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YOUR COMPUTER

NOVEMBER 1981

Vol.1 No.4

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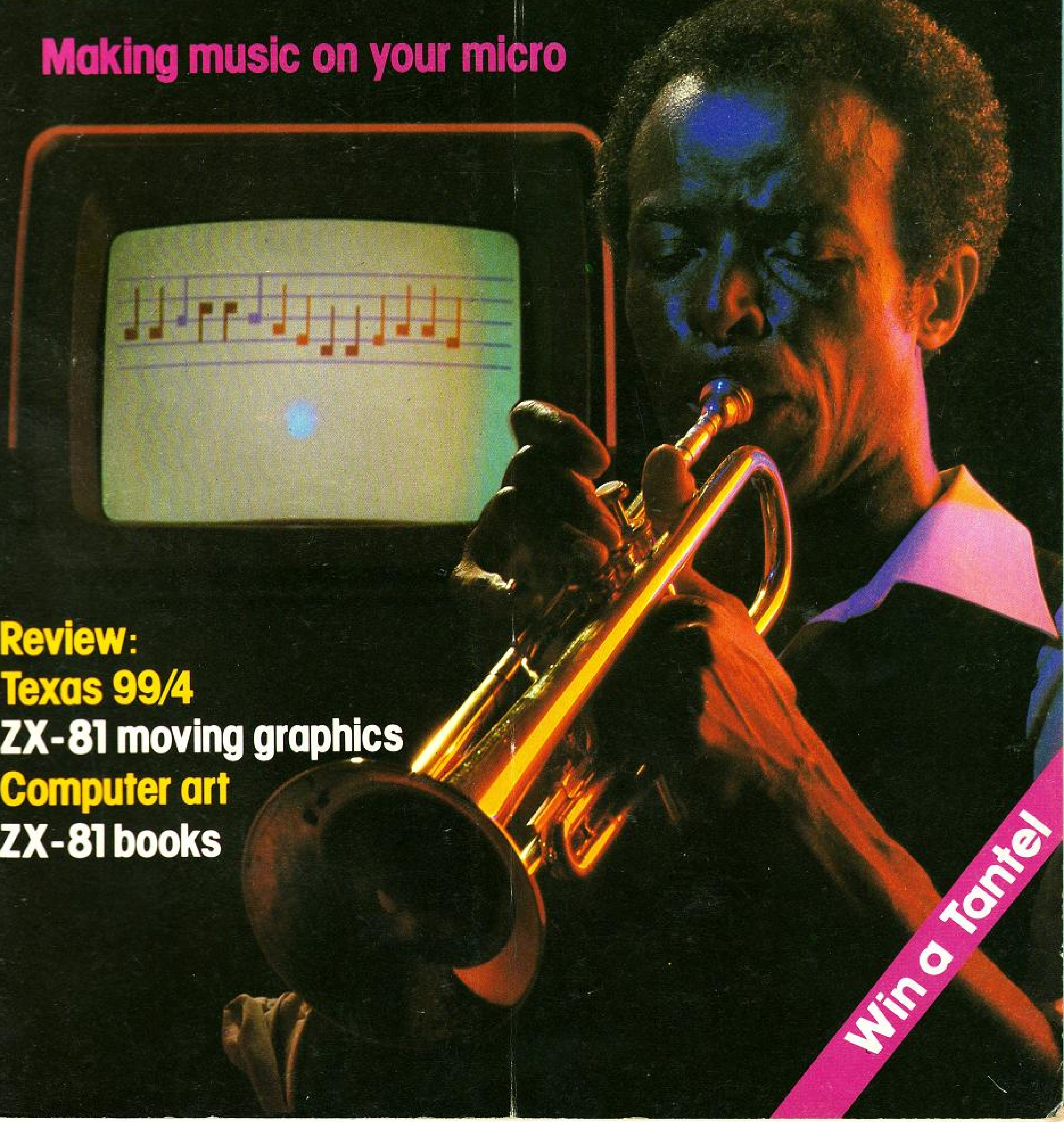

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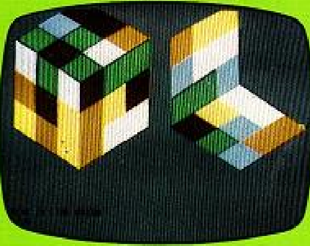
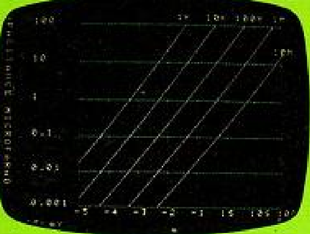

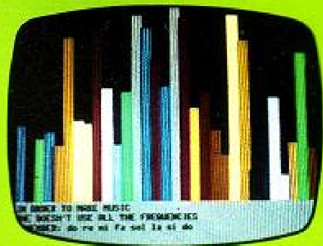
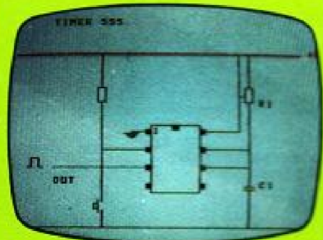

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EDITORIAL

WHY DON'T GIRLS compute? There still seems to be a popular feeling that computers are terrifically technical and whoever understands them, or even manages to use one at home, must be some kind of weird boffin. Boys' stuff, so the myths tell us. Luckily the myth is in the process of being blown away. More than 20,000 computers are being sold each month in Britain, largely thanks to Clive Sinclair; it would be hard to maintain that we are finding another 20,000 boffins every four weeks. Yet of those 20,000 newcomers to the market each month the vast majority are still boys.

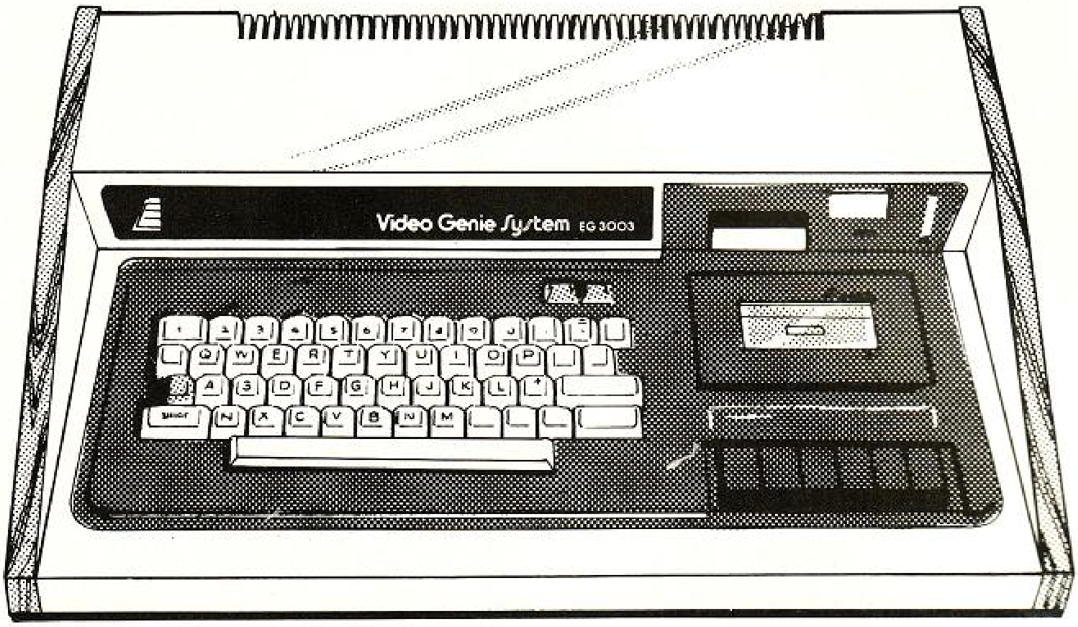
It is hard to tell whether parents deliberately buy computers for their sons rather than their daughters, or whether it is the sons who demand of their parents that they have a computer for their birthdays. Whichever it is, the girls are not computing.

At the recent ZX Micro Faire in London, the girls were outnumbered by approximately 100 to one. Parents must take a certain amount of the blame for this — perhaps they still feel that it is not quite proper for girls to compute. If that is the case, they are doing the next generation of girls a great disfavour. For the up-and-coming generation a knowledge of how computers work will be of immense value when looking for work in today's bleak job climate. Being able to program a Sinclair ZX machine is obviously no qualification for a job but at least it opens one's eyes to the possibility of learning how to program to a professional standard. Maybe some will even be sufficiently encouraged to try and start their own software companies; there are already many precedents of young entrepreneurs earning more from their hobbies than their parents do in their full-time jobs.

The other culprits are the schools. It is often in schools that the segregation between the arts and the sciences, between the girls and the boys, begins in earnest. The boys are sent to the science laboratories and the girls are left with the so-called soft options. The result is seen at every computer exhibition.

It is the teachers, not the girls, who are responsible for advising parents that the best chance of academic success for their daughters lies in languages, biology and domestic science. Part of the problem is that computing is not yet regarded as a soft option. Learning the 100-odd key words in the vocabulary of Basic is a doddle compared to mastering the intricate irregularities of French, Spanish or German. Let's tell the teachers to think again. ■

Video Genie...



Are you a home enthusiast taking your first tentative steps into the enthralling world of micro-computers? If so, the Video Genie is the ideal complete system for you!

It's a real micro-computer, not a pocket one, yet it only needs connecting to a domestic T.V. set to produce superb results.

The Genie is compatible with the popular TRS 80 16K level 2, the best selling computer of all time. As well as its lower price, the Genie offers an in built cassette deck, 16K RAM, 12K ROM with BASIC interpreter, full size keyboard and a stylish carrying case. So it is not only excellent value for money, but an ideal "First computer" on which to learn programming.

There are literally 1000's of pre-recorded programs available, including educational, leisure and small-business applications, and simple BASIC language means you can write your own programs with ease.

Extended BASIC.

The Microsoft extended BASIC has many powerful features, including double precision variables, scientific functions, formatted printing, extended editing sub-commands, automatic line numbering, multiple dimensional arrays, complete string manipulation, direct access to graphics and machine language sub-routines.

Memory.

The Genie EG 3003 model has 16K of internal RAM expandable externally to 48K using the special Expansion unit. 12K of ROM contains the Microsoft BASIC.

Cassette.

Two cassette interfaces are provided for both the internal and an external cassette unit.

CPU.

The machine uses the industry Standard Z80 micro-processor.

Display.

64 or 32 characters × 16 lines are available on the full display.

LOWE electronics

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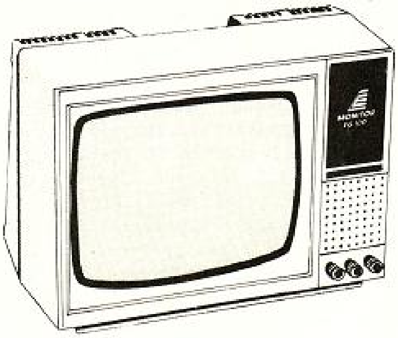
12" Monitor.

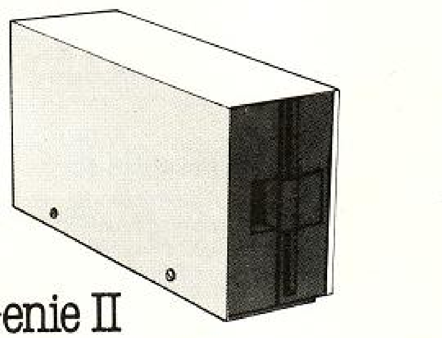


The additional purchase of the EG 100 Monitor offers 3 distinct advantages
- It gives a considerably better quality display.
- It does not interfere with domestic T.V. viewing.
- It comes in an attractive matching style.

Expander.

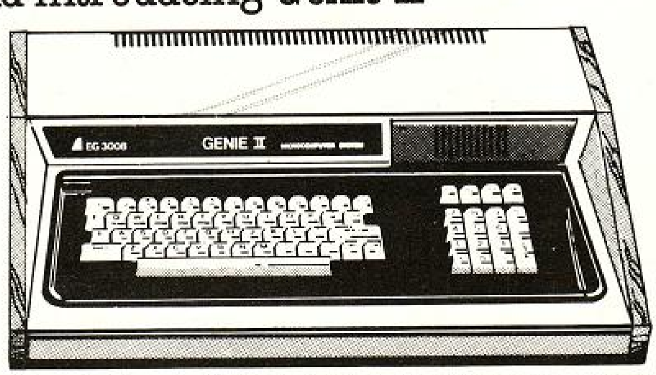
The expansion box unleashes the full possibilities of the Genie. It contains a selection of interfaces, allowing the connection of up to 48K RAM, 4 disk drives, printers and S100 cards.

Disk Drive.



As well as the obvious advantage of mass-storage, the addition of the disk system to the Genie means much faster access to other languages and full random access file handling. Up to 4 drives can be used on a system.

. . . and introducing Genie II



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- Basic business commands
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For full details and demonstrations of the Video Genie system or Genie II contact your local dealer, or write directly to the sole importers at the address below.

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A handy alphabetical summary section lists all functions, and provides a short description and example programs of all topics.

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The Complete BASIC Course has over 240 pages filled with information in an attractive durable ring binder – this is a lay-flat work of reference that deserves a place next to every Sinclair ZX 81 microcomputer.

OTHER TITLES AVAILABLE:

Melbourne House is the world's leading publisher of books and software for the Sinclair ZX 81.

The following titles are also available if you wish to expand your horizons:

BASIC Course Programs on Cassette -

All major programs in the BASIC Course are available pre-recorded in this set of cassettes. This is a valuable adjunct to the Course, saving you time and effort.

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MEMORY THRIFT

Responding to Mike Howard's letter in the August/September Software File, here are a few points concerning memory economy which ZX-81 and 8K-ROM ZX-80 owners may find useful.

Firstly, by evaluating numbers as strings;

```
10 LET A=1234
```

consumes 18 bytes and

```
10 LET A=VAL "1234"
```

takes 15. They are both equivalent lines, although the second is slower than the first, and three bytes are saved every time a number is evaluated in this way.

Secondly, although the numbers one and zero which necessarily proliferate in most programs can be evaluated as shown, it is more convenient to use SGN PI for one, and Not PI for zero — saving four bytes each time they are used.

Finally, certain small whole numbers can be expressed as character codes. For example:

```
10 GOTO 200
```

can be replaced with;

```
10 GOTO CODE "COS"
```

saving five bytes. Replaceable numbers can be found in appendix A of the ZX-81 manual.

Using these techniques, a 1K ZX-81/8K-ROM ZX-80 user may expect to fit, on average, an extra 100-200 bytes into the full computer.

Kevin Hill,
Halesowen,
West Midlands.

ZX-81 BLACK SPOT

I have a black spot in my ZX-81 16K RAM pack. It is a pixel which began appearing within days of delivery, whenever I switched on. It is always in the same place, just ahead of the K cursor. I have pinned it down to co-ordinates 63,15 but it refuses to stay unplotted.

It has friends which occur here and there while listing a loaded program or inputting a new one — sometimes four, occasionally six. And whenever an input character, whether from memory or keyboard, coincides with one of them, it is like Space Invaders — the input character actually changes, confuses the computer and throws up an error report.

The result is total frustration and absolutely no progress. You might not believe the report codes I obtain on trying to load, say, the Sinclair business utilities programs. The "Telephone" one refuses to run — persistently giving report code c/250. Every listing of programs I can load is prefaced by two or three lines of pulsating pixels down screen.

Sinclair Research warns of possible initial "non-communication" being experienced with the ZX-81 shortly after introducing the 16K RAM pack. The company advised me to return mine for repair. Did I do something wrong or do I just have a bad RAM pack?

Brian Harrison,
Redcar,
Cleveland.

SINCLAIR CRITIC

Clive Sinclair is a great experimenter and innovator and an asset to the industry, but I find his criticism of the BBC in the August/September issue considerably out of place. He has more than proved his worth with his ideas, but as a business executive he has, in my view, shown a complete lack of understanding towards his customers.

In any organisation involved with selling to the public, a supplier has to organise adequate means of dealing with queries and faults. In this matter Sinclair has fallen well below the accepted standard, and I have joined the large body of customers who have tried to contact his firm by telephone without result, and letters would be answered with greater speed if replies were conveyed by foot. This, coupled with the large number of complaints about faulty items, would suggest that he has had more success than perhaps he deserves.

I certainly wish him and his company well, but if the BBC had been involved with his method of supplying customers, I am sure that its very important programme would never have been able to expect the success that I am very sure it will have.

C Brower,
Hove,
East Sussex.

FUTURE OF VIC

In the August/September 1981 issue, Tim Hartnell and Trevor Sharples answer a letter from G Howell in Response Frame concerning the Vic-20 being upgraded to 40 columns. The answer given is extremely misleading.

It is unlikely that Vic will be upgraded to 40 columns with a replacement ROM. The reasons are very straightforward: in its present configuration the Vic uses 512bytes of RAM for the screen memory and an additional 512bytes — one for the colour of each of the 512 screen locations.

While it is quite possible for the second 512bytes to be adapted to accept the character colours for 1,000 locations — using one nybble per location instead of one byte — the screen memory would have to be expanded at the expense of user-available RAM.

Another factor is the 6561 Vic chip itself. This chip was designed for a 22-by-23 screen size and a new Vic chip will be required to drive 40 columns — the 6563.

When the Vic-40 arrives, it is much more likely to be an entirely new machine and it is unlikely that an upgrade will be supplied for the Vic-20.

On a slightly different tack, I would like to correct a few of the points which appeared in Nick Hampshire's excellent article on the Vic:

- 3.5K of RAM is user-available on the Vic as supplied, not 3.6K as stated. 1K is used for normal stack, variable storage and operating system scratchpad, .5K is used for screen memory. There is an additional .5K of RAM in the machine which is used for character-colour storage, so the total RAM in the Basic machine is 5.5K.
- Obviously, in the light of this the 3K RAM pack expands the system to 6.5K.
- The Vic disc drive will be read/write-compatible with 4040 discs and only read-compatible with 3040 discs. Obviously, there will be no interchangeability with the 8050 discs.
- The interface to the low-cost printer and floppy disc unit is not IEEE 488 or even a partical implementation of it. It is an out-and-out serial bus for which, as far as I am aware, there is no standard specification outside Commodore.
- While it is true that the 6502 in the Vic is the 2MHz version the clock rate is only 1.1084MHz — the PAL subcarrier of 4.43361 divided by four. The processor is, therefore, running faster but not twice as fast.

David Briggs,
Technical Support Manager,
Commodore Business
Machines (U.K.) Ltd.

DEVICE PROPOSAL

First of all, I find *Your Computer* by far the best periodical in its field. It is full of very good, unbiased reviews, and a great deal of information presented in a readable and intelligible form, so that anyone who is fascinated by micro-computers, but as yet does not possess one, can understand most of what is being said.

I would like to draw attention to a device I have just bought for £14.99. It is a small video game with its own integral, liquid-crystal screen. The contrast on the 23mm.-by-42mm. screen is good enough to read the 2.75mm.-by-2mm. numbers with eae.

Could not a screen such as this, be used as the VDU of a small, pocket-sized computer? Such a device would have a full keyboard, and plenty of room within it to store plug-in ROM and RAM modules. Its power consumption would also be low.

I can think of two very important applications for such a device: as a communication device for the deaf/dumb, containing pre-programmed, oft-used phrases available at the touch of a key; and secondly, as a portable database, using ROM for such uses as intelligent dictionary/encyclopaedia searching, and RAM for use as a diary/data-file.

D Austin,
Newcastle under Lyme,
Staffordshire.

TANTEL REALITY

Your reviewer of the Tantel unit does not seem to have used it under practical conditions. As supplied, it is useless in the home and in many offices — the leads are far too short.

I complained to Tantel and was supplied with longer leads. Perhaps Peter Blower can suggest how one connects it to the home TV in one corner of the room and sits in the other controlling it while the children run around in between.

Another point is that the Post Office fitter suggested that he install the jack next to the TV. That is the last place for it: it should be placed next to where one sits as should a power socket.

Many people buying this unit are going to be greatly disappointed because of these difficulties even though, otherwise, it gives excellent results.

R G Silson,
Tring,
Hertfordshire.

DISTURBING NEWS

While undertaking one of my rare journeys from my hermitage in north Wales, I happened to buy the second issue of *Your Computer* from a small newsagent on the outskirts of Bristol. After browsing through the articles, I found myself becoming disturbed by the apparent lack of rubbish normally found in computer magazines.

My usual equanimity was finally shattered when I read the editorial. The opinions expressed there, if I may speak frankly, are no less than revolutionary — not to mention enlightened. I found your attack on the pettiness of the mass-conditioned mind shocking, and your diatribe on our state educational attitudes delightful.

Perhaps, as a disillusioned ex-teacher I am biased, but I am surprised that someone as clear thinking as the editor should have been allowed to attain such a responsible position. Your magazine is showing many signs of attempting to produce quality rather than popularity — can it survive in the commercial market? I hope you are not concerned with making a million and can escape the inevitable pressures for financial success.

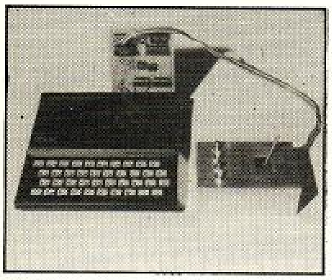
G Goldsack,
Barmouth, Gwynedd. ■

ZX user port defies sceptics

THE SCEPTICS said it could not be done, but a user port has been developed for the ZX-81. It consists of a single board which plugs into the rear of the world's most popular microcomputer to provide an eight-bit input port and an eight-bit output port, both of which are controlled directly from Basic or machine code.

Sound and music are now possible on the ZX-81 — achieved by the addition of a loudspeaker on one of the output bits. The frequency range is from 200Hz to 25KHz, and an accompanying booklet is provided to tell the user how to create sound effects.

Each of the eight output channels may be used to control a separate device, for example LED indicators or relays. The eight input lines may be connected to games paddles, microswitches or detectors. It is conceivable that some users may



want to connect their machines to remote keyboards via this port.

The booklet contains several applications including an electronic organ, a reaction timer, an electronic combination lock and many more. A complete kit of parts costs £11.50, and the booklet a further 40p. VAT and postage are extra. The ZX-81 user port is available from Technomatic, 17 Burnley Road, London NW10. Telephone 01-452 1500.

Printer for the Sinclairs

THE LONG-awaited Sinclair ZX printer is now available, and like the ZX range of microcomputers, the product is both technically advanced and economical. At only £49.50 including VAT, the printer will be well received by the thousands of Sinclair microcomputer owners.

The printer is in the same style as the ZX-81. That is, a black, hard-plastic case — and will fit directly on to the micro. It will also work in conjunction with a new-ROM ZX-80. The printer is very small — no larger than two cassette packs — and it interfaces via the connector on the back of the computer.

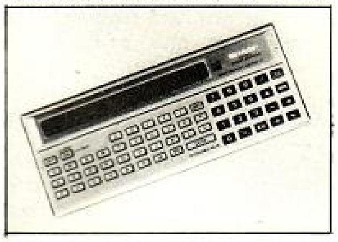
A special feature of the printer is the Copy command which prints out exactly what is on the screen. A simple copy instruction at 14 seconds costs less than one penny. There are also the more traditional printer commands such as LList and LPrint.

There are 32 characters to the line and nine lines to the inch on the special aluminised paper the printer uses. Special paper is required because the printer uses a technique known as thermal printing where the paper turns black at the points where heat is applied.

Company with Sharp bias

OWNERS OF the Sharp PC-1211 pocket computer will be interested to hear of Elkan Electronics, a company which specialises in the Sharp, providing both hardware and software. Hardware is in the shape of the computer itself, the CE-122 printer and cassette interface, as well as paper rolls to use in it.

Software available is quite extensive and covers most of the



more common applications. There is a ledger program for use by accountants, and a PAYE program, both of which cost £14.95 and include documentation.

Other software includes a Cesil interpreter, a whole series of games of which the most interesting is a draughts game which costs £3, a loan calculator, Focus — a program for photographers — a taxi-fare calculator and scientific packages.

For further details contact Barry Elkan at Elkan Electronics, 28 Bury New Road, Prestwich, Manchester, M25 81D.

Speech synthesis to have wider audience

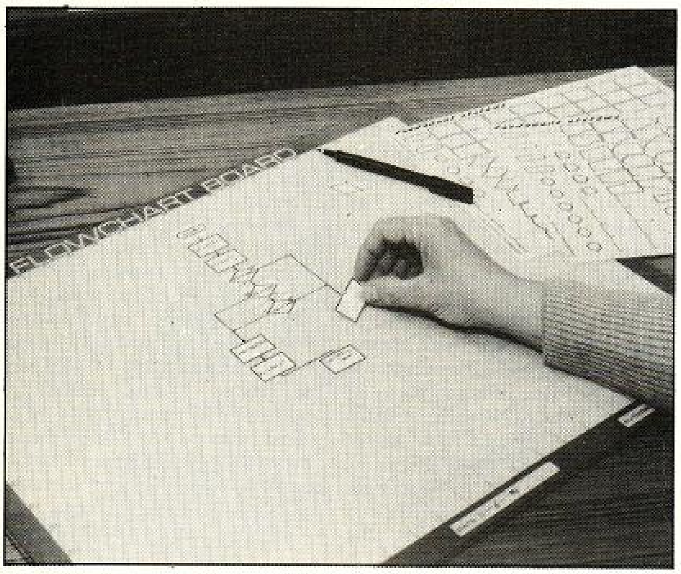
ONE OF the more exciting developments in the last year has been the introduction of speech synthesisers for microcomputers. Now such exotic peripherals are about to become commonplace with the introduction of the Arfon Microelectronics Speech Synthesiser Board.

Designed originally to interface directly with the Nascom micro via the Nasbus, the synthesiser will now interface with a variety of common microcomputers. The board itself sells for £85 plus VAT and can be used in that form with the Nascom and the Apple.

At £120, a boxed system is available for any computer with the RS-232 interface, together with systems for the Pet, Tandy and Video Genie microcomputers. The Pet system should also be suitable for the Vic-20.

The board is based on the proven National Semiconductor Digitalker chip set, with two 64K ROMs containing a vocabulary of 256 words and sub-sounds. An on-board speaker is provided so that speaking can begin as soon as the board is plugged in, but for better quality, a mono jack plug is fitted so that the speech can be output via the user's stereo system.

Arfon Microelectronics Ltd, Cibyn Industrial Estate, Gwynedd, Wales. Telephone 0286-5005.



It is sometimes a good idea to use flowcharts before writing programs. Not everyone believes in it, partly because it can become very tedious. Here, the programmer is using a laminated plastic work-board and sheet of self-cling PVC printed with the full set of British Standard flowchart symbols. The PVC sheets can be lifted and placed on the board. Notations and flowlines can be added with a write-on, wipe-off pen so that an alteration needs only to be wiped away and the correction inserted. The total cost, including postage and packing, is £26. Details can be obtained from the suppliers, Flowchart Systems, Datarite House, Grafton Road, New Malden, Surrey, KT3 3AA. Telephone: 01-942 2830.

Of peripheral interest

HARDWARE AND software products including a motherboard and a sound board designed to complement the Sinclair microcomputers have been unveiled by ZX specialists Quicksilva. The QS Motherboard is a device which enables the user to expand a ZX microcomputer.

It takes the form of a PCB which contains on-board 5 V power supply, sockets to accept add-on boards and a PCB edge connector for fitting extra RAM packs. The motherboard must be connected to the computer via a QS connector. Prices are £3 for the connector and £10 for the motherboard.

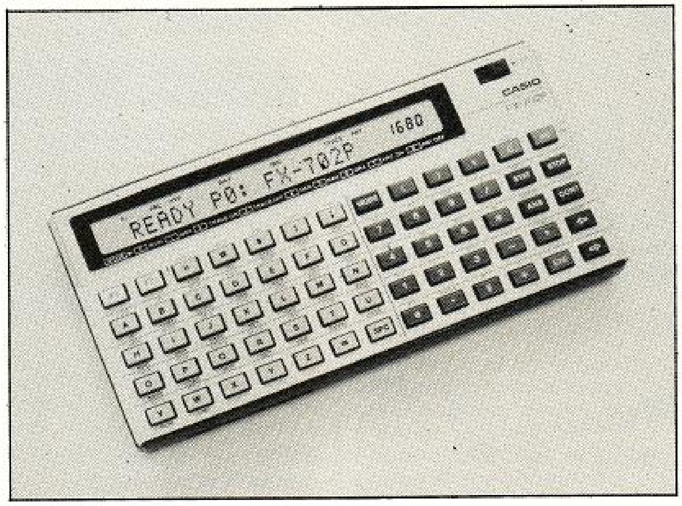
Another hardware add-on for ZX microcomputers is the QS sound board, which can play tunes in three-part harmony. It is based on the AY-3-8910 sound generator chip and features software control from Basic of all the chip's facilities. There are also two eight-bit input/output ports.

All generated sound can be accessed via a jack socket on the board which can be connected to an amplifier. The QS sound board costs £25, which includes programming

Software from Quicksilva is in the form of two games, QS Life and QS Defender. The version of the evergreen computer game Life will work only on a ZX-81 or a ZX-80 which has been modified for flicker-free graphics and will cost you £4.50. QS Defender is a version of the arcade game and includes software to drive the QS soundboard.

Quicksilva can be contacted at 95 Upper Brownhill Road, Maybush, Southampton, Hampshire.

A handful of power



THE CASIO FX-702P is a hand-held calculator which can be programmed in the Basic language. Capable of handling complex and lengthy programs, the FX-702P has a neat alpha-numeric display which means you can display words as well as numbers.

The machine can hold up to 10 programs, with subroutines nested up to 10 levels. Program looping can exist at up to eight levels. You can split the storage between memories and program steps, and the capacity varies between 1,680 steps with 26 memories and 80 steps with 226 memories.

There are 55 single-key routines covering logarithmic, trigonometric and hyperbolic functions. The statistical routines include two types of standard-deviation and regression analysis as well as correlation coefficient. There are string-handling facilities, and a random-number generator. All such functions can be used in the program or the immediate mode.

The LCD is capable of displaying 10 digits, plus two for the exponent, and a program line can be up to 30 alpha-numeric characters long. When listing programs, the lines cycle through the display automatically.

The power is produced by lithium batteries, which keep the FX-702P running for 240 hours of continuous operation.

The computer has a recommended retail price of £134.95, and is supplied complete with instruction booklet and a program library. Contact Casio Electronics Ltd, 28 Scrutton Street, London EC2A 4TY. Telephone 01-377 9087.

Cancer tragedy of micro fan

PROCEEDS FROM the sales of the new backgammon program, being sold by Bug-Byte Software, will be going to help leukaemia research.

Kevan Earl, a 16-year-old microcomputer fan from Bolton wrote the program while he was in hospital receiving treatment for leukaemia. He asked Bug-Byte to market the program, and they agreed. Three days after signing the agreement, Kevan died.

The young programmer's father wrote to Bug-Byte requesting that the royalties Kevan would have received should be sent to leukaemia research. Normally this would be 20 percent of the revenue; in fact Bug-Byte agreed to give half of all proceeds. The program costs £7 and can be obtained from Bug-Byte, 98-100 The Albany, Old Hall Street, Liverpool L3 9EP.

Nascom Basic is extended

TWO MAJOR new extensions to Nascom Basic are now available on cassette. They are a Basic expander and a double-precision package which requires the expander to run.

The double-precision, floating-point arithmetic is to 14 decimal places. It is available for those machines fitted with NasSys and the 8K Basic ROM. The Basic expander will cost around £5 and the double-precision arithmetic about £15. For details send SAE to Mike York, 9 Rosehill Road, London SW18. Telephone 01-874 6244.

Kenneth Baker, Minister for Information Technology, recently launched the second Department of Industry Schools Computer Competition. Open to all secondary schools and sixth-form colleges, the competition has 100 microcomputers to give away as prizes. The competition is being run for the Department of Industry by the British Computer Society. Entrants will be asked to submit an essay of 3,000 to 4,000 words, together with appropriate illustrations and diagrams, describing the use of a microcomputer for a project involving students. Entry applications should be sent to the BCS Project Office, 13, Mansfield Street, London W1E 2YZ before Friday, January 15, 1982.

WH Smith advances into computer world

JOHN ROWLAND, the market development manager at W H Smith, the nationwide magazine and newspaper retailer, has launched into the precarious world of selling microcomputers.

In a recent agreement, W H Smith has undertaken to offer the best-selling Sinclair ZX-81 microcomputer at more than 100 high-street branches.

At the same time, Boots the chemists has decided to market microcomputers as well. For the moment, both companies will be treating the exercise as an experiment. If the W H Smith venture is successful, then after Christmas the Vic-20 will be brought in to broaden the range of machines available.

Boots is to market the Texas Instruments TI-99/4 microcomputer in six city-centre branches; Manchester, Croydon, Cardiff, Swansea, Ilford and Leicester. If the operation is a success then both the range of equipment and the number of outlets will grow.

Yet is it not strange for a chemist chain to sell microcomputers? Aubery Ridley-Thompson, a director of Boots does not agree. He points out that Boots were the first multiple-outlet store to market pocket calculators more than 10 years ago, and the company is well established as a retailer of audio equipment.

The marketing people at Boots reckon that microcomputers will be a very big market, and at £299 a time, the Texas computer should find its way into many homes. W H Smith too realises the enormous potential — hence a massive entry into the high-street microcomputer market. Whatever the outcome of the two experiments, it is inevitable that this is only the beginning.

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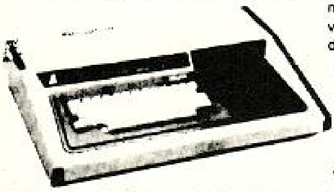

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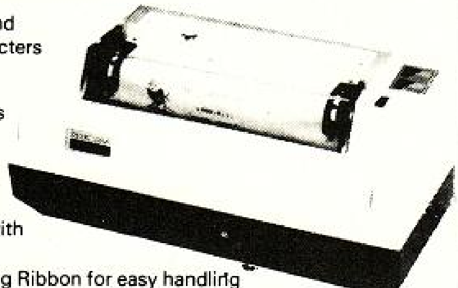

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Connects directly to TRS-80 level 2 keyboard. Operating and file handling software in ROM 8 commands add 12 powerful functions to level 2 BASIC. No buttons, switches or volume controls. Full control of all functions from keyboard or program. Maintains directory with up to 32 files on each tape.

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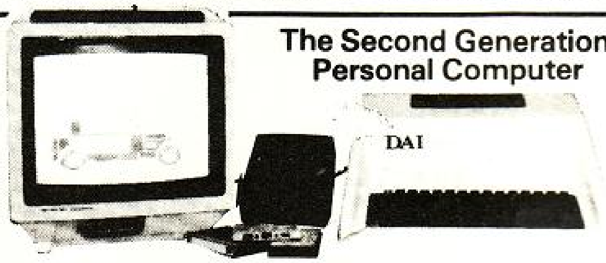

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The Paper Tiger 460 sets new standards by incorporating many features previously only available on units costing much more

Features like a specially developed nine wire 'staggered column' head which overlaps the dots of each matrix character with just one pass of the printhead giving a dense, high quality print image without reducing the units 160 c.p.s. print speed.

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Full 'width' 132 column printing at 160 c.p.s., a unique nine wire 'staggered' print head, bi-directional printing, an inbuilt tractor feed and a host of selectable features set it apart from ordinary matrix printers.

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

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

Each cassette costs £3.95 (including VAT and p&p) and comes complete with full instructions.

Although primarily designed for the Sinclair ZX81, many of the cassettes are suitable for running on a Sinclair ZX80 – if fitted with a replacement 8K BASIC ROM.

Some of the more elaborate programs can be run only on a Sinclair ZX Personal Computer augmented by a 16K-byte add-on RAM pack.

This RAM pack and the replacement ROM are described below. And the description of each cassette makes it clear what hardware is required.

8K BASIC ROM

The 8K BASIC ROM used in the ZX81 is available to ZX80 owners as a drop-in replacement chip. With the exception of animated graphics, all the advanced features of the ZX81 are now available on a ZX80 – including the ability to run much of the Sinclair ZX Software.

The ROM chip comes with a new keyboard template, which can be overlaid on the existing keyboard in minutes, and a new operating manual.

16K-BYTE RAM pack

The 16K-byte RAM pack provides 16-times more memory in one complete module. Compatible with the ZX81 *and* the ZX80, it can be used for program storage or as a database.

The RAM pack simply plugs into the existing expansion port on the rear of a Sinclair ZX Personal Computer.

Cassette 1 – Games

For ZX81 (and ZX80 with 8K BASIC ROM)

ORBIT – your space craft's mission is to pick up a very valuable cargo that's in orbit around a star.

SNIPER – you're surrounded by 40 of the enemy. How quickly can you spot and shoot them when they appear?

METEORS – your starship is cruising through space when you meet a meteor storm. How long can you dodge the deadly danger?

LIFE – J. H. Conway's 'Game of Life' has achieved tremendous popularity in the computing world. Study the life, death and evolution patterns of cells.

WOLFPACK – your naval destroyer is on a submarine hunt. The depth charges are armed, but must be fired with precision.

GOLF – what's your handicap? It's a tricky course but you control the strength of your shots.

Cassette 2 – Junior Education: 7-11-year-olds

For ZX81 with 16K RAM pack

CRASH – simple addition – with the added attraction of a car crash if you get it wrong.

MULTIPLY – long multiplication with five levels of difficulty. If the answer's wrong – the solution is explained.

TRAIN – multiplication tests against the computer. The winner's train reaches the station first.

FRACTIONS – fractions explained at three levels of difficulty. A ten-question test completes the program.

ADDSUB – addition and subtraction with three levels of difficulty. Again, wrong answers are followed by an explanation.

DIVISION – with five levels of difficulty. Mistakes are explained graphically, and a running score is displayed.

SPELLING – up to 500 words over five levels of difficulty. You can even change the words yourself.

Cassette 3 – Business and Household

For ZX81 (and ZX80 with 8K BASIC ROM) with 16K RAM pack

TELEPHONE – set up your own computerised telephone directory and address book. Changes, additions and deletions of up to 50 entries are easy.

NOTE PAD – a powerful, easy-to-run system for storing and retrieving everyday information. Use it as a diary, a catalogue, a reminder system, or a directory.

BANK ACCOUNT – a sophisticated financial recording system with comprehensive documentation. Use it at home to keep track of 'where the money goes,' and at work for expenses, departmental budgets, etc.

Cassette 4 – Games

For ZX81 (and ZX80 with 8K BASIC ROM) and 16K RAM pack

LUNAR LANDING – bring the lunar module down from orbit to a soft landing. You control attitude and orbital direction – but watch the fuel gauge! The screen displays your flight status – digitally and graphically.

TWENTYONE – a dice version of Blackjack.

COMBAT – you're on a suicide space mission. You have only 12 missiles but the aliens have unlimited strength. Can you take 12 of them with you?

SUBSTRIKE – on patrol, your frigate detects a pack of 10 enemy subs. Can you depth-charge them before they torpedo you?

CODEBREAKER – the computer thinks of a 4-digit number which you have to guess in up to 10 tries. The logical approach is best!

MAYDAY – in answer to a distress call, you've narrowed down the search area to 343 cubic kilometers of deep space. Can you find the astronaut before his life-support system fails in 10 hours time?

Cassette 5 – Junior Education: 9-11-year-olds

For ZX81 (and ZX80 with 8K BASIC ROM)

MATHS – tests arithmetic with three levels of difficulty, and gives your score out of 10.

BALANCE – tests understanding of levers/fulcrum theory with a series of graphic examples.

VOLUMES – 'yes' or 'no' answers from the computer to a series of cube volume calculations.

AVERAGES – what's the average height of your class? The average shoe size of your family? The average pocket money of your friends? The computer plots a bar chart, and distinguishes MEAN from MEDIAN.

BASES – convert from decimal (base 10) to other bases of your choice in the range 2 to 9.

TEMP – Volumes, temperatures – and their combinations.

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	22	Cassette 2 – Junior Education	£3.95	
	23	Cassette 3 – Business and Household	£3.95	
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	25	Cassette 5 – Junior Education	£3.95	
	17	*8K BASIC ROM for ZX80	£19.95	
	18	*16K RAM pack for ZX81 and ZX80	£49.95	
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A book which will save the software designer considerable time by providing 55 proven subroutines to integrate with his own programmes.

Each subroutine is preceded by a page of general information describing its purpose and implementation and possible problems that may arise. Basic, machine language and a combination of both, are used throughout this publication.

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". . . well prepared, fun to use, and will help in better program development."
Compute

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A reference book which details everything you need to know about the workings of the PET. Containing information helpful to writing more elaborate programmes, which in turn create more interesting functions.

". . . Should be congratulated. Supplies some much needed, useful and correct documentation."
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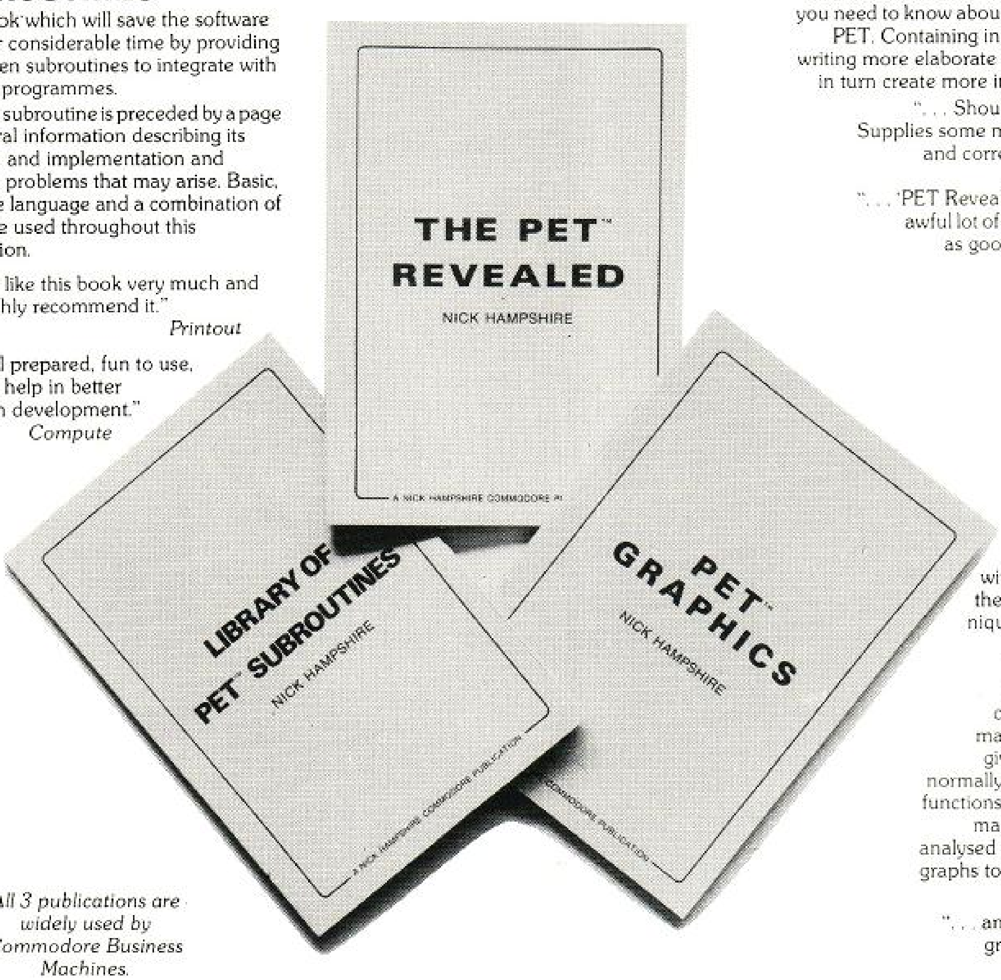

PET GRAPHICS

This book has two objectives. One, to provide the reader with an introduction to the programming techniques used to generate graphic displays. Two, providing the programmer with a complete package of machine code routines giving a wide range of normally unavailable graphic functions. The book contains many comprehensively analysed routines and photographs to illustrate the effects created.

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

Oxford Computer Workshop

David Pollard found that a surfeit of academics does not necessarily help in bringing computers to those who can use them. He describes the workshop's progress to date.

WHEN IT was started in June this year, the idea behind the Oxford Computer Workshop was to create a computing forum whose primary purpose was to help disabled people — something between social club and a factory. The reckoning was that it could just about pay its own way — with mail-order software; word processing and introductory courses. Later it would grow to design and develop equipment to aid people with specific disabilities.

By providing facilities and a suitable environment, products should evolve to suit particular needs. Surprisingly, it seems that there are but two such workshops in the U.K. — the Professional Workshop at Milton Keynes, Buckinghamshire and the Notting Dale Technology Centre in London.

Early hopes of governmental assistance were soon dashed. Manpower and the Small Firms' Advisory Service were very friendly, made encouraging noises and said, politely, that they could not help.

There is a standard Catch 22 — until you achieve something and have something positive to show, they cannot really help; by the time you have done whatever it is, you probably do not need their help anyway. One is sometimes left with a sneaking suspicion that they might be happier dealing with schemes at the level of several £100,000.

Another obstacle — perhaps peculiar to Oxford with its surfeit of academics — was the disbelief of people in authority that anyone might want to use computers: after all, you can employ somebody who does that.

It became clear that the way ahead with the workshop project for disabled people was to form a local interest group, and in recent weeks, there has been progress. Several people have offered to help and the local computer retailers have promised to do what they can. A good friend who is going abroad has offered the use of his TRS-80.

It looks as though all the constituent parts are to hand, including a Sharp, a Pet, an Apple and the use of a word processor and a mainframe machine — enough machines to stimulate interest.

A workshop became available through the Bakehouse Trust — an Oxford group which is providing rental of workshop space to new small businesses at a realistic price. There is a carpenter, electronics engineer, upholsterer, wood carver, architectural designer and now a computer.

You might raise the idea of using micros to make life better for disabled people at your next club meeting. If there is no local club, try to start one — you will be surprised to learn how many people own a micro and want advice on how to use it. There are yet more who would like to gain hands-on experience before buying their own.

First, you cannot do it all on your own, so find a few people of like mind who will help you. A small poster in the local library or community centre or perhaps a letter to the local newspaper will do the trick.

Word of mouth is effective initially. The nearest computer retailers will probably be interested enough to bring a machine to the meetings. Enlist the help of your library, adult-education centre and citizens' advice bureau.

As for premises, the church hall or community centre is probably the best bet. A few pounds will cover the cost of hire of a room, a few posters, postage and telephone calls.

The national users' groups should be able to help with useful and appropriate software. Enclose a large stamped, addressed envelope with enquiries — some of them send sample newsletters.

There are two further requirements — enthusiasm and perseverance. It may take a few weeks to get the project off the ground, so do not be discouraged if it seems to be going slowly at first. ■

Above: The workshop has found house-room through the Old Bakehouse Trust, where it shares space with a number of small businesses. The premises are relatively cheap and provide a useful mix of skills.

Right: David Pollard at the bench. Friendly local dealers and other supporters have provided equipment to start the workshop.

REVIEW

TI~99/4

Now that its price has been cut from around £1,000 to £295, the two-year-old colour computer from Texas Instruments looks set to compete with the likes of Tandy's colour machine and the Vic-20. Tim Hartnell assesses the re-launched machine.

THE TEXAS Instruments Home Computer, the TI-99/4, is a computer which seems to have missed its market. First launched about 18 months ago for around £1,000, it has been re-released recently for a quarter of the original price. The TI-99/4 now shows its age. It is an "old" computer, without the kind of features and facilities—such as Peek, Poke and the USR function—now taken for granted on most personal computers.

Despite this, it is magnificently supported by plug-in cartridge firmware, which includes the best chess program I have seen for a game marketed specifically with one computer. The TI-99/4 has an impressive range of peripherals including floppies, speech and a quality printer.

It has an uncomplicated exterior, with a slot for peripherals on the right-hand side. The plug-in software, or command modules as Texas Instruments calls them, slides in near the top right-hand corner. A speaker is built-in, with a slide volume control below it. I found the keyboard perfectly satisfactory, although the keys are closer to those found on large calculators than on electric typewriters.

The on-board Basic is somewhat limited, without, as I mentioned, such facilities as Peek and Poke, yet the superb colour and wide range of sound, compensates for this. An extended Basic cartridge will give you every command you would normally expect.

My main criticism of the machine is that it is very slow, as slow in fact as a ZX-81 operating in the Slow mode. Listing a program seems to take an age as the program is printed out a letter at a time.

The display is impressive. When you first turn on and a series of coloured blocks appear rather like a colour TV test pattern run across the top and bottom of the screen in strips, with a Texas Instruments logo and the words HOME COMPUTER, PRESS ANY KEY TO BEGIN. When you press a key, the screen clears to a blue background, and black letters on the background outline a menu which says:

```
PRESS
1 FOR TI BASIC
2 FOR EQUATION CALCULATOR
```

This is followed by the number 3, if you have a command module plugged in, and the title of the module. If there is more than one program on the module, the additional programs appear beneath the third item on the menu.

Equation Calculator allows you to use the TI-99/4 in the direct mode as a calculator. It has a rather strange display, an open rectangle filling most of the screen, with the numbers you enter appearing at the bottom. The rectangle displays assigned variables, so you have a constant reminder if, for example, you have set A equal to 10.

To return to the switch-on display, which you must do to use the Basic after using the Equation Calculator, you just type "bye", hit Return and you are back at the beginning.

The cursor is a small flashing rectangle. The computer will accept any line, including invalid ones, but will—of course—crash on running if the line is invalid, with one of a number of "cute" error messages, such as CAN'T DO THAT or the extraordinary BAD VALUE if a number is generated out of range, or outside designated parameters.

When you type Run and press Return, the display changes from black on blue which is programming mode to black on green or run mode. If the program crashes, the display immediately switches back to black on blue. When you enter Run, the listing stays on the screen except that it scrolls upward. The command Call Clear clears the screen.

The Let statement is optional to assign variables, and the TI-99/4 will accept any name up to 15 characters long. The built-in sound box is very flexible. The command Call Sound will generate tones from 110Hz to more than 44,000Hz. That is, from the A below middle C on a piano, to much, much higher than the ear can hear.

As well as this wide range of sound, there are 30 graduations of volume. If you enter

```
CALL SOUND (1000, 440, 2)
```

then press Enter, you hear a very clear, pure middle C for a second.

The Call Sound command is very flexible. The first figure after the command is the duration of the note in milliseconds, the second is the frequency, and the third is the volume which is adjustable from zero to 30, with 30 being the loudest. A routine to write an infinitely varied cacophony is:

```
10 D = INT(RND*1000) + 110
20 F = (INT(RND*4) + 1)*220
30 V = 2 + INT(RND*25)
40 CALL SOUND (D,F,V)
50 GOTO 10
```

You can easily modify this program to play two or three notes, plus noise, at a time. In other words, there are four independent sound channels. While attempting to write a program to generate three-note chords, I managed one of the few system crashes I experienced while using the TI-99/4.

As I was modifying the program, I suddenly lost my listing, and the screen started to flash on and off. I entered

```
SHIFT Q
```

to return to the opening display as instructed in the manual, and even though I did reach the initial display, the computer stuck at this point. I had to turn it off before I could use it again.

The display is 28 letters across and 24 down. However, you can have 32 graphics characters to a line. You can place the graphic symbol of your choice at the required location with a Call VChar statement which you use as follows:

```
CALL VCHAR (12, 17, 42).
```

The first number in the brackets is the row number, followed by the line number and then the character number. Call VChar is a very useful equivalent of other Basics' Print At.

The manuals provided with the computer *Beginners' Basic* and *Users' Reference Guide* are clear and detailed, and fortunately do not suffer the normal U.S. approach which you find in many manuals, such as the one provided in the States with the Vic.

Even if you have never touched a computer before the TI-99/4, you will find *Beginners' Basic* easy to understand. So long as you study the manual carefully, you will quickly learn the rudiments of programming.

Some worthwhile demonstration programs are given in the book, and once you have read through them, you are unlikely to have any real problems writing your own.

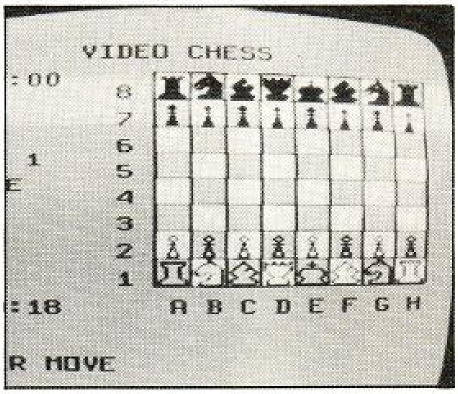
All the peripherals plug into the right-hand side of the computer, piggy-backing if necessary. I could not make the printer function at all, despite trying different leads and different drive programs.

The plug-in command modules are of mixed quality. Video Graphics were unimaginative random coloured lines with a kind of music. The so-called Life program was incomprehensible and bore nor resemblance to John Conway's famous program of the same name.

Speech Editor was fun. The voice box or solid-state speech synthesiser plugs into the right-hand side, and speaks with a modulated, American accent. It has more than 300 built-in words such as negative and hello which it says clearly and confidently, in a rather splendid way.

Other words such as those beginning with B or P are not so distinct. You can use parts of words in the vocabulary to build your own words and here we found one curious glitch: although the computer can cope with "Goodbye" the words "Good" and "Buy" separated by a space became utter gibberish.

Video Chess is superb — almost good enough to make it the sole reason you buy the machine. It plays a good, fast game, even on the higher



levels of play. The graphics are very clear, possibly the least ambiguous chess graphics I have seen on any computer.

There is also a Replay feature which, at any time in the game, allows you to re-run the whole game quickly from the beginning, complete with bleeps and blurps from the sound box. If you do not buy any other software with your TI-99/4, make sure you obtain the chess.

The first menu with some multi-games packs is in three languages. You select your language, such as German, and from then on, all printed words on the screen are in German.

The review machine was provided with a generous range of programs. The most useful was the extended Basic which gives you access to many facilities, such as multi-statement lines, which are taken for granted on other computers. Extended Basic also includes the splendidly-named Sprite command.

A sprite is a little coloured blob which you use to create moving graphics. Extended Basic also allows you to load and run one program from another. In all, there are more than 40 new or expanded commands. This module is vital for serious use of the TI-99/4.

The software modules are well packed and each is supplied with an instruction booklet and a keyboard overlay which has symbols such as arrows for cursor control, as well as game-specific words, such as the Replay feature.

Other software tested included: Children's Education which includes addition and subtraction using colour and sound, and featuring vertical problems, that is, the numbers are on top of one another, like sums written on paper.

Early Reading is quite fun, using graphics with written and spoken words. Pre-school Early Learning Fun, aimed at children from three to six, includes counting and sorting activities, an alphabet drill and an exercise in which shapes are matched. This pack is likely to prove a painless way to ensure your children become computer literate.

Beginning Grammar in Dutch and English is for primary school children, and intends to teach the parts of speech: this pack is a little tiresome. Connect Four plays a good, very fast game — far faster than the Atari cartridge of the same name. It makes good use of sound, although after a few games you will probably wish to turn it down, or off, before it drives you mad. Connect Four and Video Chess were definitely my favourites among the games. There was no Space Invader-type game supplied.

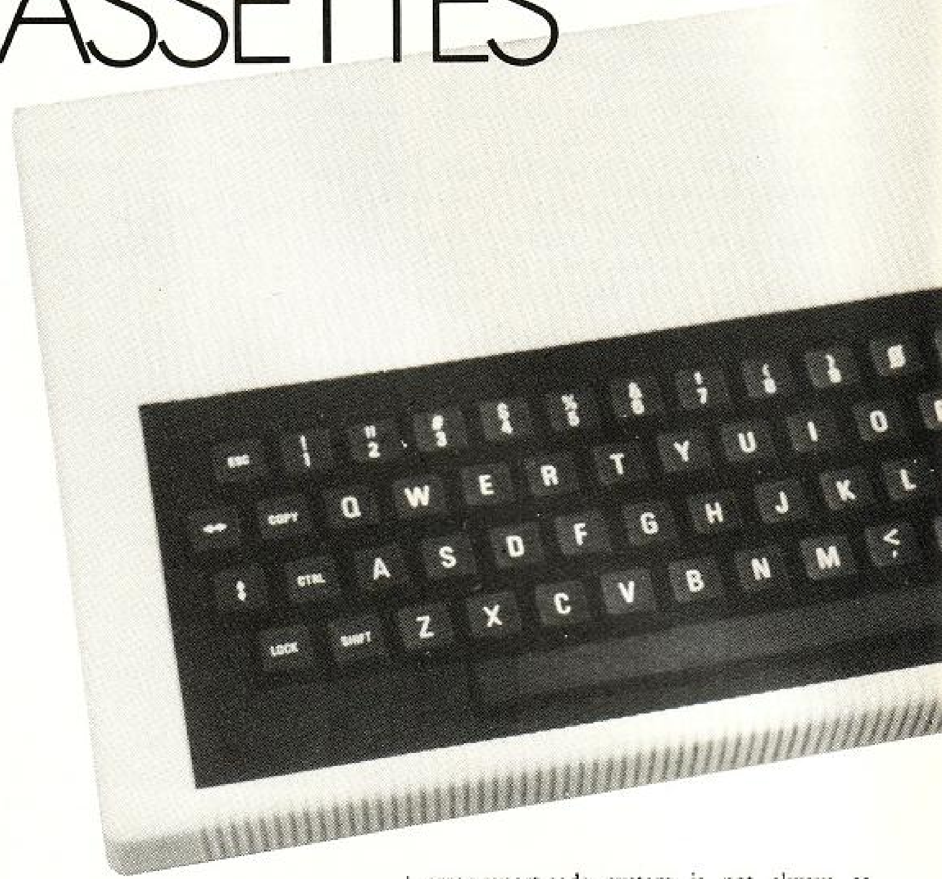
Household Money Management leads to projections of future spending, drawing pretty and depressing graphs of your finances, and can dump details on to cassette for future recall. Terminal Emulator "links your home computer to the telecommunications world through special data-accessing programs. Lets you select options such as load rate which make your computer compatible with other systems". This pack buffers up to 256 characters of incoming data, transmits control characters which signal the remote computer to perform pre-defined functions, and needs an interface and Modem to work.

CONCLUSIONS

- The computer is of little value without extended Basic. It is, however, in my opinion, much better than any of the video games machines, because at least you are buying a real computer which you can use as such when you have tired of playing the games.
- The reading and counting programs for the young are an ideal way of painlessly introducing children to computers if you do not mind taking the risk that they will start speaking with an American accent, like many Speak-And-Spell devotees.
- The better games, such as Video Chess and Connect Four, are superb — as good as, or better than, competing products.
- The graphics are very flexible with the Call VChar and Call Colour commands giving — even in the standard, on-board Basic — a system which you will quickly master. There are 16 colours available.
- The sound is clear and reasonably musical. There is a noise option, plus of course, speech if you buy the synthesiser.
- The only real objection I have to the computer, and it is a major enough objection to discourage purchasers, is the speed of the machine: it is appallingly slow in many fields, and this lack of speed is not really acceptable nowadays.
- If you want a good, noisy colour computer, have a look at a Tandy, a Vic and the TI-99/4 before you decide. Each has worthwhile features; each has different software support; and each has foibles which may discourage purchase.
- I do not believe the TI-99/4 will make a major impact on the British computer scene, and therefore you may find fellow-users a little thin on the ground. It would have been a completely different story if Texas Instruments had put the TI-99/4 on the market two years ago at the present price. ■

SURVEY

ATOM CASSETTES



Eric Deeson casts a critical eye at the standard of packages in the burgeoning Atom software market.

IN MY REVIEW of ZX-81 software in the October issue, I noted the significance of the low price of cassettes published by Sinclair Research. At £3.95, Sinclair cassettes hold down the prices of ZX software from other manufacturers. That is good for the buyer, naturally, and also helps exclude the cowboys.

Atom material is far more costly, cassette for cassette — and there tend to be fewer programs on one tape. Of course, the expanded machine is twice the price of the ZX-81 16K, so perhaps it is fair that software is more expensive — publishers have higher capital costs to claw back and a much smaller pool of purchasers.

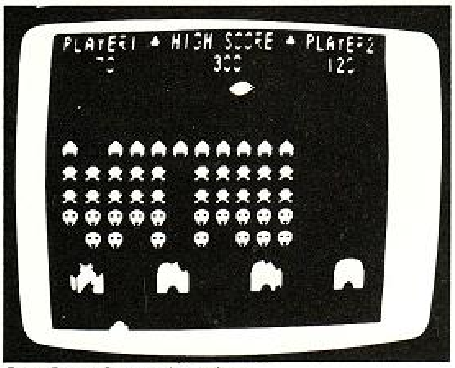
Indeed, judging by the packages I reviewed, the Atom software market is very different to the ZX one. The large majority of the review programs are games, some of them excellent models of the arcade aces — there are three versions of Space Invaders, for instance. There is little for business and education. It seems clear that the home leisure market is the aim. That is somewhat surprising as so many parents want educational programs, and so many businesses operate from the home.

I found that loading was not perfect on the Atom — neither with a Waltham W-167 which rarely fails for my ZX-80 or ZX-81, nor with the Sharp RD-620E widely recommended for those machines and the Atom. The routine was the only one I could load and save, but as *The magic book* points out, that is not a precise test. Loading the published tapes was not 100 percent — indeed, it was five percent in the first few hours.

As with the ZX-81, the recorder volume setting is critical — and of course, the level varies from publisher to publisher and even from program to program by the same publisher. It is useful to put coloured dots on the recorder volume control to help with loading levels. Software suppliers should give program-loading times — it is helpful to have a watch to stare at as well as a static screen. ZX-81 and the expensive micros give visual indication of loading progress — so, too, should the Atom as loading can be so capricious.

Atom Basic is unconventional — I do not think I shall ever understand why floating-point work is so complex. The incorporation of assembler, and Do-Until are exceptionally useful, as are the graphic modes — though it is much easier to use graphics blocks on the Sinclair.

Let us make a few general observations about the Atom for those contemplating graduating to this powerful little machine. First, the manual is poor — it is much more comprehensive than the ZX-81's, but far harder for a novice to follow. Even in its second edition, it still contains errors and shows many signs of haste. The assembly section is very good, but I found even the reference chapters hard to use and poorly compiled.



Bug-Byte Space Invaders.

I miss the Sinclair's single-key entering of keywords which then appear in full on display — Atom's P for Print is no substitute. Also the manual's so-called "powerful Edit" does not seem to work on program listings and so, as far as I am concerned, does not exist.

There is no syntax-checking either, and Go addresses must match line numbers — though the line-label system is marvellous. So, programming errors are easy to miss and the error-report-code system is not always as helpful as it could be.

It is good that with the Atom you do not need to specify the control variable in Next, but a pity that End is needed. I like the file-handling procedures but not the complex Break. Sound is good, but why not feed the speaker during Loading to help if things are going wrong? The Repeat key is useful — one misses it on the Sinclair keyboards, but it should remember the last character typed to save broken fingers.

Our review takes in five suppliers and we shall deal with them one by one. First is Acornsoft of 4a Market Hill, Cambridge, CB2 3NJ. Sitting on Acron's lap as this group is, so to speak, one would expect from it top quality, top reliability, and top utility in its programs. Acornsoft software is not, in my opinion, far and away the best — though it is very good.

The company brochure lists 17 cassettes, all but one at £11.50 each including VAT — the most expensive on the market. However, each cassette tends to have several programs, so beware when making price comparisons. Eight of the packages are games, three give mathematics utilities and three more provide computing utilities. That leaves Database, Business and Forth.

All seven of the programs we reviewed start with a star-load and automatically Run "INDEX" which also displays the character set and is useful for pre-setting the volume level. The main programs are loaded normally

— even if with difficulty — and are relatively heavy on memory. It is interesting that the listings are not closed — has Acornsoft not read *The Atom magic book?*

Acornsoft cassettes are supplied in neat polystyrene-foam boxes which are durable but not much help if you keep program cassettes in a cassette case. The covers give brief but usually adequate documentation. By absolute standards, it is too brief, but it is more than anyone else provides.

Games 5 gives us Invaders, Wumpus and Reversi which are all standard micro games, though the second is really a form of Adventure rather than a true Wumpus. Invaders which occupies 5K and 6K graphics including instructions, is a slow version of the standard one-player game using low-level graphics and sound. The score and record score appear at the end of a battle rather than simultaneously.

Wumpus — 5K and 6K graphics with no included instructions — is, as I mentioned, more like the old Adventure — any one of 20 30-cave labyrinths in memory, or a random one, four bat caves, four pits, three arrows. There are no graphics in this, but it is a game to tempt the hours away before you decide to program your own version.

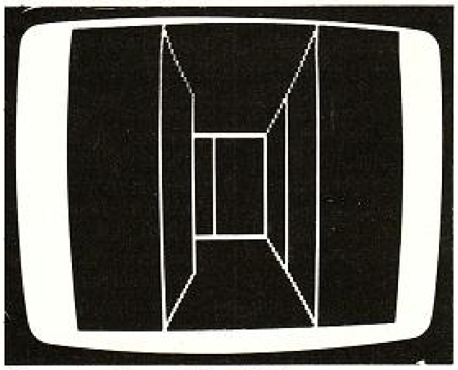
I do not like the graphics approach to Acorn's Reversi — 3K and 5K with no instructions — but the options are flexible. The computer plays itself or you, or you can play a friend using its board. In the one-player version legal moves are shown, which detracts somewhat, and the computer's game is not very strong although it is fast.

Games 6 has variety, too, and features Dodgems, a superb arcade-style racing game which is new to me. Your car races through a kind of maze, making points and avoiding the computer's car which is programmed to crash into you. It has very good low-resolution graphics and sound and uses 4K and 6K.

Simon — 2K and 6K — is the only program whose documentation mentions colour output, though it is readily played in monochrome. The sequences are of blocks of yellow, red, striped and blue, with tones. It is difficult to win — even at the lowest skill level. Instructions are included and it is worth learning them before playing.

Amoeba — 3K and 3K — is a delightful game based on the pattern shown on page 82 of the manual. Although the documentation instructions are hard to follow and contain a minor error, the game is impressive once you discover the winning technique. The game is for one player against the computer or two to four players against each other.

Maths 1 is, of course, a serious package. It is a pity that I found the review copy unloadable. Plot met the same fate — the listing was incomplete, and I could find no trace of the other two programs. Plot — 5K and 6K — has 11 options, plotting input functions, points, lines and curves with or without graded axes. Simultaneous — 2K and 5K — solves limit-unspecified sets of simultaneous equations with real coefficients. Regression — 2K and 5K — tells you the best straight line through a set of data points. Plot, incidentally, includes the option of actually showing such a line.


Struggling through Timedata's maze.

I found the Utilities 1 cassette hard to load, too, but this time not impossible. The disassembler star-loads into graphics memory, occupying 2K. Thus, the lower text space is free for machine code. Its range of options is useful.

Fast COS is particularly interesting. This 1K assembler routine allows one to Save and Load at 1,200 baud, with a visual indication on screen that the operations are in progress. Will one need special data cassettes, I wonder?

Re-number loads into 1K of graphics memory. It is less versatile than the version in the manual, re-numbering only as 10,10, but is, of course, better placed in memory. Also it displays labelled line numbers and unused labels, which is useful.

It is most important for a user of any micro to learn how to hold and process records. Acornsoft's Database, 5K, allows the use of 14 commands, which are briefly, but just about adequately, explained in a 16-page leaflet. The data is held in graphics memory — 6K will handle 100 records.

The leaflet explains the system, which is complex, using a sample database on cassette — a wine list. You need the wine by the time you have understood the commands.

As a computing teacher I was interested to have a book at the Peeko-Computer — 5K and 1K — which is a delightful simulation of the 6502 microprocessor. At all times the 50-byte memory contents are displayed. Each may hold a single decimal digit. Machine-level coding is achieved by the use of 10 decimal instructions: BRK, LDA, STA, CLC, ADC, DEC, INC, LDA, @ JNE and JMP.

There is a 16-page booklet for this material, too — necessary as the model is a good one and needs some sample assembly programs to help you start. The claim is that once you have mastered Peeko, you are close to being able to program the Atom in machine code.

Atom Business turns out to be the same as the Phipps business cassette which we shall discuss later. This time, however, the review cassette was supplied with excellent 110-page *Atom Business* book which clarifies everything.

Bug-Byte of 98-100 The Albany, Old Hall Street, Liverpool 3, is a vigorous and very reputable supplier of software for the Atom and in particular, Sinclair micros. It also sells chips and tapes.

Its Atom cassettes are neatly packaged, but there is no documentation other than the pretty descriptions in the brochure. Instead, instructions are the first item on most of the cassettes.

Bug-Byte prices vary greatly, from £3 to £8 including VAT — but most of the cassettes contain only one program, albeit, usually, a good long one.

Disassembler occupies 4K and is the company's only non-game program at the moment. It works and has the usual features. However, I do not think that it is as good as the Acornsoft model, though it costs only £4. Breakout, again 4K, insisted on giving me a distorted display — perhaps on purpose to make the game harder? The nine difficulty levels do not seem to vary enormously, but at

(continued on next page)

(continued from previous page)

any level, the game is an attractive and reasonably sophisticated version of the standard: price, £4.

Fruit Machine — 8K, graphics 2K — is, says Bug-Byte, "just as entertaining as a real fruit machine, but far cheaper in the long run". Maybe Acornsoft agrees — this, with Bug-Byte's Invaders, has the hallmark "Acornsoft Approved". At £4, it is certainly a brilliant, incredibly-fast model with lovely sound and graphics.

Golf, at 5K and £5 with floating-point arithmetic, could have done with higher level graphics. Even so, its random holes are attractive — and tough. You give your handicap, select a club and a shot to try to play on to the green and into the hole. All the hazards are there, I believe — though I tended to lose the ball embarrassingly often.

Invaders — 12K, 4K graphics, £8 — is the best excuse to expand your Atom. It is a superb version of the standard game, tough and fast with continuous score display. Players alternate turns in the two-player mode. It is brilliant, Acornsoft-approved and more costly than the Cambridge company's version but it does have such good resolution.

After than, Lander — 12K and £5 — is a disappointment. It is a relatively sophisticated version of the original game — you have three ships to land on small patches of flat ground among mountain peaks. You control the rate of descent or ascent, even off screen, against a falling fuel supply whose level is continuously displayed, and you adjust your position to the left or right by delicate control. There are five modes of difficulty and the instructions are part of the program.

Pinball — 6K, graphics 2K £4.50 — is almost as inspired a model of the real thing as Fruit Machine. Modelling one of those old mechanical arcade games, it requires little input skill and you cannot Tilt. The sound is good; the graphics average.

Finally, from this stable, there is Star Trek — 12K and £5 — whose Captain Kirk battles the Klingons in an eight-by-eight galaxy. The separate instructions on the tape are complex, and need to be — there is data to star-load, too.

I cannot give full justice to the Phipps Associates of 3 Downs Avenue, Epsom, Surrey, Atom Business tape. Costing £7.50, it goes with a £6.95 book to which I did not have access at the time. I have seen several Phipps books in the past, and have been impressed. This particular one gives all the necessary documentation for the 11 short programs supplied. As it is, though I ran them, I often could not understand them — even by dry-running the listings.

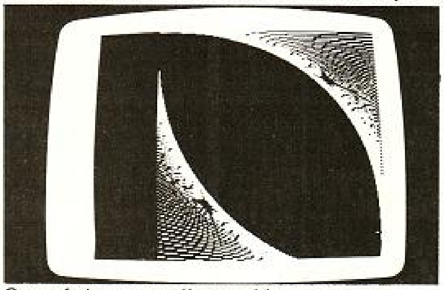
Add-up gives the running total of input sums of, say, money. Inputs are very poorly mug-trapped, however, so stick to your calculator. Label sends data for labels of up to five lines to the printer. You can have up to 100 of each. WTMS is a metric/imperial measure converter, using non-standard symbols. DCF asks for inputs about house leasing and prints out something called PCH NPV and RENT NPV for different rates.

The Sales program has good messages and traps. It allows data handling from files for 52 weeks. Graph plots data from tape. Nom forms accounts from data on tape. Budge should have been called Bug — it crashes on my copies and is to do with arrays. Do businessmen need to know about arrays?

EXS gives VAT data for input sums of money. You can not change VAT rate without going through the List, though. STD is not a telephone-bill calculator; it gives the mean and standard deviation of input data, plus or minus — but not 0, which is the End code.

QUE is the only one of these programs to use graphics. It does so delightfully, showing queue movement at up to five counters. I was particularly sorry not to have documentation here — this looks to be a powerful program as well as an enjoyable one.

Program Power of 5 Wensley Road, Leeds 7, is another company with a version of Invaders. Of the four cassettes reviewed, two are sophisticated games without documentation, one is a music maker, needs VIA and has no documentation, and the fourth is an ambitious, high-level graphics statistics program. That has reasonably good documentation, even if the second page closes with: "Perhaps the best instruction for a program of this complexity is to use it and see what happens".



One of the manual's graphics programs.

I was unable to load any of these programs into the Atom, despite two hours' struggle. They are all machine code, which sounds good, but that may be part of the problem. Two of the cassettes, by the way, also carry instructions programs. They are recorded after the main material, which makes them even less helpful.

Astrobirds and Invader Force — both 5K and 6K graphics, £8.95 — are lengthy arcade-type games with sound effects and continuous score display. Astrobirds becomes more difficult as you progress; Invader Force has six difficulty levels. Histats — 5K and 6K, floating-point arithmetic, £7.95 — sounds very good value for users in a number of contexts. It loads data to and from tape and has 11 other options. These include a wide range of statistical calculations and graphical outputs.

Finally, Music Box — 5K and VIA, £8.95 — is another exciting-sounding piece of software. You can use the keyboard as a piano, or input notes with durations one by one into memory for editing and saving. A seven-octave range and tempo change are offered.

Timedata, 57, Swallowdale, Basildon, Essex, publishes the deservedly popular *Magic books,* including the *Atom magic book,* £5.95, source of a number of the programs on the three review cassettes. The cassettes cost £5 each and contain four short but pleasant games. Instructions are in the programs; very brief notes are on a slip of paper in each cassette case.

Hammurabi *et al.* is a cassette of 3K and 1K programs. Hammurabi itself is the standard text-only version — difficult to enjoy, not least because the user has to perform, mentally, tough and unnecessary calculations. Othello is a beautifully-designed and executed version of the standard game. The computer plays better than in Acornsoft's Reversi, but is not as fast; the screen display here is excellent.

Scramble is a rather poorly-displayed screen version of the old game where one shuffles the letters round the plastic square. There are 10 well-graded levels of difficulty, and the computer counts your moves. Hexpawn must be a make-weight. The traditional game is simple anyway — here the computer could not even play the only winning move. The Cupball and Pinball cassettes contain four 5K and 1K programs each.

Cupball is a clever version of find the pea, but would not be exciting for long. The Breakout on this tape is, however, very good — fast moving and sophisticated, giving a long skill-testing game with great sound effects. Then there is a pleasant Simon game called Simon2, to add to the confusion about the order and names of programs on the tape. 3D Maze is very clever. The maze itself is two-dimensional — up to 15 by 14 — but as you go through it, you see what lies ahead in three dimensions.

Pinball, the first program on the last cassette, is an Atom version of the American form of the game. It gives continuous score display and lets you waggle the flippers to try to keep the ball in play. Spacewar is far more addictive. It is a kind of *kamikaze* Invaders with super, low-level graphics and sound. Even the easiest of the 10 play levels is tough — this is a great game for the adrenal gland. The "end of the Universe as we know it" is most impressive.

Crash is a drive-along-the-road-hitting-these-blocks-but-missing-those kind of game. Only one level — and it is not an easy one, though the low-level graphics restrict excitement. Finally, there is Letters — I have seen the same game called Tank. You must drive inside a square at a speed of 1-10, hitting the displayed letters in order. Failure is hitting the wrong letter or the sides of the square. This is surprisingly addictive.

CONCLUSIONS

- My biggest problem was loading.
- Clearly, the software can be quite excellent, and with Christmas approaching, you have a rich choice at your disposal. In these circumstances, it is a good thing that the vast majority of the available software is for gaming — but I find that a disappointing comment on home computing.
- With only a limited number of suppliers from which to choose, it is quite feasible to track developments in the whole field. Acornsoft, Bug-Byte and Timedata all supply excellent material. ■

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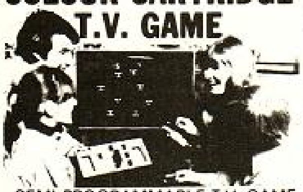

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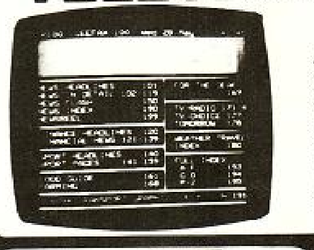

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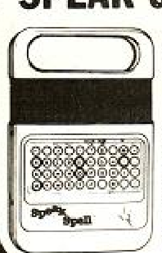

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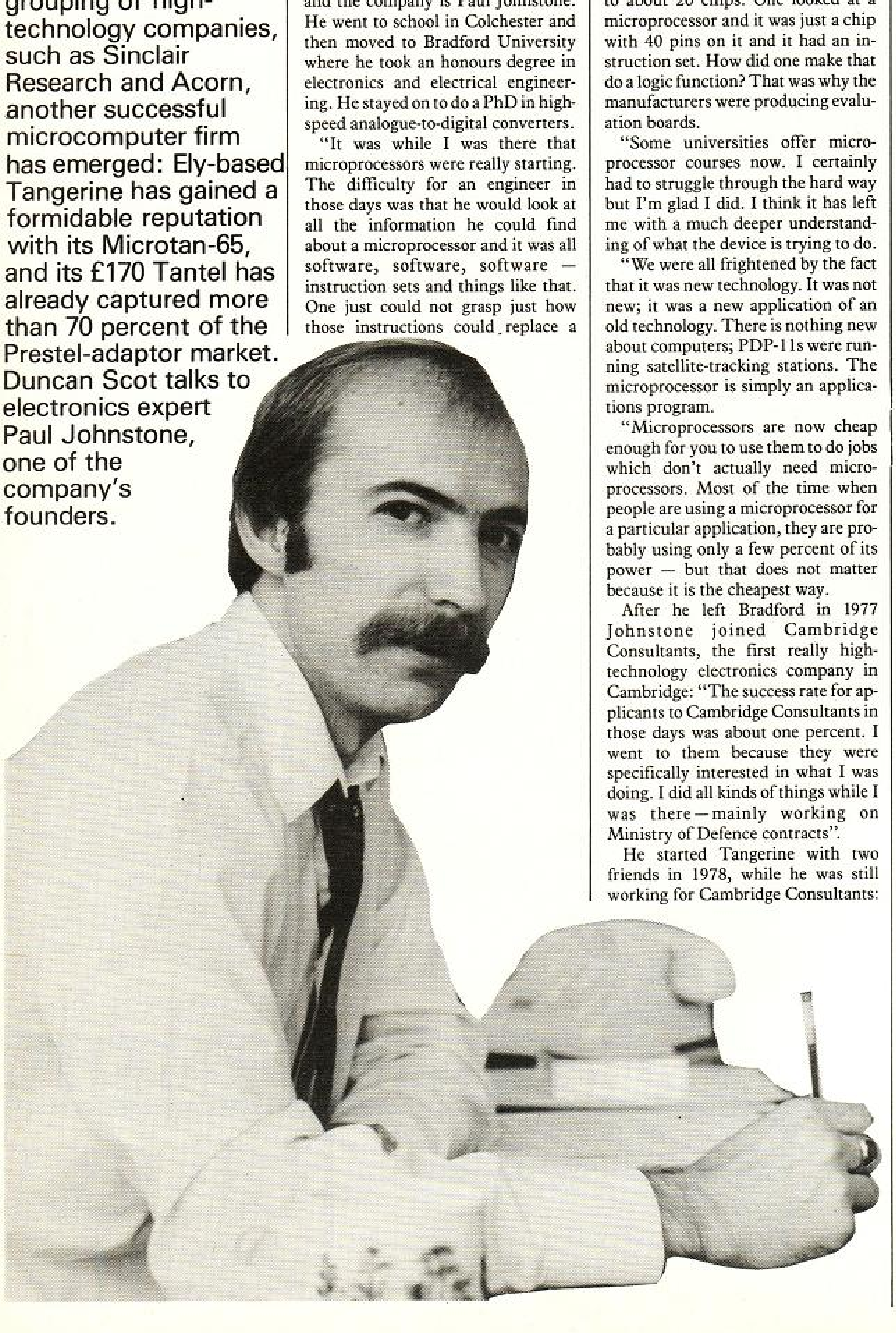
INTERVIEW

PAUL JOHNSTONE OF

A little to the north of the growing Cambridge grouping of high-technology companies, such as Sinclair Research and Acorn, another successful microcomputer firm has emerged: Ely-based Tangerine has gained a formidable reputation with its Microtan-65, and its £170 Tantel has already captured more than 70 percent of the Prestel-adaptor market. Duncan Scot talks to electronics expert Paul Johnstone, one of the company's founders.



THE MAN WITH the engineering and design skills behind Tangerine and with the original idea for the products and the company is Paul Johnstone. He went to school in Colchester and then moved to Bradford University where he took an honours degree in electronics and electrical engineering. He stayed on to do a PhD in high-speed analogue-to-digital converters.

"It was while I was there that microprocessors were really starting. The difficulty for an engineer in those days was that he would look at all the information he could find about a microprocessor and it was all software, software, software — instruction sets and things like that. One just could not grasp just how those instructions could replace a handful of gates and a few flip-flops.

"We were told that a microprocessor could reduce a 100-chip design to about 20 chips. One looked at a microprocessor and it was just a chip with 40 pins on it and it had an instruction set. How did one make that do a logic function? That was why the manufacturers were producing evaluation boards.

"Some universities offer microprocessor courses now. I certainly had to struggle through the hard way but I'm glad I did. I think it has left me with a much deeper understanding of what the device is trying to do.

"We were all frightened by the fact that it was new technology. It was not new; it was a new application of an old technology. There is nothing new about computers; PDP-11s were running satellite-tracking stations. The microprocessor is simply an applications program.

"Microprocessors are now cheap enough for you to use them to do jobs which don't actually need microprocessors. Most of the time when people are using a microprocessor for a particular application, they are probably using only a few percent of its power — but that does not matter because it is the cheapest way.

After he left Bradford in 1977 Johnstone joined Cambridge Consultants, the first really high-technology electronics company in Cambridge: "The success rate for applicants to Cambridge Consultants in those days was about one percent. I went to them because they were specifically interested in what I was doing. I did all kinds of things while I was there — mainly working on Ministry of Defence contracts".

He started Tangerine with two friends in 1978, while he was still working for Cambridge Consultants: "They were quite amenable to it. I had started another company while I was at Bradford, but that never really traded.

"I have always been interested in running my own business. I started the company with my two friends and brought out a VDU kit. It was a good product but it was a little expensive and a little too late.

"While that was happening, I designed the Microtan and worked on a few other projects. I realised that we needed a real company as opposed to a part-time one. We needed professional management, we needed a good deal of money. I was really looking around for someone to create a more professional basis".

'The BBC should have chosen the ZX-81'

He then met Barry Muncaster, who was also working at Cambridge Consultants and who became a partner in a re-formed Tangerine: "My two partners went their own way and Barry and I found some financial backing from a large private company. They did not want to take over the old Tangerine but they wanted the name. So we re-started the company, on October 1, 1979, and we bought the name Tangerine".

Under this arrangement Johnstone and Muncaster did not hold a majority shareholding in the company. A year later, in October 1980, they organised a management buy-out with the ICFC to regain control. The ICFC specialises in management buy-outs and is owned jointly by the five main clearing banks and the Bank of England.

"The company is now run by Barry and myself. We have the majority shareholding; we have equal shares and are the only two directors. We are very fortunate. The reason why the partnership works so well is that we each fall naturally into the two distinct areas needed in the company: Barry is the businessman and I am the technical man.

"It was obvious that there was a hobbyist market for the Microtan and it was obvious that people in univer-

TANGERINE

sities and enigneering establishments wanted to buy that kind of machine. We did not, however, anticipate the level of business we would do. Everyone hears about how long they have to wait for their products. I would say that we are not as bad as everyone else in supplying the goods, but we are certainly not crystal clean.

"We have only just started to promote the Microtan. We have been chasing demand as hard as we can to try and keep level with it. In our first year, we turned over more than double we thought we would.

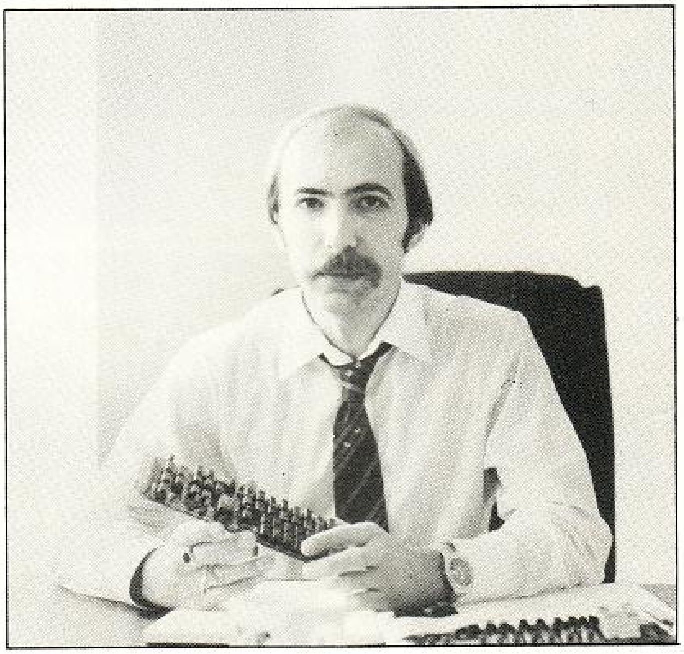
"Microtan users become very enthusiastic about the system. Certainly, the engineers to whom we sell the machine in universities and companies like it very much because it has been designed by an engineer, not by a programmer. It shows from the reaction we obtain from the OEMs and the engineers—they like the way it has been put together.

"We always planned a Modem and a colour VDU card for the Microtan. What happened with Tantel—the Prestel adaptor—is that someone we knew, who was involved with Prestel, suggested that we should build an adaptor rather than make the add-ons for the Microtan. I worked on some designs and reckoned we could build a low-cost adaptor.

"From the day we decided to manufacture Tantel, it took just seven weeks to produce a circuit diagram and a circuit-board lay-out, to finalise mechanical engineering aspects, to write the software and to win Post Office approval. We had already conceived the product and knew roughly the approach we were to take.

"Looking towards the future of Tangerine, we are designing a new computer called the Tiger. This may or may not be a Tangerine product. We might be splitting the company up into viewdata products and computer products. The Tiger would probably go under the viewdata products' side — that is where its future lies. It is a very powerful computer — it is not going to be cheap.

"Sinclair Research is doing a tremendous job with the ZX-81. It has been nothing but good news for us. If it keeps the Japanese at bay, it's doing us all a service. Sinclair is certainly doing the marketing for us. The ZX-81 is awakening public interest in microcomputers. Some people do not want to buy a ZX-81 and they want to spend more than £70. Acorn benefits from it, we benefit from it and I am sure Nascom



benefits from it — it's good news all round.

"Barry Muncaster and I are on the side of Sinclair in respect of the BBC project. The BBC should have chosen the ZX-81. The series is a good idea, but the approach is wrong. The BBC should have planned a first series on the ZX-81 and if it was a success and people wanted to move into larger systems, it should then have planned another series.

"The BBC approached us and described the kind of computer the series required. The organisers of the programme were not convinced we could do it on time, which was fair enough. We said to them that there was no way that we were going to make 12,000 computers to sit on the shelves for January based on their predictions of the market.

"Besides, we knew that companies such as Commodore would push very hard for the BBC microcomputer business. I would rather not compete with companies like Commodore, especially as the BBC has quite openly handed out the specifications of the BBC microcomputer to anyone who might want them. We could make one now. We know precisely how Acorn is doing it.

"I think it is a disaster that the BBC is going for its own Basic. There is already a standard in Microsoft. Why try and create another? Microsoft has too strong a foothold now. I think it is going to frustrate people in the future.

"We are also very disappointed in the way the Post Office has promoted Prestel. It spends an absolute fortune on telling people how wonderful Prestel is and how wonderful the Post Office is for having invented it, but the campaign does not actually say you need it, go out and buy it. About £6million was spent on one promotional campaign not so long ago".

"What the Post Office must do is increase public awareness of Prestel. Before we entered the scene, the en-

'The Tiger is a very powerful computer'

tire industry had spent £48million and produced 7,000 registrations. Goodness knows what they spent it on. Little old Tangerine has sold 5,000 adaptors since then. We are doing more for Prestel than anyone else.

"What the Post Office will not do is help the companies, apart from the set makers, who are actually doing the work. What we suggested, and it was laughed out of court, was that if the Post Office is to spend £6million on trying to increase public awareness, do not spend it all on television advertisements. The Post Office should have put an order on us for 10,000 units. We would have supplied them for a good price. What it then should have done is spend £5million on television advertising, saying that there are 10,000 adaptors to be given away free in a competition.

"You would go along to your local Post Office and ask for an application form with a series of questions on it. The first 10,000 correctly-completed forms would win a free adaptor. To win the adaptor you would have to go and find out about Prestel because the questions would be organised like that. That way you promote public awareness.

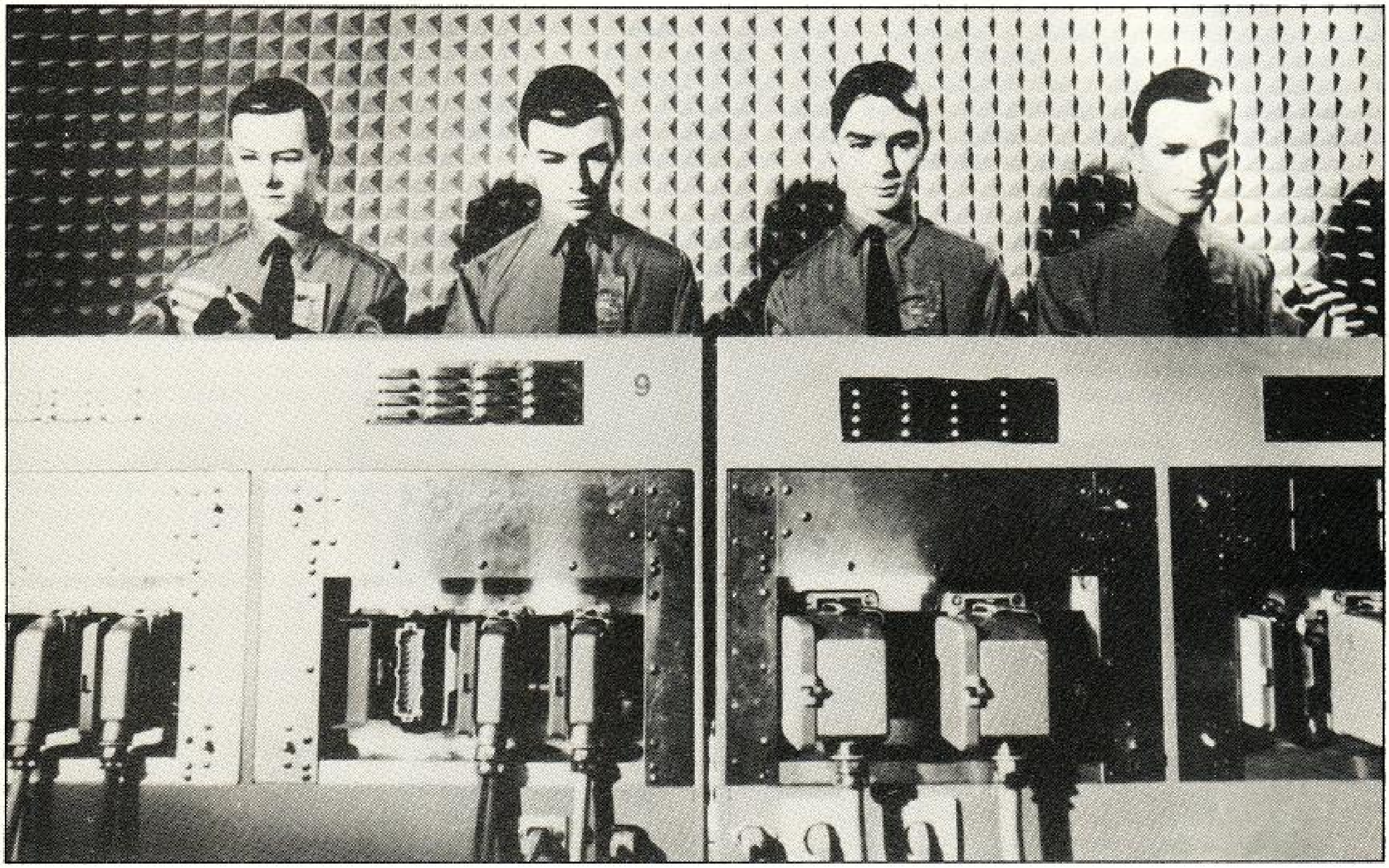
"Obviously more than 10,000 people would have applied for it, and found out all about Prestel. The registrations would have gone up 10,000 units. The Post Office would have earned the extra revenue on it—there would have been no problems on its part. We would have distributed the application forms, we would have distributed the product. We would have had to take on extra staff and they would pay income tax and we would pay corporation tax.

"The Government still has to learn how to deal with micros. The Department of Education should not be spending their £9million on stupid research grants. It ought to go buy £9million's worth of products and give them away. Just think of the mental power of the people who would be involved in using those products if they were to have them in schools.

"You can spend £9million in no time at all on expensive executives talking about fancy schemes. If you buy £9million's worth of products and ship it into schools, the science and mathematics teachers will be working night and day on it and that's where the value is. It would also be £9million's worth of business for the U.K. computer companies.

"There are science teachers in school who want to do more than buy an Apple or a Pet and program it. There are science teachers who want pupils to understand what a microprocessor is and how you can use it to solve problems. The future of the manufacturing industry of this country lies not in sitting down and writing programs for a Pet in Basic. The future lies in people understanding microcomputers and microprocessors and designing them into commercial products". ■

A LITTLE MICRO MUSIC



Whatever machine you own, Bill Bennett explains how you can coax it into producing melodious sound. He examines note-worthy machines at the top and bottom of the music-making scale, and offers some practical programming advice on how to compose musical routines.

THE NEW GENERATION of home computers, designed more for the consumer than the serious user, offers a wide range of entertaining possibilities. Most people will have played or seen a computer game of one type or another, either in the local pub upsetting the locals every time an alien finds its victim, or at home. Expensive arcade games offer a limited sound facility and so do most home computers these days.

As far as home computing is concerned, music generation has always been a neglected field. That is a shame because consumer-orientated microcomputers and music are made for each other. There are two major ways and a whole host of minor ones in which micro-computers and music may be married.

The most obvious and the original way of combining them is to use a computer to control a synthesiser. Early synthesisers worked by analogue signals—as opposed to the digital signals that computers use. These analogue signals mirrored the sound-wave form in an electronic pattern.

Instead of a keyboard, a computer and a digital-to-analogue converter can provide the input. Though originally this arrangement was unsophisticated—using the computer as no more than a sequencer—later developments along these lines produced some very interesting results.

Although the microcomputer is an ideal tool in a control system — and the results obtained by complex sequences were often very good — to be able to make the most of such a set-up, a good synthesiser was required. Synthesisers were in those days extremely expensive. What is more, the arrangement failed to take advantage of one of the most obvious features of microcomputers: like synthesisers, micros have electronic signals which can be output via a loudspeaker to create sound.

A drumbeat-simulation program.

```
10  REM metronome program
11  REM this program simulates a drumbeat
20  DIM L(2) , NN(2), P(-1)
30  C=#B002
40  [
50 :NN0  LDY #B1
60 :NN1  LDA L ; STA C
70  AND @#48 ; ADC @#38
80  ASL A ; ASL A
90  ROL L+2 ; ROL L+1 ; ROL L
95  DEY
100 BNE NN1
105 RTS
108 ]
110 INPUT " length of beat "'B," length of pause ",p
120 FOR I = 1 TO 1000
130 ?#81 = 100000 # B
140 LINK NN0
150 FOR J = 1 TO 600
160 NEXT J
170 LINK NN0
180 FOR J = 1 TO 1000#P
190 NEXT J
200 NEXT I
210 END
```

To prove to yourself just how easy it is to create sound on a micro, find a program cassette. Try playing the program cassette through a stereo system—be warned, though, keep the volume low as the sound is awful. The sound you hear is not exactly *The Planets* but it is sound and that is a start.

The cacophony you just created would be enough to discourage most computer users, but fear not, most of the popular home micros have the means to provide far more civilised forms of music. Some popular home machines have circuitry of varying degrees of sophistication which enable the user to create micro music.

At the simple end of the spectrum, there is the Acorn Atom which has a speaker connected to an output port and a simple resistive network. On the other hand, the Vic-20 has a special chip for music generation. Whatever machine you possess, there is some way of coaxing music out of it. Most machines and techniques are covered here.

At the top end of the market, there are some remarkable instruments available. The dream machine of any computer musician must surely be the Fairlight CMI. This instrument is capable of creating just about every sound possible and has been used to stunning effect on some top records. Remember the smashing of plates in *Babushka* by Kate Bush? Each one was in tune with the rest of the music. On this instrument, a wave-form can be created and then played back at any frequency, corresponding to any note on a normal piano keyboard.

Lower down the performance scale is a synthesiser which can be attached directly to the Apple. The Casheab music synthesiser is the device in question and it features 32 voices with 16 wave-forms. There is 1K of 12-bit samples per wave-form and 255 amplitudes. The synthesiser sells in the States for around the $1,000 mark.

Next on the list, descending from the lofty heights of the Fairlight is the Alf Apple music synthesiser which is available in two forms. One costs £114, and the other slightly less. Again, the synthesis is of relatively high sophistication — this time with nine voices per board, and some driving software which includes high-resolution graphics. The parameters of the program can be changed during the performance of a tune; editing is enabled by the use of the joysticks.

If these synthesisers are beyond your budget, it does not mean you cannot join in the fun. There are many ways to enable home computers to generate music. We shall cover methods for the more common machines. If your machine is not listed, a careful study of the techniques used for other machines will give you some ideas how to start.

One of the more exciting features of the new Commodore Vic-20 computer is its music-making ability. The music generated by the Vic is output via the loudspeaker on the television. If the television has an earphone socket, music can be recorded directly on to tape and can be played back through a stereo system.

The Vic's music capability is provided by a special chip, the video interface chip which gives the Vic its name. The Vic has four separate voices which are individually controlled by Poking a value which corresponds to a frequency into the location of the respective voice.

The voices can be categorised as alto, tenor, soprano and noise. By combining the first three voices, three-part harmonies can be created. The noise voice can provide white noise in a number of different ways, the most useful of which is as a cymbal for rhythmic effects.

The volume control can be used only to control the overall volume, not the volumes of the individual voices. Unfortunately this is a limitation, but only a minor source of irritation. When one voice is used, envelopes can be generated to control the volume. There are 15 different volumes which can be used. With a cleverly-written program, such effects as *vibrato* — both soft and hard — are easily achieved.

Words used in computer music.

■ **Envelope** The envelope of a sound affects its loudness at different points in time. For example, a piano has an envelope which starts with a quick attack, followed by immediate decay.

■ **Analogue** As in analogue signals — continually variable signals. As opposed to digital signals which can be either high or low, analogue signals can sit anywhere between.

■ **VCO** Voltage-controlled oscillator — a device which produces an oscillation at a frequency proportional to the input voltage.

■ **Tempo** The speed at which music is played.

■ **Voice** One voice is one possible sound which can be output from an instrument at any moment. Usually, the number of voices in an electronic instrument corresponds directly to the number of oscillators used.

■ **Vibrato** An effect where the volume of a note is varied at a slow rate to produce a warbling sound.

If you appreciate the more avant-garde forms of music, an unusual experiment is to link the random-number generator to the sound generator to produce some interesting music. Those computer users who are little more old-fashioned in their tastes will find that the Vic is good at playing baroque music. The Vic's music facility is the feature of this computer which makes it worth buying.

The Acorn Atom is one of the more popular and established home computers. Like so many of the genre, it has the basic ingredients for creating sound and hence music. If the VIA — versatile interface adaptor — is added to the Atom, an eight-bit output can be converted by digital-to-analogue techniques into a signal to control a VCO or a voltage controlled oscillator. The Atom has two such output registers which place 16 bits at your disposal. The possible combinations, with various oscillators and envelope generators are numerous.

The Acorn Atom also has a built-in loudspeaker which is located on an output port at location B002- hexadecimal. The speaker has only one-bit resolution — that is, it has only two possible states, on or off. This is limiting as it provides no flexibility of volume, but a limited amount of music-making is possible with it. The main disadvantage, is that the speaker is located within the main body of the computer and it is quiet.

In the Acorn Atom manual there is sufficient information to help the user start making music. The main technique involves exclusive-Oring the address with a number which has a one bit in the same position as the speaker.

The glorious thing about this computer and the speaker is that programs of increasing complexity are relatively easy to create. The best method is to establish a series of building blocks or subroutines to provide certain noises. *Arpeggios,* for example, are all easily added by software and before you know where you are, that tiny speaker is playing reasonable tunes.

Another feature of the Atom is the high-resolution graphics — ideal for creating a visual display to go with your symphonies. One possibility is to display the music currently being played on the screen; another is to provide a crude sound and light show. The effect can be sensational on an Atom with colour video.

The proposed BBC computer will be from the same stable as the excellent Atom and its specification is enough to delight most. Undoubtedly, the computer musician will profit enormously from such a machine. The analogue-to-digital interface is one of the useful features, the built-in loudspeaker and sound generator another.

Together, these two open many possibilities, but no more than, say, the Vic. The voice-synthesis facilities may be of use; slight tinkering with the circuit and judicious filtering of the output may lead to some interesting results.

Perhaps the feature which will be of real importance to the musician is the possibility of adding a 16-bit processor. 16 bits offer many more

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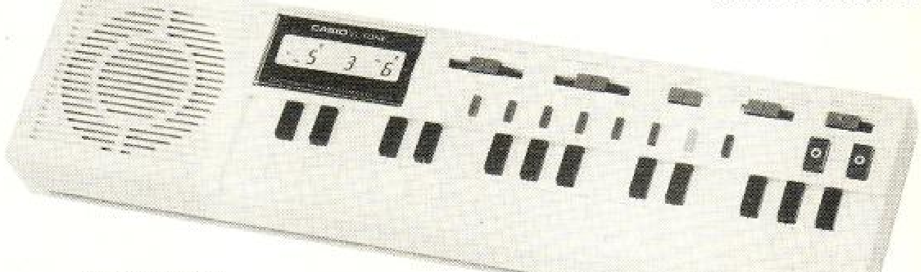
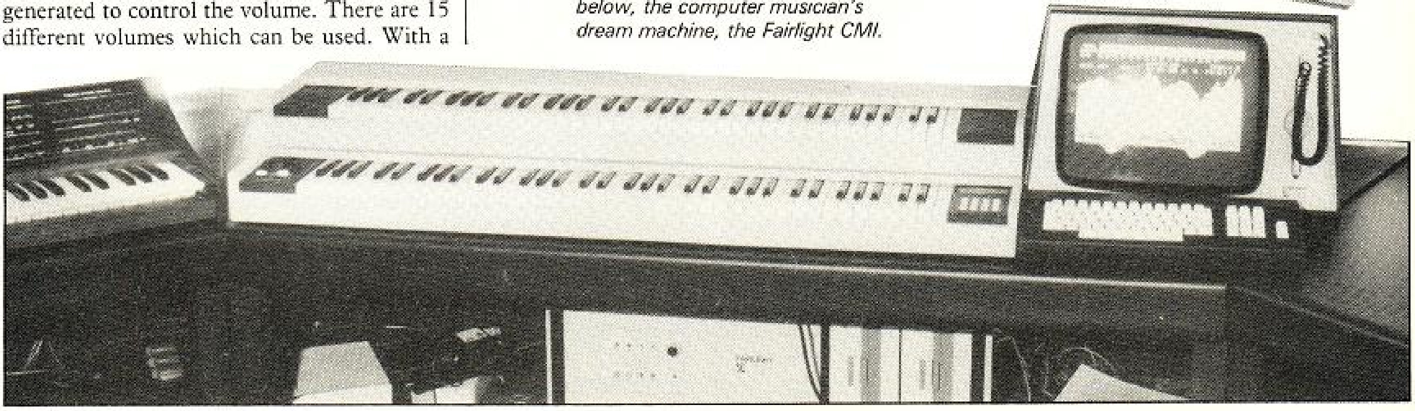


The Casio VL-1 keyboard instrument and, below, the computer musician's dream machine, the Fairlight CMI.



(continued from page 27)

combinations than eight bits, in fact 64,000 as opposed to 256.

A machine which offers the computer musician both software and hardware for computer music is the Sharp MZ-80K — albeit only in a primitive form. The Sharp has a single loudspeaker located within the main body of the machine, and there is also a volume-control potentiometer inside the chassis.

Music played on the Sharp always sounds slightly baroque, and often funny. The software for creating such music is disarmingly simple, but do not let it fool you — some very complex musical pieces can be played on the MZ-80K.

The speed at which the music plays is governed by the command Tempo. It takes the form Tempo X where X is an integer between one and seven. If X is omitted, the Tempo command will default to 4, which is the medium speed. Tempo 1 is the slowest and may be described as *lento;* seven is the fastest and can be described as *molto allegro* or *presto.*

Music itself is programmed as a string which contains a tune comprising letters, numbers and graphic symbols. A note is indicated by its corresponding letter. For example, the note C is entered in the music string as C. To rise or drop an octave a graphic symbol is used: the computer uses three octaves. To play a sharp, the hash symbol—which resembles the sharp symbol anyway—is used.

The duration of individual notes is governed by numbers, as in the diagram, and a rest is designated by the letter R. When no duration is assigned, the Sharp will default to duration 5 — the quarter beat. To write a tune in this format is not hard but requires some thought. After a number is read into the string, all subsequent notes will be given the same duration until another number is encountered.

Because of the large amount of memory available on the MZ-80K and its music software, creations of considerable complexity can be written with comparative ease.

The Texas Instruments TI-99/4 home computer, like the Sharp MZ-80K, has both hardware and software for the creation of computer music. Like the Vic, the 99/4 can operate three musical voices and one noise at any one moment. The major difference between the two is the software-handling routine integral to the 99/4's Basic.

The extra software is in the form of a subprogram, which can be called from a Basic program written by the user. The command takes the format

CALL SOUND (d,f1,v1,f2,f3,v3,f4,v4).

The first parameter, "d", specified in the call statement is the duration of the note. Next is "f", the frequency, and finally "v", the volume. The rest of the parameters are the other voices which may be used or omitted in any sub-program call.

The unit of the duration is 1ms. Thus, if "d" has the value one, the tone will last for 1ms. The maximum possible duration is about 4.25 seconds. If a negative sound duration is given, the computer will interrupt the present tone with the new one. It can do this because program execution contines while the sound is being played.

The frequency is specified directly in hertz between the limits of 100Hz and 44,733Hz—which is beyond your hearing but liable to set a dog yapping. If, for example, you wish to output the note middle C, the frequency parameter would take the value 262. A negative frequency between -1 and -8 will create a noise sound, a function useful for percussive effects.

An add-on device can be bought for the 99/4 which enables the musician to enter music from a keyboard directly to the computer — or in its other mode, by writing it in the traditional format on the screen. For the moment, this device is available only in the U.S.

```
10   CLEAR 4
20   A=1 ; GOSUB a
21   GOSUB b
30   A=8 ; GOSUBa
31   GOSUB b
40   A=24 ; GOSUB a
41   GOSUB b
50   A=24 ; GOSUB a
51   GOSUB b
100 REM  main program segment
790 END
800a   FOR I = A TO A+4
810    PLOT 12,5,(180-I*5)
820    PLOT 5,251,(180-I*5)
830    NEXT
840    RETURN
850b   Q=(180-A*5)
851    PLOT 12,5,(Q-18)
852    PLOT 5,7,(Q-23)
853    PLOT 5,9,(Q-18)
854    PLOT 5,9,(Q+4)
855    PLOT 5,11,(Q+2)
856    PLOT 5,12,(Q-3)
857    PLOT 5,6,(Q-7)
858    PLOT 5,5,(Q-10)
859    PLOT 5,6,(Q-14)
860    PLOT 5,7,(Q-17)
861    PLOT 5,13,(Q-14)
862    PLOT 5,12,(Q-9)
863    PLOT 5,8,(Q-11)
890    RETURN
900    END

1000 REM note drawing subroutine
1010 PLOT 12,R,(P+16)
1020 PLOT 5,R,P
1030 PLOT 5,(R-3),(P-1)
1040 PLOT 5,(R-4),(P-2)
1050 RETURN
```

This program contains all the necessary ingredients for creating a musical display on the Acorn Atom computer. Here are the bare bones. The program to generate the notes on the screen will have to be written by the computer user. To help, a subroutine has been added at line 1000 which will draw a note at a location defined by p and r.

The DAI personal computer is an ideal choice for the budding computer musician. Although the machine is not cheap at £595 plus VAT, it has some really very attractive features. If the Vic is called the Volkscomputer then the DAI is the Rolls Royce. The graphics of the DAI are featured on the front cover of this month's *Your Computer* and they are very smart indeed.

The music-generation facilities are also what you would expect of this top micro. Four voices are on-board, and they can be output either via the TV sound channel or the stereo DIN plug on the rear of the computer.

The commands to create music are Noise a,b which deals with the noise generator where "a" is the envelope used which is defined by the Envelope command and "b" the volume. Unsurprisingly Sound is the command which creates exactly what it suggests. There are parameters which specify which envelope is being used, the frequency, the channel through which the sound will be output, the volume and the tone of the sound. The Envelope command is a particularly good one — it allows the operator to specify exactly the shape of the sound envelope to be used on each channel.

There is another command, Talk, which generates weird and wonderful sound effects. A rumour was circulating that the function actually created speech, but DAI says it gave the command that name for want of a better one.

The ZX-80—and the ZX-81—are the most popular computers in the U.K. Unfortunately, as far as creating computer music is concerned, the Sinclair micros are not very good. Nevertheless, the ZX computer musician should not despair — there are ways of coaxing that machine to sing.

The most obvious way to create music on a ZX computer is by outputting a signal via the jack socket—which is usually used for loading programs. The output music can be recorded on to tape and played back later or it can be output directly to a loudspeaker for amplification.

Two other techniques are also available: one is to play the sound through the TV loudspeaker —but this is rarely very successful; the other is to cause high-frequency switching which can be received on a transistor radio placed near to the computer and tuned to a suitable waveband. In one application of the second technique, the pitch of the output note can be altered by tuning the radio.

The UK101 microcomputer from Compshop was one of the biggest-selling hobby computers before the latest wave of consumer machines. These two distinct types of home computers should not be confused. The hobby computer — i.e., the UK101—is usually bought by an electronics hobbyist who often will construct the machines himself. The consumer computers are generally bought by people who have little previous computing experience, who are not too interested about what is going on inside their machine, and who just want to concentrate on programming.

This, then, should explain why the UK101 does not have any facilities built-in for the creation of computer music: a hobbyist is expected to develop this kind of feature off his own bat. That does not mean that there are no computer-music facilities available for the machine, it is just that they must be bought as optional extras.

Crude computer music is possible on an unmodified UK101—or Superboard for that matter—by using the tape output port, but this is very limited because of the 300baud tape-transfer rate. In other words, digits cannot be sent at a speed faster than 3.3ms., or the pitch of an output note must be lower than 300Hz.

The add-on music board for the UK101/Superboard is reasonably sophisticated, and can be bought from certain computer or electronic component suppliers.

So, by plugging in your computer and fiddling around, you too can be there with Kraftwerk, Tangerine Dream, Visage *et al.* If you do not have a computer, or you just like gimmicks, you could do worse than purchasing a Casio VL-1 — not really music on a micro, more like music on a calculator. The VL-1 seems to fall between the two stools of the excellent Casio range of pocket claculators and the highly-praised range of keyboard instruments. ■

CRAFTY DESIGNS ON

If you mention computer art to the average hobbyist, you will probably meet with blank incomprehension. Yet for a growing number of users, computers are a valid creative medium. Christopher Histed examines the fundamentals of this infant art form.

THE COMPUTER can readily be used as a creative tool. You can construct and view drawings on the screen or produce them as hard copy on paper. Music generation can be achieved by most hobbyists on their home computers with some machine code; most micros can easily be made to play tunes of varying complexities.

All that is needed to make music is a computer, and some form of output port to which an amplifier and loudspeaker can be attached. From there, the only constraints are musical talent — if you write your own tunes — or finding the energy for a trip to the local library to choose music to load into the computer.

There are three main types of output for creating drawings with the computer:

- Some type of display, either alpha-numeric or in some graphics dot-type style on the terminal or monitor. This form is, of course, a static and regeneratable form of picture-making which cannot really be captured as hard copy other than by photographic methods.
- Hard-copy output from a normal alpha-numeric printer or from a graphics printer which then can be used to print the picture in dots. This method of producing pictures is nearly permanent, and allows the pictures to exist independently of the computer system. It can give rise to one-off pictures, which means only one output — the program that generated the picture is destroyed.
- A second form of hard copy can be obtained from graphics plotters that have a fixed piece of paper which some kind of pen or marking device is moved. This can be used only for line drawings, as it cannot properly fill in areas of colour, tone or produce dots.
- This kind of plotter cannot plot dots to create shading effects without considerable problems. However, the graphics plotter is a very useful piece of equipment and is one I have used extensively in the creation of assorted pictures and drawings.

Using the first method, your screen display need not be of the high-resolution quality of the Apple or the Atom, but may be of only, say, 16 lines by 32 characters. Even on this format, pictures are easily created — although of not such excellent resolution as 300 by 200 dots on a monitor.

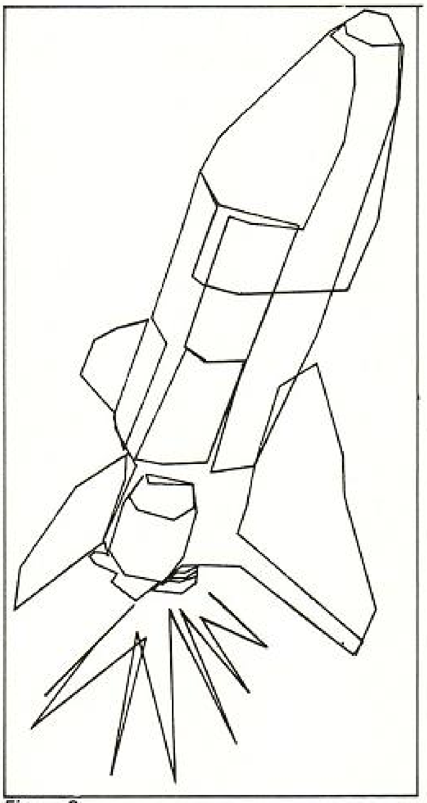


Figure 2.

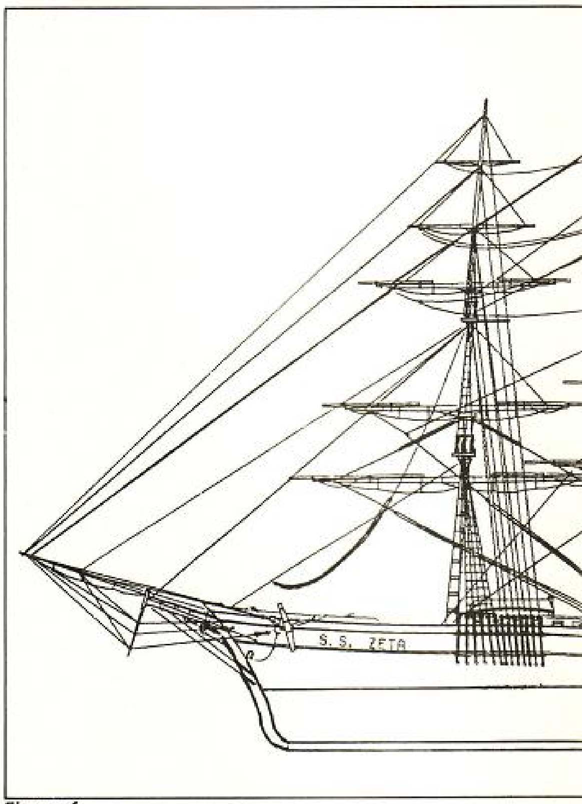


Figure 4.

Figure 3.

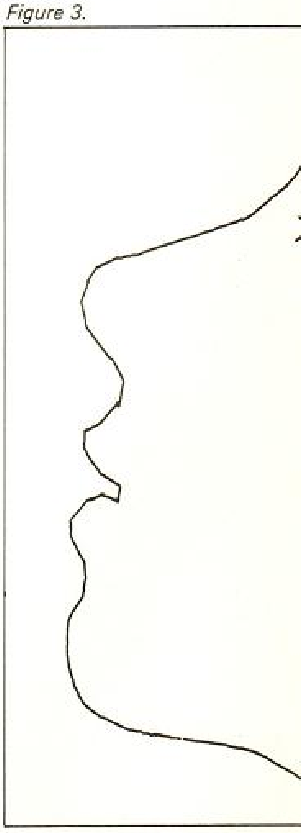
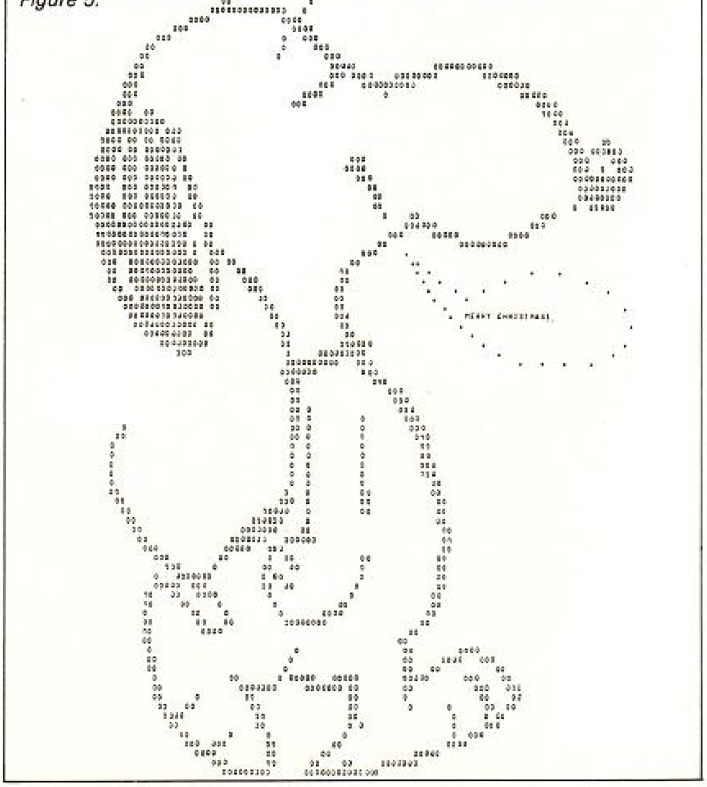
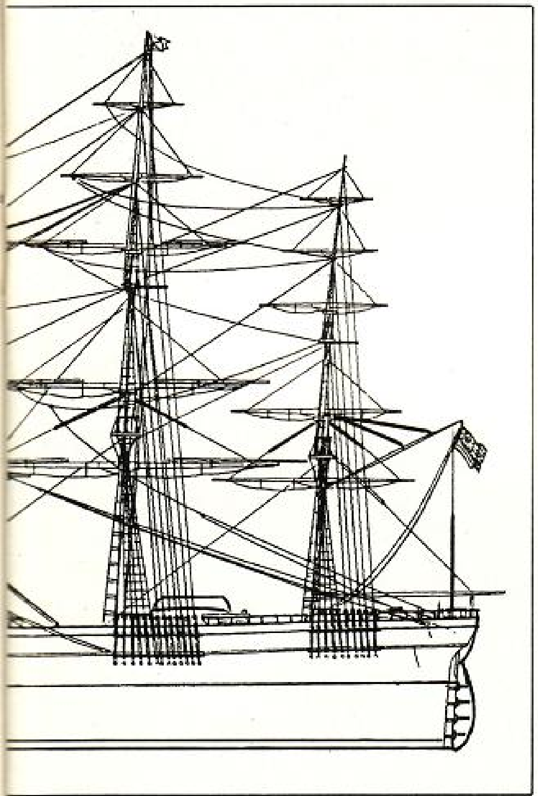
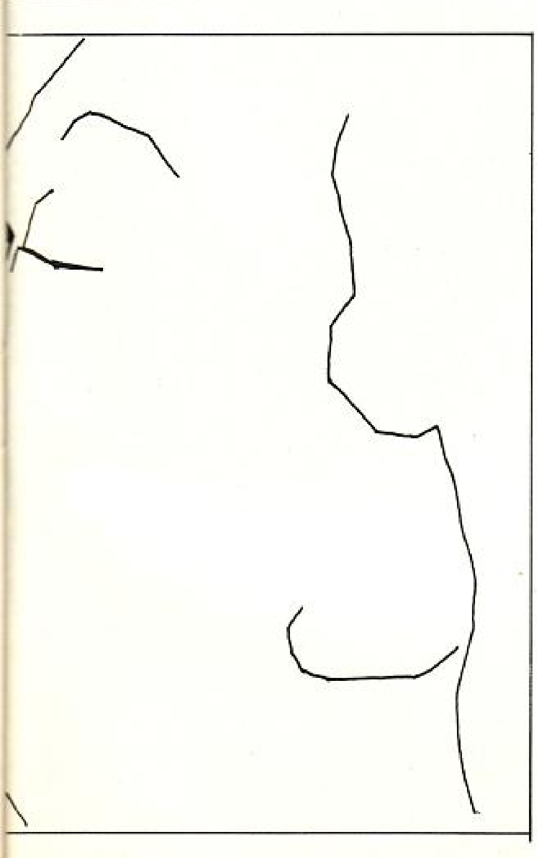


Figure 5.



A COMPUTER





For this type of computer you need a program which will clear the screen, and will, by some means, cover as much of the screen as you choose with characters of your choice. It should then be able to save the screen data on to some kind of file — either tape or disc.

That is easy if you configure a string variable to be the size of your screen, and then input characters to it. For example, on the Atom, with a screen format of 16 by 32, you would need to be able to store a string variable of length 512 bytes on to tape, and then to load one from tape and print it on the screen.

Even with this format of screen, you can make surprisingly good representations of objects — although you may have to stand several yards away to appreciate them fully.

Using a high-resolution screen such as the Apple or Atom, the idea is similar but you require far more memory. You cannot really store the data as a string, and so must use a section of memory which can be transferred to and from disc or tape when you want to save or view a picture. With this kind of screen, you can obtain some very impressive pictures.

An example program for making this kind of picture for the Acorn Atom in clear 3 mode is:

```
10 clear 3
20 for x=0 to 128; movex,0; plot 6, 64, 97
30 move x, 192; plot 6, 64, 97; next
40 for x=0 to 192; move 0,x;  plot 6, 64, 97
50 move 128,x; plot 6, 64, 97; next
60 end
ready.
```

Graphics plotters and printers are by far the most useful pieces of equipment available to the computer artist. Once the picture has been generated on the screen in high-resolution graphics, you can perform a screen dump of the screen memory on to a graphics printer which will transfer the picture on to paper.

Unfortunately, graphics printers cost £300 upwards. If you cannot afford one do not despair: wherever you live there must be at least one computer club in the vicinity. Once you have joined one you will meet other members with the same interests as yourself. You can pool your resources to buy a printer or perhaps someone at the club already has a printer or plotter.

If you cannot find a way to dump your screen on to paper, you can always photograph your monitor screen and then produce prints of it from the negative. Since the most popular amateur photographers' camera uses 35mm. film, I will explain what you need to do to obtain good-sized prints from your screen. The film should be preferably 400 ASA black and white, such as Ilford HP-5.

Assuming you are using the 35mm. camera with its standard 50mm. focal-length lens, you will be able to fill the view-finder with the screen of a 12in. monitor or TV from a distance of about 0.5m. away. There will be no problems if you use another lens, you must select a distance to frame the screen.

You will need a tripod or some firm support to keep the camera steady. An exposure meter is handy, and if set to 400 ASA or the relevant film speed, there is no need for exposure compensation with the screen. Since the screen is normally refreshed every 25th of a second with a TV, you cannot use a shutter speed greater than 1/15th of a second.

Next you will need to darken the room, so that the only light reaching the film is from the monitor screen. If you have a meter, take a reading of the correct exposure from the screen, and take the photograph. If you have no meter, an exposure of 1/15th of a second at F3.5 will probably suffice.

Do not take just one photograph — take at least four and ideally six. Have a contact sheet made from the film. This is a large, 10in.-by-8in. sheet of paper on which the negatives have been printed actual size. From this you can select the frame which is best and have a large print made.

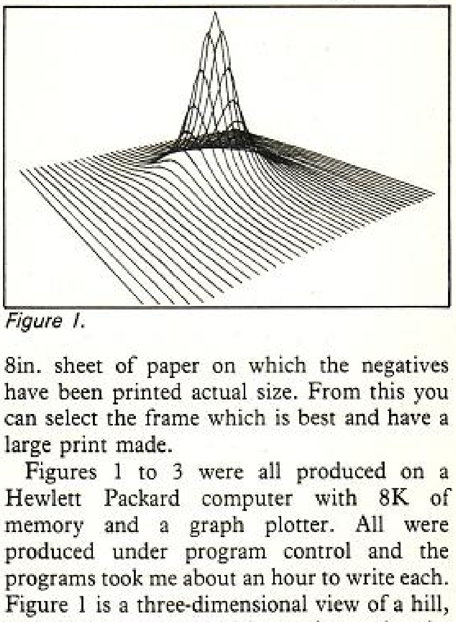


Figure 1.

Figures 1 to 3 were all produced on a Hewlett Packard computer with 8K of memory and a graph plotter. All were produced under program control and the programs took me about an hour to write each. Figure 1 is a three-dimensional view of a hill, and the program could be made to plot the picture of it as seen from any position above or below the base plane.

The other two plotter pictures created using the Hewlett Packard were originally pencil line drawings which were converted to digital form with a digitiser, and then re-plotted on the graph plotter. The picture of the ship is from deep in my computer art files and is nevertheless an extremely fine example of the kind of picture which can be produced with a graph plotter and many hours of painstaking effort. Figure 5 wil be immediately recognised as the immortal Snoopy, who has graced the walls of countless computer rooms. ■

Storm the castle: play the

BY BOB MERRY

The Duke of Petshire, with whom you are at war, has fled to his castle. The game invites you to use your skill and ingenuity in setting siege to the Duke's fortress.

I HAVE NOT used any graphics in the game and there are virtually no departures from standard Basic, so it should prove relatively easy to convert it to other systems. Because the game itself occupies a large part of the 8K memory I have in my old-ROM Pet, I have split the game into two programs, but the first of these is simply an instruction program which can be omitted if necessary.

The printed version given here uses all upper-case letters, double-spaced, as the printer used could not cope with lower case embedded in a program and called by Poke 59468,12. However, the version I play with uses lower-case, which makes the presentation so much easier to read.

The only piece of program extra to the text is the subroutine at the end of each page. This waits for you to finish reading the page before printing out the next one and while it waits, it runs through a few random numbers — a method of Randomising before the game itself starts.

The game itself is contained in the second program and is really concerned with the interaction of a number of variables. The main variables are listed in table 1 and it is the space taken by these which uses most of the 8K memory. Incidentally, although this program was written for an old-ROM Pet, it does, in fact, work just as well on update ROMs without any modification. The main purpose of this article is, therefore, to highlight the areas which will need changing on other systems.

Line 110 contains another method to Randomise the inbuilt RND function and the early lines down to 270 set most of the non-

game of siege

zero variables. The program will return to line 280 to start a new turn, so a number of variables are re-set at this point.

The display of the current state of play and options involves the use of various cursor-control symbols, so for those not familar with the Pet, here is a translation: the reversed-heart symbol clears the screen; reversed Q means cursor down; reversed S is home, i.e., the cursor goes to the top left of the screen; the reversed vertical lines in, for example, lines 1170 and 1790 are cursor-left instructions.

I spent some time making the various read-outs grammatical with correct forms of plurals and verbs, so this needed some manipulation on the screen. The R symbol in line 1900 is the command for reverse screen.

So much for the symbols — now I will explain how some of them are used to achieve the desired result on the screen. The first example of this is the initial display contained in lines 300-340. This routine lists the current numbers of each item you have at your disposal and most of these are listed by the loop in 320-330.

However, we wish to display the number of carts which have not been assigned to a task alongside the total number of carts. This is done by line 340 which first moves the cursor down and across the screen to the correct position before printing UC. A similar idea is used in the subroutine 1790, which updates the figures for unassigned men, UN, and carts, UC, at various points in the program.

It does this without disturbing the rest of the display by moving the cursor to the correct position, printing sufficient blank spaces to obliterate the previous number and then backing up the cursor ready to print the new values of UN and UC.

Where cursor-left symbols are used on their own on other lines, it is usually to overcome the fact that a numerical variable is printed with a leading blank for a positive value and this can lead to a slightly untidy lay-out on the display. In other words, they are there for aesthetic reasons and are not really necessary for the working of the program.

One area that will need to be changed for other systems is the subroutine in line 1800. This is used after each response to clear the area at the bottom of the screen by Poking blank spaces into this area, thus leaving the main display untouched. The cursor is then moved down the screen ready for the next option.

The subroutine at 1870-1890 is a simple routine looking for one-letter answers to yes/no questions and you may need to substitute an input routine with suitable checks if you cannot handle Get R$.

Apart from those points, the rest of the

(continued on next page)

Listing 1. Instruction program.

```
10 REM*******SIEGE*******
20 REM**               **
30 REM****BY R.C.MERRY***
40 REM**               **
50 REM**A 2-PART PROGRAM*
60 REM**               **
70 REM*PT 1-INSTRUCTIONS*
80 REM*PT 2-    GAME    *
90 REM*******************
100 PRINT""TAB(13)"SIEGEBY R.C.MERRY
110 FORI=0TO2000:NEXT
120 PRINT"THIS PROGRAM CONTAINS THE INSTRUCTIONS
130 PRINT"FOR 'SIEGE'. IF YOU DO NOT WISH TO SEE
140 PRINT"THE INSTRUCTIONS, PRESS 'N' - ANY OTHER
150 PRINT"KEY WILL RUN THE INSTRUCTION SEQUENCE.
160 PRINT"AT THE END OF EACH PAGE YOU CAN PRESS
170 PRINT"ANY KEY TO CONTINUE.":GOSUB1240:IFR$="N"THEN1220
180 PRINT"YOU ARE IN COMMAND OF AN ARMY OF THREE
190 PRINT"HUNDRED MEN AND YOU ARE AT WAR WITH THE
200 PRINT"DUKE OF PETSHIRE. BECAUSE YOU OUTNUMBER
210 PRINT"HIS ARMY, HE DOES NOT WISH TO MEET YOU
220 PRINT"IN OPEN BATTLE, BUT HAS FLED INTO HIS
230 PRINT"CASTLE. YOU MUST NOW LAY SIEGE TO THIS
240 PRINT"CASTLE AND OVERCOME IT, BY FORCE OR
250 PRINT"OTHERWISE.":GOSUB1240
260 PRINT"DURING EACH DAY OF THE SIEGE YOU WILL
270 PRINT"HAVE TO DECIDE HOW TO DEPLOY YOUR MEN
280 PRINT"AMONGST VARIOUS TASKS. YOU WILL NEED TO
290 PRINT"SEND MEN FORAGING FOR FOOD AND ALSO FOR
300 PRINT"ROCKS - THESE LATTER ARE USED AS THE
310 PRINT"AMMUNITION IN THE BALLISTAS WITH WHICH
320 PRINT"YOU BOMBARD THE WALLS. YOU WILL NEED
330 PRINT"BOTH MEN AND CARTS FOR THIS FORAGING.
340 PRINT"YOU WILL BE TOLD HOW MANY OF EACH ARE
350 PRINT"NEEDED FOR AN APPROXIMATE RATE OF
360 PRINT"COLLECTION BUT THESE WILL INCREASE AS
370 PRINT"MATERIALS GET HARDER TO FIND.";:GOSUB1240
380 PRINT"ALTHOUGH YOU WILL BRING A FEW ITEMS WITH
390 PRINT"YOU, YOU WILL ALSO NEED TO BUILD OTHERS.
400 PRINT"THESE INCLUDE BALLISTAS WITH WHICH TO
410 PRINT"BOMBARD THE WALLS, CARTS FOR CARRYING
420 PRINT"FOOD AND AMMUNITION, LADDERS AND SIEGE
430 PRINT"TOWERS FOR USE IN AN ASSAULT ON EITHER
440 PRINT"THE WALLS OR THE TOWER, AND BATTERING
450 PRINT"RAMS FOR ATTACKING THE MAIN GATE. THE
460 PRINT"APPROXIMATE NUMBER OF MAN-DAYS NEEDED
470 PRINT"TO BUILD EACH ITEM WILL BE SHOWN, BUT
480 PRINT"YOUR MEN MAY WORK FASTER OR SLOWER THAN
490 PRINT"THIS. MAN-DAYS ARE CUMULATIVE AND YOU
500 PRINT"CAN TAKE SEVERAL DAYS TO BUILD AN ITEM.";:GOSUB1240
510 PRINT"THE DUKE'S CASTLE IS ALMOST COMPLETELY
520 PRINT"SURROUNDED BY A RIVER. THE PLACES THAT
530 PRINT"ARE OPEN TO ATTACK ARE THE MAIN GATE,
540 PRINT"A TOWER; AND THE WALL IN BETWEEN THEM.
550 PRINT"IF YOU WISH TO WIN BY FORCE YOU WILL
560 PRINT"HAVE TO ATTACK ONE OF THESE, BUT ,SINCE
570 PRINT"THEY ARE ALL STRONG DEFENSIVELY, YOU
580 PRINT"HAVE TO SOFTEN THEM UP A BIT FIRST.":GOSUB1240
590 PRINT"THE MAIN GATE: THIS CAN BE GRADUALLY
600 PRINT"BROKEN DOWN BY USING BATTERING RAMS AND
610 PRINT"THESE WILL AUTOMATICALLY BE USED IN SUCH
620 PRINT"AN ATTACK, PROVIDING THERE ARE AT LEAST
630 PRINT"30 MEN/BATTERING RAM ASSIGNED TO THE
640 PRINT"ATTACK.":PRINT"THE TOWER: THIS IS IMMENSELY STRONG
650 PRINT"AND WILL NOT FALL EASILY TO A DIRECT
660 PRINT"ASSAULT. HOWEVER, IT CAN BE WEAKENED BY
670 PRINT"UNDERMINING. YOU DO THIS BY DIGGING A
680 PRINT"TUNNEL, WHICH CAN TAKE 15-20 DAYS. IF
690 PRINT"THE TUNNEL COLLAPSES OR IS DISCOVERED,
700 PRINT"IT WILL BE DELAYED.";:GOSUB1240
710 PRINT"THE WALLS: AGAIN, THESE ARE TOO STRONG
720 PRINT"FOR A DIRECT ASSAULT, BUT THEY CAN BE
730 PRINT"WEAKENED BY BALLISTA BOMBARDMENT. EACH
740 PRINT"DAY YOU CAN ASSIGN 10 MEN/BALLISTA TO
750 PRINT"HURL ROCKS AT THE WALLS. YOU MUST, OF
760 PRINT"COURSE, HAVE ENOUGH AMMUNITION COLLECTED
770 PRINT"TO KEEP THE BALLISTAS SUPPLIED.
780 PRINT"ONCE YOU ARE READY TO ATTACK EITHER THE
790 PRINT"WALLS OR THE TOWER, ANY SIEGE TOWERS OR
800 PRINT"LADDERS YOU HAVE BUILT WILL BE ADDED TO
810 PRINT"THE ATTACK, BUT YOU WILL LOSE ALL THE
820 PRINT"LADDERS AND HALF THE SIEGE TOWERS IN THE
830 PRINT"ATTACK.";:GOSUB1240
840 PRINT"HAVING ASSIGNED YOUR MEN TO VARIOUS
850 PRINT"TASKS, ANY LEFT OVER WILL GUARD YOUR
860 PRINT"CAMP AND SUPPLIES. IF YOU LEAVE TOO FEW
870 PRINT"MEN IN CAMP AND YOU DO NOT KEEP THE
880 PRINT"DEFENDERS OCCUPIED WITH AN ATTACK, THEN
890 PRINT"THEY MAY SALLY FORTH AND ATTACK YOUR
900 PRINT"CAMP, KILLING SOME OF YOUR MEN AND
910 PRINT"STEALING YOUR RATIONS. IF, ON THE OTHER
920 PRINT"HAND, YOU LEAVE TOO MANY MEN IN CAMP,
930 PRINT"THEY WILL GET BORED AND MAY DESERT.":GOSUB1240
940 PRINT"YOU WILL HAVE TO DECIDE WHETHER TO
950 PRINT"ISSUE FULL, HALF, OR NO RATIONS. IF YOU
960 PRINT"DO NOT ISSUE FULL RATIONS, SOME MEN WILL
970 PRINT"DESERT. THEY WILL ALSO DESERT IF YOU LET
980 PRINT"YOUR STOCK PILE RUN TOO LOW, SINCE THIS
990 PRINT"CAN START RUMOURS. SHOULD YOUR FORCE BE
1000 PRINT"REDUCED, EITHER BY DESERTION OR DEATH,
1010 PRINT"TO LESS THAN 150 MEN, THEN THERE WILL
1020 PRINT"BE A GENERAL MUTINY AND YOU WILL LOSE
1030 PRINT"THE WAR.":GOSUB1240
1040 PRINT"YOU WILL NOT HAVE AN ACCURATE IDEA OF
1050 PRINT"HOW MANY DEFENDERS ARE LEFT IN THE
1060 PRINT"CASTLE, BUT OCCASIONALLY A DESERTER MAY
1070 PRINT"GIVE YOU A VERY APPROXIMATE REPORT.
1080 PRINT"ONCE THE DEFENDERS RUN OUT OF RATIONS,
1090 PRINT"THEY WILL START TO DIE OF STARVATION
1100 PRINT"AND THEY CAN ALSO BE KILLED IN COMBAT
1110 PRINT"AND THE OCCASIONAL BOMBARDMENT. IF LESS
1120 PRINT"THAN TEN DEFENDERS ARE LEFT AT THE END
1130 PRINT"OF THE DAY, THEY WILL SURRENDER.
1140 PRINT"YOU CAN LIFT THE SIEGE AT THE END OF ANY
1150 PRINT"DAY, GIVING AN HONOURABLE DRAW.";:GOSUB1240
1160 PRINT"REMEMBER THAT THE VARIOUS FIGURES THAT
1170 PRINT"ARE GIVEN FOR WORK-RATES AND COLLECTION
1180 PRINT"OF RATIONS AND AMMUNITION ARE SUBJECT
1190 PRINT"TO THE FORTUNES OF WAR AND CAN VARY.
1200 PRINT"NOW YOU ARE READY TO BEGIN THE SIEGE.
1210 GOTO1230
1220 PRINT""
1230 PRINT"LOAD AND RUN THE 'SIEGE' GAME PROGRAM.":END
1240 R=RND(1):GETR$:IFR$=""THEN1240
1250 RETURN
```

(continued from previous page)

program is straightforward and should present no difficulty in programming. As far as playing the game is concerned, you should find that, after a while, the castle will usually have to surrender. At this point, you will want to make life a little harder and variations in the different variables will help you in this.

Table 1 can be used as a guide to the variables with which you can experiment. I would recommend increasing the values of man-days required for various items to be built, MD(I). These are contained in the Data statements in 200-210.

There are three sets of Data here for various times in the siege, in blocks of nine numbers. Other variables you could try are DN — line 120; WS, TS — line 120; GS — 150; or some of the random factors in the combat situations, e.g., lines 410-430, lines 910-950, etc. Above all, experiment; this way you will discover far more about the details of how the program works. ■

Table 1. Main variables used in the program.

DN	Number of defenders
RD	Rations available to defenders
DS	Days into siege
AN	Number of attackers
WS	Strength of walls
TS	Strength of tower
GS	Strength of gate
UD	Days digging tunnel
UT	Days required to complete tunnel
TA	Attacking strength in an attack
TD	Defending strength in an attack
NA	Number assigned to an attack
AD	Attackers killed
DD	Defenders killed
UN	Unassigned men
UC	Unassigned carts
D1	Deserters
D2	Deserters
R1	Rations gathered
A1	Ammunition gathered
HW	Hits on wall
TC	Men killed in tunnel collapse
SA	Attackers killed if defenders sally forth
SD	Defenders killed if defenders sally forth
R2	Stolen rations
N3	Battering-rams fully manned in attack
W	Current damage state of wall
T	Current damage state of tower
N$(I)	Names of equipment; I=0 to 6
N(I)	Numbers of equipment; I=0 to 6
D(I)	Accumulated man-days; I=0 to 4
B(I)	Builds this turn; I=0 to 4
MD(I)	Man-days required for each item; I=0 to 8
A$	"Do you wish to"
B$	"It takes"
Z$	Various phrases, particularly when correct plurals are used

IN N(I) and N$(I), elements 5 and 6 refer to rations and ammunition units, respectively.

IN MD(I), element 5 is the number of men need to collect rations; element 6 is the number of carts to collect rations; element 7 is the number of men need to collect ammunition; element 8 is the number of carts needed to collect ammunition.

In all arrays, elements 0 to 4 refer to ballistas, carts, ladders, battering-rams and siege towers, respectively.

Listing 2. Game program.

```
10 REM SIEGE BY R.C.MERRY. JULY 1980
100 DIMN(6),D(4),N$(6),MD(8),B(4),X$(6)
110 RESTORE:R=RND(-TI)
120 DN=INT(100*RND(1)+100):RD=INT(500*RND(1)+1500):DS=1:AN=300:WS=500:TS=1000
130 N(6)=INT(2*RND(1)+4.5)
140 N(0)=INT(RND(1)+1.5):N(1)=INT(2*RND(1)+4.5):N(5)=INT(RND(1)*1000+500.5)
150 GS=400:UT=15
160 IFRND(1)>.5THENUT=30
170 A$="DO YOU WISH TO ":B$="IT TAKES"
180 FORI=0TO6:READN$(I):NEXT
190 DATA"BALLISTA","CART","LADDER","BATTERING RAM","SIEGE TOWER"
200 DATA"RATION","AMMUNITION UNIT",50,30,10,60,100,20,1,40,3
210 DATA60,40,15,80,120,30,1,50,3,70,50,20,100,140,40,2,60,4
220 FORI=0TO8:READMD(I):NEXT:FORI=0TO4:D(I)=0:B(I)=0:NEXT
230 FORI=2TO4:N(I)=0:NEXT
240 X$(0)="VIRTUALLY DESTROYED":X$(1)="SEVERELY DAMAGED"
250 X$(2)="EXTENSIVELY DAMAGED":X$(3)="MODERATELY DAMAGED"
260 X$(4)="SLIGHTLY DAMAGED":X$(5)="HARDLY DAMAGED"
270 X$(6)="UNDAMAGED"
280 UN=AN:UC=N(1):NA=0:AD=0:DD=0:D1=0:D2=0:TA=0:TD=0:R1=0:A1=0:HW=0:TC=0
290 X=1:A=0:Y=0:SA=0:SD=0:R2=0
300 PRINT"]THIS IS DAY"DS"OF THE SIEGE."
310 PRINT"▮YOU HAVE"AN"MEN":PRINT"▮▮"UN"UNASSIGNED"
320 PRINT"▮YOU HAVE";:FORI=0TO6:PRINTTAB(10);N(I);N$(I);:IFN(I)<>1THENPRINT"S";
330 PRINT:NEXT
340 PRINT"▮▮▮▮▮▮▮▮";TAB(20);UC;"UNASSIGNED":GOSUB1790
350 PRINTB$" 10 MEN TO MAN EACH "N$(0):GOSUB1810
360 IFN=0THEN440
370 IFN<10THENGOSUB1820:GOTO350
380 FORI=0TO6STEP6:IFINT(N/10)>N(I)THENN$=N$(I):GOSUB1830:GOTO350
390 NEXT
400 IFN>UNTHENGOSUB1840:GOTO350
410 FORI=1TO10*INT(N/10):IFRND(1)>.8THENHW=HW+1:WS=WS-INT(RND(1)*6)
420 IFWS<40THENWS=40
430 NEXT:DN=DN-INT(HW*RND(1)*.3):UN=UN-N:N(6)=N(6)-INT(N/10)
440 GOSUB1790
450 PRINTB$;MD(5);"MEN &"MD(6);N$(1);:IFMD(6)<>1THENPRINT"S";
460 PRINT" TO GATHER":PRINT"EACH "N$(6):GOSUB1810:IFN=0THEN510
470 IFN<MD(5)THENGOSUB1820:GOTO450
480 IFN>UNTHENGOSUB1840:GOTO450
490 A1=INT(N/MD(5)):C=A1*MD(6):IFC>UCTHENGOSUB1860:GOTO450
500 UN=UN-N:UC=UC-C:A1=A1+INT(RND(1)*2+.5)-1:N(6)=N(6)+A1
510 GOSUB1790
520 PRINTB$;MD(7);"MEN &"MD(8);N$(1);"S TO GATHER":PRINT"300 "N$(5);"S."
530 GOSUB1810:IFN=0THEN580
540 IFN<MD(7)THENGOSUB1820:GOTO520
550 IFN>UNTHENGOSUB1840:GOTO520
560 R1=INT(N/MD(7)):C=R1*MD(8):IFC>UCTHENGOSUB1860:GOTO520
570 UN=UN-N:UC=UC-C:R1=INT(R1*300*(RND(1)/2+.75))
580 GOSUB1790
590 FORI=0TO4:B(I)=0
600 PRINTB$;MD(I);"MAN-DAYS TO BUILD A ":PRINTN$(I):GOSUB1810:IFN=0THEN640
610 IFN>UNTHENGOSUB1840:GOTO600
620 D(I)=D(I)+INT(N*(RND(1)/2+.75)):UN=UN-N
630 IFD(I)>=MD(I)THENB(I)=B(I)+1:D(I)=D(I)-MD(I):GOTO630
640 GOSUB1790:NEXT
650 PRINTB$;" 30 MEN TO DIG A TUNNEL TO UNDERMINE THE TOWER."
660 PRINT:PRINTA$;"DIG TODAY (Y/N)?":GOSUB1870:IFR$="N"THENX=0:GOTO740
670 IFUN<30THENGOSUB1840
680 UD=UD+1:IFUD<.6*UTTHEN730
690 IFUT=30ANDRND(1)<.1THENX=2:TC=INT(RND(1)*10+.5)
700 IFUT=15ANDRND(1)<.2THENX=2:TC=INT(RND(1)*7+.5)
710 IFX=1ANDRND(1)<.1THENX=3:TC=INT(RND(1)*5+.5)
720 AN=AN-TC:IF(UD=UT)ANDX=1THENX=4:TS=TS-INT(RND(1)*500+500)
730 UN=UN-30
740 GOSUB1790
750 PRINTA$;"ATTACK THE GATE (Y/N)?":GOSUB1870
760 IFR$="N"THEN810
770 GOSUB1810:IFN>UNTHENGOSUB1840:GOTO750
780 IFN=0THEN810
790 N3=INT(N/30):IFN(3)<N3THENN3=N(3)
800 A=1:TA=N+80*N3:TD=DN+GS:NA=N:GOTO920
810 GOSUB1790:PRINTA$;"ATTACK THE WALLS (Y/N)?":GOSUB1870
820 IFR$="N"THEN870
830 GOSUB1810:IFN>UNTHENGOSUB1840:GOTO810
840 IFN=0THEN870
850 A=1:TA=N+100*N(4)+10*N(2):TD=DN+WS:NA=N:N(4)=INT(N(4)/2+.5):N(2)=0
860 GOTO920
870 GOSUB1790:PRINTA$;"ATTACK THE TOWER (Y/N)?":GOSUB1870
880 IFR$="N"THEN950
890 GOSUB1810:IFN>UNTHENGOSUB1840:GOTO870
900 IFN=0THEN950
910 A=1:TA=N+100*N(4)+10*N(2):TD=DN+TS:NA=N:N(4)=INT(N(4)/2+.5):N(2)=0
920 IFTA/TD>3*RND(1)+.5THENY=1
930 AD=INT(RND(1)*.1*DN):DD=INT(RND(1)*AN*DN/TD*.1):DN=DN-DD:IFDN<0THENDN=0
940 IFAD>NATHENAD=NA
950 GS=GS-INT(20*N3*RND(1)+10):AN=AN-AD:UN=UN-NA:IFN(5)<ANTHEN990
960 GOSUB1790:PRINTA$"ISSUE FULL RATIONS (Y/N)?":GOSUB1870
970 IFR$="N"THEN990
980 N(5)=N(5)-AN:GOTO1060
990 GOSUB1790:IFN(5)>=INT(AN/2+.5)THEN1020
1000 PRINT"YOU DO NOT HAVE ENOUGH RATIONS EVEN FOR"
1010 PRINT"HALF RATIONS. NONE WILL BE ISSUED.":FORK=0TO2500:NEXT:GOTO1050
1020 PRINTA$"ISSUE HALF RATIONS (Y/N)?":GOSUB1870
1030 IFR$="N"THEN1050
1040 N(5)=N(5)-INT(AN/2+.5):D2=INT(AN*.05*RND(1)+.5):GOTO1060
1050 D2=INT(AN*.2*RND(1))
1060 IFN(5)<50THEND2=INT(AN*.5*RND(1))
1070 AN=AN-D2
1080 PRINT"]YOU HAVE LEFT"UN"MEN DEFENDING YOUR"
1090 PRINT"CAMP AND SUPPLIES":IF(DN<2*UN)ORA=1THEN1180
1100 R2=INT(5*DN*RND(1)):IFR2>N(5)THENR2=N(5)
1110 SA=INT(.2*RND(1)*UN):SD=INT(.1*RND(1)*DN):AN=AN-SA:DN=DN-SD:N(5)=N(5)-R2
1120 PRINT"▮BECAUSE SO FEW WERE LEFT IN CAMP, THE
1130 PRINT"CASTLE'S DEFENDERS SALLIED FORTH IN A
1140 PRINT"SURPRISE ATTACK. THEY KILLED"SA"OF YOUR
1150 PRINT"MEN AND STOLE"R2"RATIONS,BUT THEY LOST
1160 Z$="MEN":IFSD=1THENZ$="MAN"
1170 PRINT"▮"SD;Z$" IN THE ATTACK.":RD=RD+R2
1180 IFUN<AN/3.5THEN1230
1190 D1=INT(.1*INT(DS/10+1)*RND(1)*UN):IFD1=0THEN1230
1200 PRINT"▮DUE TO TOO MANY IDLE MEN HAVING THE
1210 Z$="HAVE":IFD1=1THENZ$="HAS"
1220 PRINT"CHANCE TO GRUMBLE."D1;Z$" DESERTED.":AN=AN-D1
1230 GOSUB1900
1240 W=INT(WS/100+.5):T=INT(TS/200+.75)
1250 IFWS=500THENW=6
1260 IFTS=1000THENT=6
1270 RD=RD-DN:IFRD<0THENRD=0
1280 IFRD=0THENDN=DN-INT(DN/2*RND(1))
1290 PRINT"]RESULTS OF DAY"DS"OF SIEGE:
1300 PRINT"▮YOUR BOMBARDMENT SCORED"HW"HIT";:IFHW<>1THENPRINT"S";
1310 PRINT" AND THE":PRINT"WALLS ARE "X$(W)
1320 PRINT"▮YOU COLLECTED"A1;N$(6);:IFA1<>1THENPRINT"S";
1330 PRINT" AND":PRINT"▮"R1;N$(5);"S"
1340 N(5)=N(5)+R1
1350 PRINT"▮YOU BUILT";
1360 FORI=0TO4
1370 PRINTTAB(10);B(I);N$(I);:IFB(I)<>1THENPRINT"S";
1380 N(I)=N(I)+B(I)
1390 PRINT:NEXT
1400 IFX=0THEN1520
1410 PRINT"▮YOUR TUNNEL ";
1420 ONXGOTO1430,1460,1470,1500
1430 PRINT"IS PROGRESSING NORMALLY,"
1440 IFUT=15THENPRINT"THROUGH SOFT GROUND.":GOTO1520
1450 PRINT"THROUGH HARD ROCK.":GOTO1520
1460 PRINT"HAS COLLAPSED.":UD=UD-5:GOTO1480
1470 PRINT"HAS BEEN DISCOVERED.":UD=UD-8
1480 Z$="MEN WERE ":IFTC=1THENZ$="MAN WAS "
1490 PRINT"▮"TC;Z$"KILLED":GOTO1520
1500 PRINT"HAS SUCCEEDED IN UNDERMINING THE TOWER."
1510 PRINT"THE TOWER IS "X$(T)".":UD=0
1520 IFA=0THEN1570
1530 PRINT"▮YOUR ATTACK ";
1540 IFY=1THENPRINT"SUCCEEDED AND THE CASTLE HASSURRENDERED":GOTO1990
1550 Z$="MEN":IFAD=1THENZ$="MAN"
1560 PRINT"WAS REPELLED WITH"AD;Z$:PRINT"KILLED"
1570 IFD2=0THEN1600
1580 Z$="MEN":IFD2=1THENZ$="MAN"
1590 PRINT"▮DUE TO LOW RATIONS."D2;Z$" DESERTED."
1600 GOSUB1900
1610 PRINT"]"A$"CONTINUE THE SIEGE (Y/N)":GOSUB1870
1620 IFR$="N"THEN1970
1630 IFDN<10THEN1710
1640 IFAN<150THEN1940
1650 DS=DS+1
1660 IFDS=10ORDS=20THENGOSUB1930
1670 IFRND(1)<.7THEN280
1680 PRINT"▮A DESERTER FROM THE CASTLE TELLS YOU
1690 PRINT"THAT THERE ARE";INT(DN*(.8+RND(1)*.4));"DEFENDERS LEFT ALIVE
1700 AN=AN+1:DN=DN-1:GOSUB1900:GOTO280
1710 IFDN=0THEN1750
1720 IFDN=1THEN1760
1730 PRINT"]THERE ARE"DN"DEFENDERS LEFT AND THEY
1740 PRINT"HAVE DECIDED TO SURRENDER. YOU WIN!":GOTO1990
1750 PRINT"]THERE ARE NO DEFENDERS LEFT. YOU WIN!":GOTO1990
1760 PRINT"]THERE IS ONE DEFENDER LEFT AND HE HAS
1770 PRINT"DECIDED TO SURRENDER. YOU WIN!":GOTO1990
1780 PRINT"▮TRY AGAIN.":FORK=1TO500:NEXT:RETURN
1790 PRINT"▮▮▮▮▮    ▮▮▮▮"UN:PRINT"▮▮"TAB(20)"    ▮▮▮";UC:PRINT"▮▮▮▮▮▮▮▮▮▮▮▮▮▮▮▮
1800 FORJ=33368TO33767:POKEJ,32:NEXT:PRINT"▮▮▮▮▮▮▮▮▮▮▮▮▮▮▮":RETURN
1810 INPUT"▮HOW MANY MEN DO YOU ASSIGN TO THIS";N:RETURN
1820 PRINT"▮NOT ENOUGH MEN ASSIGNED":GOSUB1780:GOSUB1790:RETURN
1830 PRINT"▮YOU DON'T HAVE THAT MANY "N$;"S":GOSUB1780:GOSUB1790:RETURN
1840 PRINT"▮YOU DON'T HAVE THAT MANY MEN":GOSUB1780:GOSUB1790:RETURN
1850 PRINT"▮INSUFFICIENT":GOSUB1780:GOSUB1790:RETURN
1860 PRINT"▮YOU DO NOT HAVE ENOUGH CARTS":GOSUB1780:GOSUB1790:RETURN
1870 GETR$:IFR$=""THEN1870
1880 IFR$="Y"ORR$="N"THENRETURN
1890 PRINT"▮ANSWER Y OR N":GOTO1870
1900 PRINT"▮▮PRESS ANY KEY TO CONTINUE
1910 GETR$:IFR$=""THEN1910
1920 RETURN
1930 FORJ=0TO8:READMD(J):NEXT:RETURN
1940 PRINT"▮YOU HAVE LOST OVER HALF YOUR FORCE AND
1950 PRINT"THE REST HAVE MUTINIED. YOU HAVE BEEN
1960 PRINT"FED TO THE CAMP DOGS! YOU LOSE!
1970 PRINT"▮AFTER"DS"DAYS OF SIEGE. THERE ARE"AN
1980 PRINT"ATTACKERS AND"DN"DEFENDERS LEFT ALIVE
1990 END
```

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YC 11/81

W H Smith brings ZX-81s to the High Street

BY TIM HARTNELL

AFTER RELYING on mail order for 18 months, Sinclair Research has ventured into the retail field — via the giant newsagency chain, W H Smith. In 112 stores, Computer Know-How centres feature displays based around an operating ZX-81 which is backed up by computer magazines and books.

The agreement, which began in September, is for a trial period of 12 months. "Both parties view the agreement as an experiment", says Clive Sinclair, inventor of the ZX-81. "We accepted Smith's approach because they've clearly researched the subject carefully, and take the new operation very seriously".

Under the sales contract, W H Smith has established the computer departments in its stores, and although the company is selling a wide range of computer books and magazines, it is staying away from hardware — except for the ZX-81.

W H Smith has made the move into the computer field after its success with computer books and magazines. For several years, the only place you could find computer books was in specialist computer shops. Then, the retail chains discovered the appeal of computers and began to stock the magazines. Now, few of the specialist stores bother to stock the British monthlies, relying instead on issues of U.S. magazines and books. The same is unlikely to happen with computers, because both W H Smith and Sinclair Research believe they will be tapping a whole new market — one which would not consider buying by mail order.

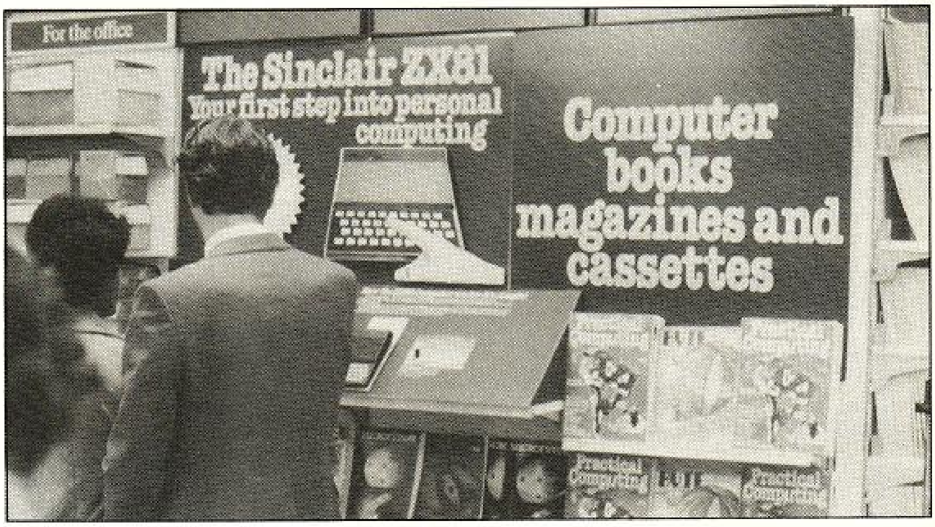
John Rowland, W H Smith market-development manager, said the company had decided to approach Clive Sinclair for the rights to sell the ZX-81, because Sinclair Research was the only company with "both a proven product available in the right quantities, and a proven sales record.

"Last year we started a small experiment with computer books and magazines", says Rowland, "and it worked well. So what we've done now is bring the computer-orientated publications together with an actual computer, to create the Computer Know-How section of the store".

Growing market

The first test market for computer products was the W H Smith store in the Brent Cross Shopping Centre. "We sold a good deal of books there", Rowland recalls. "We thought that we were at the beginning of something important, and that with suitable hardware, we'd have a combination which would prove successful".

Rowland says that the traditional strengths of W H Smith in selling books and magazines had increased in recent years with the development of the record and toy departments, the camera and film sections, and the small office and home products such as typewriters and calculators. Computers seemed the next logical step.



"We sell about 500,000 computer magazines a year", says Rowland. "CB is the latest boom, with a new magazine in the field just about every month, but computer magazines are very strong, and we expect this area to keep growing".

W H Smith started in the computer magazine field by importing magazines from the United States: "We had many American magazines", says Rowland, "and they sold very well". He says he found that the home-bred magazines quickly improved out of sight, and the need to import U.S. publications diminished.

As well as the ZX-81 and computer books and magazines, the Computer Know-How section of the W H Smith's stores sell blank cassettes at 50p as well as the Sinclair-produced software.

"We'll look at how the ZX-81 goes, and then decide if we want to carry other machines", says Rowland.

He is aware of the problems some people had had with early 16K memory packs, but says he has been assured by Sinclair Research that the problems associated with the RAMs had been ironed out.

"We'll be providing our own service on the computers, and related hardware", says Rowland. "The machines will be covered by our normal audio guarantee. We normally repair cassette recorders and the like within 24 hours, and we imagine we'll be able to do the same with the ZX-81. Of course, we've had no experience here — time will tell".

W H Smith has decided that if the ZX-81 experiment works, it could well become a major part of the company's marketing policy in the 1980s. The company believes that its strength in the book and magazine markets places it in a good position to attract potential purchasers of the machine.

W H Smith is aiming to sell as many machines during the five months' retail agreement as Sinclair Research sell in one month by mail order — about 10,000 computers a month.

Bewildering selection

W H Smith sees the back-to-school and Christmas trading periods as very important for ZX-81 sales. The company expects sales to grow slowly as people gradually became aware that it is selling the computer. Then, when Christmas gift-buying time arrives, W H Smith hopes people will automatically turn to their local branch as the source for the ZX-81.

About 300 W H Smith staff have been trained in the rudiments of the ZX-81. They have been shown how to plug in the machine, attach the 16K pack and the printer, and know the memory requirements of the five cassette software packs on sale. A number of magazines have been moved from the general magazine section to the Computer Know-How departments. These include *Your Computer,* and its sister publication *Practical Computing.*

A number of books — none of which has any particular relevance to the ZX-81 — are also on sale in the special computer areas. Some, such as *Illustrating Basic* and *Introduction to microprocessing* are likely to prove bewildering and worse than useless for first-time computer buyers.

If you are having problems with your mail-order ZX-81, do not try taking it into your nearest W H Smith claiming you bought it from there, and expecting to have it repaired. ZX-81s sold by W H Smith have a WH serial number. Staff have been told not to accept any ZX-81s without this serial number. ■

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	25	5.24
4116 150ns	1	1.15
	25	1.06
4116 200ns	1	0.80
	25	0.72
4118 200ns	1	3.90
	25	3.23
6116 200ns	1	10.95
2k-8	25	9.95
8264 200ns	1	12.00
64k-1	25	11.00
REGULATORS		
7805		0.50
7812		0.50
7905		0.56
7912		0.56
DIL SOCKETS		
8 pin		0.07
14 pin		0.09
16 pin		0.09
18 pin		0.15
20 pin		0.17
22 pin		0.21
24 pin		0.23
28 pin		0.25
40 pin		0.29

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ELECTRONICS FOR THE 80'S

JOYSTICK CONTROL FOR THE VIC~20

BY NICK HAMPSHIRE

TWO TYPES OF joystick can be attached to the Vic: a simple paddle-switch joystick, and a potentiometer joystick. The principal application for joysticks is in interactive games and simulation programs. They are used to control the position of some object on the screen. This can be either the cursor or special graphics charcters. Alternatively, the cursor can be used to change the viewing position, handling the joystick like the control stick on an aircraft.

Choice of joystick depends on the application intended. If you want fine positional control where a particular joystick position has a distinct value, a potentiometer joystick is required. If you just want to tell the computer which of eight directions you require, then a switch joystick is the best choice.

A switch joystick consists of four switches mounted at right angles to each other. The joystick handle is connected to a mechanism which allows no more than two adjacent switches to be closed at any one time. The joystick handle has nine possible positions:

- One with no switches closed — the handle is vertical.
- Four positions with one switch closed — handle in north, south, east and west positions.
- Four positions with two switches closed — handle in north-east, south-east, south-west, and north-west positions.

An extra switch is usually mounted on the end of the joystick handle; this is called the fire button and is usully used to indicate to the computer when the cursor or games figure is in the correct position on the screen.

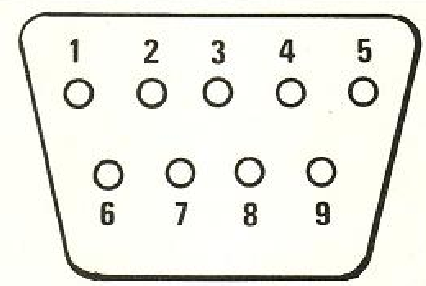
Each of the switches is connected to one of the I/O lines from the 6522 VIAs. Their connection and the pin assignation for the output connector on the Vic are shown in figure 1. The joystick switches are arranged as follows:

```
                    Top (north)
Fire button
Switch 4

                     Switch 0
                        !
                        !
                        !
Switch 2 - - - - - - - - - - - - - - Switch 3
                        !
                        !
                        !
                     Switch 1
```

Switches 0, 1 and 2 and the fire button are connected to lines from VIA # 1 and switch 3 to a line from VIA # 2. The VIA memory locations used by the switch joystick are:

Hex	Decimal	Function
\$9113	37139	Data-direction register for port A VIA # 1
\$9111	37137	Output register A bit 2 — joystick switch 0 bit 3 — joystick switch 1 bit 4 — joystick switch 2 bit 5 — Fire button
\$9122	37154	Data-direction register for port B VIA # 2
\$9120	37152	Output register B bit 7 — joystick switch 3



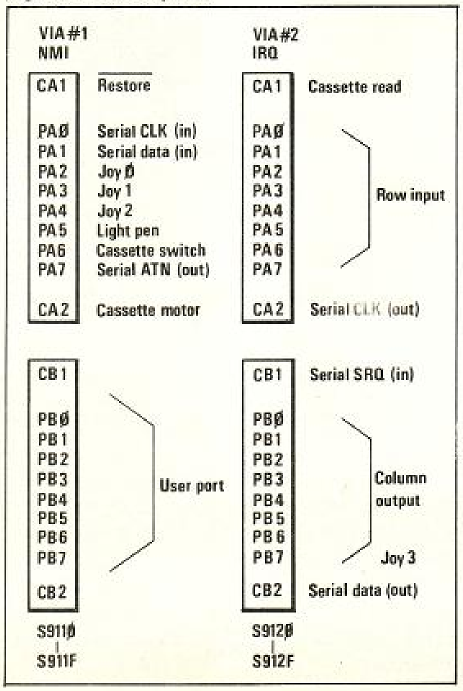
PIN#	TYPE	NOTE
1	JoyØ	
2	Joy 1	
3	Joy 2	
4	Joy 3	
5	Pot Y	
6	Light Pen	
7	+5V	Max1ØØmA
8	GND	
9	Pot X	

Figure 2. Game input/output on Vic-20.

To read the joystick-switch inputs, the I/O lines used must first be set into the input mode. This is done by setting the corresponding bit of the data-direction register to 0.

That poses one problem — the line used for joystick, switch 3 is also used for scanning the keyboard. Thus, the keyboard cannot be used in full at the same time as the switch joystick, and the data-direction register should always be restored to normal after the joystick is used.

Figure 1. Vic-20 ports.



The following program can be used to initialise the data-direction registers and input the switch position:

```
10 POKE 37139,0 : POKE 37154,127 : set up DDRs
20 S=PEEK (37137) : input from VIA # 1
30 S0=((S AND 4)=0) : switch 0
40 S1=-((S AND 8)=0) : switch 1
50 S2=((S AND 16)=0) : switch 2
60 F=((S AND 32)=0) : Fire button
70 S=PEEK (37152) : input from VIA # 2
80 S3=-((S AND 128)=0) : switch 3
90 POKE 37154,255 : restore keyboard function
```

The variables S0, S1, S2 and S3 will normally be 0 but if the joystick handle is pointed in that direction, they will have a value of either 1 or —1.

If the Fire button is pressed, the variable F will have a value of 1; otherwise, it will be 0. These variables can be used to decode the joystick into the following pattern:

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

The following program lines will convert the variables S0, S1, S2 and S3 into the values shown in the pattern which correspond to the handle position and store in variable P:

```
100 DATA 7,0,1,6,8,2,5,4,3 : data for joystick pattern
110 FOR I=0 TO 2
120 FOR J=0 TO 2
130 READ JS (J,I) : put joystick pattern into array
140 NEXT J,I
150 X=1+(S2+S3) : Y=1+(S0+S1)
160 P=JS(X,Y) : set P to joystick pattern value
```

Switch joysticks for the Vic are identical to those produced by Atari and these devices can be used. Potentiometer joysticks will be covered in the next issue. ■

COMAL'S CHALLENGE

BBC English is widely received as the language's standard. In the world of computer languages, however, BBC Basic does command the same position — many argued for the adoption of the structured language Comal and against the creation of just another Basic dialect. Clare Gooding reports.

THE BBC COMPUTER, most people seem agreed, is a good thing. It will certainly bring some understanding of computers and how to program them to people who would not otherwise have had a chance to find out — but many people in education are also saying that it is a chance lost.

The bone of contention is Basic — the language chosen as the teaching vehicle of the series of programmes scheduled to start in January 1982. Acorn, the small Cambridge-based company, commissioned to produce the machine and the language for the series, found itself at the centre of a fierce debate over the choice of language, originally planned to be a dialect along the lines of Microsoft Basic.

The strongest lobbyists are the champions of Comal, a language dating from the early seventies — not much younger than Basic — which started in Denmark as a teaching tool.

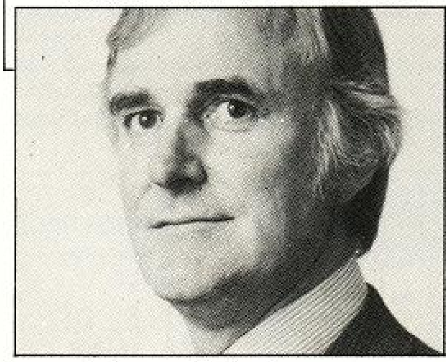
Comal — Common Algorithmic Language — developed from the ideas of one man, Borg Christensen, who was teaching computing at the State Teachers' College in Tonder, Denmark, in the early seventies. He designed Comal to combine the simplicity and ease of learning provided by Basic with the powerful control structures of Pascal.

Although he appreciated the simple syntax of Basic, he found that his students had the traditional problem of understanding programs which had been written some time ago: rather like unravelling a ball of wool with several ends.

The villain of the piece was the Goto instruction, which allowed programs to be written untidily with no clear flow of control. Goto was aided and abetted by meaningless variable names, which made debugging even more difficult.

Christensen resolved to build a language which would provide the structures which he found essential in teaching good programming habits. His priorities — to teach habits which would result in robust programs, easily read and understood by others long after they are written — were not so different from those

```
PRINT " **** ROULETTE **** "
REPEAT
  INPUT "How much money for playing - up to 100": cash
UNTIL  cash > 0 AND cash <=100
REPEAT
  win :=0; chance :=RND(1,36); oddch :=chance MOD 2
  REPEAT
    INPUT "Single number (1) or Odds/Evens (2)?": choice
  UNTIL  choice = 1 OR choice = 2
  REPEAT
    PRINT "You have "; cash; " pounds".
    INPUT "How much do you bet?": bet
  UNTIL  bet >0 AND bet <= cash
  cash := cash-bet
  CASE  choice OF
  WHEN  1
    REPEAT
      INPUT "Guess number 1 - 36" : guess
    UNTIL  guess >=1 AND guess <=36
    IF guess = chance THEN win :=35*bet
  WHEN 2
    REPEAT
      INTPUT "Type 2 far Odd, 0 for even ":guess
    UNTIL  guess = 1 OR guess = 0
    IF  guess = oddch THEN win :=2*bet
  ENDCASE
  IF win > 0 THEN PRINT "You win";win;"pounds"
  IF win = 0 THEN PRINT "You lose."
  cash := cash + win
  PRINT "You have"; cash;" pounds"
  INPUT "Type 0 to quit, 1 to continue":continue
UNTIL  cash <=0 OR continue = 0
```



The Comal roulette program and, left, chief U.K. proponent of the language, Roy Atherton.

drummed into professional programmers at software houses.

Comal spread extremely fast among educational users. Christensen himself is amazed at the way it has spread "from a corner of Denmark" to having strong following from all over Europe. Its main proponent in the U.K. is Roy Atherton of Bulmershe College in Reading, Berkshire, who explains how and why it became popular:

"First, Comal draws strength from two great traditions: the practicality of the Fortran/Basic line and the educational, and practical appropriateness of the Algol/Pascal development. Secondly, the strong grip of Basic was acknowledged and there was no confrontation, simply extension and infiltration".

So, Comal's origins and growth could not be more different from the grand strategy of BBC Basic: it grew under its own impetus, from one man's attempts to meet the needs of one group of students.

BBC Basic has already received its fair share of slung mud: the choice of the language followed the decision that there was to be a series broadcast by the BBC, teaching anyone with a TV set about computers. The series was going to use a small, cheap microcomputer which would be within the reach of a wide range of people.

The contract for the BBC machine and the language went to an innovatory company with a high concentration of brainpower: Acorn Computer. The decision was a controversial one, because so much depended on it. Not only was there at stake a lucrative income from inevitably huge sales of the BBC machine, but more important, the *lingua franca* of the huge number of new computer devotees.

The BBC's choice of machine was limited by one factor: the contract must go to a British firm. The language was chosen by the BBC to preserve the status quo rather than to in-

TO BBC BASIC

novate: the obvious choice was Basic whose most popular established dialect was the Microsoft one.

The BBC's decisions have been attacked from all sides, not just by the advocates of Comal. Clive Sinclair of Sinclair Research, which failed to win the contract itself, had hard words for the BBC's choice in his interview with *Your Computer* this September:

"What the BBC is doing it is doing badly, and it is damaging the whole progress of computers in this country. We have put a new version of Basic into our machines. It has been highly praised in the U.K. and abroad because of its editing facilities.

"It is silly to ignore progress. What the BBC has offered is Microsoft Basic. If we had wanted to use Microsoftware we could have bought it off the shelf for $10,000".

Acorn had to pull something better than Microsoft Basic out of the hat if it was going to forestall the cries of "I told you so". It is an unusual outfit, and it could probably only happen in Cambridge, where, as director Andy Hopper explained, if he cannot solve a problem for himself in a few hours, he pops across the road to have tea with a professor.

Acorn used technology which did not exist a year ago to create the BBC machine, and while it had to stick to the guidline specified by the BBC, there were ideas which Acorn was keen to implement to improve on Microsoft's Basic.

The person responsible for implementing the BBC Basic was Roger Wilson, one of the many people who have filtered across from the university to Acorn. Wilson is far from being a standard run-of-the-mill programmer: he knew machine code before taking his computing and mathematics course at Cambridge. To give an idea of his skill, he was responsible for a .5Kbyte monitor in his first job for Acorn: "It was written by hand in machine code, programmed in hex, and it worked first time", he says with justifiable pride. He probably would not approve of the description "genius", but he certainly has an infinite capacity for taking pains to ensure things are right.

At university, Wilson became acquainted with that elegant language Algol W, and also with BCPL, the portable systems programming language developed by Martin Richards at the Computer Laboratory in Cambridge. Both these, and the structured ideas of Pascal, have influenced his ideas on how flexible, powerful, and elegant a language should be.

The Basic version of roulette and, right, Chris Curry of Acorn.

Some of the quirky but useful functions in the original Acorn Basic developed from his BCPL influence. For example, in directional operators, where the contents of one value points to an address holding another. When he turned to the task of writing the BBC Basic, he had his rich source of experience and the strait-jacket of BBC specifications: "It was difficult to start again but I knew more about it and guided it towards Pascal. My level of interpreter skill was such that I could write a single-pass Pascal compiler".

Wilson had to work within the Microsoft framework — the one unavoidable stricture was that the Basic must be Microsoft-compatible. Acorn already had 12K of working language which could be "bent at will" for the BBC, and Wilson set about bending it towards Pascal, thrashing out the borderline with the advice of John Coll, consultant to the Micro Users in Secondary Education group, filtering out features to leave them with a core on which to build.

From that point, Wilson built a Basic interpreter with functions which behave like Pascal, including multi-line procedures and long verbal names: "There are few new statements but they are more powerful".

Unlike Comal, BBC Basic is hot off the press, and has had no chance to "infiltrate" the existing market on the strength of its virtues. It will have a hype which will easily exceed any publicity other languages might receive, and it stands a chance of becoming a *de facto* standard for the same reasons that Microsoft Basic was picked as a starting point in the first place: many people will be using it.

Like Comal, it owes much to Basic, and something to Pascal, and is a compromise rather than a major attempt at innovation. Basic and Comal share the same goal: to educate people who have had no prior contact with computing and programming skills. Comal attacks the root of programming, the way people think about problems, according to Roy Atherton.

He describes the six structures which he considers an essential part of problem analysis and program design: For-Next, Repeat-Until, While-Endwhile, If-Then-Else, Cases and procedures. These six can follow one another, be nested, or in the case of procedures, they can be defined and called.

The advantages he says Comal can offer over Basic derive mainly from these structures. Putting problems in these terms helps analysis, and means that a clear diagram or flowchart can be built which the actual shape of the written program closely shadows.

Such simple aids as indentation can be a great teaching aid, and teachers using Comal generally find that if there is a problem among the dreaded nested If statements, then it can be traced if the indentation does not "come home". The naming of procedures is also a helpful alternative to Gosub, and there is no danger of landing accidentally in the middle of a subroutine.

While Comal was developed in a small way, restricted to a sparsely-used micro, the RC

(continued on next page)

```
 10 REM Roulette test program to demonstrate the
 20 REM BASIC interpreter in action !!!!!!!!!
 30 beep$="":pad$=STRING$(10,""):bell$=CHR$(7):REM makes a noise
 40 CLS:PRINT STRING$(55,"*") " Roulette " STRING$(55,"*")
 50 REPEAT PRINT TAB(0,5);beep$+"How much money available"+pad$;
 60   INPUT TAB(POS-10,5),funds : beep$=bell$
 70   UNTIL funds>0 AND funds <=100 : beep$=""
 80 REPEAT  chance=RND(36) : odd chance=chance MOD 2
 90   PRINT ''"You have ";funds" pounds currently"
100   REPEAT PRINT TAB(2,10);beep$+"How much money to bet"+pad$;
110     INPUT TAB(POS-10,10),bet : beep$=bell$
120     UNTIL bet>0 AND bet<=funds : beep$=""
130   REPEAT PRINT TAB(3,12);beep$+"On which number"+pad$;
140     INPUT TAB(POS-10,12),guess : beep$=béll$
150     UNTIL guess>0 AND guess <=36 : beep$=""
160   odd guess=guess MOD 2
170   FORZ=0TO5000:NEXT:REM pause for 2.5 secs
180   reason$="You have lost your bet":win=0
190   IF guess=chance win=35*bet: reason$="WELL DONE !!!"
200   IF win=0 AND odd guess=odd chance win=bet: reason$="Odd/even only"
210   funds=funds+win-bet
220   PRINT reason$;:IF win<>0 PRINT", you have won ";win;
230   PRINT '"It was, of course, a ";chance
240   IF funds=0 PRINT"So you are wiped out":END
250   REPEAT PRINT TAB(O,18);beep$+Another go Y/N"+pad$;
260     INPUT TAB(POS-10,18),ans$ : beep$=bell$
270     UNTIL ans$="Y" OR ans$="N"
280   FOR line=9 TO 18:PRINT TAB(0,line) SPC(40);:NEXT
290   UNTIL an$="N"
300 PRINT "Finished with ";funds" Pounds"
310 END
```

(continued from previous page)
Piccolo, it has grown and is even becoming ambitious.

The interest in Comal has grown so quickly in the last year that Commodore was persuaded first to make a ROM version available — not very powerful as it left little room for manoeuvre — and then to start work on a RAM version.

The team at Acorn faced slightly different problems, namely a compromise which was not of their own making, and a huge audience to their efforts, clamouring for favourite whizzo features to be included. "We're trying to develop computer awareness", explains one of the team, Paul Bond. "The difficulty is talking to people who don't talk our langauge, and the compromise is fitting it into the space available while giving people what they want".

Roger Wilson probably would have started from a different point if it had been possible, but handicapped by the lack of any real informed guidance from the BBC, he has jettisoned as much as possible and worked in his own ideas on programming.

"You have to look at it from the point of view of the naive user without ignoring the needs of the more advanced users. The advanced utilities have to be provided in such a way that the beginners don't trip over them, while sophisticated users don't feel that it's a machine limited to beginners.

"At the same time, it's important to keep to the spirit of Basic, so that it isn't overloaded with facilities out of all recognition. That's the danger in building in features which other languages such as Comal and Pascal provide".

Bond adds: "People should be able to express themselves easily; one should try to cope with the way people think, and the way they would like languages to be, but one shouldn't try to create non-standard features for the sake of it".

Other features have been limited by the Microsoft/BBC strictures. Roger Wilson's original design included Pascal-like labels which the BBC dropped, and the If-Then-Else statement was limited to single-line format. The Basic can cope with numeric procedures preceded by the statement Proc, and includes a Repeat-Until verb for handing loops.

Many of the Microsoft pitfalls have been avoided: BBC Basic will not allow you to use a variable that has not been declared, so that "finger-trouble" variables are not created and set to 0. Instead, the user is alerted to the fact that there is no such variable declared and it must, therefore, be a keying error.

Integer handling has been improved, and far more emphasis put on function and decision handling. There are also features like in-string subscripting which can be powerful for text processing. As well as cramming in the Microsoft necessities and the Pascal-ish variations, Acorn has paid attention to the speed of the interpreter: "We've put in as much speed as possible", says Roger Wilson. "I did my best considering the limitations".

Roy Atherton has criticisms even for the parts of BBC Basic which have attempted to look like structures: "They are only three-quarters of the way there: the If-Then-Else is restricted, not global, and not laid out properly. The odd thing is that properly made procedures wouldn't be difficult to provide in Basic".

Borg Christensen is even more scathing: "In England you have a great tradition for good programming. Instead of seeing this, the BBC wants you to ape the Americans in a field where they are definitely bad, and where you could be very good. That many progams have been written in Basic, doesn't matter. They are very few compared to the immense number which are going to be written in the future. In Denmark we have learned that people will turn away from Basic if they are given something better: simultaneously easier and more powerful".

David Johnson-Davies of Acornsoft has solid reasons why Comal would not do for the BBC machine, apart from the necessity of Microsoft compatibility: it is a very large language, and not compatible with existing Basic. While the recently-released Comal-80 from Metanic occupies 36K to Acorn Basic's 16K, Christensen contends that the early versions of Comal including Goto, Gosub, Return and On Goto, which are all redundant statements by Comal standards, only took 12 percent more space than the Basic interpreter — presumably the RC7000s. Basic is said to be a subset of Comal much as Microsoft Basic is a subset of BBC Basic: you can restrict yourself to it if you wish.

Roger Wilson's objections to Comal are that apart from its unacceptable size, it is limited in its mathematical functions, and only a small subset of Comal statements can be used in the interactive command mode. He does not like the frequent use of semicolons, and he points out that Comal will not do type conversion if an integer becomes a real number, nor can the Comal Len — length of string — function find the length of sub-strings, only string variables, both of which he finds strange.

Roger Wilson and Roy Atherton agreed to illustrate their protegés by writing programs in BBC Basic and Comal from the same specification. It is dangerous to compare the abilities of the two languages on the strength of one very limited illustration, but to give examples of how the two languages deal with the same problem at least show the difference in approach.

There are features which are fundamental to the different styles of the two, like numbering and having more than one statement to a line, on which the champions of both languages will never agree: structures are the main stumbling block.

"Why not go the whole hog and use Pascal"? asks the Acorn faction. "Because Comal is simpler", reply the Comal-ites, and there the two engage in a conflict about what is simple and what is not. The arguments will probably still be going when BBC Basic has established its own niche.

Meanwhile, it seems fair to give the last word to Roger Wilson and Acorn: they have all been a little too busy working on the project to answer the bad press and criticism they have received: "While Comal's structure is better than Basic, it cannot compete with Basic for straightforward ease of use and small size. Perhaps Comal is better than the BBC realised, but on the other hand, our Basic is far more powerful than people seem to think". ■

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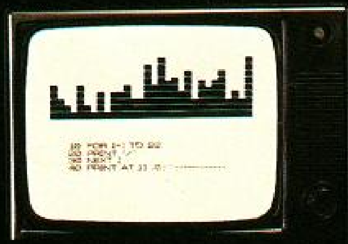

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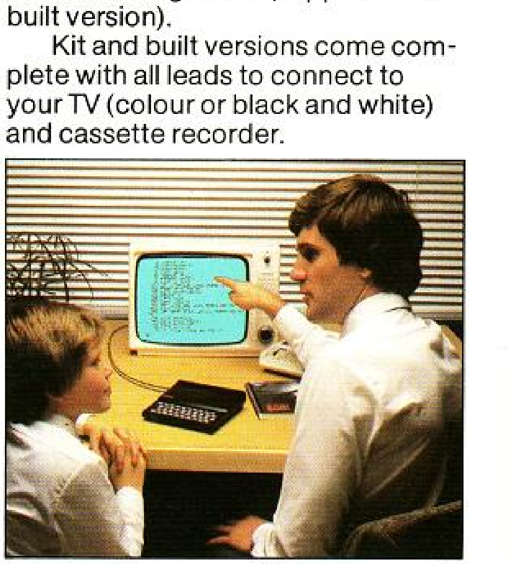
You'll be surprised how easy the ZX81 kit is to build: just four chips to assemble (plus, of course the other discrete components) – a few hours' work with a fine-tipped soldering iron. And you may already have a suitable mains adaptor – 600 mA at 9 V DC nominal unregulated (supplied with built version).

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



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Available now- the ZX Printer for only £49.95

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

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

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

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

Printing speed is 50 characters per second, with 32 characters per line and 9 lines per vertical inch.

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

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

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

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

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

How to order your ZX81

BY PHONE – Access, Barclaycard or Trustcard holders can call 01-200 0200 for personal attention 24 hours a day, every day.

BY FREEPOST – use the no-stamp-needed coupon below. You can pay by cheque, postal order, Access, Barclaycard or Trustcard.

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

To: Sinclair Research Ltd, FREEPOST 7, Cambridge, CB2 1YY.

Qty	Item	Code	Item price £	Order Total £
	Sinclair ZX81 Personal Computer kit(s). Price includes ZX81 BASIC manual, excludes mains adaptor.	12	49.95	
	Ready-assembled Sinclair ZX81 Personal Computer(s). Price includes ZX81 BASIC manual and mains adaptor.	11	69.95	
	Mains Adaptor(s) (600 mA at 9 V DC nominal unregulated).	10	8.95	
	16K-BYTE RAM pack.	18	49.95	
	Sinclair ZX Printer.	27	49.95	
	8K BASIC ROM to fit ZX80.	17	19.95	
	Post and Packing.			2.95

☐ Please tick if you require a VAT receipt

TOTAL £ ______

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

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

*Please delete/complete as applicable.

Please print.

Name: Mr/Mrs/Miss

Address:

FREEPOST – no stamp needed.

YOC 11

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ZX81

6 Kings Parade, Cambridge, Cambs., CB2 1SN. Tel: (0276) 66104 & 21282.

How the ZX81 compares with other personal computers

SYSTEM IDENTIFICATION		ZX81	ZX80	ACORN ATOM	APPLE II PLUS	PET 2001	TRS 80 LEVEL I	TRS 80 LEVEL II
ROM		8K	4K	8K	8K	14K	4K	12K
GUIDE PRICE	Basic unit – inc. VAT	£70	£100	£175	£630	£435	£290	£375
	Unit plus 16K RAM (*12K RAM)	£120	£150	£285*	£630	£530	£360	£375
COMMANDS	LIST, LOAD, NEW, RUN, SAVE	●	●	●	●	●	●	●
STATEMENTS	PRINT, INPUT, LET, GOTO, GOSUB/RETURN, FOR/NEXT IF/THEN	●	●	●	●	●	●	●
	STEP	●		●	●	●	●	●
	TAB	●			●	●	●	●
ARITHMETIC	ABS, RND	●	●	●	●	●	●	●
FUNCTIONS	INT	●			●	●	●	●
	ATN, COS, EXP, LOG, SGN, SIN, SQR, TAN	●			●	●		●
	ARCSIN, ARCOS	●						
STRING	CHR$	●	●		●	●		●
FUNCTIONS	LEN	●		●	●	●		●
	ASC(CODE), STR$, VAL, INKEY$	●				●		●
NUMBERS	FLOATING PT $\pm10^{\pm38}$	●			●	●	●	●
	INTEGERS		●	●	●	●		●
NUMERIC	A-Z			●			●	
VARIABLES	AA-ZØ				●	●		●
	An-Zn, n=any alphanumeric string	●	●					
STRING	A$ & B$						●	
VARIABLES	A$ to Z$	●	●	●				
	An$ to Zn$ n=any alphanumeric character				●	●		●
NUMERIC	SINGLE DIMENSIONAL		●	●			●	
ARRAYS	MULTI DIMENSIONAL	●			●	●		●
DISPLAY	ROWS	24	24	16	24	25	16	16
	COLUMNS	32	32	32	40	40	64	64
	LOW RES GRAPHICS (<7000 pixels)	●	●	●	●	●	●	●
	HI RES GRAPHICS (>40000 pixels)			●	●			
SPECIAL	USR (CALL, LINK)	●	●	●	●	●		●
FEATURES	PEEK, POKE (OR EQUIV)	●	●	●	●	●		●

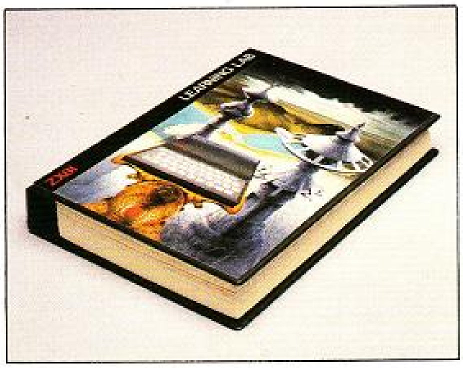
Sinclair software on cassette.

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

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

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

The ultimate course in ZX81 BASIC programming.



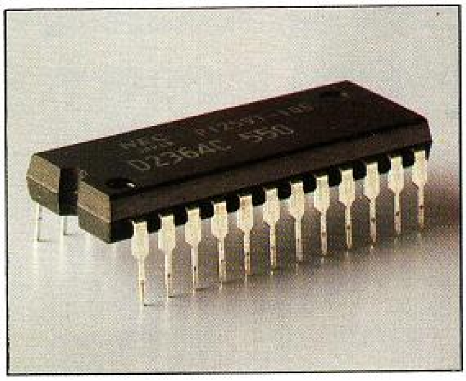
Some people prefer to learn their programming from books. For them, the ZX81 BASIC manual is ideal.

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

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

Full details with your Sinclair ZX81.

If you own a Sinclair ZX80...



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

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

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ZX81

**6 Kings Parade, Cambridge, Cambs., CB2 1SN.
Tel: (0276) 66104 & 21282.**

ZX BOOKS

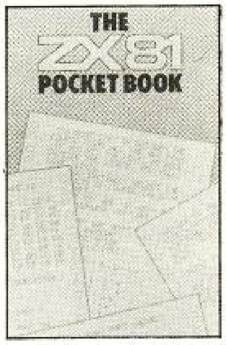
The success of Sinclair's ZX-80 and ZX-81 has led to the publication of an astonishing number of books. Martyn Thomas helps you pick your way through the ZX library with his comparison of 15 of the main titles.

THERE ARE a number of things you should have clear about yourself, and about your computer, before you try to pick the books which will be of most help and interest.

Some books were written for the ZX-80 and appeared before the ZX-81 was widely available. Some of the ZX-81 books deal in detail with the facilities of the new 8K ROM for the ZX-80, some are rather more sketchy — depending we suspect, on which computers the authors had available. Some books assume you have the memory extension packs: the better games in particular all require more than the basic 1K systems.

Then there are your own skills and ambitions. Are you looking for a book of programs, so that you can play with your computer and impress the neighbours without learning a line of Basic? Or, at the other extreme, do you want to learn in detail how the monitor works so that you can include calls to useful ROM routines in your own machine-code programs?

First, let us examine the Sinclair manuals. The ZX-80 was supplied with a rather poor manual, which contained a description of how to set up the computer, a brief introduction to each of the Basic statements, and little else. There was a section describing the action of the Basic interpreter and the organisation of the systems variables, but it required considerable previous experience to interpret

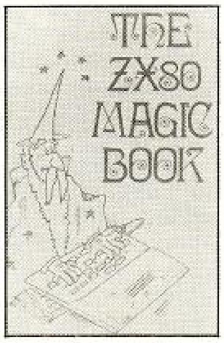


usefully although it was invaluable to experienced programmers. The ZX-80 manual was badly bound, too, and tended to fall apart if used often.

By comparison the ZX-81 manual is very good. It is spirally bound, far more robust and more substantial. The extra space is used for a much fuller explanation of the Basic commands and for an introduction to machine-code programming using USR. However, no attempt is made to explain what the machine instructions actually do.

ZX-81 Basic is, of course, a larger language than ZX-80 Basic, so this, too, accounts for some of the extra pages. The ZX-80 manual was rather limited as an introduction to programming for a complete beginner, so many of the books which were published for the ZX-80 users contained some extra programming instructions.

The ZX-81 manual, however, provides enough explanation and exercises to enable most users to learn to program after a fashion, by following this text alone. We recommend that you become thoroughly familiar with the Sinclair manual for your ZX-80 or ZX-81 before you rush out to buy another book. There is a great deal of valuable information



to be learned from both. Do not take all the ZX-81 exercises seriously, however — particularly not exercise 4 on page 111.

For the rest of this review, we shall presume that you have digested your Sinclair manual and you are still not satisfied. What other books are available, what do they contain, and how useful will they be to you?

Four of the books we reviewed are really useful only to owners of original ZX-80s with the 4K integer Basic ROM. The first, the *ZX-80 pocket-book*, is a helpful handbook written at a basic level. The author, Trevor Toms, sets out to build on the knowledge you will have gained from reading the Sinclair manual and shows you how to write better and more successful programs by planning ahead and by adopting various tricks of style.

It also contains 12 reasonably good games, showing how much and how little can be squeezed into the 1K RAM of the unexpanded ZX-80. The de luxe versions of some games, for larger RAM sizes, should encourage RAM sales.

The *ZX-80 pocket-book* explains how machine code can be loaded into ZX-80 RAM and executed, but it does not provide any tuition in machine-code programming, so the reader seeking that knowledge must turn elsewhere. Overall, this can be seen as the book which turns the Sinclair ZX-80 manual into the book it should have been.

The second book, *Hints and tips for the ZX-80*, contains precisely what its title suggests, a collection of useful tricks for making programming easier and programs shorter and faster. It is clearly the result of a great deal of thought, insight and experimentation with the ZX-80, and represents a very inexpensive way of acquiring the benefits of months of programming experience.

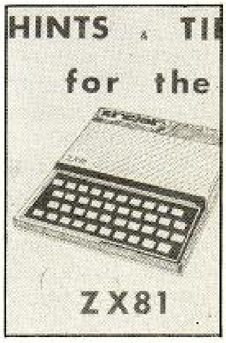
This book is privately printed, from a normal typewriter script, and is only 48 pages long. It is, however, most informative, though, and mostly accurate — although the listing on the last page contains a Gosub to a line which has to be retrieved from a program listing two pages earlier.

The useful routine listings include a renumber routine and an active display. Unfortunately, the description of each routine concentrates only on essentials, so an opportunity of teaching more general programming techniques by example is missed.

The third of these ZX-80 books is the *ZX-80 Magic Book*. It is an odd collection of simple games and more unusual and advanced routines, interspersed with discussion on topics such as plotting graphs, and random numbers. There are interesting articles on improving the television display with the help of a soldering iron and adding extra memory and input-output.

Among the other games is an unconventional routine which allows you to generate music and record it on tape through the cassette interface. No other book offers this, and although as presented the routine allows you to generate only pre-composed programs, it would be possible to modify it to allow keyboard entry. So if you see yourself as the next Stockhausen, perhaps this book is for you.

The last book in this section is very special and most highly recommended. Ian Logan's *ZX-80 Monitor Listing* lists the 4K monitor of the ZX-80 in hexadecimal and in Z-80 machine instructions, divides it into sections of functions and offers a brief description for



each. It is hard to understand why Sinclair does not make this book and a ZX-81 equivalent freely available.

A good understanding of the way in which the ROM achieves its miracles, and particularly of how calls to ROM routines can be incorporated in programs, greatly increases the power of the computer and the scope of programs which can be written for it.

The books in this section are essentially books for the 4K ROM ZX-80 although they have been updated with some details of the 8K ROM. The first, *Learning Basic with your Sinclair ZX-80*, is the only book in this review from a mainstream book publisher, Newnes Technical books, an imprint of Butterworths, better known as publishers of the *All England Law Reports*. This shows clearly in the excellent quality of type and binding, photographs and line diagrams.

The text is, indeed, a tutorial text in Basic using the ZX-80. It is very gentle, very easy, and will be found most suitable for anyone who is finding the Sinclair manual rather hard

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to understand. The author, Robin Norman, includes 14 programs. They are mostly games, but they serve well as examples of programming techniques and the documentation for each one is particularly good.

This book is strongly recommended for complete beginners, and will be found valuable even for new ZX-81 owners. A single-page appendix describes the ZX-80 8K ROM thus justifying the book's inclusion in this section.

Our second ZX-80/ZX-81 book is the second edition of the *ZX-80 companion*, from the excellent Linsac team of Bob Maunder, Terry Trotter and Ian Logan. This is a superb introductory book for ZX-80 users who want to become serious programmers, especially if they have an interest in machine-code programming.

There is considerable explanation of the basic theory of computers, a good summary of ZX-80 Basic, interspersed with detailed explanations clearly marked as intended for advanced users. A good description of the 4K monitor offers examples of how the monitor subroutines can be called usefully from Basic programs. Combined with Ian Logan's full monitor listing described, this really is the key to the fullest possible use of a 4K-ROM ZX-80.

The last chapter contains seven games from the Linsac catalogue. A four-page appendix describes the 8K ROM, including a sample program to illustrate the moving display.

Making the most of your ZX-80 is the last of our ZX-80 books which make passing referece to the 8K ROM. Written by Tim Hartnell of the National ZX-80 and ZX-81 users' club, this book aims to remove the feelings you may have developed that the ZX-80 is a rather limited computer and less impressive than you had hoped.

It achieves this by means of more than 60 programs, each interesting in itself, and each introducing a new feature of the ZX-80. In this way, the reader learns new features of ZX-80 Basic painlessly. The idea is reasonable, in practice, things do not work out quite so well.

The games do not use the full power of the ZX-80 and are limited — they are all games, despite claims made in the section "The ZX-80 as teacher". The documentation of each program is less useful than it could be — fewer programs, better described, would be an improved formula — and the style of many games is rather juvenile.

Now let us turn to ZX-81 books which are also suitable for 8K-ROM ZX-80s. The six books in this section are mostly updated or upgraded versions of books reviewed earlier. Tim Hartnell takes the prize for the most prolific author, the first three of the six books are written partly or wholly by him.

The first is *Getting acquainted with your ZX-81 and new-ROM ZX-80* and contains 75 programs including a reasonable program to play draughts. As might be expected, the greatest changes in the style of programs written for the ZX-80 is that far better use is made of the display. The basic 1K-RAM ZX-81 is even more limited in capacity than the 1K-RAM ZX-80, so all interesting games rely on the availability of more memory.

50 rip-roaring games for the ZX-80 and ZX-81 has been included in this section as an honour even though the programs are written for the old-ROM ZX-80 since instructions are given for converting them to the ZX-81 or new ROM.

The programs really are most impressive, compressing more into 1K of old-ROM ZX-80 RAM than I would have thought possible. There is even a 1K version of draughts and a program to generate music. Strongly recommended as an alternative to selling your ZX-80 if you think you have outgrown it and need a ZX-81. Recommended, too, to ZX-81 owners: the exercise of converting the programs will be instructive, and the results will be well worthwhile. You will really need the 16K RAM pack or extra 1-3K on the 8K-ROM ZX-80, though.

Stretching your ZX-81 or ZX-80 to its limits follows the earlier Tim Hartnell and Trevor Sharples formula of teaching by example, painlessly, while you are playing interesting games. Assuming you have some knowledge of Basic, you should have little trouble making these games work on your computer, although we feel the authors have been lazy in not annotating each program clearly with the ROM and minimal RAM requirements.

The ZX-81 pocket-book is Trevor Toms' update of his ZX-80 book completely written for the 8K-ROM ZX-80 and ZX-81. It is an excellent companion, again building on the knowledge of Basic you will have gained from the Sinclair manual, and benefiting greatly from the additional power the 8K-ROM machines have.

Whereas the *ZX-80 pocket-book* was rather fundamental and simple, the *ZX-81 pocket-book* contains a great deal of valuable hints, tips, experience and program fragments while remaining easy to read. The last chapter of this book contains guidelines for writing a ZX-81 version of Adventure — justifiably the best-known and most popular computer game. There is even a complete version of Adventure for those fortunate enough to have the 16K RAM pack. This book is strongly recommended.

Hints and tips for the ZX-81 is again an updated and re-written version of an earlier ZX-80 book. The author, Andrew Herson, has concentrated on techniques for making maximum use of the basic 1K-RAM ZX-81, so all the programs given run on this unexpanded machine. In addition, the section on machine-code programming has been expanded to 27 pages, containing a description of the Z-80 architecture, the instruction set, and how to write machine-code routines.

The final book is the latest from Linsac, the *ZX-81 companion* written by Bob Maunder. This is an excellent introduction to the advanced features of the ZX-81, well up to the standard of their earlier books.

Chapter four provides the very first listing of the 8K-ROM monitor, with useful routine entry points and descriptions. Once again, Linsac has produced the book for the serious end of the market — the programmer rather than the game player.

CONCLUSIONS

- The ZX-81 is a better machine than the 8K-ROM ZX-80 by a great amount — all the authors seem agreed about this.
- You really need the 16K RAM pack for the ZX-81 if you plan to do any serious programming; 1K of RAM is simply not enough.
- Suprisingly, none of the books reviewed could be described as bad — unlike many books on other microcomputers. You will find each provides a satisfactory amount of enjoyment and information.
- However, the Tim Hartnell series seems aimed at the games-player whereas the Linsac books are far away the best for serious programmers.
- Do not overlook *Hints and Tips* books — both are good value and quite fascinating.

THE BOOKS

The ZX-80 pocket-book, by Trevor Toms. Available from Phipps Associates, 3 Downs Avenue, Epsom, Surrey KT18 5HQ. 03727-21215.

50 rip-roaring games for the ZX-80 and ZX-81, edited by Jeff Weinrich. Available from Database Consultancy, 105 Fairholme Avenue, Gidea Park, Romford. £4.95.

Stretching your ZX-81 or ZX-80 to its limits, by Trevor Sharples and Tim Hartnell. Available from Computer Publications, Unit 3, 33 Woodthorpe Road, Ashford, Middlesex, TW15 2RP. £6.95.

Hints and tips for the ZX-80 by A D Hewson and J S Heson. Available from Hewson Consultants, 7 Grahame Close, Blewbury, Oxfordshire, OX11 9QE. 48 pages. £3.50 including postage.

Learning Basic with your Sinclair ZX-80 by Robin Norman. Newnes Microcomputer Books (Butterworth & Co). 153 pages. ISBN 0 408 011017.

The ZX-80 Magic Book. Available from Timedata Limited, 57 Swallowdale, Basildon, Essex SS15 5B2. 64 pages. £4.75 including postage.

Getting acquainted with your ZX-80 and new-ROM ZX-80, by Tim Hartnell. Published by Database consultancy, 105 Fairholme Avenue, Gidea Park, Romford. 120 pages. ISBN 0907563 01 5.

The ZX-80 companion, second edition, by Bob Maunder, Terry Trotter and Ian Logan. Published by Linsac, 68 Barker Road, Middlesbrough TS5 5ES. 128 pages. £7.95 but currently out of print.

The ZX-80 monitor listing (4K version) by Ian Logan. Published by Linsac, 68 Barker Road, Middlesbrough TS5 5ES, 30 pages. £5.95.

The ZX-81 companion, by Bob Maunder. Published by Linsac, 68 Barker Road, Middlesbrough TS5 5ES. 131 pages. £7.95 including postage.

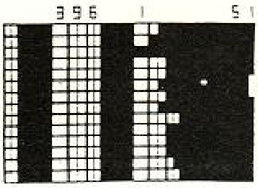
Making the most of your ZX-80, by Tim Hartnell. Published by Computer Publications, Unit 3, 33 Woodthorpe Road, Ashford, Middlesex, TW15 2RP. 108 pages. ISBN 0 907442 00 5.

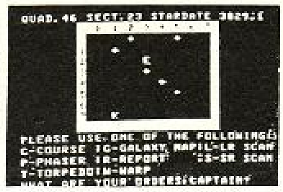
ZX-81 Basic programming, by Steven Vickers, Sinclair Research Limited. 212 pages, supplied with ZX-81 computers.

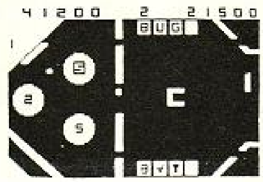
Hints and tips for the ZX-81, by Andrew D Hewson, available from Hewson Consultants, 7 Grahame Close, Blewbury, Oxfordshire OX11 9QE, £4.25 including postage.

The ZX-81 pocket-book, by Trevor Toms. Published by Phipps Associates, 3 Downs Avenue, Epsom, Surrey KT18 5HQ, 136 pages. ■

Acorn Atom software on cassette







OLD FAVOURITES

LABYRINTH 12K, BASIC, Gr.2A, sound, FP – High resolution 3D colour graphics! £6.95

BACKGAMMON 7K, BASIC – Challenge your Atom to a game – can you beat it? £7.00

★ PLEASE NOTE – 50% of the takings from BACKGAMMON will be donated to LEUKAEMIA research & treatment, so please help.

LAST RUN 7K, BASIC, sound – A compulsive game requiring fast reactions and good nerves! £3.00

RHINO & WIGGLE 10K, BASIC, sound, FP – Two highly entertaining games for the price of one £5.00

STATISTICS 12K, BASIC, FP – A set of 4 programs covering mean, variance, Standard intervals, Student's t-Test (Paired & unpaired samples), Chi squared test, Linear regression analysis – complete package with documentation, price £20.00

Make cheques payable to "BUG-BYTE"

NEW RELEASES

INVADERS 12K, m/c, Gr.4, sound – The original and best version £8.00

PINBALL 6K, m/c, Gr.2, sound – Packed with features, 1 or 2 players £4.50

STAR TREK 12K, BASIC & m/c, sound, FP – Fantastic real-time version £5.00

BREAKOUT 4K, m/c, Gr.1, sound – This will keep you frustrated for hours! £4.00

FRUIT MACHINE 8K, BASIC & m/c, Gr.2, sound – Spinning reels, hold, nudge etc. £4.00

DISASSEMBLER 4K, BASIC – Invaluable machine code aid £4.00

UFO BOMBER 7K, BASIC, sound – entertaining space game with great sound effects £4.00

LUNAR LANDER 12K, BASIC & m/c, Gr.4 – Gets harder as you get better – fantastic graphics £5.50

GOLF 6K, BASIC, FP – The only thing missing is the 19th hole! £5.00

"THE ATOM" Bi-monthly magazine written exclusively for Atom users containing high-quality, TESTED programs, features etc. ANNUAL SUBSCRIPTION (6 issues) ONLY £3.95 inclusive.

All figures refer to TOTAL memory required. **ALL OUR PRICES ARE INCLUSIVE!**

BUG-BYTE SOFTWARE

98-100 THE ALBANY
OLD HALL STREET
LIVERPOOL L3 9EP

Sinclair ZX81 software on cassette

ZXAS
MACHINE CODE ASSEMBLER

Now you can you can use the full power of the Z80 microprocessor without having to laboriously POKE in instruction codes. This full specification Z80 assembler assembles all the standard Zilog mnemonics, which are simply written into REM statements (more than one per line is allowed) within your BASIC program. When assembled, the assembly listings, together with assembled codes and addresses, are displayed on the screen. The assembled code is executed by USR. The program occupies 5K, and is situated at the top of the memory, and is protected from overwriting. This means that ZXAS may be used in conjunction with ZXDB (see below), providing an extremely powerful machine code system normally only found on very expensive computers.

The program is available for both the ZX81 and 8K ROM ZX80, and in both cases, the 16K RAM pack is required. Despite the exceptionally low price, ZXAS is a FULL-SPECIFICATION assembler, and is a must for all serious ZX users. Full documentation on how to use the program (including a list of the mnemonics) is supplied.

PRICE STILL ONLY £3.95

NEW ZXDB

The perfect complement to the ZXAS assembler, ZXDB is a complete combined machine code disassembler and debugging program. Like ZXAS, it is itself written in machine code for compactness, and may be used in conjunction with ZXAS, still leaving about 9K of memory for your own program.

Apart from the DISASSEMBLER, the program has features including SINGLE STEP, BLOCK SEARCH, TRANSFER AND FILL, HEX LOADER, REGISTER DISPLAY and more, all of which are executed by simple one key commands from the keyboard. All in all, an extremely powerful programming aid, well worth the money for the disassembler alone!

PRICE ONLY £5.95

PROGRAM PACK 1

(for 1K ZX81 & 8K ROM ZX80)

8 compact and entertaining programs for unexpanded ZX81, including DIGICLOCK, CATCH, GOBBLER, REACTION TEST, SKETCHPAD.

Fantastic value at £3.50

PROGRAM PACK 2

(for 16K ZX81)

Four programs for the expanded ZX81 – OXO (against the ZX81), PONTOON (against the ZX81), FRUIT MACHINE (with hold & nudge), and BIO-RHYTHMS. ONLY £3.50

PROGRAM PACK 3

(for 1K ZX81 & 8K ROM ZX80)

Three amazingly compact machine code programs with fast moving graphics; ASTROPILOT, AUTOMATIC GRAPHIC GENERATOR and ROADRACE.

PRICE ONLY £4.50

PROGRAM PACK 4

(for 16K ZX81 & 8K ROM ZX80)

To highly entertaining and addictive games for the expanded ZX81, written in machine code (so they're fast) – ASTEROID BELT and SURROUND.

ONLY £4.50

BREAKOUT

This cassette contains two programs – ZXBREAKOUT and ZXBRIKTHRU, both of which fit into the unexpanded ZX81, and are based on the popular arcade game. Fast moving grapics, highly entertaining.

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PROJECT

AN INTERPRETER FOR THE

Beginning with an explanation of the principles used to translate high-level languages into machine code, John Dawson continues his series by outlining the structure of a control-orientated interpreter.

IN THE SERIES so far, we have looked at the general principles of closed-loop feedback systems and the similarities between control systems in biological and computer applications.

In the first article, I showed how a radio transmitter could be used to send one form of control information from a computer to a remote device. In the second article, I presented some ideas for interfacing the signal from a radio-control receiver to a hefty DC motor.

I used a common-or-garden car windscreen wiper motor and a comparatively simple electronic circuit to show how an effect — regulating the speed of a DC motor — can be achieved with the minimum cost and time spent in construction.

The extent to which you may wish to go beyond the ideas in the article to a finished, definitively-engineered product is entirely up to you — there are many reference works on control electronics which will help you to improve, say, the pulse-width modulation circuit. You might, for example, include feedback control of the motor speed to make it independent of the load on the motor.

Exhausted by analogue electronics and metalwork, this month we shall examine the foundations of a control-orientated interpreter for the Microtan. I shall indicate which sections of the machine code are specific to the Microtan so that those with access to other machines with 6502 CPUs may modify the code accordingly.

Some form of go-between is required to cross the no man's land between the language of humans and the internal machine-code instructions obeyed by a computer. People recognise and understand the relationships between numerals, characters and symbols; the internal store of the computer, the various electronic circuits and logic elements are able to respond only to binary patterns of on or off electrical impulses.

The binary machine-code instructions used by a computer are known generally as object code, while a series of instructions written in a high-level language is known as source code.

The purpose of every language other than machine code is to create a bridge between instructions we can write and recognise and

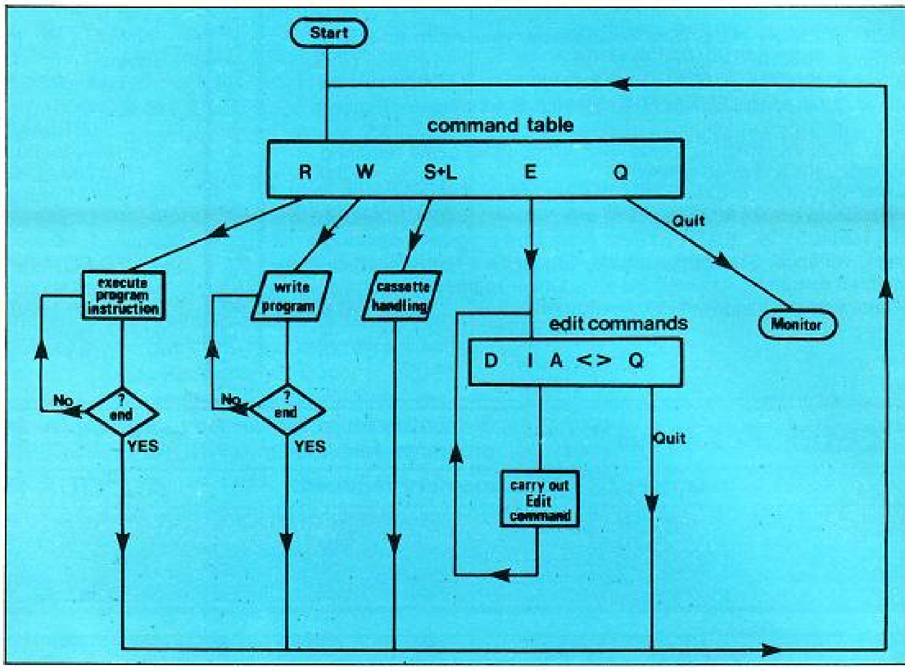


Figure 1. The minimum elements for a high-level interpreter.

the binary machine code which will achieve the desired effect. A program written in Basic will calculate results through a series of machine-code instructions which are invisible or transparent to the user.

There is a hierachy of computer languages ranging from fundamental machine code, in which each instruction entered by the operator produces one instruction to be executed by the computer, to high-level languages where a spoken command may initiate sustained computing activity.

For example, reports from the States already suggest that intelligent microwave ovens are a distinct possibility. The oven would contain a program to allow it to respond to the instruction sequence:

"Cook the pork casserole for 10 minutes or until the thermometer probe has reached 110 degrees for three minutes. Tell me when it's done — I'm in the sitting room".

"Cook" is a reserved word in this instruction sequence and "pork casserole" a variable. "thermometer probe" is an input device and the alert at the end of the process is to be routed to an output device in the sitting room.

There are many high-level computer languages and it is possible to debate endlessly and fruitlessly which is the best language. There is no best computer language — computers exist to solve problems and a computer language is purposeless until put to some task. Certain languages are more successful for some applications than others.

Cobol, or COmmon Business-Orientated Language, was designed for general commercial use, originally under the sponsorship of the U.S. Department of Defense. Program steps in Cobol are specified by means of instructions expressed in stylised English statements which can be recognised by the compiler and translated into a sequence of machine-code instructions.

The program statements consist of reserved words which have a special significance, enabling the compiler to generate the appropriate machine instructions for the particular operation required, and identifying labels used by the programmer to refer to units of data. For example, the Cobol statement:

Add London-weighting To Salary

uses the reserved words "Add" and "To" to generate the machine coding which will perform an addition in which a quantity, London weighting, is added to another quantity, Salary.

Specialised, high-level languages have been written for many purposes such as engineering design tasks, medical information storage and retrieval, the control of British Telecom's new automatic telephone exchanges, and scientific and industrial control applications.

High-level languages fall into two groups; interpreters and compilers. Some languages may be available in both forms. I have used the word "compiler" already and there is an important distinction between the two types of high-level languages.

The way in which an interpreter works is

6502 CPU BY JOHN DAWSON

illustrated later in this article; in contrast, a compiler works through the source code and generates a complete set of machine-code instructions before the program is executed. The high-level source program can be erased from the computer memory before the program is run.

Compiled programs execute faster than interpreted ones because the computer does not have to keep referring to the high-level source code to discover which trick it is expected to perform next. Interpreted programs, on the other hand, are generally easier to correct and edit.

These sweeping generalisations overlook the fact that you could spend most of a three-year university course examining the nuances of various computer languages. Nevertheless, our definitions contain the kernel of the difference between interpreters and compilers.

Figure 1 is an outline illustration of the minimum elements necessary for a high-level interpreter. The following functions constitute the core of any interpreter:

- The programmer must be able to write a new set of instructions into the computer to create a source code for a particular applications.
- The interpreter must have a facility for running the program, directing the computer into sequences of machine-code operations by sequentially examining one source-code instruction after another.
- For anything but the most trivial work, an interpreter must be able to offer facilities for permanently storing a source-code program on tape or disc. Having stored the program, it must be able to retrieve it and load the program from cassette tape or disc back into the computer.
- Most programs require editing either to correct faults or to extend the program's application, and a minimum set of commands for modifying the source code is set out in the edit-command table of figure 1. The interpreter should be capable of Deleting or Inserting material in the source-code program; of Appending new material to an existing program; of moving a cursor to different parts of the program so that one of the previous operations may be carried out. One further function is required — a command to Quit editing the stored program, returning control to the main command loop.

Figure 2 illustrates the operation of a high-level interpreter. Imagine that the oval path in the diagram is a race track. Each of the source-code instructions, starting at the beginning of the program, is picked out of the computer memory and taken round the looped track like a baton carried by a runner.

If the instruction matches one of the instructions or reserved words in the machine's repertoire, a sequence of machine-code operations achieves the effect specified by the high-level instruction. Program control in the computer then returns to pick up the next source-code instruction.

If there is no match between the instruction picked from memory and any one of the list of reserved words in the computer's interpreter, then point E has been reached and it is likely that an error message will be printed, typically

SYNTAX ERROR

There are several subroutines which will be used time and again by different parts of any interpreter. Many of these subroutines move data into the machine from the user and display information in an orderly fashion on the VDU.

As far as possible, the subroutines I shall use in this series are relocatable — which means that the machine-code instructions can be typed in at any place in RAM. I shall also try to ensure that the subroutines leave the 6502 registers in the same state at the end as they were in at the beginning of the routine.

Building a program by writing modules which can be used anywhere without upsetting any adjacent operations will save hours of frustration when you are completing a major, multi-kilobyte exercise. This modular approach is just as valid in Basic as it is in machine-code programming.

List 1 is a simple set of machine-code instructions for a Microtan to clear any information from the screen, leaving it filled with blank spaces.

The Microtan computer uses a memory-mapped VDU which is stored in RAM locations from 200 Hex to 3FF Hex. Two of the 6502 registers — the accumulator and index X — are used by the subroutine and these are saved on the stack by the instructions in line 500, 501, 502.

The accumulator is then loaded with the ASCII code for a space and register X with the value 00 Hex. The space code 20 Hex is stored at the memory location pointed to by adding X to 200 (507) and then to the location pointed to by 300 + X (50A).

The next instruction decrements X to FF Hex on the first time round the loop and then branches if X is not equal to zero to 507 (50E). The value of A, which is unchanged, is stored at the location pointed to by adding 200 to the new value of X — FF Hex — which equals 2FF Hex.

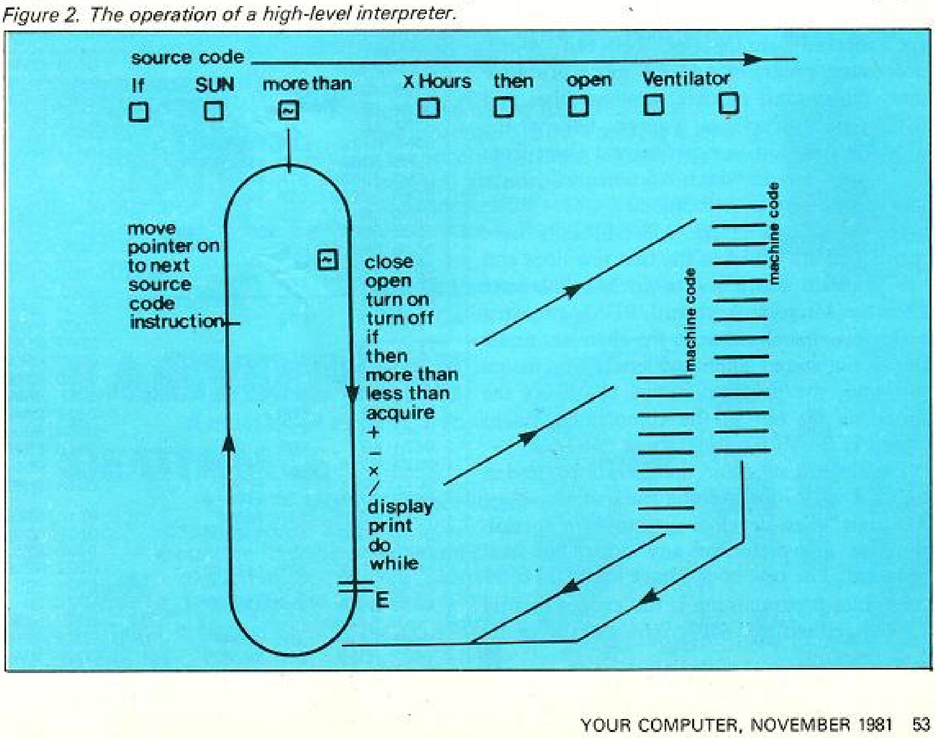
The process is continued until X equals zero when the branch instruction is not carried out and the program continues to restore the index register X and the accumulator to their original values in instructions 511 to 513. The RTS instruction in 514 directs the computer to return from the subroutine to the place in the main program from which it was called originally.

I have covered this tiny subroutine in detail because it performs a useful function in a larger program while being the simplest possible example of a repetitive operation involving a decision by the machine as to whether or not a condition is satisfied.

In figure 1 the top of the diagram illustrating the general structure of an interpreter

(continued on next page)

Figure 2. The operation of a high-level interpreter.



(continued from previous page)

shows the entry point to the command table labelled "Start". The first task an interpreter should perform is to clear the screen and then display a message to tell the user that control has been passed from the system monitor to the high-level language and that the interpreter program is running.

After removing any previous information from the screen, the interpreter could then call up the subroutine set out in figure 3 which will display a message at the top of the Microtan screen.

A flowchart for the operations is set out next to the listing in figure 3. With the aid of the Microtan manual, you should be able to trace through the machine-code instructions, working out the purpose of each and its relationship to the whole.

The address of the line on the screen along which the cursor is located is stored in the zero-page locations 0A Hex and 0B Hex and the position of the cursor along that line is stored in zero-page location 03 Hex. The monitor subroutine at FE75 Hex loads a character into the next sequential position along the VDU line from the CPU register A.

The message to be displayed on the screen is stored in memory locations pointed to by locations 48 and 49 Hex plus the contents of index register Y. For example, the first message put on the screen is stored at 0F00 Hex and locations 48 and 49 contain 00 Hex and 0F Hex — remember that the low-order byte is stored first.

If Y contains 00 Hex when the subroutine is entered, that message will be displayed byte by byte until a null value — 00 Hex — is encountered. The second message in the program from which this is taken is stored at 0F20 Hex and Y must be loaded with 20 Hex before the SR is called.

List 2 is a subroutine to clear a section of memory from 1010 Hex to 2000 Hex. You can use it to set a part of the computer RAM to a known state before a new program or text is written into it.

List 3 is the start of a word-processing program called Asimov I am writing at present. Interpreters need editors, and there are marked similarities between word-processing programs and the more primitive text editors used to alter program lines and insert new instructions. You can tell that the program is still in an experimental phase from the untidy way in which reference values are loaded into zero-page locations.

However, two of the subroutines I have mentioned are called in the first few lines and the program continues to fetch a character from the Microtan keyboard, 0D33, and then seeks for a match between the character and a number of stored command letters. If a match is found, the program jumps to one of the functions set out in the command table of figure 1; if not, the program is re-started.

Finally, you may find the chart illustrated in figure 4 useful for keeping track of zero-page locations when developing your own special-purpose interpreter or any other low-level program. The best book I have found on 6502 assembler programming is the extraordinarily lucid, well-written *6502 Software Design* by Leo Scanlon. ■

```
0540 48      PHA       1
0541 8A      TXA
0542 48      PHA
0543 98      TYA
0544 48      PHA
0545 A50A    LDA $000A      2
0547 48      PHA
0548 A50B    LDA $000B
054A 48      PHA
054B A920    LDA #$0020     3
054D 850A    STA $000A
054F A900    LDA #$0000
0551 8503    STA $0003
0553 A902    LDA #$0002

0555 850B    STA $000B
0557 B148    LDA ($0048),Y   4
0559 C900    CMP #$0000      5
055B F006    BEQ $0563
055D 2075FE  JSR $FE75       6
0560 C8      INY             7
0561 D0F4    BNE $0557       8
0563 A920    LDA #$0020      9
0565 A403    LDY $0003
0567 910A    STA ($000A),Y
0569 A900    LDA #$0000      10
056B 8503    STA #0003
056D 68      PLA
056E 850B    STA $000B

0570 68      PLA
0571 850A    STA $000A
0573 68      PLA             11
0574 A8      TAY
0575 68      PLA
0576 AA      TAX
0577 68      PLA
0578 60      RTS
```

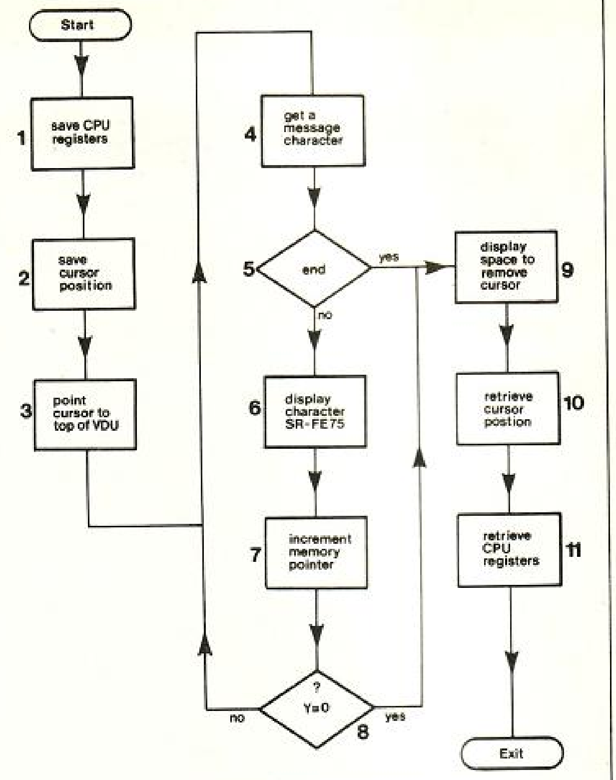


Figure 3. Subroutine to display a message on screen.

Figure 4. Chart for zero-page locations.

6502 Zeropage chart — Tanbug

	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0	Status	IChar	OChar	VDUind	Fast	interrupt	link	NWI	jump	link	CursL	CursH	Run			
1	Slow	interrupt	link	HXPKL	HXPKH	pcl	pch	psw	sp	x	Y	a	MD L	MD H	CP L	CP H
2																
3																
4																
5																
6																
7																
8																
9																
A																
B																
C																
D																
E																
F																

program ________ date ________

Listing 1.

```
0500 48      PHA
0501 8A      TXA
0502 48      PHA
0503 A920    LDA #$0020
0505 A200    LDX #$0000
0507 9D0002  STA $0200,X
050A 9D0003  STA $0300,X
050D CA      DEX
050E D0F7    BNE $0507
0510 EA      NOP
0511 68      PLA
0512 AA      TAX
0513 68      PLA
0514 60      RTS
```

Listing 2.

```
0670 48      PHA
0671 8A      TXA
0672 48      PHA
0673 98      TYA
0674 48      PHA
0675 A910    LDA #$0010
0677 854E    STA $004E
0679 A910    LDA #$0010
067B 854F    STA $004F
067D A000    LDY #$0000
067F 98      TYA
0680 914E    STA ($004E),Y
0682 C8      INY
0683 D0FB    BNE $0680

0685 E64F    INC $004F
0687 A920    LDA #$0020
0689 C54F    CMP $004F
068B D0F2    BNE $067F
068D 68      PLA
068E A8      TAY
068F 68      PLA
0690 AA      TAX
0691 68      PLA
0692 60      RTS
```

Listing 3.

```
IDOO
0D00 D8      CLD
0D01 A2FF    LDX #$00FF
0D03 9A      TXS
0D04 200005  JSR$500
0D07 A90F    LDA #$000F
0D09 8549    STA $0049
0D0B A900    LDA #$0000
0D0D 8548    STA $0048
0D0F A000    LDY #$0000
0D11 204005  JSR $0540
0D14 A900    LDA #$0000
0D16 854A    STA $004A
0D18 8544    STA $0044
0D1A 8545    STA $0045

0D1C 8560    STA $0060
0D1E A90D    LDA #$000D
0D20 8561    STA $0061
0D22 A220    LDX #$0020
0D24 8651    STX $0051
0D26 CA      DEX
0D27 8652    STX $0052
0D29 A910    LDA #$0010
0D2B 8540    STA $0040
0D2D 8541    STA $0041
0D2F A90E    LDA #$000E
0D31 854B    STA $004B
0D33 20FAFD  JSR $FDFA
0D36 A501    LDA $0001

0D38 C957    CMP #$0057
0D3A D003    BNE $0D3F
0D3C 4C5304  JMP $0453
0D3F C945    CMP #$0045
0D41 D003    BNE $0D46
0D43 4CE004  JMP $04E0
0D46 C953    CMP #$0053
0D48 D003    BNE $0D4D
0D4A 4C000D  JMP $0D00
0D4D C952    CMP #$0052
0D4F D003    BNE $0D54
0D51 4C000D  JMP $0D00
0D54 C950    CMP #$0050
0D56 D003    BNE $0D5B

0D58 4C6004  JMP $0460
0D5B C958    CMP #$0058
0D5D D003    BNE $0D62
0D5F 4C800D  JMP $0D80
0D62 4C000D  JMP $0D00
0D65 00      BRK
0D66 00      BRK
0D67 00      BRK
0D68 00      BRK
0D69 00      BRK
0D6A 00      BRK
0D6B 00      BRK
0D6C 00      BRK
0D6D 00      BRK
```

ZX-81 machine code

Programs in machine code run faster than equivalent Basic programs and need less storage space. Brendan Clancy explains how you can store machine code from your ZX-81 and describes an entertaining game.

THERE ARE various ways of storing machine-code programs on the ZX-81. One method is to lower the address held in RAM-Top and Poke the machine code into the area above this address. Alternatively, you can use an array, or store the machine code in a Rem statement.

The last method is the most useful, since machine code in an array is likely to change its position in memory and can be destroyed by pressing Run. Machine code held above the address stored in RAM-Top cannot be Saved.

The only major problem with storing machine code in a Rem statement is that Listing the program can sometimes cause the machine to crash, but this problem can easily be overcome.

The program shown in listing 1 provides a useful means of entering machine code into a Rem statement. The program has been written to fit on the unexpanded ZX-81, but it can, of course, be used with the 16K RAM fitted. The only constraint is that the program must be less than 251 bytes, but this is a reasonable length for a machine-code program. The program also has facilities for editing the machine code.

To enter the machine-code loading program, first type in line 1 as a Rem statement containing 250 Qs. This should produce seven full lines of Qs plus the first line. Next, enter

PRINT PEEK 16511

as a direct command to give the length of the line. This should equal 252; if it does not, edit the line and add or delete Qs as required.

Line 1 will ultimately be used to hold the machine-code program. It is best to enter line 1 in the Fast mode since in Slow, the computer takes a while to re-write the line when the final Qs are being entered.

After entering line 1, it is best to enter lines 10 to 90 since after line 5 has been entered, lines 10 and upwards will have to be listed separately because line 5 contains a Newline character. After entering line 90 and checking that everything is correct, type in line 5.

The commas are only to help distinguish between keywords and other letters, and the line should not contain any commas or spaces apart from the spaces put in automatically around the keywords. To enter a keyword in the Rem statement, type

THEN

followed by the key with the required keyword. Then go back one, delete the Then and move the cursor to the right-hand side of the keyword.

After entering line five, Poke the following values as direct commands:

```
POKE 16771 , 123
POKE 16776 , 169
POKE 16782 , 118
POKE 16785 , 128
POKE 16787 , 167
POKE 16789 , 82
POKE 16791 , 127
POKE 16795 , 195
POKE 16796 , 3
POKE 16797 , 4
```

After entering the program, press Run followed by Newline. The string-input prompt should appear in the corner of the screen. To enter a machine-code program, enter each byte separately in decimal form. It is useful to remember that negative numbers will be converted into twos-complement form automatically when Poked. For example, −5 becomes 251. The program checks for numbers greater than 255 and asks for the byte to be re-input.

As well as Poking the machine code into the Rem statement, the program also performs certain other functions. If you enter an incorrect value by mistake, input "J" instead of a number. The next number entered will then replace the erroneous value.

Pressing "L" followed by Newline will produce the prompt for a numerical input. If you then enter the value of an address in your machine-code program, the computer will list the program from that point, giving the addresses in the left-hand column and the values in decimal of the corresponding bytes in the right-hand one. To stop the listing, press Break.

After listing the machine-code program in this way, it is not possible to continue entering machine code from the point at which you stopped, since — due to restrictions on the amount of memory available — the same variable is used to hold the address when listing and inputting data. To return to the address at which you stopped, or to change the current address for any other reason, stop the program using Break and then enter

LET A = (new address)

as a direct command, and then enter

GOTO 15

followed by Newline. You can then continue to enter the machine code from the address of the value you gave to A.

A problem often found when using a Rem statement to hold machine code is how many bytes to reserve in it. Making the statement too long is wasteful of memory since it can be difficult to edit long lines of machine code to remove the excess bytes, and making it too short will obviously lead to running out of memory.

The last function offered by the loading program provides a solution to the problem, and also to the problem of how to dispense with the loading program once the machine code has been loaded.

Typing Del followed by Newline in response to the input prompt will destroy the loading program and also search to find where the machine code ends in line 1. It then removes all the excess Qs, leaving only line 1 as a Rem statement containing your machine code.

Removing Qs will, of course, alter the length of the line, so the value for the new length of the line is then loaded into loction 16511. Finally a Newline character is placed at the end of the line.

All of this is achieved by the machine-code program held in line two, which is listed here. If you Run the loading program, enter "L" and then input 16770 as the address, the computer should list the values given on the right-hand side of the listing:

```
LD HL , 16763     33 , 123 , 65
LD A , 54         62 , 54
CPD               237 , 169
JR Z 250          40 , 250
INC HL            35
INC HL            35
```

(continued on next page)

Listing 1. Program to enter machine code into a Rem statement.

```
1             SEE TEXT
2  REM 5 , X , INKEY$ , Y , Q , GOSUB , X , C , IF , 7 , 7 , Q
   X , FAST , ) , X , RND , X , GOSUB , X , 6 , X , RND , LPRINT
   7 , X , X , X


10  LET A = 16514
15  INPUT A$
20  IF A$ = "DEL" THEN PRINT USR 16770
25  IF A$ = "L" THEN GOTO 55
30  IF A$ = "J" THEN LET A = A - 1
35  IF A$ = "J" THEN GOTO 15
40  IF VAL A$ > 255 THEN GOTO 15
45  POKE A , VAL A$
50  GOTO 70
55  PRINT "ADDRESS?"
60  INPUT A
65  CLS
70  PRINT AT 16 , 0 ; A ; "=" ; PEEK A
75  LET A = A + 1
80  SCROLL
85  IF A$ = "L" THEN GOTO 70
90  GOTO 15
```

(continued from previous page)

```
LD ( HL ) , 118    54 , 118
PUSH HL            229
LD DE , 16512      17 , 128 , 64
POP HL             225
INC HL             35
JP 1027            195 , 3 , 4
```

The reason why machine-code programs in Rem statements can often cause the computer to crash is that there is not enough memory to display the complete line on the screen, and so the computer becomes caught in a never-ending loop as it keeps trying to re-write the line.

This is shown by the fact that machine-code programs which cause the unexpanded ZX-81 to crash will list easily with the 16K pack fitted.

If two consecutive Newline characters are Poked into the first two bytes after the Rem in the Rem statement containing the machine code, they will have no effect when the program is run but will prevent the rest of the Rem statement from being listed. This will stop the computer from crashing if the program is listed.

The rest of the program cannot now be listed simply by pressing List but will have to be listed separately — that is, you will have to enter

LIST 2

to list the program if line 1 contains the machine code.

If the machine code is in line 1, it can now be called by

USR 16516

instead of

USR 16514

although it does not make much difference as Halt commands have little effect on the speed.

It is best to Save the loading program along with the machine-code program before deleting the rest of the program so that if the machine-code program does not work, it can be loaded again and edited using the loading program.

Listing 2 is for a machine-code game. A plane flies over a randomly-generated skyline and its up-and-down movement is controlled by the up and down cursor keys. The object is to destroy as many buildings as possible to clear a space in which to land without crashing through more than three blocks.

Bombs can be dropped by pressing the 0 key and each bomb destroys up to four blocks in each building. Moving the plane up to avoid hitting the buildings uses up one of the original 15 units of fuel. When the plane runs out of fuel, it continues to fall. The plane descends one space automatically at the end of each line.

It is worth remembering when writing your own machine-code programs that you can take advantage of the unused system variables by storing in them the variables required in the machine-code program. As an example, in this program locations 16507 and 16508 are used for holding the position of the plane. Some of the system variables used can be utilised as long as they are not needed for the Basic program, e.g., Coords and Seed. The first 32 bytes of the printer buffer, 16444-16475, can also be used as long as there is no return to Basic until the end of the machine-code program.

To enter the program, first load the machine-code loading program given in listing 1. Press Run followed by Newline and then enter the values given on the right-hand side of the listing byte by byte. At intervals, an address is given on the left of the listing.

If at this point you are not entering the value on the left-hand side of the column, type "L" followed by Newline and then enter the value of the last address given. When you reach the point at which you went wrong, stop the listing with Break and enter

LET A = (address where program goes wrong)

followed by Goto 15 as direct commands. Then continue to enter the program from the point at which it went wrong.

When you have entered all the numbers and listed the program from the beginning to make sure that everything is correct, run the machine-code loader and type

DEL

followed by Newline. This will leave you with a Rem statement containing the machine code.

Then enter the Basic program at the end of listing 2 exactly as it is written; lower case has been used to denote inverse characters. Next enter

PRINT PEEK 16396 + 256 × PEEK 16397

as a direct command. This should give 16922, otherwise you have made a mistake.

If so, if PRINT PEEK 16511

followed by Newline gives 251, then the fault is in the Basic part of the program — otherwise a mistake has been made when entering the machine code.

If you want to give yourself more fuel, the amount which is given at the beginning is held in location 16571. The number of blocks you are allowed to crash through is held in location 16663, and the speed of the game can be changed by Poking address 16752 with a different value. ■

Listing 2. Program for aircraft-landing machine-code game.

```
16514  HALT                 118
       HALT                 118
       LD DE , 33           17 , 33 , 0          ;set up towers
       LD C , 30            14 , 30
       LD A , ( FRAMES )    58 , 52 , 64         ;random number
       LD ( 16537 ) , A     50 , 153 , 64
       LD HL , 17218        33 , 66 , 67
       DEC HL               43
       PUSH HL              229
       LD HL , 16537        33 , 153 , 64
       INC ( HL )           52
       LD A , ( RAND No )   58 , 0 , 6
       POP HL               225
       AND 7                230 , 7              ;height of towers
       LD B , A             71
       INC B                4
       PUSH HL              229
       LD ( HL ) , 8        54 , 8
       SBC HL , DE          237 , 82
       DJNZ 250             16 , 250
       POP HL               225
       DEC HL               43
       DEC C                13
       JR NZ 231            32 , 231
       LD HL , 16929        33 , 33 , 66
       LD ( 16507 ) , HL    34 , 123 , 64        ;reset plane position
       LD HL , 16438        33 , 54 , 64
       LD ( HL ) , 0        54 , 0               ;reset hit counter
       LD HL , 16417        33 , 33 , 64
       LD ( HL ) , 15       54 , 15              ;reset fuel
16572  LD DE , 33           17 , 33 , 0
       LD HL , ( 16507)     42 , 123 , 64        ;erase last position
       XOR A                175                  ;of plane
       LD ( HL ) , A        119
       DEC HL               43
       LD ( HL ) , A        119
       DEC HL               43
       LD ( HL ) , A        119
       INC HL               35
       INC HL               35
16586  LD A , ( 16417 )     58 , 33 , 64
       CP , 0               254 , 0              ;out of fuel?
       JR Z 29              40 , 29
       LD A , (LAST K)      58 , 38 , 64
       CP , 239             254 , 239            ;'up' key pressed?
       JR NZ 10             32 , 10
       SBC HL , DE          237 , 82             ;move plane up
       PUSH HL              229
       LD BC , ( D FILE )   237 , 75 , 12 , 64
       SBC HL , BC          237 , 66
       POP HL               225
       JR C 10              56 , 10
       PUSH HL              229
       LD HL , ( 16417 )    33 , 33 , 64
       DEC ( HL )           53
       POP HL               225
       CP , 223             254 , 223            ;'down' key pressed?
       JR NZ 1              32 , 1
       ADD HL , DE          25                   ;move plane down
       PUSH HL              229
       LD BC , ( 16520 )    237 , 75 , 144 , 64  ;check to see
       SBC HL , BC          237 , 66             ;if plane has
       POP HL               225                  ;landed
       RET NC               208
       INC HL               35                   ;move plane forwrd
       PUSH HL              229
       LD A , ( HL )        126
       CP , 118             254 , 118            ;check for end
       JR Z 34              40 , 34              ;of line
       CP , 8               254 , 8              ;check for hit
       JR Z 10              40 , 10              ;on tower
       DEC HL               43
       LD A , ( HL )        126
       CP , 8               254 , 8
       JR Z 4               40 , 4
       DEC HL               43
       LD A , ( HL )        126
       CP , 8               254 , 8
       POP HL               225
       JR NZ 21             32 , 21
       PUSH HL              229
16661  LD A , ( HL )        126                  ;check number
       CP , 3               254 , 3              ;of crashes
       POP HL               225
       JR NZ 4              32 , 4
       XOR A                175
       LD B , A             71
       LD C , A             79
       RET                  201                  ;too many crashes
       JR 4                 24 , 4
       POP HL               225
       INC HL               35
       INC HL               35
       INC HL               35
       LD ( 16507 ) , HL    34 , 123 , 64        ;store plane position
       LD ( HL ) , 131      54 , 131             ;print plane
       DEC HL               43
       LD ( HL ) , 7        54 , 7
       DEC HL               43
16686  LD ( HL ) , 130      54 , 130
       LD BC , ( 16444 )    237 , 75 , 60 , 64
       LD HL , ( 16446 )    42 , 62 , 64         ;position of bomb
       BIT 0 , C            203 , 65
       JR NZ 15             32 , 15
       LD HL , ( 16507 )    42 , 123 , 64
       DEC HL               43
       LD A , ( LAST K )    58 , 38 , 64
       CP , 253             254 , 253            ;'bomb' key pressed?
       JR NZ 34             32 , 34
       SET 0 , C            203 , 193
       LD B , 4             6 , 4
       LD ( HL ) , 0        54 , 0
       ADD HL , DE          25
       PUSH HL              229
       LD DE , ( 16520 )    237 , 91 , 144 , 64
       SBC HL , DE          237 , 82
       POP HL               225
       JR C 4               56 , 4
       RESET 0 , C          203 , 129
       JR 13                24 , 13
       LD A , ( HL )        126
       CP , 0               254 , 0
16736  DJNZ 4               16 , 4
       RESET 0 , C          203 , 129
       JR 2                 24 , 2
       LD ( HL ) , 4        54 , 4
       LD ( 16444 ) , BC    237 , 67 , 60 , 64
       LD ( 16446 ) , HL    34 , 62 , 64
       LD B , 20            6 , 20               ;pause
       LD C , 255           14 , 255
       DEC C                13
       JR NZ 253            32 , 253
       DJNZ 249             16 , 249
       JP 16572             195 , 188 , 64

10  FOR A = 1 TO 200
20  PRINT "";
30  NEXT A
40  IF USR 16516 THEN GOTO 70
50  PRINT "you crashed",
60  GOTO 80
70  PRINT "a safe landing",
80  PRINT "FUEL LEFT="; PEEK 16417
```

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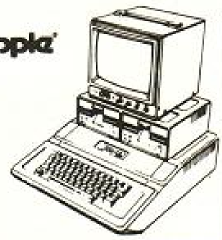

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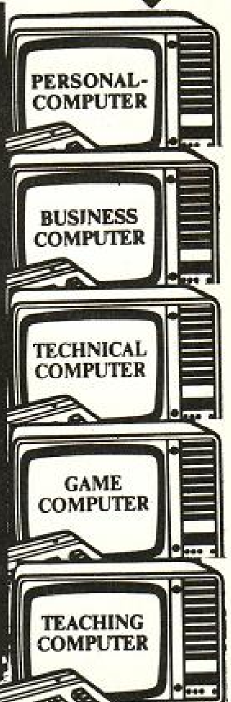

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Fingertips is our regular calculator column covering calculator news, programming hints and examples of unusual applications. The column is written and compiled by calculator enthusiast David Pringle who is glad to hear of any of your ideas. *Your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

HOW DOES a calculator generate all those standard functions, such as square roots and sines, which we all take very much for granted? A look-up table similar to the antediluvian log book would require vast data storage on a scale hardly compatible with the size of the universe, never mind a pocket.

As I hinted last month, the calculator is micro-programmed with algorithms which generate these functions from simple operations such as addition, subtraction and register shifting — see Jargon. The algorithms are chosen for their conciseness, accuracy and speed in handling the binary-coded decimal (BCD) arithmetic.

There is, of course, no definitive solution and so it is not surprising to find different algorithms implemented on different machines. For instance, look at the maximum angle for which trigonometric functions are evaluated on the following calculator:

CASIO 602P $\theta < 1440°$
TI 58C $\theta < 3.6 \times 10^{14}°$
HP41-C $\theta < 10^{100}$

I would like to show you one in-depth example of how the Hewlett-Packard evaluates its trigonometric functions. For program compactness, the tangent function, tanθ, is always generated first and, if required, sinθ or cosθ are subsequently derived using the formulae:

$$\sin\theta = \frac{\pm\tan\theta}{\sqrt{1+\tan^2\theta}}$$

$$\cos\theta = \frac{\pm\cot\theta}{\sqrt{1+\cot^2\theta}}$$

Where

$$\cot\theta = \frac{1}{\tan\theta}$$

Note how the form of the two equations is identical and sŏ obviates the need for separate subroutines. All calculations are performed in radians, requiring angles input in degrees to be multiplied by $\pi/180$. The first problem is to scale angles so that they lie in the first four quadrants — 0 to 2π radians.

This is performed for positive angles by subtracting multiples of 2π radians until the next operation gives a negative result. Remember that

$$\sin(\theta - 2\pi) = \sin(\theta).$$

Such a method will lead to rounding errors for large angles because the value of θis only stored internally to 12 decimal places. For instance sin 1080° should be exactly equal to 0. Is this true for your calculator?

The heart of the technique lies in dividing the required angle into easily handled portions. Consider the angle 0_3 as represented by the vector with co-ordinates (X,Y) in figure 1.

This may be formed by two successive rotations of the vector through angles

θ_1 and θ_2

if

$\theta_1 + \theta_2 = \theta_3$

See figure 2.

We can relate the final and intermediate co-ordinates by the form:

$$X = X_1 \cos\theta_2 - Y_1 \sin\theta_2 \qquad -(1)$$

$$Y = Y_1 \cos\theta_2 + Y_1 \sin\theta_2$$

It follows that:

$$\frac{Y}{X} = \tan(\theta_1 + \theta_2) = \tan\theta_3 = \frac{Y_1 + X_1 \tan\theta_2}{X_1 - Y_1 \tan\theta_2} \qquad -(2)$$

Simply by recognising that it is possible to extend this argument and build a large angle from numerous smaller ones, we see that a tangent may be expressed as a product involving the tangents of the composite angles.

The sleight of hand involves using composite angles whose tangents are simple powers of 10. Any angle may be expressed in a register of four-bit digits in the form

$\theta = A\,B\,C\,D\ldots$

where

$\theta = A\tan^{-1}(1) + B\tan^{-1}(0.1) + C\tan^{-1}(0.01) + \ldots + r$

$\tan^{-1}(1) = 45°$

$\tan^{-1}(0.1) = 5.7106°$

r = remainder

For instance 73.42° would be stored as 1497. Thus to generate X and Y by repeatedly applying the second equation, we need only add, subtract or register shift given the initial values X_1 and Y_1.

So, the Hewlett-Packard algorithm starts by dividing the required angle into a sum of smaller angles whose values are stored on ROM. All that is then needed is the initial seed X_1 and Y_1 of the second equation. The remainder r will be a small angle for which $\tan\theta = \theta$ is a good approximation — this is why we use radians.

Thus, to good accuracy, the initial Y_1 can be set to the residual angle and the initial X_1 set to 1.

The second equation is then repeatedly applied to generate a final X and Y co-ordinate. If tan θ is required, the quotient Y/X is calculated and displayed. Sinθ and Cosθ follow simply from the routines mentioned earlier. If you think you have a better way, I am sure Hewlett-Packard would love to hear from you.

Figure 1.

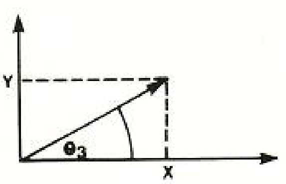
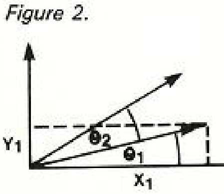


Figure 2.



All linguists will be glad to know that I had to swallow my Poisson evaluation challenge hook, line and sinker. As you may remember this entailed evaluating the sum

$$\sum_{X=0}^{110} \frac{(229)^X e^{-229}}{X!}$$

in less than 22 seconds.

No Hewlett-Packard or Texas Instruments owner was game enough to write to *Your Computer*, but I had not banked on Casio releasing a new calculator in an attempt to disrupt the competition. The previously-published program will run on the slick 602-P in considerably less than 20 seconds. To add insult to injury, Londoner John Matzak, wrote the following piece which requires a mere 5.5 seconds.

```
01  110        09  MR 01
02  Min 00     10  +
03  229        11  MR 00
04  Min 01     12  =
05  Ln         13  Min 02
06  x          14  MR 00
07  MR 00      15  x
08  -          16  2
17  x          37  Ln
18  y^x        38  M- 02
19  =          39  MR 02
20  √          40  e^x
21  Ln         41  Min 02
22  M- 02      42  Min F
23  MR 00      43  LBL 0
24  Ln         44  X<->M02
25  x          45  x
26  MR 00      46  MR 00
27  =          47  DSZ
28  M- 02      48  ÷
29  1          49  MR 01
30  +          50  =
31  1          51  M+ 02
32  ÷          52  X<->M02
33  12         53  x=F
34  ÷          54  HLT
35  MR 00      55  Min F
36  =          56  GOTO 0
```

Remember that one problem in deriving the algorithm was in handling products greater than 69! Ray Wilkes of Shipley has written to *Your Computer* showing an interesting way of generating factorials whose values lie well in excess of 10^{100}

Recall that

$$X! = X(X-1)(X-2)\ldots 1$$

and so

$$\text{Log } X! = \sum_{n=1}^{X} \text{Log } n$$

Ray Wilkes' program evaluates log X!, which is much smaller than X!, through this summation. The value of X! is then

(Fractional Part of Log X!) × 10

(Integral Part Log X!)

Why? well:

$$\text{Log}(A \times 10^B) = B + \text{Log } A.$$

The number of ways of selecting R objects from a set of N objects is denoted by $P(^N_R)$ and equals N!/(N—R)! permutations.

If there is no regard for the

(continued on next page)

JARGON

■ Register shifting
Remember that a register is a segment of memory which in a calculator normally contains seven or eight bytes of binary information. A shift register is one in which bits are synchronously shifted *en masse* through a series of memory cells under the command of a common signal. If, for instance, your machine is asked to add 28.24 and 57.3, the first operation it must perform is to shift each digit of the larger number, including the decimal point, one place to the left. The shifted number is then 57.30. The decimal places now line up and so addition may take place. The shifting in the case of the trigonometric evaluation is slightly different. Here we want to move each digit, except the decimal point, by X positions to the left or right. This corresponds to multiplication by 10^X for leftward movements and 10^{-X} for rightward.

■ Digit
By Digit, I mean group of bits corresponding to one decimal digit or number between 0 and 9.

■ Concatenation
Usually applied to describe the linking together of two or more character expressions.

(continued from previous page)
ordering of the R objects, we have a combination $C(^N_R)$ equalling

N!/R!(N-R)!.

```
01  R/S
02  STO 5
03  SBR 3
04  STO 1
05  STO 2
06  R/S
07  INV SUM 5
08  SBR 3
09  INV SUM 1
10  RCL 5
11  SBR 3
12  INV SUM 1
13  INV SUM 2
14  R/S
15  2nd LBL 1
16  RCL 1
17  GTO 6
18  2nd LBL 2
19  RCL 2
20  GTO 6
21  2nd LBL 0
22  2nd INV ct
23  RST
24  2nd LBL 3
25  2nd x=t
26  GTO 5
27  STO 0
28  2nd LBL 4
29  RCL 0
30  2nd LOG X
31  +
32  2nd DSZ
33  GTO 4
34  0
35  =
36  INV SBR
37  2nd LBL 5
38  0
39  INV SBR
40  2nd LBL 6
41  R/S
42  2nd INV INT
43  2nd INV LOGX
44  R/S
```

To clear and re-set registers SBR 0:

Enter n R/S; Enter r R/S

For $C(^n_r)$ press SBR 1

For $P(^n_r)$ press SBR 2

For n only press SBR 3 then SBR 6

To calculate 1000:

Enter 1000 SBR 3 SBR 6

2567.6046 displayed

Note 2567 Press R/S

4.02355 displayed

Therefore $1000 = 4.02355 \times 10^{2567}$

I briefly mentioned earlier that Casio have brought out a new calculator, the 602-P.

At first sight the Casio 602-P looks identical to one of the 500 series machines, but the 602-P can hold a maximum of 512 lines of program — twice that of its cousin, the 502-P.

A new and most welcome innovation, in keeping with other top-range calculators, has been to introduce a user-defined data- and program-memory partitition.

The input capacity ranges from 32 program steps and 88 data memories to 512 steps and 22 memories. Each memory will cost you eight program steps. Instructions involving any but the first 22 memories, e.g., MR 45, now occupy two program lines instead of one. This also applies to the only new numeric function INV RND FIX which will round a number to a specified value of decimal places. It will have no effect on numbers like 10.327×10^{30}.

Incidentally, Casio has omitted the old NOP dummy function which I never used anyway. What really differentiates this calculator from its predecessors is its alpha-numeric ability. Although this lends nothing to the computing power of the machine, it greatly increases its utility.

No longer those dreary attempts to decipher the meaning of program line FF-05. Not only can you see your present line in its full glory, but the preceding line or lines if they will fit into the additional free display space. This makes program editing and writing a pleasure.

Extra display characters as well as the choice of upper and lower case almost let the user become grammatical. To sustain these characters Casio has produced a rectangular, dot-matrix, liquid-crystal display which I found disarming at first but have grown to like.

There is no separate alpha-numeric display register. The X-register doubles up for both numeric and character display with an Alpha annunciator present when Alpha mode is accessed by

INV "ALPHA".

There is, however, a register which stores the last alpha-numeric display before returning to Normal or numeric mode. This may be accessed on the next return to Alpha mode by the command

(INV ;)

and may be concatenated with this character expression.

It is possible, if wished, to give any program a four-character password which must be entered before that program can be accessed. I really cannot see why Casio has done this especially as forgetting the password means scrapping the program. I carry no state secrets on my calculator.

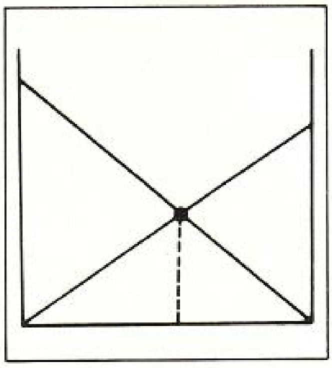
The handbook and program listings are, as usual, very useful. I especially recommend the extended pictorial information on subroutines and looping. Occasionally, though, the abysmal standard of English obscures the meaning of sentences. For instance:

> All characters between these two signs, " " " and " " ", will be alphabetical comments, regardless of any numerals or calculating signs, even there, merely remaining displayed as they are, and nothing being affecting the calculation.

Not a very good advert for Casio's English-Japanese translating machine.

Minor quibbles aside, the 602-P and its half-capacity brother, the 601-P, represent a great addition to the calculator inventory. I hear through the grapevine that Casio will be launching yet another range soon. The FX-702P, already available in the U.S., is a Basic-programmable machine and will provide the first challenge to the Sharp PC-1211. Its memory will hold 1,600 program steps while storing 26 Basic variables. Built-in interfaces for a printer, tape recorder and pre-programmed ROM will eventually make it a powerful system.

To make up for the lack of a competition in last month's issue, here is a brain-teaser posed by D J Davies of Troon. Consider two ladders resting against opposite perpendicular walls as shown below. The large ladder is



30ft. tall, the small, 20ft. Their point of intersection is 10ft. above the ground. The neatest program to evaluate the distance between the walls to four decimal places will win £5. You may well find it not as easy as it looks.

Now let us turn to readers' programs. First, something for the 602-P. The following program allows the user to add numbers without using the + key or a program Execute command.

```
LBL
MR F
LBL I
INV PAUSE
INV X=F
GOTO I
M+F
GOTO O
```

Actually, this will run on any of the 500/600 series machine and presumably any other with a Pause command. It was from Leon Goodfriend of Cardiff who also gives a biorythm calculation.

After requesting your age in days the calculator displays your biorythms in the order physical, emotional and intellectual. A special feature is the trend indicator: a + sign after your biorythm — which is calculated on the sale +1, best and −1 worst — indicates that you are moving upwards in the cycle while a − sign indicates that you are on a downward trend.

```
01 MODE 4        19 MIN 01
02 "             20 LBL 1
03 A             21 MR00
04 G             22 ÷
05 E             23 MR'01
06 INV SPACE     24 =
07 -             25 Inv FRAC
08 INV SPACE     26 MIN 02
09 d             27 MIN 03
10 a             28 MR01
11 y             29 INV 1/X
12 s             30 M+ 03
13 ?             31 3
14 "             32 6
15 HLT           33 0
16 MIN 00        34 X
17 2             35 X
18 3             36 MR 03
37 =             51 INV;
38 SIN           52 +
39 MIN F         53 "
40 MR 02         54 GOTO 3
41 =             55 LBL 2
42 SIN           56 "
43 INV RND       57 INV;
44 FIX 2         58 -
45 =             59 "
46 #             60 LBL 3
47 "             61 HLT
48 INV X>F       62 5
49 GOTO 2        63 M+ 01
50 "             64 GOTO 1
```

Bernard Denchfield has a flight-simulator program for his Sinclair Cambridge Programmable.

The program is based on a Boeing 737 aircraft making an instrument-landing-system approach on a 3° glide-path.

The aircraft starts at a range of 10 nautical miles from the threshold of the runway. The height, between 2,000 and 4,000ft., and speed, between 160 and 210 knots, are selected at the beginning of the game by the player. The object of the game is to secure a safe landing by crossing the threshold at a height of 0-100ft. and a speed between 120 and 140 knots.

This is achieved by selecting your descent rate, at each stage and also the thrust-setting value and the distance you wish to travel under those conditions. If at any time during the game, the aircraft's speed drops below 100 knots the aircraft has stalled and crashed. Similarly, if a negative height is achieved the aircraft has also crashed.

```
18 stop    00 x
19 )       01 stop
20 sto     02 +
21 =       03 #
22 +       04 5
23 stop    05 0
24 =       06 -
25 stop    07 #
26 -       08 3
27 (       09 0
28 stop    10 x
29 x       11 (
30 rcl     12 stop
31 )       13 x
32 ▼       14 #
33 goto    15 6
34 0       16 0
35 0       17 ÷
```

Descent rate: between 50 and 2000 ft./min

Thrust-setting value:

1 idle

2 10,000rpm

20 13,000rpm

40 50,000rpm (max)

or any other value between 1 and 40 may be used.

Distance: 1 or nautical miles at a time is recommended.

To execute: enter descent rate, run, enter thrust-setting value, run, enter distance, run, enter present speed, run, enter present speed again and run. New speed will be displayed. Then enter present height, run, enter descent rate again, run and then new height will be displayed. Finaly enter, ▲▼▲▼ goto 00 and C/CE. ■

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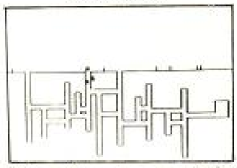

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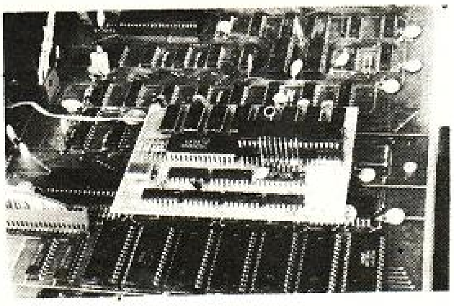

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STEPPING UP

■ As an old newcomer to computing — I am over 70 — I must congratulate you on your magazine; the next issue is eagerly awaited. I want to progress from my ZX-80, but am puzzled about the choices. My maximum outlay will be £300 and I shall have to sell my ZX-80 to make that possible. Yet what do I buy? I'm interested in colour for the grandchildren but will want to use it for more personal computing uses. Another aspect will be weight and portability — from cupboard to table — as we have no provision for permanent location. Therefore, I'm not too happy about the so-called add-on features. Having no experience with more powerful computers I don't know how to assess their merits, and at my age, the next computer is likely to be my last.

A Immins,
Sale, Cheshire.

THERE ARE, as you say, a number of computers on the market, and the choice can be a little bewildering. We think the choice can be reduced to four in your case. The Vic which offers colour and sound for around £200, but needs a special £50 cassette player and uses Pet Basic; the Tandy Colour Computer which offers colour and sound, and uses cassettes for saving programs, is ideal as the next step up from the ZX-80 as it uses almost standard ZX-80 Basic — apart from the sound and colour commands; the Texas TI-99/4 has colour, sound, good software support, but it is rather slow and limited without the extra plug-in extended Basic; the BBC Proton will have the added advantage of a vast library of software, articles, books and the like — plus the TV programme. Delivery times on the Tandy and the BBC machine are a little uncertain, so we think it is a choice between the Vic or the Texas. Of these, the Vic is a much younger computer than the Texas which, in some respects, is like a glorified games machine, but the Texas has — at present — better software support.

GAMES CHOICE

■ I am registered blind but have sufficient vision to read at close range a domestic TV, preferably white print on coloured background. I want a home computer best suited for intellectual and hobby use. Top priorities are in the following order: very good games potential; comprehensive software; exceptional graphics; good facilities for learning programming from beginners' to advanced level. I would require sufficient memory to cope with these facilities. I think a domestic TV as VDU would be best suited to me if clarity does not suffer.

F A Norton,
Ruthlin, Clwyd.

WE HAVE MET three people with limited vision who find the ZX-81 very useful, especially if a large-screen domestic television is used for the display. However, the Vic has an even larger display, as well as having much more flexible graphics including colour, and a memory-mapper screen, so this may be more suitable. The Tandy Colour Computer, which will be available later this year, has large clear letters in its display. Obviously, the money you have to spend will dictate to some extent the computer you buy. The ZX-81 is around £70, the Vic around £200 and the Tandy Colour Computer will be more than £300. However, the Vic and Tandy are more flexible than the ZX-81.

ZX-81 COMMAND

■ Would it be possible for you to tell me what the ZX-80 "TL$" would be on the ZX-81? I have spent hours trying to discover it. I am also very interested in graphics. Is it possible to obtain high-resolution graphics on the ZX-81?

Andrew Hunt,
Bury, Lancashire.

THE EQUIVALENT function to TL$ on the ZX-81 is

```
(2 TO)
```

This is how you use it. On the ZX-80 you say:

```
LET A$ = TL$ (A$)
```

While the ZX-81 equivalent is:

```
LET A$ = A$ (2 TO)
```

SINCLAIR PRINTER

■ How is the ZX printer connected to the ZX-81 if you have a 16K RAM pack connected to the back of the computer? Is the ZX printer connected to the back of the 16K or to the inside of the computer? Also, what kind of paper does the ZX printer use? Is it normal or a special expensive kind only available from Sinclair?

Antony Upward,
King's Heath, Birmingham.

THE ZX PRINTER is connected by a short lead to a unit which plugs directly into the ZX-81, leaving a further connector strip at the back for attaching the 16K pack. The one we have seen flops about alarmingly, but we believe this will be improved on the units put on sale. The printer needs a special metallic paper, but it will be available from other sources as well as Sinclair Research.

O.K. FOR MATHS?

■ I read your review of the Vic-20 with interest since I am considering buying my first computer. I am beginning to feel that since three-quarters of home computer users are interested in their machines only as toys, that games-related facilities are accordingly heavily weighted in reviews. Am I right, or is it fairer to say that the more serious mathematically-related facilities are common to all micros? I ask this question since the Vic-20 is obviously generating plenty of interest and favourable comment, yet it seems to me that, to someone who is not interested in playing games and who does not require external storage, the Sinclair ZX-81 with 16K RAM at £120 is far better value for money than the Commodore machine, or indeed any other.

N J Ford,
Newmarket.

FIRSTLY, ALTHOUGH people buy computers for a wide variety of reasons, nearly all find they spend some time playing with them. It is fun and the least painful way to learn programming and to become familiar with your computer. So, do not look down on game playing until you have tried it. Secondly, reviews often highlight game features because these are precisely the same features which you'll use for serious mathematical work. If you really do not want external storage — that is, if you are happy to enter the program every time you want to run it — then for many mathematical tasks, you will not even need the 16K pack on the ZX-81. The things to look for are: floating-point arithmetic; highest and lowest acceptable arithmetic values; how many decimal points accuracy; and functions available direct from the keyboard such as sin, cos, square root and the like. You can find these from reading the manufacturer's literature, and you can be reasonably safe in assuming that if they are listed, they will work accurately and quickly. As a final thought, you may find a programmable calculator is more suitable for your task than a small computer.

MUSIC PROGRAM

■ I would like to congratulate you on the first two issues of your magazine. As a recent owner of the ZX-81, I find the majority of the articles interesting and easy to read. I have spent some time trying with little success, to convert Robin Arlott's complete music program, August/September issue, to run on my ZX-81. The program crashes the machine as soon as the USR routine is entered on line 110. Could you help?

D J Lamb,
Bracknell, Berkshire.

A COMPLETE routine to enable you to play your ZX-81 like an organ is given in the book *Mastering machine code on your ZX-81 or ZX-80,* by Tony Baker, and the revised *ZX-80 magic book* with ZX-81 supplement also gives a way of producing music from your ZX-81. It is not particularly simple. Another way of getting the first steps towards music on the ZX-81, suggested by L D Tanner of Waddon, Croydon, a member of the National ZX-80 and ZX-81 Users' Club, is as follows: you need to put a transistor radio near your computer to hear the music. You may be able to hear it through your TV speaker if you turn up the volume. It may be necessary to tune the TV slightly off the best picture position to obtain the best sound. This routine is reprinted from the book *50 rip-roaring games for the ZX-80 and ZX-81.*

```
1  LET K = 100
2  FOR C = 1 TO 2
3  FOR A = 1 TO K
4  GOSUB 30
5  NEXT A
6  FOR A = 1 TO K
7  GOSUB 30
8  NEXT A
9  FOR A = 1 TO K
10 LET J = J + 1
11 GOSUB 30
12 NEXT A
13 PAUSE 5
14 FOR S = 1 TO 3
15 FOR A = 1 TO 17
16 GOSUB 30
17 NEXT A
18 NEXT S
19 NEXT G
20 PAUSE 5
21 FOR A = 1 TO 50
22 GOSUB 30
23 NEXT A
24 FOR A + 1 TO K
25 GOSUB 30
26 LET J = J + 1
27 NEXT A
28 PAUSE 10
29 RUN
30 SLOW
31 FAST
32 LET J = 0
33 RETURN
```

SCREEN LINK-UP

■ What is the difference between a monitor and a VDU and can I connect my ZX-81 directly to either?

A Burge
London, NW9.

VDU STANDS for visual display unit and is a generic term for any cathode-ray tube used as an output device. A monitor is, in effect, a TV without a unit to tune in stations. It produces a superior display from computers compared to a normal television. You need a small circuit to connect your ZX-81 to a monitor. A suitable circuit is described in Timedata's book *The ZX-80 magic book,* now available with a ZX-81 supplement. ■

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Remember re-number

James Tyler,
Portsmouth.

ZX-81

THIS PROGRAM is a modification of the re-number routine by Ian Craig, which was published on page 37 of the August/September issue of *Your Computer.*

The old version of the re-number had a few shortcomings. When executed, it would cause the system to crash irrevocably if line 9999 was not present in the listing, or if there was no listing.

This new program does not have these disadvantages. It is virtually crashproof and once loaded is unaffected by New.

Before entering the following Basic program, type in:

```
POKE 16388, 222
POKE 16389, 67
```

On a 1K ZX-81 this saves 34 bytes above RAM-Top — 17374 to 17407. This is where we will store the machine-code routine. If you have a 16K RAM pack, different values must be entered. So, type:

```
POKE 16388, 222
POKE 16389, 127
```

This means that the routine will then be stored in addresses 32734 to 32767. See page 168 in the ZX-81 manual for details. As soon as you have Poked these two values, type New.

Now that we have reserved our memory area, we can start to enter the program. You must remember to perform the last procedure before loading the re-number from tape.

```
10 DIM M (34)
20 FOR B = 1 TO 34
30 INPUT M(B)
40 PRINT AT 6,4; "[3 SPACES]"
50 PRINT AT 6,4: M(B)
60 NEXT B
```

Enter and run the program, and then type the following decimal numbers from left to right.

33, 125, 64, 17, 10, 0, 126, 254, 118, 32, 6, 35, 126, 254, 118, 200, 43, 114, 35, 115, 6, 10, 19, 16, 253, 35, 126, 254, 118, 32, 250, 35, 24, 228

When all 34 values have been entered, return to the listing and erase the line numbers, but do not use New or any command likely to clear the variables, such as Run or Clear. Now enter:

```
 10 REM "RE-NO."
 20 FOR B = 17374 TO 17407
 30 POKE B, M(B-17373)
 40 NEXT B
 50 PRINT AT 1,5; "ZX-81 RE-NUMBER"
 60 PRINT AT 3,5; "CALL AT: USR 17374"
 70 PAUSE 200
 80 NEW
 90 SAVE "RE-NO."
100 GOTO 20
```

Remember to change addresses at lines 20 and 30 appropriately if you have more than 1K of memory. Now start your recorder recording and type:

```
GOTO 90
```

This saves the program together with the re-number routine in such a way that when the program is Loaded in future, it will automatically Run.

When the program is written on to tape, there will be a pause and the screen will clear. The re-number routine can then be called at any time by entering

```
PRINT USR 17374
```

or 32734 on the 16K version.

```
21 7D 40 LD HL,407D ; FIRST LINE IN NO. IN LISTING
11 0A 00 LD DE,0A
7E       LD A,(HL)  ; TEST FOR END OF BASIC LISTING
FE 76    CP 76
20 06    JRNZ
23       INC HL
7E       LD A,(HL)
FE 76    CP 76
C8       RET Z      ; IF SO, RETURN TO BASIC
2B       DEC HL     ; OTHERWISE RENUMBER
72       LD (HL),D
23       INC HL
73       LD (HL),E
06 0A    LD B,0A    ; INC LINE NO. BY 10
13       INC DE
10 FD    DJNZ
23       INC HL
7E       LDA,(HL)
FE 76    CP 76      ; TEST FOR END OF PROG LINE
20 FA    JRNZ
23       INC HL
18 E4    JR         ; JUMP
```

Free memory

Paul Brittain,
Chelmsford, Essex.

ZX-81

IF YOU LOOK at the memory map for your Sinclair computer — page 171 ZX-81 manual, page 106 ZX-80 manual — you will see that the free memory is bounded at the upper end by the machine stack, and at the lower end by the top of the Basic system. Thus to find the amount of free memory at any particular moment, you must subtract the relevant system variable from the SP register.

However, since it is not possible to access the contents of a register directly from Basic, a machine-code routine must be used, such as the one I have written.

Turning to the listing, you can see that the machine code required is relatively simple, and for the most part self-explanatory. However, I shall attempt to answer two questions likely to arise.

First, as you may have noticed, the system variable marking the top of the Basic system is DF-END — address 16400 — in the case of the 4K ROM, or STKEND — address 16412 — in the case of the 8K ROM and ZX-81.

Secondly, note that the 8K ROM version contains extra instructions to transfer the result from the HL register into the BC register, and to satisfy the return conditions. These instructions should be added to all routines converted from the 4K ROM if they are to function correctly — especially those which give a numeric result or alter the IY or I registers.

Finally, some notes on how to use the program. Since the code is entirely position independent, it can be placed anywhere convenient in memory. For this reason I have not included any addresses in the listing.

When storing the machine code, my favourite method is to Poke it into a Rem statement in the first line of a Basic program, remembering that the address of the first byte after the Rem is 16427 in 4K ROM machines, and 16514 in 8K ROM machines. For further details on this and other methods of storing machine code, consult the article by Trevor Sharples in the August/September issue.

Once the routine has been loaded into memory, it is called using

```
PRINT USR (address)
```

where address is the one to which the first byte was Poked. This will result in the number of bytes of free memory being displayed on the screen.

DECIMAL	HEX	INSTR	COMMENTS
175	AF	XOR A	;zero A,reset C flag
103	67	LD H,A	;zero HL (quicker
111	6F	LD L,A	; than LD HL,0,0)
57	39	ADD HL,SP	;leads SP into HL
237,75,28,64	ED,4B,1C,40	LD BC,(16412)	;top of BASIC into BC
237,66	ED,42	SBC HL,BC	;subtract giving free ;memory
229	E5	PUSH HL	;transfer result

(continued on next page)

(continued from previous page)

```
193              C1            POP BC         ;  into BC
253,33,0,64      FD,21,00,40   LD IY,4000 H   ;satisfy
62,30            3E,1E         LD A,1E H      ;  return
237,71           ED,47         LD I,A         ;    conditions
201              C9            RET            ;return to BASIC


4K ROM (11BYTES)

DECIMAL          HEX           INSTR          COMMENTS
175              AF            XOR A          ;zero A,reset C flag
103              67            LD H,A         ;zero HL (quicker
111              6F            LD L,A         ;  than LD HL,0,0)
237,75,16,64     ED,4B,10,40   LD BC,(16400)  ;top of BASIC into BC
237,66           ED,42         SBC HL,BC      ;subtract giving free
                                              ;memory
201              C9            RET            ;return to BASIC
```

Mortgage calculator

J Consadine, North Ferriby, Humberside.

PET

As the greatest expense incurred by any family is buying a house, the effect of changes in mortgage payments should be quickly checked. To simplify the check, I have written Mortgage Calculator, which allows you to see what happens when any variable is changed.

The menu allows you to select which variable to re-calculate and therefore many options can be investigated quickly without repeated manual calculations.

```
5 PRINT"[CLR][CUD]"TAB(8)"[RVS]**********************"
10 PRINTTAB(8)"[RVS]*MORTGAGE CALCULATOR*"
20 PRINTTAB(8)"[RVS]*********************"
25 REM**BY J.CONSADINE 30/7/81**
30 PRINT"[CUD][CUD][CUD]"TAB(16)"MENU"
35 PRINTTAB(16)"####"
40 PRINT"[CUR][CUD]RESULT OF CHANGING VARIABLES ON:-"
50 PRINT"[CUR][CUD][CUD][RVS]1.[RVO] MONTHLT REPAYMENTS."
60 PRINT"[CUR][CUD][RVS]2.[RVO] AMOUNT BORROWED."
80 PRINT"[CUR][CUD][RVS]3.[RVO] NUMBER OF REPAYMENT YEARS."
90 PRINT"[CUR][CUR][CUR][CUR][CUD][CUD][CUD][RVS]PRESS OPTION NO.TO CONTINUE."
100 GOSUB5000
110 W=VAL(A$):IF1>W>3THEN100
120 ONWGOTO1000,2000,3000
1000 PRINT"[CLR][CUD][CUD]TO SHOW AFFECT ON [RVS]MONTHLY REPAYMENTS"
1005 PRINT"[CUD]TYPE IN NEW VALUES OF:-"
1010 INPUT"[CUD][CUD]AMOUNT BORROWED";Y
1020 INPUT"[CUD]ANNUAL RATE OF INTEREST(I.E 12,15 ETC.)";A:A=A/100
1030 INPUT"[CUD]NO.OF YEARS PAYBACK.";N
1040 AR=(A*Y)/(1-(1/(1+A)↑N)):MR=INT((AR/12)+1)
1050 PRINT"[CUD][CUD]WITH THE ABOVE VALUES YOUR MONTHLY"
1060 PRINT"REPAYMENTS WILL BE:-[CUD]"
1070 PRINTTAB(21)"[RVS]"MR"[CUL] POUNDS."
1080 GOTO6000
2000 PRINT"[CLR][CUD][CUD]TO SHOW HOW MUCH YOU CAN [RVS]BORROW"
2005 PRINT"[CUD]TYPE IN NEW VALUES OF:-"
2010 INPUT"[CUD][CUD]MONTHLY REPAYMENTS";MR:AR=MR*12
2020 INPUT"[CUD]ANNUAL RATE OF INTEREST(I.E.12,15 ETC.)";A:A=A/100
2030 INPUT"[CUD]NO.OF YEARS PAYBACK.";N
2040 Y=(AR-(AR/((1+A)↑N)))/A:Y=INT(Y+1)
2050 PRINT"[CUD][CUD]WITH THE ABOVE VALUES YOU CAN BORROW:-[CUD]"
2060 PRINTTAB(15)"[RVS]"Y"[CUL] POUNDS."
2070 GOTO6000
3000 PRINT"[CLR][CUD][CUD]TO SHOW THE AFFECT OF CHANGES ON THE"
3010 PRINT"[CUD][RVS]REPAYMENT TIME[RVO] TYPE IN NEW VALUES OF:-"
3020 INPUT"[CUD][CUD]MONTHLY REPAYMENTS";MR:AR=MR*12
3030 INPUT"[CUD]ANNUAL RATE OF INTEREST(IE.12,15 ETC.)";A:A=A/100
3040 INPUT"[CUD]AMOUNT BORROWED";Y
3050 N=LOG(AR/(AR-(A*Y)))/LOG(1+A):N=INT(N+1)
3060 PRINT"[CUD][CUD]WITH THE ABOVE VALUES YOUR [RVS]REPAYMENT"
3070 PRINT"TIME WILL BE:-[CUD]"
3080 PRINTTAB(15)"[RVS]"N"[CUL] YEARS"
3090 GOTO6000
5000 GETA$:IFA$=""THEN5000
5010 RETURN
6000 PRINT"[CUD][CUD][CUD][CUR][CUR][CUR][CUR][CUR][RVS]PRESS 'M' FOR MENU."
6010 GOSUB5000
6020 IFA$="M"THEN5
6030 GOTO6010
```

Line drawer

Guy Brooker, St Albans, Hertfordshire.

ZX-81

In the ZX-81 manual, in chapter 18 on graphics, there is an exercise containing a subroutine which plots a line between two pixel co-ordinates on the screen. Line Drawer performs this same function at half the length of the program in the manual and using fewer variables. This means it would be very useful to a 1K machine owner.

The variables X2,Y2 — the co-ordinates of the end of the line — and X1,Y1 — the co-ordinates of the beginning of the line — must be initialised before entering the subroutine.

It draws the line by first finding the height and width of the line, then starts a loop which is as long as the greater of these two. Having plotted the first position, it increments the current co-ordinates by the fractions "width over greater length" and "height over greater length." It continues the loop until the final pixel is reached and returns to the main program.

```
1000    LET G=0
1005    LET H=0
1010    LET X=X2-X1
1015    LET Y=Y2-Y1
1020    LET Z=ABS X
1025    IF ABS Y>Z THEN LET Z=ABS Y
1030    FOR F=1 TO Z
1035    PLOT G+X1,H+Y1
1040    LET G=G+X/Z
1045    LET H=H+Y/Z
1050    NEXT F
1060    RETURN
```

Atomic invaders

Jonathan Histed, Chislehurst, Kent.

GENIE

The idea is to shoot down as many invaders before they overrun you. They appear from the bottom and move upwards. Each invader is three characters wide and you have to hit them using bombs which fall downwards. You fire them by pressing the control key. The bomb then tumbles from the present position of your destroyer which you move with the shift key for left, and the repeat key for right.

The destroyer stays on the top line during the game. While one drops a bomb, one can still move, but one cannot drop another one. At the beginning of the game you are asked for the delay which is how many moves you have compared to with their one. 70 is average. The lower the number the harder it is and more skilful.

It also asks you the number of invaders. This is the total number which will appear. The higher the number, the harder it is.

Finally, it asks you for the height they must reach. This is the number of lines from the bottom they must reach to end the game.

Each time an invader appears, it is always on the bottom line of the screen, and all the others which are still left on the screen scroll up.

1000-1999 are a set-up routine.

2000m — Small letters after the line number are a label used in jumps/Gosubs. This subroutine is for movement and firing by the person.

3000f — If a bomb is falling, a branch is made to this subroutine. If the bomb hits a side of an alien it is deflected. If it hits one, a branch is made to 3500.

3500 — An alien is hit. Check for no more on the screen, if so, make another one appear. It also wipes out alien.

4000a — Checks for aliens' turn. It sounds the internal loudspeaker, plots a new one, checks for any going above the line, and moves the others up.

5000e — The End subroutine. It prints out relevant data. A total score is not provided, though this could be added to the program if it is needed.

The whole program sits in about 1.5K of memory though I think it might be possible to fit it in an unexpanded Atom, if pains are taken to exclude spaces, shorten commands, etc.

```
1     INPUT " DELAY "R,'" NO. OF INVADERS"K;R=ABS(R);K=ABS(K)
2     IF R>200 OR K>50 GOTO 1
3     INPUT "THE HEIGHT THEY MUST GET TO",V;V=ABS(V);IF V>15 G.3
5     W=25;D=0;S=0;@=1;U=0
10    P.$12;?#E1=0;A=#20202020;P.$15''''''''''''''''''';P=15;F=0
20    Y=#C0C9FCC6;Q=#8000;L=#C01CFC2F
30    GOSUB 1000;
40    GOSUB M;U=U+1
50    IF F=1 GOSUB F;
60    GOSUB A;
70    GOTO 40
1000  DIM AA(V)
1010  FOR X=0 TO V;AA(X)=0;NEXT;T=999
1999  RETURN
2000m P!  Q=A;IF?#B001&#40=0 IF F=0 F=1;X=Q+33+P
2010  IF?#B001<128 IF P>0 P=P-1
2020  IF ?#B002&#40=0 IF P<29 P=P+1
2030  Q!P=Y
2999  RETURN
3000f FOR M=0 TO 4;?0=32;IF ?X=#FC GOTO 3500
3010  IF?X=#2F X=X-1
3020  IF?X=#1C X=X+1
3030  ?X=W; O=X;IF X>#81E0 F=0;M=4;?X=32
3040  X=X+32;NEXT
3050  RETURN
3500  X!-1=A;X=16-((X-Q)/32);AA(X)=0;F=0;S=S+1;M=4;IFS=D LETT=999
3510  IF S=D+K GOTO e
3520  GOTO 3040
4000a T=T+1;IFT<R RETURN
4005  ?O=32;T=0;F.M=V TO2 STEP-1;AA(M)=AA(M-1);N.;IFAA(V)<>0G.e
4010  P.$7';IF K<1 RETURN
4020  K=K-1;D=D+1;AA (1)=ABSRND%28+1;!(AA(1)+Q+479)=L
4999  RETURN
5000e IFAA(V)=0 GOTO5005
5003  M=AA(V)+#821F-V*32;FORX=0TO9;P.$7;!M=!M:#808080;NEXT
5005  FORX=0TO16;P.$7';N.;P." BOOOOOOOOOM!!"'"YOU DESTROYED "S
5010  P."INVADERS,"'" OUT OF THE "D" THAT APPEARED!"'
5020  IFAA(V)<>0 P."ONE FLEW ABOVE THE LINE AT A HEIGHT OF "V'
5030  P." AND IT TOOK YOU "U" MOVES."'"      BYE FOR NOW !!"'''
5999  END
```

Moving graphics

Loll Holt,
Warsley, Manchester.

WHY SO MUCH fuss is kicked up about moving graphics on the ZX-81 is easy to understand: most ZX-80 owners will tell you its most severe limitation — barring, possibly, the integer Basic — is the screen flicker. This set-back, which even new-ROM ZX-80 owners suffer, makes real-time, continuous, non-flicker moving graphics impossible in Basic.

The ZX-81 is free from screen flicker, but this does not make good moving-graphics programs easy to write. Here are a few of the tricks necessary to achieve a convincing and professional moving display in just 1K RAM — and in Basic. It even includes an addictive moving-graphics game to illustrate the points.

There are, effectively, two types of moving-graphics programs for the ZX-81: those which require a permanent display of which only a part moves, e.g., a maze game, and those in which not much is displayed and so the screen can be cleared completely in between moves.

The advantage of the second group is that clearing the screen saves memory by preventing the computer remembering lines of blank spaces where something used to be. The disadvantage is that, unless there is very little to be re-drawn after each CLS, such programs tend to be very slow.

Already it can be seen that memory-saving plays a large part in graphical-program design. However, moving-graphics programs have the additional problem of time-saving: programs which use too much display — unless you have 16K RAM — or which have 30 lines between each move are less than useless. Remember, these programs have to work in slow mode to avoid screen flicker.

To overcome these two main problems — time and memory — several programming tricks must be used to produce a program which, apart from being interesting and useful, actually works.

The usual structure of moving-graphics programs is a loop in which the display is updated by erasing the current positions of the moving object, calculating their new positions and displaying them before returning for another pass through the loop. The loop must also contain a test for leaving the loop, e.g., has time run out? or a finish position been reached? etc. Let us now consider each part of this loop in turn before looking at the other parts of the program.

Why erase the moving objects before you know where they are going to go next? The reason is that their positions are remembered by two variables, usually L for line and C for column when using Print At statements or X and Y for Plot statements. These two variables are updated continuously.

Thus, it is essential to erase the object before its position is changed and its old position forgotten. However, if the moving objects are the only things on the screen, the whole screen can be cleared at once and this does not have to be done until the new positions have been calculated.

We now examine two possible components of the calculating-new-positions part of the loop. Most moving-graphics programs require a method by which the user can affect the display: usually by means of moving a cursor. Using the Inkey£ instruction, such an effect can be easily created. In the following program, L is the line and C the column denoting the cursor's position. By pressing the unshifted cursor keys 5 to 8, the user can move the cursor by altering its line and column numbers and thus its position on the screen.

```
10 LET L=10
20 LET C=15
30 PRINT AT L,C; "■"
40 LET L=L+(INKEY£="6")-(INKEY£="7")
50 LET L=L+(L<0)-(L>21)
60 LET C=C+(INKEY£="8")-(INKEY£="5")
70 LET C=C+(C<0)-(C>31)
80 CLS
90 GOTO 30
```

Lines 40 to 70 use the special end-of-loop conditional statement of the ZX-81 and ZX-80. If the part in brackets is true, it counts as 1; if not, it counts as 0. The conditional statement re-positions the cursor, lines 40 and 60, and secondly prevents it wandering off the edge of the screen, lines 50 and 70. This small section of the program is fundamental to almost all moving-graphics programs in which the user plays a part. You will find yourself using lines 30 to 70, in identical form, over and over again.

The Plot statement can be used to create a ball which moves in a diagonal fashion around the screen, changing direction when it meets the edge of the screen. The following program illustrates how this is done, again using the special conditional statement.

```
10 LET H=1
20 LET V=1
30 LET X=31
40 LET Y=21
50 PLOT X,Y
60 LET H=(X=0)-(X=63)+H*(X>0 AND X<63)
70 LET V=(Y=0)-(Y=43)+V*(Y>0 AND Y<63)
80 LET X=X+H
90 LET Y=Y+V
100 CLS
110 GOTO 50
```

H and V are the horizontal and vertical directions of the ball: they are changed only when the ball reaches the edge of the screen. X and Y cannot be changed directly as it would then prove difficult to remember which way the ball was travelling.

The two processes we have just examined are extremely useful and are the basis of the main program. Notice that, as yet, we have no means of leaving these loops. Let us now cover the rest of the potential program.

The ZX-81 has an in-built clock which counts in .02 of a second. At the start of the program it may be set to some known value by Poking locations 16436 and 16437. These may be Peeked to find the elapsed time. The clock counts down so it must be set to a large value and this value subtracted from the result of the Peeks at a later stage. Beware of letting the clock count down to zero as this results in the system crashing completely.

This feature has obvious applications for imposing time limits or timing the user in completing a certain task. It is usual to insert a test in the loop already described to see if time is up or if the task has been completed.

If there is some permanent display, such as a maze, the screen cannot be cleared completely so it is necessary to erase the previous position of the moving object as already described. The display itself is, of course, drawn at the start of the program and remains throughout. The end of the program merely consists of printing information such as time or score.

You now have the basic information necessary to write a moving-graphics program on the ZX-81. Even so, the task is not as easy as it sounds. Most of your programs will go one of two ways — and sometimes both.

You will run out of memory or your program will be so slow that it is a great presumption to call it moving graphics. Here are a few tips.

(continued on page 71)

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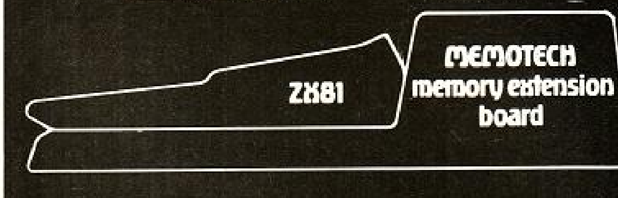

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(continued from page 69)

- Keep instructions in the loop as sparse as possible to avoid a slow program.
- Keep the program as short as you can to save memory for the display — more than 30 lines is generally too much.
- Keep the amount to be displayed as small as possible, again to save memory.
- Keep the amount to be re-drawn — that is, the moving parts — as small as possible since it takes time to print things.

Zero is based on the strange fact that the ZX-81 prints zeros, or variables set to zero, faster than any other character. Thus a fast and difficult game can be developed using this fact. The aim is to capture as many zeros as you can within 60 seconds. You capture one by moving your cursor over the bouncing zero.

When you have managed this, another zero appears immediately at a random position. This continues for 60 seconds, at the end of which your score is displayed. Seven is the maximum.

Lines 10 to 100 initialise the variables: L,C for the cursor; D,M for the zero; and H,V also for the zero. The loop, starting at 110, clears the screen, prints the cursor and zero, tests for a capture, updates the cursor and zero, tests for time up and returns to the start. Line 240 prints the score I at the end of 60 seconds.

```
10  RAND
20  LET L = 10
30  LET C = 15
40  LET H = 1
50  LET V = 1
60  POKE 16437, 255
70  POKE 16436, 183
80  FOR I = 0 TO 25
90  LET M = INT(RND*22)
100 LET D = INT(RND*32)
110 CLS
120 PRINT AT L,C; "■"; AT M,D; "0"
130 IF L=M AND C=D THEN NEXT I
140 IF INKEY# = "" THEN GOTO 190
150 LET L = L + (INKEY#="6") - (INKEY#="7")
160 LET L = L + (L<0) - (L>21)
170 LET C = C + (INKEY#="8") - (INKEY#="5")
180 LET C = C + (C<0) - (C>31)
190 LET H = (D=0) - (D=31) + H*(D>0 AND D<31)
200 LET V = (M=0) - (M=21) + V*(M>0 AND M<21)
210 LET D = D + H
220 LET M = M + V
230 IF PEEK 16437 243 THEN GOTO 110
240 PRINT AT 3,13; I
```

At your command

David Jones, London N9. GENIE

OWNERS OF TRS-80 level 2 and Video Genie systems without discs may be interested to note that they can use disc Basic commands to run their machine-code routines. This is achieved in a similar manner to the use of X=USR(0).

TRS-80 disc Basic is not normally resident in the computer as it is loaded from disc into a reserved area of RAM from such programs as TRSDOS and NewDOS80. Although the machine code of the disc Basic is not available to non-disc users, the command list is.

When the computer executes a DOS command, control is passed from the ROM to a portion of reserved RAM which gives a jump address for that command. When the computer is switched on, this area of RAM is initialised so that the jump address of all DOS commands is the start of the syntax-error routine in the ROM. When a DOS is loaded, the jump addresses within the DOS.

From this it can be seen that a few Pokes in the RAM at the correct place will cause disc Basic commands to jump to whatever address we like. For example, if we wish the disc Basic command Line to run Tandy's line-re-number program, Renum, we would have to cause Line to jump to 7C4C which is the start address of Renum. The jump vector of Line is 41A3H so:

41A3 C3 4C 7C JP 7C4CH

or

Poke 16803, 195: Poke 16804, 76: Poke 16805, 124.

will cause a jump from Line to the address 7C4CH and therefore run the line-re-number program. The other disc Basic commands and their jump vectors are:

CVI	4152	FN	4155	CVS	4158	DEF	415B
CVD	415E	EOF	4161	LOC	4164	LOF	4167
MKI#	416A	MKS#	416D	MKD#	4170	CMD	4173
TIME#	4176	OPEN	4179	FIELD	417C	GET	417F
PUT	4182	CLOSE	4185	LOAD	4188	MERGE	418B
NAME	418E	KILL	4191	&	4194	LSET	4197
RSET	419A	INSTR	419D	SAVE	41A0		

TRS-80 compatibility

Gareth Monkman, Driffield, East Yorkshire. GENIE

HAVING BOUGHT a Video Genie some 18 months or so ago, advertised as fully compatible to TRS-80 software, I soon discovered that not only was it not machine-code-compatible but also not even Basic level-2-compatible. However, with the addition of the Tab and Clear keys, it is at least now Basic compatible.

Recently, with the addition of a Microtek MT-80P printer, I found myself in the same position regarding compatibility. For example, the editor/assembler EDTASM and the disassembler RSM2/2D would not output to the printer. The reason was that TRS-80 software drives the printer by outputting to memory position 37EBH, while the Video Genie uses port FD for printer input/output.

Here are the necessary modifications for both editor/assembler and disassembler programs originally written for the TRS-80.

The following modifications can be done by using RSM2D, which can be used to modify itself, as well as EDTASM. TBug can also be used, but only on RSM as it normally resides in the same memory location as EDTASM and so one of the two must first be moved to another location. EDTASM is resident in 4300H to 5D41H. 45CA 32E837 LD (37E8), A is the TRS-80 version of memory locations 45CAH, 45CBH and 45CCH, and serves to load the contents of the accumulator into location 37EB for driving the printer. This must be changed to the following: 45CA D3FD00 OUT A, FD. This loads the contents of the accumulator out to port FD which is the Video Genie printer port.

45DB 32E837 LD (37E8), A must also be changed to 45CA D3FD00. The 00 part is a non-operation to fill in the empty space.

45EE 3AE837 LD A, (37EB) checks printer status by loading the contents of memory location 37EB into the accumulator and must be changed as follows: 45EE DBFD00 IN A, FD which loads the accumulator from port FD.

(continued on next page)

(continued from previous page)

The disassembler is normally resident from 6C00 to 7E0C. 705B 21E837 LD A, 37E8 loads the accumulator with the contents of 37EB and can be replaced by a call to the printer routine in Basic ROM thus: 705B CDD205 CALL 05D2.

70B4 3E0A LD A, 0A loads the accumulator with 0AH, which is the Hex equivalent for carriage return and must be eliminated, as the ROM routine at 05D2H creates its own carriage return.

Therefore, if it is left, you obtain two carriage returns which tends to waste paper, especially over long listings of memory. It can be removed simply by replacing the entire function with non-operations: ie 70B4 00 00 NOP NOP.

If you take the trouble to disassemble RSM, or use the Hunt facility to find all the positions of 37EB you will also find another at location 6D30H.

6D30 3AE837 LD A, (37EB) must be left as it is, otherwise the program fouls and you may have to re-load.

Bigger screen

Nigel Moat,
Colchester, Essex.

ZX-81

WHILE EXPERIMENTING on my ZX-81 I found a way of putting two extra lines at the bottom of the screen. In the manual on page 123 it states that you cannot Print or Plot on these two lines — which is true, but you can Poke on to these two lines just the same way as you Poke on to the rest of the screen. This can be very useful when you need a slightly larger screen.

With these two extra lines, your game displays can be larger. The extra lines can also be used to display messages, i.e., a message showing who wrote the program. Here is an example program to Poke on to these lines:

```
10  REM***POKE ON TO BOTTOM TWO LINES***
20  REM***  FOR ZX81 WITH 16K RAM***
30  LET X=PEEK 16396+256 * PEEK 16397
40  FOR N=1 TO 792
50  IF PEEK(N+X)<>118 THEN POKE (N+Z),23
60  NEXT N
```

This program Poked an asterisk on to every screen location, including the extra lines at the bottom. If it is used with only 1K RAM, a display file will have to be set up first — it is already there with the RAM pack. Here is an example program to print on to those lines:

```
10  REM *** PRINT A STRING ON TO BOTTOM LINES ***
20  REM *** FOR ZX81 WITH 16K RAM ***
30  LET A$="PROGRAM BY NIGEL MOAT"
40  LET X=PEEK 16396 + 256 * PEEK 16347
50  FOR N=765 TO 765 + LEN A$
60  LET Y=CODE A$(N-764)
70  POKE N+X,Y
80  NEXT N
```

This program prints A$ at the bottom of the screen. Finally, here is a program using the bigger screen. This program draws a box and then 140 blocks in random positions. You are the asterisk in the middle of the screen and you have to navigate yourself around the screen, without touching the barrier or the blocks or the trail of asterisks that you leave behind.

To move, you press "W" to go up, "X" to go down, "A" to go left and "D" to go right. Once you have started moving you cannot stop but can only change direction by pressing the appropriate key. At the top of the screen there are two scores. The first is the present score — the second is the highest so far. It starts easy but grows harder as the screen fills. You can make it harder by changing the number of blocks in line 16C.

(continued on page 74)

```
10  LET H=0
20  SLOW
30  LET X = PEEK 16296+256*PEEK16397
40  FOR N=34 TO 65
50  POKE N+X,128
60  NEXT N
70  FOR N=65 TO 792 STEP 33
80  POKE N+X,128
90  NEXT N
100 FOR N=791 TO 760 STEP-1
110 POKE N+X,128
120 NEXT N
130 FOR N=760 TO 34 STEP-33
140 POKE N+X,128
150 NEXT N
160 FOR N=1 TO 140
170 LET P=INT(RND*758)+34
180 IF PEEK(X+P)<>0 THEN GOTO 170
190 POKE X+P,128
200 NEXT N
210 PRINT AT 0,7;"000"; TAB 23;"000"
220 PRINT AT 0,  -(LEN(STR$ H)); H
230 LET X=X+381
240 LET S=0
250 POKE X,23
260 LET C$="0"
270 LET B$=INKEY$
280 IF B$="W" OR B$="X" OR B$="A" OR B$="D"
    THEN GOTO 300
290 LET B$=C$
300 IF B$="0" THEN GOTO 270
310 LET C$=B$
320 IF B$="W" THEN LET X=X-33
330 IF B$="A" THEN LET X=X-1
340 IF B$="D" THEN LET X=X+1
350 IF B$="X" THEN LET X=X+33
360 IF PEEK X<>0 THEN GOTO 390
362 POKE X,23
380 GOTO 270
390 POKE X,151
400 IF S>H THEN LET H=S
410 PRINT AT 0,13:"PRESS ANY KEY"
420 IF INKEY$<>""THEN GOTO 420
430 IF INKEY$=""THEN GOTO 430
440 CLS
450 GOTO 30

365 LET S=S+1
370 PRINT AT 0, -(LEN(STR$ S));S
```

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(continued from page 72)

Revolutionary art

S Farr,
Hampshire.

ZX-81

THIS REVOLUTIONARY new program plots three-dimensional pictures. The program is for a 3K or larger ZX-81. When the program is run, you have to enter an equation which must contain the values X or Y or both. The program then prints the picture, which takes about three minutes.

Here are four different demonstration lines which can be entered into the machine when the program is run, or you can create your own input lines and see your own masterpiece being created.

1: SIN(X/13)* SIN(Y/6.5)* 30
2: (SIN((X-10)/6.5) + 1)* (SIN((Y−5)/3.25) + 1)*8
3: SIN(X/6.5)* SIN(Y/6.5)* 15 + 11
4: SIN(X/6.5)* SIN(Y/3.25)* 10 + 11

```
10  FAST
20  REM ** 3-D EQUATION PLOTTER **
30  DIM W(2,64)
40  INPUT Z$
50  FOR Y = 0 TO 21
60  FOR X = 0 TO 42
70  LET Z = VAL Z$ + Y
80  IF Z<W(2,X+Y+1) OR NOT Y OR X = 42 THEN LET W(2,X+Y+1) = Z
90  IF Z>W(1,X+Y+1) OR NOT Y OR X = 42 THEN LET W(1,X+Y+1) = Z
100 IF W(2,X+Y+1) = Z OR W(1,X+Y+1) = Z THEN IF Z<44 AND Z>-1 THEN
PLOT X+Y,Z
110 NEXT X
120 NEXT Y
```

Instant execution

D Jansons,
Bolton.

GENIE

WHEN EITHER of these two routines replace the End statement of an assembler program, they enable execution immediately the program has loaded. Version 1 intercepts the keyboard-scan routine and sends back an oblique then an Enter just as if they had been typed in through the keyboard.

Version 2 intercepts the keyboard-scan routine, re-sets the driver address to 03E3H, then loads the start address from the system tape entry point store, 40DFH, and jumps to it. The main assembler program is assumed to start at Start; this can easily be altered as required.

```
VERSION 1

CHANGE  LD HL,CHANG2
        LD (4016H),HL
        LD A,'/'
        RET
CHANG2  LD HL,0DH
        LD (4016H),HL
        LD A,0DH
        RET
        ORG 4016H
        DEFW CHANGE
        END START
```

```
VERSION 2

CHANGE  LD HL,03E3H
        LD (4016H),HL
        LD HL,(40DFH)
        JP (HL)
        ORG 4016H
        DEFW CHANGE
        END START
```

Figure handling

B M Hawkes,
Budleigh Salterton,
Devon.

ZX-81

ALTHOUGH BASIC is a mathematically-orientated language, the versions on most hobbyist micros suffer from excessive accuracy — the results are displayed to far more significant figures than are required for most purposes. This can be awkward when the results are to be tabulated, especially in such micros as the ZX-81, where the number of characters per line is only 32.

Also, tabulation is normally left-justified, whereas it is neater to align the decimal points. These subroutines are designed to carry out those operations.

The first corrects a number of N significant figures, the second to N places of decimals, and the third prints a number with the decimal point at a specified tabulator position. In the first two, it is assumed that the number is already held as A, and that N is also held. At the end of the subroutine, A is corrected to the given accuracy. If the full value is required also, a line such as LET B=A should be inserted beforehand.

In the third program, the number to be printed is again assumed to be held as A, but the tabulator position X of the decimal point is inserted by an Input statement in the subroutine, though it could equally well be inserted by a Let or a Data statement if appropriate to the machine concerned.

Although the programs are written in ZX-81 Basic, the modifications likely to be required for other dialects have been noted.

Lines 510-550 handle integers, 560-650 handle decimals with an integral part, and 660-720 handle decimals less than one. The following modifications are likely to be needed for other dialects of Basic. Line 580:

```
IF ASC(MID$(A$,X,1)) = 46 THEN GOTO 610
```

Line 670:

```
IF ASC(MID$(A$,Y,1)) > 47 THEN GOTO 700
```

Also many Basics use "up arrow" for exponentiation where Sinclair uses two asterisks, so this may need to be altered, and in some Basics storage space could be saved by omitting Let, etc.

To correct A to N decimal places:

```
500 LET X = 10**N
510 LET A = INT(A*X + 0.5)
520 RETURN
```

This should run with any Basic dialect except, of course, integer Basics. To align decimal points in a list:

```
600 INPUT X
610 LET M = LEN STR$ INT A
620 IF INT(10*A)<> 0 OR A = 0 THEN GOTO 640
630 LET M = M−1
640 PRINT TAB X−N; A
650 RETURN
```

```
500  IF INT A <> A THEN GOTO 560
510  IF A < 10**N THEN RETURN
520  LET X = LEN STR$ A
530  LET A = A+5*10**(X-N-1)
540  LET A = 10**(X-N)*INT(A/10**(X-N))
550  RETURN
560  LET A$ = STR$ A
570  LET X = 1
580  IF CODE A$(X) = 27 THEN GOTO 610
590  LET X = X +1
600  GOTO 580
610  IF A < 1 THEN GOTO 660
620  LET A = A + 5 * 10 ** (X-N-2)
630  LET Y = 10**(N-X+1)
640  LET A = INT(A*Y)/Y
650  RETURN
660  LET Z = 1
670  IF CODE A$(Z)>28 THEN GOTO 700
680  LET Z = Z + 1
690  GOTO 670
700  LET A = A + 5*10**(X-Z-N)
710  LET Y = 10**(N+Z-X-1)
720  GOTO 640
```

Spacefire

Marcus Altman,
Westcliff-on-Sea, Essex.

PET

THIS GAME is in two parts: the first is a maze and the second is a Space Invaders-type game.

The program starts by asking you if you want to play the easy or difficult version of the game. In the hard version, there are explosive mines to avoid in the second part of the game which are absent in the easy version. You are then asked if you want instructions and once you have either read them or skipped them, you progress to the first part of the game.

In the top left-hand corner of the screen you will see the time ticking away, second by second. When it reaches 200, the game is over and you are told so. You have to find your way through the maze as quickly as possible by using the keys described in the instructions. Once you arrive within one square of the dot at the top of the screen, you are put into the second part of the game automatically.

The idea here is to destroy as many of the enemy ships as you can. They will swoop down from the mother-ship at the top of the screen at various angles. They leave the screen at one side and they will return from the opposite side.

You can move your sight around the screen using the same keys as for the maze but you do not have to keep on banging the keys because once you have pressed a key to move in a certain direction, your sight will move that way until you press another or press 7 which stops your movement. To make the game a little easier, when you move up or down, the enemy ships stay where they are and start to move again when you stop or turn sideways.

To fire, press 5. If the enemy is on one of the crosspieces of your sight when you fire, you score five points, but if you hit it dead centre, you score 10 points.

```
0 PRINT"J"
1 PRINT"THIS IS THE GAME OF SPACEFIRE AND IT WAS"
2 PRINT"      INVENTED BY MARCUS ALTMAN              "
3 PRINT:GOTO 10
4 PRINT " DO YOU WANT INSTRUCTIONS?(Y-OR-N)"
5 GET O6$
6 IF O6$="Y" THEN GOTO 19
7 IF O6$="N" THEN GOTO 38
8 GOTO 5
9 PRINT"QQQQQQ"
10 PRINT"DO YOU WANT TO PLAY THE EASY OR HARD    GAME?(E-OR-H)"
11 GET A7$:IF A7$="E" THEN S7=1:GOTO 4
12 IF A7$="H" THEN S7=0:GOTO 4
13 GOTO 11
19 PRINT"J"
20 PRINT"IN THE FIRST PART YOU HAVE TO GET TO              THE END OF THE MAZE."
21 PRINT"Q";"TO CONTROL YOUR SHIP(+):"
22 PRINT"2=DOWN 4=LEFT 6=RIGHT 8=UP"
23 PRINT"Q";"WHEN YOU GET OUT OF THE MAZE YOU GO ONTO          BATTLE COMPUTER."
24 IF S7=1 THEN GOTO 26
25 PRINT"IF YOU HIT A MINE YOU LOSE 1 OF 3 LIVES."
26 PRINT
27 PRINT"YOU HAVE 200 SECONDS TO KILL AS MANY     ENEMY SHIPS AS POSSIBLE."
28 PRINT
29 PRINT"YOUR SIGHTS ARE MOVED THE SAME AS ABOVE AND TO FIRE PRESS 5.";
30 PRINT"YOU CAN HIT WITH THE EDGE OF THE SIGHTS BUT SCORE 5 NOT 10."
31 PRINT"YOUR SIGHTS KEEP ON MOVING IN THE SAME  DIRECTION AS THE LAST NO.";
32 PRINT"PRESSED UNTIL    YOU PRESS A DIFFERENT NUMBER."
33 PRINT"7 STOPS YOUR SIGHTS MOVING."
34 PRINT"REMEMBER YOU CAN GO OFF ONE EDGE OF THE SCREEN AND COME ON AT THE OTHE
35 PRINT" TO GO ON PRESS G."
36 GET G$:IF G$="G" THEN GOTO 38
37 GOTO 36
38 REM SET UP MAZE
39 PRINT"J":FOR B=32768 TO 32807:POKE B,160 :NEXT B
40 LET C=32788
50 POKE C,46
60 LET BB=INT(40*RND(1)+34752)
62 LET CC=INT(3*RND(1)+1)
63 IF CC=1 THEN DD=1
64 IF CC=2 THEN DD=-1
65 IF CC=3 THEN DD=-40
68 BB=BB+DD:POKE BB,96
69 IF BB<=33928 THEN GOTO 71
70 GOTO 62
71 FOR EE=1 TO 400
72 GG=160
73 LET FF=INT(800*RND(1)+32928)
74 IF PEEK(FF)=96 THEN GG=96
75 POKE FF,GG
76 NEXT EE
90 LET E=INT(40*RND(1)+34752)
100 POKE E,43
110 Z=TI
111 REM SET TIMER
115 V=TI-Z
117 Y=Y/60
118 Y=INT(Y)
119 REM GET KEY FOR MOVING SHIP
120 GET F$
125 PRINT"S":PRINTY
128 POKE E,65
130 IF F$="2"THENG=40:        GOTO 170
140 IF F$="4" THEN G=-1:       GOTO 170
150 IF F$="6"THENG=1:        GOTO 170
160 IF F$="8" THEN G=-40:       GOTO 170
165 GOTO 115
167 REM MOVE SHIP AND SEE IF IT HAS HIT A SQUARE
170 POKEE,32:E=E+G
171 IF PEEK(E)=160 THEN GOTO 250
172 POKE E,65
220 IF PEEK(E-40)=46 THEN GOTO 300
230 GOTO 115
250 GOTO 255
254 REM DON'T LET SHIP TOUCH SQUARE
255 POKE E,160:E=E-G:POKE E,43
260 Y=Y+10:GOTO 115
299 REM SET STORES TO 0 AND SET UP SCREEN
300 PRINTCHR$(147):A=0:B=0:C=0:D=0:E=0:F$="0":G=0:S=0:T=0:U=0:V=0
301 POKE 32821,160:POKE 32835,160
310 FOR P=32781 TO 32795:POKE P,160:NEXT P
324 REM STARS
325 FOR A1=1 TO 200
330 LET A=INT(800*RND(1)+32928)
340 POKE A,46
345 NEXT A1
349 REM MINES
350 IF S7=1 THEN GOTO 360
351 FOR S4=1 TO 10
352 LET S5=INT(800*RND(1)+32928)
353 POKE S5,35
354 NEXT S4
355 REM SIGHTS
360 B=33307:B1=33309:B2=33268:B3=33348
370 POKE B,70:POKE B1,70:POKE B2,93:POKE B3,93
389 REM ENEMY SHIP
390 LET C=INT(11*RND(1)+32865)
391 GOSUB 2000
399 REM SET ANGLE OF MOVEMENT
400 LET D=INT(5*RND(1)+38)
420 POKE C,32:C=C+D:POKE C,83
430 IF C>=33767 THEN POKE C,32:GOTO 390
440 GET E$
441 Y=TI-Z:Y=Y/60:Y=INT(Y):IF Y>=200 THEN GOTO 5000
442 PRINT"S":PRINTY:PRINT"Q":PRINTZ3
450 IF E$="2"THEN F=40
460 IF E$="4" THEN F=-2
470 IF E$="6" THEN F=1
480 IF E$="8" THEN F=-40
490 IF E$="5" THEN GOTO 560
495 IF E$="7" THEN F=0
497 REM MOVE SIGHTS AND SEE IF SIGHTS HAVE TOUCHED  A MINE
510 POKE B,32:POKE B1,32:POKE B2,32:POKE B3,32
520 B=B+F:B1=B1+F:B2=B2+F:B3=B3+F
521 IF PEEK(B)=35 THEN GOTO 3000
522 IF PEEK(B1)=35 THEN GOTO 3000
523 IF PEEK(B2)=35 THEN GOTO 3000
524 IF PEEK(B3)=35 THEN GOTO 3000
530 POKE B,70:POKE B1,70:POKE B2,93:POKE B3,93
534 REM STOP SIGHTS MOVING TOO FAR
535 IF B3>=33698 THEN J=-40:GOTO 2500
540 IF B2<=32928 THEN J=40:GOTO 2500
545 IF F=40 THEN GOTO 440
546 IF F=-40 THEN GOTO 440
550 GOTO 420
555 REM FIRING SEQUENCE
560 K=B-10:L=B1+10  :M=B3+400:N=B2-400
570 K=K+1:L=L-1:M=M-40:N=N+40
571 P0=93
572 IF M>=33698 THEN P0=32
573 POKE K,64:POKE L,64:POKE M,P0:POKE N,93
580 IF K=B THEN GOTO 600
588 GOTO 570
600 K=B-10:L=B1+10:M=B3+400:N=B2-400
610 K=K+1:L=L-1:M=M-40:N=N+40:POKE K,32:POKE L,32 :POKE M,32:POKE N,32
615 IF (B+1)=C THEN LL=10:GOTO 1000
616 IF B=C THEN LL=5:GOTO 1000
617 IF B 2=C THEN LL=5:GOTO 1000
618 IF B 3=C THEN LL=5:GOTO 1000
619 IF B1=C THEN LL=5:GOTO 1000
620 IF K=B THEN POKE B,64:POKE B1,64:F=0:   GOTO 420
630 GOTO 610

999 REM SUCCESS-YOU HIT ENEMY
1000 PRINT"J"
1001 Z3=Z3+LL
1010 PRINT"▒▒▒▒▒▒▒▒▒▒ ▒▒▒▒▒▒▒▒▒ ▒    ▒    ▒ ▒ ▒ ▒"
1020 PRINT"▒        ▒ ▒       ▒ ▒    ▒    ▒ ▒ ▒ ▒"
1030 PRINT"▒        ▒ ▒       ▒ ▒    ▒    ▒ ▒ ▒ ▒"
1040 PRINT"▒        ▒ ▒       ▒ ▒    ▒    ▒ ▒ ▒ ▒"
1050 PRINT"▒        ▒ ▒       ▒ ▒    ▒    ▒ ▒ ▒ ▒"
1060 PRINT"▒▒▒▒▒▒▒▒▒▒ ▒       ▒ ▒    ▒    ▒ ▒ ▒ ▒"
1070 PRINT"▒          ▒       ▒ ▒    ▒    ▒ ▒ ▒ ▒"
1080 PRINT"▒          ▒       ▒ ▒    ▒    ▒ ▒ ▒ ▒"
1090 PRINT"▒          ▒       ▒ ▒    ▒    ▒ ▒ ▒ ▒"
1100 PRINT"▒          ▒       ▒ ▒    ▒    ▒ ▒ ▒ ▒"
1101 PRINT"▒          ▒       ▒ ▒    ▒    ▒ ▒ ▒ ▒"
1102 PRINT"▒          ▒       ▒ ▒    ▒    ▒"
1103 PRINT"▒          ▒▒▒▒▒▒▒▒▒ ▒▒▒▒▒▒▒▒▒▒▒ ▒ ▒ ▒"
1110 FOR Q3=1 TO 1000:NEXT Q3
1120 GOTO 300
1999 REM SET UP MOTHER SHIP AGAIN
2000 POKE 32821,160:POKE 32835,160
2010 FOR P=32781 TO 32795:POKE P,160:NEXT P
2020 RETURN
2499 REM STOP SIGHTS GOING TOO FAR
2500 POKE B,32:POKE B1,32:POKE B2,32:POKE B3,32
2510 B=B+J:B1=B1+J:B2=B2+J:B3=B3+J
2520 POKE B,70:POKE B1,70:POKE B2,93:POKE B3,93
2530 GOTO 420
2999 REM BAD LUCK-YOU'VE BEEN HIT
3000 PRINT"J"
3010 PRINT"▒▒▒▒▒▒▒▒ ▒▒▒▒▒▒▒▒ ▒▒    ▒ ▒▒▒▒▒▒▒"
3020 PRINT"▒      ▒ ▒      ▒ ▒▒    ▒ ▒"
3030 PRINT"▒      ▒ ▒      ▒ ▒ ▒   ▒ ▒"
3040 PRINT"▒      ▒ ▒      ▒ ▒  ▒  ▒ ▒"
3050 PRINT"▒▒▒▒▒▒▒  ▒▒▒▒▒▒▒▒ ▒   ▒ ▒ ▒    ▒▒▒"
3060 PRINT"▒      ▒ ▒      ▒ ▒    ▒▒ ▒      ▒"
3070 PRINT"▒      ▒ ▒      ▒ ▒     ▒▒ ▒     ▒"
3080 PRINT"▒▒▒▒▒▒▒▒ ▒      ▒ ▒     ▒▒ ▒▒▒▒▒▒▒"
3085 FOR O6=1 TO 1000:NEXT O6
3090 Z6=Z6+1
3100 IF Z6>=3 THEN GOTO 3200
3110 GOTO 300
3200 PRINT"J"
3210 PRINT"QQQQQQ"
3220 PRINT"YOU'VE BEEN HIT 3 TIMES AND SCORED:"
3230 PRINT"QQQQQQ"
3240 PRINT"▶▶▶▶▶▶▶▶▶▶▶";Z3;"POINTS"
3250 GOTO 4000
4000 PRINT"QQQQ";"▶▶▶"
4001 PRINT"DO YOU WANT ANOTHER GAME?"
4002 Z3=0:Z6=0:Y=0
4010 INPUT A$
4020 IF A$="YES" THEN GOTO 0
4030 IF A$="NO" THEN END
4040 GOTO 4010
5000 PRINT"J"
5001 PRINT"QQQQQQ"
5010 PRINT"YOU'VE RUN OUT OF TIME AND SCORED:"
5020 PRINT"QQQQQQ"
5030 PRINT"▶▶▶▶▶▶▶▶▶▶▶";Z3;"POINTS"
5040 GOTO 4000
```

(continued on next page)

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Easing operation

P R Ainsworth,
Swansea.

ZX-81

I HAVE NOTICED an interesting number of letters from Sinclair ZX-80/81 owners complaining about faults and difficulty of operation. I have owned a ZX-81 for several months and have experienced and investigated many of the problems. Most can be solved and I hope my experiences will save other owners from some of the frustration and annoyance.

Operating temperature is a problem with ZX-80 and ZX-81 not helped on the ZX-81 by the fact that the Sinclair-designed integrated circuit has an operating temperature of 70°C. I have carefully drilled four .25in. holes along the back face of the ZX-81, using a sleeve on the drill bit to prevent internal damage to the machine. This allows warm air to escape, and the keyboard remains only slightly warm after several hours of operation.

My cassette recorder, a £20 Ferguson model, has always loaded and saved perfectly using standard C-60 tapes, provided that the correct procedures are followed. A few points worth re-stating are:

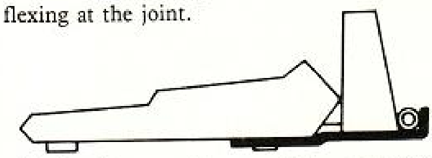
- Disconnect one end of the lead not in use — the ear lead when saving, the microphone lead when loading — this prevents interference and is particularly important during Save to ensure that the five-second silence preceding the program is not distorted.
- When loading programs without using the name option, ensure that the tape is positioned just inside the five-second silence before starting the load, otherwise the buzz preceding the silence may cause problems. This is particularly important on the ZX-80 which does not have the named-program facility.
- If you are buying a recorder, avoid the very cheap ones unless you can test them and try to find one with a tape counter.

Intermittent memory failure is an extremely frustrating problem which occurs only since I received my 16K RAM pack. The symptoms are a sudden program crash, often just as a key is depressed, with strange patterns appearing on the screen.

The only way to regain control is to power off, although the machine may occasionally re-set itself but clearing its memory in the process. There is not any fault in either ZX-81 or RAM — the problem arises because of the design of the edge connector. The ZX-81 has flexible cushion feet and the RAM does not — as both touch the surface on which the machine rests, and the joint is not rigid, some slight relative movement occurs every time a key or the machine itself is touched.

In these circumstances, memory lapses are not just possible — they are inevitable. Cleaning the edge connector and smearing it with petroleum jelly improves the mean time between failures — in my case from 15 to 45 minutes but the effective and permanent cure is to make the edge connector a rigid joint.

I have attached a rigid aluminium strip to the underside of the ZX-81 and this supports the underside of the RAM pack. With thicker sponge feet on the ZX-81, the RAM is then clear of the working surface and there is no flexing at the joint.



In the diagram, the gap at the rear of the supporting strip is to allow removal of the RAM, and is filled with flexible plastic or rubber tube when the RAM is in place. If the support strip is attached using screws and nuts, be careful that they do not project too far into the machine — the PCB is quite close.

I have spent an evening modifying the Lunar Landing program to improve the display, the speed of execution and screen update, the crash graphics which did not work, the orbital calculations which were not very accurate and the ease of control. Of course, the program is now larger but the end result is very different.

Incidentally, I have found that most reasonable games programs written with good graphics and clear instructions and designed to be crash-proof tend to occupy about 10 to 12K on the ZX-81 — Lunar Landing, Black Box, Yahtzee and Sheepdog for instance have all finished in this range.

For those who find that the Sinclair Combat program will not work without crashing the system, there are several invalid program lines in my version: Line 705 should read

```
POKE 16437,255
```

Line 6012 should read

```
LET MC=MC-1
```

Line 7091 has such severe corruption that any attempt to edit it crashes the machine. However, deleting this line number does work, and a new line 7092 appears as if my magic. Line 7091 can now be input as

```
POKE 16437,255
```

My normal means of checking that an input number is, say, a positive whole number is to use the form:

```
100 INPUT X
110 IF ABS INT X <> X THEN GOTO 100
```

However, on the ZX-81 I suddenly discovered that if alphabetic keys are pressed, they can be accepted. The system will accept them if they are the same as a previously declared variable, otherwise the program will terminate with an undefined-variable error.

To make my programs foolproof now requires all input to be either Character or via the Inkey function, and validity checking of multi-digit numbers input via a character variable can be quite cumbersome.

More in store

E J Harding,
Cullompton, Devon.

ATOM

THIS PROGRAM is useful for storing large amounts of text — in this case, the upper text/graphics space. When typing in text using the program, care should be taken that words have enough space to be fitted on the rather small lines, and do not overlap on to the next line.

Instead of using the delete key, use Ctrl h, as this will delete the unwanted characters from the memory, while delete only adds back-spaces to the text.

To return from the typing-in mode, type Ctrl 1. The listing of the text is in the non-paged mode, and to halt the printing of the text, the Ctrl key should be pressed and the shift key resumes the output.

If you have the off-board expansion RAM card fitted, the value of "m" in line 10 should be altered to the start address of the expansion text space. This will reduce the screen noise, which results from accessing graphics memory when in- or outputting text.

Running the program from a cold-start, "d" should be cleared of random contents by setting it to zero. To save the text on tape, first enter the immediate mode by typing Esc, then find the end address by typing:

```
P.&d+£8201
```

then save the text by typing

```
*save 8200 XXX
```

where XXX is the number typed.

```
2   REM textfiles
4   ?#81≠0;F=#80
6   V=#21C;!V=#B0FE7120;V!4=#022C2007;V!8=#60EA8185
8   V!12=#F8D0FFA9;V!16=#FEA74C08
10i M=#8200;R≠#FFE3
12  P.$12,"(11 spaces)TEXT FILES"'''''
14k IN."WRITE/LOAD/REVIEW(W/L/R)"$F;IF $F="W" D=0;G.c
16  IF $F="R" AND D 0 G.z
18  IF $F≠"R" P."NO TEXT IN MEMORY";G.k
20  IN."END ADDRESS OF FILE "D;D=D+#8200
22  P."WIND TO FILE AND"'
24  *LO.8200
26  G.α
30c DO
32t LINK R;LINK V;IF ?#81=255 G.t
34  IF ?#81  13 G.v
36  D?M=13
38  P.$13
40  D=D+1
42  D?M=10
44  P.$10
46  G.l
48v IF ?#81  8  G.a
50  D=D-1;P.$8
52  G.b
54a IF ?#81 =#1F G.b
56  D?M=?#81;P.$?#81
58l D=D+1
60b IF D=5000 P.$7
62  U.?#81=17
64  P.$12
66α IN."REVIEW/CONTINUE/BEGIN(R/C/B)"$F
68  IF $F="C" ?#E1≠#80;G.c
70  IF $F="B" 0=0;?#E1=0;G.c
72  P.$12;?#E1=0
74z F.W=0 TO (D-1)
76  IF ?#B001  191 G.o
78  DO U.?#B001=127
80  P.$W?M
82  N.;G.α
```

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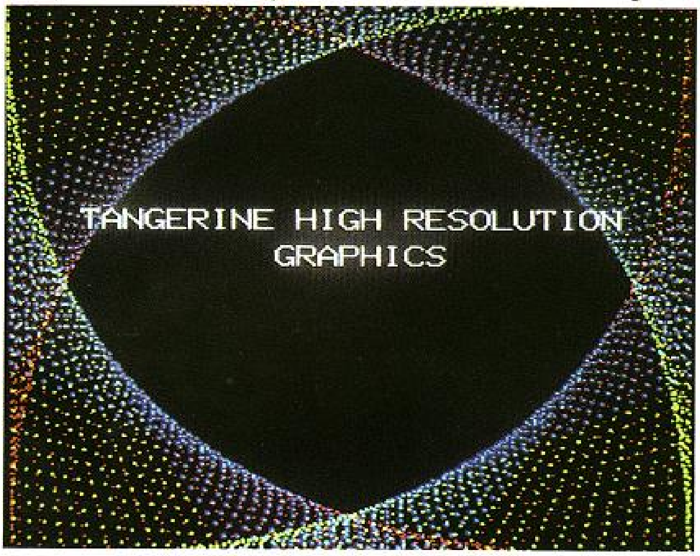

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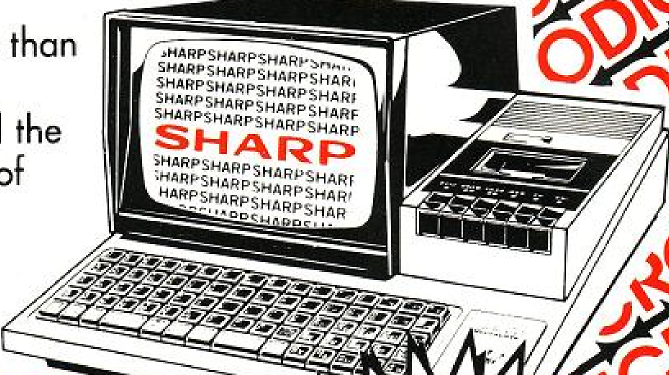

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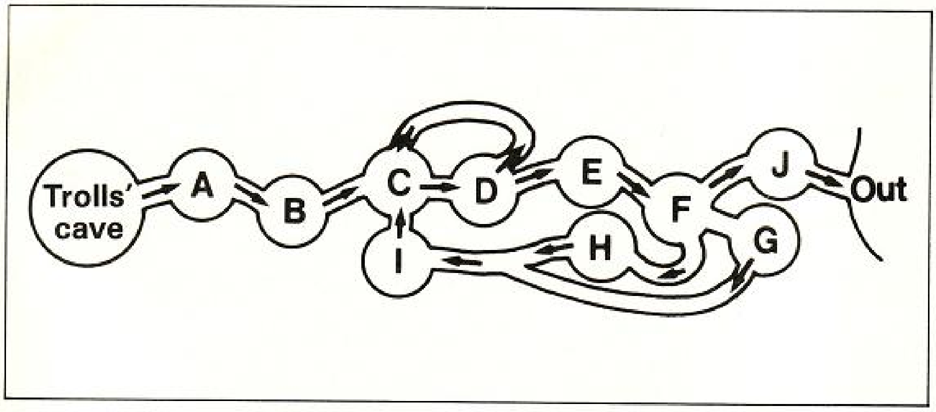
Trolls' cave

BY ANTHONY ROBERTS

YOU HAVE BEEN captured by the trolls of Zellers Hill and suspended in a cage over a pit of ravenous man-eating worms. You are fed well enough, but the smell of the worms is revolting. Your only chance to escape is on New Year's Eve, when the trolls let you down to join in the festivities, and just for fun, may make you run for your life at midnight through their cave system while they pile treasures on to you — or perhaps take some away.

You know for a certainty that should you walk out of the hill carrying any treasure, you will be set on and killed by the bandits waiting for you. So you must ensure that you loose it all before you leave. Of course, you make it. On what day of the week did you make your escape?

This is the cave system and the trolls' individual instructions for each cave: all passages are one-way only.



Cave A — Gives you an amulet and five bracelets.
Cave B — Gives you one more diamond than the new year — e.g., 80 diamonds in 1979, 86 diamonds in 1985.
Cave C — Gives you as many coins as you have bracelets, but takes away as many diamonds as you have amulets.
Cave D — Sends you down the left fork if you have fewer amulets than diamonds, else sends you to the right.
Cave E — Gives you three more amulets.
Cave F — Directs you left to the final cave, if you have at least 10 amulets, straight on if you have less than five, and to the right otherwise.
Cave G — Takes from you as many bracelets as you have amulets.
Cave H — Gives you two coins.
Cave I — Swaps each coin for a diamond, but takes any diamonds you walked into the cave with.
Cave J — Takes all your amulets, bracelets, and coins, and just one diamond "for good luck" — and kicks you out of the hill into the midst of the bandits' camp. ■

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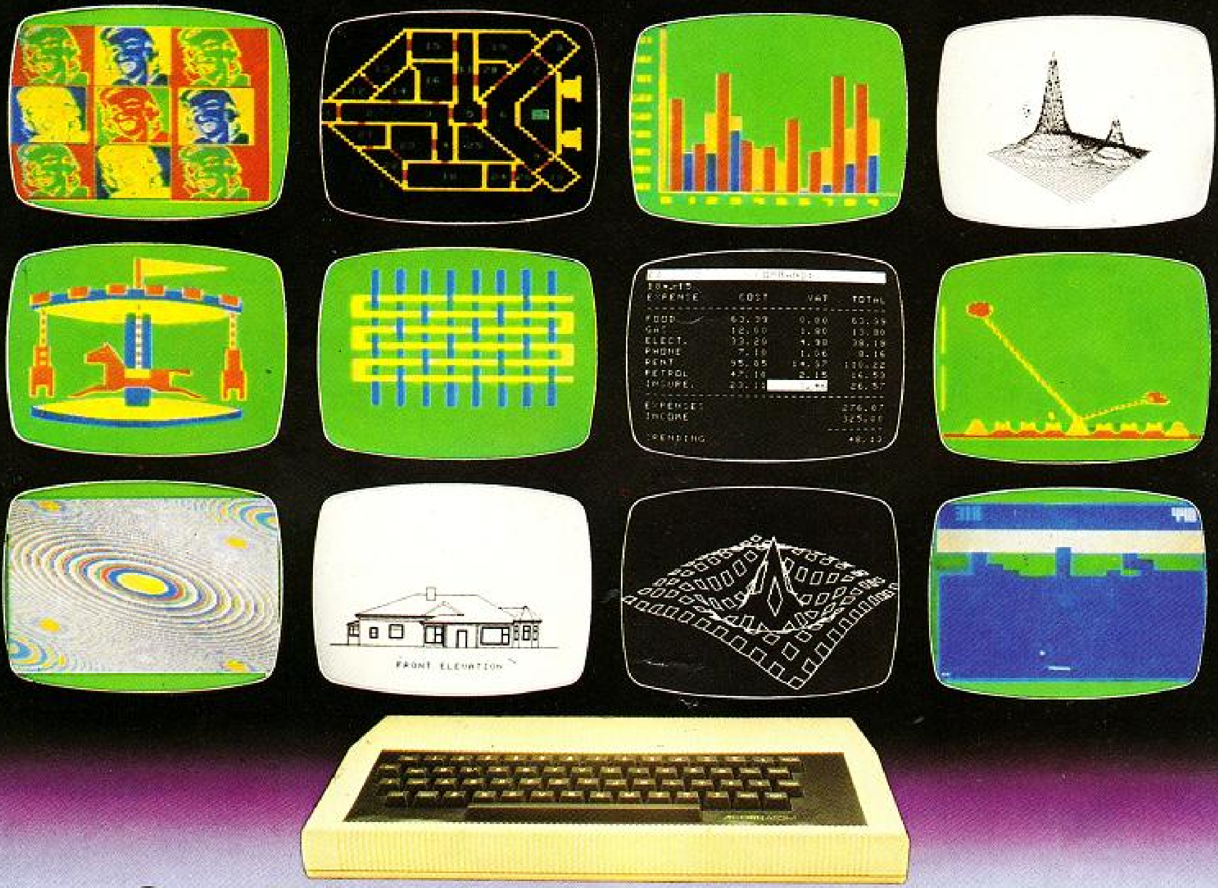

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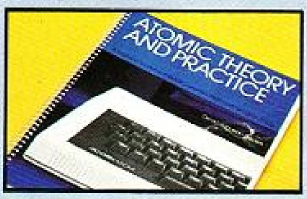

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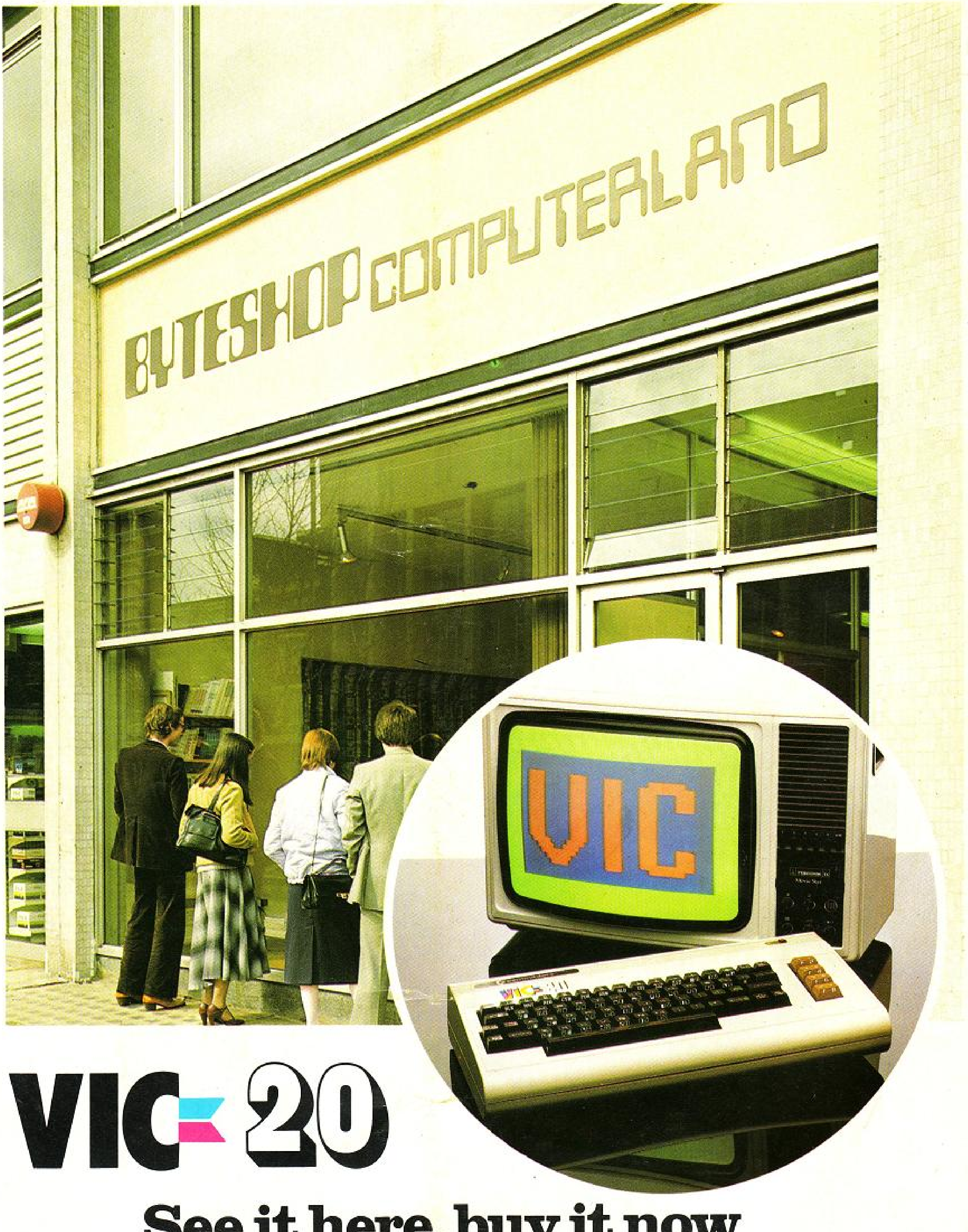
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