  CMP &82,X
670        BNE ERRR
680        INX
690        INX
700        INX
710        DEY
720        BNE TTYP
730        RTS
740 \
750 \ Subroutine to test parameter values are in the range
760 \    -32768 to +32767     X reg set for POINT on entry
770 \
780  .TPRAM JSR POINT      ;tests that high order bytes
790         LDY #2         ;are both &FF or both &00
800         LDA (&80),Y
810         INY
820         EOR (&80),Y
830         BNE ERRR
840         RTS
850 \
860 \ ERROR routine - returns to BASIC
870 \
880 .ERRR  PLA
890        PLA       ;fetch subroutine return address off stack
900        LDX #0
910 .GCHR  LDA MESG,X
920        JSR OSWRCH
930        INX
940        CMP #&0D
950        BNE GCHR
960        RTS
970 \
980 \ Subroutine to negate the low bytes of integer pointed to
990 \
1000 .MINUS LDY #0
1010        LDA (&80),Y
1020        EOR #&FF
1030        CLC
1040        ADC #01
1050        STA (&80),Y
1060        INY
1070        LDA (&80),Y
1080        EOR #&FF
1090        ADC #00        ;add in any carry from lower byte
1100        STA (&80),Y
1110        RTS
1120 \
1130 \ Subroutine to send PLOT 4,X,Y as VDU command
1140 \
1150 .P4XY  LDA #&19
1160        JSR OSWRCH
1170        LDA #4
1180        JSR OSWRCH
1190        LDX #0         ;set up pointer to X bytes
1200        JSR POINT
1210        JSR SEND2      ;send 2 bytes to OSWRCH
1220        LDX #3         ;point to Y
1230        JSR POINT
1240        JSR SEND2
1250        RTS
1260 \
1270 \ Subroutine to send low order bytes of integer
1280 \
1290 .SEND2 LDY #0
1300 .NBYT  LDA (&80),Y
1310        JSR OSWRCH
1320        INY
1330        CPY #2
1340        BNE NBYT
1350        RTS
1360 \
1370 \ Subroutine to send the sequence
1380 \ PLOT 1,0,L and PLOT 1,L,0 assumes L pointed at
1390 \
1400 .P10L  LDA #&19
1410        JSR OSWRCH
1420        LDA #1
1430        JSR OSWRCH
1440        LDA #0
1450        JSR OSWRCH
1460        LDA #0
1470        JSR OSWRCH
1480        JSR SEND2
1490        LDA #&19
1500        JSR OSWRCH
1510        LDA #1
1520        JSR OSWRCH
1530        JSR SEND2
1540        LDA #0
1550        JSR OSWRCH
1560        LDA #0
1570        JSR OSWRCH
1580        RTS
1590 ]
1600 MESG=P%
1610 $MESG="Invalid SQUARE Arguments"
1620 NEXT PASS
1630 REM A SIMPLE DEMO[illegible]
1640 CLG
1650 H%=500:V%=200:L%=900
1660 REPEAT
1670  H%=H%+7:V%=V%+5:L%=L%-20
1680  CALL SQUARE,H%,V%,L%
1690 UNTIL L%=-700
1700 END
```

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IAN BIRNBAUM sets out to improve your programming techniques on the BBC micro.

He will answer reader's questions in this column and develop their ideas – as well as giving some of his own. But the real aim is for readers to provide the questions and the answers.

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The idea must be original and be described clearly and fully. It should not have been published before.

Your contribution should be typed or printed, with any substantial listings on cassette, but only included to make a point.

Send your hints or questions to BBC Forum, Acorn User, 53 Bedford Square, London WC1B 3DZ. Please include a self-addressed envelope if your contribution is to be returned. We cannot answer letters individually, but a cross-section of common and interesting points will be covered.

TAPE TO DISC TRANSFER – T

To transfer programs from tape to disc is easy:

*TAPE, LOAD"",*DISC, SAVE"PROG"

However, with a lot of programs on one tape, this can be speeded up. Program 1 will load an entire tape onto disc automatically. Once set up, it can be left to make the transfer itself. What's more, it is not even necessary to type in the names of the programs to be transferred.

Type in program 1, and press the red function key f0. Set up the tape recorder, load the tape, rewind it and press play on the tape recorder. Finally, put the desired disc into the drive. That's all there is to it!

Here's how the program works. *FX 138,0,128 puts the ASCII code 128 into the keyboard buffer. This is the code generated by f0. Once this key is pressed, it will continue to call itself until Escape is pressed. After loading the program from tape the rest of the code reads the name (or the first seven letters of the name) and saves the program with that name (stored in A$) on disc.

```
10PROCTEST:END
20DEF PROCTEST
30PRINT~256*?5+?4
40CLEAR
50PRINT~256*?5+?4
60ENDPROC
```

Program 2a.

```
10GOSUB20:END
20PRINT~?&25
30CLEAR
40PRINT~?&25
50RETURN
```

Program 2b.

```
*KEY0 *TAPE|M*FX138,0,128|MCLS|MLO.""|M
A$="":I%=HIM.+200:J%=0:REP.A$=A$+CHR$(J
%?I%):J%=J%+1:U.I%?J%=32 OR J%=7|M*D.|M
SAVE A$|M
```

Program 1.

★ AUTO-DESTRUCT EARNS IAN COPESTAKE £20

Programs written for other people to use must be able to handle the deviant behaviour pattern known as 'pressing Escape by mistake'.

In operating system 1.0, *FX229,1 should take care of the problem. Those of us with 0.1 systems could try using:

```
ON ERROR GOTO ERL
```

but this will not always jump back to the right part of a multi-statement line, and it falls down completely if Escape is pressed during a loop or a procedure (*User Guide* pp 149, 309).

The following program line provides a solution. Insert it near the beginning of your program, after you have finished de-bugging.

```
20 DIMP%1:?514=P%:?515
   =P%DIV256:[OPTO:RTS:]
   *K.10 1:IM
```

To test this out, add the following lines and run:

```
30 REPEAT PROC%
40 UNTIL FALSE
50 END
60 DEFPROCx:FOR A=0 TO
   9:PRINT A;:FOR B=1 TO
   1000:NEXT,:ENDPROC
```

Escape never causes the program to lose its place, and you will have to press Break to get out of it. The *KEY10 definition means that after Break, the program has apparently disappeared. It cannot be listed, and OLD will not help.

However, most of it is still in memory, and a recovery routine (such as that published in December's *Acorn User*) would bring it back from the dead. To prevent this, delete *K.10 1:IM and enter a separate line:

```
10 *K.10 Z%=&E00:REP.
   !Z%=0:Z%=Z%+4:U.FA.IM
```

When this is RUN, pressing Break will cause the program to self-destruct. A program protected in this way is almost impossible to list, once it has been run.

In passing, note the comma in 'NEXT,'. It is short for 'NEXT B,A' – a syntax not mentioned in the *User Guide*. The B loop is just to slow things down.

HE EASY WAY

```
10REPEAT
20PRINT~?&24
30CLEAR
40PRINT~?&24
50UNTILFALSE
```

Program 2c.

```
10FORI%=1 TO 10
20PRINT?&26/15
30CLEAR
40PRINT?&26/15
50 NEXTI%
```

Program 2d.

If a load error occurs from tape, no further programs will be loaded, since a search will be made for the rest of the program. This can be averted using *OPT2,0 before starting, but there is then a danger of saving a faulty program. In general, however, the 'bad program' message will occur and this program will not be saved (this does not stop the rest of the programs being loaded, and saved, however).

Although this process is used to maximum effect when transferring programs from a single tape, it can also be used to load from several tapes. In this case, you will have to change the tapes manually, but the rest is still automatic.

As a final point, don't forget files can be renamed after being saved on disc using *RENAME.

UNEXPECTED RESULT

Type X=3:PRINT −X 2 into your computer, but before you do write down the answer you expect. Now see what the computer gives. This discrepency is not in accordance with the dictates of algebraic logic : -3^2 should be −9; it is $(-3)^2$ which is 9.

The reason is that the unary operator 'minus' takes precedence over all binary operators, including exponentiation. This in turn owes its existence to the way negative numbers are stored and manipulated at machine code level. The consequences are worth bearing in mind, especially when EVAL is applied to input from users.

CLARIFYING CLEAR AND ONE PROBLEM OVER TO YOU

Two interesting letters this month. Timothy Matsell of Lincoln writes: 'While writing a program for the BBC micro it was necessary for a procedure to contain the command CLEAR. When the program was executed the procedure was called and executed perfectly, but stuck at the line containing the Basic instruction ENDPROC. I have also found that CLEARing within a subroutine produces the message 'No gosub' on exit. I presume the return address has been cleared from the stack. Am I correct, and should it happen? I have the 0.1 operating system and wonder if the 1.2 system will perform similarly.'

The first thing to say is that this effect must be independent of the operating system in use. CLEAR is a Basic statement and so the way it is interpreted depends upon how the Basic language ROM interprets it, and not on the OS ROM in use.

What happens when CLEAR is executed is that all the following pointers are re-initialised: top of variables (stored in 2,3); bottom of Basic stack (stored in 4,5); number of nested REPEATs (stored in &24); number of nested GOSUBs (stored in &25); and number of nested FOR/NEXT loops (stored in &26). Programs 2a to 2d make this clear. This is obviously a deliberate implementation on Acorn's part, though not a particularly helpful one. It would be enough to reset the top of variables, I would have thought.

Paul Hopkins of Hove wanted to know the best way to tell a program when each vertical synchronisation signal is sent to the television. As he says, this would be useful for machine code graphics programs where animation is involved. The best answer we receive to this from readers will be published here in Beeb Forum, so let's hear from you.

1280 bits

2700 bits

5120 bits

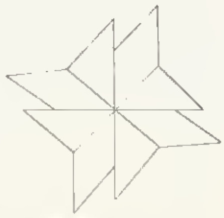
9100 bits

20,480 bits

Have you guessed yet? Turn to page 53 for the answer.

Figure 1. This pattern is made up of triangles and rotated. Pupils must first define a triangle and a diamond. The pattern then can be drawn with a simple program viz:

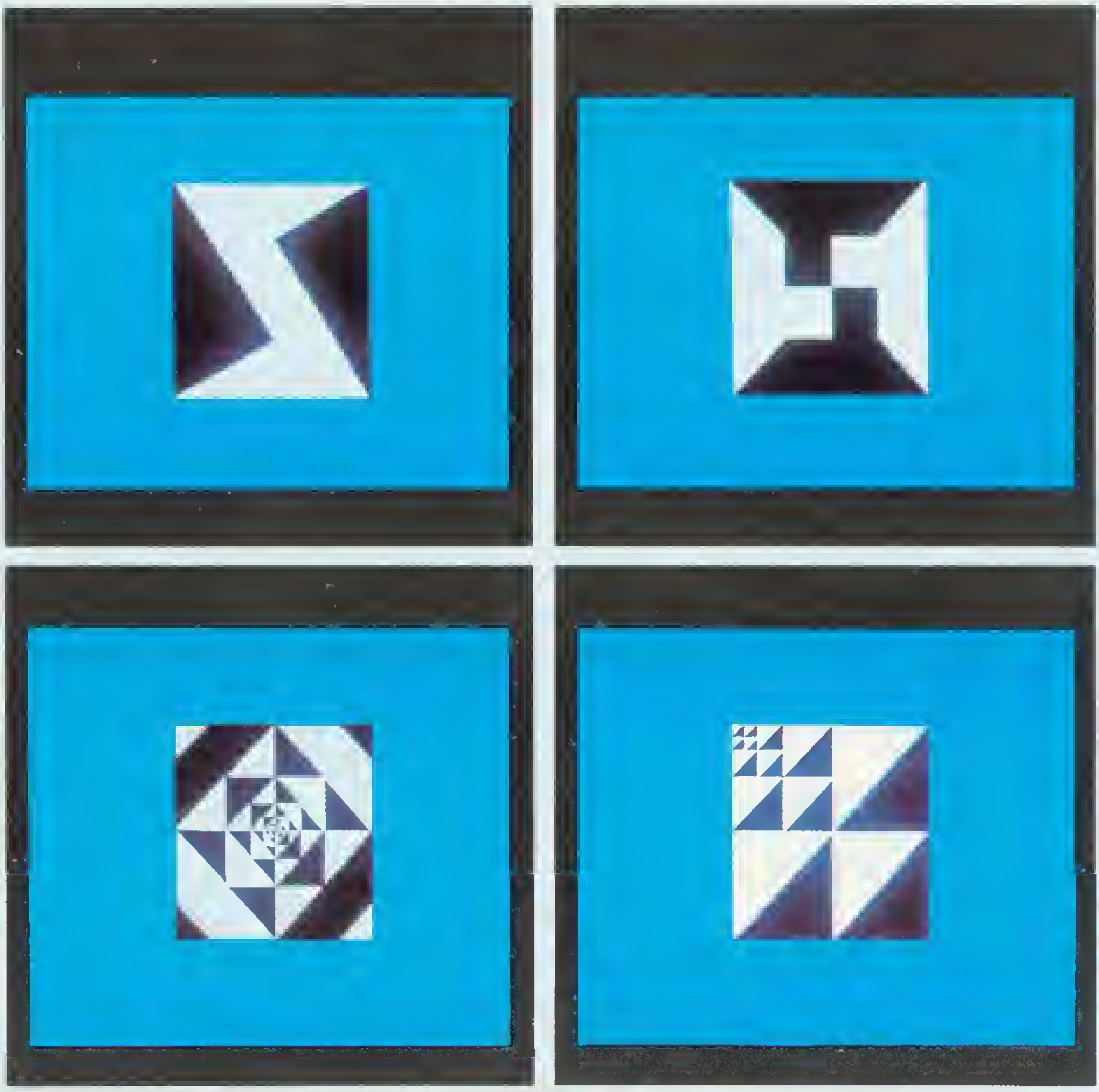
```
REPEAT 4
TRIANGLE
LEFT 45
DIAMOND
LEFT 45
AGAIN
```



Such analytical strategy is not only a sound approach to programming a computer, but also a problem solving skill of much more general applicability.

PROGRAMMING– HOW TO FACE THIS DIFFICULT ISSUE

Heather Govier discusses how primary children should learn to program and whether the right tools are available



Photos: Malcolm Aird

Heather Govier is microelectronics advisor for the London borough of Croydon. Series consultant is Paul McGee.

A computer program is a sequence of instructions which gives anyone who has a computer control over it. The question faced by primary schools is whether pupils should be given this control through: already-written software; programming languages designed for primary pupils; a general purpose programming language like Basic.

At present, much work in schools is based solely on pupils' enthusiasm for computers, without any underlying philosophy or planned progression, but it is important that the teaching of programming should not be approached in such an unco-ordinated manner.

Pupils will need to learn to use computers, but not all will need to program them. Among the reasons for pupils learning to program are:

- to produce programs which perform some useful task that would be unduly tedious otherwise;
- to help pupils appreciate the power and limitations of the computer;
- to provide new tools for thinking;
- to aid the teaching of work related to computers and information technology.

It is not clear that these objectives will be met by teaching the type of Basic available on most micros,

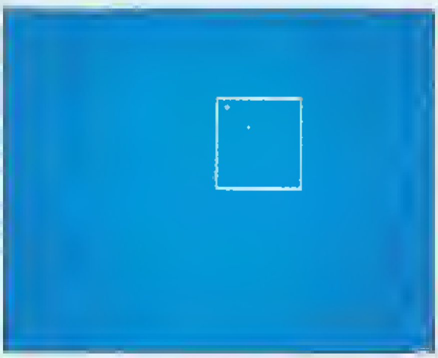
```
100 REM ADDRESS
110 REM TO PRINT MY ADDRESS.
120 CLS
130 PRINT TAB(6,8)"JASON GUZIKOWSKI"
140 PRINT TAB(7,10)"125, MEADOW VALE"
150 PRINT TAB(8,12)"COULSDON"
160 PRINT TAB(9,14)"SURREY CR3 5JR"
170 END

  J A S O N   G U Z I K O W S K I

    1 2 5 ,   M E A D O W   V A L E

      C O U L S D O N

        S U R R E Y   C R 3   5 J R
```

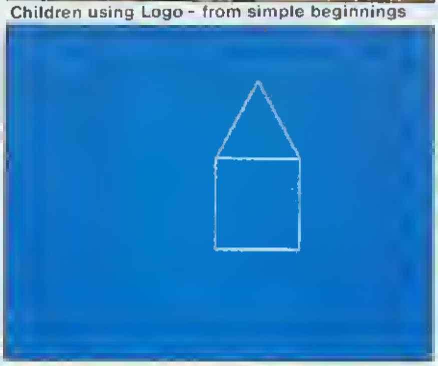
although BBC Basic is better than most. Primary pupils and many secondary pupils, will probably gain more from using a language such as Logo which concentrates on the problem-solving aspect at the expense of detailed syntax. However, structured languages, including structured Basic, will probably be used in secondary schools.

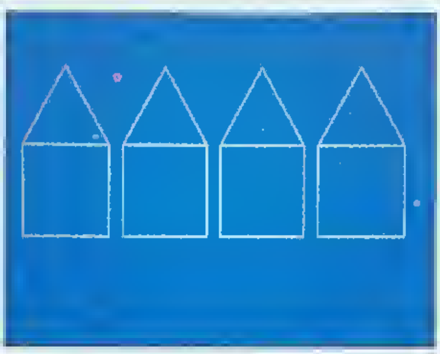
Teachers in primary schools will face difficulties as parents suggest there ought to be more programming teaching, particularly if this skill is possessed by some parents and pupils who have computers at home. Many primary pupils are keen and ready to learn programming and certain pupils manage extraordinarily well.However, the development of skills of a small minority can have adverse effects on other pupils. The school's problem is deciding what resources to commit to this activity when it is robbing other pupils of the teacher's time and energy.

Many primary teachers will not feel confident or competent to teach programming, which could have an adverse effect on pupils. So organising a computer club may make it possible for pupils who wish to learn to program to do so without effecting others.

Children using Logo – from simple beginnings







Secondary schools use computers to teach computer studies, usually from the fourth year upwards and it is unlikely that most will have sufficient computers to teach computing to all pupils in the first three years. Bearing this in mind, it could be difficult if pupils arrive from primary school with programming skills to find no outlet for them in secondary schools. It might be more valuable for the primary school to develop some more generally worthwhile educational activities and leave the teaching of programming languages to secondary schools. There is also a danger of a recurrance of the problems with mathematics – pupils being wrongly taught concepts, particularly set theory, and then having to be untaught it in secondary school before they can start on the correct notation and methodology.

The arguments about Basic are complicated because it means different things to different people. Early versions of the language are extremely unsophisticated, and the user sometimes has to tiddle about with machine code via peeks and pokes. Primary school pupils should certainly not have to learn to program at this level. Some computers, such as the BBC micro have a very sophisticated Basic which although not tully structured, does offer pupils the chance to write ordered programs.

The great advantage of Basic is its availability. It seems likely that many pupils will have access to, or own, a computer at home. They will therefore expect to learn the languages available on these machines, and to many parents it may seem strange if school prepares them tor something else.

Also, there are different levels at which programming can be understood by such pupils. They may simply wish to be able to read, understand and where necessary make minor alterations to programs, or at the other extreme the pupil may expect to be able to design a program starting from outline specification. Even at the level of reading a program it becomes particularly difficult to cope with all the dialects of Basic. Although many keywords are the same in most variations, interesting features such as graphics are often performed by tunctions specific to the machine. The BBC computer is particularly bad in this respect because it has a string of VDU commands that are totally incomprehensible in other Basics.

Another great advantage of Basic, and its disadvantage in the long term, is that it is apparently easy to start programming. Years of experience have shown that almost anyone can start to write programs after a very short time, but this leads to great difficulties as initial success is frequently bought at the price of sloppy thinking and bad habits. An analogy is the art of essay writing where it is easy to write thoughts in a fairly random sequence when the piece of work is small, but much more detailed planning is needed when a longer piece of work is required. Teaching correct forms of programming can otten be slow and tedious, and in primary schools there are not many people whose interest would be in such formal programming rather than in using the computer in a straightforward way.

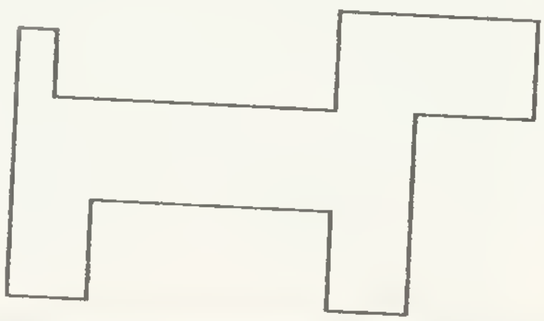
The second difficulty to be taced by primary teachers is the absence ot books on programming at the right level. The problem of dialects has been mentioned and books tend to be written for particular machines. Many authors hope to produce ditterent versions of their book for ditterent micros and tend to write in a limited subset of all the dialects, often concentrating on the least interesting features ot each. Most books are not produced specifically for schools, but are written for enthusiastic amateurs who can be assumed to have high standards of literacy and certainly be highly motivated. This will lead to difficulties when the activity has to be organised in groups. As there is no agreed method of teaching programming, it is unlikely that anyone in the near future will develop teaching materials specifically related to primary schools which will be consistent with secondary schools.

There is much discussion in the academic world about the wisdom and desirability of using flowcharts, decision tables or structure diagrams as aids to programming. Many of the ideas encompassed in structured programming seem sophisticated and would appear complex to a primary teacher.

Most computers come with a Basic interpreter in ROM so it is not possible to use a compiler. The immediate feedback from an interpreter can be helpful to the novice although many computers give extremely unhelpful diagnostic error messages. Several systems either give an error number which forces the pupil to refer to an incomprehensible manual, or merely give a response such as 'Syntax error'. The effect of this is not hard to imagine and the early teaching

```
>
 100 REM TABLES
 110 REM TO CALCULATE TABLES.
 120 CLS
 130 PRINT
 140 INPUT "WHICH TABLE (1-12) ", T
 150 PRINT
 160 FOR N=1 TO 12
 170 PRINT N*T
 180 NEXT N
 190 END

    W H I C H   T A B L E
     ( 1 - 1 2 )   ? 6

              6
            1 2
            1 8
            2 4
            3 0
            3 6
            4 2
            4 8
            5 4
            6 0
            6 6
            7 2
```

```
>
 100 REM DRAWING
 110 REM TO DRAW A DOG.
 120 MODE 1
 130 MOVE 300,200
 140 DRAW 400,200
 150 DRAW 400,350
 160 DRAW 700,350
 170 DRAW 700,200
 180 DRAW 800,200
 190 DRAW 800,500
 200 DRAW 950,500
 210 DRAW 950,650
 220 DRAW 700,650
 230 DRAW 700,500
 240 DRAW 350,500
 250 DRAW 350,600
 260 DRAW 300,600
 270 DRAW 300,200
 280 END
```



of programming with such unsatisfactory software aids may be harmful for the pupils. Although a compiler may be more difficult to use, it does impose more discipline on the user and prevents fundamentally wrong programs from starting. Even more satisfactory is the use of software, which gives easily understood messages when syntax errors are made.

The turtle-graphics of Logo provide a better medium than Basic for teaching young children about programming. There are a number of reasons why this is true, the most important of which is immediate feedback. When a simple program or procedure is typed into the computer there is often an immediate graphical response to each line of the procedure. Thus pupils can immediately spot errors. Debugging is straightforward and the thinking processes involved are kept as simple as possible.

This is in stark contrast to a Basic program which must be typed in full before being run. Any logical error is likely to mean the program simply will not run. Under such circumstances there will be few clues as to where the problem lies, or what its nature is.

The immediate response of Logo is an aid to debugging and a great motivator. Children can make the computer respond by typing in just a single instruction and the graphical result is particularly dramatic. There is also no need for pupils to learn a new language to program in Logo. The commands are everyday words with their everyday meanings, even five year olds can use the words. In the better versions of Logo there is no complex syntax to learn and typing mistakes produce sensible error messages. For example if a pupil types the command Foorward 60, the response will come:

'I do not know how to FOORWARD'

Again the mistake is easily found.

Not only is it easy to start with Logo, it is also easy to progress towards more sophisticated programs. Use of repeat loops, procedures and variables can be introduced in a systematic way, preferably in response to the needs of the pupils. Thus comments that it is tedious to type the same instructions over and over again (when drawing a square for example) could lead to the introduction of REPEAT. Similarly a desire to 'make the house smaller' to draw a street is an ideal stimulus for the pupils to learn about editing and variables.

Because it is based on procedures, Logo has good structure and its use can develop sound programming habits. Pupils can be taught, in the early stages, the need to break down a problem into its constituent parts and to tackle these elements one at a time (figure 1).

The pictorial nature of turtle graphics means good habits of planning can be developed. In the early stages, pictures and patterns can be drawn on squared paper and the procedures to produce them worked out before coming to the keyboard. Later, the drawing stage may be omitted, but habits of thinking through the problem and analysing the constituent parts while away from the computer can still be encouraged. This may be an essential approach if congestion at the keyboard is to be avoided.

As many pupils are unlikely to continue programming in later life, it is important that the teaching of programming develops skills in other subjects. It is easy to see how Logo can benefit maths, for example, because in the planning stage pupils will need to use protractors, rulers and compasses and thus be motivated to learn to use them effectively.

Use of Logo is one of the best ways to acquire the concept of an angle as a unit of turn. Children commonly confuse the angle with the length of its bounding lines but this can never arise with Logo. Other mathematical concepts such as variables are also given new clarity. Lest it be thought that only mathematical spin-offs are possible, the value of the language as a stimulus for discussion and debate must be mentioned. When working in a group to debug a program there is an obvious need for care in thinking and speaking.

While there are no good texts for teaching Basic to young pupils, there are a number which suggest ways of using Logo. Papert's book *Mindstorms* is one, and good versions of Logo are accompanied by teachers' notes and a book aimed at primary pupils.

Another language which could be used to teach programming to juniors is Prolog. Although, like the full Logo, Prolog is a sophisticated language, one aspect – its use with databases – is most commonly cited in introductory texts.

There are few command words to learn, but current versions of Prolog have a more complex syntax than Logo and give less helpful error messages. As with Basic there is no immediate response to each line of input which means the language is less motivating and searching for bugs is likely to be more difficult.

However, Prolog (which stands for PROgramming with LOGic) could be used to develop logical thinking and enable older pupils to write useful programs. For example, by building up a database on 'what eats what' food webs can be created and deductions made which may not seem obvious.

Again as with Basic there is a lack of good teaching materials appropriate to pupils under the age of 11 but Prolog is still a young language itself. Versions which respond to 'ordinary English' and which are less sensitive to syntax errors could be useful for teaching problem solving and reasoning skills.

In the long term there must be serious questions raised about whether programming will be significant in the adult world. In industry and commerce, almost everyone uses professionally produced software and it is likely this trend will spread. Also under development are program generators which write programs without the user having to know the detailed structure of the programming language. A typical invention in this respect is a program called *The Last One* which will write Basic programs quickly and efficiently for anyone who is able to specify the problem in sufficient detail. It could be argued there is no more need for a person to know how to write a program than there is for such a person to be able to mend a television or service a car.

Programming is like mathematics in that it is easy for pupils to meet problems which they cannot resolve and become disheartened. A good teacher will take great care pupils attempt problems within their capabilities, which implies some knowledge of the difficulties of programming. This can only be acquired by writing programs which is a time consuming activity.

Many people start programming using low resolution graphics or producing simple messages on the printer. In both cases the use of squared paper as a design aid can save frustration and time. For any worthwhile programming work the school needs a printer since it is difficult for young children to think when reading a program on a screen. They will nearly always need to sit down with a listing and think about it. A printer will be useful in other activities, but it is essential if pupils are to learn to program effectively.

Another important aspect of designing a program is the need for carefully thought out test data before coding begins. One view is that the best programs are written from the output and the test data, and only at the end are input and the procedures determined.

```
>LIST
  100 REM TEXT AND GRAPHICS
  110 MODE 5
  120 MOVE 500,900
  130 DRAW 200,900
  140 DRAW 200,300
  150 DRAW 500,300
  160 MOVE 200,600
  170 DRAW 350,600
  180 MOVE 800,300
  190 DRAW 800,900
  200 DRAW 600,900
  210 DRAW 1000,900
  220 PRINT TAB(4,26)"PHONE HOME"
  230 END
```

BBC computer software BBC

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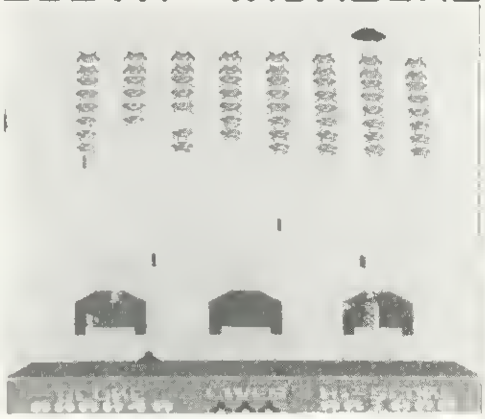

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TWO APPROACHES IN THE CLASSROOM

PRIMARY school software must meet two requirements: it must appeal to children, and have some educational merit. Two programs I use, *Animal* and *Explore*, are successful in both respects.

The first is a program which requires children to think up questions to differentiate between various animals of their choice. These questions are typed at the keyboard and stored in the computer so it 'remembers' the names of the animals and their distinguishing characteristics. These questions then reappear as prompts during the next cycle of the program.

The program can be used by a whole class but the fewer the children the more opportunities for discussion about questions to be input. This discussion may lead the children to consult reference books about unfamiliar animals they have chosen. In this respect the program can be used with pupils of various ages. Young children might simply like to think about the differences between pets, for example, while older juniors might develop a more rigorous classification of animals (eg whether they are mammals, invertebrates, herbivores).

One further point is that *Animal* is a program where the children teach the micro and not the other way around – they are masters of the machine. This is an important attitude to convey as many adults blame computers for mistakes: they forget computers only follow instructions.

Explore is different altogether and offers opportunities for simple problem solving and decision making rather than language extension. It is an adventure game, though without the puzzles, cryptic clues and frustrations of adult versions. In *Explore* you journey through four levels of underground caves and rooms, and use compass directions to move. The aim is to collect the hidden treasure and return to the surface. There are various monsters to overcome by bargaining with your treasure or fighting. This, however, expends precious 'life force', when it reaches zero, the game comes to a premature end – you're dead! Magic spells help defeat the monsters but these can only be used once.

This might not appear to have much educational value, but I have found it useful with lower-juniors. It is a marvellous stimulus both for creative writing (stories about exploring, descriptions of magical surroundings etc) and for art (my class produced a wall collage showing rooms and caves mentioned in the program). Also, since no map of the caves is supplied children can devise one for themselves: a network seems the most suitable format and is a good introduction to this form of representation.

Perhaps the main value of *Explore* lies in its requiring children to weight up conflicting courses of action and see what happens as a result of their decisions. Forward planning is essential to succeed and some routes are more sensible than others. When the children are debating which route to take I encourage them to reason out why one seems preferable. Other children can then put their views and the class can argue it out.

Finally, I should point out differences in classroom organisation that stem from using *Explore* rather than *Animal*. In the latter the children's thinking becomes part of the program (in the form of discriminatory questions) and thus can be appraised subsequently using, for example, a printout. With *Explore* this is not the case and discussion should be monitored by the teacher. Also, *Explore* can take half an hour to play, so is not ideal for the teacher who wishes to allow all his groups to take their turn on the micro during the day. It seems better to use *Explore* with a whole class – children can take turns to suggest the next move.

Animal: Microprimer pack – MEP
Explore: similar adventure games are available from several distributors.

Charles Bake

TEN POINTS TO NOTE

- **Programming is about problem solving, it is not particularly about coding programs into a particular language.**
- **Early success is often paid for by later failure if good habits are not developed.**
- **Do not allow a small minority who show an exceptional ability in programming to make progress at the expense of everyone else.**
- **Remember that good programming is like literature, it is an art of communication.**
- **Look carefully at available languages before choosing one to use with your pupils.**
- **Be alert to the danger of making programming a boys' activity and always ensure girls have at least as much time on the computer.**
- **Do not allow pupils to spend a long time thinking about programming while at the screen, insist they go away and try to solve the problem at a desk.**
- **Use squared paper at the design stage to save typing time and reduce errors.**
- **Consider using graphics because of their motivation value, whatever the language.**
- **Many pupils need constant encouragement if they are not to become discouraged. They also need careful guidance to ensure they do not attempt programs beyond their capabilities.**

Next month: Language development in primary school children

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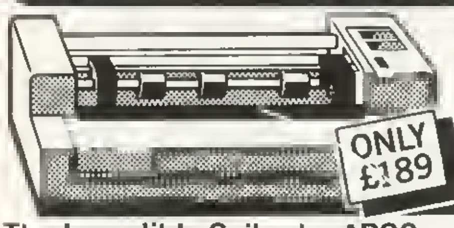

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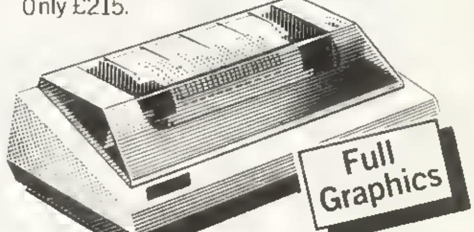

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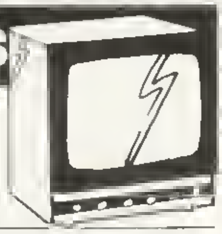

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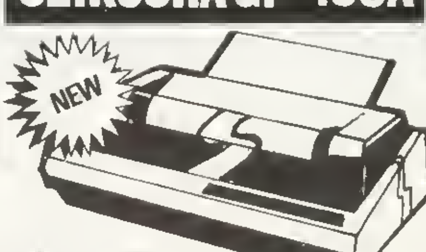

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TEACHERS NEED MORE PROGRAMS

Heather Govier looks at the software in the *Microprimer* pack for primary schools. Her verdict, not enough and could do better

THE software in the *Micro Primer* package is perhaps the least satisfactory element. Only a small amount of that promised is supplied as only one of the four packs is available. Thus instead of receiving 30 software items with their machines, schools will get only 11. Of these, two are short programs designed to help set up the system; one is simply a datafile used by another program and the pair called *Mquiz* and *Quiz* are two stages of the same activity. So there are really only seven discrete items. For schools with good LEA support, this may not be too serious a blow, but for others eight programs is shamefully few.

These seven distinct pieces of software vary substantially in the extent of their value to primary teachers. The programs are designed mainly for use by individuals or small groups working without direct supervision. While some have been specially written for the package, others have been drawn from a variety of sources and collected together as examples of the 'kinds of computer based learning currently available for primary schools'. When the 50 promised programs are available they may present a spectrum of possible educational uses, but the initial package is too small to meet this objective.

A teachers' booklet gives full documentation on each program and contains suggestions for pupil activities and occasional sample worksheets. This documentation is clear and easy to follow and is machine specific. The notes in the teacher's book are written with the assumption that teachers will explore the programs themselves at the computer before allowing them to be used by pupils. This is essential if maximum educational benefit is to be derived from any software.

The programs vary considerably in format but all make some use of colour. This presents problems with black and white monitors as some colours do not show up clearly. Moreover, the use of colour seems to have been grafted on to the programs as an afterthought.

I shall now run through the packages one at a time. *Crash* presents an obstacle course chosen from a menu of options around which a vehicle (represented by an arrow) must be directed to move by a set of instructions which effectively constitute a program. It is thus like a screen version of Bigtrak or a simple form of Logo. *Crash* differs from the standard maze program in that the full series of instructions must be typed in at the outset and these are then executed. Thus the similarity to Bigtrak is stronger than to Logo. If a program results in a 'crash', pupils can edit their instructions and use a trial-and-error strategy. The teacher's notes suggest the courses be duplicated on paper so pupils may plan programs away from the computer, also that the program is best used as part of a coordinated scheme at work including Bigtrak and Logo.

When used in this way *Crash* could be a valuable activity. It serves as an introduction to the concept of a program and the process of debugging can help develop sound programming skills. This problem solving exercise is one of the most interesting and valuable of all the programs in the *Micro primer* package. It lacks the sophistication of Logo but makes a good starting point. The program is recommended for pupils between the ages of 7 and 14 but could well be used (in conjunction with Bigtrak) with bright infants.

Shopping provides a graphic simulation of a visit to the shops and aims to give practice in handling change, planning a short sequence of events and accounting for small sums of money. The child must 'visit' five shops to purchase items presented initially as a shopping list. At each shop the financial calculations involved in the purchase must be made and the whole expedition must be completed in 10 minutes. A sample worksheet is provided on which the child can record results of the expedition after the program has been completed.

A worksheet would be more valuable if used during, rather than after, the session with the computer, but clearly this would result in a considerable Increase in the time taken. In any case, the use of a time limit is counterproductive.

Yes, its Bjorn Borg, the recently-retired tennis star. These pictures use 82,000, 655,000 and 2.6 million bits to store the image as seen in The Computer Book.

It is surely preferable to encourage pupils to be accurate and careful rather than to rush through any activity – and the timing here is remarkably tight.

I doubt whether this program achieves anything which could not be better done by the use of the traditional class shop. The program makes little use of colour as all pictures and text are blue. Furthermore, there are bugs in the program which result in correct response being occasionally rejected.

It is unlikely that *Diet*, originally developed for biology at secondary level, will be useful to many primary teachers. The program is recommended for pupils aged 10 to 15, which includes only fourth year juniors.

The purpose is to allow pupils to match their own diet, or that of another individual, to a recommended one. It could be used as part of a project on food or to illustrate the use of computers for data collection, analysis and display. However, pupils must be familiar with terms such as megajoule, kilojoule and gram, and the use of code numbers instead of natural English for entering the food items is an encumberance.

Much of the software available to primary teachers was written for secondary pupils. Some programs make the move better than others, but *Diet* is one which would have been better left as a secondary course.

Topic work is one of the most exciting areas in which a microcomputer can be used. Examples of this are given in *Micro primer* and the program *Litter* is a software illustration.

It is described as a simple decision-making program to simulate factors which might influence local elections. The user is set in the role of a local councillor seeking re-election who has decided to run an anti-litter campaign to curry favour with the electorate. Litter can be controlled by six options which can be revised weekly over the ten week run-up to the election. The campaign must be completed within a given budget.

Financial status and popularity index are constantly monitored and the object of the exercise is to keep the streets clean, become popular and win the election.

```
THINK OF AN ANIMAL (INSECT,BIRD,ETC.)
THEN ANSWER MY QUESTIONS.YES OR NO.


IS IT A MAMMAL?
? NO
IS IT A BIRD?
? YES
CAN IT FLY?
? NO
IS IT AS TALL AS A MAN?
? YES
IS IT AN OSTRICH, CHARLES?
? NO
WHAT IS IT THEN? EMU
IF I WANTED TO CHOOSE
BETWEEN AN OSTRICH
AND AN EMU,
WHAT QUESTION SHOULD I ASK?
```

```
THINK OF AN ANIMAL (INSECT,BIRD,ETC.)
THEN ANSWER MY QUESTIONS.YES OR NO.


IS IT A MAMMAL?
? NO
IS IT A BIRD, CHARLES?
? YES
CAN IT FLY?
? NO
IS IT A CHICKEN, CHARLES?
? NO
WHAT IS IT THEN? OSTRICH
IF I WANTED TO CHOOSE
BETWEEN A CHICKEN
AND AN OSTRICH,
WHAT QUESTION SHOULD I ASK?
? IS IT AS TALL AS A MAN
AND THE ANSWER FOR AN OSTRICH IS?
? YES
THANKS, CHARLES, I'LL REMEMBER THAT!
ANOTHER GO? YES
```

A typical run of Animal. See Charles Bake's review on page 51

While the program is little more than a simple game, it could serve as a valuable element in a topic on environmental education. The nature of local politics, the litter problem, and the repercussions of various attempts to solve it could all be matters for discussion.

Mquiz, *Quiz* and *Birds* form a suite of software illustrating an important principle in the use of computers in schools – software flexibility. Pupils are not limited here with a ready-written quiz but are provided with a software tool to set up any number of multiple-choice tests or quizzes.

Mquiz allows the child to set up a quiz of up to 40 questions with up to five possible answers of which only one must be correct. When typing the questions and answers,editing is possible.

Once the full quiz has been set up the compiler is allowed to work through it and again may make any necessary corrections before the quiz is saved onto cassette.

The prepared quiz file can be used wth *Quiz* to set questions. This program gives full instructions for loading files and for a short quiz this is very fast. Suggestions for storing data files are given in the teacher's notes. One benefit of the program is that it introduces pupils and teachers to the idea of saving data files, a facility also used in *Animal*. The value of the *Mquiz/Quiz* programs, because of their flexibility, depends entirely upon the skill of the teacher.

The use of *Quiz* as a tool for learning could be greater if users were told the correct answer when they made a mistake. Although the teacher's notes suggest this, no information was given when using the program.

Animal is a version of perhaps the most ubiquitous computer game. The program can store approximately 130 animals but initially contains only two. Data files built up can be saved onto cassette. Although true editing is not possible the program does allow deletion of the last addition in case of errors. A more flexible package which allows the construction of branching keys on any subject has been produced by the ITMA Project but is not yet available for the BBC micro.

The final program, *Farmer*, invites pupils to solve the old problem of getting a farmer, his dog, a chicken and a bag of grain safely across the river. The boat will only hold the farmer plus one other item. If the chicken and grain are left together the grain will be consumed and if the chicken is left with the dog the chicken will be eaten.

The notes suggest the program is best used as a group or class activity with discussion. However, when used in such a way this software is limited. There is no scope for extension of the activity or generalising the problem-solving skills involved. A better version of a similar problem is available from the *Smile* software development project. Here the travellers consist of a variable number of adults and children and the boat will hold only one adult or two children. This problem, while in many ways similar to that presented in *Farmer* can be explored in greater depth as a mathematical investigation.

FINDING A HOME FOR MACHINE CODE

THE programmers at Acorn have expressed concern that Tony Shaw and John Ferguson did not emphasise the use of the Basic DIM statement as the standard way of reserving space for machine code routines in their February article 'Finding a home for machine code'.

As a reminder of how to use this, consider program 1. This is their preferred way to claim store on the BBC micro, and there is a further refinement which lets you use this scheme regardless of how large the machine code program grows. By making an extra pass over the code you can work out its size and DIM the array to suit. The extra pass places the code at address &C000 (on top of the MOS ROM) so it is not planted in memory. Then you make the normal two pass assembly. Program 2 gives an example.

This method of the four suggested by JF and TS is the only one guaranteed to work under all circumstances.

Please note that locations D00 to DFF are *not* for user routines. They are for routines which are essential to certain parts of the operating system. Programs written using this space will only work on cassette systems.

JF and TS reply: In the series our primary concern is for the beginner and with the excellent BBC assembler we hope many will be lured into the delights of assembly language programming. Consequently our approach is to tread warily in areas that we anticipate may cause difficulty for the reader.

Finding a home for the machine code provides many confusing concepts for the newcomer. Whilst the use of the DIM statement was covered in the article the emphasis given has not suited Acorn programmers – but then they are not beginners. (We are pleased their comment is constructive and the 'variation' is interesting).

Use of DIM is to be encouraged, but so is an understanding of the principles that control where the machine code is placed. Such understanding is vital if the programmer is to readily apply the knowledge gained.

In many applications it is desirable to place the machine code at a specific location so it may be easily accessed from any language. Examples include the terminal simulation program and the PET printer driver described in earlier issues of *Acorn User*.

The *User Guide* conflictingly described page D as 'space for user supplied resident routines' (p 501) and '. . . used by Disc or Econet filing systems' (p502). Believe page 501 if you don't have discs and page 502 if you do. A safe haven for user routines is a valuable feature which presumably disappeared as the disc operating system developed?

Final decision: There is bound to be serious discussion about the facilities offered by the BBC micro, and I am glad to see *Acorn User* as the major forum for this. The magazine is produced as a service to readers, who will be the final arbiters on these issues.

The Editor.

```
10REM Program to print "FRED"
20REM WITHOUT using fixed addresses
30OSASCI = &FFE3
35
40REM Declare enough space for the string
50DIM message 4
60$message = "FRED"
70
80REM Now declare space large enough for the code
90DIM code 32
100P% = code
110[
120.start Lda message     \ Get first byte
130       Jsr OSASCI      \ onto screen
140       Lda message+1   \ Get second byte
150       Jsr OSASCI      \ onto screen
160       Lda message+2   \ Get third byte
170       Jsr OSASCI      \ etc...
180       Lda message+3
190       Jsr OSASCI
200       Rts
210]
220CALL start
230END
```

Program 1

```
10REM Program to print "FRED"
20REM WITHOUT using fixed addresses
30OSASCI = &FFE3
40
50REM Declare enough space for the string
60DIM message 4
70$message = "FRED"
80
90REM Pre-pass places code onto ROM.
100REM (This area is also unused in Tube machines)
110code_address = &C000
120
130FOR pass = -3 TO 3 STEP 3
140P% = code_address
150IF pass<0 THEN passopt=0 ELSE passopt=pass
160[ OPT passopt
170.start Lda message     \ Get first byte
180       Jsr OSASCI      \ onto screen
190       Lda message+1   \ Get second byte
200       Jsr OSASCI      \ onto screen
210       Lda message+2   \ Get third byte
220       Jsr OSASCI      \ etc...
230       Lda message+3
240       Jsr OSASCI
250       Rts
260]
270
280REM Now that we know how big it is,...
290IF pass<0 THEN DIM code P%-code_address : code_address = code
300
310NEXT pass
320
330CALL start
340END
```

Program 2

EDUQUEST

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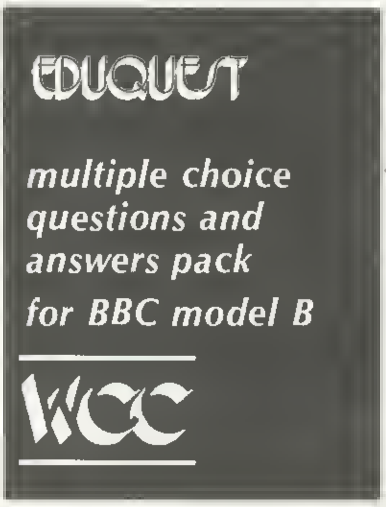

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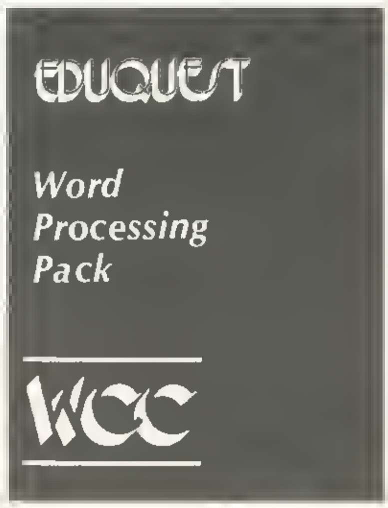

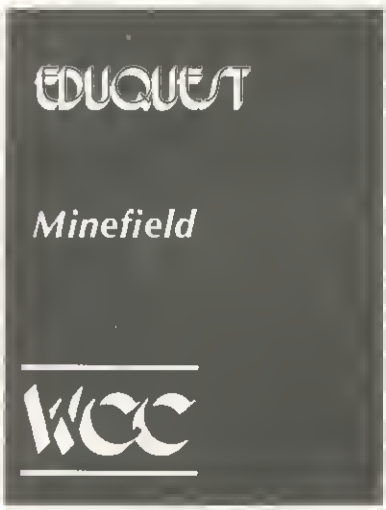

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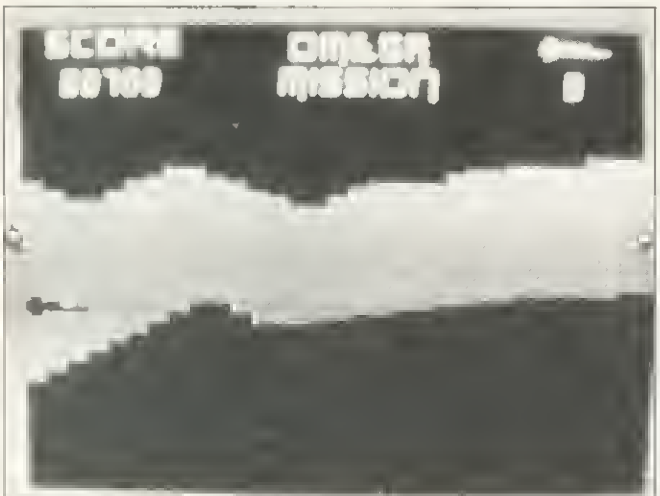
GAME FOR AN ADVENTURE?

Barry Pickles looks at four games for the Atom – and three adventures to whet your appetite

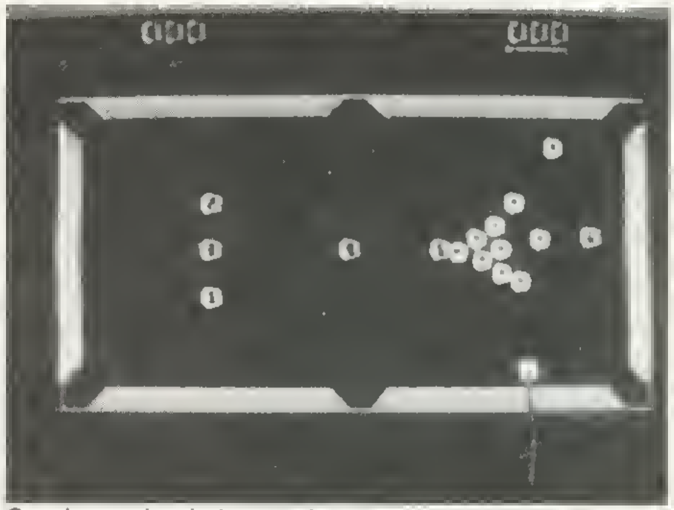
THE games described here need a 12k Atom and give a colour display, except *Astrobirds*. Each is a copy of an arcade favourite written largely in machine-code. They all came with clear instructions and loaded first time.

Omega Mission, comes from a new software house, Micromania, whose catalogue has four arcade games for the Atom. This is a good version of *Scramble* and the action is reasonably fast and very smooth, the landscape scrolling to the left as you play. There are five stages with all the arcade features: fireballs, spaceships, missiles, mutants, caves and a tunnel. Keys control up, down, brake, accelerate and fire. The keys are bit-mapped, so you may use them in combination to achieve movement in eight directions, firing as you go.

Completing the game presents a new, harder, mission. In the arcade version, if you get hit, the game returns to the start of the current

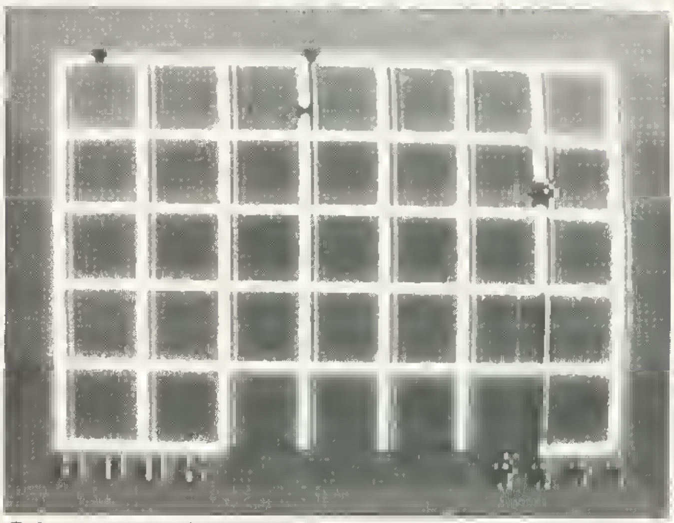


Omega Mission. . . fast and furious



Snooker. . .slow but accurate

Astrobirds. . . swooping 'intelligence'



Painter. . . superb animation

ACORNSOFT

EDUCATIONAL

PACKS

FIVE educational packs have been released by Acornsoft, each with teachers' notes. The programs allow teachers to set a time limit for each child,

The first *Word Sequencing* (models A and B) presents a series of jumbled words which can be arranged to form proverbs, nursery rhymes or sentences. Words are moved using the cursor keys. *Sentence Sequencing* (model B) works similarly with jumbled sentences.

***Word Hunt* (A and B) consists of four programs, each containing a list of nine words. Pupils select one word at a time and from its letters create as many words as they can.**

Addition, subtraction, multiplication and division are covered by *Missing Signs*. Pupils must calculate both sides of an equation before deciding whether the missing sign should be greater than (>), less than (<) or equal to (=).

Finally, *Number Balance* (model B) features a set of scales for practising simple mathematics with numbers from one to 20. Children have to balance the scales by putting the correct numbers into one side of a simple equation.

Acornsoft say the packs are available now on disc (£15.35) or cassette (£11.90), from: Acornsoft, Vector Marketing, Denington Estate, Wellingborough, Northants NN8 2RL.

***Suppliers:* Hopesoft, Hope Cottage, Winterbourne, Surrey RG16 8BB; Acornsoft, c/o Vector Marketing, Denington Estate, Wellingborough, Northants, NN8 2RL; Program Power/ Micro Power, 8 Regent Street, Leeds LS7 4PE; A&F Software, 830 Hyde Road, Gorton, Manchester M18 7JD, Micromania, 14 Lower Hill Rd, Epsom, Surrey (mail order only).**

stage. Here, however, you return to the start of the game and completing the mission is a real achievement! Good sound effects are provided and the highest score is kept.

A challenging and addictive game for £7.

Program Power's *Astrobirds* is based on *Galaxians*, an old game by arcade standards, but with an enduring appeal. This version, from a well-established stable, opens with a fanfare and then the action begins, with swooping, screaming birdmen spraying bomb clusters. The attackers are 'intelligent', so if you move, they will try to follow. Like *Space Invaders*, there is no end to the attackers, so you can't win – just try to beat the high score. Control is easy, using three keys for left, right and fire. The screen is superbly detailed and shows both the current and the high score. The secret is to keep moving, so the aliens don't get a 'fix' on your position. After you have mastered the normal game, you can opt for a double-speed game – so fast as to be nearly impossible!

At £6.95, a fine version, with excellent graphics and sound effects.

Painter is a version of *Amidar*. Since this game is by no means commonplace, it takes some explaining. The screen displays a grid of cells, around which you move your 'painter'. As each side of a cell is traversed, it changes colour and, when all four sides have been passed, the cell is painted. The object is to complete a screenful of cells, but your painter is being pursued by 'Blue Meanies', who try to dislodge the painter from the grid – with fatal results! Completing the screen produces a new grid, with an extra painter – and an extra meanie.

Four keys control the painter's movement and a fifth allows you to leap over an approaching meanie (beware of jumping off the grid). There is also a 'panic' key, which makes the painter run, instead of walking. The animation is superb, the painter having moving arms and legs. If he's killed, he lies at the bottom of the screen, arms and legs in the air, whilst a Funeral March is played. Sound effects are plentiful and a score-ladder is provided. There is on-screen scoring and a bonus is given for each completed screen, which 'clocks up', arcade style.

This game is not as easy as it sounds and is very addictive. In all, a fine game from A & F Software at £5.95.

'Snooker proved to be compelling at the local club'

Games Pack II from Acornsoft contains three games, all of which need a fully expanded Atom. The one reviewed here, *Snooker*, is in colour, although the balls are numbered for black and white sets. Normal snooker rules apply with penalty points for fouls. Shots are controlled by placing the cue at the required angle using any of four keys. The length of the cue determines the power of the shot.

Pressing CTRL plays the shot and the balls move correctly, albeit slowly. The game is for two players, control passing to the second player after a 'break'. There is no time limit for a shot but, otherwise, this game is a faithful reproduction of arcade versions and, in some ways, is an improvement on some.

Trying it out on my local computer club proved it to be a compelling game. However, because of its speed of play, you must allow for a longish session to complete a frame.

The other games on this pack are a complicated, action-packed version of *Missile Command* and a traditional version of *Dominoes*. At £11.50 for three games this pack is very good value.

THE popularity of adventure games is built upon their ability to present players with a series of challenges which may take weeks rather than hours to overcome.

The first package considered here is *Atom Adventures* from Acornsoft which provides three basic games. All adventures use the same principles, so this offering first loads a base, which is used to manipulate data for the three games. Once loaded, any game can be selected by typing *RUN (filename), and loading takes about five minutes for each part. The first game, *Dungeons*, is a standard scenario, in which you explore a series of caves, collecting treasure. The map is simple to deduce and there are some nice touches of humour – for example, saying 'Man Utd' sends you back to the start and confiscates your treasure! The second game, *House* is built around a mansion inhabited by ghosts of 'famous' people – although I wonder what someone playing this game 30 years hence would make of Basil Fawlty, Reggie Perrin and Anna Ford! By the way, beware of Prince Charles who picks up *anything* left lying about.

The final game, *Intergalactic* is the most complex, and creates a galaxy with locations and characters based on the 'Dragonrider' series of SF novels. Three games for £11.50 has to be good value, but this pack is more suited to newcomers and will not provide a challenge for experienced gamers.

Adventure, from Hopesoft, is a full-blown game which takes the explorer into forests, caves, an old building and a castle (all familiar territory to experienced gamers) littered with trolls and other nasties. If you get stuck, try the Help facility – but it's not very helpful! There is not much humour here, but a lot of frustration and it will take you hours to crack, especially the final part! *Adventure* is well-written and good value at £6.75. Hopesoft also produce *Pirate Island* and a *DIY* adventure kit.

The next two games, from A&F Software, have both been the subject of cash competitions and it is a measure of their complexity that few correct entries were received, from hundreds submitted. The first is *Death Satellite* set on an abandoned space station. Your task is to search for fuel to make the journey home. There are few monsters, but a lot of 'natural' hazards. Many of the objects have more than one use and there are some subtle touches of humour. This game has a minor flaw in that it is possible (but unlikely) to complete your mission without exploring the satellite fully.

'The author has foreseen the results of frustration'

The other game is *Zodiac* – a pure fantasy. Players explore the houses of the zodiac in search of treasure, encountering characters whose attributes correspond to their sign. This time there are no flaws and some of the clues are very subtle, providing a real challenge and some unexpected twists. Each game costs £6.90 and a third is in preparation.

'A real challenge with some unexplained twists'

The final game is *Adventure* from Program Power (a bit repetitive these names!). This is unusual in that it is written largely in Basic but it is every bit as good as the rest, a fact attested to by the fan mail kindly loaned to me by the author. The scenario is standard *Dragons & Dungeons*, the object being to rescue a princess, albeit a somewhat reluctant damsel. There are caves to explore, a castle to search and trolls and wizards to combat. Again, there is a niggardly Help function and the author has forseen the results of frustration by causing the game to terminate if obscenities are typed in! If you get hopelessly lost, you can write to Program Power for a clue. *Adventure* costs £6.95 and a version of *Nightmare Park* is available from the same source.

If you've never played an adventure before, try one – I'll bet you get hooked – and the great thing is that the whole family can join in. All the programs here are good value, although experienced users may find the Acornsoft pack disappointing. Finally, a word of thanks to authors and adventurers for providing crib notes, without which I might still be stuck at the keyboard.

CASSETTE BUG FIX FOR 0.1 OPERATING SYSTEM

HERE, as a result of popular demand, we repeat the cassette filing bug patch, first printed in September's *Acorn User*.

Problems with the BBC micro's cassette filing system (0.1 operating system) can be relieved by the listing below. (Type *FX0 to find which OS you have.

Two factors need to be overcome. The first involves character output routines whereby complete Basic strings are sometimes not written to the tape. The second is caused by a hardware problem which corrupts certain files as they are written to the tape.

The modification, devised by Richard Russell of the BBC, is given below as a program to be typed into the BBC micro and RUN on startup. It contains a *KEY command on line 9 to ensure it is preserved over use of the BREAK key. Obviously, the modification is lost from memory if power is turned off and also on a 'hard reset' (rapid BREAK BREAK). Having installed the modification, SAVE it on the front of a tape to be LOADed whenever the computer is started up.

```
1REM OS 0.1 CFS PATCH
2REM <FIX1> restores register A
3REM over a PUTBYTE call.
4REM
5REM <FIX2> avoids tape corruption
6REM during SAVE and PUTBYTE
7REM
8REM Machine code is located at &DD0
9 *KEY 10 ?&218=&D0:?&219=&D:
   ?&20A=&D6:?&20B=&D|M
10FORI%=0TO1:P%=&DD0:GOSUB50:NEXT
20?&218=FIX1:?&219=FIX1 DIV 256
30?&20A=FIX2:?&20B=FIX2 DIV 256
40END
50[ OPT I%*2
60.FIX1 PHA:JSR &F521:PLA:RTS
70.FIX2 CMP#&91:BNE GO:CPX#0:BNE GO
80TSX:LDA&102,X:CMP#&F7:BEQ TRAP
90LDX#0:.TX LDA#&91:STA&FE09:RTS
100.GO JMP(&DB60)
110.TRAP PLA:PLA
120JSR&F9D8:JSR&FB7B
130JSR TX:JMP&F7FB
140]RETURN
```

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

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

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

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

The BBC's choice too.

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

All this for only £399.

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

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

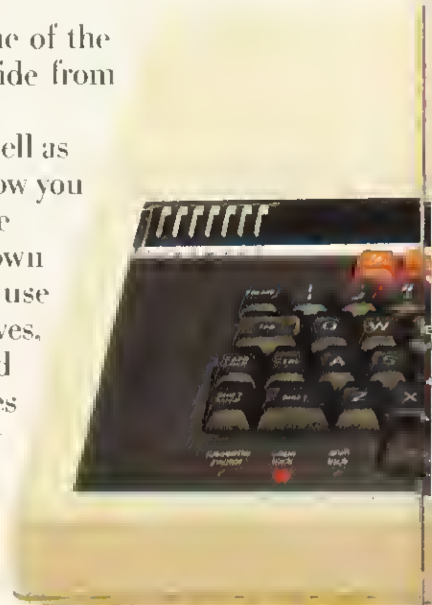
Designed to grow.

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

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

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

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



The Tube. A unique feature.

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

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

Linking up with other computers.

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

Make full use of Prestel & Teletext.

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

BASIC plus.

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

*Trademark of Digital Research.

A full range of software.

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

The best possible back-up.

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

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The BBC Microcomputer System.

Designed, produced and distributed by Acorn Computers Limited.

Paul Beverley introduced the 1MHz interfa

MOVE OVER TO

In January's issue, I introduced you to Fred, Jim and Sheila, the three pages of memory-mapped input/output on the BBC micro, and explained how they could be accessed using byte indirection (? – the equivalent of peek and poke). However, this is the 'unofficial' way of doing it – the recommended way is to use the operating system calls. If you faithfully stick to using the routines provided within the operating system, all your programs will still work when you add a second processor, or upgrade your machine.

Sheila accesses all the interface hardware on the machine itself, including the 6522 versatile interface adaptor used for the printer and user ports, but if you want to hang more hardware onto your machine than can fit onto the user port you will have to start using Fred and Jim – the 1 MHz interface bus.

Figure 1 gives suggested memory allocations for the 1 MHz bus and shows the sort of devices Acorn are anticipating we will be linking onto it. It confines 'user applications' to memory locations &FCC0 to &FCFE, but the memory locations mentioned do not include Jim (&FD00 to &FDFF). This is because these locations along with the 'paging register' (&FCFF) are to be used to allow the addition of 64k of 'paged memory' which will be explained later. First we need to look in detail at how to attach devices to Fred and before we can do that we need to look at exactly what facilities are provided on the 1MHz bus connector.

FC00 – FC0F	**Test hardware**
FC10 – FC13	**Teletext unit**
FC14 – FC1F	**Prestel unit**
FC20 – FC27	**IEEE 488 interface**
FC30 – FC3F	**Cambridge Ring interface**
FC80 – FC8F	**Test hardware**
FCC0 – FCFE	**User applications**
FCFF	**Paging register**

Figure 1. Address allocations for Fred

It will be worth referring to the circuit diagram of the 1MHz bus interface (*User Guide*, p.503) when considering individual lines on the connector. The 'N' at the start of line names like NPGFC and NIRQ means they are 'negative active', ie it is when they go to logic 0 that they perform their specified functions.

A0 – A7 (pins 27–34) are the eight low address lines of the 6502 which, when combined with one of the page select lines, can be decoded to identify any address between &FC00 and &FDFF. They are buffered by a 74LS244 which is permanently enabled, so they are always active.

D0 – D7 (pins 18–25) are the eight data lines from the processor. They are buffered by a 74LS245 which is a bi-directional buffer since the data has to be able to come from the processor to the devices on the bus and vice versa. However, this buffer is only enabled when either Fred or Jim is being

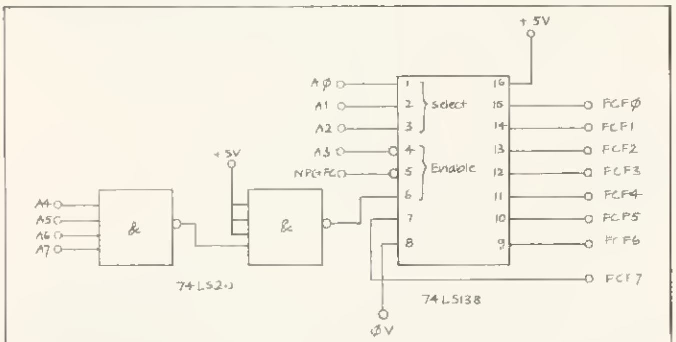

Figure 2. Simple address decoding for user applications.

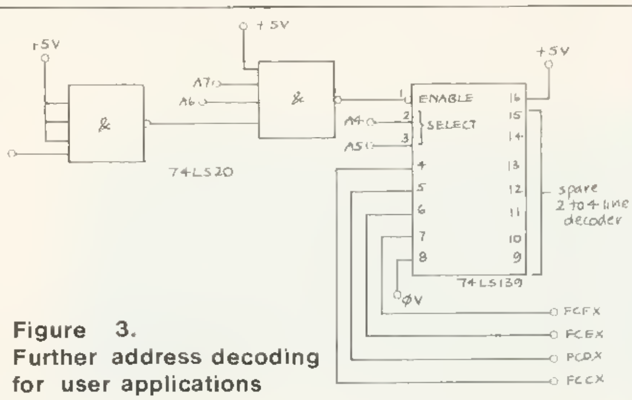

Figure 3. Further address decoding for user applications

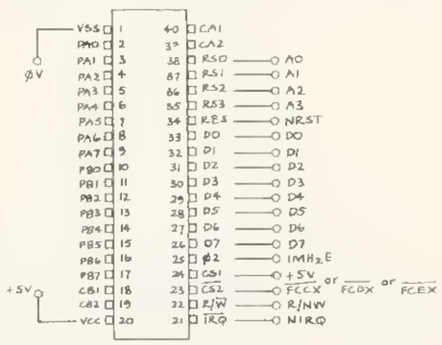

Figure 4. Connections to 6522 VIA

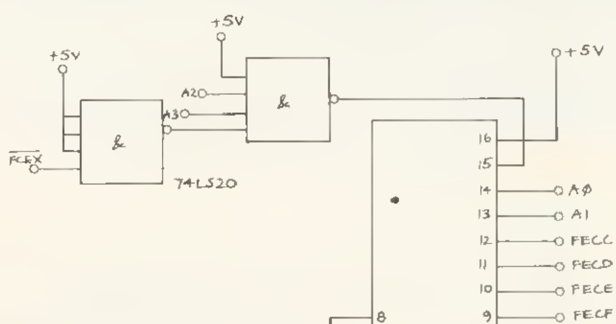

Figure 5. Extra decoding for figure 3

ce in January. Now he shows how to use it

FRED AND JIM

accessed, and the direction of data flow is controlled by the read/write line from the processor.

Each of lines NPGFC and NPGFD (pins 10, 12) is decoded from the top eight bits of the processor's address lines to select pages &FC00 and &FD00. They go low when the processor tries to access a device in the given page.

Analog in (pin 16) is an input to the audio amplifier on the computer. Any signal applied here will be added to the sound or speech already being passed to the amplifier. Its input impedance is 9kohms and in the absence of any on-board speech or sound signals it requires 3V rms for full volume output to the speaker, but if you do use the speech or sound as well, the full 3V will cause distortion.

NRST (pin 14) is an *output only* from the computer and goes low on power-up when the Break key is pressed. It can therefore be used to initialise devices on the bus to a known condition.

NIRQ (pin 8) is the usual IRQ (interrupt request) line of the 6502 processor but because many functions of the machine use interrupts, it should be left well alone unless you know what you are doing.

NNMI (pin 6) is not non-maskable interrupt. Again, this interrupt line should not be played with unless you have 'an advanced knowledge of 6502 programming techniques', as the Acorn application note puts it. This is especially so if you have a disc system.

1MHzE (pin 4) is a system clock for the devices on the bus and is derived from the master clock for the processor, which is 2MHz. When devices on the bus are being accessed, the processor clock pulses are therefore 'stretched' by a special circuit so they coincide with the 1MHz clock pulses.

R/NW (pin 2) is the 6502's read-write line, buffered to improve its drive capability.

(Pins 1,3,5,7,9,11,13,15,17 and 24 are all 0V lines to act as screens where adjacent lines are non-synchronous.)

The idea of address decoding is that each device connected to the data lines must only be enabled when a particular combination of 1s and 0s appears on the address lines and the appropriate page select line also goes low. If you are sure you will never want to attach more than a few simple devices onto the bus and will not decide later to add more things onto the bus, you don't need to decode all eight lines. You need only do just enough to discriminate between the devices you have got. However, it is not that difficult to do the decoding properly and is worth the effort in the long run.

Figure 2 shows what is needed to attach a few simple devices onto the bus and have them addressed in the range suggested by Acorn for user applications. It uses a single 3 to 8 line decoder chip and a single chip with a couple of four input NAND gates in it. One of the gates is only being used as an inverter, so if you are designing circuits to be attached to the bus, you might be able to use an inverter from another chip, leaving the second four-input gate for other decoding. The address range it uses is &FCF0 to &FCF7, for no other reason than that, within the user application addresses, these can be decoded with the minimum number of gates.

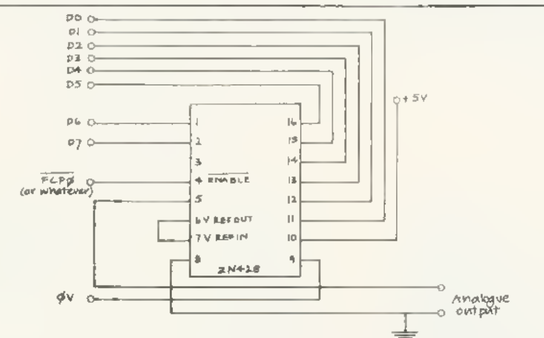

Figure 6. Connecting to ZN428 digital to analogue convertor

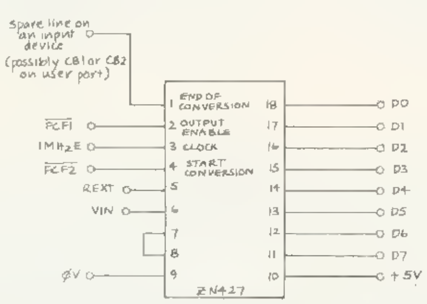

Figure 7. Connecting to ZN427 digital to analogue converter. To start conversion read &FCF2: to read resultant value, read &FCF1

a

b

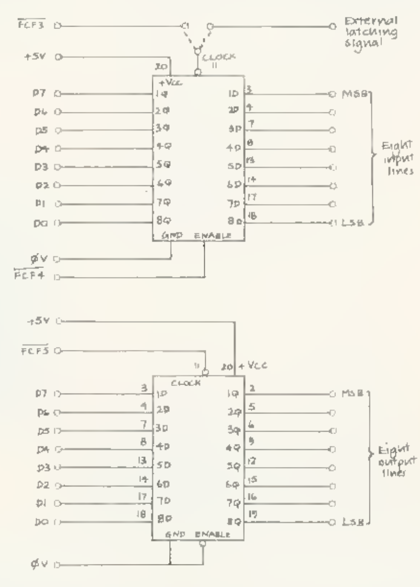

Figure 8. Connecting to eight-bit latch.
(a) Input: Data latched when clock input goes logic 1 to logic 0. To latch data either read &FCF3 or use external signal. To read data, read &FCF4
(b) Output: To output data, write to &FCF5
Output is permanently enabled by 0V on enable input

The circuit in figure 2 will connect eight individual devices such as ADCs or DACs or eight-bit latches, but to link devices which have a number of internal registers such as 6522 versatile interface adaptor you will have to arrange your initial decoding as in figure 3. This divides up the user applications addresses into four groups of 16 address, and since the 6522 has just 16 register addresses it can be enabled by one of the lines this circuit provides. However, Acorn's note suggests we avoid using &FCFF, so if you want to add a VIA, it is better to attach it to either &FCCX, &FCDX or &FCEX. The connections for a 6522 VIA are shown in figure 4.

If you have got that far and want a few lines for extra individual devices, you can use the other half of the 74LS139 to give four extra individual address lines (figure 5), or use another 74LS138 to provide eight more lines.

Figures 6, 7, and 8 give examples of how to connect various devices onto the bus using the individual address lines provided by the decoding. The only thing to be careful of is when interfacing to devices that are being used as inputs to the system such as the ADC in figure 6 or the 74LS374 being used in the input direction. The problem is that if by mistake you try to write to an input device, then both the device and the data buffer will be trying to write onto the data lines at the same time and one or other may be damaged.

You could remove the problem altogether by putting in extra hardware on each device, or rely on yourself never to make that mistake– the choice is yours! To be really safe, you have to use the processor's read/write line (R/NW) and gate it with the decoded address to provide the chip enable (figure 9). It only requires half of one 74LS00 chip for each device that needs protecting.

In Acorn's applications note on the 1 MHz bus, it mentions a problem with the page select lines.

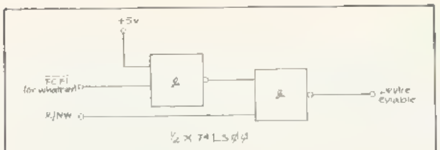

Figure 9. Gating the device select with read/write line

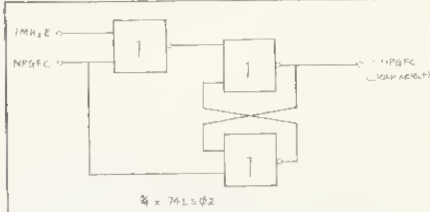

Figure 10. Cleaning up page select line

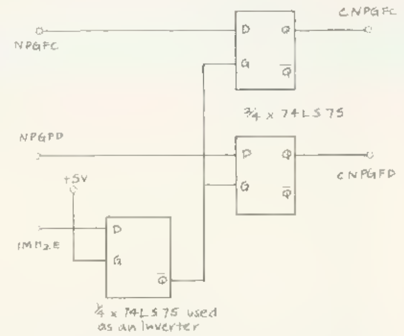

Figure 11. Alternative for producing clean select lines

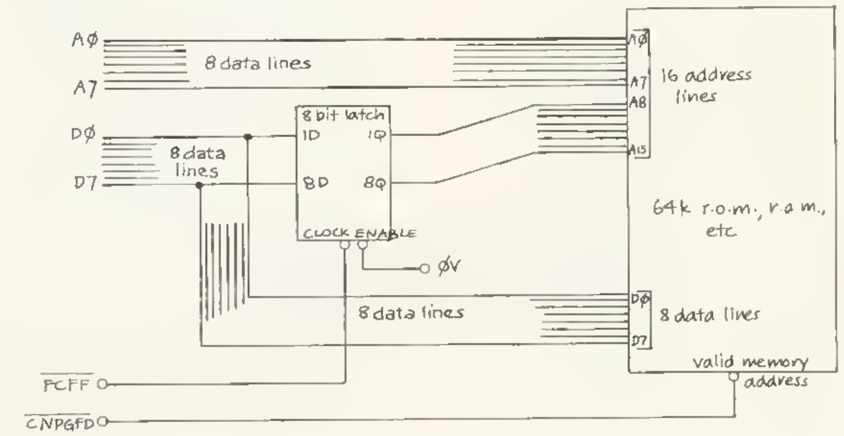

Figure 12. 64k of 'paged' memory on 1MHz bus

It is rather technical, but basically, because of the way the processor clock pulses are 'stretched' while accessing 1 MHz bus, it is possible to get spurious page select pulses appearing.

Instructions are given in the applications note as to how to clean up the select lines. If you just want to use page &FC00 then the circuit in figure 10 will do the job admirably. If you want to use both pages &FC00 and &FD00 then the suggestion is to use the circuit in figure 11 which cleans up both lines using only one chip.

The applications note explains in detail how to provide 64k of paged memory addresses on the bus. There is no space here to go into too much technical detail, but as a matter of interest, let me explain the principle which is illustrated in figure 12. To address 64k of ROM, RAM or whatever, 16 address lines are needed. The lower eight lines can be provided by the eight address lines on the bus, but for the upper eight, you use an eight-bit latch attached to the data bus. This is referred to as the 'paging register'. You store in this latch (which is addressed at &FCFF) the page number (the top eight bits) of the memory to be accessed and then read and write to page &FD00. All data transfers which the processor makes to and from this page are actually going through to the selected page in the extended memory.

Hopefully you should now be able to connect various devices onto the 1 MHz bus.

● *BBC Microcomputer Applications Note 1 – The 1MHz Bus, from Acorn Computers at £2.50.*

June's *Acorn User* will feature an article on interrupts

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FASTER THAN BASIC

Stan Froco gives an introduction to BCPL, a fast language which is valuable for word processing, adventure programs and real-time games

The utility writing language BCPL arose, in the late 1960s, from the ashes of a project to produce CPL – the Combined Programming Language – by Cambridge and London universities. CPL aimed to produce a more powerful and consistent block-structured language to replace earlier languages like Algol 60. Whilst the CPL project had some very useful ideas, its sheer size and complexity caused it to collapse without a full compiler ever being produced.

Much had been learned, however, about desirable features in programming languages, and some of the original workers on the project took the ideas, trimmed them down to size and produced BCPL (Basic CPL). After about five years BCPL became established in its final form, and since then has found world-wide favour as a small yet powerful, efficient, medium-level language for compiler writing and system software implementation. The BCPL compiler is itself written entirely in BCPL, and many operating systems have used it, notably Tripos, which under various commercial guises is proving a powerful alternative to Unix on 16-bit micros and minis. In addition, BCPL is valuable for word-processors, adventure programs and, because of its speed, real-time games.

BCPL has, in its turn led to new languages. In America, it became the B programming language. This did not last long, but was improved to form the C language, which among other things, was used to write Unix. BCPL has even affected Basic. Users of Acorn Atoms and BBC micros have many of the features of BCPL incorporated in the Basic of their machines.

BCPL is a fully recursive block-structured language, after the style of Algol or Pascal. Unlike these languages, which have many data types such as floating-point, integer, strings etc, BCPL has only one type, the BCPL word. This can be considered as an integer, usually of 32 bits (on mainframes) or 16 bits (on micros). 16-bit implementations will be described, although the differences from 32-bit implementations are not generally important. Various operations are provided on these words, such as arithmetic operations, shift operations and Boolean operations, as well as routines to print them out as decimal or binary numbers.

MORE LANGUAGE ROMS ON THE WAY

SEVERAL languages are being developed in the form of ROMs to be plugged into the Beeb. Word-processing packs already make use of this facility, but BCPL is the first language to do so. It should be available from Acornsoft by the end of April.

The 116k ROMS come complete with a 40-track disc containing the BCPL utilitles and a 450 page manual. The disc carries 11,000 words in 22k (BCPL uses two bits per word), and extra copies of the manual will be sold separately.

Machines must be fitted with the 1.2 operating system to run the language, and this is supplied free of charge when a dealer fits the ROM (fitting inclusive).

BCPL uses the same datatype for text. Since an ASCII character requires eight bits, you can hold two characters in a BCPL word. Since there is no datatype distinction you are perfectly at liberty to consider these as numbers and add them or apply any other operation if you so desire. The result in this case is not particularly useful, since all that will happen is that the ASCII values will be manipulated. However, the ability to hold, say, a label or procedure in a variable so simply can be useful. For instance the following piece of code calls either a routine SUB or a routine ADD with arguments EXP1 and EXP2, depending on the value of OPER:

```
PROC := OPER = '+' -> ADD, SUB
PROC(EXP1,EXP2)
```

The first command means give variable PROC the value ADD if OPER is equal to '+', else give it the value SUB. In Basic this would be:

```
IF OPER = "+" THEN LET PROC =
ADD ELSE LET PROC = SUB
```

In fact all objects in BCPL are represented as BCPL words. A label for a GOTO statement is just the 16-bit value pointing to that place in the code. Similarly procedures are just 16-bit addresses of the start of the procedure. You can even multiply labels or subtract procedures: not particularly useful but perfectly legal.

This may itself not seem important, but, what is important is that a BCPL word may hold a 16-bit address. Since BCPL uses 16-bit words, the address of a BCPL word will be only half the address of the byte in memory. Thus the fourth byte in memory will be the second byte of the second BCPL word.

BCPL has an operator to use addresses. This is the indirection operator, '!'. Thus, while in BCPL the assignment B := 4 will give B the value 4, the assignment B := !4 will give B the value held in the fourth BCPL word in store. This is rather

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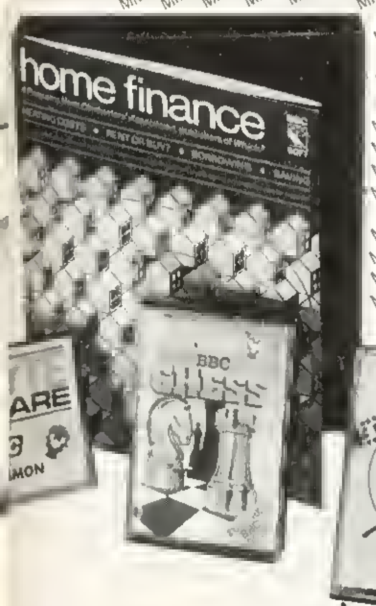

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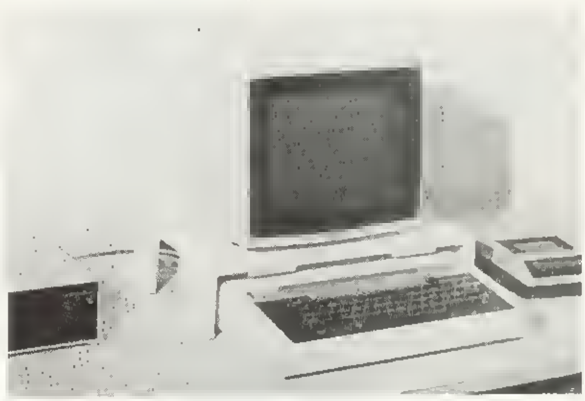

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similar to Basic's PEEK instruction using BCPL words rather than bytes. Similarly !4 := B will put B in the fourth word in store. BBC micro and Acorn Atom users will recognise the similarity with '?' used for PEEK and POKE on their machines.

BCPL programs may use this feature to build up complex data structures, with BCPL variables holding addresses pointing to different parts of the structure. A common use is to build vectors, BCPL's equivalent of arrays. V := GETVEC(5) will assign six consecutive words of store and V is given the address of the first one. Thus, !V will give the contents of the zero element of the vector, !(V + 1) may give the contents of the first element and so on. For convenience !(V +1) may be written as V!1 or 1!V. The six elements of the array may be accessed by: V!0, V!1, V!2, V!3, V!4 and V!5.

Vectors like this are also used for strings in BCPL (the first byte of the zero element holding the number of characters in the string). Thus:

```
B := "A string"
```

sets up a five element vector as in figure 1.

B!2 will give a word holding the characters 't' and 'r'. Clearly we want to be able to get at the characters, and the byte indirection operator, %, does this. Thus B%3 gives the third character (or byte) in the string ('s' here). B%0 gives the length of the string. This facility gives unlimited power to perform any string manipulation.

Finally, a very distinctive feature of BCL is its rich variety of control statements. First there are the conditionals, IF and TEST. The IF statement has the form IF <condition> THEN <block to execute> and the TEST statement has the form TEST<condition> THEN <block to execute> ELSE <block to execute>.

The reason for having two statements, rather than just an IF statement with an optional else, is illustrated by the following fragment of Basic:

```
10 INPUT B
20 IF B > 99 THEN IF B < 1000
   THEN PRINT "Hundreds" ELSE
   PRINT "Thousands"
```

It is not clear which IF the ELSE belongs to. Presumably it belongs to the second, because if it belongs to the first, entering 10 will cause "Thousands" to be printed, presumably not what was intended. This is called the 'Dangling ELSE problem' and by having two different statements BCPL avoids it, since a TEST must have an ELSE, while an IF may not. The above code would be written:

```
IF B > 99
THEN
   TEST B < 1000
   THEN
   WRITES("Hundreds")
ELSE
   WRITES("Thousands")
```

and the meaning is clear.

The above example also illustrates BCPL's flexible layout. Spaces and new lines are always ignored, so long as they don't produce an ambiguous program, except where they appear in strings. They may be used freely to lay the program out clearly. In addition, BCPL has FOR–NEXT loops, and REPEATUNTIL and REPEATWHILE instructions, with the condition tested at the beginning or end of the loop. It becomes extremely easy to produce very structured programs without using a single GOTO statement (although BCPL does provide them if you must use them). This in turn facilitates debugging, making BCPL programs very efficient in terms of programmer effort.

This is only a brief description of the flavour of BCPL. What then are the advantages for micros? The main one is its size. The language is small enough for a full compiler to be fitted on an eight-bit machine. In addition, it can be compiled in small sections. By dynamically linking in sections as they are needed, programs which in total are bigger than the machine's main store may be run.

Since the code may be compiled into machine code, the programs run about two orders of magnitude faster than the fastest interpretive language, such as most Basic and Lisp implementations on micros.

The clarity and structure in BCPL is of great value when compared with other compiled languages. Forth, the only major contender as a compiled language is harder to understand.

However, BCPL is not perfect. A major problem for micros is that

```
//The seive of Erastothenes
GET "LIBHDR"

MANIFEST
 $(
   highest = 5000
 $)

LET START () BE
 $(
    LET prime = VEC highest
    LET divisor = 2
    FOR i = 2 TO highest
    DO
       prime!i := TRUE  //Initially assume prime
    prime!0 := FALSE  //Zero not prime
    prime!1 := FALSE  //One not prime
    UNTIL divisor * divisor > highest
    DO
     $(
       LET nextcross = divisor * divisor
       UNTIL nextcross > highest
       DO
        $(
          prime!nextcross := FALSE  //Delete
          nextcross := nextcross + divisor
        $)
          divisor := divisor + 1  //Select next divisor
       REPEATUNTIL prime!divisor  //Must be TRUE for prime
     $)
    WRITEF ("*PPrimes up to %N*N*N",highest)  //Header
    FOR i = 0 TO 5000
    DO
       IF prime!i  //TRUE => i is prime
       THEN
          WRITED (i,8)
 $)
```

Program 1. The seive of Erastothenes

while the compiled code is of a high standard, it ofen takes up a lot of room compared with hand-written machine code. A solution recently made available is to compile to a compact intermediate

A full compiler can be fitted on an eight-bit micro

code, Cintcode, which can be efficiently interpreted. This typically occupies only about one third of the room of identical compiled code at the expense of running at one third the speed. This is the system used by the BBC micro implementation.

Other disadvantages of BCPL are more inherent in the language. The facilities for treating BCPL words as real numbers are invariably poor and slow, and for complex scientific calculations interpreted Basic is certainly as fast, and better equipped. In addition, the compiled code, while good, cannot be fully optimised. Those requiring a further increase in speed will have to use machine code or a language such as Fortran (although on 8-bit micros you won't find optimising compilers yet).

The example program calculates prime integers up to 5000. The method used is the Seive of Erastothenes, a technique invented by a Greek called Eudoxus (just to confuse matters). All the integer numbers from two to 5000 are written down. Then all multiples of two are struck out, followed by multiples of three, five and so on for all primes up to the square root of 5000. All integers which have not been struck out must now be prime. The method is efficient for large numbers of prime integers, although it requires a large amount of memory, particularly with the simple implementation given here.

BCPL does not distinguish between upper and lower case, and so for clarity lower case is used for all variable names, labels etc.

Comments are introduced by a double slash, as in line 1. Everything from // to the end of the line is ignored by the compiler.

The GET directive of line 2 inserts the text file LIBHDR which contains declarations of all the standard headers.

The MANIFEST declaration in line 4 is used to declare highest as a constant equivalent to 5000. Wherever it occurs in the program, 5000 will be substituted. This makes for clarity, and also means that if I want to generate integer primes up to 10,000 I can just alter this one declaration.

The procedure START is declared in line 9. BCPL commences execution of a program by entering the procedure called START. The body of a procedure is a block, and a block is delimited by section brackets, $(and $). The section brackets for the body of START are in lines 10 and 37. Note the use of indenting to clarify the position of blocks.

Prime is declared as a vector of 5000 elements. Divisor is declared as a variable, with initial value 2; this is the first prime integer for which multiples will be struck out.

The FOR loop of line 13 is used

Basic is better equipped for complex calculations

to set all elements of prime to TRUE. When a number is struck out its element will be set to FALSE. Elements 0 and 1 are set to false so they won't be printed out as prime. Line 18 has an UNTIL loop. the following block is executed until the condition is met, ie the divisor to be struck out exceeds the square root of 5000. Inside, the loop nextcross is declared as the next number to strike out. It is set to divisor * divisor since all lower multiples of divisor will have been struck out by previous passes.

The second UNTIL loop strikes out all multiples of divisor. This is followed in lines 28 and 29 by a REPEATUNTIL loop. This is like the UNTIL loop, except the condition is tested at the end. The block to be executed consists of the single statement, divisor := divisor + 1, to increment the divisor until it reaches the next prime integer. Being a single statement, it need not be surrounded by section brackets.

Then follows a header for the output, using the formatted output routine, WRITEF. A '*' in the output string introduces an escape character. Here *P means form-feed (ie clear the console screen) and *N means new line, so the heading will be followed by a blank line. The % introduces a formatted item. %N means insert a decimal number from the next argument (highest).

Finally, the primes are printed out using WRITED. If i is prime then prime!i will be TRUE! and WRITED (i,8) will print i out in a field of eight characters, neatly fitting five numbers on a 40-character line.

This program when run on a BBC micro (which in fact requires one more line of program to declare the amount of stack required) takes 11.3 seconds, compared with 37.7 seconds for an equivalent Basic program.

For further information on BCPL the best currently available book is *BCPL, the language and its compiler*, by Martin Richards and Colin Whitby-Strevens, published by Cambridge University Press. For further information on co-routines, the only literature I know of is the original paper by Ken Moody and Martin Richards.

BCPL systems are available for most machines running CP/M, as well as some others. Details of Cintcode implementations may be obtained from Richards Computer Products Ltd, Brookside, Westbrook Street, Blewbury, Didcot, Oxfordshire OX11 9OA. Details of the implementation for the BBC microcomputer may be obtained from Acornsoft, 4A Market Hill, Cambridge CB2, 1NJ.

Those interested in numerical applications of BCPL may be interested in a book by R.J. Macmillan, to be published shortly by Acornsoft. This describes a set

BCPL does not distinguish between upper and lower case

of routines for performing multiple precision integer arithmetic. Programs are given in both BBC Basic and BCPL, but the superior speed of BCPL allows far larger numbers to be manipulated.

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Thus spoke Christopher Latham Scholes, the American printer who around 1867 perfected a machine which could type faster than the human hand could write – something engineers and designers had been striving to achieve for 150 years.

Scholes's words, sexist as they were, were also prophetic. Even more than the outbreak of war, the new profession 'typewriter operator' paved the way for generations of women to enter business.

My complaint about Scholes is that his machine was specifically designed to allow words to be written quickly – but not so quickly that the mechanical keys of the machine became jammed.

Just as many criticize CP/M as being backward, complicated, or not 'state of the art', so the layout of the typewriter in the 1980s is inefficient and illogical. I refer to the infamous QWERTY layout.

On a piano keyboard (which has a far less flexible layout than a typewriter) a reasonable player has little trouble in producing 1500 – 2000 keystrokes a minute. The equivalent to this, on a typewriter, would be 300 – 400 words. In practice, the world's fastest typists barely manage 180 – 200 wpm.

Many attempts have been made to improve on the design Sholes

page 79▶

DECEMBER'S RESULTS

THE December competition was a tough one – and the response was just under a hundred entries, only about half correct.

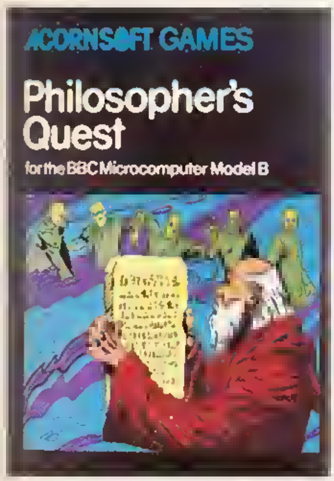
Despite careful checking and dire threats from the Editor about there being 'no room in *Acorn User* for lame-duck puzzle editors . . .' question 2 and 8 were susceptible to interpretation because we hadn't specified different digits.

I was then clever enough to break my leg while engaged in a game of poker (no need for details here). 'Quack! Quack!' read the telegram to St Richard's Hospital, Chichester where I spent Christmas recovering with *The Puzzle Mountain* by Gyles Brandreth (Penguin, £4.95). Both hospital and book are warmly recommended.

The correct answers are:

1) 20,64
2) 46,96 (but also 99 × 99 was accepted)
3) 840
4) Several solutions, equally valid. Two goats, one sheep and 261 piglets was a popular answer. 'Sheep are cheaper up north', wrote one reader
5) 6, 999, 999, 556 or 2, 909, 199, 969
6) 8, 12, 14, 17, 18, 19, 20, 21, 22, 23, 25, 26, 27, 29, 30, 31, 33, 35, 37, 39, 41, 43, 45, 47, 49 (total = 711)
7) 496
8) 1089 (mean-minded readers who gave trivial answers like 11 or 99 were allowed)
9) 6788
10) 3 – 39,364; 4 – 472, 390; 5 – 590, 488; 6 – 6, 377, 290; 7 – 7, 440, 172; 8 – 8, 503, 054; 9 – 9, 565, 936

The winner was Derek Chown from Dorset, to whom £50 worth of Acornsoft's addictive wares have been sent.



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And View, a program that enables your machine, together with a printer, to operate as a fully operational word processor. (The program is in ROM, but can easily be fitted to most BBC Micros by your local dealer.) You can find out more by sending for our free catalogue.

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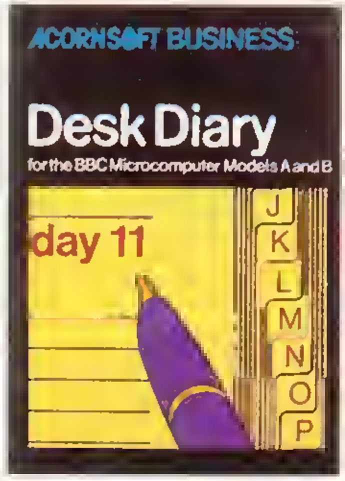

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ACORNSOFT

This month's problem is in two parts. The first is for under-13 year-olds only. Please give your school and class with your answer.

a) The words King and Knight are both perfect squares (ie the squares of whole numbers). If each letter stands for a different digit what positive numbers do they represent?

b) This is for everyone. In 1752 the government 'stole' 11 days from the people by introducing the Gregorian calendar. Assuming the twentieth century began on January 1 1901, are there any days of the week on which a new century cannot begin?

Answers on a postcard please, to arrive not later than May 3. Three winners will receive two packages of Acornsoft programs – worth about £20. Please specify which micro you have. Entries to: April Competition, Acorn User, 53 Bedford Square, London WC1B 3DZ.

▶*page 75*

adopted. The Edison Mimeograph, for example, which went into production in the 1890s grouped together letters such as *the*, *and*, *of* and *ing* which resulted in a more logical structure. Other manufacturers built typewriters with keys arranged in semicircular rows and had independent keys for upper and lower case letters – all to no avail.

The only minor success at reforming the QWERTY keyboard came in the 1940s when an American, Dr August Dvorak, proposed a layout to increase performance. The new design placed the five vowels under the left hand and the five most frequently-used consonants under the right. This keyboard has many fans, particularly among computer enthusiasts, and as more personal computers are produced with all keys independently user-definable, there might be a shift from the OWERTY layout.

Incidentally, do you know what is the longest word so far known that you can type using only the top row of a OWERTY keyboard? The answer is at the end of this article.

The original specifications of the BBC micro state that the keyboard action 'must be acceptable to a professional typist'. As the Beeb begins to link up to disc systems (without which no serious word-processing can really begin), it will be intersting to see if this objective is achieved. Personal taste makes objective standards difficult to set. However, I did see something recently which caused a grin. A reviewer writing about the Spectrum declared that '. . . a touchtypist would find it very satisfactory'. The idea of a touchtypist coping with a rubber-membrane keyboard, not to mention only one shift key, is ludicrous and shows how much that reviewer understands about the needs of people who deal with words all day.

My main grouses about the BBC keyboard are the absence of a numeric keypad and the way the Break key destroys your program (on most computers it merely acts as a boon to sloppy programmers – you can see what your Basic program is doing and then type CONTINUE without destroying the variables). I also continually hit the reverse arrow key instead of ERASE when I want to backspace – a legacy from using typewriters and other computers.

However, compared to many computers the keyboard on the Beeb is delightful. I recently had a session on the much-vaunted IBM Personal Computer. Quite apart from the astonishingly mean-minded approach to the layout, the racket the keys made was frightful. Presumably IBM, in its wisdom, decided secretaries aren't going to be happy unless they hear the clicking of the keys.

A recent development which is a godsend to writers who want portable machines is the Microwriter. This has an 8k RAM (which will store around 1200 words) and allows the user to enter the entire ASCII character set using only six keys. It also interfaces to a TV or monitor, telephone modem or printer, and other devices via an RS232.

Norman Giller, who does 'The Name Game' in *The Sun* and ghost writes the books of sportsmen such as Jimmy Greaves and Tom Graveney, swears by his Microwriter, which he says took him a few days of practice to get up to two-finger typing speed.

The main drawback of Microwriter is the price – £485 before buying any interfaces. However, the company claims it will be announcing something 'very exciting' to do with the Beeb later on this year, and says that so far all its marketing has been directed at the business rather than consumer market.

No doubt future generations, accustomed to direct voice input and response from their machines, will laugh themselves silly at the thought of us tapping away day and night.

As Simon Dally said on page 75, he has broken his leg. However, as only the best types write for *AU*, he will continue to do the competitions. Assessing the results may be delayed, but winners will get their prizes.

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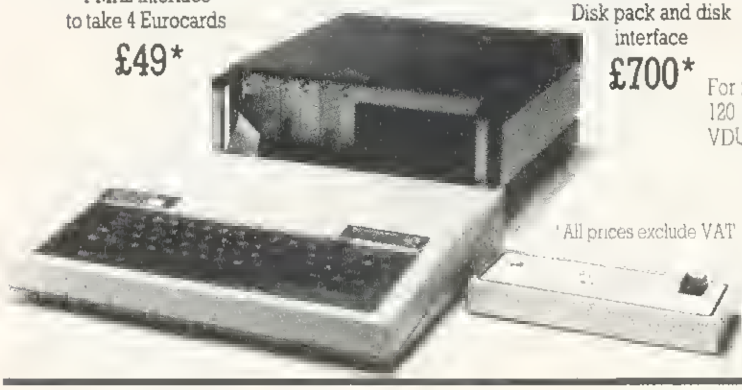

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HARD COPY MADE EASY

George Hill guides you through the jargon jungle which surrounds anyone trying to buy a printer in the second of his articles. Next month he tackles writing graphics software dumps and reviews one of the latest products

Let's start with a simple explanation of binary numbers, which is the system all computers use.

Data is transferred from place to place in the computer in bytes, each of which corresponds to a number between 0 to 255. The computer is based around electrical circuits which are able to detect the difference between a wire carrying 2.5 volts and a wire carrying 0 volts. Circuits do not discriminate between minor voltage changes, but merely categorise the state as 'high' or 'low'. The computer, then, has the equivalent of two fingers, compared with our 10. It works in the number system based on 2, the binary system. Translation mechanisms enable it to converse with us via the screen and keyboard, but it communicates with other machines, such as the printer, in binary.

The binary system has two symbols to represent its numbers, 0 and 1. (The decimal system has 10: 0,1,2,3,4,5,6,7,8 and 9.) A digit is a single symbol within a number, the position of which within a number tells you what it represents. For example, 255 (decimal) : the digit 2 represents 2 * 100, the first 5 represents 5 * 10, and the second represents 5 * 1.

A byte consists of eight binary digits, and each digit in a byte is referred to as a bit. A typical byte would be 10010111. It represents the number 151 (decimal). This is best demonstrated by figure 1.

Normally the bits are transferred from place to place on a 'data bus', – a set of eight wires which connect the various parts of the computer, eg, memory to central processing unit (CPU), or CPU to the other chips which control input and output of information. The least significant bit (ie the 'units' bit) goes on wire 0 and the most significant bit (the 128's bit) goes on wire 7. A byte is transferred by sending voltage pulses along all eight wires at the same time. Thus all eight bits start out together and arrive together. This is parallel data transfer, illustrated in figure 2. A potential of 2.5 volts on the wire represents a 1, and 0 volts represents a 0. The computer's own internal clock takes care of the timing of these pulses.

When transferring a byte to a printer the computer must first check the printer is ready to receive data. It then sends the data. Then it sends a short pulse (called a 'strobe' pulse) to say the wires now contain the data and should be read. It finally asks the printer whether it understood, and repeats the whole process for the next byte.

This clearly requires the sending and receiving of more than just the eight bits on the data bus. Extra wires are required to carry the additional information. The whole process of communication of the 'status information' between computer and printer is known as 'handshaking'. There are many different conventions for handshaking just as there are between groups of people. Each particular convention is referred to as a 'protocol'. A typical set-up is illustrated in figure 3. The signals are shown as changes from low to high, but changes from high to low would do just as well.

Parallel data transfer requires a minimum of 10 wires for communication of data and handshakes, plus one 'signal ground' or 'earth' wire, a total of 11. However,

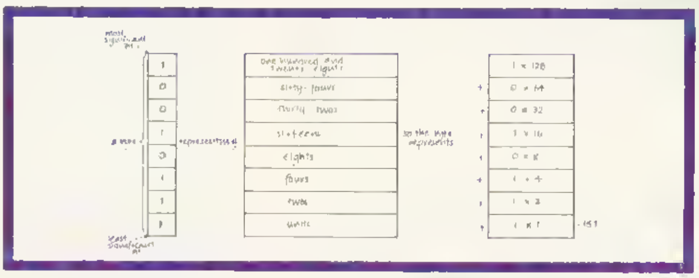
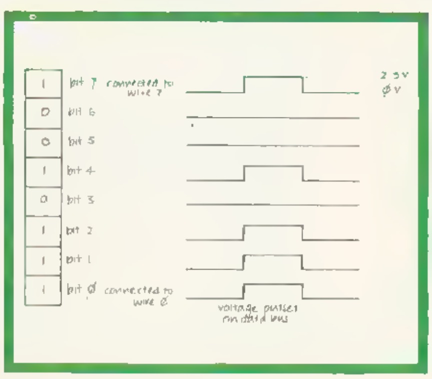
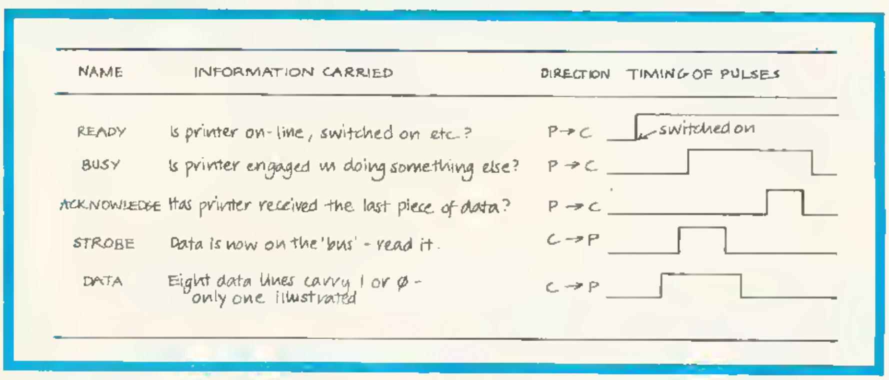


Figure 1. Binary representation of decimal number 151 (left)

Figure 2. Parallel data transfer (below left)

Figure 3. Protocol (conventional) for handshaking (communication of status) between computer and printer in parallel (below)





13 or more connections are common.

In a serial system, the data is transferred along a single wire, bit by bit. The byte 10010111 would therefore appear on the transfer wire in the form shown in figure 4. The bits are again represented by voltages on the wire, but commonly a 1 is a positive voltage (3 to 27) and 0 is a negative voltage (-3 to -27). Handshaking arrangements must be made, but these are different in nature from the parallel arrangements. First, the printer must be told where a particular byte starts and stops. If this information were absent, there would have to be extremely close timing accuracy between computer and printer. This can be achieved by running both off the same clock pulses. (a 'synchronous' system) but the longer the lines from computer to printer, the more difficult this is to achieve. The serial system was developed to transfer data along telephone or other landlines between terminals and mainframe computers, so the distances would be great. When adapted for home computers, this problem is less acute, but the 'asynchronous' system is still preferred over the synchronous.

In an asynchronous system, the computer and printer have their own internal clocks running at the same preset rates, and the data is read at certain intervals after the arrival of the 'start' bit. Figure 5 gives an idea of how this is accomplished. A 'start' bit has been added to signify the arrival of a byte, and two 'stop' bits give a gap between bytes. A 'parity' bit has also been added which can check whether there is an odd or even number of 1s in the byte sent. This enables errors on transmission lines, due to external pulses, to be trapped. It is not normally sent by micros, so the printer must be instructed to 'ignore parity'. The data line is normally in the 'switched on' state while no data is on the wire. This means breaks in the transmission lines halt transmission automatically, and makes fault tracing easier.

The rate at which the computer puts data on the line is measured in bits per second, and this is known as the 'baud' rate. Thus if each pulse lasts 1/1200 seconds, this baud rate is 1200 bits per second, or 1200baud. The units are variously referred to by abbreviations b/s, bs^{-1}, bit/sec, bps etc. The SI system of units has yet to impinge on computing!

A discrepancy in timing between computer and printer might cause mis-reading of the data. Hence the timing must agree to about five per cent, otherwise the 'trailing edge' of the last bit might pass before the printer has read it, or the printer might read the last bit twice, and become confused. Thus in serial transfer it is necessary to set the baud rates of both computer and printer to coincide before any data is transferred.

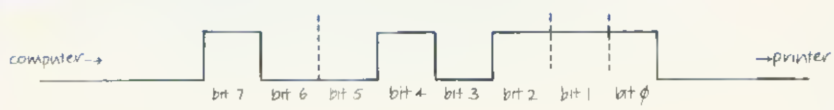


Figure 4. Byte 10010111 transferred by serial system

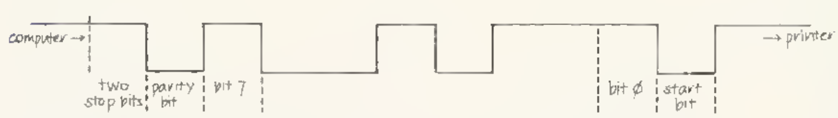


Figure 5. Serial data transfer with start and stop bits bracketting byte in figure 4

JARGON U

Printers have as much jargon associated with them as the rest of computing. Here are some explanations of the more common technical terms and advertising puffs.

Port: **The CPU (sorry, central processor) communicates with peripheral devices (sorry, those external to the computer) via another microprocessor which converts the signals to the necessary form to be output, and decodes incoming signals. This microprocessor is itself an 'interface adaptor' and its connections with the outside world constitute a 'port'.**

Centronics **and IEEE488 are two of the standard parallel interfaces, and are not necessarily compatible.**

Modem: **When a computer communicates along landlines or via satellite links, a MOdulator/ DEModulator is necessary to boost, or change signals for travel down the line, and to unravel them at the other end. This is a modem. If the distances are short (as they are between computer and printer), no boosting may be needed, and if the connections are standard, communication may be achieved directly.**

RS232C **and** ***RS423*** **are standard forms of connection. Small sub-sets of their connections are often used for connecting micros to printers. These two are completely compatible.**

Current loop or 20mA: **This is another serial interface where data is transferred by changing currents as opposed to changing voltages. It is not compatible with the voltage controlled methods.**

Bidirectional **means the printer can print with the head**

FULL GRAPHICS CAPABILITY

NRAVELLED

travelling in either direction. It usually indicates a faster printing speed than is possible in uni-directional printers.

Logic-seeking means the bi-directional printer will start printing at whichever end of the line it is currently nearest to. It is unlikely to improve printing speed enough to be worth bothering about.

True descenders: This jargon indicates that letters such as 'y' and 'g' which should have sections below the line, will actually look as they should. It is often an indication on a dot-matrix printer that it has nine dot-wires rather than seven.

Full graphics capability: Beware! This might mean anything. Graphics capability in any printer is a matter for a full article in itself, but performance is linked to number of dots per line. A full capability requires at least 640 dots per line with each dot individually addressable. Anything less is going to involve great skill in programming and some trickery to obtain more than a single tone picture.

High res graphics: Whose? The resolution in graphics modes varies greatly between computers. If you can plot 320 separate elements in the *X* direction, and around 200 in the *Y* direction, then the requirements above apply. If your graphics can plot fewer elements than this, you may be able to get away with fewer dots per line.

Buffering: When data is transferred it is placed in a 'buffer' before being printed. This is a small memory specially dedicated to this function. A large buffer may help to increase the speed of printing, particularly for graphics.

Baud rates are normally set at the printer by DIP switches, or jumpers connecting points on the circuit board. Thus to change the rate normally involves a foray into the bowels of the printer with a screwdriver, although once located the switches are normally easy to set. The baud rate is set at the computer by sending a sequence of commands from the keyboard, details of which can be found in the manual. It is important to realise that the baud rate decides the rate at which bits are transferred, not characters. The rate of transfer of characters will always be below the theoretical maximum.

To complete the communication system, it is at least necessary for the printer to be able to interrupt the computer if it cannot keep up. Thus the minimum handshaking arrangement will require the presence of a second wire to take this 'busy' signal back to the computer, and at high rates more sophisticated methods may be necessary. A third wire will act as the signal ground.

The principal comparisons between the two methods of connection fall into three categories: rate of data transfer; circuitry; ease of connection.

Theoretically the parallel mode is much faster as data is transferred at the maximum rate which the computer can manage. In practice, all printers within our price range (say up to £500) have a maximum printing speed of around 100 characters per second. To transfer this requires about 1200 bits per second on the data line in the serial mode. (Each character needs 8 data bits, start, parity and two stop bits, a total of 12.) Thus as long as the higher baud rates are available, subject to a 1200 minimum, you are unlikely to detect any major differences in the rate at which the printer produces its output. (Printers used with mainframe computers can print over 1000 characters per second, so parallel data transfer is essential.)

Less electronic juggling is necessary to transfer data in parallel, as it can be sent and received in the form that the microprocessors at either end use normally. In serial transfer the computer must convert its normal output of eight parallel pulses into a 'train' of pulses, and the printer must do the reverse, ie decode the train and re-convert it to parallel form. This is why the serial option often involves extra expense, and the purchase of an extra interface board in computer, printer, or both.

The serial mode wins hands down when it comes to connections. Normally only three wires are needed to effect connection and, for simple printer use, never more than four. The possessor of a soldering iron will be able to construct such a cable easily, and it is a job that the complete beginner should not fear. I would not recommend the amateur to attempt to build a parallel connection cable. This requires a minimum of 11 connections, and mistakes might cause damage. Furthermore, parallel connectors are often made in 'ribbon' cable, which requires special tools in its handling. A second disadvantage of the parallel mode is that ribbon cable is a nuisance as a means of linkage because it gets in the way even more than ordinary cable!

In actual fact, it probably doesn't matter which you choose, but answering the questions in the box opposite will give you a better idea.

You should try to have both options available if possible and use the parallel option if it is cheaper, or if printing speed is affected by the available baud rates. Otherwise use serial as it offers greater ease of connecting (and mending) cables.

If you have more than one computer or printer it is almost certainly easier to standardise on serial connections than on parallel. Finally, use the highest baud rate possible if connected in serial.

When it comes to connecting up, take care as it is possible to damage computer or printer if you get it wrong. Serial voltages are higher than parallel, so be careful to ensure the two devices are matched.

First read the manual (frequently a bewildering and distressing experience) to discover the whereabouts of any DIP switches and links which need checking. Set the printer for the selected mode of operation (serial or parallel). If in serial, set the baud rate to the maximum your computer will support (normally 9600 b/s). Now set any switches controlling paper length, wraparound, auto-linefeed, etc to reasonable settings. (They are normally set before leaving the factory, and you may leave altering them until after an initial trial.) Check that any 'protocol' switches are set to match computer and printer. (Centronics unblocked is normally a safe setting.)

Replace the lid on the printer if necessary, and join the computer and printer with the correct cable. Beware of two things. First, never force connectors, as pins are fragile, and once bent are difficult to unbend without damage. Second, ensure you have put all the connectors in the right way up. Most are impossible to insert upside down, but the BBC micro has a serial plug which can be plugged in upside down. It only works one way up!

Switch on and place the printer 'on-line'; often achieved using an external button or switch. Most printers are on-line when switched on, (a light usually indicates the on-line status). Some need to be placed on-line every time they are used, others have no switch, and are always on-line.

Call the printer with the code used by your computer. This will consist of one code to select serial/parallel operation (if you have the option), and a second to select baud rate if in serial. Now type in the code to switch on the 'echo printing', ie, to make the printer print everything that appears on the screen. This is CTRL B on the BBC and Atom, but CTRL P is more common. The printer should now echo anything typed at the keyboard, when terminated by a carriage return.

If your keyboard 'hangs up' or refuses to accept further input, press escape, check cables, on-line switch, and try again. If nothing happens, check the DIP switches again.

If the printer overprints everything on a single line, there may be a mechanism for controlling this from the keyboard (on the BBC micro type *FX60). If this facility is not available, alter the positions of the switches controlling auto-linefeed, and printing codes. No harm can be done by experimenting. In case of trouble, do not hesitate to contact the manufacturer. I have found their technical advice over the telephone has been remarkably good. They clearly have expertise concerning their own printer which cannot be covered in a general survey of this type.

Finally, a repeat of last month's warning: Don't buy a printer unless you have seen it in action, preferably connected to your own type of computer.

SERIAL, PARALLEL or BOTH?

1. **Does your computer support serial and parallel printing? (If so skip question 2).**

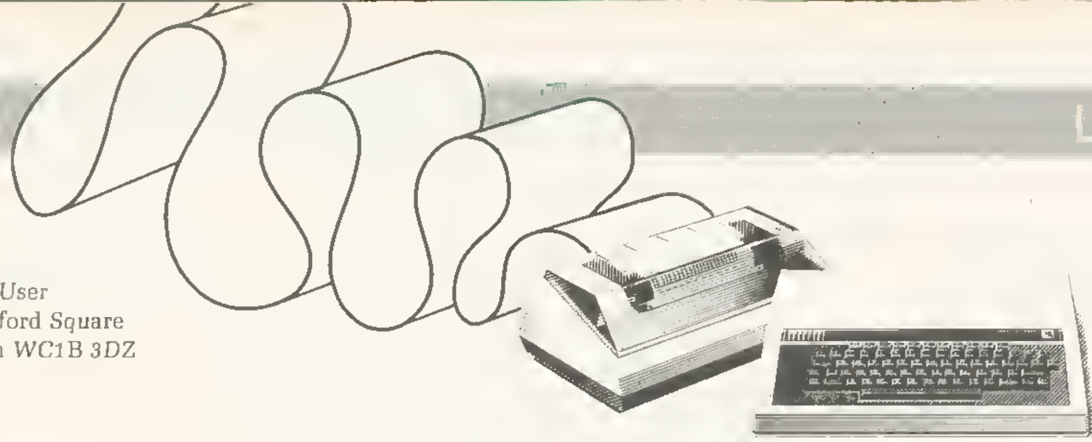
2. **Is it worth the fuss and expense of fitting the necessary serial interface board? (See 3 and 4 for reasons why you might find it necessary.)**

3. **Are all the capabilities of computer and printer identical in both modes? (An example of a critical difference: The RML 380Z uses bit 7 as the 'strobe' pulse in parallel; hence it is impossible to carry out any graphics printing in parallel.)**

4. **Are you going to want to use both options for different purposes in the same program? For example: to use the parallel port to control a device, while leaving the printer hooked up to the serial port; to use the serial port for communication with another computer, while leaving the printer connected in parallel.**

5. **Does the printer you can afford have both options available? If not 3 and 4 may offer limitations in its use.**

6. **Are the interfaces of the computer and printer completely compatible? There are several different methods of connection in both modes. For example, IEEE and Centronics parallel, and RS232C, and current loop serial. These are not compatible with one another, so check before buying. Most home computers and printers seem to have one or both of Centronics parallel, and RS232C serial. Many printers with a serial board contain facilities to take both RS232C and current loop input.**



Letters
Acorn User
53 Bedford Square
London WC1B 3DZ

Boggled by the line numbers

Sir, Can you please explain the mind-boggling system used to store line numbers in BBC Basic. I don't mean the numbers at the beginning of lines, which are stored as normal two-byte binary integers. It's the line numbers after GOTOs, GOSUBs etc that are so puzzling.

As far as I can make out, they occupy four bytes. The first is some sort of token with the value 8D. The other three hold the binary value distributed as follows:

2-byte binary

a b c d e f g h	i j k l m n o p

3-byte binary

0 1 k l m n o p	0 1 i j a b 0 0
0 1 c d e f g h	

with the added complication that the pairs i,j and a,b are Exclusive OR'd with 01.

There must be good reason for adopting such amazing code.

Joan New
London

When a line of Basic is typed into the Beeb it is 'crunched' – ie each keyword which Basic recognises is turned into a binary number in hexadecimal format called a 'token'. For example, ELSE becomes 8B (see 'User Guide' p483). This is done so each word takes up fewer characters in memory.

Now, when a keyword such as IF . . .THEN is used, the machine looks for a possible matching keyword, such as ELSE. However, it is possible (but very unlikely) that a line number after a GOTO will have the same token as ELSE, in which case it would be recognised as ELSE and acted upon – resulting in heaven knows what.

So line numbers after GOTOs etc, are encoded in this way so they cannot be coofused with ELSE, or certain other tokens.

This 'amazing' technique was designed as the most efficient way to avoid the problem above. Athough it may take a relatively long time to generate a line number token (which the user won't notice while typing or loading), it is very quick to turn back into a usable form.

Expecting zeroes

Sir, I have an 0.1 OS (EPROM) BBC micro. On investigating the resident integer variables from switch-on (eg using PRINT A%), I find the initial assignment of variables A% to O% is –1 and P% to Z% is 0. Why are they not all initially set to zero, as I was expecting?

G.Rooker
London

The integer variables are not initialised at all. Their value is determined by the contents of RAM at switch-on.

Radar pollution?

Sir, I would like to add my experience to that of C.Dickens of Wiltshire ('Acorn User', Letters, February). I too have recently upgraded a model A to model B and have been satisfied with the machine's performance. By way of demonstration I took the machine to my father-in-law who lives in Gloucestershire (adjacent to Wiltshire!) Imagine my dismay when, having loaded and run 'Defender', an impressive graphics demo, I experienced an annoying 'shudder'. This is best explained as a jumping between line 0 and line 1 of the whole display and was unique to modes 0 to 3. Indeed, by interrogating every mode I became increasingly concerned that there was a failure with the upgrade. However, on return to Middlesex the fault had disappeared.

I recognise C.Dickens symptom and question your analysis, as the TV I used was new and stable in modes 4–7. However, could there be an environmental problem? The location in Gloucestershire is only one mile from the large USAF refuelling base and their large radar installations.

I was unable in Gloucestershire to measure the mains voltage, which was my first suspicion, particularly as father-in-law finds that after 10pm he cannot 'load' or 'save' when using his ZX81. However, when he returns to his system the following morning, having touched none of the controls, the machine loads and saves trouble-free!!

Chris Allard
Middlesex

It sounds as if we should put together a map showing areas of known video interference. Has anyone living near the radar 'golfballs' in Fylingdales, Yorkshire, noted a similar problem?

Disappearing act

Sir, It's only two months since I bought a BBC model B and something seems to be going wrong. When typing in a program there's a buzzing sound in the speaker that gradually builds up, and when I get to the tenth or eleventh line – well!! Everything flashes and disappears . . .

Could you tell me if this is a serious fault?

Suzy Diver
Croydon

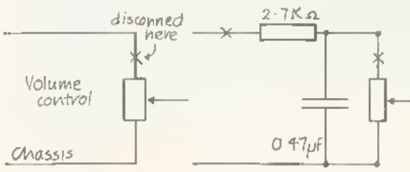
We've asked the lads at Acorn about this, and it seems to have them stumped. They suggest that you send the machine to their service people (Retail Control Systems, Gresham House, Twickenham Road, Feltham, Middx) describing the problem and they'll sort it out. It is advisable to insure the machine if sending it by post.

Loading fix for tape players

Sir, I have noticed a number of people using the Philips N2234 cassette players with computers. I purchased one a few months ago thinking it would cure my loading problems which I had with my old clapped-out cassette player. Anyway, on getting it home and plugging it in, my joy was dashed when I found the new cassette player was worse than the old one. I started to investigate the reasons with a scope and found the waveform output from the cassette player looked like:

After a few hours experimenting I came up with a modification for this cassette player.

Disconnect the lead from the top of volume control and connect in series with this lead a 2.7kΩ resistor, solder across the volume control a 0.47 uF capacitor as shown in diagram.



I know there could be better ways of curing this problem, but I feel this is the simplest – all you have to do is to take the back off and you can get at the volume control without any further trouble. The modification can be removed easily.

I have since fitted this modification to several of this type of cassette player and found they give no loading problems thereafter. I hope this will be of interest to other owners of this type of cassette player.

After all that, can you help me? I own an Atom and suffer with graphics interference – that is, on the simplest of programs I get flashing across the screen. I know the Atom does suffer from this (so I have been told by several other Atom owners) but is there a cure? I find it very annoying.

R. Verge
Kent

Thank you for your cassette modification. We hope other people may find this useful.

Your problem: the reason for the 'snow' on the display during graphics operations is that the 6847 video generator is not allowed to refresh the screen whilst the CPU changes the graphics memory. This can be cured by using the following machine code before issuing any graphics commands:

```
Z=!#3FE;P=#21C;!#3FE=P
P.$21;(LDA#B002;BMIP-3;JMPZ;)
```

After any CLEAR or COLOUR statements remember to use

```
!#3FE=#21C
```

to restore the pointer to the new patch.

Prompt problem

Sir, Could you explain why my BBC model B becomes unable to load programs that have been saved and loaded before without problems. The screen shows the program to be loading, prints the end address but the cassette motor does not switch off and the '>' prompt does not return leaving me no option but to escape.

The computer is then unable to load anything from cassette. Switching off does not help, nor does changing the volume control. My OS is 0.1 EPROM.

B.Sargent
East Sussex

This sounds like a combination of a faulty serial ULA and the 0.1 OS problem. (See patch program, page 61, September's Acorn User.) Your dealer can either fix the ULA or replace it and only a new ROM will cure the software fault. As you have EPROMs, the dealer will exchange these for a ROM free of charge.

Terrible at maths

Sir, My new BBC model B does not add some real numbers correctly. So far the dealer has been unable to solve this problem. For example, running the program below produces the erroneous value 0.730000001 as the first of many incorrect results, and also fails the condition REPEAT . . . UNTIL A=1 (therefore looping indefinitely).

```
10 A=0
20 REPEAT
30 A=A+0.01
40 PRINT A
50 UNTIL A=1
```

The bug has appeared on all the model B machines I have been able to test. Is this a known fault?

Paul Rynn
Chorley

Rest assured, you don't have a faulty machine. This problem occurs on computers whose arithmetic works in a certain way (which is nearly all computers). The computers use the floating point technique for calculating decimal numbers and this is only accurate to a certain number of digits. Consequently you shouldn't test to see if, for example, A=1, but instead you should test whether A–1<0.0000001. It's difficult to explain why, but it has to do with floating point numbers being stored as a series of fractions (eg 0.75 = 0.5+0.25). Hence some numbers (eg ⅓) cannot be accurately represented, however many fractions you add together.

It is possible to write a program to enable the computer to do double- or triple-precision maths. Normal floating point maths is accurate to nine digits, double to 18 and so on. A bookshop with a good computer section should be able to recommend a book on this subject.

Discs and cassettes

Sir, I own a BBC model B and I am considering upgrading it to use a disc system.

Please could you confirm (or deny) that it is possible to copy a file on the disc to a cassette tape without loading, changing the file system and then saving.

If it is not possible, is there any method of getting the same effect for non-loadable files?

A. Loyns
Lancashire

It is not possible to copy from disc to tape except by the method you describe. This applies to Basic and machine code programs.

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July/August The first issue. Articles on drawing techniques, the BBC Computer Programme, machine code graphics, questions and answers, hints and tips, sound, interfacing scientific instruments, dumb terminals for 0.1 machines, disc drives, Econet in schools.

September Ceefax telesoftware, Beeb in business, mailing list, simple files, 30-Hour Basic course, art on a micro, music, BBC micro as a keyboard, extra Atom commands, BBC Basic board, ULA design, teletext graphics, machine code graphics, analogue input, schools training, 0.1 cassette bug patch.

October Electron details, BBC TV series – confessions, two Epson graphics dumps, Seikosha GP100 dump, Worldwide networking for BBC micro, garbage handling, voice ROMs, sound pitch envelope, moving graphics, ZX printer for Atom, RGB colour separations for Atom, biofeedback, book reviews.

November Teletext, second BBC TV series, machine code series 1, programming forum, Trek III, speeding up graphics, Bomber game listing, 7-tone Epson graphics dump, Atom graphics manipulation, dumb terminal for 0.1 machine, firework graphics, editing tips.

December BBC TV in schools, machine code 2 – registers, programming forum, program generators, carols, hints and tips, Logo and turtle graphics in schools, introduction to procedures, software review, Atom word processing, toolbox review, 16-colour graphics on model A, sorting, sound envelope design.

January MEP school launch, *FX commands for sound, second BBC TV series, machine code 3 – two pass assembly, disc drives for the Beeb, programming forum, program protection, micros in schools – new series, Commodore Pet printer used with Beeb, BBC programs written on an Atom, extra Atom memory.

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AU9

USER GROUPS

NEW IN HERTS

The **Harpenden Microcomputer Group** has a number of BBC micro and Atom users, I would be pleased if you would publish my name and address in your user group list. R. Welch, Secretary, 7 Tylers, Harpenden, Herts, AL5 5RT.

SOBAT IN ACTION

There is a new club for East London (mainly Waltham Forest area) called **Sobat**. It is mainly for BBC and Atom users. Membership is free and a newsletter will be distributed soon.

The club's main aims are software exchange, group discussions and the sharing of programming experience. We already have a number of programs, although we would obviously appreciate more.

Thanks for your help, and a very useful magazine! Keep up the good work. Details from T. Kayani, Sobat Computer Club, B25 Berridge Rd, Hillfield Rd, West Hampstead, London NW6.

NORWAY TAKE-OVER

The **BBC User Group** managed by Mr Morten Christiansen in Trondheim has ceased to exist, and all activity has been taken over by Oivind Grenness **BBC Norway**, 0-Inform, PO Box 716, N3191 Horten, Norway.

MULTIPLE SCOUSE

The **Liverpool BBC & Atom Group** now meets twice monthly. There are two venues: First Wednesday of each month, Old Swan Technical College, Room C33, 7.30 – 9.30 pm: Third Thursday of month, Birkenhead Technical College, First Floor, Science & Maths Dept, 7.30 – 9.30 pm. For information and news contact: Nik Kelly, 56 Queens Drive, Liverpool L4 6SH. Tel: 051-525 2934.

If you have any news or comment suitable for the User Group page, send it to the address below.

Please use the latest list when trying to contact groups, as these are updated each issue. Most groups also appreciate a self addressed envelope for reply.

Anybody else out there? Contact Acorn User, 53 Bedford Square, London WC1

CLUB CONTACTS

- Rupert Steele
Amataur Computer Club
St John's College
Oxford OX1 3JP

- **West Midlands Computer Group**
12 Apsley Road
Oldbury
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- Mr J. Price
Bedford House
27-28 St George's Road
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- Mr P. Beverley
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Ipswich Road
Norwich NR2 2LJ

- Keith Mitchell
Edinburgh ZX Computer Club
19 Meadowplace Road
Edinburgh
Tel: 031-334 8483

- Steve White
Atom/BBC User Group
c/o Superior Systems Ltd
178 West Street
Sheffield
Tel: (0742) 755005

- Robin Bradbeer
Association of London Computer Clubs
Polytechnic of North London
Holloway
London N7 8DB

- Nik Kelly
Liverpool BBC & Atom Group
56 Queens Drive
Liverpool L4 6SH
Tel: 051-525 2934

- Mr C. Rutter
Medway Atom Users Club
St John Fisher School
Ordnance Street
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- **Beebug**
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- R. Welch
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- Mr P. Frost
Atom Users Group
18 Frankwell Drive
Potters Green
Coventry CV2 2FB

- Oivind Grenness
BBC Norway
O-Inform
PO Box 716
N3191 Horten
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- **Liverpool BBC Microgroup**
c/o Fred Shaw
14 Albany Avenue
Eccleston Park
Prescot
Merseyside L34 2QW

- John Harris
Bottisham Acorn User Group
1 Rowan Close
Bottisham
Cambridge CB5 9BN
Tel: (0223) 811487

- Peter Smith
Fareham and Portchester Amateur Computer Club
23 Sandy Close
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- Paul Barbour
Laserbug
4 Station Bridge
Woodgrange Road
London E7 ONE

- Brian Pain
Colour Micro Users Group
40a High Street
Stony Stratford
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Tel. (0908) 564271

- Mr D. Coulter
Preston BBC User Group
8 Briar Grove
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Preston PR2 3UR

- **Acorn Users Group of Sweden**
c/o Janne Soderberg
Frihetsvagen 32
S-175 33 Jarfalla
Sweden

- Mr J. Craig
National BBC User Group
40 Mount Pleasant Avenue
Wells
Somerset BA5 2JQ

- Mr R. Luff
Kingbee
54 Arlington Close
Kingswinford
West Midlands

- **Computer Club**
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- Ted Ryan
Eastwood Town Microcomputer Club
15 Queens Square
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- Mr T A Kayani
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Hillfield Road
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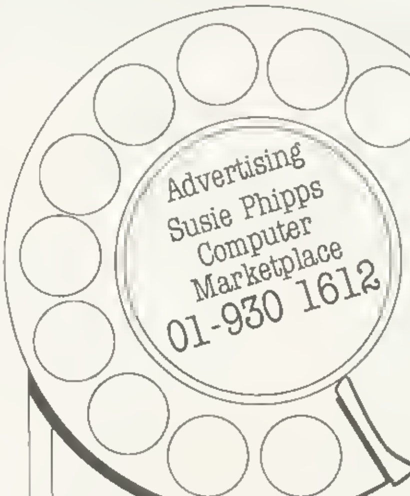

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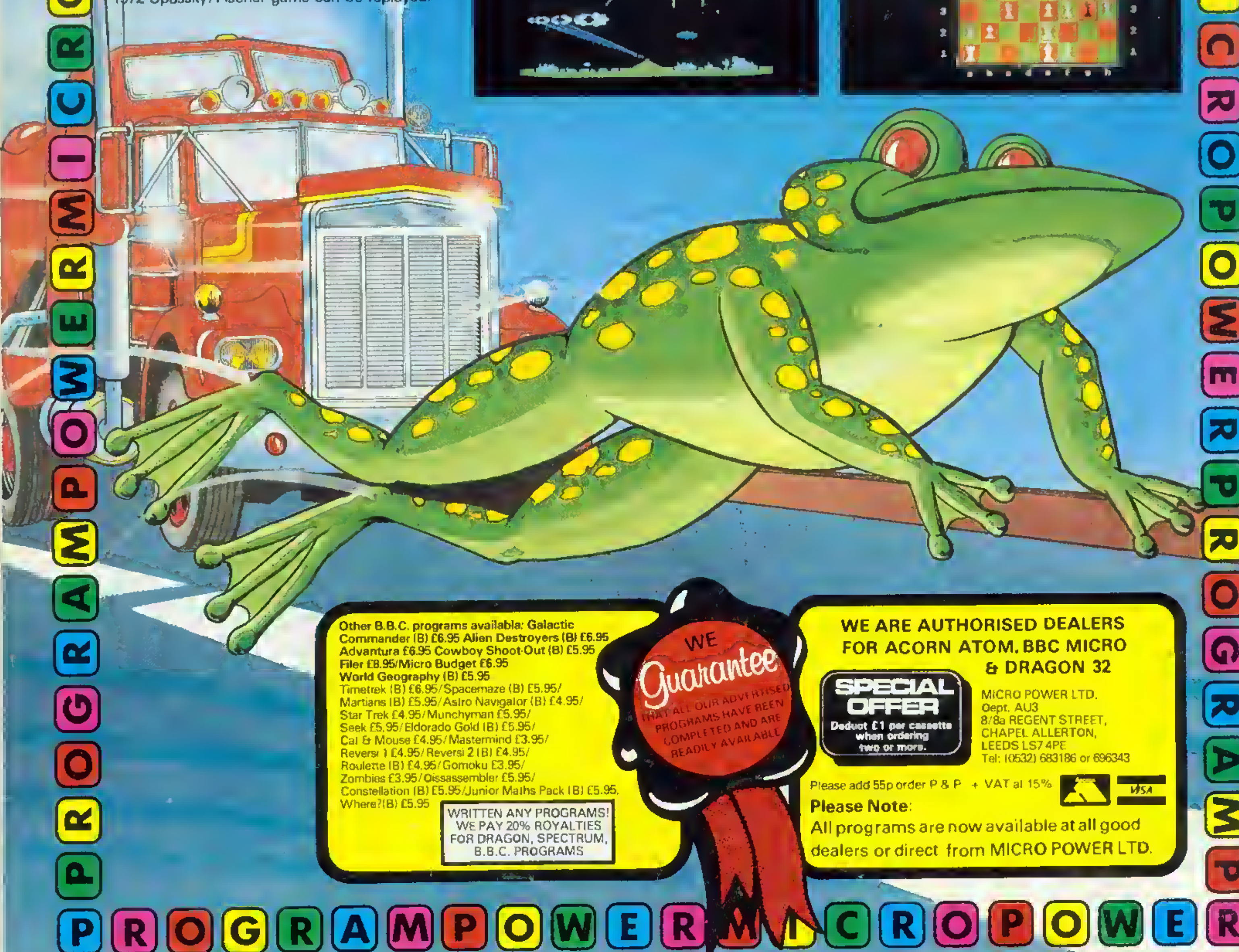

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