ACORN USER

BBC micro, Electron and Atom magazine

June 1983 £1

SCHOOLS: computers and IT

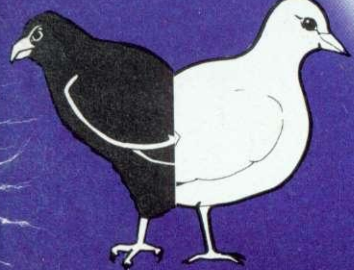
PRINTERS: picture dumps

BBC: drawing procedures

INTERRUPTS: system control

GRAPHICS: CAD displays

ATOM: cash forum



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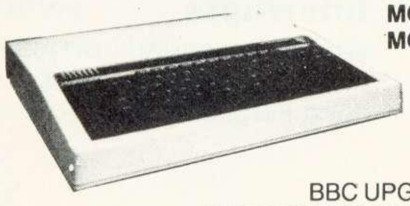

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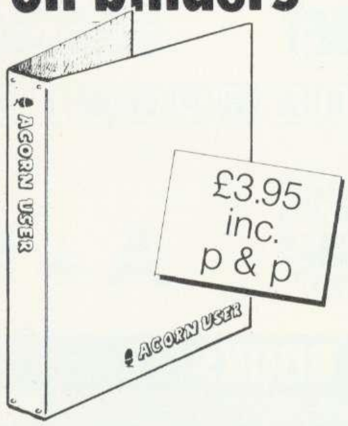

THESE quality binders have been specially commissioned for readers from a major British manufacturer. They are available exclusively through *Acorn User* at an introductory price of £3.95 which includes postage and packing.

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Also turn to page 92 for details of other reader services – subscriptions, back issues, photocopies and reprints.

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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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Electron: yet more exclusive scoops on the way

Teletext: the adaptor under scrutiny

Printers: colour graphics dumps

Interfacing: add a second keyboard

Atom: sound revisited

Reviews: EPROM programmer, utility ROMs, games

Birthday: Acorn User is one-year old in July!

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NOTICEBOARD

Micro books offer to subscribers

***Acorn User* has arranged a special £1 discount with Addison-Wesley Publishers on the following books. Details of this offer (which applies to subscribers only) are contained in an insert to this issue.**

☐ **The BBC micro book**
Basic, sound and graphics
Jim McGregor and Alan Watt
Normally.................. £7.95
Subscriber price......... £6.95

☐ **Assembly language programming on the BBC micro**
John Ferguson and Anthony Shaw
Normally.................. £7.95
Subscriber price......... £6.95

☐ **Games BBC computers play**
Tim Hartnell, S M Gee and Mike James
Normally.................. £6.95
Subscriber price......... £5.95

☐ **Creating adventure programs on your BBC micro**
Ian Watt
Normally.................. £6.95
Subscriber price......... £5.95

Authors please note

We've been inundated with articles for publication – many of an extremely high standard. It takes time to read them, try listings out and edit them – which is the only way to maintain standards. Also please remember that magazines work at least two months in advance.

So please bear with us if you hear nothing for weeks (although all submissions are acknowledged).

Thanks for your patience and apologies for any frustration caused.

Free personal ads

STARTING from the next issue, we plan to run a free personal ad service. It's for individuals only, no companies please. See the form on page 89 if you've got anything to unload. First come, first served, so get a move on!

AU author wins

ACORN User author Peter Voke (see May's issue) won the race to solve Acornsoft's *Castle of Riddles* adventure game.

Details of the competition were released on the same day to prevent anyone gaining an unfair advantage. Peter worked on the program over the weekend and managed to get his correct entry in at 8.31 am on the Monday.

His prize, presented by Acornsoft's David Johnson-Davis, included a choice of £1500-worth of hardware and software.

Amazed reader

Mr Tugwell was amazed to be a runner-up in our 'Grin' competition in May. He rang in to say how delighted he was that 'ordinary people' could win. Who knows, he may even win the competition starting in this issue.

Dumping service

BEEBPRINT is offering a printer service for anyone wanting a hard copy of their programs from cassette. A sample price is £1.95 for &20 blocks. Beebprint, 19 Orchard Way, Hurstpierpoint, West Sussex BN6 9UB.

Logo club

LOGO users can now join their own club (Blug) which plans to produce a quarterly newsletter and an annual journal. A conference is being set up for the beginning of September.

Details from Pam Valley (secretary), British Logo User Group, c/o Shell-Centre for Mathematics, University of Nottingham.

Summer micro show on Granada

CHIP-IN is a TV series on micros to be shown on Granada this summer.

The programme will run for six weeks while the early evening local news show *Granada Reports* is off the air. Peter Connors who is working on the pilot show described Chip-In as 'aimed at the gap between the hardened user and the person who is totally mystified.

'The series will not cover programming, or lift the lid,' said Connors, but will concentrate on 'reviewing software, add-ons and applications'.

User groups and computer clubs in the North-West have been approached and one idea is to have two families taking part in each episode.

If you have any ideas for the series, write to: Chip-In, Granada TV, Quay St, Manchester M60 9EA.

Voice processor to plug Beeb hole

THE long-awaited speech synthesis chip – which uses the voice of Kenneth Kendall – should be available at dealers this month.

Acorn's Speech Processor was due to be launched by last Christmas, but has been held up so the cartridge ROM system could be fitted at the same time.

The system will initially be limited to a vocabulary of 164 words, or part-words, but this can be extended by cartridge ROMs or from RAM (see last October's *Acorn User* for details).

Former-BBC newsreader Kenneth Kendall provided the voice recordings which were digitised to provide vocabulary for the synthesis chip. Hence Acorn claims it is the first English-speaking (rather than American) voice synthesiser.

Voice commands are issued using the sound statement (on channel – 1), from Basic or assembly language. They take the form:

SOUND –1, number,0,0

or

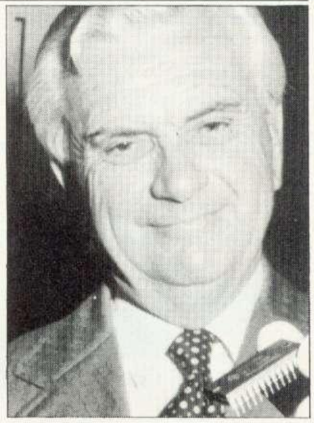
SOUND –1, ASC"char",0,0

In the first case 'number' is a designated value which calls a particular word, while in the second case 'character' is an ASCII code.

With assembly language, OSWORD and OSBYTE can be used. The first has the same effect as the Basic sound command, while the second reads the speech processor direct.

A new-found *FX call controls the speech processor. It consists of *FX209,0 to turn it off, and *FX209,80 to turn it on.

When the two voice chips are fitted (£55 inc VAT and 1.2 ROM if needed), dealers enable the ROM cartridge socket. This is located on the left of the keyboard (the mysterious hole or 'ash tray' on early BBC machines which has now been covered over).



Kendall. . . chip's voice

Acorn plans to release a vocabulary extension and games in cartridge form later in the year.

☐ Acornsoft's View word processing chip should now be at dealers (see page 73 for comparative review with Computer Concept's Wordwise). It costs £70 (including VAT, fitting and 1.2 ROM).

View can be used with most printers automatically, but cassettes are to be made available which will allow it to use the special facilities of each printer (italics, bold, double-height characters etc).

August first showing for Electron

THE Electron – Acorn's new hobby micro – will be launched in August and will coincide with the *Acorn User* Exhibition.

So it will be the first chance to get your hands on one, as well as using the new BBC add-ons.

London's Cunard International Hotel will host the event on August 15-28. *Acorn User* is sponsoring the Exhibition, and subscribers will receive a £1 voucher against the £2 entrance fee (children half price) in the August issue.

Acorn, Leasalink Viewdata and Microage have already booked major stands at the Exhibition.

Bulk discounts on tickets are available to schools for the Exhibition.

Details from Acorn User Exhibition, 20 Orange St, London WC2H 7ED.

Ups and downs for computers in Australia

THE Australian distributor of the BBC micro, Barson Computers, recently announced a price reduction.

This coincided with the opening in Sydney of the first Australian Personal Computer Show (March 10 – 12) and with a 10 per cent devaluation of the Australian dollar.

The model B, which previously retailed in Australia for $1860, will now sell for about $1650 (£950 at the post-devaluation rate of exchange).

Whilst the price of the computer fell, Acornsoft and BBCSoft products increased in price as a result of the devaluation, and the average program now costs $33 (£19).

There have been persistent rumours that local manufacture of the BBC micro in Australia is planned, which would presumably lead to a further price reduction in what is becoming a fiercely-contested market. A number of local companies are understood to be interested, but as yet no likely manufacturer has been named.

Penetration of the Australian market has been rather slow to date: the inevitable supply problem, which has now been overcome, and the relatively high purchase price having been the two principal causes.

The majority of machines sold have gone to schools, with relatively few being purchased by individuals. However, the price reduction and a recent advertising campaign should lead to an increase in interest.

In addition, the first series of *The Computer Programme* is scheduled to be shown during schools' broadcasts, commencing in June (see April *Acorn User*).

Steve MacLeod
Australia

Vision systems adapted to run on model B

DIGITHURST has released an interface to link a model B to a home video recorder and transfer pre-recorded images into the micro.

MicroEye can digitise pictures with a resolution of 256 x 256, although with the BBC model B only 128 x 128 pixels are used.

The interface package (£295 plus VAT) provides cable connections to both the video recorder and the BBC user port. Software allows the user to analyse captured images, which can then be dumped onto disc or a printer.

Digithurst also produce Microsight, a £500 camera system, which can digitise images such as maps for display on a monitor or TV. This was featured in the recent BBC TV series *Making the Most of the Micro* and has now been adapted to run on a model B.

Further information from Digithurst, Leaden Hill, Orwell, Royston, Herts. Tel: (0223) 208926.

Big success at sea for able-bodied Beeb micro

MODELLING the behaviour of hovercraft is one of the latest applications for the BBC micro.

In the heavy swell of the Solent off Southampton, a small fast boat transports buoys with wave and wind probes attached. These are dunked into the choppier patches of water and connected to the Beeb which lives in a waterproof case on deck.

Movement of the buoys is detected and measured by the micro. The results can then be taken back to the lab and compared to the way model hovercraft behave in similar conditions.

The model hovercraft are tested in the same water, which must be as choppy as possible – hence the fast boat moving around to find the best sites. Once the behaviour and conditions have been compared, the stability limits of hovercraft can be determined. These limits are then used in the US and Britain to improve their design.

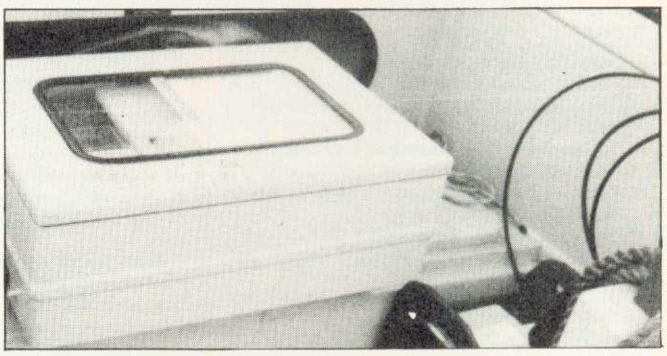
Vosper commissioned the tests, which are being made by Gifford Technology of Southampton.

The Beeb is run on batteries while at sea, and dumps its initial results on tape. These are then analysed, displayed and printed out later.

Gifford are pleased with the results, especially as the programs are in Basic.

Buoys dumped in swell

Beeb in sealed box



Microfloppy made in Hungary

A MICROFLOPPY disc system is being adapted for the BBC micro.

The Bats MCD1 microfloppy comes from Hungary and is based around a 72mm (3″) disc which is sealed in a cassette.

Cumana has developed an interface, while Kenda has written a filing system. A single drive should cost about £150 (plus VAT).

Each single-sided minidisc has an 80k capacity and comes in 45-track form. Kenda claims the number of files per disc is virtually unlimited and that deleted files can be recovered.

The MCD1 drive is 85mm wide, 115mm deep, and 41mm high. Each disc-cassette is expected to sell for £4.

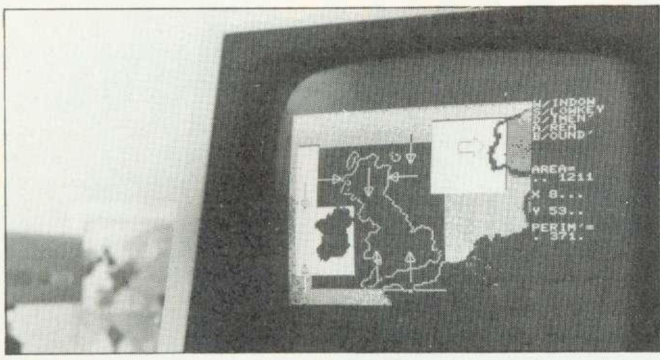
Bats-NCI who import the drives are at 53 Ballards Lane, London N3.

Disc chip warning

ACORN has warned that only one version of the disc filing system has officially been released.

A spokesman said versions other than DFS 0.9 cannot be guaranteed compatible with other ROMs when upgrades are made. The same goes for Econet (NFS 3.34).

You can check which version you have by typing *HELP.



Microsight camera transfers a map onto a monitor

Thatcher stands firm on cash limit for computers in schools

PREMIER Margaret Thatcher has stood firm against parliamentary pressure to earmark more cash for classroom computers.

The Prime Minister says the £40 million due to be spent between now and 1986 is enough to be going on with.

Proposals for more money were put to her in the Commons by senior Tory backbencher Sir Paul Bryan who thinks it is time the government began looking at further ways of boosting computer literacy in schools.

Sir Paul told *Acorn User* he believes it is important to build on the obvious classroom enthusiasm for computers – where more than four-fifths of the micros supplied under the government's pound-for-pound scheme are BBC micros.

He made a similar point to Mrs Thatcher when he told her during Prime Minister's question time that the two existing government schemes were proving 'a phenomenal success.'

'Has the time not now come to expand those schemes on a dramatic scale he suggested.

□ The government has announced a £200 million boost for information technology.

Industry Secretary Patrick Jenkin said the five-year scheme would ensure the competitiveness of Britains IT industry.

IT and micros in primary education – page 45.

Demon terror is putty in Beeb's hands

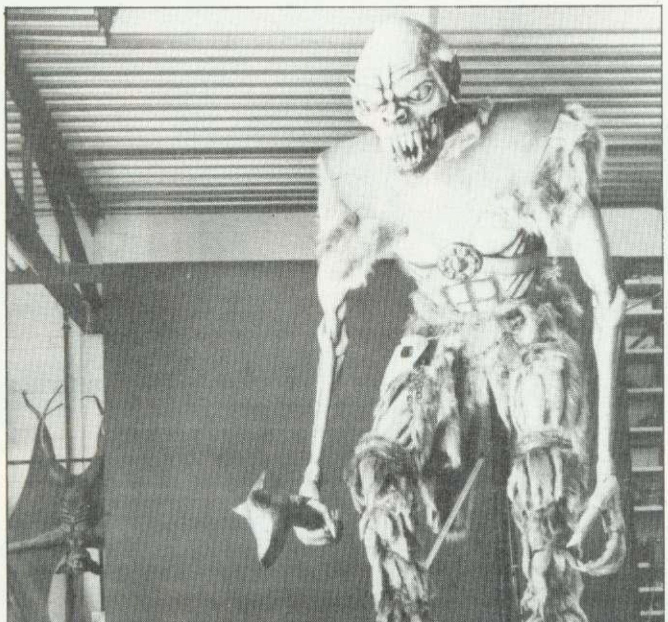
NO, this toothy beauty is not an escaped Acorn programmer, but a Chamber of Horrors monster being controlled by a BBC micro.

The Beeb is used to synchronise the 10-foot demon's movements to a soundtrack of grunts, growls and roars.

Once sound and movement have been matched up the programmed sequence is recorded onto the sound tape. This can then be played back and the program operates valves and pistons on the demon to make him move. It can also control lighting on the figure.

The demon is made of plastic and rubber over a steel skeleton, complete with moving limbs, heads, eyes and jaw.

N.J. Farmer of Leicester did the programming and you can see these rugged features in action at The Terror Castle on Great Yarmouth's Marine Parade.



A smash with monsters... micro's in control

Musical launch for Quicksilva

QUICKSILVA has launched three pieces of software for the BBC micro.

Their pride and joy is *Muproc* – a music synthesiser for models A and B. It runs on both operating systems.

At £15 it's dearer than usual, but worth looking out for.

Two games make up the trio – *Protector* (£7.95) and *The Wizard* (£6.95). Both make good use of colour and graphics; *Protector* has pulsing (not flashing) characters, and *Wizard* has flying killer ducks!

Both need 32k and *Protector* only works with joysticks.

Courses and software aids available to teachers

THE MUSE summer course will take place at Nottingham University on July 25-27.

Lectures are planned to cover all aspects of educational computing at all levels, with several addressed specifically to the BBC machine.

Topics include: programming, Logo, networks, interfacing, music, software, organisation, telesoftware – to name some. Details from MUSE, Freepost, Bromsgrove, Worcs B61 7BR.

And the National Union of Teachers is running computing courses at its training centre, Stoke Rochford Hall.

A 13-station BBC Econet system is in operation and topics covered include primary, secondary and special education.

Contact Penny Muir, Education Department, NUT, Hamilton House, Mabledon Place, London WC1.

Software on maths, physics and biology is available from Garland Computing. Many of the programs simulate practical techniques. Garland are at 35 Dean Hill, Plymouth.

Workcards for primary schools to introduce programming on the BBC micro have been released by Educal, 28 Ingersoll Rod, Shepherds Bush, London.

Beeb micro with Election fever

by Bill Penfold

IN A Westminster office within 100 yards of Big Ben a BBC micro has been quietly compiling the membership of the next House of Commons.

Before a single vote has been cast in the next General Election, the computer holds potted biographies on just about every one of the future MPs . . . and their chief rivals for the seats.

In a matter of days after the Election results are known the Beeb will be ready to begin printing out the text of the new edition of a reference book which has established itself as an essential guide for politicians of all parties – and commentators on the wacky world of Westminster.

For the next version of *The MPs' Chart* by political journalist Andrew Roth will be ready for publication well ahead of its usual schedule thanks to the BBC B . . . and a 17-year-old schoolboy.

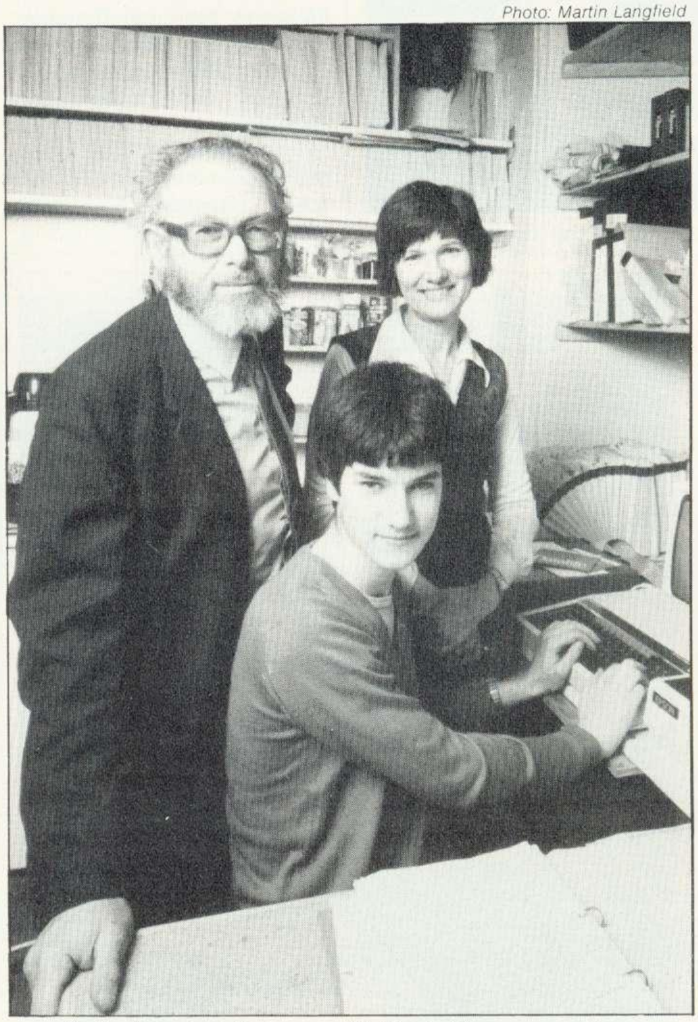
Over the last few months Andy and his colleague Judy Tench have been completing hundreds of snappy descriptions on each of the parliamentary runners.

Not just the constituency choices of the Tory, Labour and Alliance parties but also politicians hoping to carry the colours for the Scottish Nationalists, Plaid Cymru and the ever confusing spectrum of Ulstermen.

A massive job – but one clearly suiting the Beeb. However, before it could begin Andy discovered they would have to write their own special program, as none of the commercially-available packages could handle the filing requirements.

Even Acorn's own disc filing system was too limited for the journalistic needs of the job as it holds too few files per disc. It was a case of tailoring something for the peculiar parliamentary requirements.

Photo: Martin Langfield



Andy, Dan and Judy. . . with Beeb, Epson and discs

But where there is a computer programmer there is usually a way, and the way was provided by Judy's 17-year-old son Dan Tench.

Dan is part of that rising generation of schoolboy computer console stars whose micro mastery is already sending shivers down the backs of ageing veteran programmers now deep into their 20s.

Though it was obviously possible to adapt existing software, Dan saw his job as starting from scratch. The program needed to be capable of searching by either a candidate's name or his constituency, and Andy's requirements included being able to extract particular categories.

For instance he might need to know which Conservative backbenchers were concerned with accountancy and had interests in agriculture. Or a Labour MP concerned with education and the pharmaceutical industry.

'Dan is part of that rising generation of schoolboy micro stars'

Soon, thanks to the Beeb and two months' work by Dan, Parliamentary Profiles – the name of Andy's company – will have the facts flashing on to the office monitor, and being dumped to an Epson printer.

Each MP takes about 700 bytes and each disc holds the profile of around 60 – 70 candidates.

A pupil at Dr Challoners Grammar, Amersham, Dan has two up-graded model As at home and is part of his school's computer group.

Recently he was one of a three-pupil, one-teacher team from the group which walked off with the £1,000 first prize in a computing competition run by the University of Kent and sponsored by Barclays Bank. The money has gone towards upgrading the school's own BBC computer system.

Now Andy Roth and Parliamentary Profiles are banking on the Beeb speeding the new *MPs' Chart* into the printers even before all the election posters have been pulled down.

For regular readers of the *Chart*, a long-time favourite has been the section of pithy comments on the traits and political outlooks of various parliamentarians.

After the last general election for instance Mrs Thatcher's thumb-nail profile was 'Iron Nancy incarnate; hard-working, high standards.' For Michael Foot, who at the time was deputy Labour leader, the traits tag was 'Publically angry; privately gentle; mannered orator.'

David Steel's description was given as 'Dark; boyish; energetic; even-tempered; charm.'

As Roy Jenkins had not returned to Westminster when the last edition was published, let's look at what it says about Dr David Owen, who is described as 'Celtic-handsome; v. bright; able; impatient; arrogant.'

Across the road from the House of Commons today the new descriptions of our political leaders – plus the rest of our next parliament – are now waiting on the Beeb files to be printed out. Wonder what those files hold?

WIN £1,100

Acorn system: BBC micro with single disc drive ink-jet printer plus software

The competition comes in two parts – you are recommended to enter both parts. This month we introduce you to our hawk-dove micro-world and ask you to determine a character mix which will set up a stable society. Next month, the model society gets more complicated with more characters and you will have to write a computer program (on cassette) to simulate the hawk-dove society

THIS month's puzzle is a bit different from the usual. It's based on the work of the geneticist J. Maynard Smith and it is developed in a brilliant book, *The Selfish Gene**. By all means buy or borrow it if you can – but it won't help you win the competition as the author has significantly adjusted his conclusions since he first wrote the book.

Imagine a closed world consisting of a single species where each individual looks the same but behaves in one of two pre-programmed ways when encountering another individual. The *hawk* behaves aggressively and will savagely attack any individual who offers resistance. A *dove* on the other hand puts up a dignified display of ruffled feathers but will run away when seriously menaced.

Thus in any hawk-dove confrontation the dove will flee and the hawk wins the contest. When two hawks meet they fight to the death. When two doves meet there is an immensely protracted display of feathers before one gets bored or hungry and backs off. Since our model is based on the Darwinian concept of natural selection, the winners of the contests contribute more to the genetic pool than the losers.

The purpose of our model, however, is not to consider natural selection, but Maynard Smith's concept of the *evolutionarily stable strategy* (ESS). In essence this can be defined as 'the only strategy that . . . once evolved cannot be bettered by any deviant individual'. It is important to realise that this built-in resistance to individual enterprise is the paramount objective of our model.

To do this on the computer we have to allocate an arbitrary system of points to all contests, which in our case is as follows: plus 50 points for a win, minus 100 points for death or injury, 0 points for a loss and minus 10 points for wasting time in a lengthy confrontation when important things like breeding and feeding are being neglected.

Thus when a dove meets a hawk the dove runs away and scores 0 while the hawk scores +50. When dove meets dove, both score -10 for wasting time and the winner scores +50. All things being equal, a dove's chances of winning these encounters are one in two and his score per contest will be the average of -10 and +40 which equals 15. The average score in any hawk versus hawk contests is (-100+50)/2 =-25.

To underline the concept of the ESS let us look at one possibility. You might imagine that because a hawk will always win any hawk-dove contest, only hawks will prevail genetically and therefore your computer population consists entirely of hawks. As we have just seen, the average score per contest in this society is -25. Now out of the genetic pool a mutant dove arises. The dove does not win a single contest. Indeed it spend most of its life running away from the hawks. Nevertheless, its average score is 0, which is a lot better than what the hawks are achieving and dove genes will therefore start flooding into the pool.

Again, you might imagine that a society composed entirely of doves was a good recipe for success: no battles, no -100 points for death or injury, in short a paradise apart from a certain amount of wasted time.

The reason why it doesn't work is that the first hawk to appear on the scene will do spectacularly well. Since there are no other hawks to fight the hawk will win every contest for an average score of +50 and, the genetic pool will begin to adjust accordingly.

This notion of the deviant individual undermining the collective strategy of the group to his own advantage is sometimes called 'treachery from within' and it is at the heart of the concept of ESS. It also has a direct counterpart in the real world.

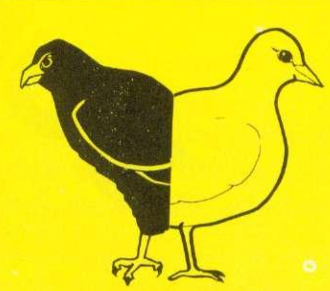
Quite often a group of people – for example, OPEC (Organisation of Petroleum Exporting Countries) – will band together and agree to fix the price of a commodity to the long-term benefit of its members. For a time all may work well.

Simon Dally launches you into a Hawk-Dove microworld in the first part of our major quiz. The full blown idea will be a mammoth task, so we suggest you start thinking and get some practice.

This month: Solve our simple computer model and you could win the first prize of £50 of software, or a runner's-up award of a copy of The Selfish Gene.

Next month: Analyse our full-blown model and produce a computer program (on cassette) to simulate it, complete with graphics. Entries will be assessed on how well the program works, structure and presentation (among other things, so we don't limit your imagination).

Remember: Whether you enter this month's simple competition or not,



you must give the answers with your program next month to qualify for the big £1100 prize.

Sooner or later, however, treachery from within will lead one member of the cartel to start undercutting his fellow members for his own short-term benefit and a price-cutting war is sparked off. In the case of OPEC it needs only a nodding acquaintance with recent newspapers to observe this process in action.

Since, as we have seen, an all-dove population and an all-hawk population are both unstable your task is to establish where, if anywhere, between these two extremes an equilibrium is established.

Try to determine what ratio (eg four hawks per three doves) is best. When you've done that you're ready to introduce a new strategic character into your model.

The *bully* is indistinguishable from a hawk and a dove. A bully rushes round pretending to be a hawk until someone fights back, at which point he runs away. Thus a bully will win a confrontation with a dove but lose to a hawk. When a bully meets another bully one of them takes fright more quickly than the other and backs off – so a bully has a one in two chance of winning these confrontations – for an average score of +25.

It is apparent that a society composed entirely of bullies is not an ESS – again, a mutant hawk will create treachery from within. So your task is to determine which mix of characters will create the most stable society.

In setting up your model it is important to realise before your computer characters start fighting that it is impossible for any group to be entirely eliminated: however poorly one type may be faring, its genes are still lurking there waiting to come to the fore if the opportunity arises. Indeed, in the

Genetic type	Opponent Hawk	Dove	Bully
Hawk	–25	+50	+50
Dove	0	+15	0
Bully	0	+50	+25

Figure 1. How the types fare

real world, an individual species would not be composed of three or more types: each individual would be composed of a mixture of strategies. Thus you might find that in a more sophisticated version of our model an individual would react like a hawk four times out of five, a bully one in 10 times and a dove one in 10 times. For our purposes, however, we are taking the species as consisting of three different types. Figure 1 shows what they score against one another.

One way to organise your model is to set up a league whereby all characters 'confront' other characters. When you've done that you should set up the next generation, basing the mixture on the performance of the previous generation. Depending on what sort of population you start out with, you may see some wild oscillation in the composition of the population at the beginning. But sooner or later, as in real life, things should settle down.

Of course, the model is very crude, taking no account of things like sex, youth or old age. Nevertheless it's fun and useful to set up these strategies and see what happens. Next month we'll give you a more complicated model and introduce some new characters into this one.

**The Selfish Gene* by Richard Dawkins, Oxford University Press, £8.50. We are indebted to Dr Dawkins for his help in setting up the model.

Once you have worked out a stable hawk-dove-bully mix, send your answer on a postcard please to June Competition, Acorn User, 53 Bedford Square, London WC1 to arrive not later than Monday July 4. Please say which machine you have (if any).

Three winners in February quiz

FEBRUARY'S competition featuring the travelling salesman problem produced nearly a hundred entries, only about one-third of them correct. The mileage table was drawn from a battered copy of the Michelin *Guide to Britain and Ireland* (1981 edition) which contained some bizarre anomalies. For example, according to the table, London to Birmingham is 121 miles. But if you go via Coventry it's only 117 miles! Michelin in their wisdom presumably take things like by-passes into account. Answers were as follows (routes can be followed in reverse order):

a) Seven-city problem. London, Brighton, Bristol, Carlisle, Edinburgh, Birmingham, Coventry, London. Total = 983 miles. (Carlisle and Edinburgh can be visited in reverse order.)

b) Twelve-city route. London, Ipswich, Leeds, Edinburgh, Carlisle, Liverpool, Manchester, Birmingham, Coventry, Bristol, Oxford, Brighton, London. Total = 1153 miles.

c) Longest route. There are at least four equally long routes, one of which is London, Carlisle, Brighton, Liverpool, Ipswich, Birmingham, Leeds, Bristol, Coventry, Edinburgh, Oxford, Manchester, London. Total = 2790 miles.

The winners were: James Boulder (aged 10) of St Roberts Primary Schools, Harrogate; John Wright of Ipswich, and Malcolm Newton of Mickleover, Derby.

BUBBLE & SHELL

In the first of a series on classic techniques in computing, Stan Froco looks at sorting

ONE of the commonest problems facing the computer programmer is that of sorting data into order. Methods used by beginners are often horrendously inefficient, and yet many fast techniques are no more complex.

A method widely used is the bubble sort. In program 1, 100 numbers held in the array a% (line 30) are sorted using this technique. The array is initially set up with the numbers 0 to 99 in descending order, ie

a%(1) = 99
a%(2) = 98
.
.
a%(100) = 0

The program then sorts them into ascending order. The reason for choosing this set, rather than random numbers, is that it is a severe test of a sorting routine since the numbers have to be completely reversed in order.

The bubble sort works by taking each element in turn (the FOR loop in line 160) and 'bubbling' it up by swapping it with the element before (lines 250 to 270) until the element before is smaller than the one under consideration. There is no need to compare it with elements before this since they have all been sorted and are thus even smaller. After each element has been bubbled into place the array is in order.

Bubble sorting is unfortunately not very good for sorting large numbers of items (ie more than about 20). Whilst the given program sorts 100 numbers in 24.65 seconds, performing 4950 exchanges in the process, it takes 2852 seconds and 499,500 exchanges to sort 1000 numbers. To sort 10,000 numbers would take about 80 hours and 50 million exchanges. To sort the 400 million items that once existed on Rolls Royce's parts list would be impossible.

There are two cases though where bubble sorting is efficient. One is sorting small numbers of items (where it is invariably the best technique because of its simplicity), and the other is for sorting large numbers of items, which are already nearly in order. Donald Shell used these virtues when he devised his Shell sort in the early 1960s.

Shell's technique is to break the items to be sorted into small sets and bubble sort these (which is efficient). These small sets are then merged into large sets, which will thus be roughly in order, and bubble sorted again (also efficient). These larger sets are then merged into still larger sets (still efficient) and so on, until a few large sets are merged into one roughly ordered set, which can again be efficiently sorted into order.

Program 2 shows a Shell sort for 100 integers. The size of the sets is controlled by n%. Each time round the REPEAT-UNTIL loop (line 200) the numbers are broken into n% different sets. In this case the first time round there are 33 sets, each with three or four items. The outer loop (line 220) takes each of these sets in turn and sorts them. The first set consists of items 1, n% + 1, 2 * n% + 1 . . . , the second of items 2, n% + 2, 2 * n% + 2 . . . up to the last set which comprises n%, 2 * n%, 3 * n% . . . The code from lines 230 to 360 is virtually that of the bubble sort, but incrementing and decrementing by n% instead of 1. The outer REPEAT-UNTIL loop (line 200) is used to decrease the number of sets each time round. Notice how the number of sets is not divided down evenly, a constant (2 here) is added in. This helps the sets mix, which improves sorting.

Despite being only nine lines longer than the bubble sort, this program is far more efficient. The comparable times are:

100 numbers 3.04 secs. 316 exchanges
1,000 numbers 46.76 secs, 4,366 exchanges
10,000 numbers 1,248.53 secs. 173,878 exchanges

To be fair, the data given is the worst possible for the bubble sort, and on average it would take about half the time with random numbers. However, one of the criteria of a good sorting routine is that it should have no bad cases, and in this respect Shell sort again wins.

These sorts can be easily modified to handle other data – they could use a string array of names, and the comparison could be for alphabetic order. A word of warning though. If you have data with two or more fields, such as a person's name and his age, and you sort the names into alphabetic order, and then sort the ages into numeric order, and expect the names of all people of the same age to be in order, do not use Shell sort. If items are identical (ie same age, but different name) they may be swapped in the second sort as the names are ignored. For sorting on multiple fields other techniques (of which bubble sort is one) should be used.

If you wish to know more about these and other techniques (such as how to sort really large amounts of data) the best book is *Data Structures and Algorithms* by Aho, Hopcroft and Ullman, published by Addison Wesley. This is sadly not a book for the total novice, and the examples are given in Pascal rather than Basic. However, there is as yet nothing for real beginners on the market, and if you have grasped the fundamentals of programming, you should learn a lot from this book. For reference you could look at volume 3 of *The Art of Computer Programming* by D.E. Knuth, again published by Addison Wesley. But unless you are a mathematician I would not recommend it.

● Hash tables and recursion will be covered in future articles. Are there and other techniques you would like covered? Write in and tell us.

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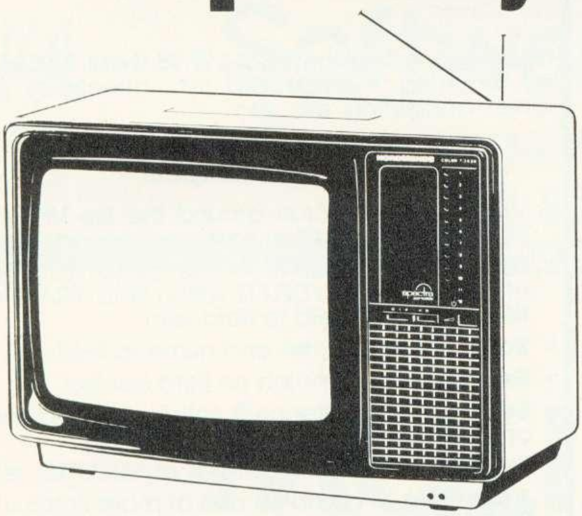

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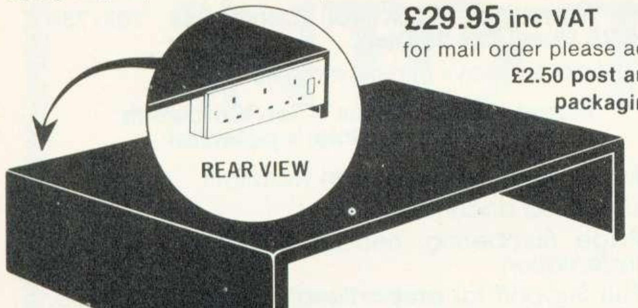

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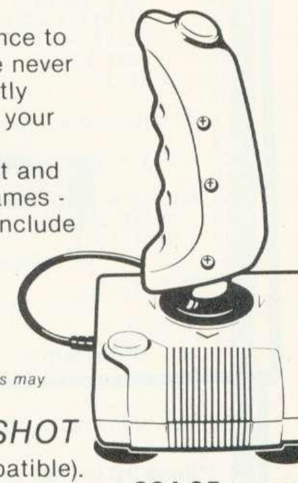
PLEASE NOTE: Planetoids and certain other games may still require the use of some keyboard commands.



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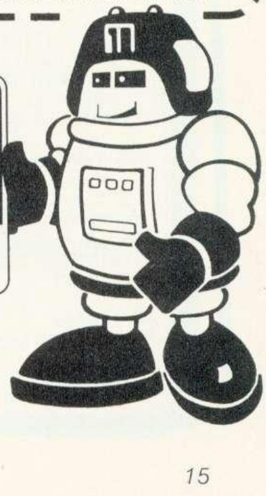

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BUBBLE & SHELL

```
 10 REM Bubble sort 100 integers
 20
 30 DIM a%(100)
 40 @% = 4
 50
 60 REM Initialise in reverse order
 70
 80 FOR i% = 1 TO 100
 90    a%(i%) = 100 - i%
100    NEXT i%
110
120 REM Now sort them
130
140 start% = TIME
150
160 FOR j% = 2 TO 100
170    FOR k% = j% TO 2 STEP -1
180
190       REM If bubbled high enough jump out
200
210       IF a%(k%) >= a%(k% - 1) THEN GOTO 290
220
230       REM Else exchange and proceed
240
250       t% = a%(k%)
260       a%(k%) = a%(k% - 1)
270       a%(k% - 1) = t%
280       NEXT k%
290    NEXT j%
300
310 REM Take the time and print out the results
320
330 time% = TIME - start%
340
350 FOR i% = 1 TO 100
360    PRINT a%(i%) ;
370    NEXT i%
380
390 @% = &90A
400 PRINT '' "Time taken: " ; time% / 100 ; " seconds"
410 END
```

Program 1. Bubble sort

```
 10 REM Shell sort 100 integers
```

lines 20 to 150 as program 1

```
160 REM This is the outer Shell loop
170
180 n% = 100
190
200 REPEAT
210    n% = (n% + 2) DIV 3
220    FOR m% = n% + 1 TO n% * 2
230       FOR j% = m% TO 100 STEP n%
240          FOR k% = j% TO m% STEP -n%
250
260             REM If bubbled high enough jump out
270
280             IF a%(k%) >= a%(k% - n%) THEN GOTO 360
290
300             REM Else exchange and proceed
310
320             t% = a%(k%)
330             a%(k%) = a%(k% - n%)
340             a%(k% - n%) = t%
350             NEXT k%
360          NEXT j%
370       NEXT m%
380    UNTIL n% = 1
390
400 REM Take the time and print out the results
410
420 time% = TIME - start%
430
440 FOR i% = 1 TO 100
450    PRINT a%(i%) ;
460    NEXT i%
470
480 @% = &90A
490 PRINT '' "Time taken: " ; time% / 100 ; " seconds"
500 END
```

Program 2. Shell sort

Joe Telford sets up a graphics procedure library and develops a 50p network

PICK A SHAPE

Continuing our examination of library routines, we turn to three shapes for constructing complex graphics on the BBC micro – rectangles, triangles and circles/ellipses.

Program 1 might appear trivial, but it is useful if a large number of triangles need drawing. Suitable calling lines might be:

```
100 MODE 2
110 PROC_tri(100,100,200,100,
    150,300,1)
```

The first three pairs of numbers are co-ordinates of the vertices. The last number should be 0 to produce a line drawing, or 1 for a filled triangle.

Program 2 uses program 1 as the procedure 'tri' to produce a simple pattern. Figure 1 gives several variations on this. Line 50 of program 2 shows we are transmitting the usual three pairs of vertex parameters, plus a final 0 to produce a line drawing. Figure 2 shows how the contents of line 50 can be related to the vertices of a regular (equilateral) triangle. This only works when the screen origin is moved by a VDU29 command so the triangle can be drawn around it (line 30). Try running program 2 without line 30 to see the effect.

Rectangles are probably the most common shape, so it is well worth while having a library routine to handle them. Look at program 3, which may be called by a simple three line program:

```
10 MODE 2
20 PROC_rect(300,200,600,400,0)
30 END
```

This will draw the outline of a rectangle on the screen. Control over the rectangle produced is by the parameters passed to the routine. Examine line 9400. The parameters are x,y,l,w, and f. Here, x and y are the coordinates of the bottom left-hand corner of the rectangle, l is the length across the screen, and w is the width up the screen. The final variable, f, may be 1 or 0 to produce an outline or filled rectangle – the opposite of the triangle routine. Less calculation is needed as only one corner's coordinates are required. The disadvantage is that the rectangle can only be aligned along the

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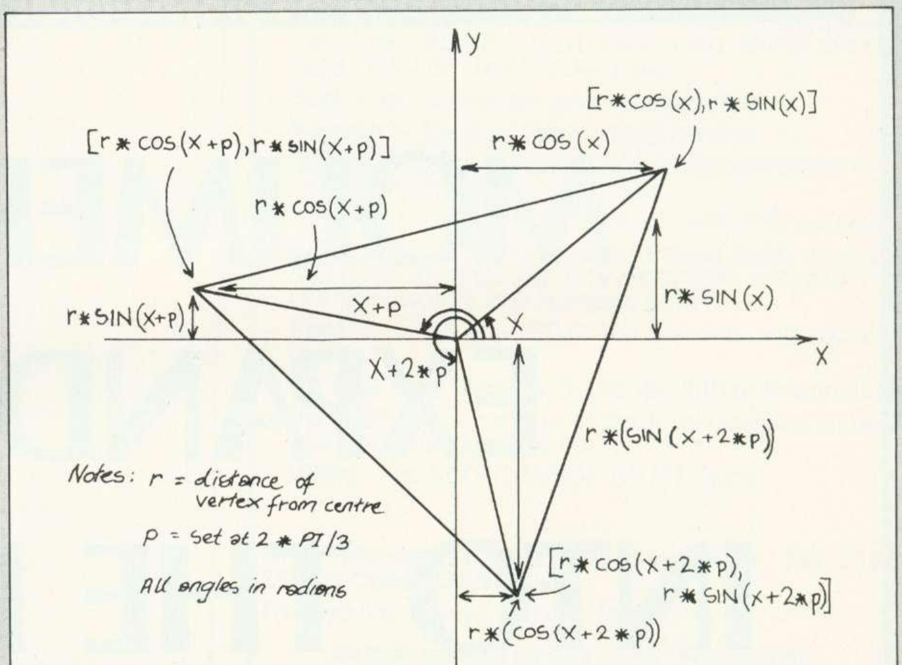


Figure 2. Locating vertices for program 2

```
9460 DEFPROC_tri(x1,y1,x2,y2,x3,y3,f)
9465 MOVE x1,y1
9470 IFf=0 DRAWx2,y2 EL. MOVE x2,y2
9475 IFf=0 DRAWx3,y3:DRAWx1,y1
     ELSE PLOT85,x3,y3:MOVEx1,y1
9480 ENDPROC
```

Program 1. Procedure for handling triangles. Note, this must be called up from a program (see text)

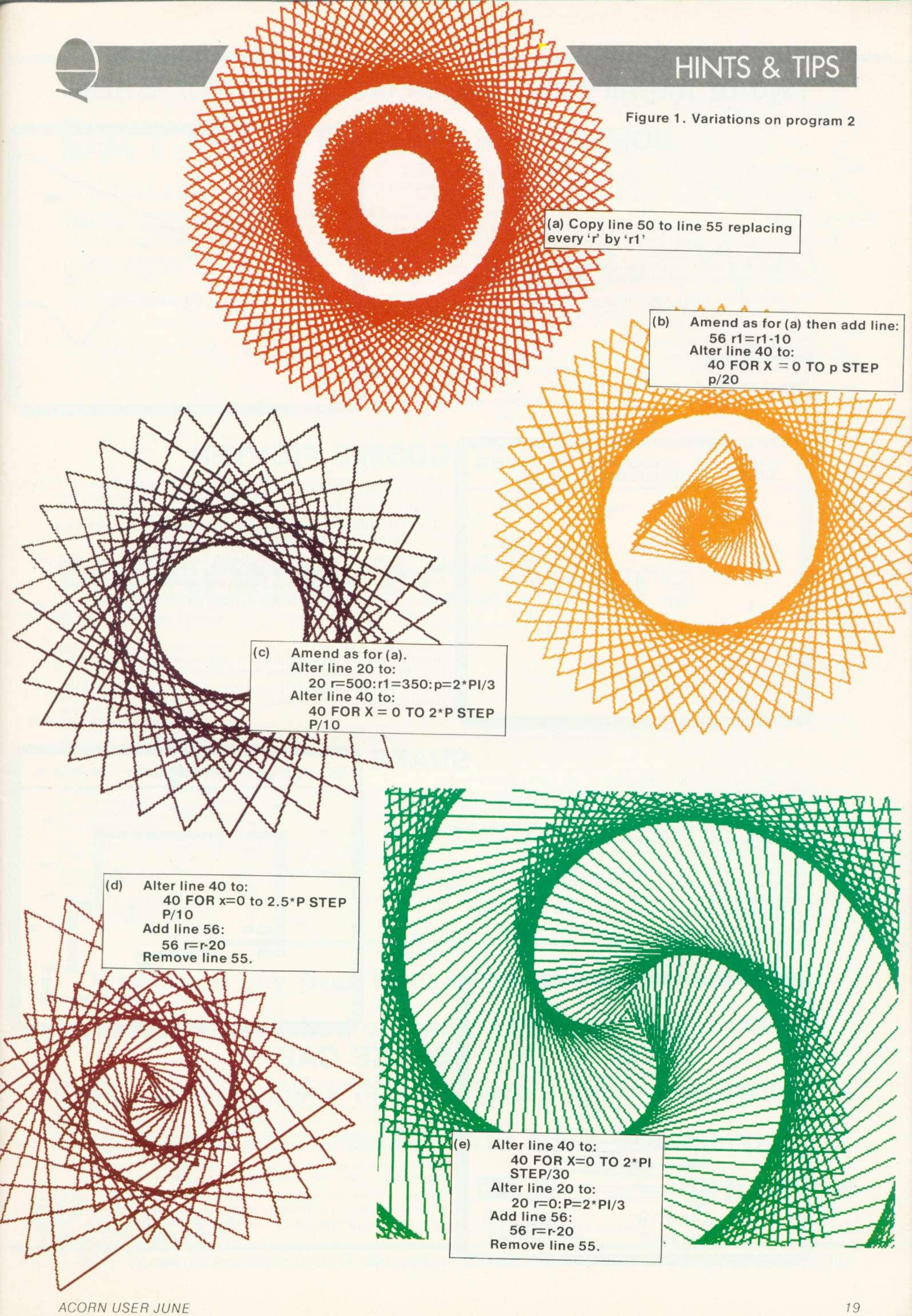
```
 5 REM PATTERNS
10 MODE4
20 r=500:r1=200:P=2*PI/3
30 VDU29,640;512;
40 FOR X=0 TO P STEP P/30
50 PROC_tri(r*COSX,r*SINX,
   r*COS(X+P),r*SIN(X+P),r*COS(X+2*P),
   r*SIN(X+2*P),0)
60 NEXT
70 END
```

Program 2. Triangle patterns

```
9400 DEFPROC_rect(x,y,l,w,f)
9410 MOVEx,y:DRAWx+l,y
9420 IFf=0 DRAWx+l,y+w ELSEPLOT85,x,y+w
9430 IFf=0 DRAWx,y+w ELSEPLOT85,x+l,y+w
9440 MOVEx,y+w:IFf=0 DRAWx,y ELSEMOVEx,y
9450 ENDPROC
```

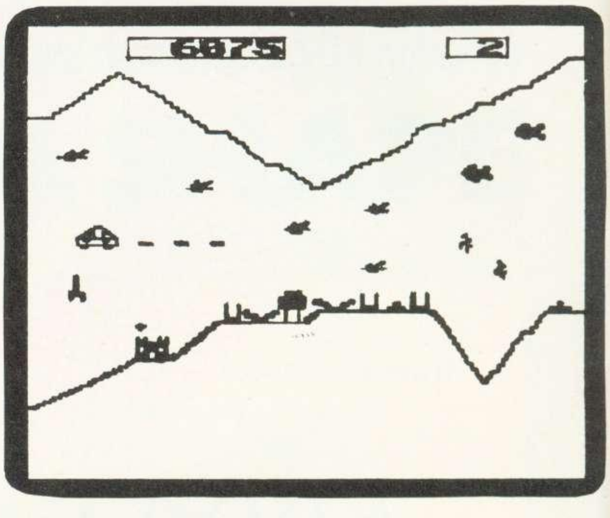
Program 3. Rectangle drawing routine

Figure 1. Variations on program 2



Two of the all-time Arcade greats

BOMBER SCRAMBLE



For over two years our best selling TRS-80 Arcade game was Mike Chalk's acclaimed Bomber Scramble. Now there's a new generation Scramble, in the colours, sound and high resolution graphics of the BBC Micro.

This new one has so much it's unbelievable! Two types of fighters –with their own unpredictable movements. Ack-ack–which no other BBC game, Acorn's included, can offer–with random detonations. Intelligent rockets–which are released as you come on target. Blimbs –another Kansas 'original' to make the game harder.

The game starts fairly easy, then gets harder and harder, with of course the ground and 'top' moving all the time–and completely random, with no two games ever the same. As the game progresses so more and more is 'thrown' at you.

Keyboard or joystick operation giving infinite control of the bomber, the bombs and firing. Top score table and extra 'lives'.
There is no other Arcade game to touch it!

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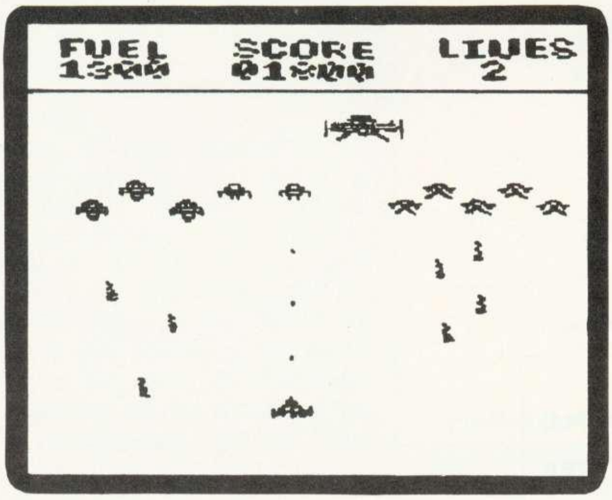
COSMIC FIGHTER



As Kansas reigned supreme with its TRS-80 Arcade games in Britain, Big Five Software were our counterpart in the States, with their 'flagship' being the famous Cosmic Fighter.

This fast-action multi-screen game has been brought to the BBC Micro by Kansas programmer Wal Mansell.

Four entirely different 'screens' with four different types of Alien, each with its own brand of attack, and all of them relentlessley homing down on your base. Four games in one in fact!

Move your base to fire whilst dodging their bombs, but as soon as you wipe out one lot, another type appears–and all of them hell-bent on your destruction!

Then comes your Mother Ship, so home onto her to re-fuel, but get it exactly right... Then it all starts again–with a difference–you have to hit each Alien twice to destruct!

Colour, sound, keyboard or joystick control, with of course the usual Kansas top score table. An all-time great.

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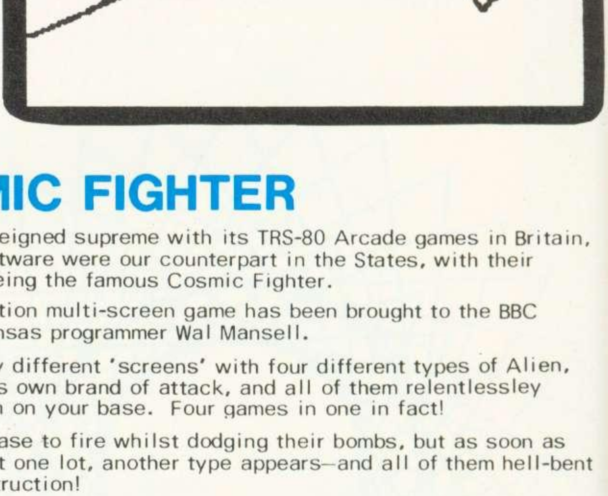
SNAKE



You have control in all directions of the Snake to devour the mushrooms. It's a real snake, not just a line, pulsating along and growing longer and longer as each mushroom is devoured.

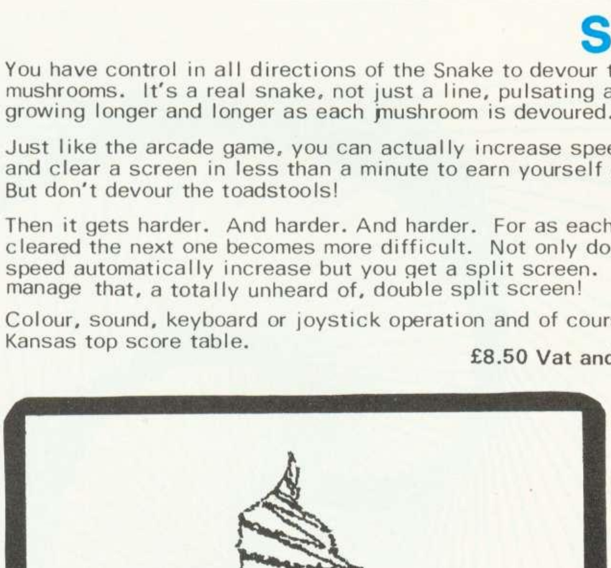
Just like the arcade game, you can actually increase speed to try and clear a screen in less than a minute to earn yourself a bonus. But don't devour the toadstools!

Then it gets harder. And harder. And harder. For as each screen is cleared the next one becomes more difficult. Not only does the speed automatically increase but you get a split screen. And if you manage that, a totally unheard of, double split screen!

Colour, sound, keyboard or joystick operation and of course the Kansas top score table.

£8.50 Vat and post paid

SPACE CAB



Slow the pace right down now, to a thinking mans' game. Ferry passengers over the random mountain, choosing the number, the amount of fuel and liquid oxygen to get you there and back. It's totally logical–the more passengers you carry the more fuel and oxygen you'll need. There's a purpose too, for you have to earn enough to pay off the mortgage on the craft or it's re-posessed!

Not too easy to play as control must be spot-on or you can run out of fuel, starve the passengers of oxygen or crash!

Infinite control of thrust and braking in all directions allowing you to ascertain the best velocity both in accent and deceleration. Very realistic sound effects. Colour and totals.

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PROGRAMS ARE CASSETTE BASED AND RUN ON ALL 32K SYSTEMS

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vertical and horizontal axes. This is acceptable for most diagrams, but readers who need a tilted rectangle should put an extra coordinate in the triangle routine. Also notice the routine will produce squares, simply by setting l and w to the same value. Let's look at three simple applications of the 'rect' routine; in education, to demonstrate movement, and for business use.

Teaching children about shapes

PRIMARY children's concept of shape and form needs careful direction by teachers. One particularly difficult area is in the analysis and synthesis of complex shapes from simple ones (which the next MEP Microprimer pack will examine). However, the 'rect' routine may help teachers to use the computer with work of their own. Program 4 is an example of how the 'rect' routine can be used to build a more complex shape. Because each school will want to progress along its own lines of interest, program 4 is not interactive, and does not attempt to dictate a 'best' approach. The 'best' approach is the one which works in your school.

We can also use the rectangle routine to generate the illusion of movement. Look at program 5, which should be understandable without much explanation. Line 110 looks strange but in fact is doing the stirling job, along with line 90, of keeping the multiple rectangle display symmetrical.

The *FX19 in lines 310 and 240 cause the micro to wait until the beginning of the next screen frame. This results in smoother movement with less flickering – remove them to see how necessary they are!

```
100MODE2
110REM do sky
120GCOL0,6
130PROC_rect(0,400,1280,624,1)
140REM do grass
150GCOL0,2
160PROC_rect(0,0,1280,400,1)
170REM paint wall
180GCOL0,1
190PROC_rect(200,200,700,400,1)
200REM add bricks
210FORY=200 TO 600 STEP48
220FORX=200 TO 900 STEP32
230GCOL0,7
240PROC_rect(X,Y,32,24,0)
250NEXT,
260FORY=224 TO 576 STEP48
270FORX=216 TO 884 STEP32
280PROC_rect(X,Y,32,24,0)
290NEXT,
300REM make door
310GCOL0,4
320PROC_data(1)
330REM doorframe
340GCOL0,5
350PROC_data(2)
360REM downstairs windows
370GCOL0,2
380PROC_data(2)
390REM upstairs windows
400GCOL0,6
410PROC_data(2)
420REM Window frames
430GCOL0,5
440PROC_data(16)
450END
460DEFPROC_data(n)
470LOCAL I%
480FOR I%= 1 TO n
490READ a%,b%,c%,d%,e%
500PROC_rect(a%,b%,c%,d%,e%)
510NEXT
520ENDPROC
530REM door data
540DATA500,200,100,200,1
550 REM doorframe data
560DATA500,200,100,200,0
570DATA580,300,8,8,1
580REM downstair window data
590DATA275,250,150,150,1
600DATA675,250,150,150,1
610REM Upstair window data
620DATA700,450,100,100,1
630DATA300,450,100,100,1
640REM Windowframe data
650DATA275,250,75,75,0
660DATA350,250,75,75,0
670DATA275,325,75,75,0
680DATA350,325,75,75,0
690DATA675,250,75,75,0
700DATA750,250,75,75,0
710DATA675,325,75,75,0
720DATA750,325,75,75,0
730DATA700,450,50,50,0
740DATA750,450,50,50,0
750DATA750,500,50,50,0
760DATA700,500,50,50,0
770DATA300,450,50,50,0
780DATA300,500,50,50,0
790DATA350,500,50,50,0
800DATA350,450,50,50,0
```

Program 4. House-building program

```
10 REM  Goggle box
20 :
30 ON ERROR GOTO 390
40 MODE2
50 :
60 REM Draw lots of multicoloured
70 REM Boxes inside one another.
80 :
90 FORX%=0 TO 512 STEP 8
100 GCOL0,(X%/8)MOD15 +1
110 PROC_rect(X%+128,X%,(512-X%)*2,(512-X%)*2,0)
120 NEXT
130 :
140 REM Now set all boxes to black
150 :
160 FOR X%=0 TO 15
170 VDU19,X%,0,0;0;
180 NEXT
190 REPEAT
200 :
210 REM Loop through the colours
220 :
230 FORX%=15 TO 1 STEP-1
240 *FX19
250 :
260 REM Turning then on sequentially
270 :
280 VDU19,X%,1,0;0;
290 time=TIME
300 REPEAT UNTIL TIME>time
310 *FX19
320 :
330 REM and then off.
340 :
350 VDU19,X%,0,0;0;
360 NEXT
370 REM Use Esc to exit
380 UNTIL FALSE
390 MODE7:REPORT:END
```

Program 5. Moving graphics

Figure 3. Screen form design

SURNAME	....		
FORENAME	....		
TITLE	....	SEX	.
ADR 1	....		
ADR 2	....		
ADR 3	....		
CODE	......	PHONE	......

Program 6. Screen form design

```
 10 MODE4
 20 width=64
 30 PROC_screenform
 40 END
 50 DEFPROC_screenform
 60 PROC_rect(0,946,11*32,width,0)
 70 PROC_rect(11*32,946,21*32,width,0)
 80 PRINTTAB(1,1);"SURNAME   "
 90 PRINTTAB(12,1);"...................."
100 PROC_rect(0,882,11*32,width,0)
110 PROC_rect(11*32,882,21*32,width,0)
120 PRINTTAB(1,3);"FORENAME "
130 PRINTTAB(12,3);"...................."
140 PROC_rect(0,818,11*32,width,0)
150 PROC_rect(11*32,818,10*32,width,0)
160 PRINTTAB(1,5);"TITLE     "
170 PRINTTAB(12,5);"........."
180 PROC_rect(21*32,818,11*32,width,0)
190 PROC_rect(30*32,818,2*32,width,0)
200 PRINTTAB(22,5);"SEX  ";TAB(31,5);"."
210 PROC_rect(0,754,7*32,width,0)
220 PROC_rect(7*32,754,25*32,width,0)
230 PRINTTAB(1,7);"ADR 1";TAB(8,7);
"........................"
240 PROC_rect(0,690,7*32,width,0)
250 PROC_rect(7*32,690,25*32,width,0)
260 PRINTTAB(1,9);"ADR 2";TAB(8,9);
"........................"
270 PROC_rect(0,626,7*32,width,0)
280 PROC_rect(7*32,626,25*32,width,0)
290 PRINTTAB(1,11);"ADR 3";TAB(8,11);
"........................"
300 PROC_rect(0,562,7*32,width,0)
310 PROC_rect(7*32,562,7*32,width,0)
320 PRINTTAB(1,13);"CODE   "
    ;TAB(8,13);"......"
330 PROC_rect(14*32,562,11*32,width,0)
340 PROC_rect(25*32,562,7*32,width,0)
350 PRINTTAB(15,13);" PHONE ";
    TAB(26,13);"......"
360 ENDPROC
```

```
9300 DEFPROC_crclp(x,y,r1,r2,F)
9310 LOCAL z,x%,y%
9320 MOVEx+r1,y:MOVEx+r1,y
9330 FORz=0TO 6.4STEP.2
9340 x%=x+r1*COSz:y%=r2*SINz
9350 IFf<>1 DRAWx%,y+y% ELSE
     PLOT85,x%,y+y%:PLOT85,x%,y-y%
9360 IFf=1 AND z>3.2 z=6.4
9370 NEXT:ENDPROC
```

Program 7. Circle/ellipse routine

Designing forms

THE third area which may usefully exploit the 'rect' procedure is in designing forms for data input. There are two separate parts to input via the screen as a form. The easy part is design, the more difficult part is using that form during input. Program 6 uses the 'rect' procedure to produce a screen form (figure 3). The program uses mode 4 and creates the form from rectangles, each 64 units high by 32 times the number of characters which are intended to fit into each entry box. The labels for each box plus the number of characters allowed (dots) are inserted at the correct positions by PRINT TAB statements. Readers might like to experiment to produce their own form input programs, based on this example and using a general prupose input routine.

The third of our graphics routines draws and fills circles or ellipses (program 7). The procedure requires five parameters, x,y,r1,r2 and f. The first two are coordinates of the centre of the circle. If r1 = r2, the shape is a circle of radius r1. If r1 and r2 are different, an ellipse is produced. The large value between r1 and r2 decides the major axis of the ellipse, with r1 controlling the horizontal axis and r2 the vertical. The last parameter is our usual f which may take the values 1 for filling the shape or 0 for an outline drawing. Try using the routine with program 8 which has a CB radio flavour.

Program 8. Using 'crclp' routine

```
 10 MODE2:Y=600
 20 GCOL0,129
 30 CLG
 40 FOR X= 256 TO 768 STEP 512
 50 GCOL0,7
 60 PROC_crclp(X,Y,200,100,1)
 70 GCOL0,4
 80 PROC_crclp(X+70,Y-10,80,80,1)
 90 GCOL0,0
100 PROC_crclp(X+70,Y-10,30,30,1)
110 NEXT
120 END
```

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INTERACTIVE GRAPHICS AND CAD

Jim McGregor and Alan Watt analyse the GCOL statement, and show how procedures based around it can provide interactive graphics – line drawing, picking and dragging, menu selection and rotation

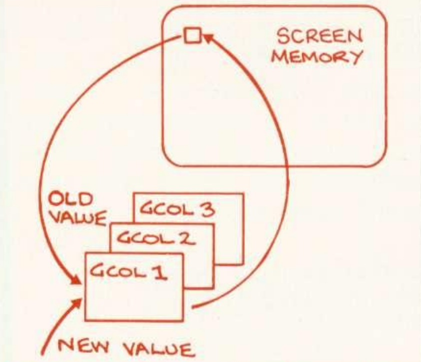


Figure 1. GCOL parameters select operation to be performed between value in screen memory and new value

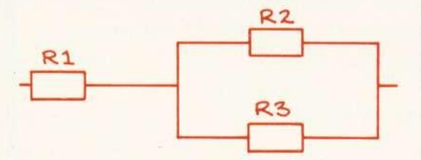


Figure 2. Electrical diagram

The GCOL statement controls the way new values are loaded into the screen memory. Either a new value (or colour) specified for a particular pixel is loaded directly into the appropriate position in the screen memory, or a logical operation is performed between the new value and the current value (figure 1). The type of logical operation is specified by the first parameter in the GCOL statement.

Using the GCOL facilities we can implement two classic graphical input techniques – 'rubber banding' and 'picking and dragging'. Both use the keyboard, but clearly the principles are the same for either a keyboard or a more convenient device such as a lightpen. Both interaction techniques can be used in picture construction and this forms a part of most CAD (computer aided design) systems which enable designers to work in two-dimensional pictures. This means for example that an electrical engineer can work with circuit diagrams and an architect with elevations or other projections of buildings, rather than just numbers.

CAD techniques are an extensive topic, and we shall only concern ourselves with picture or line-drawing generation, although it is not out of place to examine briefly how such techniques fit in. A CAD program that accepts a picture as input has to deduce certain information from it. An electrical engineer may draw a circuit diagram as input. A simple but somewhat unrealistic example serves to illustrate the point; say he inputs a series parallel resistor configuration (figure 2). From this the CAD program will have to deduce that a resistor connected in series with two resistors in parallel has a total resistance (RT):

$$RT = R1 + R2*R3/(R2 + R3)$$

It can then evaluate numerical calculations and output information graphically or otherwise. The CAD program will also be able to cope with alterations to the diagram.

In the same way, an architect may sketch in elevations of a house and ask for costing, insulation or sunlight calculations.

Returning to the case of an electronic circuit diagram, this would be built up using picking and dragging. In this technique a user is presented with a menu of objects from which he can pick a particular object and 'drag' it anywhere on the screen. Other operations that might be available on objects are magnification and rotation. Again in the case of an electrical circuit diagram, as well as the picture-drawing modules there will be procedures to keep track of the spatial relationships between components. The CAD program can then build up a formula reflecting some required attribute or behaviour of the circuit. This might be transfer characteristic, frequency response and so on. The computer program's view of the problem is numerical or formula based, while the engineer's view remains pictorial – a tremendous advantage in most design problems.

We now look at the front end of such CAD programs: first by looking at how we can sketch line drawings on the screen, and second at how we can pick and drag predefined sub-pictures across the screen.

Rubberband line drawing is used to build up a sketch or line drawing on the screen, using line segments whose length and direction are controlled from the keyboard. Program 1 starts off by drawing an arbitrary line from (0,0) to (640,512). By using keys R, L, U, and D (right, left, up and down) as direction indictors we can move the end point of the line anywhere we want. Key F can be used to 'fix' the end point of the line. In the program 'xs' and 'ys' always represent the start position of the line currently being drawn and 'x' and 'y' represent the position of the end of the line being moved. The program consists of a REPEAT loop that processes commands until the Q (quit) is pressed.

PROCprocesscommand first checks for a valid key. If 'F' has been pressed, the line being operated on is fixed and the coordinates are set for a new line. Otherwise PROCdrawordelete is used to delete the current line in preparation for redrawing it in a new position. One of the coordinates x, y is updated if one of the movement keys (L, R, U, D) has been pressed. PROCprocess-command terminates by drawing a line to the position now specified by the xy coordinates. A drawing sequence is shown in figure 3.

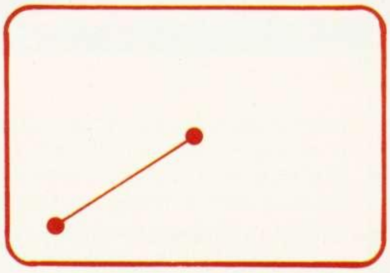
The critical statement in the program is GCOL 3, 1 (exclusive OR). This means lines can be moved over existing lines without

```
 10 MODE 4
 20 xs = 0 : ys = 0
 30 x = 640 : y = 512
 40 GCOL 3, 1
 50 PROCdrawordelete
 60 REPEAT
 70   command$ = GET$
 80   PROCprocesscommand
 90 UNTIL command$ = "Q"
100 MODE 7 : END

110 DEF PROCprocesscommand
120   IF INSTR("FLRUD",command$) = 0 THEN ENDPROC
130   IF command$ = "F" THEN PROCfix
                        ELSE PROCdrawordelete
140   IF command$ = "L" THEN x = x - 5
150   IF command$ = "R" THEN x = x + 5
160   IF command$ = "U" THEN y = y + 5
170   IF command$ = "D" THEN y = y - 5
180   PROCdrawordelete
190 ENDPROC

200 DEF PROCdrawordelete
210   MOVE xs, ys : DRAW x, y
220 ENDPROC

230 DEF PROCfix
240   REM Permanent draw to fill in gaps where
250   REM moving line crosses existing lines.
260   GCOL 0,1 : PROCdrawordelete
270   GCOL 3,1
280   xs = x : ys = y
290   x = 640 : y = 512
300 ENDPROC
```

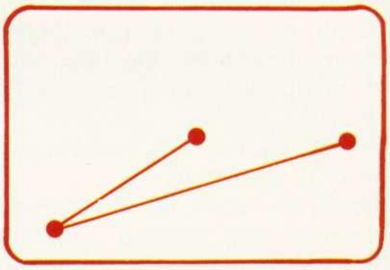
Program 1. Rubberband program without extensions

```
 15 lineoff = FALSE
 16 hcursor = FALSE : vcursor = FALSE
 17 printmeasure = FALSE

120   IF INSTR("FLRUDOHVM",command$) = 0 THEN ENDPROC

171   IF command$ = "O" THEN lineoff = NOT(lineoff)
175   IF command$ = "H" THEN hcursor = NOT(hcursor)
176   IF command$ = "V" THEN vcursor = NOT(vcursor)
177   IF command$ = "M" THEN printmeasure =
      NOT(printmeasure)
178   IF printmeasure THEN PROCmeasure ELSE
      PRINT TAB(3,3);"

200 DEF PROCdrawordelete
204   PROCcheckcursors
205   IF lineoff THEN ENDPROC
210   MOVE xs, ys : DRAW x, y
220 ENDPROC

310 DEF PROCcheckcursors
320   IF hcursor THEN MOVE x-500, y: DRAW x+1000, y:
      MOVE x, y
330   IF vcursor THEN MOVE x, y-500: DRAW x, y+1000:
      MOVE x, y
340 ENDPROC

350 DEF PROCmeasure
360   PRINT TAB(3,3), ABS(xs-x)
370 ENDPROC
```

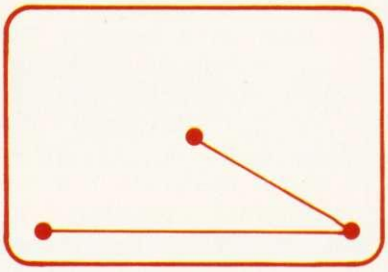
Extensions to program 1



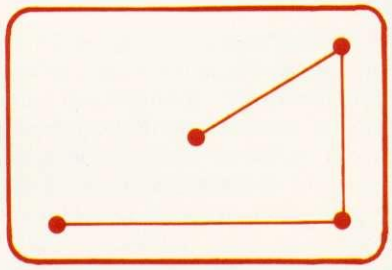
Start arbitrary line drawn from (0, 0) to (640, 512)



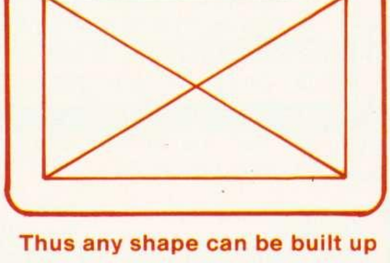
Line can be moved anywhere from (640, 512)



Key F depressed. First line fixed. Arbitrary line drawn to (640,512)



This line can be moved and key F depressed again



Thus any shape can be built up

Figure 3. Drawing sequence using first version of program 1

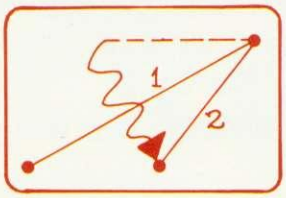


Figure 4. Lines can safely move over existing ones using GCOL 3

First Draw			Second Draw		
old	plotting	new	old	plotting	new
0	1	1	1	1	0
1	1	0	0	1	1

Table 1. Cumulative effects of draw with GCOL 3

permanently wiping part of them out, as would be the case otherwise. Normally, to delete an object we would replot the object in the background colour but this would wipe out intersecting parts of existing lines. Using the above method, an existing line disappears only momentarily while the current moving line passes over it (figure 4). Thus line segment 2 can be swept over existing line segment 1 without rubbing it out. This can be explained by reference to table 1. You can see from the bottom row of the table that plotting a 1 on top of a 1 in the first draw results in a zero that is restored to a 1 by the second draw. The top row of the table gives the effect of a normal draw and erase function. The second draw thus erases or undraws, at the same time restoring any holes in existing lines made by the first draw. (See if you can work out why the behaviour is unaltered if GCOL 3 is replaced by GCOL 4.)

As it stands the program is slightly impractical – figures are constructed without the 'pen being lifted off the paper'. That is to say after a line is fixed it is assumed another line is required. This may not be the case and the easiest way to incorporate line off/line on is to have another key controlling this option:

```
171 IF command$ = "0" THEN
    lineoff = NOT(lineoff)
```

This IF statement sets up a push on/push off key – a mechanism we shall use again. If the variable 'lineoff' is originally set to false then pressing the appropriate key will set it to true. PROCdrawordelete can then be:

```
200  DEF PROCdrawordelete
205  IF lineoff THEN
     ENDPROC
210  MOVE xs, ys : DRAW x, y
220  ENDPROC
```

which prevents the drawing action if the line is switched off. Now, for example, to construct two isolated rectangles we would use a sequence similar to that shown in figure 5.

There are two useful elaborations to make to the rubberband line drawing program. First, we can include a horizontal and vertical cursor line to enable us to line up different parts of a drawing. This simply adds another two selections to PROCprocesscommand. These would be:

```
175  IF command$ = "H"
     THEN hcursor = NOT(hcursor)
176  IF command$ = "V"
     THEN vcursor = NOT(vcursor)
```

This means the H and V key functions are push on/push off keys as we used above to switch a line off. PROCdrawordelete can now be further elaborated to check if cursors have to be drawn (program 1, lines 200-340).

Figure 6 shows the cursor being used in the course of a construction.

Another useful aid is a length measuring device. Consider for example measuring the current x projection of the line. This could be accomplished by:

```
177  IF command$ = "M"
     THEN printmeasure = NOT
     (printmeasure)
178  IF printmeasure THEN
     PROCmeasure ELSE PRINT
     TAB(3,3);"  "

350  DEF PROCmeasure
360  PRINT TAB(3, 3),
     ABS(xs-x)
370  ENDPROC
```

Note the string on line 120 must now be changed to 'FLRUDOHVM' and that as the program stands the cursors must be switched off before fixing. If the measure option is switched on then PROCmeasure is obeyed and prints, using TAB, the current x projection of a line. In

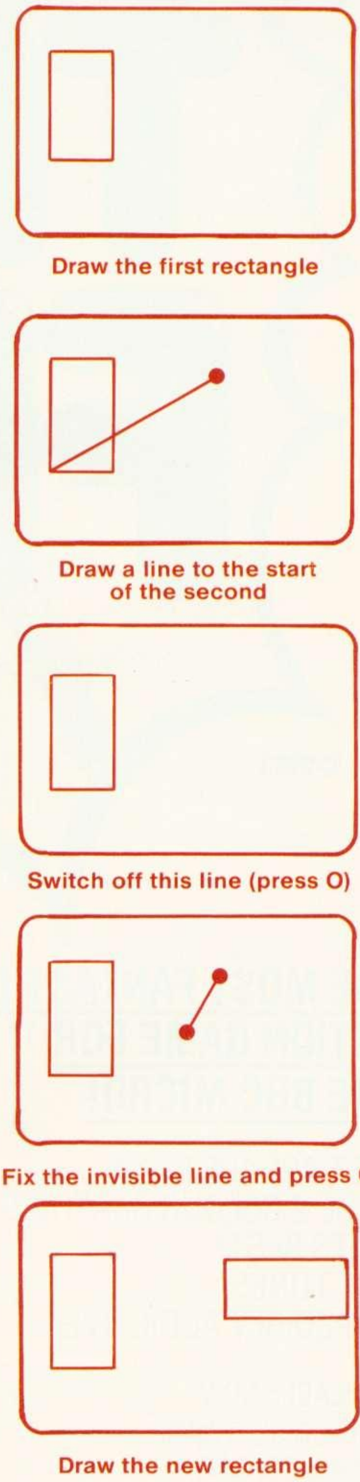


Figure 5. Drawing sequence using improved structure

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Figure 6.

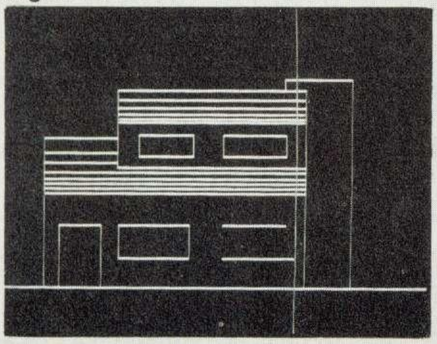

Figure 7.

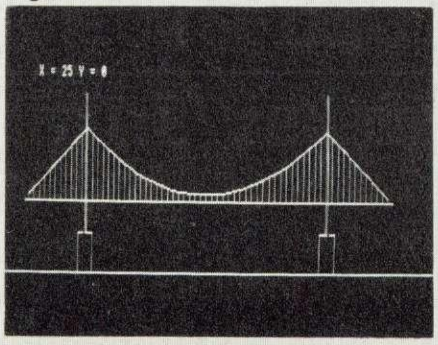

Figure 8.

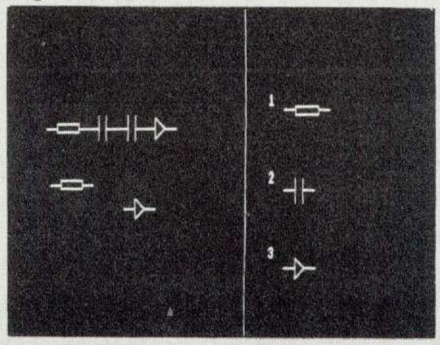

figure 7 the hangers on the suspension bridge were accurately positioned using this.

We have already mentioned picking and dragging so let's jump straight into it. In program 2 we have set up a menu of objects in the right-hand side of the screen. An object is selected by typing 1, 2 or 3. In practice, if we were using this technique frequently, an object would be selected from the menu by pointing a lightpen at it. When an object is selected it is dragged into position and fixed as before. Instead of dragging a line we are now dragging a complete object. The program to drag an object is identical to the rubberband program (which drags the end of a line) except every occurrence of PROCdrawordelete is replaced by PROCdrawordelete(selection$). This procedure selects one out of the three drawing procedures (resistor, capacitor, diode) and the selected object is drawn at a position under control of the directional keys. Figure 8 shows the screen during execution of the program.

Other common facilities in picking and dragging programs are magnification and rotation. For example, the above dragging program, another key option could be M for magnify and T (turn) for rotation. The structural alterations now required in the program are significant. In particular we have to change the way in which we store shape information. Currently this information is embedded in the drawing procedures as parameters of the PLOT 1 statement. The most convenient scheme is to store the current displacement coordinate values for an object in an array. These displacements will of course change as a function of the angle of rotation. Initially we could set up

```
10  MODE 0
20  PROCdrawmenu
30  GCOL 3,1
40  PROCpick
50  REPEAT
60    x = 500: y = 500 : PROCdrawordelete(selection$)
70    REPEAT
80    command$ = GET$
90    PROCprocesscommand(command$)
100   UNTIL command$ = "F"
110   PROCpick
120 UNTIL selection$ = "Q"
130 END

140 DEF PROCdrawmenu
150   MOVE 900, 0: DRAW 900, 1000
160   PROCdrawresistor(1000,600)
170   PROCdrawcapacitor(1000,400)
180   PROCdrawdiode(1000,200)
190   PRINT TAB(60,12);"1";TAB(60,18);"2";TAB(60,24);"3"
200 ENDPROC

210 DEF PROCpick
220   PRINT TAB(0,0); "Pick, (1/2/3)";
230   selection$ = GET$
240   PRINT TAB(0,0); "              ";
250 ENDPROC

260 DEF PROCprocesscommand(c$)
270   IF INSTR("FLRUD", c$) = 0 THEN ENDPROC
280   IF c$ = "F" THEN PROCfix: ENDPROC: ELSE
      PROCdrawordelete(selection$)
290   IF c$ = "L" THEN x = x - 5
300   IF c$ = "R" THEN x = x + 5
310   IF c$ = "U" THEN y = y + 5
320   IF c$ = "D" THEN y = y - 5
330    PROCdrawordelete(selection$)
340 ENDPROC

350 DEF PROCfix
360   GCOL 0,1 : PROCdrawordelete(selection$)
370   GCOL 3, 1
380 ENDPROC

390 DEF PROCdrawordelete(s$)
400   IF s$ = "1" THEN PROCdrawresistor(x, y)
410   IF s$ = "2" THEN PROCdrawcapacitor(x, y)
420   IF s$ = "3" THEN PROCdrawdiode(x, y)
430 ENDPROC
440 DEF PROCdrawresistor(x, y)
450   MOVE x,y: PLOT 1, 30, 0
460   PLOT 1, 0, 10: PLOT 1, 60, 0
470   PLOT 1, 0,-20: PLOT 1,-60, 0
480   PLOT 1, 0, 10: PLOT 0, 60, 0
490   PLOT 1, 30, 0
500 ENDPROC
510 DEF PROCdrawcapacitor(x, y)
520   MOVE x, y: PLOT 1, 30, 0
530   PLOT 0, 0,-30: PLOT 1, 0, 60
540   PLOT 0, 20, 0: PLOT 1, 0,-60
550   PLOT 0, 0, 30: PLOT 1, 30, 0
560 ENDPROC
570 DEF PROCdrawdiode(x, y)
580   MOVE x, y: PLOT 1, 30, 0
590   PLOT 0, 0,-25: PLOT 1, 0, 50
600   PLOT 1,25,-25: PLOT 1,-25,-25
610   PLOT 0,25, 25: PLOT 1, 30, 0
620 ENDPROC
```

Program 2. Picking and dragging

an array for a square, for example, as:

squarex(1)	100	squarey(1)	0
(2)	0	(2)	100
(3)	-100	(3)	0

To draw the square in any (dragged) position from x,y we need PROCdrawsquare (program 3). This is the same scheme as we have in the component drawing procedures (above) except that we are now storing the displacements in an array.

Now, pressing T would make the object rotate by a predetermined angular increment of, say, 10 degrees by altering the relative displacements. To do this we simply use a standard two-dimensional rotation transform. The procedure that services the rotation command is PROCrotate (program 4). Each time the key is depressed new displacements are calculated from the previous one. Note the figure is stationary while it is being rotated, it cannot be rotated using this structure and dragged at the same time.

```
440   DEF PROCdrawsquare(x, y)
450     MOVE x, y
460     FOR i = 1 TO 3
470       PLOT 1, x(i), y(i)
480     NEXT i
490     DRAW x, y
500   ENDPROC
```

Program 3. Example procedure

```
510   DEF PROCrotate
520     sintheta = SIN(RAD(10))
530     costheta = COS(RAD(10))
540     FOR i = 1 TO 3
550       x = x(i) : y = y(i)
560       x(i) = x*costheta + y*sintheta
570       y(i) = -x*sintheta+ y*costheta
580     NEXT i
590   ENDPROC
```

Program 4. Rotation procedure

HOW TO HANDLE INTERRUPTS

John Ferguson and Tony Shaw explain what interrupts are and how they work, with examples

Interrupts allow external devices such as alarms, temperature sensors, timers etc, to demand immediate attention from the computer's microprocessor.. They force it to abandon its current task and initiate a completely separate program call an *interrupt routine*. The concept of an interrupt is similar in some respects to a subroutine call. In both cases program flow is diverted to a separate program (a subroutine or an interrupt routine) which is then executed before control returns to the main program. However, there are some important differences. Subroutines are called at specific positions in the main program using a JSR (Jump to SubRoutine, see January issue) instruction. In contrast an interrupt routine can occur at any time, initiated by an external device sending a signal to one of the microprocessor's interrupt pins.

The 6502 microprocessor in the BBC micro has two input pins to detect interrupts:

NMI (Non Maskable Interrupt). This input is 'edge sensitive', and only initiates an interrupt routine when it detects a *high* to *low* transition.

IRQ (Interrupt ReQuest). A level sensitive input, active at logic zero.

As the name implies, the non maskable interrupt has a higher priority than IRQ. Further important differences between these two will be discussed later.

The operating system of the BBC micro makes extensive use of interrupts (figure 1). Both the floppy disc system and the Econet network use non maskable interrupts. Software to handle these interrupts is provided in special ROM chips issued with each system. The *User Guide* suggests NMIs should be avoided by the user and left only for the machine's use. Interrupt request (IRQ) is also used by the operating system with the microprocessor receiving interrupt signals generated by two on board chips – the 6522 VIA (versatile interface adaptor) and 6850 ACIA.

The system 6522 VIA (&FE40-&FE4F) provides periodic interrupts from one of its internal timers, updating the real time clock.

The 6850 ACIA serial interface chip can be programmed to generate IRQ interrupts whenever a serial character is received at the RS423 port.

Whenever a key is pressed a signal initiates an interrupt using the system VIA. The interrupt routine decodes which key has been pressed, evaluates its ASCII code, and places it in the input buffer.

The simple routine below illustrates how the operating system is still active capturing depressed keys even when running a Basic program:

```
10 FOR N = 0 TO 30000 : NEXT
```

While the program is running, type LIST and press Return. The characters will not appear on the screen and you might think it has not received your command – but it has! The characters have been captured and stored in an input buffer using an interrupt routine. Once the program above finishes the command LIST will appear and be performed.

Finally, the analogue to digital converter (ADC) uses the system VIA to pass its 'end of conversion' signal to the microprocessor's IRQ input. New samples are taken approximately every 10 milliseconds with an interrupt routine updating a table of results for each of the four input channels.

Because the machine is continually generating interrupts, great care is needed with any routine where execution time is important, ie any 'real time' programming. For example, a common method for producing a time delay is to use a simple program loop. If interrupts occur during the loop the overall execution time is increased by including the interrupt routine.

Although the machine operating

```
 10 REM USING INTERRUPTS TO INITIATE
 20 REM A PERIODIC "EVENT"
 30 REM (FOR OP. SYSTEMS>=1.0)
 40 REM USE KEY 9 TO START
 50 *KEY9"CALL&0D65 |M"
 60 OSASCI=&FFE3
 70 OSWORD=&FFF1
 80 OSBYTE=&FFF4
 90 EVNTV=&0220:REM EVENT INTERRUPT VECTORS
100 message=&0D01
110 REM SET UP TIME CONSTANT FOR INTERRUPT
120 constant=message+50
130 !constant=&FFFFFDFF:?(constant+4)=&FF
140 REM INSERT MESSAGE (UP TO 49 CHARACTERS)
150 $message="TIME TO TAKE THE DOG A WALK"
160 FOR PASS=0 TO 3 STEP 3
170   P%=message+100
180  [OPT PASS
190  .START LDA #EVENT MOD 256     \POINT TO EVENT
200         STA EVNTV              \HANDLING ROUTINE
210         LDA #EVENT DIV 256
220         STA EVNTV+1
230         LDA #14:LDX #5         \SAME AS *FX14,5
240         JSR OSBYTE             \ENABLES TIMER EVENT
250  .SETUP LDA #4                 \SELECT TIMER
260         LDX #constant MOD 256 \POINT TO TIME CONSTANT
270         LDY #constant DIV 256
280         JSR OSWORD             \START TIMER
290         RTS
300  .EVENT PHA:TXA:PHA:TYA:PHA:PHP \SAVE REGISTERS
310         JSR MESS                  \DISPLAY MESSAGE
320         JSR SETUP \RESTART TIMER
330         PLA:TAY:PLA:TAX:PLA:PLP \RESTORE REGISTERS
340         RTS
350  .MESS  LDA #7:JSR OSASCI      \BLEEP
360         LDX #0
370  .AGAIN LDA message,X          \GET CHARACTER
380         JSR OSASCI             \OUTPUT
390         INX                    \NEXT CHARACTER
400       CMP #&0D                \WAS IT A C-RETURN
410       BNE AGAIN               \IF NOT BACK FOR MORE
420         RTS                    \MESSAGE COMPLETE
430  ]
440   NEXT PASS
450 END
```

Program 1. Using the interval timer to initiate an 'event'

system makes extensive use of IRQ interrupts, the user can easily add interrupt handling routines. In theory, this should be possible with any of the machine operating systems, but it has not been documented for release 0.1. The remainder of this article deals only with the interrupt handling facilities offered from release 1.0 onwards. Also, page D locations are used by the disc operating system and the BRK handling routine should be placed elsewhere if your machine has discs. The contents of &202 and &203 should be altered to point to the new home of the BRK handling routine.

To simplify interrupt handling the BBC micro's operating system contains some ready made interrupt software that can be used to handle interrupts generated as the result of an 'event' within the machine. A typical event would be a pressed key, or completion of a task by the ADC. The complete list of events is: input buffer empty; input buffer full; depressed key on keyboard; start of TV field pulse; 'timeout' condition on interval timer; escape condition detected.

The user may decide to detect a particular event or ignore it. Figure 2 gives the list of *FX14 commands used to enable events and the corresponding *FX13 commands that disable events. (See *Acorn User*, May issue.)

When an event is detected the operating system can be diverted to the user's own event handling routine. Two vectors, EVNTV and EVNTV+1 (&0220 and &0221), are used to point to the start of the event handling routine. (This routine must terminate with an RTS instruction to return control to the main program.) The *User Guide* suggests the routine should last no longer than one millisecond and should preserve the processor registers.

Program 1 shows an example using the interval timer to initiate an event every five seconds. The timer is configured using an OSWORD call with the accumulator equal to 4 (figure 3). The X and Y registers are set up to act as pointers to the starting location of a five-byte time constant that is loaded into the timer. The timer increments by one every 1/100th of a second and initiates an event when it reaches

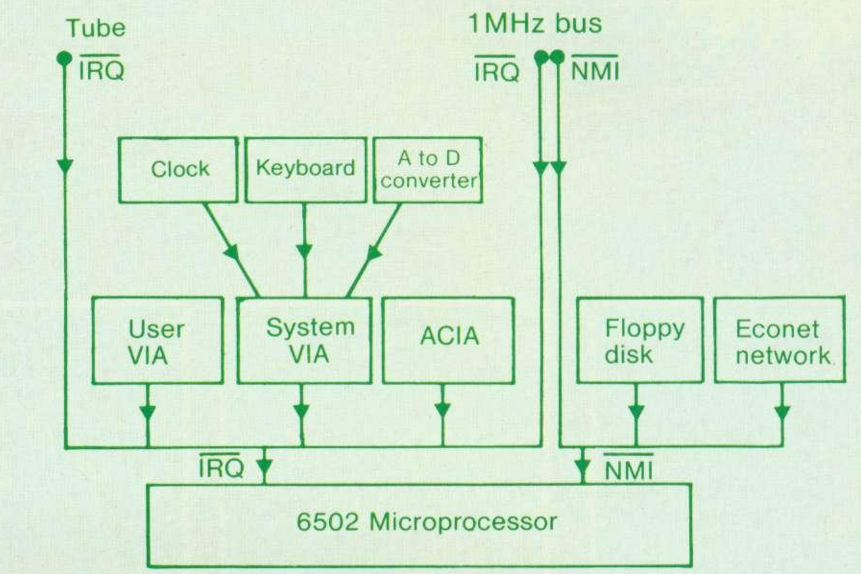

Figure 1. Interrupt schematic of the BBC micro

Disable	Enable	Event
*FX13,0	*FX14,0	Output buffer empty
*FX13,1	*FX14,1	Input buffer full
*FX13,2	*FX14,2	Character entering input buffer
*FX13,3	*FX14,3	ADC conversion complete
*FX13,4	*FX14,4	Start of vertical sync.
*FX13,5	*FX14,5	Interval timer crossing zero
*FX13,6	*FX14,6	Escape pressed

Figure 2. *FX commands used to enable and disable events

A =	SUMMARY OF FUNCTION
Ø	Read a line from the current input stream to memory
1	Read the elapsed-time clock
2	Write the elapsed-time clock
3	Read internal timer
4	Write internal timer
5	Read a byte in the input/output processor memory
6	Write a byte in the input/output processor memory
7	Generate a sound
8	Define an envelope for use with the sound statement
9	Read pixel colour at screen position X,Y
A	Read dot pattern of a specific displayable character
B	Read the palette value for a given logical colour

Note: All OSWORD calls use a parameter block somewhere in memory. On entry X(LSB) and Y(MSB) are used as pointers to the START of the block.

Example
A = 3 means 'read interval timer'.
The interval timer is incremented every 1/100 of a second.
The time interval is stored in 5 bytes pointed to by X and Y.
A = 4 means 'write interval timer'.
On entry X and Y point to the 5 locations containing the new time constant.

Figure 3. System OSWORD call summary

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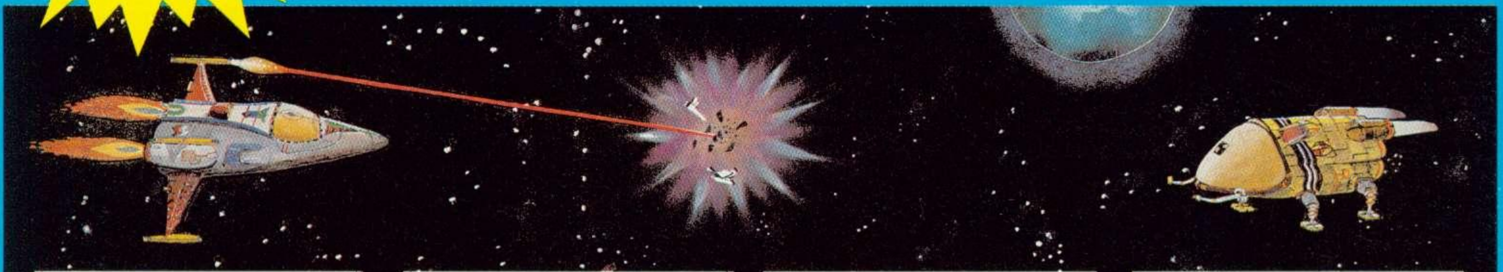

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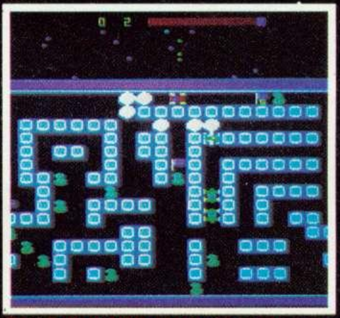

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```
10 REM CHANGING IRQ1 VECTORS
20 REM (OP. SYSTEM >=1.0)
30 IRQ1V=&0204
40 OSASCI=&FFE3
45 REM INSERT INTERRUPT ROUTINE
60 P%=&0D01
70[
100.RUPT   PHA                    \SAVE ACCUMULATOR
110        LDA #&41:JSR OSASCI \PRINT "A"
120        PLA                    \RESTORE ACCUMULATOR
130        RTI                    \RETURN FROM INTERRUPT
140]
160 REM CHANGE IRQ1 VECTORS TO POINT TO ABOVE ROUTINE
170[
180.GO     LDA #RUPT MOD 256:STA IRQ1V
190        LDA #RUPT DIV 256:STA IRQ1V+1
200        RTS                    \BACK TO BASIC
210]
220 CALL GO
```

Program 2. Disabling IRQ interrupts during a timing loop

```
10 REM DISABLING IRQ INTERRUPTS
20 OSASCI=&FFE3
30 OSRDCH=&FFE0
40P%=&0D01
50[
60.START SEI          \DISABLE IRQ INTERRUPTS
70.AGAIN JSR OSRDCH \GET KEY
80       JSR OSASCI \ONTO SCREEN
90       JMP AGAIN
100]
110 CALL START
120 END
```

Program 3. Disabling interrupts disables the keyboard

zero. Line 130 sets up the time constant to &FFFFFFFDFF in memory locations starting at address 'constant'. The machine code program begins by setting up the event vectors to point to the event handling routine event, and then proceeds to enable interrupts from the interval timer using the machine code equivalent of *FX14,5.

The event handling routine begins by saving the processor's registers and displays the message: 'TIME TO TAKE THE DOG A WALK'. Before returning control, the routine initialises the interval timer for a new event, ensuring events continue to occur at regular intervals. The routine ends by restoring the processor's registers.

After assembly, the program can be executed by pressing function key 9. Now, any activity, the machine is performing will be interrupted at five second intervals with the reminder to take the dog a walk. Even typing NEW and entering another program will not stop the repeated interruption. Pressing Break however will disable the timer event and restore normality.

The example may seem trivial, but this relatively simple technique will enable the BBC micro to perform several different tasks apparently simultaneously. For example, an event routine could be written to capture and store data from the ADC at say 10 minute intervals. At the same time a student could use the machine, completely unaware the micro was performing a second job. Provided any programs used did not overwrite the event handling routine or the captured data, a short program run at the end of the day would display the captured data.

On receiving a high to low transition on the NMI input the processor completes its current instruction before carrying out the following sequence of events.

The program counter followed by the processor status register is pushed onto the stack. The microprocessor then goes to memory locations &FFFA and &FFFB to find the ADL and the ADH of the first instruction in the interrupt routine. With most systems this is an indirect jump through two RAM locations that can be altered to point anywhere in the memory map. On completing the interrupt routine, control is returned to the original program using an RTI instruction. RTI restores the program counter and processor status values which were placed on the stack at the time of interrupt.

The program counter and processor status are the only registers saved automatically on entering the interrupt routine. If the routine makes use of A, X or Y then these registers should be saved at the start of the interrupt routine and restored at the end.

During the interrupt routine the I flag is set preventing interrupts on the IRQ input.

When an IRQ interrupt is received the activity followed by the processor is similar to that for NMI. As with NMI, an IRQ interrupt waits until the processor has finished its current instruction. The processor then checks the interrupt flag in the processor status register and if the flag is set ignores the interrupt and continues with the main program. If the flag is clear the microprocessor sets the flag to prevent further IRQ interrupts and then proceeds to store the porogram counter and the processor status register on the stack. Vector locations &FFFE and &FFFF are then used to point to the first instruction in the interrupt handling routine. As before this instruction is usually an indirect jump through two RAM locations. Again, an RTI instruction is used to return the microprocessor to its original program and restore the processor status register.

Two instructions give the

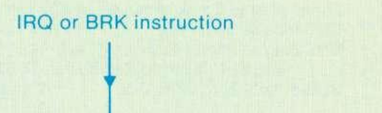

Figure 4. Operating system IRQ/BRK handling

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programmer control over IRQ interrupts: SEI (set interrupt disable); CLI (clear interrupt disable). The first is used to set the interrupt flag in the processor status register thereby disabling IRQ interrupts. CLI clears the disable flag, enabling IRQ interrupts.

Program 2 shows how both instructions can be used to protect a routine where the execution time important. Two points are worth attention. Setting the interrupt disable flag will only give protection from IRQ interrupts, not from NMI. Furthermore, disabling interrupts within the BBC micro will result in problems with some of its normal housekeeping duties (for example, the real time clock will lose time). Program 3 shows a second problem that will arise if interrupts are disabled when the 'get a key' routine OSRDCH is used. The program is the typewriter example given earlier with the addition of an SEI instruction. However, the program 'hangs' in OSRDCH, waiting for the key which is never detected since interrupts are disabled.

Once an IRQ interrupt is received, the operating system follows the routine shown in figure 4. The routine first checks the processor's status register to see if the interrupt was caused by a BRK instruction (a software interrupt described later). If not, vectors point at the machine's own routine to handle interrupt signals from devices such as the ADC or the real time clock. The machine's interrupt handler then interrogates each of these devices to determine which has to be serviced. If the source of the interrupt is not found the handler assumes it came from a new source, eg the VIA or the 1MHz bus, and progresses using an indirect jump through locations &0206 and &0207 (IRQ2V) to a user supplied routine.

It may sound complicated, but the following examples should help. Program 4 begins by inserting a short interrupt routine to place the character 'A' on the screen. Only the accumulator is preserved since this is the only register used by the routine. The second part of the program then sets up the IRQ1 vectors to point at interrupt routine 'RUPT'.

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```
  10 REM CHANGING IRQ1 VECTORS
  20 REM (OP. SYSTEM >=1.0)
  30 IRQ1V=&0204
  40 OSASCI=&FFE3
  45 REM INSERT INTERRUPT ROUTINE
  60 P%=&0D01
  70[
 100.RUPT   PHA                     \SAVE ACCUMULATOR
 110        LDA #&41:JSR OSASCI     \PRINT "A"
 120        PLA                     \RESTORE ACCUMULATOR
 130        RTI                     \RETURN FROM INTERRUPT
 140]
 160 REM CHANGE IRQ1 VECTORS TO POINT TO ABOVE ROUTINE
 170[
 180.GO     LDA #RUPT MOD 256:STA IRQ1V
 190        LDA #RUPT DIV 256:STA IRQ1V+1
 200        RTS                 \BACK TO BASIC
 210]
 220 CALL GO
```

Program 4. Changing IRQ1 vectors – take care!

```
  10 REM ENABLING INTERRUPTS FROM CB1 OF USER VIA
  20 REM USING IRQ2 VECTORS TO POINT TO INTERRUPT ROUTINE
  30 REM (OP. SYSTEM >=1.0)
  40 IRQ2V=&0206
  50 OSASCI=&FFE3
  60 REM FIRST INSERT INTERRUPT ROUTINE "RUPT"
  70 P%=&0D01
  80[
  90.RUPT   PHA                     \SAVE ACCUMULATOR
 100        LDA #&41:JSR OSASCI     \PRINT "A"
 110        LDA &FE60               \CLEAR INTERRUPT FLAG
 120        PLA                     \RESTORE ACCUMULATOR
 130        RTI                     \RETURN FROM INTERRUPT
 140]
 150 REM ENABLE INTERRUPTS ON CB1 OF USER VIA
 160 REM AND POINT TO INTERRUPT ROUTINE
 170[
 180.GO     LDA #0:STA &FE6C     \SET UP PCR TO DETECT H-L TRANS.
 190        LDA #&6F:STA &FE6E   \DISABLE ALL BUT CB1
 200        LDA #&90:STA &FE6E   \ENABLE CB1 INTERRUPTS
 210\CHANGE IRQ2 VECTORS TO POINT TO ABOVE ROUTINE
 220        LDA #RUPT MOD 256:STA IRQ2V
 230        LDA #RUPT DIV 256:STA IRQ2V+1
 240        RTS                 \BACK TO BASIC
 250]
 260 CALL GO
 270 END
```

Program 5. Using CB1 on the user VIA to initiate an interrupt

```
  10 REM ENABLING INTERRUPTS FROM CB1 OF USER VIA (USING OSBYTE)
  20 REM IRQ2 VECTORS POINT TO INTERRUPT ROUTINE
  30 REM (OP. SYSTEM >=1.0)
  40 IRQ2V=&0206
  50 OSASCI=&FFE3
  60 OSBYTE=&FFF4
  70 REM FIRST INSERT INTERRUPT ROUTINE "RUPT"
  80 P%=&0D01
  90[
 100.RUPT   PHA:TXA:PHA:TYA:PHA \SAVE REGISTERS
 110        LDA #&41:JSR OSASCI \PRINT "A"
 120        LDA #&96            \READ PORT B
 130        LDX #&60:JSR OSBYTE \AND CLEAR INTERRUPT FLAG
 140        PLA:TAY:PLA:TAX:PLA \RESTORE REGISTERS
 150        RTI                 \RETURN FROM INTERRUPT
 160]
 170 REM ENABLE INTERRUPTS ON CB1 OF USER VIA
 180 REM AND POINT TO INTERRUPT ROUTINE
 190[
 200.GO     LDA #&97:LDX #&6C   \SELECT PCR ON USER VIA
 210        LDY #0:JSR OSBYTE   \SET UP TO DETECT H-L TRANS.
 220        LDA #&97:LDX #&6E   \SELECT IER ON USER VIA
 230        LDY #&6F:JSR OSBYTE \DISABLE ALL BUT CB1 INTERRUPTS
 240        LDA #&97:LDX #&6E   \SELECT IER ONUSER VIA
 250        LDY #&90:JSR OSBYTE \ENABLE CB1 INTERRUPTS
 260\CHANGE IRQ2 VECTORS TO POINT TO ABOVE ROUTINE
 270        LDA #RUPT MOD 256:STA IRQ2V
 280        LDA #RUPT DIV 256:STA IRQ2V+1
 290        RTS                 \BACK TO BASIC
 300]
 310 CALL GO
 320 END
```

Program 6. As program 5, but using OSBYTE

MULTIPLE STATEMENT LISTING OPTION

£20 Program legibility idea earns £20 for Tony Hallam

IN interpretative languages such as Basic there is continual conflict between program efficiency and legibility. The existence of the LISTO command in BBC Basic is evidence of the designers' wish to reduce this conflict. However, a major cause of illegibility is the use of multiple statements on a line separated by colons, which LISTO does nothing to tackle.

Listing 1 checks the output stream for colons and precedes each by a carriage return, line feed and five spaces. Colons which appear in REMs and text strings will be affected also. However, colons tend not to be used in such circumstances and the inconvenience is usually minimal.

When run, the program loads three machine code routines into memory page D (which is reserved for user routines in non-disc machines).

The first routine loads lines 60 – 190 into memory D00 – D23. It checks for a colon and outputs the extra characters and colon if detected. If one is not detected it simply outputs the character. The scheme is similar to that on page 457 of the *User Guide*.

Lines 200 – 240 form the second routine in D24 – D2E. This restores the vector WRCHV to its original value and provides a means of turning the listing option off using CALL &D24.

The third routine (250 – 290 in D2F – D39) is for changing WRCHV so the output stream passes through the first piece of code. It can turn the listing option on by CALL &D2F.

CALL &D24 and CALL &D2F are potential causes of disaster since any finger trouble in typing could cause a system crash. For this reason lines 320 and 330 assign function keys f0 and f1 to perform the calls (f0 turns the listing option on; f1 turns it off).

Finally, the listing option described above can be used in conjunction with LISTO. However, when using edit and copy keys it is recommended to disable all listing options.

NB, If you have discs, or any other upgrade which accesses page D, use &C00 onwards instead of &D00. Change 270 to #&C instead of #&0. Change line 30 to &C00 instead of &D00. Also change lines 320 and 330.

This excellent idea could be slightly improved if text following an ELSE was also separated out. However, this is not easy. Again, LISTO will not indent the portions of text separated out between colons, but modifying this is even harder. Readers with these or other modifications are invited to write in.

```
10 V%=&20E:X%=?V%:Y%=V%?1:A%=X%+256*Y%
20 FOR PASS=0 TO 3 STEP 3
30 P%=&D00
40 [
50 OPT PASS
60 .START CMP #58
70        BNE S1
80        LDA #10
90        JSR A%
100       LDA #13
110       JSR A%
120       LDA #32
130       JSR A%
140       JSR A%
150       JSR A%
160       JSR A%
170       JSR A%
180       LDA #58
190 .S1   JMP A%
200       LDA #X%
210       STA V%
220       LDA #Y%
230       STA V%+1
240       RTS
250       LDA #0
260       STA V%
270       LDA #&D
280       STA V%+1
290       RTS
300 ]
310 NEXT
320*KEY 0 CALL&D2F |M
330*KEY 1 CALL&D24 |M
340 STOP
```

Listing 1. Multiple statement listing option

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.

At least £5 will be paid for any tip published, with £10 for those which merit a one-star award and £20 for real humdingers!

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.

SCREENS ON TAPE

MR H. Edwards of Oxney has written to ask how to save the screen contents on tape. This is easy, as long as the screen has not been allowed to scroll since the last clear-screen. Use *SAVE to save from HIMEM to the top of RAM (&7FFF in a model B). However, if the screen has scrolled, HIMEM will not correspond to the top left pixel. For this reason always clear the screen before using *LOAD to get back the display.

PASSWORD LEGIBILITY

MR E. Robertson of Edinburgh has written to say there is a problem with the March password program. If the program is listed on a printer, the 'invisible' three lines appear. This does not detract from Benjamin Finn's idea, but can anyone improve on it? As well as correcting the printer display, readers might like to think of ways of making it difficult to erase the three extra lines. Write in with your suggestions – the best will be published.

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Quick retrieval tip from disc using hash routine from Hugh Simpson-Wells

£10

OPENIN is particularly useful for writing to files in Basic version 1 on disk. This means, for instance, you can output just one record to a file without having to rewrite the whole file to disk using OPENOUT, saving time and memory.

Here is an example of a hash function which could be used to generate addresses on disk to store for example, names and addresses, and retrieve them quickly:

```
HASH = 120*((ASC(Z$)-&40)*4+
   INT((ASC(MID (Z$,2,1))-&40)/6))
```

This generates an address between 0 and 12480 depending on the first two characters of Z$ which might be a surname. Assume a file has been opened called NAMES using:

```
X=OPENIN "NAMES"
```

Now put PTR#X=HASH and check what is there using INPUT#X. If it is available we could write to it using PRINT#X, (variable), if that's what we want otherwise, we must add 120 to our old HASH (since record length is 120) and set the pointer:

```
HASH=HASH+120:PTR#X=
   HASH MOD 12480
```

(this makes the file 'circular')

This must continue until a suitable location is found.

When reading from the file a similar procedure must be adopted, advancing the pointer until the correct record is found. Average access time is very short for a file which is not too full.

I put forward the hash function as an example of the use of OPENIN to output to a file on disk, which is apparently not documented. I am sure readers will come up with more interesting uses.

If you intend to append to your file later, it is essential to create dummy records, which can be overwritten. If this is not done, space will be lost if other files or programs are saved afterwards.

Also, when you try to append the 'can't extend' error will crop up (disc manual p67).

Line spacing variation from A. Kiernan

£5

HAVE you ever wondered how the BBC micro generates lines between lines in modes 6 and 3? Well it is possible to control this line spacing by reprogramming the 6845. Type in listing 2, but don't run it!

Line 10010 does all the work. VDU 23;9. . . sets the spacing, and the remainder of the line centralises the screen and adjusts the vertical hold.

Now enter mode 6 (or mode 3) and type in listing 3.

The screen will jump and shrink a little and you will find the lines between the rows have disappeared. Any value between about 0 and 3 can be used in the brackets, but silly values will cause the display to lose synchronisation.

```
10000 DEF PROCLINE(L):L=L+7
10010 VDU23;9,L;0;0;0;23;4,
      (7-L)*4+38;0;0;0;23;7,28+(8-L)*2;0;0;0;
10020 ENDPROC
```

Listing 2. Controlling line space (do not run)

```
VDU19,0,1;0;
PROCLINE(0)
```

Listing 3. 'Shrinks' screen in mode 6

RARE GLOBAL BUG

THERE is a rare bug concerning global variables that may occur in programs, but which is difficult to track down. To understand this, type in listing 4 and follow the instructions, ie press escape when asked. Note the values of X%, Y% and A$. They are the local values 6,6 and 'second' respectively; the global values of 4,2 and 'first' have been permanently lost!

```
10 ON ERROR PRINTX%,Y%,A$:END
20 X%=4:Y%=2:A$="FIRST"
30 PROCTEST("SECOND")
40 DEF PROCTEST(A$):LOCAL X%,Y%
50 X%=6:Y%=6
60 CLS:PRINT''"Press ESCAPE";
70 GOTO70
80 ENDPROC
```

Listing 4. Procedure 'error'

My advice is to always disable the escape key (see April's Forum if you have OS 0.1) if the loss of the global value would be problematic. Other errors in procedures and functions, such as disc errors, are more difficult to control. Nevertheless, it is important to be aware of the potential problems.

DISC SHIFT PROBLEM

ONE reader has sent in a listing of February's disc shift machine code program, which on the surface looks an exact copy of the one published. However, he reports it does not work. The most likely reason is that one or more lines of the listing contain extra spaces at the end. These are invisible in the listing but will affect the program. For readers with other similar problems here is a check: type NEW and *EXEC the program. TOP-PAGE should be 786; if it isn't, you have extra spaces.

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THE FUTURE FOR MICROS

The government clearly believes information technology is vital to Britain's industry. It will also play an increasingly large role in our lives and education. Tricia Strong and Paul McGee outline an IT course being developed in Croydon schools for the last in our six part series on micros in primary schools.

Information Technology Year 1982 aimed to make people aware of the impact of IT. It achieved limited success and by the end of the year 62 per cent of the population had heard of IT, although fewer knew what IT is or how it would affect them.

In the same year, the Department of Industry extended its scheme to put a micro in every secondary school to include primary schools. We are now feeling the effets of two large government schemes aimed at educating the population of this country. But how should primary schools make their pupils aware of the effects of microelectronics and what role can the micro itself play?

IT is not a dream of the future, yet pupils still leave school unable to answer a telephone properly – let alone use an information retrieval program. But this is not something to be left to secondary schools. Teachers have a hard job before them, delving into these fast-moving concepts, but if the next generation is to be confident about new technology, provision must be made on primary timetables now.

Many schools have prepared some kind of course in information technology, either as a separate entity or as part of several current subjects. The MEP (Microelectronics Education Programme) is concerned about the lack of suitable materials for anything other than examination courses in computer studies, and has sponsored, in conjunction with the DoI, a two-year project in Croydon to develop an IT curriculum for the 9-14 age range.

Information technology is an umbrella subject taking in three existing disciplines; microelectronics, computing and telecommunications. In schools, this includes communication studies, office practice, library studies, computer studies and computer appreciation. A syllabus to cover these areas needs to look at the impact of IT on information handling in all areas at home, school, leisure and work. Consequently much of the material will also be encountered in other subjects, but the purpose here is to highlight the principles and to set the applications within the context of IT.

One way of introducing information technology is for teachers to make pupils aware of the communication methods used in school and to discuss why a particular method is used in any given situation. Many teachers will need to improve their attitudes to technology and, in particular, to ensure that sexist views which allow women to use office products and men to usee obviously mechanical or electronic devices, are not passed on.

An IT course will stimulate demand from pupils for more suitable styles of teaching and learning and should thus make it easier for teachers to use computers. The existence of such work will provide an IT course with practical, day to day examples. Teaching, learning and working will be transformed by word processing and information retrieval systems, while the IT curriculum would focus on the undoubted advantages of these examples of information technology.

Once we began to look at applications relevant to the pupil the syllabus grew to include:

- What is information?
- How do we use information?
- How is information represented in a machine?
- How is information stored and accessed?
- How is information transmitted and communicated?
- IT in education and the home.
- IT in the office.
- IT in monitoring and control.
- IT in forecasting and simulation.
- Machinery of IT.
- Applications and implications of IT.

A series of 12 pupils' books with supporting software and teacher's notes will cover this syllabus and provide the core for a course in IT. The course will be practical, though not necessarily using a micro. Much of the technology referred to will be too expensive for schools, but it can be demonstrated using programs on micros. Trying to run an IT course without using a micro would be like learning to drive a car on a simulator and never going on the road.

Each booklet will provide a complete unit of work on a topic in the syllabus. The series will not be sequential and, although one volume will be an introduction to the course and some will be aimed at the top end of the age range, the course can be ordered to suit teachers. Two booklets will be devoted to considering real-life applications and the resulting implications of IT. Through studying applications the topics covered in other booklets can be put into context and the implications become meaningful. (Two of the titles aimed at top juniors are outlined below.)

In Croydon, several secondary schools will be including IT on their timetables in September and teachers are already attending weekly meetings to give them a grounding in the subject. They come from a wide range of backgrounds, including geography, languages, PE and needlework.

To provide a balanced picture of IT and dispel any feeling that it is a technical subject for superbrains only, it is important to recruit teachers who are skilled communicators and have an interst in the technology, rather than 'spanner-men' and electronics 'whizzkids'. To avoid the risk of IT becoming a male-dominated reserve, it is essential to involve everyone. The effects of technology are not confined to men and girls must not be discouraged from enjoying and benefitting from the course.

Educators shaping schemes of work have a responsibility to ensure that girls are encouraged to take as large a part in this subject as boys. Perhaps this course will help to break down any ideas that technology is a man's domain.

As ideas for the course are developed, they are presented for discussion to teachers in the weekly meetings. They try out the programs and teaching materials themselves and can take them back to school to use where possible with children.

Several schools – primary, middle and secondary – have volunteered to test and criticise the materials. Because of the range of schools, the materials will be used in many different ways – as they will be in their final form. Some schools use them for one or two lessons a week regularly while others, where the timetable allows, use them as the core of a project lasting a few weeks and incorporating related work in the way that many primary school teachers prefer to work.

Response has been tremendous and interest expressed by organisations as diverse as the Citizen's Advice Bureau, a word processing association and a women's magazine. The Equal Opportunities Commission has provided additional funding to ensure the project is acceptable to girls, and to provide guidelines for teachers and parents on why and how to encourage girls to follow an IT course.

OUTLINE OF TWO PUPILS' BOOKLETS IN SERIES OF 12

Introductory booklet

THIS aims to develop an awareness of what information is and how we handle it. By studying human methods of information handling an easier understanding of automated systems should be reached.

Objectives

After following the work in this booklet, a pupil should be able to:

- recognise sources of information, informal as well as specific.
- recognise occasions and processes for handling information – analysing, refining, sorting, synthesising and classifying.
- understand the importance of relevance, availability and accuracy of information.

First we examine what is considered to be information and how our perceptions absorb it. Next follows a brief history of man's need for information and developments in access and transmission. It looks at methods of communicating information and the problems involved, taking as examples proverbs, mnemonics, flag signals and coded messages (code breaking program is being written to support this).

Another section will look at developments affecting the transmission of information; the printing press, railways, telegraphy, photography, telecommunications and broadcasting.

The importance of availability, accuracy and relevance of information are considered as are the effects of information on planning, organisation and forecasting.

Information skills

The aim of this booklet is to ensure that all pupils are equipped with the necessary skills to enable them to cope as people living in an information society dealing with real situations, in education, at work and at home.

Objectives

By the end of the booklet pupils should:

- be able to identify their needs for information, formulate questions, find and select resources, evaluate, record and present the information they have found, and apply it.
- have developed these skills further when using new technology in the areas of communication and information.

The work in this booklet will be familiar to any English/library study skills teacher. However, traditional work has been extended to new technology. It begins with the traditional information skills, but incorporating IT wherever possible, eg, teletext or viewdata. Organising and presenting information is suggested as a practical exercise on an actual project, during whch pupils must also practise their skills of interpreting, evaluating, analysing and recording information. Various techniques are suggested for this. The principles of a word processor and text editing are explained and a demonstration program is being developed.

SUMMARY OF INFORMATION TECHNOLOGY SYLLABUS

THIS syllabus is not a teaching scheme and the latter has to be developed by each individual school. Pupils of this age are unlikely to be ready to discuss abstract concepts relating to the implications of IT which should be taught through applications which are meaningful to the pupil. Wherever possible these applications should have direct relevance to pupils and should involve them in practical activities.

Nature of information
Brief history of man's need for information and significant developments in communication. Role of information in modern society. Effect of information on planning, forecasting, organisation and control. Importance of relevance, completeness, accuracy and availability. The information explosion.

Information representation
Ideas of data and information. Coding systems, eg post codes. Consideration of ease of use, validation techniques, compatibility, loss of information and storage requirements.

Analogue and digital representation in mechanical and electronic devices and the consequences for accuracy, storage and transmission.

Graphical representation of information. Choice of medium: effects of medium on author and recipient; evaluation of medium.

Information skills
Understanding and interpreting: links with grammar and literacy. Analysing, processing and synthesising: refining and broadening; discussing and questioning; sorting and classifying; merging, collating and extracting.

Recording and presenting: the medium and the message. Applying: emphasis on information lost in coding.

Concept of a system
Relationship between input, output, storage, process and transmission. Comparison of the features of manual and electronic systems from the user's point of view.

Storage and retrieval
Reference books: encyclopaedias, telephone directories (printed and microfiche), timetables and route maps. Retrieval of information using titles, contents, indexes and cross references. Card-based and microfilm library reference systems.

Concepts of file, record and field. Basic knowledge of computer storage systems – main store, tapes, discs, videodiscs, associative storage. Use of and need for computer data bases – relational and key word.

Information transmission
Modes: serial or parallel; local or remote; interactive; electronic.

Telephone systems: viewdata systems including electronic mailbox, gateways, local viewdata systems and telesoftware. Line and packet switching systems, digital exchanges. Local and business subscribers: exchanges; message recorders; paging, facsimile and transmission.

Radio and television systems: phone-ins; telex and telesoftware; citizens' band; cable systems.

Information manipulation
Use and importance of merging, collating, extracting and sorting files of data or information. Comparison of manual and computerised systems.

Office practice
Written communication: letters, reports, memoranda, accounts.

Visual communication: charts, tables, graphs. Importance of presentation.

Need for organisation, collection, classification, storage and retrieval of documents.

Accounting systems: audit, control, forecasting. Impact of IT on: word processing, data processing, computer file storage, output devices.

Impact on staffing: levels, skills required, training, job satisfaction and expectations.

Man-machine interfacing
Keyboards, including QWERTY, touchpads, special purpose including microwriters. Use of screens: importance of graphics, colour and touch sensitive screen and lightpens as input. Voice input and output. Electro-mechanical devices: paddles, jòysticks.

Types of printer: dot matrix, daisy wheel, ink jet. Graphical output of low and high resolution graphics, use of colour.

Control applications
Idea of feedback systems. Analogue to digital and digital to analogue conversions. Control applications in domestic appliances: washing machines, central heating. Importance of the microprocessor. Need for standard interfaces. Practical experience of controlling simple devices including those which accept inputs to control outputs.

Simulation and modelling
Non-mathematical approach to using computers to simulate events and hence to forecast. General understanding of applications such as Ernie, weather forecasting, industrial process control. Simple practical experience of simulations of situations from the school curriculum.

Personal devices
Electronic games. Educational toys: dedicated and general purpose. Home computers and networks. Links with television and telephone. The computer controlled home. Telesoftware via telephone and television. Computer clubs. Role of the Education Service.

Computers in education
Use of computers for CA1 CAL and CML. Role of word processing and information retrieval for teachers and students. Use of computers in school administration, libraries and the careers. Computer aided design.

Implications
Organisation of work: skills needed, location, changing patterns of work. Privacy and security of information: legal framework, practical problems of computerised and manual systems, human considerations.

There is a growing need to see education extending far beyond compulsory schooling. People will need to study for their employment; for personal or social needs; or for pleasure. To do this, education should help people to learn and give them confidence to undertake further study.

The styles of learning exemplified by the Open University, the proposed Open Tech and distance learning methods are likely to become more common, and it will be essential for pupils to use these systems. Culturally deprived homes may not be able to offer the guidance and support that the children most in need require, and thus the edcuation system must enable all people to benefit from improved learning possibilities.

The IT course is meant to have a strong practical bias with pupils learning how to use computers rather than only being able to write about them. To encourage this a certificate of competency, similar in approach to scout and guide badges, has been developed at a series of levels. The tasks to be carried out successfully to gain the first level are shown in appendix 1.

SOFTWARE

Software being developed for the scheme includes quiz and search programs. Young pupils often have exaggerated ideas about the power of computers and instinctively type questions of the sort 'Who won Wimbledon in 1980?', and are surprised to receive answers such as 'Syntax error', 'What?' or '????'. The quiz programs are designed to help young children understand that computers only know what someone tells them. Although this idea can be developed by writing programs the lack of success of so many 16-year olds suggests that even younger pupils would never gain a realistic idea of the power of computers.

Process allows pupils to make up a multiple choice test on any topic. The finished test is stored on a data tape for later use. Pupils enter their questions and, for each question, the correct answer and distractors. The pupil is then asked to provide messages for those who score well, who gain an average score and those who do badly.

Student's name ....

A:	Effective Use of Hardware	
1.	Connect and disconnect, as appropriate, a computer with:	....
	a cassette deck	....
	a disc drive	....
	a monitor	....
	a keyboard	....
2.	Switch on/off in the correct manner.	....
3.	Display reasonable accuracy on the keyboard.	....
4.	Load cassette/disc.	....
5.	Make a copy of a program:	
	cassette to cassette	....
	disc to disc	....
6.	List unsuitable storage practices for:	
	i) hardware — strong heat	....
	excess moisture	....
	excess dust	....
	switched on	....
	ii) magnetic media — as above, plus	....
	strong magnetic fields	....
	uncovered	....
	do not touch surface	....
	do not write on case	....
B.	Running Programs.	
7.	Load BASIC, if necessary.	....
8.	Load and run a named program.	....
9.	Use files: update an existing file	....
	save a new file	....
10.	Edit an existing program:	
	list program	....
	identify line	....
	alter line	....
	re-run program	....
11.	List correct procedures for appropriate error messages:	
	syntax error	....
	not found	....
	bad program	....
	no room	....
	bad load	....
	load error	
	mistake	....
12.	Understand what is meant by the following terms:	
	hardware	....
	software	....
	program	....
	memory	....
	backing store	....
	RAM	....
	ROM	....
	K	....
	operating system	....
	data	....
	debug	....
	disc drive	....
	file	....
	information retrieval	....
	line printer	....
	magnetic tape	....
	peripheral	....

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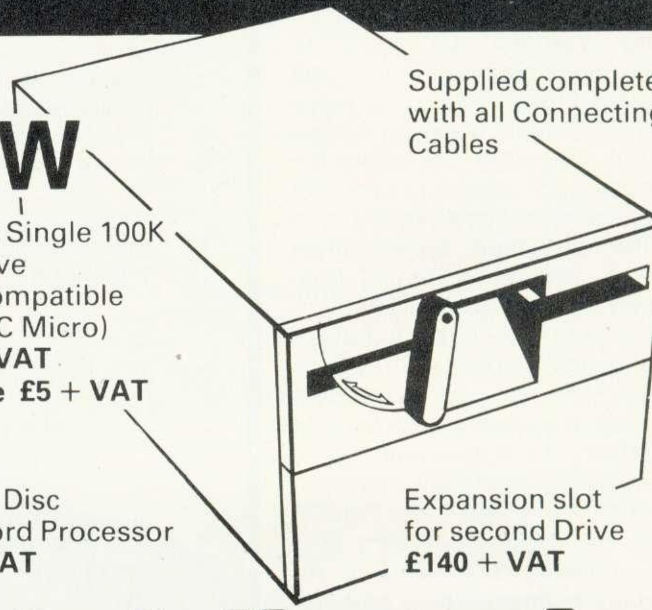

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SBL01	Forth Cassette	£14.65
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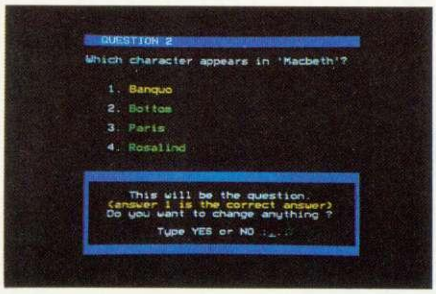
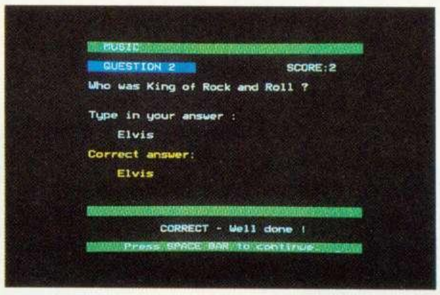


Process: **Program which allows pupils to develop their own quizzes**



Proctest: **Similar to *Process*, but allows a greater variation in answers, and in difficulty**

Search: **Database software in action, having just traced what blue coats are available**

There are editing routines to allow changes to be made to the question, answers and comments. So far, this program is similar to one in the Micro Primer pack but the next one is rather different.

Proctest develops the idea of what the computer can know. The questions are more open-ended and the computer can be given up to eight acceptable answers. For example all the possible ways to write 'Henry VIII in reply to the question 'Which English king had six wives?'. Not only do pupils learn about the limitations and power of computers, they also discover a little about the different ways information can be coded as data, a topic which is developed more fully in the accompanying books.

Information will increasingly be stored or manipulated as data by electronic devices, and schools will have to teach a far greater range of information handling skills than at present.

What information can be retrieved from a data base and how this is performed depends on the structure of the system. Pupils will be encouraged by the teaching materials to use a database to perform tasks which would otherwise be tedious, but they also need a simpler idea of how the database is implemented. *Search* does this. It shows graphically the structure and operation of a relational database, a linked list and an inverted database.

In each case the files used for demonstration are small. Two small databases can be searched using moderately complex enquiries and the pupil is able to follow the action of the search. The inverted database program is almost finished and all three programs are supported by material written by a former school librarian.

The importance of information retrieval, word processing and financial spreadsheet packages are reflected in the higher levels of the Certificate. The books must be related to software which the pupils can easily use and so a limited word processing package and a simplified Visicalc-type package are being developed.

Schools which are willing to seriously trial written material and related programs should contact Trisha Strong c/o Acorn User, 53 Bedford Square, London WC1B 3DZ. Those who want a draft copy of the Certificate of Computer Competence should enclose a stamped addressed envelope.

THIS is the sixth and final part of our initial series on computers in primary education. If you have any enquiries, comments, or suggestions for the second series which will start in the Autumn, write to Tony Quinn, Acorn User, 53 Bedford Square, London WC1B 3DZ, marking your envelope 'Education'.

Education authorities, or individuals requiring reprints of this series should write to the same address.

Finally, we omitted to mention that the program *Tray* described in May's *Acorn User* was devised by Bob Moy and Mike Blamires and initially developed at Forest Hill School, London. It is being extended with the help of the English Centre of the ILEA. *Tray* is one of a suite of programs Bob Moy has developed to help teach reading and text analysis up to 'A' level. Enquiries should be addressed to: Mr Bob Moy (Advisory Teacher for English at the usual Acorn User address.

NINE ESSENTIALS

- **Information technology must be a practical activity which builds pupils' confidence to use computers.**
- **Knowing about computers means knowing when and how to use them rather than the details of how they work.**
- **Pupils should learn to use computers sensibly, ie, by using the appropriate software, to perform tasks which would otherwise be unduly tedious.**
- **There is already encouraging evidence that sensible activities using computers have a positive benefit on girls' attitudes if started in primary school.**
- **Information technology can be taught either as a separate subject or as a co-ordinated part of many other subjects.**
- **Teachers need training over a reasonable period of time to become confident and proficient in the use of computers.**
- **Information technology is the future revolution which has already happened.**
- **IT can be taught effectively only with sufficient computers and informed and well motivated teachers.**
- **Teachers can help pupils appreciate IT by using appropriate means of communication in their own lessons.**

▶page 24

The 50p network

THE BBC micro is a remarkable machine for communicating with other systems across phone lines using an acoustic coupler. Robin Kennedy of Kensoft in Cleveland has passed on a gem of a program for handling the BBC side.

Program 9 runs happily on OS 0.1, 1.0, and 1.2 (but not the Tube). To understand how it operates we need to look at memory locations &FE08 and &FE09. The second is easily dealt with – it is the location of the 6850 ACIA register dealing with transmitting and receiving character via the RS423 port. Any received character enters the BBC through this location, while any character placed into this location is apparently transmitted through the RS423 circuitry. The other location, &FE08, is more complex. It appears &FE08 can be read from as a status register for the 6850 ACIA. If the first bit is set, it indicates a character has been received in &FE09. If the second bit is set, it is 'clear to send'. Program 9 above looks at both these bits in line 40, where it says; 'if there is a character and it is clear to send, continue'. This is fine for 300 baud, but the program can be tweaked to run at higher rates. I use the BBC micro coupled to a development Z8 running at 1200 baud (program 10).

And inter-Beeb communication is possible at 9600 baud with program 11. Whereas programs 9 and 10 made the BBC into a terminal which requires the host system to return each transmitted character so that the user could see his/her own keypresses (full duplex), program 11 acts in a different way. Each of the two communicating Beebs prints the characters which it receives and those it is transmitting. Additional coding is required to handle the CR codes at the end of lines.

```
10 *FX8,3
20 *FX7,3
30 st%=&FE08:trx%=&FE09
40 IF ?rx%=3 PRINT (?trx% AND 127);
50 a$=INKEY$(0):IF a$<>"" ?trx%=ASCa$
60 GOTO40
```

Program 9. Terminal software

```
10 *FX220,0
20 *FX7,4
30 *FX8,4
40 st%=&FE08:trx%=&FE09:MODE3
50 IF(?st% AND 1)=1 PRINTCHR$?trx%;
60 a$=INKEY$(0):IFa$<>"" ?trx%=ASCa$
70 GOTO50
```

Program 10. BBC to Z8 communications system

```
10 *FX7,7
20 *FX8,7
30 st%=&FE08:trx%=&FE09
40    IF?&FE08=3   a$=CHR$(?trx%   AND   127)
 :PRINTa$;:IF a$=CHR$13 PRINT
50 a$=INKEY$(0):IFa$<>"" ?trx%=ASCa$:PRINTa$;
55 IFa$=CHR$(13) PRINT
60 GOTO40
```

Program 11. BBC to BBC communication

While playing with the software shown above, the germ of an idea arose. While running courses, a common need is that of loading Basic programs for teachers to evaluate. What was required was the ability to load each BBC from a disc system. But this seemed at first a non-starter because of the need for multiple disc upgrades. However in OS 1.2, typing *FX2,1 causes the machine to think the RS423 port is a keyboard. This meant it was possible to receive via the RS232 port with a single command. Each of our BBC micros could be configured to receive with a function key.

*KEY1 *FX8,8¦M*FX7,8¦M*FX2,1¦M

Eventually I found *FX3,5 would transmit from an RS232 port, and so developed the function key:

*KEY0 *FX8,8¦M*FX7,8¦M*FX3,5¦MLIST¦M*FX3,4

Because LIST produces ASCII text, and *FX3,5 sends it down the RS423 port, this function key worked and transmission was successful. Unfortunately the recipient BBC micro still had its keyboard locked out. The final approach was:

*KEY0 *FX8,8¦M*FX7,8¦M*FX3,5¦ML.¦MP."*FX2,0"¦M*FX3,4¦M

This had the result of commanding the receiving micro to listen to its keyboard, by making it print *FX2,0 as a direct command. The final *FX3,4 in key0 simply sets up the transmitting micro to print to screen only. The connections between the two micros can be seen in figure 4. Transmission is effectively a SPOOLing/EXECing process and programs can be appended. For the best transmission:

- load program for transmitting (Tx) from disc;
- press Break on the receiving (Rx) micro;
- press f1 on the Rx micro;
- press Break on Tx micro;
- type OLD on Tx micro;
- press f0 on Tx micro.

The lead used is 10 metres long, and is taken to the RS232 socket on each Rx micro in turn 'hosepiping' Basic programs swiftly into them (10k in 30 seconds).

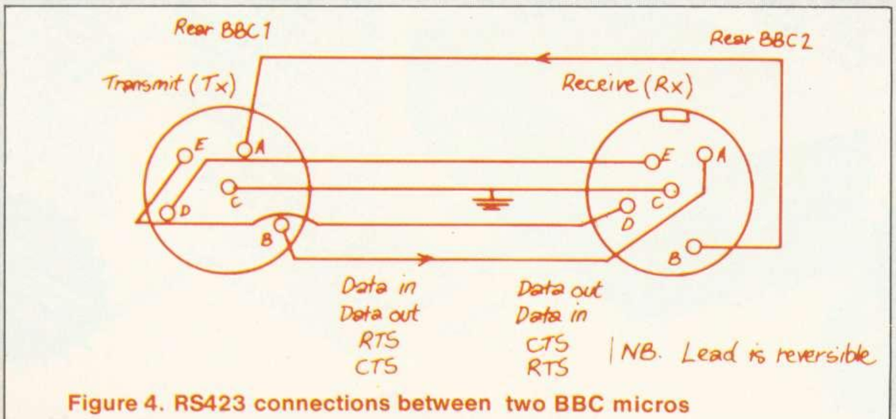


Figure 4. RS423 connections between two BBC micros

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String Handling by S. Todd

HERE are two assembly language programs (inspired by your excellent book on assembly language for the BBC micro) to help write large Basic programs.

The first, called 'finder', is located in page &C as a default but can be located anywhere by changing line 100 in listing 5. It expects an input string up to 32 characters and will output any Basic line containing that string (keywords excluded). The output is done in paged mode as it is extremely fast. Instructions are included within the program.

Second, 'error-util' acts as an extension to the BBC machine's error reporting (listing 6). The program redirects the BRK vector to the start of my code.

When an error occurs, the offending line is printed with the error highlighted. Then control is passed back to the machine which prints the normal error message.

Note, these routines will not work with the new version of Basic.

```
   10REM Find utility. S.A.Todd. Copyright 1983.
   20REM Uses zero page addresses &70 and &71 only. Requires 1.0 MOS or later.
   30REM Set code assembly location in line 100. Code is 215 bytes long.
   40REM Type in string to be found on prompt 'find ? '.
   50REM Output is whole BASIC line with string occurence.
   60REM NOTE. GOTO numbers are NOT output correctly.
   70REM GOTO numbers will be correct if subroutine 'out_number_line'
   80REM is replaced by the ROM listing routine. I can't find the address.
   90
  100page=&C00
  110
  120len_string=0
  130FOR T% = 0 TO 3 STEP 3
  140P%=page
  150[OPT T%:.start:LDA #&C:JSR &FFEE:JSR &FFE7:JSR &FFE7:LDA #14:JSR &FFEE:LDA
#0:TAX:STA &70:LDA &18:STA &71:LDY #len_string:.next:LDA message-1,Y:JSR &FFEE:D
EY:BNE next:TXA:LDX #start_table MOD 256:LDY #start_table DIV 256:JSR &FFF1
  160BCS finish:CPY #0:BEQ finish:INY:LDA #13:STA &A0F,Y:JSR &FFE7:JSR &FFE7:.ne
xt_try:LDY #1:LDA (&70),Y:CMP #&FF:BEQ finish:JSR check_occurence:BEQ next_try:J
SR out_number_line:JMP next_try:.finish:JSR &FFE7:JSR &FFE7:LDA #15:JSR &FFEE:RT
S
  170.check_occurence:LDY #4:STY &72:DEC &72:.next_part_line:LDX #4:INC &72:LDY
&72:.nextt:LDA (&70),Y:CMP #13:BEQ next_line:CMP &A0C,X:BNE next_part_line:INX:L
DA &A0C,X:CMP #13:BEQ found:INY:BNE nextt:.next_line:JSR find_line:LDA #0:RTS
  180.found:LDA #&FF:RTS:.out_number_line:LDY #1:LDA (&70),Y:STA &2B:INY:LDA (&7
0),Y:STA &2A:JSR &98F1:LDA #32:JSR &FFEE:JSR out_line:JSR &FFE7:RTS:.out_line:LD
Y #4:.next_byte:LDA (&70),Y:CMP #13:BEQ end_outline:JSR &B53A:INY:JMP next_byte
  190.end_outline:JSR find_line:JSR &FFE7:RTS:.find_line:LDY #3:LDA (&70),Y:CLC:
ADC &70:STA &70:BCC no_add:INC &71:.no_add:RTS:]
  200P%=P%+1:message=P%
  210$message=" ? dnif"
  220len_string=LEN($message)
  230P%=P%+len_string+1
  240start_table=P%:?P%=&10
  250P%?1=&A:P%?2=&20:P%?3=32
  260P%?4=127
  270NEXT
  280END
```

Listing 5. 'Finder' to detect string

```
   10REM Error utility. S.A.Todd. Copyright 1983.
   20REM Should run on any current MOS.
   30REM Set value of page to convenient address.
   40REM On error condition code prints out offending line
   50REM with error highlighted by '>>>error character<<<'.
   60REM NOTE. The 'error character' is position machine found the error.
   70REM Pressing BREAK reinstates normal error handling.
   80REM Code does not print GOTO numbers correctly,
   90REM GOTO numbers will be correct if subroutine 'print_line' is
  100REM replaced by the ROM listing routine. I can't find the address.
  110
  120page=&C00
  130
  140?&202=page MOD 256:?&203=page DIV 256:REM point error vector to this code.
  150
  160FOR T% = 0 TO 3 STEP 3
  170P%=page
  180[OPTT%:.search:LDY #0:LDA (&FD),Y:CMP #17:BEQ machine:LDA &B:STA &70:STA &7
2:LDA &C:CMP &18:BMI machine:STA &71:STA &73:INC &72:BNE no_add_on:INC &73:.no_a
dd_on:JSR &FFE7:JSR &FFE7
  190.again:LDA (&70),Y:CMP #&D:BEQ got_line:DEC &70:LDA &70:CMP #&FF:BNE no_dec
rement:DEC &71:.no_decrement:JMP again:.got_line:INY:LDA (&70),Y:STA &2B:INY:LDA
 (&70),Y:STA &2A:JSR &98F1:LDA #32:JSR &FFEE:JSR print_line:JSR &FFE7
  200.machine:JMP &B433 \ go to machine error routine
  210.print_line:LDY #4:.next_char:LDA (&70),Y:CMP #&D:BEQ end_print:TYA:CLC:ADC
 &70:CMP &72:BNE no_check:LDA &71:CMP &73:BEQ highlight:.no_check:LDA (&70),Y:JS
R &B53A:.next:INY:JMP next_char:.end_print:RTS
  220.highlight:LDA #62:JSR &FFEE:LDA #62:JSR &FFEE:LDA #62:JSR &FFEE:LDA (&70),
Y:JSR &B53A:LDA #60:JSR &FFEE:LDA #60:JSR &FFEE:LDA #60:JSR &FFEE:JMP next:]:NEX
T
```

Listing 6. Error report extension

No speed penalty to eliminate graphics snow

IN THE letters page of the April issue, a routine was given to eliminate the annoying 'snow' that can appear whenever graphics memory is used. However, this fix slows down screen plotting. This is because it waits for the TV 'frame sync' pulse, which is only sent 60 times a second. However, the video chip (IC 31) also produces a 'line sync' pulse (don't worry what it all means) every 1/15000 second, on pin 38. If you have the 6522 VIA fitted this pulse can be read by connecting a wire link from pin 38 (IC 31) to pin 17 of IC1.

If the idea of soldering onto ICs worries you, connect pin 3 of PL4 to the fifth pad from the left of the *innermost* row of solder pads on the port marked PL7 – this is user port PB7 and, to use it for other purposes, insert a switch in the wire link. Once installed, the following short routine will assemble a new version of the point plot routine:

```
10P.S21; P=#21C; [LDA #B800;
        BMI P-3; JMP #F7AA;];
        P.$6
```

This line should begin every program using graphics. To call it, use:

```
9000a !#222=!FE; !#3FE=#21C;
        R.
```

Call by GOS. a, everytime you use CLEAR or COLOUR. You will find noise is eliminated (except in mode 0) but plotting is not noticably slowed.

Barry Pickles hosts a new cash-for-tips column. Here's a chance to show off your talents – and earn some crinkly green stuff into the bargain. There are reckoned to be some 40,000 of you out there and, bearing in mind that the Atom has been around for more than two years, you must have accumulated a fair amount of expertise.

What we're looking for are those little routines, tips and hardware mods you've discovered. Don't worry if your little wrinkle seems too simple – it's probably just what someone else has been looking for. The same rules apply here as in Ian Birnbaum's Beeb Forum. Short, sweet and as original as possible is the name of the game. I'll start you off, but this is *your* page, so let's hear from you!

Send your ideas to Atom Forum, Acorn User, 53 Bedford Square, London WC1B 3DZ. If you want it returned, enclose a SAE. It should be typed or printed, with programs on cassette (with listing if possible).

Bad program – but all is not lost

IT HAPPENS to all of us. You've just typed in the latest epic and are getting ready to save it, when something happens – maybe the freezer thermostat has just switched on – and the machine locks up. You press break and type OLD – nothing happens! Your masterpiece has just gone west as a 'bad program'.

The Atom recognises the end of a program by a marker, which is a carriage return followed by a negative byte (ie; 0D FF in hex). Whenever you press break, these two characters are inserted at the start of the current text area. As a program is typed in, the FF moves along in the next byte.

If a bad program error crops up, all is not lost, but you need to know how a program is stored, to effect recovery. If you have a program resident, type P.$#2901 (CR). What you should see is the first line of the program! From this, you will realise that, unlike most Basics, the Atom does not 'tokenise' words, but stores program lines as an ASCII string, exactly as typed in. The format is:

line no. (MSB);line no.(LSB);(line of text);(CR);(FF– if last line)

One way of recovering a bad program is ?#2901 = 0; LIST (CR). However, since OLD didn't work, you are likely to get a list of garbage. Listing 1 provides the answer – an ASCII disassembler. It should be placed in a different area of memory to the one your program is in! It displays eight bytes to a line, with the address given at the start of the line. Using it will show where the program is corrupt and it can be corrected using the ? operator. It prints ASCII, if the particular byte is in the correct range, so you may see some odd characters where the program line is stored. To use the program as an ordinary hex dump, delete line 20.

```
 5 P.$12"ASCII DISASSEMBLER"
     ' ' "PRESS shift TO TERMINATE AND" ' '
10 P."copy WHENEVER PRINTING
     STOPS" ' ' '$14; ?#E1=0
15 ?#E6=5; @=0; IN."START
     ADDRESS"S; P.'&S": "; DO
20 IF?S>31 AND?S<160 P." "$(?S); G.z
25 IF?S<16 P."0"
30 P.&?S
35zIF C.>28 P.'&S":"
40 P." "; S=S+1; U. ?#B001&#80=0
45 ?#E1=#80; P.$15'; E.
```

Listing 1. ASCII disassembler

INKEY routine – and how to find it

AT FIRST sight, the Atom seems to lack an INKEY routine, as found on the BBC and other micros. However, the machine responds quite readily to anything typed at the keyboard, so there must be one somewhere. And there is, at location #FE71 in the Atom ROM. It continually scans the keyboard and, if no key is being pressed, returns a value of 255 in the 6502's Y register.

If a key is being pressed, the Y register will contain the value (ASCII – 32). By calling this routine, we can find the state of any key (except CTRL, SHIFT and REPT). The following line will assemble such a routine and store the ASCII value in free location #80:

```
10 P.$21; P=#21C; [JSR #FE71;
      TYA:  CLC;  ADC@32;
      STA#80; RTS;]; P.$6
```

To try it out, after assembling, type:

```
11 DO LI.#21C; P.?#80; U.0
```

and run, noting the value of different keys as they are pressed. A value of 31 will be returned, if no key was pressed (255+32-256 –this is called 'modulo' arithmetic. All eight-bit machines work to modulus 256).

It is now a simple matter to make real-time games respond to specific keys only, without stopping the action as follows (delete line 11 first!):

```
95 LI.#21C
100 IF ?#80 = "U" THEN (action 1)
110 IF ?#80 = "D" THEN (action 2)
```

Similarly, if a user response to a question can be defined by a single *unique* character such a routine can be used to eliminate the need to press return. Carrying this theme one step further, a flashing cursor is a useful way of reminding a user that a response is needed. This can be done, using the previous routine, by the outlined Basic subroutine below, which alternately turns the cursor on and off, until a response is obtained.

But what is LINK#FB8A? It's another inbuilt Atom routine, this time providing a delay of 1/10 second. Here are some more:

```
LINK#FB7D – two second delay;
LINK#FB81 – ½ second delay;
LINK#FB83  –  X/60  second
delay.
```

In the latter case, variable X sets the number of sixtieths. All these calls can be used in machine code by a JSR # instruction.

```
95 P."PRESS THE APPROPRIATE
       KEY"; GOS.b
100 as above
110 . . .

9100b ?#E1=0; P." "$8;
   LI.#FB8A;LI#21C; IF ?#80<>
      31 THEN R.
9110 ?#E1=#80; P." "$8;
   LI.#FB8A; G.b
```

Strings, variables and things

UNLIKE most Basics, Atom variables are not cleared by break. This can be useful, as parameters can thus be passed from one program to another. However, it does place the onus on the programmer to set variables before they are used. On power up, things are even worse as variables take random values! In a string variable say $M, the M doesn't hold the actual string, but only the address where it begins. Using unassigned strings can really screw programs up!

However, it means strings can be explicitly positioned. $#3B00 is just as valid as $M and has the advantage of you knowing exactly where it is.

Dimensioning strings (or other variables) can sometimes be a problem. TOP may not be the best place to store arrays. The 'free space pointer' governs where arrays are dimensioned. This is held in locations #23(LSB) and #24(MSB), as an address. Setting up your own vector in these locations starts dimensioning from that address. As a bonus, if the vector is set equal to TOP, as the first line of your program, you will be able to auto-run a Basic program. The way to do this is to begin a program with:

```
5 ?#23=#XX; ?#24=#YY
```

then type in the program as normal. When complete, type P.&TOP (CR) and, using the editor, insert the appropriate values in XX and YY on line 1. Save by:

```
*SAVE "(filename)" (start address)
      (end address) F141
```

and you may subsequently use *RUN, instead of LOAD.

Confused Atom aids protection

IF YOU have ever listed an Acornsoft Basic program, you will have seen the last line is a copyright message number 0. If you've tried to delete it (naughty!), you will have found it well-nigh impossible. This is because the Atom expects line numbers to be consecutive. Putting line 0 at the end confuses the poor thing! Non-erasable lines are a simple, yet reasonably secure method of protection. Here's how its done. After typing in your program, in direct mode, add the listing below.

Having done this, use the ASCII disassembler to check everything is OK and list the program. You will find that the last line has acquired an extra line, but listing the last line and editing it doesn't work, nor does LIST 0. Finally, before saving, type END to reset TOP. The secret lies in !M =#080000, which inserts a new line (0) over the previous #FF marker and then backspaces once, so the line number is erased, making it appear part of the previous line! $M can be any message, of course.

```
M = TOP-1; !M = #080000;
M = M+3;  $M = " (C) ACORN
      USER 1983";
N = LEN(M); N?(M+1) =#FF
```

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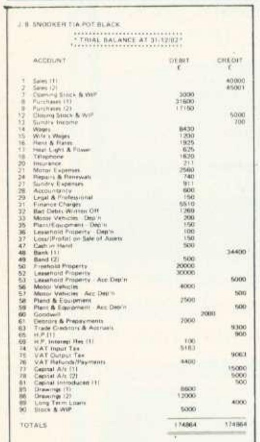

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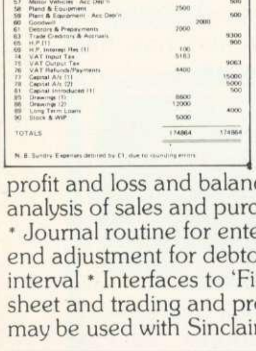

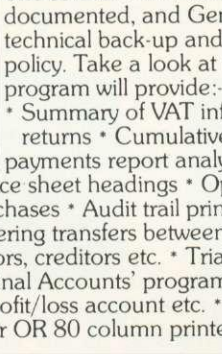

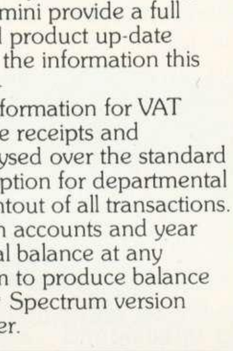

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4		Oct.	Nov.
5		£	£
6	INCOME		
7	Sales	11786	10944
8			
9			
10	REVENUE EXPENDITURE		
11	Purchases	500	500
12	Advertising	500	1000
13	Director's salary	1596	1596
14	Salaries	2216	2216
15	Rent		
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Dragon 32k or 64k	●	●	●	●	●			●	●		
VIC 20 (16k +)	●	●	●	●				●	●		
Sinclair ZX81 (16k +)	●										
Grundy Newbrain	●										
Sharp MZ80A	●	●	●	●				●	●		
Sharp MZ80K	●	●	●	●				●	●		
Sharp MZ80B	●	●	●	●				●	●		
BBC Micro model A or B 32k	●	●	●	●	●	●	●	●	●	●	●
Atari 400/800	●										
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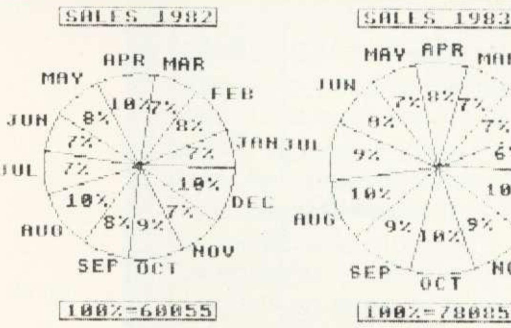

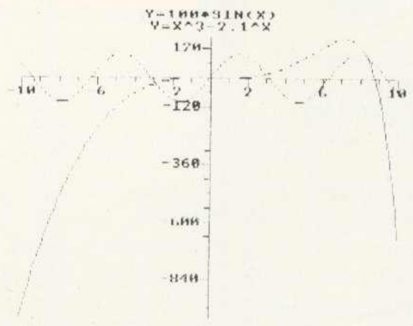

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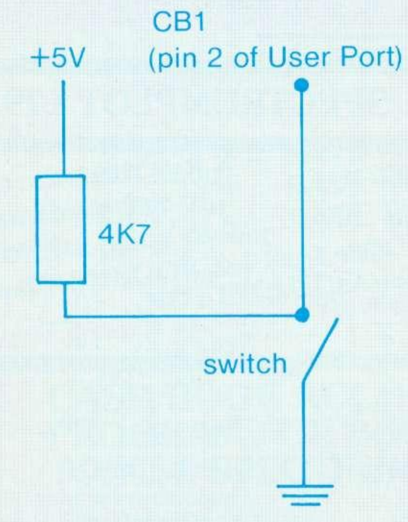

Figure 5. Circuit to initiate interrupt using CB1 control line

On running the program, line 220 executes the short program to change the IRQ1 vectors. As a result the screen fills with As. Why? Well, the various on-board peripheral chips are all demanding attention and supplying the microprocessor with a valid IRQ signal and instead of pointing at their normal interrupt routine the IRQ1 vectors are directing control to the new routine 'RUPT'.

Normally user interrupt routines will be indirected through the IRQ2 vectors leaving the IRQ1 vectors for any interrupts that require top priority. If IRQ1 vectors are used, the interrupt routine begins by interrogating the various I/O devices to determine the source of the interrupt, ie either a user device (eg user VIA) or the operating system (keyboard, ADC, clock etc). If the operating system was the source, control should pass to the operating system's own interrupt handling routine.

Program 5 and 6 make use of IRQ2 vectors to illustrate how an interrupt routine can be initiated by a high to low transition on control line CB1 of the User Port. Both programs perform the same function, providing an interrupt routine to print A on the screen. Program 6 uses the operating system routine OSBYTE to configure the user VIA.

Both programs begin by inserting the interrupt routine into page D. The routine is similar to the

```
100 REM BRK handling routine OS 1.0
110 OSASCI=&FFE3:OSNEWL=&FFE7:OSRDCH=&FFE0
120 REM Key 1 - enable register trace
130 REM KEY 2 - default BRK handler.
140 *KEY1 "?&0202=&01:?&0203=&0D|M"
150 *KEY2 "?&0202=&33:?&0203=&B4|M"
160 FOR PASS=0 TO 3 STEP 3
170 P%=&0D01
180[OPT PASS
190\save registers in store area
210            STA STORE      ;save A
220            TXA
230            STA STORE+1    ;save X
240            TYA
250            STA STORE+2    ;save Y
260            PLA            ;get P off stack
270            STA STORE+3    ;save here
280            STA STORE+4    ;and here (later corrupted)
290\main routine - output register values to display
300            JSR PHEAD      ;print header info
320            LDA STORE      ;get A value
330            JSR OUT
340            LDA STORE+1    ;get X value
350            JSR OUT
360            LDA STORE+2    ;get Y value
370            JSR OUT
380            JSR BINOP      ;output P in binary form
390            JSR SPACES
400            LDA &FE        ;output next pc address
410            JSR CONV
420            LDA &FD
430            JSR CONV
440            JSR OSRDCH     ;wait for a key press
450            JSR OSNEWL
460\clean up stack, restore A,X,Y and P then return
470            PLA
480            PLA
490            LDA STORE+3
500            PHA            ;save P on stack
510            LDA STORE+2
520            TAY            ;restore Y
530            LDA STORE+1
540            TAX            ;restore X
550            LDA STORE      ;restore A
560            PLP            ;restore P
570            JMP (&00FD)    ;return to instruction after BRK
580\
590\ ******************** SUBROUTINES *************************
600\subroutine to print header details
610.PHEAD      LDX #&FF
620.NCHAR      INX
630            LDA HEAD,X
640            JSR OSASCI
650            CMP #&0D       ;<cr> terminates string
660            BNE NCHAR
670            RTS
680\subroutine to output contents of A as hex on screen
690.CONV       TAX            ;save data in X
700            AND #&F0       ;get leftmost 4 bits
710            LSR A
720            LSR A
730            LSR A
740            LSR A
750            JSR ACI        ;convert to ASCII
760            JSR OSASCI
770            TXA
780            AND #&0F       ;deal with rightmost 4 bits
790            JSR ACI
800            JSR OSASCI
810            RTS
820.ACI        CMP #&0A       ;is character 0-9?
830            BCC OK
840            CLC
850            ADC #7         ;add 7 for A-F
860.OK         ADC #&30
870            RTS
880\subroutine to output char + 4 spaces to screen
890.OUT        JSR CONV
900.SPACES     LDA #ASC(" ")
910            LDX #4
920.RPT        JSR OSASCI
930            DEX
940            BNE RPT
950            RTS
960\subroutine to output P in binary form
970.BINOP      LDX #8         ;bit count
980.NBIT       LDA #ASC("0")
990            ASL STORE+4
1000           ADC #0         ;form ASCII "1" if carry set
1010           JSR OSASCI
1020           DEX
1030           BNE NBIT
1040           RTS
1050]
1060 REM STORE AND MESSAGE AREA AT END OF ROUTINE
1070 STORE=P%
1080 P%=P%+5
1090 HEAD=P%
1100 $HEAD=" A     X     Y    NV_BDIZC  NEXT PC"
1110 P%=P%+39
1120 NEXT PASS
1130 END
```

Program 7. BRK handling routine

```
100 A%=&22:X%=&77:Y%=&99
110 FOR PASS=0 TO 3 STEP 3
120P%=&2000
130[OPT PASS
140         CLC
150         LDX #4
160.AGAIN   BRK       \trace here
170         DEX
180         BNE AGAIN
190         BRK       \and here
200         SEC
210         BRK       \and here
220         RTS
230]
240 NEXT PASS
250 CALL&2000
```

Program 8. Program trace using BRK handling routine

previous example with the addition of extra program instructions (lines 110-110) to clear the interrupt flag in the VIA. The second part of the routine uses the peripheral control register (PCR) to configure CB1 to detect high to low transitions.

Several different sources within the VIA can generate an interrupt. Lines 190 to 200 ensure only interrupts arising from valid transitions on CB1 reach the IRQ pin on the processor.

Finally, the BBC micro's IRQ2 vectors are set up to point to the interrupt routine RUPT. On running the program line 260 configures the VIA and sets up the IRQ2 vectors. To initiate the interrupt routine the simple circuit shown in figure 5 can be used.

The 6502 has an instruction that will interrupt the program flow in the same way as when IRQ goes low.

On receiving a BRK instruction the processor pushes the value (program counter +2) and processor status register onto the stack. Program control then diverts to the address in &FFFE (ADL) and &FFFF (ADH) – the interrupt handling routine of the machine operating system. By examining the break flag (B) of the processor status register this routine determines if it is a BRK or IRQ that has caused the interrupt (figure 4). The machine's BRK handling routine then saves the accumulator contents in &FC and computes the return address (ie the address of the instruction that follows the BRK). The return address is placed in &FD and &FE. An indirect jump finally picks up a second address from &202 and &203. These vectors can be altered to point to a user defined BRK handling routine which enables the programmer to determine exactly what should happen when the processor encounters a BRK instruction within a program.

Assembling program 7 places a BRK handling routine in page D and sets up function keys 1 and 2 for altering the vector at &0202. Key 1 selects the user defined routine in page D and key 2 enables the machine operating system's default handler at &0B43.

Using key 1 to install the address for the BRK handler of program 7 means that each time the processor encounters a BRK instruction our own routine will be executed. The purpose of this routine is to print out the register contents at the time of the BRK instruction.

Thus placing a BRK in any program will result in a printout of register contents at that point, assuming the user defined BRK handler has been selected with function key 1.

Program 8 provides a simple illustration of this. BRK instructions have been inserted at several places to obtain a trace of the register contents when the program is executed. (The call to OSRDCH in the BRK handler routine is used to wait for any key to signal 'continue' after a BRK). The output listing illustrates the trace obtained when program 8 is executed with the BRK handling routine of program 7 enabled.

Paul Beverley and Acorn get together to sort out 1MHz 'glitches'

TESTING THE INTERFACE BOX

Let me begin by apologising for the errors which have crept into this series of articles. It would be easy to try to lay the blame on Acorn by pointing to the technical problems we have encountered with the 1MHz bus. These have helped delay publication of Acorn's Application Note on the bus (first draft April 1982). However, it must be admitted the errors were caused by publishing articles before the ideas were thoroughly tried and tested.

In the April issue we corrected mistakes from March, but further tests on the interface board have shown up a fault when using the digital to analogue converters (DACs) at high speed in machine code. Fortunately, we were able to change the diagrams in the April issue before they went to the printers, but we could not change the text.

We explained in the first article that, as suggested in the provisional version of Acorn's Application Note, there might be a problem with glitches on the page select lines of the 1MHz bus. By the second article it became clear these problems were more serious than we thought. Acorn's method of cleaning up the page select lines seemed to work, and only after a number of printed circuit boards had been made up and tested further, did we discover this method did not work properly in all cases *.

Let me explain the changes. The timing diagrams in figure 1 show the various control and data lines when running a particular test program (figure 1d). The program writes the numbers 0 and 128 alternately to the DAC. As can be seen from the diagram, the page select line is low at a time when data on the bus is not valid. Hence every time you write to the DAC, the output goes up to almost full voltage for about 200 nano-seconds (1/5 of a microsecond) before taking on the correct value.

In the second issue of the Application Note, Acorn has admitted there is a second problem with the page select. Under certain conditions you can get a double access of a memory location. This occurs at the wider of the two page select pulses in figure 1a. But it seems to me there is an additional problem in that while the page select line is low you can get spurious data on the data bus, as you can see from the timing diagram. However, since this is a fault on the bus itself, how do we overcome it?

The circuit suggested in the Application Note to use for cleaning up the page select lines clears the two problems they have recognised, but it does not solve the problem of this spurious data (figure 1b). Its effect in this case is to clean up *every other* page select pulse: it simply halves the number of glitches.

To *really* clean up these page select lines we had to add two extra gates (figure 2b). The timing of this circuit is shown in figure 1c. As you can see, the width of the page

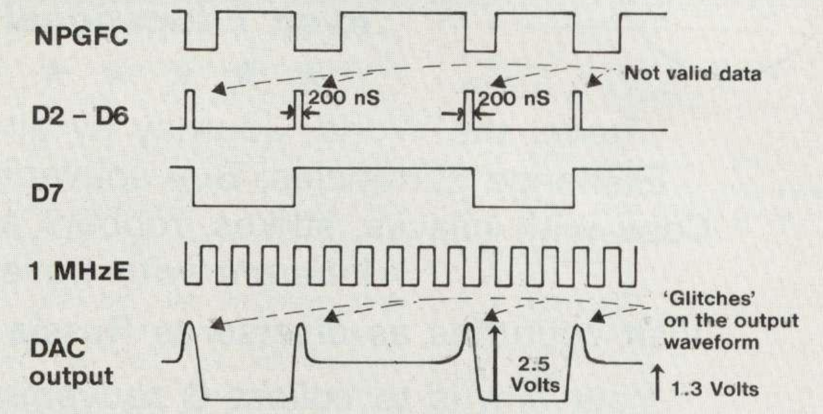

Figure 1a. Using original uncleaned page select lines

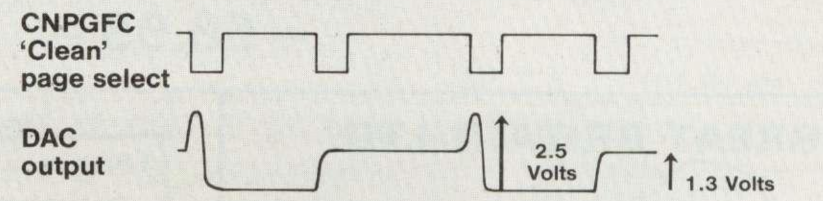

Figure 1b. Using Acorn's original 'clean' page select

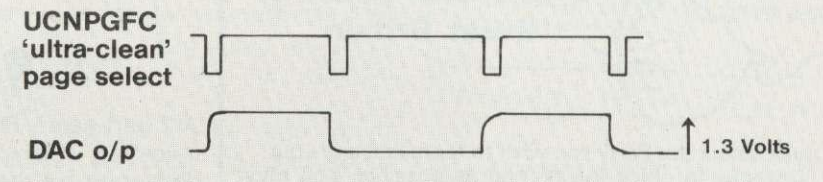

Figure 1c. With extra gates added to give 'ultra-clean' page select

```
.start
LDA #0
STA &FCF0
LDA #128
STA &FCF0
JMP start
```

Figure 1d. Test program

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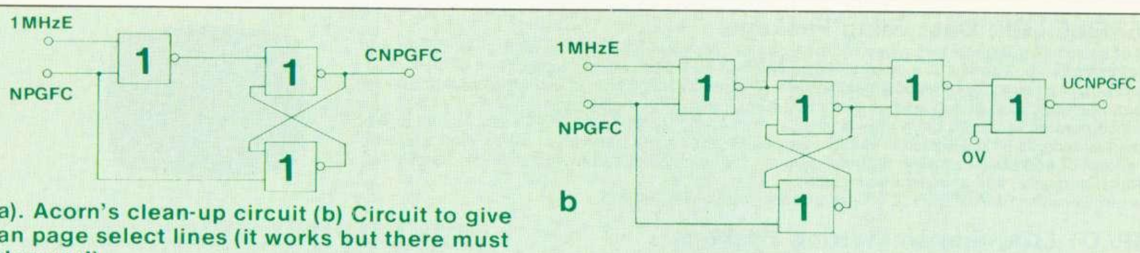

Figure 2(a). Acorn's clean-up circuit (b) Circuit to give really clean page select lines (it works but there must be a simpler way!)

select pulses is now reduced to something like 250ns, which is not really what you would expect to have available for a device on a 1MHz bus. You would expect the page select to be low for one half of a cycle of the 1MHz clock, which is 500ns. This narrower pulse removes glitches under all circumstances we have been able to test, but unfortunately means some devices may not work properly due to the shortness of access time. We have tried the ZN427 and the ZN428 and these work fine as far as we can tell. We will try to get Acorn to do some work on this and pass on any more information.

Now supposing you have built the board we showed last month, how do you test it out? Programs 1–7 form a series of tests to check the various parts of the board. In all the testing procedures which follow you will need an oscilloscope.

The first program tests ports A and B are connected correctly. In reply to the INPUT, you enter either 'A' or 'B' and it produces square waves on each of the lines of the port in question. The least significant bit, ie PA0 or PB0 will have the highest frequency of square wave and each line will have successfully half the frequency or twice the time period for its square wave. This is because the output port is working as a binary counter. The program is a closed loop in machine code and therefore the only way to escape is to press break. At line 10, the break key is programmed using *Key10 to get the program back.

Program 2 gives a way of checking that the control lines on the user port are working correctly as inputs. If you respond to the prompts by grounding CB1 and CB2 you should get the replies of 'OK' if all is well. The program checks the interrupt flag register in the 6522 versatile interface adaptor (VIA) to see if the appropriate flag has been set as a result of touching of CB1 or CB2 to ground, ie providing a negative-going edge.

Program 3 checks to see if CB2 works as output. (CB1 on the VIA can only be used for input, whereas CB1 can be used for either.) The program simply produces a square wave on CB2 by altering the contents of the peripheral control register to output logic 1 and logic 0 alternately. Since this is done in Basic there will be some instability in the waveform produced. This is because the processor is continuously servicing interrupts which affects the output of the square wave.

The next two programs can be used to check the control lines on the printer port, but in this case because of the way the electronics is arranged (*User Guide* page 503) CA1 can only be used as input, while CA2 can only be used as output.

Program 6 is the one which originally exposed the glitches on the 1MHz bus mentioned earlier. What the program does is to output repeatedly the numbers 0 to 255 in sequence to the DAC. This is done at high speed in machine code, and the effect is to produce a 'ramp' or 'sawtooth' waveform. Change line 70 to STX &FCF1 to check the other DAC. Using the oscilloscope to look at the output of the DAC should show a sawtooth wave as the output voltage rises from 0 to 2.5 volts, drops back to zero, and rises steadily to 2.5 volts again. Without extra page select cleaning, the glitches caused the output at each step on the sawtooth wave to shoot up almost to 2.5 volts for a fraction of a microsecond, producing a comb-like effect on the output.

One way to check the analogue to digital converters (ADCs) would

```
Program 1 - To check PA and
PB ports as outputs

  10 *KEY10 OLD|M
  20 INPUT"Which port",PORT$
  30 IF ASC(PORT$)=65 THEN port =
     &FE61 ELSE port = &FE60
  40 DIM CODE 20
  50 P%=CODE
  60 [SEI
  70  LDA #255
  80  STA port+2
  90  .start
 100  INX
 110  STX port
 120  JMP start
 130 ]
 140 CALL CODE
```

```
Program 2 - To check CB1 and
CB2 working as input
  10 V=&FE60
  20 V?12=0
  30 ?V=0:REM clear flags
  40 PRINT"Ground CB1"
  50 REPEAT UNTIL (V?13 AND 16)= 16
  60 PRINT"OK!"
  70 PRINT"Ground CB2"
  80 REPEAT UNTIL (V?13 AND 8)= 8
  90 PRINT"OK!"
```

```
Program 3 - To check CB2 as output

  10 V=&FE60
  20 REPEAT
  30    V?12=128+64
  40    V?12=128+64+32
  50    UNTIL0
```

```
Program 4 - To check CA1 as input

  10 V=&FE60
  20 V?14=128+2
  30 V?12=0
  40 V?1=0:REM clear flag
  60 PRINT"Ground CA1"
  70 REPEAT UNTIL (V?13 AND 2) = 2
  80 PRINT"OK!"
```

```
Program 5 - To check CA2 as output

  10 V=&FE60
  20 REPEAT
  30    V?12=8+4
  40    V?12=8+4+?
  50    UNTIL0
```

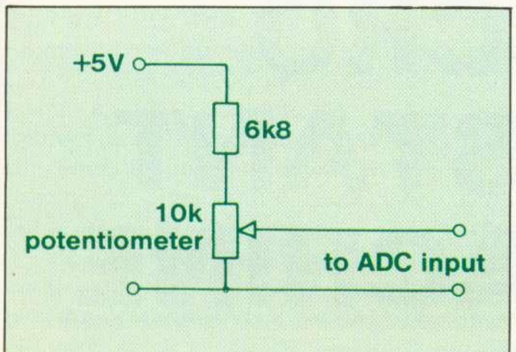

Figure 3. Variable voltage source for testing ADC

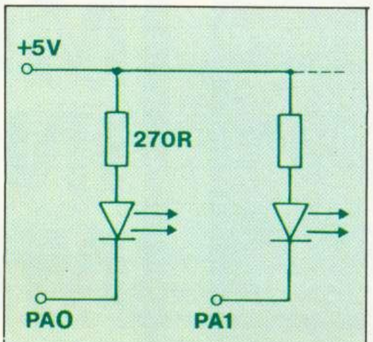

Figure 4. Connecting LEDs to printer port

be to read the ADC input and then output the number which has just been read to one of the DACs. Thus a voltage put into the ADC input should produce the same or almost the same voltage out of the DAC output. This of course requires a variable voltage source which could be a 10k ohm potentiometer connected across the 5V to 0V rail with a 6K 8 series resistor to limit the output voltage (figure 3). The problem with this is that it also requires a way of measuring the input and output voltages.

As an alternative, program 8 shows a way of checking the ADC against the DAC directly. The output of one of the DACs is fed into the input of one of the ADCs. The program then outputs the numbers 0 to 255 to the DAC in sequence, each time reading the ADC. The number being sent out to the DAC is plotted against the number which comes in to the ADC and should produce a straight line graph. This graph is plotted automatically by the program. You will see a certain amount of randomness in the readings due to the last bit or two bits of the ADC output not being stable because of noise. In both these programs it is necessary to provide a 'start/convert' input for the ADC. This is done by taking the output of one of the select lines from the 74LS138 and feeding it into the 'start/convert' input of the ADC. Then within the program you need only read or write to that memory location, and a pulse will be generated which will start the conversion.

The final program is not for direct use with the interface box but for checking the ADC inputs of the computer itself. This is included because in our interface box we have brought connections to these four ADC inputs out to the box itself so sockets are available for both the slow ADC inputs and the fast ADC inputs. This program reads the four input channels and outputs to the screen a binary representation of the numbers read. If you put steady voltages into the four inputs, perhaps by using games paddles, you will find there is a considerable amount of variation of the last three bits of the ADC conversion. In other words it is not in fact 12-bit conversion but more like an eight or nine-bit conversion.

The circuits around the ADC in the machine itself give the reason. Because of the way the circuit has been designed, the earth line coming to the ADC chip has a considerable amount of digital noise on it. If attempting to measure a voltage to an accuracy of one part in 4000, which is what a 12-bit ADC does, you would in fact need to have the noise limited to about 1/4000 of the maximum voltage of 1.8V (45μV). Unfortunately the noise level on the earth line is something like 40μV. The analogy this brings to mind is that of trying to measure the height of a 1000 foot cliff to the nearest foot from a boat riding in a 30 foot swell! No amount of capacitors on the ADC inputs will change the fact that the earth line is not truly at zero because of noise and therefore it is impossible to get anything more than about a nine-bit conversion.

There are numerous applications for this interface box. Obviously the digital inputs and outputs can be used for all sorts of on/off switching and for reading the position of switches.

One nice application using the printer port is to drive a seven-

```
Program 6 - To check
the DAC output
 10 *KEY10 OLDIM
 20 DIM CODE 20
 30 P%=CODE
 40 [SEI
 50  .start
 60  INX
 70  STX &FCF0
 80  JMP start
 90 ]
100 CALL CODE
```

```
Program 7 - Use the DAC output
to check the ADC input
10 MODE 0
20 FOR N% = 0 TO 255
30    ?&FCF0 = N%
40    ?&FCF4 = 0
50    M% = ?&FCF3
60    DRAW N%*4, M%*4
70    NEXT
80 END
```

```
Program 8 - To show the
bit patterns produced by
the on-board ADC's

  10 MODE3
  20 PROCinit
  30 REPEAT
  40   FOR T=1 TO 4
  50     M=ADVAL(T)/16
  60     PROCbyte(M)
  70     NEXT
  80   UNTIL0
  90
1000 DEFPROCbyte(M)
1010 LOCAL T,H
1020 @%=4
1030 T=2048
1040 PRINTM;CHR$253;
1050 FORH=0TO11
1060 IF(M AND T)>0 THEN
     VDU255 ELSE VDU32
1070   T=T/2
1080   NEXT
1090 @%=3
1100 PRINTCHR$254;"  ";
1120 ENDPROC
1130
1140 DEFPROCinit
1150 LOCAL N
1160 VDU19;4;0;23;
     10,32,0;0;0;
1170 N=1
1180 VDU23,253.N.
     N,N,N,N,N,N,N
1190 N=128
1200 VDU23,254,N,N,
     N,N,N,N,N,N
1210 N=126
1220 VDU23,255,0,N,
     N,N,N,N,0;
```

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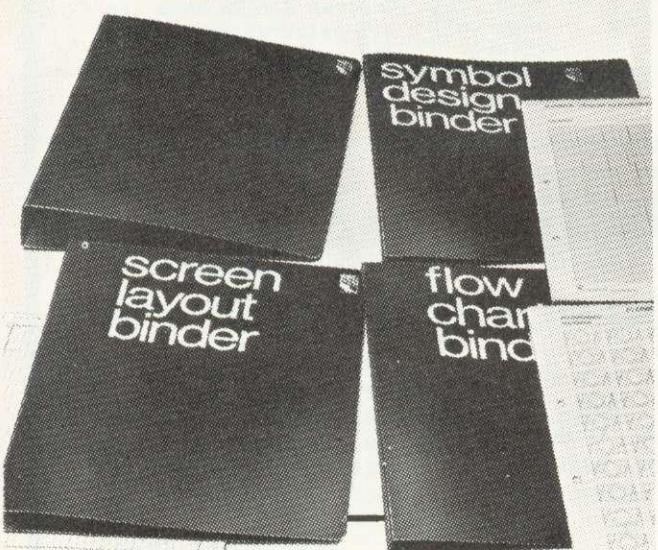

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segment LED. This can be done directly on the printer port because it has sufficiently high current available. All you need do is to connect a 270Ω resistor in series with each segment and connect it directly to the printer port line (figure 4).

You may have seen designs for using the BBC micro as a storage oscilloscope. In other words you can make it measure voltage waveforms at high speed. This data can be stored and displayed on the screen or sent out to a chart recorder, or re-synthesised into a periodic waveform on an oscilloscope. This is an effective way of catching transient events and storing the information for later processing.

Another possibility would be to use the fast ADC to input the waveforms coming from some sound source. This information could then be stored in RAM and later 're-played' through one of the DACs – a simple form of digital recording.

Finally, one idea would be to write a program in which a voltage could be read by an ADC and stored temporarily before being output on the DAC. This could be done with some sort of deliberate delay by going through a loop where you input the data and put it in some form of 'stack' and then output the data from the other end of the stack. This could produce some interesting effects due to the delay in transmission of the sound, and has implications for echo and other effects.

All these possibilities need a certain amount of work. If you have any interesting applications, send them to *Acorn User* for possible publication.

***Acorn assure us that the 'ultra-clean page select' circuit is only necessary with certain chips. Acorn's own circuit is adequate when interfacing standard 65-series peripherals, such as the 6522, since they latch on the positive edge of the pulse.**

In this series of four articles, Paul Beverley has designed an interface box for the BBC micro which works through the 1MHz bus. Acorn User has arranged for a high-quality circuit board to be made up which is the vital part of the interface box. The cost of a double-sided printed circuit, with plated through holes and component overlay is £11.95. This includes VAT and UK postage (write in for overseas prices).

Kit of parts, as well as fully built and tested boards are being prepared, prices on application (should be about £80 for completed board).

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Fine choice of words

Paul Beverley compares two word processing chips – View and Wordwise. The first is dearer, but are the extra functions worth it?

WHEN I agreed to review Acorn soft's View word processing systen I did not realise what a difficult tasl it would be. Using Wordwise for a couple of months made it difficult to be unbiased, especially as the two are so different.

View comes with two manuals. The first is a chatty introduction to work through page by page. The second is more of a reference manual to keep by the computer. Both were written not by Acornsoft, but by Information Transfer of Cambridge. This is a good move in my view, as the ability to write good software is no guarantee of being able to explain how to use it.

What does View offer? Those who have used a professional word processing system will have come to expect the facilities View aims to provide. Many of these professional systems use large numbers of function keys as well as text keys. The Acornsoft programmers have used all three levels available for the function keys on the BBC micro. That is, the keys on their own, with shift, or with CTRL. This gives 30 possible commands, of which they have used 29.

To give some idea of the extent of the commands on the function keys, see figure 1 which simply names them all. Other functions are typed either into the text itself (stored commands) or in the command mode. A summary of these is available through *HELP.

Comparing the facilities of View, with those of Wordwise from the review in February's *Acorn User*, will show View is far more comprehensive. For example Wordwise does not have any macro facility, and neither does it have any of the number registers available in View except for the page number. The only facility in Wordwise which does anything approaching the sort of jobs which are possible using macros, is GETFILE (GF), which allows pre-prepared text from a disc or tape to be added. This is nowhere near as comprehensive as offered by macros, and so for work with large numbers of form letters, View is without doubt what you need.

Figure 2 provides a comparative list of the advantages and disadvantages of the two systems, but let's consider some significant differences.

One interesting difference is the approach to the search and replace facility. View is more comprehensive in that it caters for a 'wild-card', where instead of just looking for one specific word you can look for something with a certain amount of ambiguity in it. For example, if searching the word 'Frances', which could have been spelt with an 'e' or an 'i', you can look for 'Franc?s'. The question mark represents any character, so this search would pick up 'Frances', 'Francis', or even 'Franczs'.

The approach to finding words which could be in either upper or lower case is an example where the two systems have used opposite techniques, each equally valid. View takes no account of upper or lower case when doing a search or a replace. This is useful if the sought after word could be at the beginning of, or in the middle of a sentence. Wordwise on the other hand, distinguishes between upper and lower case which means you would have to do separate searches for 'recieve' and 'Recieve' to correct the spellings. On the other hand if a number of occurrences of a word such as 'Basic' need changing to 'BASIC', Wordwise can make the change, but View cannot.

A third difference is that Wordwise searches from the cursor's present position towards the end of the document, the cursor being left at the last occurrence of the match unless Escape is pressed. Hence to make several changes through the whole document you have to remember to put the cursor back to the top before the next search. However, this can be done by a programmed function key (eg *KEY9¦[¦!¦O¦[).

With Wordwise, since the text is entered directly, and not as it will appear on the final document, TAB characters simply appear as arrows in the text, until you PREVIEW the document. With View, tabbing takes place as you press the TAB key, so you can see what the document looks like immediately.

Wordwise only provides two markers, whereas View gives up to six which are all numbered. Two are visible (as in Wordwise), the other four being found by MOVE TO CURSOR. In Wordwise there is no simple way of removing the markers as they don't respond to search and replace. Instead you have to program a key to move to the top, move to marker and delete character.

Contrary to what you might have read in other magazines, you can edit Basic programs with both systems, in exactly the same way. First you spool the program into a text file, which can be loaded into the word processor and edited. Then you save it, still as a text file,

Control	Shift	Normal
Delete block	Move block	Format block
Next match	Swap case	Top of text
Format mode	Release margins	Bottom of text
Justify mode	Delete up to character	Delete end of line
Insert mode	Highlight 1	Beginning of line
Default ruler	Highlight 2	End of line
Split line	Go to marker	Insert line
Concatenate lines	Set marker	Delete line
Mark as ruler	Edit command	Insert character
	Delete command	Delete character

Figure 1. Function key commands on View

before execing it to re-form a Basic program.

Since View uses all three levels of the function keys, there is no possibility of further programming. Wordwise on the other hand allows you to put your own commands onto the function keys. These could be actual items of text, such as words which you use frequently (useful for inexperienced typists). Also they can be commands written in the form of control sequences. This is explained in the Wordwise manual and allows you to write your own routines, for example to put in a couple of markers and delete a complete line or to produce, say, "<return>, <return>, TI15", for a new paragraph format, and each of these can be done with one press of the function key, while holding shift and control keys down at the same time.

View needs special software to use a particular printer. This is because you can put within the text one of two 'highlight' commands, which could be things such as underlining or italics. These then are automatically interpreted by the word processor and sent to the printer as control codes. Wordwise on the other hand does not have any such feature, and therefore you have to send out the control codes as numbers which appear within the text. So you say for example, 'OC27,69' to switch an Epson printer to emphasised text. These can be put on function keys.

The use of the two highlight commands on View is fine if you only want to use two types of special command for your printers. However, the Epson FX80 allows underlining, emphasised, condensed, enlarged, pica, elite, double strike, RAM and international character sets, italics, proportional spacing, etc, etc! Acorn intends to release a printer driver for the FX80, but since there are only two highlight commands, you have to redefine one each time to use a different facility. So for each facility you have a single number and would say, for example, 'HT 1 135', so each subsequent occurrence to highlight 1 would switch on or off say the underlining. Then after 'HT 1 132', each occurrence of highlight 1 would cause a switch between American and English character sets to allow the use of both # and £ within the same document.

Advantages of Wordwise

Programmable keys.
Any number of printer functions.
Sample text provided.
Free touch typing tutor.
Good use of colour.
Spooling of text to file.
Simple to learn.

Disadvantages of Wordwise

Search and replace more cumbersome and less flexible.
Load and save slower (not done in blocks).
Not as easy to use on black and white monitor.

Advantages of View

Wild card on search and replace.
Microspacing with printers.
Can process documents > 25k, using continuous processing from disc.
Six markers (two on Wordwise).
Allows macros and number registers.
Tabs and stops visible.
Printing of pages within a document.
Two-sided documents.

Disadvantages of View

Control of more than two printer functions difficult.
Maximum line is 132 characters (200 on Wordwise).
Headers and footers only single line.
No pad character to enforce single spaces.
Printing is direct from disc or tape, not from RAM.
Costs £69.75 against £46.50.

Figure 2. Comparison of the two WP systems

One feature missing from View but present in Wordwise is a pad character to force a space at a particular place in the text. The idea is that when justification is used, some items of text may look strange because of the added spaces. Also it means that two words separated by a pad character will be treated as a single word and therefore will not be put on separate lines. Thus to write '*FX 5,2', you would avoid it being split up with '*FX' on one line and '5,2' on the next.

The way in which the printing is done is also different in the two systems. In Wordwise printing is done from the text held in RAM. The only addition to this is to use the GF command to get a file from tape or disc which has been spooled ready to be added into the document.

View on the other hand takes data for printing directly from the file system. This has the advantage that you can print out a whole set of files in sequence to form a single document, by simply calling their names after the print command. The disadvantage is that to print some text in RAM, you have to save it first and then print it. Therefore if you want to make a number of simple edits, printing it out each time, you have to save it each time. This is tedious with disks, never mind tapes.

Readers will have to make their own decision as to which set of functions is appropriate to their particular application. Both systems have limitations, so bear these points in mind before making a choice.

Does Wordwise have sufficient facilities? For example, if you need to do form letters with automatic addressing etc, there is no choice – it has to be View.

If you choose View, is the person operating it going to be able to cope with learning what is undoubtedly a more complex system? (To indicate how easy Wordwise is to use at its simplest level, my four-year-old son can type things in and get them printed out with little or no prompting!)

Consider the way text is entered, and decide which you think is easier; to type it in directly and worry about what it looks like later,

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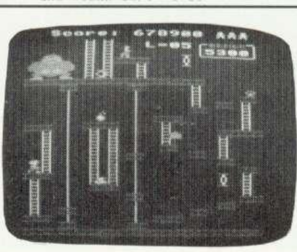

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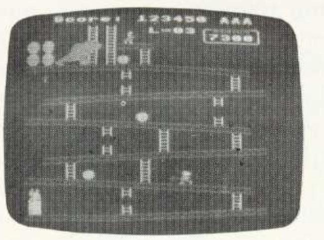

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Mike Milne examines three graphics packages – two for drawing and one for shading

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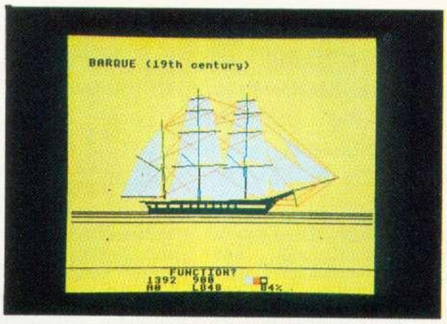


EDG design: fewer functions, but faster and more friendly

THE two packages compared here are the AB Designs Drawing Program and the EDG Graphics Package (from Salamander Software).

A drawing program allows the user to construct on a TV screen various shapes (lines, squares and circles, for example) with simple commands – typically one or two keystrokes – and then to move, repeat or modify these shapes. The position on the screen at which the drawing is to start, and the dimensions of the shape, are entered by moving a cursor (normally a cross) to the appropriate position using the control keys. Additional features usually include a 'fill routine', which can fill a specified area with colour, and some method of saving the result on tape or disc.

Both the AB Designs Program and the EDG Graphics System (referred to as AB and EDG from now on) were supplied with

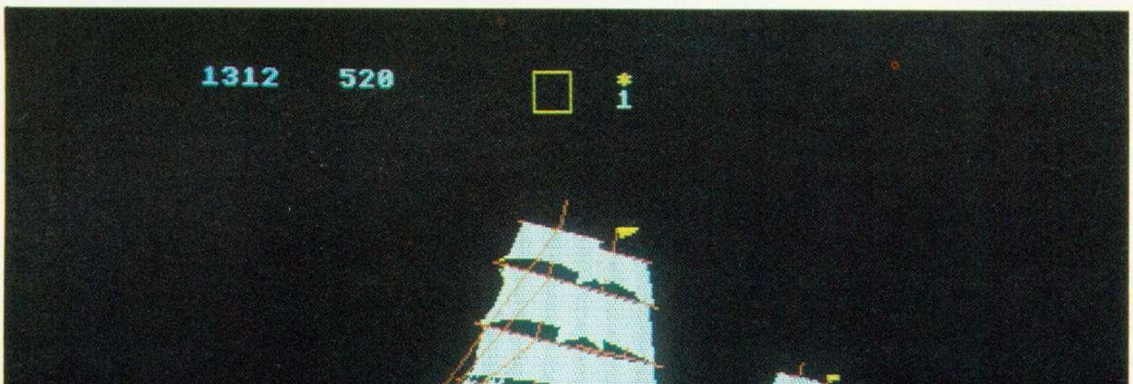
□ **EDG Graphics Package, Salamander Software, 27 Ditchling Rise, Brighton BN1 4QL. (Also available from Acorn dealers) Price: £24.95**

□ **AB Designs Drawing Program, AB Designs, 81 Sutton Common Road, Sutton, Surrey. Price: £35.50.**

provisional manuals which ran to some 30 pages. In each case the programs loaded successfully first time, displaying a title page while the main program loads. EDG then makes an intimidating high-pitched whistle until you select mode 0, 1 or 2, the AB system runs in mode 1 only.

At this point you are faced with a screen which is completely blank except for a crosshair cursor in the middle, and a few cryptic symbols at the top (AB) or the bottom (EDG). These symbols are in a 'text window' which displays information such as cursor co-ordinates, current drawing colour and drawing mode (solid or outline). The cursor can be moved about the screen using control keys and its speed is variable. The AB system has three speeds, selected by pressing a single key. In EDG, the cursor starts off slowly and picks up speed if the control key is held down (acceleration can be inhibited if desired).

To start drawing, a program needs to know what you want to draw and where. EDG asks for the function first (the message 'Function?' appears in the text window): the function is selected by pressing an appropriate key, such as 'C' for circle. The message 'Centre?' then appears, and the point is 'fixed' by moving the cursor to the required point and pressing



AB design: perspective, repeat and curve functions make for more creative drawings the space bar. The radius is defined on the same way, and a circle is automatically drawn. In the AB system the commands are somewhat different. Points are defined first, by moving the cursor to the appropriate position and pressing '1', then moving to another position and pressing '2', and so on. For a circle, the two points required mark the diameter (not the centre and radius). Finally, the command 'C' draws the circle.

The two programs both offer line, rectangle, circle and fill routine; beyond this, however, their functions differ considerably. This is primarily due to the dfferent approach the programmers have taken. Examination of the repeat function will illustrate this.

In the EDG system, an area of memory (called the picture memory) stores the commands put in by the user. When the repeat function is called by pressing a key the last operation in the picture memory is repeated at the location of the screen cursor. Thus the repeat command is limited to the previous drawing operation, whatever that happens to be. In the AB system, the repeat function is more versatile, allowing a rectangular area to be defined and copied to another part of the screen. It may also be shrunk, rotated through 90 degrees, or reflected as a mirror image. The process is much slower than in the EDG system, because the program is scanning the rectangle pixel by pixel before copying it.

In both programs the drawing colour is easily selected, either by moving a dot along a colour 'palette' (EDG) or by pressing an appropriate key (AB). The logical colours may also be easily changed, providing the user with the usual range of Beeb colours. The EDG system can support eight colours on the screen at one time in mode 2, whilst the AB system (which only runs in mode 1) can only support four. This is not as serious as it sounds, however, because the AB system allows filling in a mixture of colours – for instance, if white, cyan and yellow are selected, the fill routine will plot vertical bars of each alternately, giving a pale green.

In all graphics systems, fill routines are notorious for getting out of hand. This happens when there is a break in the boundary of an area being filled, and the colour 'escapes' into the surrounding picture. EDG handles this quite easily, by telling the program to

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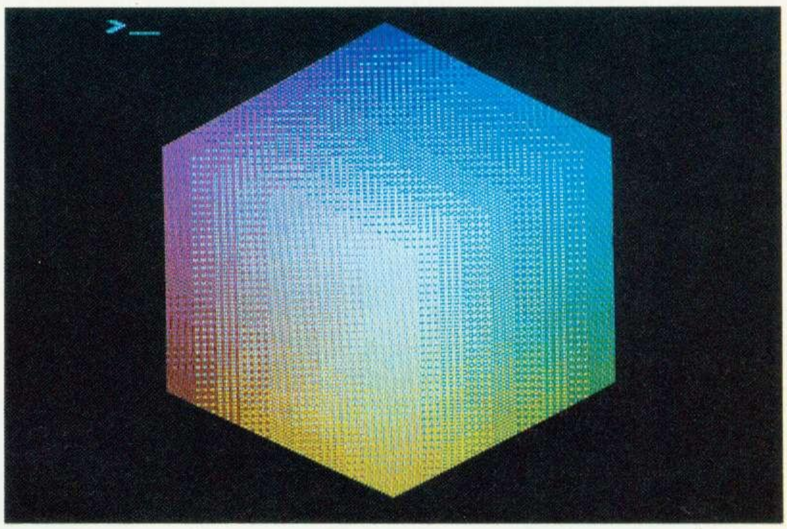
GAELSETT - ECFG



Multicoloured cube by ECFG

□ ECFG from Gaelsett Software, 44 Exeter Close, Stevenage, Herts, SG1 4PW. Price: £10.

THE Extended Colour Fill Graphics program (ECFG) from Gaelsett can fill areas with patterns of different-coloured pixels to give the effect of additional 'shades' of colour on the BBC micro. The program loads into the lower region of user RAM and automatically resets page so it is not overwritten when other programs are loaded.

The program works by providing two new extensions to the GCOL statement which affect the way the triangle-filling routines PLOT 81 and PLOT 85 operate. The more easily understood statement takes the form VDU 18,L,32,C1,C2,C4,C8 where L is the normal logical parameter following the GCOL statement, and the 32 instructs the computer to accept four further parameters to define the mixture of logical colours 1,2,4 and 8. Default colours are red, green and blue for C1, C2 and C4 while C8 is 'flashing'; the parameters only operate if the graphics mode selected supports the required logical colour. The parameters may have values between 0 and 32, so setting C1 at 32, C2 at 16 and C4 at 0 will give a mixture of two parts red, and one part green and no part blue, which results in an orange colour. (Remember that, unlike mixing paints, mixing colour light is additive: ie, the more light you add the paler the shade gets, and vice versa. Thus red and green make yellow, which can be confusing until you get used to it.)

The second statement is less easy to operate. Once again it operates on the VDU 18 command, equivalent to GCOL, and looks like this: VDU 18,L,64,R1,R2,R3,R4. As before, L is the normal parameter after the GCOL command and 64 instructs the computer to accept the four following parameters. These can each have values between 0 and 255, allow on/off control of each bit in a four-row high VDU mask. The width of the mask varies from two to eight pixels, depending on mode. By controlling this mask, a wide range of patterns such as vertical bars, diagonal stripes and cross hatching may be obtained. This statement also operates through PLOT 81 and PLOT 85.

The documentation provided is scant, and the only way to get to grips with ECFG is to try it out in as many ways as possible. Some of the effects are similar to those given by using the GCOL statement with parameters higher than 4, but there are many others besides.

A word needs to be said about the term 'shades' used in relation to ECFG. The cross-hatched patterns the program produces are very visible, especially in mode 2. It is doubtful whether, for instance, a broad red-and-white check could be called a 'shade of pink'; perhaps the word 'pattern' would have been more realistic.

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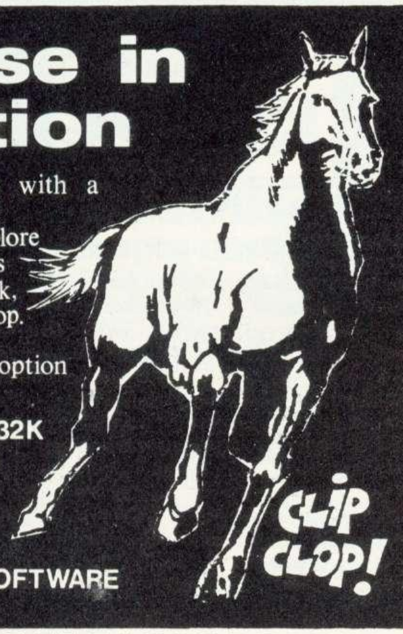

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'forget' the last command. The picture is automatically re-drawn without the fill operation, the boundary can be repaired, and the fill executed again. In the AB system, escapes are more serious. The operation is stopped by pressing escape, but any picture information under the escaped filling colour is lost, and has to be re-drawn. It is therefore advisable to keep a finger hovering over escape when using the fill routine.

Three useful EDG features that do not appear on the AB system are 'grid' which covers the screen with a grid of points to which cursor movement is related; 'arc' which allows any segment of a circle to be drawn (AB only allows half- and quarter-circles); and 'elastic band', which allows you to see the line being drawn.

However, AB has a wealth of commands not implemented in EDG. These include 'ellipse' (useful for isometric drawing); 'smooth curve', which connects up to seven points at a time with a curve; the 'rotate' and 'shrink' features already mentioned; a special memory that can store up to nine circles and ellipses; and, most importantly, a perspective facility that automatically draws planes, box sections and lines in perspective, and can fill areas with 'perspective shading'.

To sum up, the differences between the two packages lie in the use of the limited RAM available to the programmer. The EDG designers have opted for a user-friendly approach in which mistakes can be corrected easily, decisions changed, and pictures saved and loaded rapidly. This inevitably means the range of drawing commands is limited, and the resulting pictures tend to be collections of coloured lines, squares and circles.

The designers of the AB system, on the other hand, have decided to cram every available byte of memory with drawing routines, at the expense of speed and friendliness. Pictures can be sophisticated, but mistakes are not easily corrected, and saving a picture to tape takes a long time.

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as in Wordwise, or to see it being formatted as you go, as with View.

If you only have a cassette system, are you prepared for the time involved in saving a file after each edit to print it out?

Do you have documents larger than 25,000 characters long (approx 4,000 words) which have to be processed in one single operation? If so you will have to use View.

Are you prepared to pay £59.80 for View, plus £9.95 for the printer driver software compared with £46.50 for Wordwise? (Also the free typing tutor with Wordwise is better than any one I have found commercially available.)

My personal view is that Wordwise is better value and easier to use, but certain applications will demand the advanced facilities of View. One final comment is that View may well have facilities I did not discover. If so, tell us!

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WRITE YOUR OWN GRAPHICS DUMP

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A graphics 'dump' is a program to translate the picture on the screen into a form the printer can reproduce. Writing programs to do this is not difficult but requires clear thinking and knowledge.

To write a dump there are two pre-requisites. First, the printer must have some graphics facility. This may be by addressing individual wires on a dot-matrix printer, or may be the block graphics character set (or may be a programmable character, similar in principle to the VDU23 characters). Second, you must be able to 'read' the graphics memory to determine the state of a particular picture element – known in the jargon as a 'pixel'. For the simple dumps introduced this month it is only necessary to know whether a pixel is on or off.

Some information about the graphics memory now follows. For the Atom it is essential to understand this organisation, as there is no way of reading the state of a pixel other than by 'peeking' the screen memory. The BBC screen memory organisation is more complex, and to compensate for this a Basic function POINT, and an operating system call (OSBYTE) are provided to allow direct reading of pixels.

First, the similarities. There is always an increased memory requirement as the detail of the information carried becomes greater. Thus the smaller the pixels, the more memory is required to contain a 'screenful'; and the more colours, the more memory needed again. The number of pixels available is described in terms of 'resolution'. The greater this is the more pixels, and the more detail. The pictures of Bjorn Borg in April's *Acorn User* illustrate this perfectly. Thus in BBC mode 1 we can have four colours, and 320 by 256 pixels. This takes up the memory locations from &3000 to &7FFF (20k of your precious available memory). With discs, the operating system workspace, Basic workspace, 6502 stack, and disc operating system workspace take up a little over 8.5k, and your program, with its variables, has only 3.5k left. In mode 2 the number of colours is increased to 16, and since the graphics memory cannot be expanded, the resolution is reduced to 160 by 256 pixels. If we forego the extra colours, but maintain the resolution, we can pack the information into a smaller memory. Thus mode 4 and 5 graphics memories start at &5800, and are identical to modes 1 and 2 in resolution, with fewer colours.

The same principles apply to the Atom. This is nicely explained with examples in *Atomic Theory and Practice*.

There are major differences between the BBC and Atom graphics memories. The first is in the location of the top and bottom of the memory. On the Atom memory always starts at #8000 (hexadecimal numbers are prefixed by # on the Atom, by & on the BBC). The position of the top of the graphics memory is determined by the extent required by a particular mode. The BBC works in reverse: the top of the graphics memory is always at &7FFF, but the bottom (called HIMEM) is different according to mode.

The second difference is in how the values of X and Y are used to plot points. On the Atom the range of X and Y values varies with mode, and is equal to the number of pixels per line (and the number of bits of graphics memory per line). The Y axis is treated similarly. Thus careful arithmetic will enable you to read the individual bit of a byte corresponding to a particular pair of X, Y co-ordinates. For example, (191-Y) will give the row a pixel is in for mode 3, #8000 + (191-Y)*16 will give the address of the byte at the left end of the row; #8000 + (191-Y)*16 + X/8 will give the address of the byte containing the pixel for (X,Y).

You must now sort out which bit it is from the value of X%8. (For confused BBC owners X/8 is equivalent to X DIV 8, while X%8 is X MOD).

BBC graphics modes always use X values from 0 to 1279, and Y values from 0 to 1023, independent of mode. This does not imply 1279 individually plottable dots per line in any mode. In fact, to give an example, the 16 points in the bottom left-hand corner of the screen [(0,0) to (3,3)] all address the same pixel in modes 1 and 4.

In modes 2 and 5, 32 points [(0,0) to (7,3)] address the same pixel. Thus the program:

```
FOR X=0 TO 1279
PLOT 69,X,500
NEXT
```

Plots points making up a horizontal line across the screen.

In modes 1 and 4 the program:

```
FOR X=0 TO 1279 STEP 4
PLOT 69,X,500
NEXT
```

will plot an identical line four times as fast. In modes 2 and 5 the program:

```
FOR X=0 TO 1279 STEP 8
etc
```

will plot the same line eight times as fast. Thus when reading the screen, POINT (0,0) and POINT (3,3) are the same (as are values for other members of the matrix). They must only be decoded once, otherwise a lot of time and effort is wasted.

The screen scan must be tailored to the graphics mode being used. The rules are:

- always step 4 in the Y direction (vertically) 3,
- in mode 0, step 2 in the X direction (horizontally),
- in modes 1 and 4, step 4 in the X direction,
- in modes 2 and 5, step 8 in the X direction.

How is this information matched to the printer? Consider the dotaddressable printer first. In all cases printers require information one byte at a time. Each byte causes the printing of up to eight dots. This byte can address the dots in two basic orientations.

In plan A (figure 1), lines of dots are printed, starting at the top left of the picture (the configuration used by the Olivetti and Amber).

In plan B (figure 2), bands of dots are printed. These bands may vary in width. For example, the Epson prints a band eight dots wide, Seikosha seven dots wide and Centronics 739 six dots wide. In Plan A it is usual to organise the bytes so the most significant bit (ie the digit for 128s) is at the left side.

In plan B there is the usual total lack of concensus amongst manufacturers (figure 3 shows three methods).

The basic technique for dumps matches pixels to dot wires, so a dot wire is fired if the pixel is on and not fired if it is off. This involves building up 'printer bytes' (normally the variable 'byte' in the programs which follow), whose bits match the screen pixels. The variables X (or X%) and Y (or Y%) represent the current position of a notional 'pointer' to the screen, and x and y (or their equivalent integer variables) make adjustments to X and Y which cause the building up of 'byte'. Let us follow through the building up of a printer byte in plan A (figure 4). The pixel corresponding to MSB of the printer byte is read first. The result is deposited in the LSB of

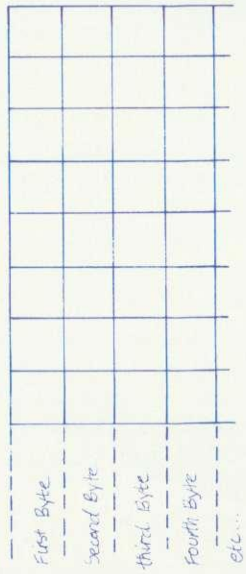


Figure 2. Plan B: band of dots

Figure 1. Plan A: line of dots

'byte'. When 'byte' is multiplied by 2, the bit will move left one place, and after eight repetitions, it will reside in its correct place – the MSB of 'byte'.

The Basic program segment to accomplish this in mode 1 at the top left corner of the screen is:

```
byte=0
FOR x=0 TO 31 STEP 4
byte=byte*2
IF POINT(x,1023)>0 THEN byte=byte+1
NEXT
```

The byte is initialised to 0 and then shifted left (byte=byte*2). If the pixel is on, 1 is added. The last two steps are repeated until eight pixels have been scanned. The byte produced might have any value between 0 and 255. It is therefore essential it is not intercepted by the central processor and acted on as a normal ASCII value. (This was explained last month, and the use of VDU1 is essential).

To scan the whole of the top line of the screen, therefore, we would embed the first segment in a loop to scan the other X values. The variable x has the values 0,4,8,12,16,20,24,28 in each scan, so X must step 32. The data is sent to the printer by the line VDU1,byte:

```
FOR X=0 TO 1279 STEP 32
byte=0
FOR x=0 TO 31 STEP 4
byte=byte*2
IF POINT (X+x,1023)>0 THEN
   byte=byte+1
NEXT
VDU1,byte
NEXT
```

A final loop to scan all the Y values completes the picture. The Y loop must run from top to bottom of the picture, and so runs from 1023 to 0. The whole procedure is:

```
1000 FOR Y=1023 TO 0 STEP 4
1010 FOR X=0 TO 1023 STEP 32
1020 byte=0
1030 FOR x=0 TO 31 STEP 4
1040 byte=byte*2
1050 IF POINT(X+x,Y)>0 THEN
   byte=byte+1
1060 NEXT x
1070 VDU1,byte
1080 NEXT X
1090 REM linefeed if necessary
1100 NEXT Y
```

If your dot-matrix printer produces bands of dots (as is most common), modifications are needed. The method is illustrated in figure 5 for the Epson and Seikosha printers.

The program segments for the Epson are (changes for Seikosha in italics, *byte = byte + 128* is extra line):

```
FOR Y=1023 TO 0 STEP -32
         FOR Y=1023 TO 0 STEP -28
FOR X=0 TO 1279 STEP 4
byte=0
FOR y=0 TO 31 STEP 4
              FOR y=27 TO 0 STEP -4
byte=byte*2
IF POINT (X,Y-y)>0 THEN
   byte=byte+1
NEXT y
                    byte=byte+128
VDU1,byte
NEXT X
VDU1,10
NEXT Y
```

These dumps will operate perfectly in modes 1,2,4 and 5. This may seem odd, as the pixels are twice as big in modes 2 and 5 as in the other two. What is happening is that the mode 2 or 5 rectangular pixel is being read twice, and so getting two dots, while the mode 1 and 4 pixels get one.

You will have noticed references to linefeed (VDU1,10) or to the possible need for them. This leads on to the use of control codes or escape sequences to switch to graphics mode, and their consequences. There is a staggering lack of agreement between manufacturers on this. Each printer seems different, and the manuals are frequently bewildering. One problem that arises is that if (as with the Epson and Olivetti) *all* codes from 0 to 255 cause the

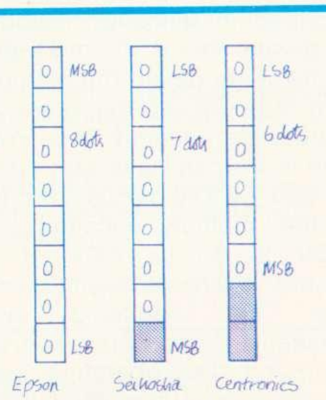


Figure 3. Three versions of plan B

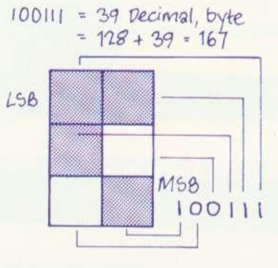
printing of a dot pattern, then *no* code, or combination of codes, can take the printer *out* of graphics mode once it is in. This is solved by announcing the number of graphics bytes to be sent in advance. This may be necessary every line, or for the whole picture. Consequently, if escape is pressed in a graphics mode the printer will not resume normal operations until the necessary number of bytes has been received. The only ways out are to switch the printer off, or send large numbers of 0s to match the necessary number of bytes. Some printers avoid this by having a minimum value, below which codes are interpreted normally. The Seikosha and Centronics both interpret codes below 32 normally. The Centronics graphics characters start at 32, the Seikosha's at 128.

There are three types of control sequence I have come across:

- a single escape sequence to define the whole picture;
- an escape sequence or control code sent each line to determine how many bytes to print.
- a control code or escape sequence to switch to graphics mode, and another to switch out.

These sequences must be sent in the appropriate places in the program. The process is given as a flow chart in figure 6.

Some printers have the 'block' graphics character set (sometimes called 'chunky' or 'domino' characters). Mode 7 teletext characters are a sub-set of these. They are based on a three by two matrix, and constitute a set of 64 characters, printed typically by codes 128 to 191 (though the Epson starts at 160). The Microline 80 has these characters as its only graphics facility. Each cell corresponds to a six-digit binary number (0 to 63), and the ASCII code is generated by adding 128 to this. For example:



Dumping the screen with these characters uses the same technique.

The printer byte will be made up by scanning the pixels corresponding to the most significant square first. Six pixels are read in sequence, finishing with the top left. We scan the cell in the order:

6	5
4	3
2	1

using the program segment;

```
FOR x=7 TO 0 STEP 4
FOR y=11 TO 0 STEP -4
read the Pixel
NEXT y
NEXT x
```

This will now be embedded in loops to cover the screen using X and Y.

One major snag arises. There are normally 80 characters per line of printing. Thus the block graphics set prints a maximum of 160 small squares per line. As should have become clear, it is necessary to have at least 320 graphics elements per line to correspond to the 320 pixels in mode 1. The only solution, if the full screen is to be reproduced without distortion, is to print it in two halves.

Building a printer byte in Plan A

Pixels A B C D E F G H

At start byte = 0 : binary 00000000

Value of byte * 2	Pixel Read	increment added	Value of byte	byte in binary
0	A	1	1	00000001
2	B	0	2	00000010
4	C	1	5	00000101
10	D	1	11	00001011
22	E	0	22	00010110
44	F	1	45	00101101
90	G	1	91	01011011
182	H	0	182	10110110
			dot pattern	●○●●○●●○

Figure 4. Building printer bytes in plan A

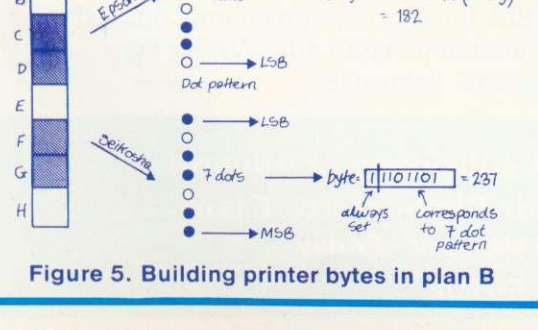


Figure 5. Building printer bytes in plan B

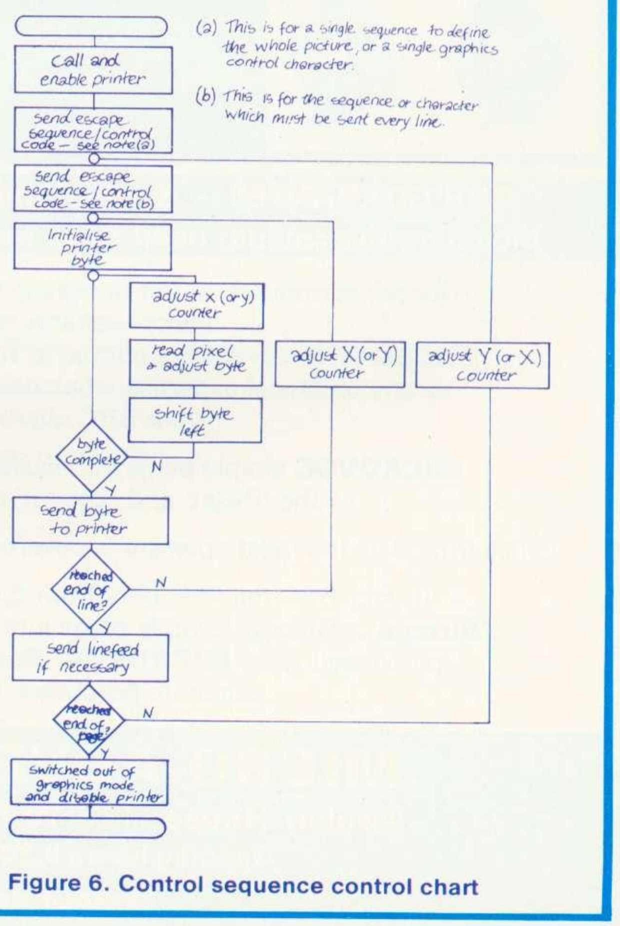


Figure 6. Control sequence control chart

The printer byte is built up in a similar way to that described for the earlier dot patterns (program 1). This type of dump requires no escape sequences or control characters.

```
1000 FOR A=0 TO 1                                 split screen
1010 START=640*A:FINISH=640*A+639
1020 FOR Y=1023 TO 0 STEP -12                     step 3 pixels at a time
1030 FOR X=START TO FINISH STEP 8                 step 2 pixels at a time
1040 byte=0                                       initialise
1050 FOR y=11 TO 0 STEP -4                        read bottom to top
1060 FOR x=7 TO 0 STEP -4                         read right to left
1070 byte=byte*2                                  shift left
1080 IF POINT(X+x,Y-y)>0 THEN byte=byte+1         adjust byte
1090 NEXT x
1100 NEXT y
1110 byte=byte+128                                add on starting value
                                                  to set on Printer
1120 VDU1,byte                                    send to Printer
1130 NEXT X
1140 VDU1,10                                      may not be necessary
                                                  if linefeed active
1150 NEXT Y
1160 VDU1,10,1,10,1,10,1,10                       space between halves
1170 NEXT A
```

Program 1. Building up the printer byte

Program	Comment
VDU28,maxX,31,maxX,31	Define minimum text window at bottom right of screen. maxX is 39 in modes 1 and 4 and 19 in 2 and 5.
COLOUR 128+n :CLS	n is the colour of the bottom right square of your picture, now filled as text background. (eg, if n is 3, COLOUR131:CLS)
PAGE=TOP+&100	Set address for start of next program.
CHAIN"DUMP"	load and run 'dump'

Program 2. 'Cheat' to avoid screen messages

In general, graphics dumps written in Basic are slow, taking up to half an hour. Speed can be considerably increased by two simple alterations. The first is to use integer variables instead of floating point in FOR . . . NEXT loops (ie X%,Y%,x%,y%,); second is to omit the variable letter in the NEXT statement.

Dumps can be used in a variety of ways, in conjunction with Basic graphics programs. Probably the simplest is to save the dump in the form of a procedure. This means inserting the statement DEFPROC-DUMP at the start, and ENDPROC at its end. You will have to merge it with your graphics program. This can be accomplished as described in the *User Guide* (page 402). There are two methods: save the dump using *SPOOL and call it up using *EXEC, (which the *Guide* prefers, but I find slow); save the dump normally, and then merge using *LOAD at TOP-2.

The *User Guide* refers to the latter method as 'dirty', but I find it at least as clean as the other way. It has the advantage that if you forget to take care of the line numbers (you should remember for both methods), typing OLD, followed by RENUMBER, will correctly renumber the program in most cases. You can now call the dump from within the Basic program by simply inserting the line PROCDUMP.

An alternative method is to save the dump as a normal program. It can be called up and 'hidden' from the other program as follows. Insert the line PAGE=&0E00 at the end of the DUMP (or PAGE=&1900 if you have discs). Then, to call up and run the dump from within the graphics program insert the lines PAGE=TOP+&100, and CHAIN "DUMP". (A similar effect can be obtained for a machine code dump by using *SAVE with load and execution addresses, and calling it up using *RUN.)

There are certain undesirable consequences of using the latter methods with tape. Unless you have defined a text window, the messages 'Searching' and 'Loading' will appear on the screen, removing sections of your picture. The 'cheat' in program 2 will stop this.

Finally, programs 3 and 4 give dumps for the Olivetti ink-jet printer reviewed last month, and for the tried and trusted Seikosha.

```
1000  DEFPROCOLIDUMP
1001  REM CONTROL is the code to define the image
1002  DIM CONTROL 15
1003  $CONTROL=CHR$(27)+"G120;40;32;2"+CHR$(27)+"Z"
1004  REM call printer
1005  *FX5,1
1006  REM enable printer
1007  VDU2
1008  REM send CONTROL to printer via VDU1
1009  FOR I=0 TO 15:VDU1,CONTROL?I:NEXT
1010  REM scan screen and send data to printer
1011  FOR Y%=1023 TO 0 STEP -4
1012    FOR X%=0 TO 1279 STEP 32
1013      byte=0
1014      FOR x%=0 TO 31 STEP 4
1015        byte=byte*2
1016        IF POINT(X%+x%,Y%)>0 THEN byte=byte+1
1017        NEXT
1018      VDU1,byte
1019      NEXT
1020    NEXT
1021  REM disable printer
1022  VDU3
1023  ENDPROC
```

Program 3. Olivetti ink-jet dump

```
1000 DEFPROCSKDUMP
1001 REM call printer
1002 *FX5,1
1003 REM enable printer, and switch to graphics mode
1004 VDU2,1,8
1005 FOR Y%=1023 TO 0 STEP -28
1006   FOR X%=0 TO 1279 STEP 4
1007     byte=0
1008     FOR y%=27 TO 0 STEP -4
1009       byte=byte*2
1010       IF POINT(X%,Y%-y%)>1 THEN byte=byte+1
1011       NEXT
1012     VDU1,byte+128
1013     NEXT
1014   VDU1,10
1015   NEXT
1016 REM switch off graphics mode and disable printer
1017 VDU1,15,3
1018 ENDPROC
```

Program 4. Seikosha dump

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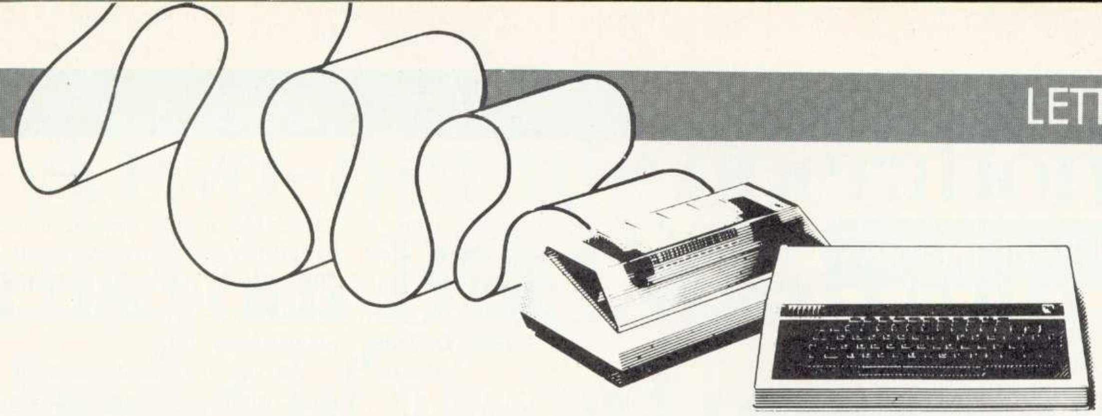


SOUND THEORY

Sir, In the article 'The Beeb plays Bach' (*Acorn User* April) the authors describe how playing multi-part music involved 'some tricky queueing and synchronisation problems', and present a complex solution that keeps a clock for each line of the music to avoid interference between note sequences of different rates.

The designers of the BBC micro sound system were aware of these problems and devised the sound queue arrangement to overcome them, providing the clock function automatically. As a result, it is easy to ensure channels get independent supplies of notes, using the ADVAL function to test the queue status. The program sends the next note only if there is room for it, keeping the queues full at all times. Here's a demonstration:

```
10 REPEAT
20 IF ADVAL (-6)> 0 THEN
   SOUND1,-15,RND(10)*4+48,5
30 IF ADVAL (-7)> 0 THEN
   SOUND2,-15,RND(10)*4,20
40 UNTIL FALSE
```

Repeated synchronisation is now unnecessary since the relative timing is 100% accurate. An initial synch-ed 'chord' of rests can be used to start the parts off simultaneously.

This and other sound programming techniques are fully described in *Creative Sound on the BBC Microcomputer*; a forthcoming Acornsoft book.

Chris Jordan
Acornsoft
Cambridge

The problem of synchronisation certainly exists and the programmer who wants to synchronise two or more voices containing notes of different duration must be aware of it. He must *not* simply issue a sound statement for each channel in turn.

An algorithm using the ADVAL function as suggested above would have a rather similar loop structure to ours – the only saving would be removal of the need to add each note duration to the corresponding clock (hardly a 'complex solution').

As for repeated synchronisation, we experimented with both approaches and there certainly appeared to be no perceptible need for synchronisation parameters. However, the 100% accurate relative timing is not documented. Available documentation suggests synchronisation parameters should be included where possible. We therefore opted for the algorithm that permitted their inclusion where appropriate.

Jim McGregor
Alan Watt

BUG? WHAT BUG?

Sir, The operating system of my BBC micro has recently been changed from 0.1 to 1.2. When running a program with many sequential sound statements I noticed that the shift lock LED seemed to be flickering dimly and that running the program with both shift and caps lock LEDs off caused them both to flicker.

Investigation showed that they were in fact being driven by high frequency square waves from IC32 (74LS259) which is driven by IC3 (6522 VIA).

Whilst this is obviously a bug in the series 1 operating system, it does not seem to produce any other side effects. Could you let me know how to cure this bug?

Jonathan Duff
Belfast

This 'obvious bug' isn't a bug. It acutally indicates when a buffer gets full. Since the sound is buffered, both lights come on to indicate it's full. If you use paged mode (CTRL-N) you will notice that both LEDs come on at the end of each page (waiting for shift to be pressed).

Acorn said, when we asked them about this, 'it hurts to be told it's a bug. It's meant to be a help!'

FREE PERSONAL AD SERVICE

A new feature for readers from the next issue. Sell your bits and bobs, no charge!

Why not sell that old Sinclair and make a few bob? Just fill in the form below to a maximum of 32 words (one in each box) and send it to Acorn User Free Ads, 53 Bedford Square, London WC1. Use capital letters, and remember your name, address or telephone number. This is a free service to readers – no companies please. One entry per form only, and we cannot guarantee any issue.

ANTIPODEAN THANKS

Sir, Many thanks for sending the April copy of *Acorn User* dealing with our Antipodean activities.

Thank you very much indeed for giving us such a prominent position and for your amazing accuracy down a 12,000 mile crackling phone line! The piece was a real reflecton of the situation here and we all appreciate it.

Siriol Giffney
BBC Sydney
Australia

READER POLLUTION

Sir, I also have experienced the same kind of radar interference as mentioned by Chris Allard of Middlesex (*Acorn User*, April). Am I right in assuming this is because radar transmissions are around chahnel 36?

If so, is there any way of adjusting my BBC micro to give a different UHF output? My interference also takes the form of a regular pattern of white lines moving across the screen every six to seven seconds. This I assume is due to my proximity to Heathrow. (If this is the case will the problem disappear if I buy an RGB monitor?)

The problem also affects video recorders which put out their signal at channel 36. When moved to a new location, some miles away, I have no problems with my micro or video recorder.

B. Holmes
Berks

RADAR SOLUTION

Sir, With regard to the letter by Chris Allard which appeared in the April issue of *Acorn User* concerning the 'jitter' appearing in modes 0 to 3 on his father-in-law's TV set, I too had this sort of problem. I traced it to the fact that the television frame synch was trying to synchronise on the flyback signal. The higher resolution modes are the only ones that suffer from this problem.

The easy way to remedy this is to adjust the vetical hold variable resistor to enable a stable pattern. If, however, Mr Allard's father-in-law's set is like mine (and many other modern sets) it will not have a vertical hold adjustment. However, this must be added. If the set in question has a Thorn chassis (Ferguson, Baird, etc.) there may be a provision for the addition of this variable resistor.

John D. Long
Leicester

Poking around the back of TV sets is dangerous, so unless you know what you are doing, check this out with a TV engineer.

PHANTOM POSTMARK

Sir, I have heard Acorn have had problems in answering letters and meeting delivery schedules. The postmark shown may explain the problem. Are they in a world of their own? They use a different calendar obviously.

Dr. R. Flinn
University of Birmingham

CATCH 64

Sir, I have the 1.2 ROM and every time I press break, location &D00 is set to 64. Is this a bug?

S.A.Todd
Fife

No, it's not a bug. The code 64 (&40) is an RTI instruction (meaning ReTurn from Interrupt). &D00 is the memory location where the non-maskable interrupt (NMI) service routine is placed, and since no routine has been provided (a DFS would put one there if you had a disc system) an RTI is automatically placed there so the interrupts are ignored.

BASIC II BOOB

MANY thanks to those who pointed out that I had misunderstood what OPENIN would do in Basic I (Mr Ward of London and Mr Tracy of Coventry, among others). As you rightly pointed out, OPENIN can be used in Basic I in the same way as OPENUP in Basic II, in fact they use the same token. Therefore, when you load a program written in Basic I as 'OPENIN' it will appear in the listing as 'OPENUP'. So what is the point of OPENIN in Basic II? Presumably so it provides a read-only method of accessing a file.

As you may have guessed, I hadn't used random access files more than once or twice before writing the article in May's *Acorn User*. Will someone please write in to explain, for idiots like me, exactly how to use random files? Thank you.

Paul Beverley

MONSTERS BLOW OUT

Sir, We have a BBC upgraded model A with 1.2 OS and we bought a copy of Acornsoft's *Monsters*. As an experiment we tried jumping the man through a hole when his oxygen was about to run out, so the oxygen would run out while he was in mid-air. When he lands, he lies down as normal, but his stomach appears to explode! Is this normal?

Also, is it true that the Basic II ROM does not allow certain programs to run?

Michael Isard
E. Sussex

We got on to Acornsoft and asked the author if the exploding stomach is normal – and he assures us it is!

As to your second point, all Acornsoft programs run under any operating system with any Basic.

VOICE ON VIA

Sir, First of all, micro and magazine are great! Could you please tell me whether it is possible to add another sound voice on the CB2 line of the VIA. My friend has a VIC-20 and we have done it on his computer. Can I do it on mine?

A. Wilkinson
Kent

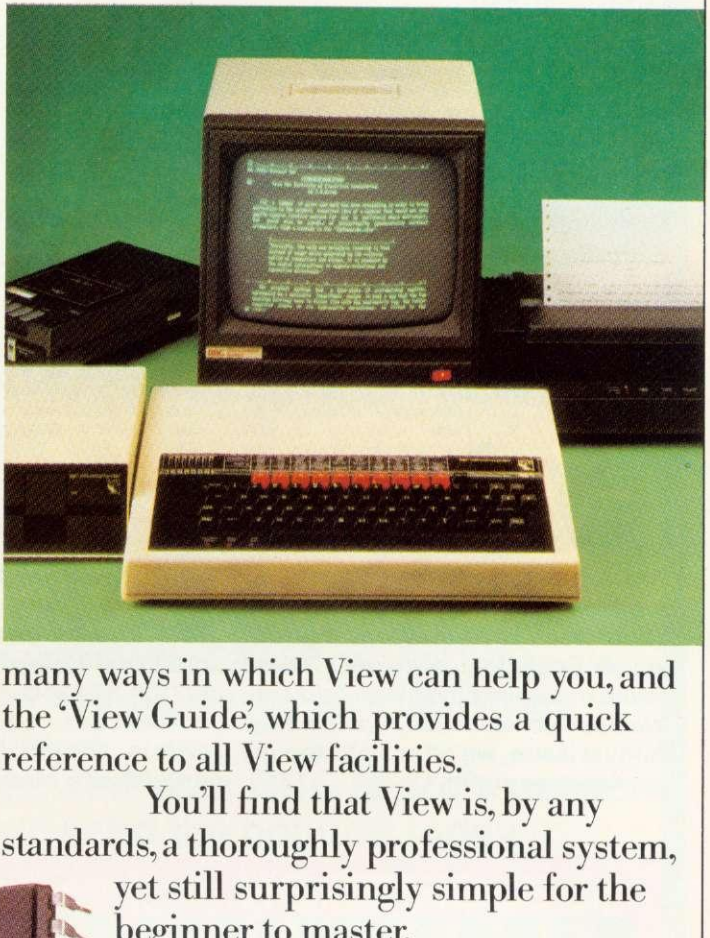
If you have a second 6522 installed (standard on a model B and usually in upgraded Model A's) then you can use the CB2 line as on the VIC. This line is brought out on the user port connector and connection details are given on p503 of the User Guide. You would be advised to purchase a 6522 data sheet (£1 from Acorn). They need cash with order, and their address is Fulbourn Road, Cherry Hinton, Cambridge CB1 4JN. Tel: 0223 245200.

A two-minute operation turns your BBC Micro into the heart of a word processor.

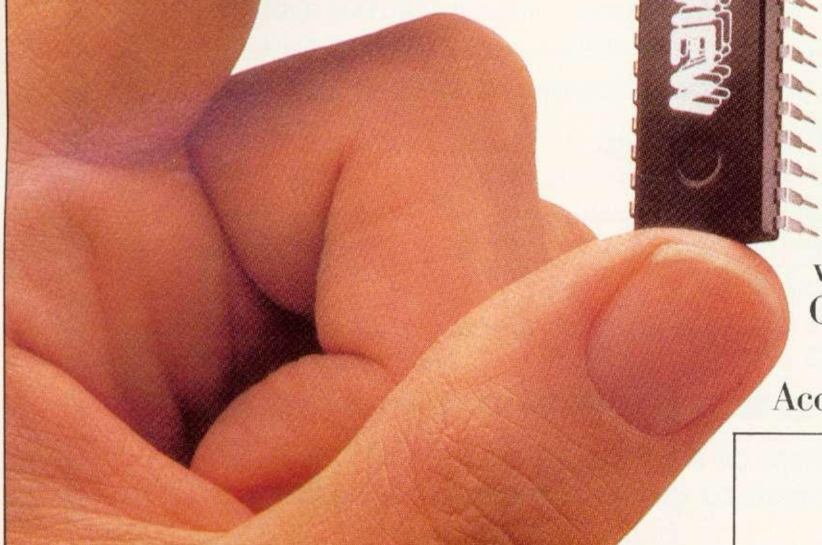
VIEW is a software program from Acornsoft (the software division of Acorn Computers Ltd., who designed and built the BBC Micro) that enables you to use your BBC Micro, together with a printer, as a fully operational word processor.

View is supplied as a Rom chip that can easily be fitted to your BBC Micro by your local dealer, in a painless two-minute operation.

Then, once installed, you only have to switch on and View is operating immediately. (You can easily switch back to normal computing with a single command.)



Also included in the View package are two special books: 'Into View,' that takes you by easy stages through all the word processing commands and explains the many ways in which View can help you, and the 'View Guide,' which provides a quick reference to all View facilities.



You'll find that View is, by any standards, a thoroughly professional system, yet still surprisingly simple for the beginner to master.

The 'Spark-Jet Printer' shown in the photograph is the ideal choice of printer for your word processing application. Extremely quiet, it offers high resolution graphics from monitor or T.V. screen and is available now from dealers.

If you'd like more information, write to Acornsoft, 4a Market Hill, Cambridge CB2 3NJ.

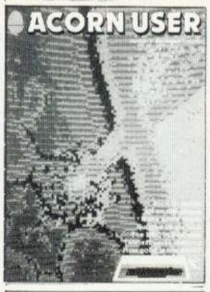
Or, for details of your local Acornsoft dealer, phone 01-200 0200.

ACORNSOFT

BACK ISSUES

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.

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.



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.

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.

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.

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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AU11

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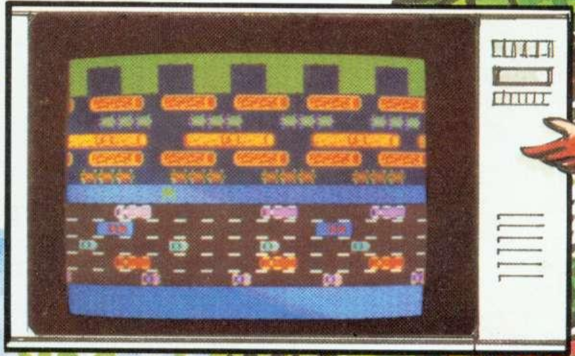

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