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SIZE	SQR		*	ENTER	MAG
CONT	SYS	STATEMENTS	UNIT	LIST	TOF
MON	TIC	IF	BAUD	PURGE	TON
	SQN	ELSE	CALL	NUMBER	DIM
	BIT	ON	DATA	RENUM	DEF
FUNCTIONS	CRB	GOTO	READ	BOOT	NEW
ABS	CRF	GOSUB	RESTOR	GRAPH	END
ADR	MEM	POP	RETURN	TEXT	BIT
ASC	MWD	REM	STOP	PLOT	CRB
ATN	LEN	FOR	TIME	UNPLOT	CRF
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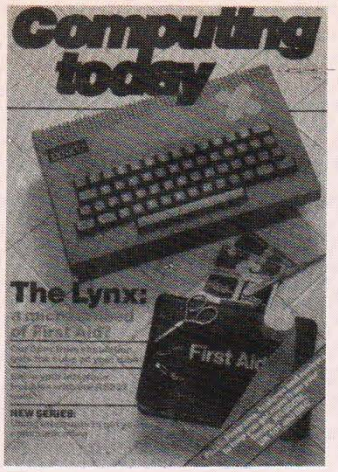

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Computing Today is constantly on the look-out for well written articles and programs. If you think that your efforts meet our standards, please feel free to submit your work to us for consideration.

All material should be typed. Any programs submitted must be listed (cassette tapes and discs will not be accepted) and should be accompanied by sufficient documentation to enable their implementation. Please enclose an SAE if you want your manuscript returned, all submissions will be acknowledged. Any published work will be paid for.

All work for consideration should be sent to the Editor at our Charing Cross Road address.

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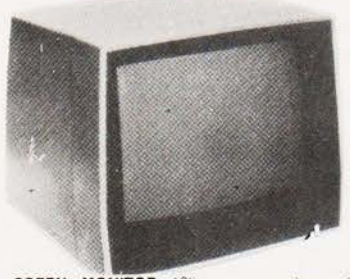

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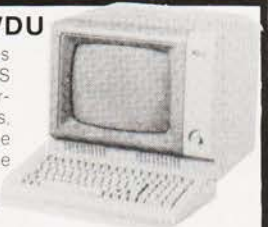

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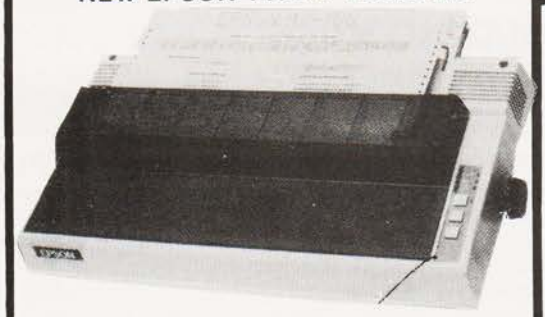

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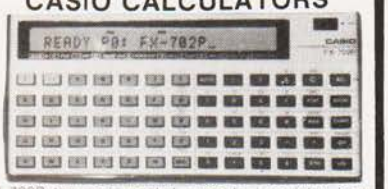

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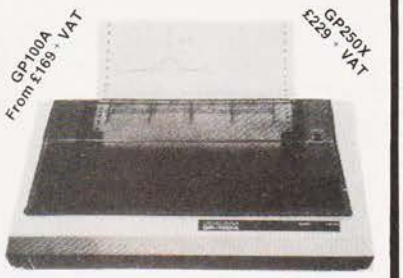

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CONSUMER NEWS

BUG BYTES

Our apologies must go to those *Computing Today* readers who keyed in the Froglet program from the April issue, only to find that it wouldn't work! Let us emphasise however that it will work quite happily if your BBC Micro has an operating system of 0.1, providing you put one extra bracket at the end of line 1710, which most of you spotted was missing. As listed in the magazine though the program will not run with the newer operating systems, 1.0 and 1.2. If you have these systems or would like to read about some slight refinements to the program please read the article called Updating Froglet later in this issue of *Computing Today*.

Referring back to the Spring 1983 issue of *Personal Software* some of the more discerning of our readers realised that line 830 was missing from the Multi Test program which should have read exactly the same as line 1090.

BEEB GO LIVE

Since the success of the BBC TV series *'Making the Most of the Micro'* which had a regular audience of nearly 3,000,000 viewers a week and generated a fantastic amount of written response, the BBC have decided to put on a live show on the subject of microcomputing for nearly two hours on BBC1 on Sunday October 2nd 1983.

There will be a phone-in to the studio, where presenter Ian McNaught-Davis will be joined by various experts and micro users. They will be answering questions, demonstrating equipment and software in a 'workshop', and discussing the uses and abuses and the past, present and future of the micro. There will also be a studio audience who will be able to join in the questions and discussion.

The production team would like to hear from anyone interested in taking part, either in the phone-in or as a member of the audience. Please write with suggestions, comments or questions and with a daytime telephone number to Micro Special, PO Box 7, London W3 6XJ. Not every letter will be replied to but ideas from viewers (and not just micro owners) will be most welcome.

MICRO REJUVENATION

For ZX81 owners who want to keep and improve their machines, you can now get a comprehensive package deal to upgrade your computer. Called the ZX8100 Deal (since the manufacturers claim you will end up with a computer 100 times better) it is designed to overcome such aspects of the ZX81 as the flat keyboard, no repeat key, 'eye-straining' white display and lack of reset key. The package comes with a six month guarantee at a price of £42.50 inclusive of fitting charge. Those handy with a soldering iron can order one for fitting themselves for £40. A range of optional extras are also available including a pair of joystick sockets, an output socket to drive a standard computer monitor, and even the RAM pack and power supply can be put inside the keyboard case, making one neat unit.

Details are available from the TEC shop, 26a Bradford Street, Shifnal, Shropshire, where the system can be viewed along with a vast range of software for the ZX81 and other computers.

COLOURFUL TEXET ▼

Texet have produced a 8K RAM eight colour computer which is expandable to 64K for the amazing prize of £98. A memory expansion module is available for just £52.

The language is Microsoft BASIC, it has a full size keyboard with moving keys, and can be attached to either a monitor or TV. The cassette interface card connects to any standard audio cassette recorder, and there is a memory expansion bus and a peripheral expansion bus built into the machine. To accompany the TX8000 is a wide variety of software ranging from home finance to video games. A selection of joysticks are also available ranging from £7.95 to £59.95 in price. Other hardware include a printer at £129, monitors, cassette players, computer cassette tapes, light pens and a printer interface. For more information please contact Texet, Commercial Avenue, Stanley Green Trading Estate, Cheadle Hulme, Cheshire SK8 6PT or 'phone 061-486 9231.

GETTING COMMERCIAL

Whilst the vagaries of the pocket calculator market have, in general, little to do with the world of the personal computer it is nice to see one manufacturer beginning to advance his marketing strategy for both products as part of a massive sales campaign. The manufacturer, Sharp, has decided to push the humble calculator through a wide range of High Street shops, newsagents and supermarkets. And, as part of their campaign to spread the good word about things that compute they have tacked the PC-1251 pocket computer onto the top end of the range. So, don't be surprised to see a self demonstrating machine in your local Hi-Fi shop or High Street electrical outlet in the very near

future. Sadly, for those who love to re-program the demos Sharp have incorporated a Perspex shield so little fingers can't get at the keys!

Also quietly announced at the launch was the imminent arrival of a new electronic typewriter. Due to be unveiled at the Hanover Fair it will shortly be available in this country and has the option of an RS232 interface which should provide Sharp with a low cost, high quality printer for their range of personal computers. News from Japan concerning the company also indicates that we may well have a rather smart small business machine launched here by the end of the year. Designated the MZ-3541 it should come as standard with 128K of RAM, twin 5¼" discs and detached keyboard plus a tilt and turn green monitor to cap the package off. Price, well it should be somewhere around £1,700 but time will tell how accurate this estimate is.

PLAYING IT SAFE

Texas Instruments have stated that there is no electrical shock hazard with the European version of TI's 99/4A Home Computer. This is to quell any fears that may have been generated by the possible problem with the 100 volt version of the power transformer provided for use in North America and which received extensive publicity there. The potential transformer defect was discovered by TI in the laboratory and they have implemented a voluntary program to eliminate the possible defect for all users of the machine.

TI emphasise however that the European 220-240 volt transformer for the 99/4A Home Computer is in full conformance with European safety standards and is perfectly safe for continued use by customers and for continued sale by retailers.

RETRACING STEPS

RD Laboratories have opened a manufacturing base in Cwmbran, Gwent: the need for new premises was precipitated by the success of the RD Digital Tracer which was launched in October 1982. Sales of the Tracer far exceeded projections and delivery dates began to slip, but with the new production facility they are claiming that orders now being placed will be met within the 28-day delivery promise again.

The Digital Tracer makes it possible for a ZX Spectrum (or ZX81) user to transfer a picture or design straight to TV screen through display file. This is done simply by moving the head of the Tracer's jointed arm over the original shape. At around £50 the product appeals as much to the home hobbyist as in education (where it is used extensively in visual aid preparation) and professionally. For more information contact RD Laboratories, 20 Court Road Estate, Cwmbran, Gwent NP44 3AS, or 'phone 06333-74333.

HOT OSBORNES

During the weekend of February 26-28 thieves broke into the offices of Ø1 Computers and stole over £30,000 worth of computers and peripherals. The haul included eight Osborne Microcomputers, 14 Osborne printers, 17 Osborne monitors, a Wang computer, parts of an Olivetti computer, and a selection of other 'goodies' including two months' supply of coffee!

A substantial reward is being offered for information leading to the recovery and/or successful persecution of the thieves and their accomplices. So if someone offers you any of the above at a price too good to be true, why not do the right thing and contact Bob Rothman on 01-228 2207, or at Ø1 Computers, Southampton House, 192/206 York Road, London SW11 3SA.

THE PRICE OF PLEASURE

The price of pleasure with Atari home computer products is now lower than ever. The new prices are £159.99 for the Atari 400 Home Computer with 16K RAM, £39,99 for the Atari Programmer Kit, and £399.99 for the Atari 800 Home Computer including BASIC cartridge and manuals, now upgraded from 16K to 48K RAM.

SINCLAIR SOUNDING OFF

Bi-Pak Semiconductors have introduced a modified version of their sound generator for use with the ZX81, Sinclair Timex 1000 and the ZX Spectrum. Designated ZON X, the unit is self-contained in a black plastic case with a loudspeaker and manual volume control. No power supply or batteries are required to power the unit – it simply plugs into the back of the micro. A wide range of sound effects are available with the unit including pianos, organs, bells, helicopters, lasers and

explosions. For use with the ZX Spectrum there is a further plug-in adaptor for the ZON X which houses a crystal and other electronic devices needed to give unlimited sound facilities.

The ZON X unit is available from Bi-Pak Semiconductors, PO Box 6, Ware, Hertfordshire or you can 'phone 0920-3442/3182. The prices (including VAT and postage) are: £25.95 for the ZON X to use with the ZX81 and Sinclair Timex 1000, £32.75 for the ZON X plus special adaptor for the ZX Spectrum, and £6.80 for the ZX Spectrum adaptor only. Trade and overseas enquiries are also welcome.

BRIEFING

Commodore Business Machines (UK) Ltd have announced a £20,000,000 programme to build personal computers in Corby. The new manufacturing facility is expected to employ over 300 people by the end of next year and will become the Company's manufacturing and distribution centre for Europe.

Granada Publishing Limited have published two new books on the BBC Micro: **BBC Micro Graphics and Sound** by Steve Money (£5.95) and **Introducing the BBC Micro** by Ian Sinclair (£5.95). Details of these or other books published by the company can be obtained from **Granada Publishing Limited,** PO Box 9, St. Albans AL2 2NF.

The UK publishers of Sinclair User, **ECC Publications Limited** are launching a similar title in the USA. One of the world's largest publishers, CW Communications of Massachusetts have been signed up to handle the magazine's North American distribution and arrangements have also been made with editorial and advertising representatives to give the magazine a truly North American bias.

Software News

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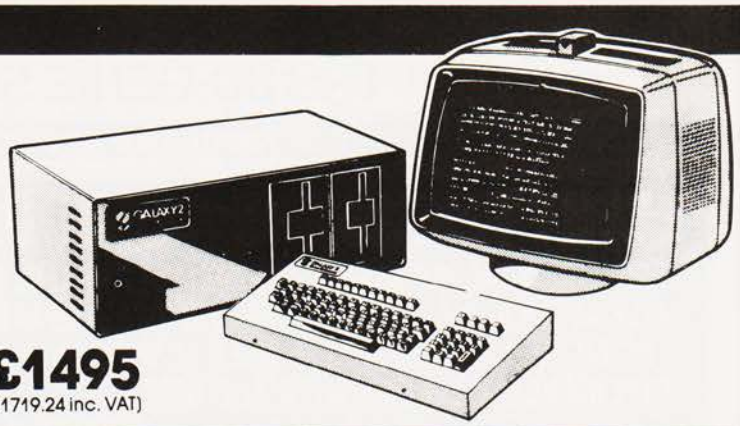

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NASCOM 2 KIT
£225 (£258.75 inc. VAT)

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80x25 Video for nascom

£125
(£143.75 inc. VAT)

Nascom owners can now have a professional 80x25 Video display by using the Gemini G812 Intelligent Video Card with on-board Z80A. This card does not occupy system memory space and provides over 50 user controllable functions including prog character set, fully compatible with Gemini G805 and G815/809 Disk Systems. Software supplied on Gemini system disks. Built and tested.

The **Microvector 256A** is a high performance graphics display interface on an 80-BUS and NASBUS compatible card. Various graphic primitives such as vector and character generation are executed in hardware by a Thompson EF9356 Graphic Display Processor. Plotting rates are typically 1 million pixels per second giving full animation capability. Various vector and character types can be selected. Characters can be scaled to give 256 different sizes.
MV 256A Suitable for TV use (PAL-UHF) **£199.00** + VAT
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SHARP MZ80A

FREE SOFTWARE!
Home budget, bank reconciliation, SPACE INVADERS, STAR TREK, SCRAMBLE, bank loan calculator, mortgage calculator + 7 other games.
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Z80A C.P.U. · 48K RAM · 4K ROM · Industry standard Qwerty keyboard with numeric pad · 9" GREEN C.R.T. · 1200 baud cassette · Music and sound · Real time clock · Enhanced BASIC · Full editing facilities · Internal expansion.

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Epson MX80 FT Type III
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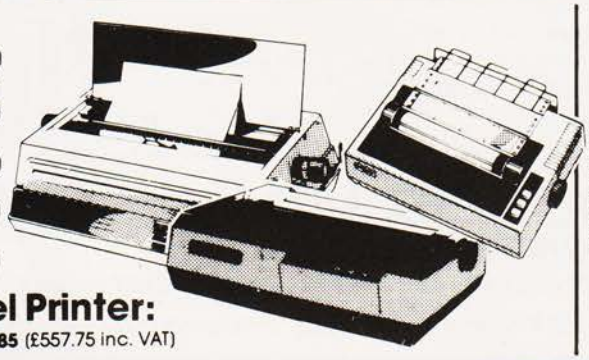
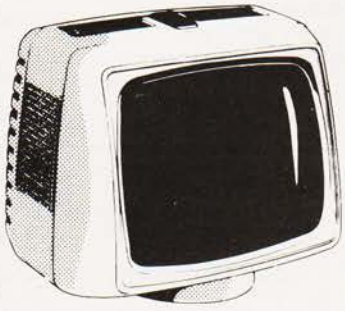
Epson MX100 Type III
£496 (£569.95 inc. VAT)
NEC 8023A
£339 (£389.95 inc. VAT)
SEIKOSHA GP100A
£215 (£246.95 inc. VAT)



Daisy Wheel Printer:
Smith-Corona TP-1 **£485** (£557.75 inc. VAT)



Phoenix P12 Monitor

A high quality data display monitor, ideal for all Nascom and Gemini systems. 20MHz resolution. Available in amber or green phosphor.

£110
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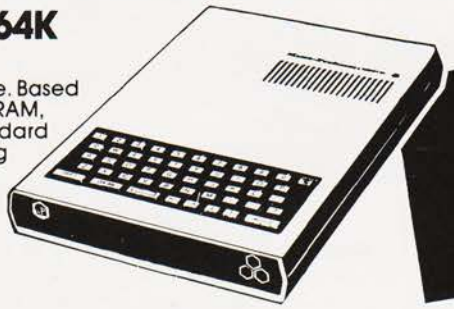
Value - MicroValue - Micro

LOW COST SYSTEMS

NEW Micro Professor MPF II 64K



MPF II is a most exciting addition to our range. Based on 6502 microprocessor this machine offers 64K of RAM, high resolution 6 colour graphics, and sound. Standard BASIC interpreter is Applesoft compatible, allowing MPF II to read and write tapes in Apple format. Complete with excellent 600 page manual.

★ Micro Professor	**£233.92**	(£268.99 inc V.A.T.)
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A powerful colour computer for under £200.
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Full range of Dragon software available.

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SPECIAL OFFER 16K RAM PACK for ZX81 **£17.17** + VAT

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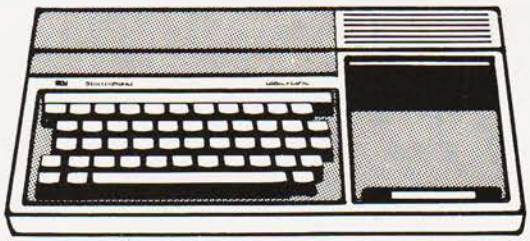
★ 48K ZX Spectrum Microcomputer **£152.17** (£175 incl. VAT)
★ Sinclair ZX printer **£52.13** (£59.95 incl. VAT)

Texas TI99-4A



Colour, sound and a typewriter type keyboard for under £160
A truly expandable microcomputer system with a wide range of educational and games software.

★ Texas TI99-4A Microcomputer 16K **£139.08** (£159.95 incl. VAT)
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ORIC 1

ORIC 1 when used with the ORIC MODEM will allow access to PRESTEL-Viewdata, which has 200,000 pages of interactive information covering sport, travel, hotel bookings, games, etc.

★ ORIC 1 48K Microcomputer **£147.79** (£169.95 incl. VAT)
★ ORIC 1 Communications Modem **£68.69** (£79.00 incl. VAT)

MICROVALUE DEALERS:

AMERSHAM, BUCKS
Amersham Computer Centre,
18 Woodside Road,
Tel: (02403) 22307

BRISTOL
Target Electronics Ltd.,
16 Cherry Lane.
Tel: (0272) 421196

EGHAM, SURREY
Electrovalue Ltd.,
28 St. Judes Road,
Englefield Green.
Tel: (07843) 3603

IPSWICH
MDW (Electronics),
47/49 Woodbridge Road East.
Tel: (0473) 78295

LONDON W2
Henry's Radio,
404 Edgware Road.
Tel: 01-402 6822

LONDON SW11
OFF Records,
Computer House,
58 Battersea Rise,
Clapham Junction.
Tel: 01-223 7730

MANCHESTER M19
EV Computing,
700 Burnage Lane.
Tel: 061-431 4866

NOTTINGHAM
Computerama,
(Skytronics Ltd.)
357 Derby Road.
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BUSINESS NEWS

GETTING TOGETHER WITH EPSON

Norbain are the first company to develop and supply a battery powered acoustic coupler for the new Epson HX-20 hand-held micro. They have adapted the tried and tested mains driven Sendata 700 Series acoustic coupler and the HX-20, so that the acoustic coupler draws power from the HX-20's internal power supply and operates through the RS232 port. Data transmit and receive is at 300 bps. The price is £220 excluding VAT. If you have bought your Epson HX-20 from someone other than Norbain Micro, there is an additional £25 charge to modify the micro. For more information, please contact Norbain Micro Limited, Norbain House, Boulton Road, Reading, Berkshire RG2 0LT or 'phone 0734-752201.

CRA Corner

This month I would like to register a plug for the National Microprocessor and Electronics Centre. The reason that it comes to mind at the moment is that the Computer Retailers Association is at this time in the midst of preparing a stand for a permanent display there.

It seems to me to be one of the most missed of the London attractions, particularly to any user or dealer who is interested in microcomputers. On permanent display at the Centre you will find most of your favourite machines plus quite a few of the more interesting component parts for them. It never does an end user any harm at least to have a rough idea of what goes on in his machine and the NMEC is educational in this respect.

The Centre is in the City of London at:

The World Trade Centre,
Europe House,
East Smithfield,
London E19.

As a matter of fact it is just under the Royal Mint offices — perhaps an added incentive for a visit.

The Computer Retailers Association's new stand should be ready in a few weeks. We are not quite sure as yet how it will be manned, but the present idea that we are working on is having various dealers up in London with their wares from time to time.

Anyway, the point is that the Centre is well worth a visit and better still, for London it usually provides a quiet backwater in which to contemplate the wonders of science.

A J Harding

FINDING COMPUTERLAND

You may have had trouble locating ComputerLand in Southampton if you read our news item 'IBM get personal' in the April issue of *Computing Today*. That will be because we gave you the wrong address. The correct address is ComputerLand, Spencer House, 12-14 Carlton Place, Southampton SO1 2EA. Our apologies to everyone concerned.

STUNTS MADE EASY

Advanced Technology Marketing has introduced its Model 54 Stunt Box to provide engineers, technicians and those involved with interfacing different RS232 devices a simplified approach to a longstanding problem. Under the cover of the Stunt Box is a PC card containing a male and female RS232 connectors. Frame ground, pin 1, is permanently connected between connectors; each of the remaining 24 connector pins from each connector is wired to a 0.025" square pin and a plated thru' hole. This arrangement gives the user the choice of wire wrap or jumper plugs for signal interconnect while wires or components can be soldered to the holes on the PC card. Four common bussing areas are provided for multiple connections. Additional external wiring is accomodated by two grommeted access holes on the side of the unit.

The Model 54 Stunt Box is priced at £62 excluding VAT. For more information please contact ATM Limited, PO Box 204, Coulsdon, Surrey CR3 1YB.

MORE FROM TEXAS

Earlier in the year Texas Instruments announced their new TI Professional Computer. It supports a wide variety of software and the available languages include BASIC, COBOL, FORTRAN, Pascal and others. The computer has a detached keyboard and has a high resolution 12" monochrome or 13" colour display. The memory is 64K as standard RAM with external expandability to 256K. Standard mass storage is provided by a 320K floppy disc and a Winchester disc is also available.

At the same time TI introduced a new impact printer in the OMNI 800 family to complement the Professional Computer. Called Model 850 it prints various fonts at

up to 150 characters per second in a 9 by 9 matrix and can also print 'raster' graphics to copy screen displays. The TI Professional Computer is priced at £2075 (excluding VAT) for the basic system and the new printer is priced at £495 (excluding VAT) for the cheapest version.

For more information about these or other products, please contact Texas Instruments Limited, Manton Lane, Bedford MK41 7PA, or 'phone 0234-67466.

MICRO FROM WANG▼

Perhaps best known for their word processors, WANG have introduced their Professional Computer. Aimed primarily at professionals and managers the product has been designed to complement WANG's Office Automation strategy. The Professional Computer is a 16-bit system that can run in a stand alone mode with between 128K and 640K of memory. At the same time it will integrate with the whole range of WANG products and function as a workstation on any WANG VS, OIS, 2200 or Alliance system.

As a highly modular system, the Professional Computer is configured either as a basic 'off-the-shelf' system or it can be expanded into more powerful configurations with optional displays, graphics software, printers and discette or Winchester fixed disc storage devices.

Prices range from under £2,000 to under £6,500: the PC001 consists of a compact, enclosed, electronics unit containing the CPU, 128K RAM, 360K 5¼" discette drive, keyboard, MS-DOS and MS-BASIC and is priced at £1,900 excluding VAT. If you would like more information please contact WANG (UK) Ltd, Wang House, 661 London Road, Isleworth, Middlesex TW7 4EH or 'phone 01-560 4151.

NEWBRAIN GETS ITS DOS

If you've been waiting for your NewBrain discs then the time is at last here! Grundy have managed to produce a single 200K drive system running under CP/M based on a 32K NewBrain for the remarkable price of around £6-700. The NewBrain slots into a housing unit together with the expansion module, power supplies and disc and the video monitor (included in the price) sits neatly on top. The price is not yet fixed but should fall inside the range given above making this a very cheap entry to the world of CP/M and discs.

To expand the system to cope with the business and professional end of the market you can expand to twin 800K discs plus 96K of RAM and add a range of software to suit. Among the suppliers Grundy have signed up to produce packages are Peachtree who will be offering a range of their standard products including Peachtext and probably such industry standards as dBase II and Wordstar.

After the poor start to the documentation Grundy have now had the system manual re-written and this will soon be available for general release and for those interested in the software and systems side there is a strong possibility that a Beginner's Guide and disc will also be produced in the near future.

To complement that business aspect of the machine a series of training courses have been arranged with Blackwood Hodge at Neene College in Northants and details of these are available from your local dealer. For more information about the new CP/M NewBrain contact Grundy Business Systems at Somerset Road, Teddington, Middlesex TW11 8TD.

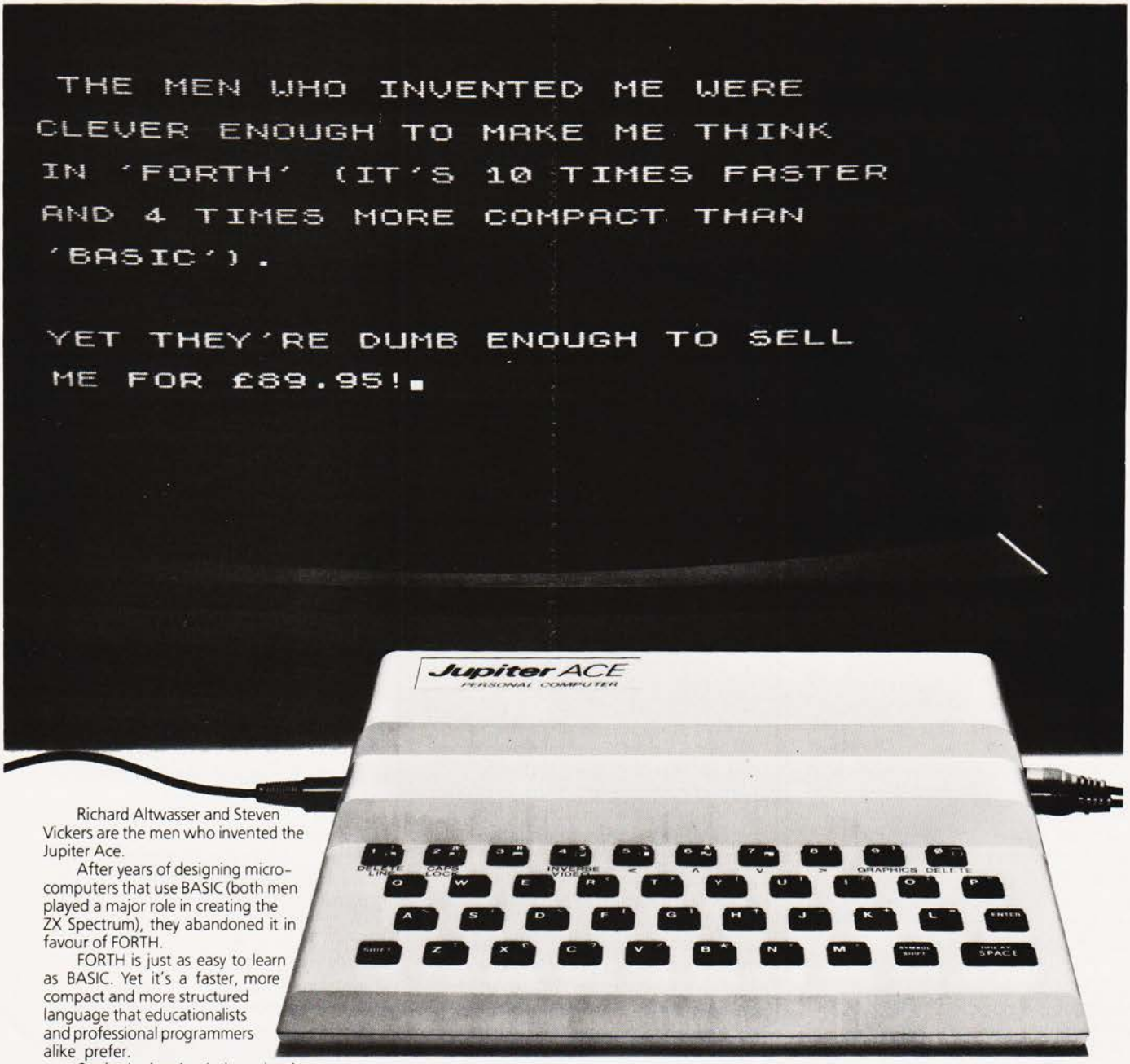
BRIEFING

Two new printers, that can be used as electronic typewriters when not needed as computer printers, are available from Datarite Terminals. The **Datarite T/Printer 350** costs £475 plus VAT and can be used as a printer with most Centronics compatible mini and micro computers. The **T/Printer 3500** adds RS232C interfacing and also the ability to act as a Keyboard Send Receive computer terminal and retails at £535 plus VAT. More information can be obtained from **Datarite Terminals Ltd,** Caldare House, 144-146 High Road, Chadwell Heath, Essex RM6 6NT, or 'phone 01-590 1155.

Td 2000 is an integrated viewdata terminal aimed specifically at the business market, enabling users to access private viewdata systems as well as the full range of Prestel services. It has a 10" diagonal colour monitor, full qwerty keyboard and standard Centronics interface to printer. The terminal is priced at £499 plus VAT and you can get more details from **Tandata Marketing Ltd,** Wells Road, Malvern, Worcestershire WR14 4PA or 'phone 06845-68421.

A new range of office computer-related **furniture** has been launched. Prices for VDU tables start at less than £100. Computer accessory shelves (to take disc drives, processors etc), printer tables and fully-adjustable chairs are also available. More information can be obtained from **Project Office Furniture Limited,** Hamlet Green, Haverhill, Suffolk CB9 8QL or 'phone 0440-705411.

As part of its expanding dealer network, **NEC Business Systems (Europe) Limited** has appointed the John Lewis Partnership chain of high street shops to sell its PC-8000 microcomputer. At present, two stores are selling the PC-8000 — the Oxford Street store in London and the Milton Keynes branch. Full systems are available with full service and backup.



Richard Altwasser and Steven Vickers are the men who invented the Jupiter Ace.

After years of designing micro-computers that use BASIC (both men played a major role in creating the ZX Spectrum), they abandoned it in favour of FORTH.

FORTH is just as easy to learn as BASIC. Yet it's a faster, more compact and more structured language that educationalists and professional programmers alike prefer.

So the Jupiter Ace is the only micro-computer you can buy that is designed around FORTH.

Using it, there's little fear of accidentally 'crashing' programs halfway through and having to start all over again (a common fault with BASIC). The Jupiter Ace's comprehensive error checking sees to that.

The Jupiter Ace has a full-size keyboard, high resolution graphics, sound, floating point arithmetic, a fast, reliable cassette interface, 3K of RAM and a full 12 month warranty.

You get all that for £89.95. Plus a mains adaptor, all the leads needed to connect most cassette recorders and T.V.'s, a software catalogue (35 cassettes available, soon to be 50), the Jupiter Ace manual and a free demonstration cassette of 5 programs

The Jupiter Ace manual is a complete introduction to personal computing and a simple-to-follow course in FORTH, from first principles to confident programming.

Plug-on 16K and 48K memory expansions are also available, at very competitive prices. (There'll be a plug-on printer interface available soon, too.)

It'll take you no time at all to realise how clever Richard and Steven were to design the Jupiter Ace around FORTH. And even less time to realise what a silly price £89.95 is to charge for it.

Technical Information

Hardware
Z80A; 8K ROM; 3K RAM.

Keyboard
40 moving keys; auto repeat; Caps Lock.

Screen
Memory mapped 32 col x 24 line flicker-free display upper and lower case ascii characters.

Graphics
High resolution 256 x 192 pixel user defined characters.

Sound
Internal loudspeaker may be programmed for entire audio spectrum.

Cassette
Programs and data in compact dictionary format may be saved, verified, loaded and merged. All tape files are named. Running at 1500 baud.

Expansion Port
Contains D.C. power rails and full Z80 Address, data and control signals. Can connect extra memory peripherals.

Editor
Allows complete editing and listing of compiled programs.

Please send cheque/postal order to:
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Jupiter ACE

Please send me _____ Jupiter Ace microcomputers @ £89.95 (+ £3.95 p. & p.)
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SOFT WARES

BACK TO SCHOOL

Users of dBase II, Britain's top selling relational data base package, can attend seminars in London to gain instruction in this software, and its program generator, Autocode I. A one day dBase appreciation session or a full three day dBase course including workshop are being provided by Stemmos. Within an hour of starting the course, programmers and non-programmers alike will get the chance to start writing what Stemmos claim will be the most powerful program of their lives, through Autocode I. This automatically generates programs using dBase II without any previous experience, creating menus and sub menus, data entry screens, routines, edit, validation and much more.

For details of dates and more information contact Stemmos Ltd, 344 Kensington High Street, London W14 or 'phone 01-602 6242.

SPREADING THE BUDGET

Tandy have announced an enhanced version of the VisiCalc budget planning and forecasting program that is compatible with the Tandy TRS-80 Model II, Model 16 and Model 12 micros. VisiCalc Enhanced offers the ability to generate much larger 'spreadsheets' by utilising any additional memory available in the computer and new features have been included. The price is £249.

To take advantage of Enhanced VisiCalc's expanded memory capability, Tandy also offers a new 64K Memory Expansion Board for £299. This Board requires installation (not included) and is not usable by other programs.

More details on either product can be obtained from Tandy Corporation (Branch UK), Tameway Tower, Bridge Street, Walsall, West Midlands WS1 1LA.

EPSON DERBY

Don't worry, I haven't lost my ability to spell — I'm talking about a new piece of software to forecast horse races for the Epson HX-20. Based on the probability of winning, the program can be used by the serious punter by using the information published in the sporting press concerning each horse in the selected race. The details of the race have also to be entered. The Epson HX-20 then produces betting recommendations on each horse. The data can be stored as required. Since the Epson HX-20 is easily portable you can carry it along to the course. If this sounds like a good bet to you you'll be pleased to know that the forecaster is £24.50 plus VAT and comes from Kuma.

On a slightly more serious note for the Epson HX-20, Kuma have announced a word processor specifically designed for the miniature in-built printer. Called Desk Master 2, an option can be also chosen to produce larger documents for an external full-sized printer. Desk Master 2 is priced at £29.50.

For more information about either of these products please contact Kuma Computers Ltd, 11 York Road, Maidenhead, Berkshire SL6 1SQ.

8000 LANGUAGES

Pet Forth, a standard fig-FORTH with many extensions (including double-precision arithmetic, random numbers, IEEE control words and a string package), has been announced from Kobra. It is designed for the Commodore 8000 microcomputers and is priced at £179. The package requires a minimum of a CBM 8032 and CBM 8050 1M disc drive. More information can be obtained from Kobra Micro Marketing, Farm Road, Henley-on-Thames.

MASTERING THE IBM

DB Master, the top selling business file management program for the Apple, has been re-written and expanded with substantially more power, for the IBM personal computer. With this package records can contain complex mathematical fomulas which offer storage capacity of up to 240 characters. An array search feature allows a selection of records that contain multiple entires for the same items.

The requirements to use the package are an IBM personal computer with at least 192K of RAM, two 320K double-sided disc drives, and the use of a printer is recommended. The package is priced at £349 and more details can be obtained from Pete & Pam Computers, New Hall Hey Road, Rossendale, Lancashire BB4 6JG, or 'phone 0706-227011.

I'LL JUST SAY THAT AGAIN

It may well be that this is the first time that a lisp actually helps communication. In fact an interpreter for the artificial intelligence research language LISP is now available for the ZX Spectrum. The interpreter's functions are varied and include a full property list implementation, full error checking, supports machine code routines, and 4.5K machine code interpreter plus 2.6K initialised property list. The interpreter ideally requires 48K RAM but will run on 16K; it is supplied on cassette with a demonstration program and a programmer's manual for only £15. To learn more about the interpreter send for details (mail order only) to Serious Software, 7 Woodside Road, Bickley, Bromley, Kent BR1 2ES.

SPEEDING UP THE PET

A version of Petspeed BASIC compiler is now available for the Commodore 64. Offering considerable savings in terms of running time and running memory space, Petspeed is extremely simple to use and is supplied with comprehensive documentation.

Petspeed is priced at £125 plus VAT and is available from Oxford Computer Systems Ltd, Woodstock, Oxford, or via the worldwide Commodore dealer network.

SOFTWARE 64 ▲

Now you can add more software for your Commodore 64. Called Software 64, the line includes Motor Mania (a cross country car race game), Renaissance (the Commodore 64 version of the best selling VIC cartridge game), Grandmaster (a chess game), FORTH, Monitor (taking the misery out of machine code) and Wordcraft 64 (a word processing package).

Motor Mania and Renaissance are on cassettes and are priced at £8.95 and Grandmaster costs £17.95. For further information, contact Audiogenic Ltd, PO Box 88, Reading, Berkshire.

IBM GO COBOL

Personal COBOL has been announced for the IBM Personal Computer. It comes from Micro Focus and is based on their Level II COBOL, the only COBOL for microcomputers to be certified by the US Government at the same level as mainframe COBOL compilers. Personal COBOL offers full ANSI'74 COBOL language functionality. In addition there are facilities for interactive source level debugging with program Animation, a FORMS facility for creating application screens and a full screen COBOL editor. The cost of Personal COBOL is £250 and is licenced per machine. To complement Personal COBOL, Micro Focus will make the Level II compiler and Run Time System available for the IBM Personal Computer running the PCDOS operating system.

For more information contact Micro Focus Limited, 58 Acacia Road, London NW8 6AG, or 'phone 01-722 8843.

CASHING IN ON YOUR MICRO

The Electronic Cash Book is used for recording the receipt and payment of money. It is menu driven and is designed to be suitable for both the first time micro user and the more experienced user. The Electronic Cash Book will run on the Commodore 8000 Series including the new SK range and 4000 Series. Priced at £195 the package includes a comprehensive user's manual and security key. More details can be obtained from Dataview Limited, Portreeves House, East Bay, Colchester C01 2XB, or 'phone 0206-869414.

BRIEFING

Acornsoft have announced two new games, **Super Invaders** and **Castle of Riddles**, and five new educational packages. Super Invaders is available on both disc and cassette at £11.50 and £9.95 respectively and Castle of Riddles is only available on cassette at £9.95 including VAT. The educational packages are **Word Sequencing, Sentence Sequencing, Missing Signs, Word Hunt** and **Number Balance** and are available on disc or cassette at £15.35 and £11.90 respectively including VAT. The packages are available from **Acornsoft**, Vector Marketing, Denington Estate, Wellingborough, Northamptonshire NN8 2RL.

Dax Software have produced a piece of software called **PIMS** (Personal Information Management System), a business oriented package. Manufactured in The Netherlands and aimed at the VIC-20 market, more details can be obtained from **Dax Software**, Leidsegracht 52, 1016 CN Amsterdam, The Netherlands.

Tiny Word is a word processing package on cassette for the Newbrain models A and AD at a retail price of £24.50 plus VAT. **Map of UK**, like Tiny Word, is available from Kuma Computers. This cassette is now available for the 48K ZX Spectrum and costs £11.95. More details can be obtained from **Kuma Computers**, 11 York Road, Maidenhead, Berkshire SL6 1SQ or 'phone 0628-71778.

Two programs to save time and money in the 'home office' are **VICPRO**, a word processing package, and **VICDATA**, a data base program. Designed for the VIC-20, the programs cost £12.95 and come with full documentation. Details from Audiogenic Ltd, PO Box 88, Reading, Berkshire, or 'phone 0734-595647. Flexicalc is a new spreadsheet program for the 48K ZX Spectrum. Priced at £9.95 you can get more information from **Saxon Computing**, 3 St Catherines Drive, Leconfield, Beverley, Humberside, or 'phone 0401-50697.

Ulysses and the Golden Fleece is an adventure game for the IBM Personal Computer at a price of £22.95, and comes from Pete & Pam Computers. They also distribute a family of more serious programs for the IBM Personal Computer: **EasyWriter II** (a word processing package for £225), **EasyFiler** (£249), **EasyPlanner** (£125), and **Easy Speller** (£125). For details of these or the game contact **Pete & Pam Computers,** New Hall Hey Road, Rossendale, Lancashire BB4 6JG or 'phone 0706-227011.

NEXT MONTH

computing today

JULY ISSUE ON SALE JUNE 10th

SWEET SIXTEEN

The current industry fad seems to be the 16-bit processor. Indeed, there can hardly be a business or professional machine launched these days without acres of publicity material being devoted to the fact that it has one of these new super processors built in. All well and good but just what difference does a 16-bit processor make to the user?

In next month's *Computing Today* we'll be taking a long hard look at the heart of these new generation machines and discovering some rather disturbing facts about their true capabilities. To back this up further there will also be a guide to the current 16-bit market in the form of a buyer's guide.

If you have been considering the purchase of a 16-bit machine it could well pay you to wait a week or two, after all there needs to be a lot of extra power and facility available to justify a doubling in price, or perhaps . . .

PRINTING ON THE CHEAP

Some months ago we ran a feature on interfacing possibly the cheapest form of printer possible to your computer. Well, next month we go a little bit up market. Only last year daisy wheel printers would set you back around £1000 for the privilege of providing letter quality output. Then we had a couple of daisy wheel printers that sold for around the £500 to £600 mark. Now, thanks to typewriter giant Olivetti we have a daisy wheel typewriter with full correction facility that you can link to your micro through a parallel port for less than £500!

Two for the price of one can't be bad, at least that's what we reckon. If you are after higher quality output than your matrix printer can provide and don't mind waiting a while to get it then this package could be a real alternative. And, if you need to justify its purchase, you can always say that you're buying a typewriter!

THE MIDDLE GROUND

What's half a disc drive but twice a cassette tape? The answer to this seemingly Gollum-like riddle is not a mess of home-brewed equipment but the Ikon Hobbit. Based on the Philips digital micro cassette unit and provided with its own operating system it could well be a real alternative for the home user of the BBC Microcomputer who can't justify buying discs but still needs something faster than the good old 1200 baud tape.

Our reviewer took the Hobbit home, fed it well (they always were hungry little beggars) and delved deep into its psyche. The resultant review could well save you a few bob so if you're frustrated by the price of a floppy disc and even more tormented by tape it could pay you to invest in our July issue!

TALKING GRAPHICS

Our occasional series on languages and selecting the right one for the task in hand turns its attention to the subject of graphics. Whilst virtually every new version of BASIC comes with some facilities to handle the generation of graphics it can hardly be described as the simplest and most logical to use, try remembering all the variations of a BBC BASIC PLOT command for example!

Help is at hand though with GINO. You thought he was a pop artist, heresy indeed. GINO is an extension to the language FORTRAN, you'd be surprised to find how many machines can run FORTRAN these days, which offers a number of very powerful facilities to the graphically inclined. As usual our feature demonstrates the power of the language by developing a BASIC program and then showing how the right language would make the task more straightforward.

Articles described here are in an advanced state of preparation but circumstances may dictate changes to the final contents.

COR!
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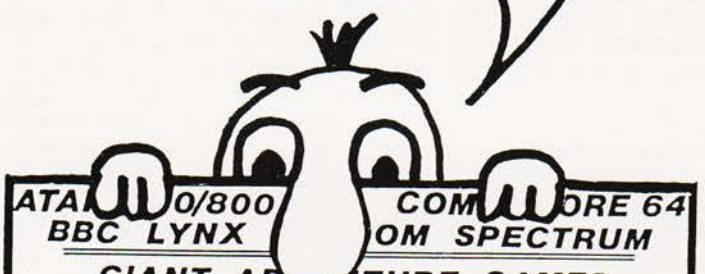

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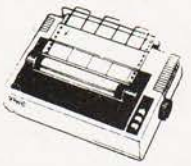

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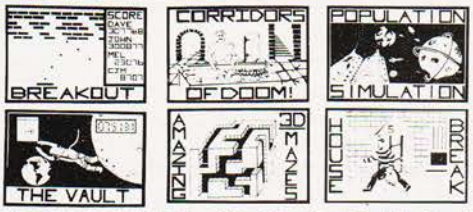

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MICRO INTERRUPTIONS

In the first part of this series we show you how to connect two computers by using interrupts.

The microcomputer has been available now for several years and its popularity as an entertainment machine is well known.

After some months however, when you have just finished beating your seventeenth version of space trek, you begin to feel that a lot of the software written for the machine is just a variation on a simple theme. What you really need is to find something new to do with the machine or find a more challenging game. This two part article offers you both. In the first part we will look at one of the eight bit parallel port chips (the Z-80 PIO). We will see how this device can be used to communicate with the outside world, how it can be used to interrupt the processor and then how we can use these two facilities to connect two computers together in communication with each other. Part two will then expand these ideas and show how they can be used to create a very exciting new type of game where two players, on separate machines, do battle to the death. Finally we will draw all of these ideas together by presenting a Hex dump of a very fast interactive two player game

THE PIO

The peripheral Input/Output controller chip (PIO) is one of the Z-80 family of microcomputer chips. This particular chip contains two separate eight-bit parallel data ports each with its own associated control port. This means that one PIO occupies four ports in the Z-80 port map which has a maximum of 256 port spaces. As well as eight data bits each of the two data ports also has associated with it two other leads. These have the names READY and STROBE and are used to pass information between the PIO and the peripheral device to tell each end when to transfer data and when to read data. Passing this information is called handshaking and the two leads are, therefore, called handshake leads.

The PIO chip has four different operating modes for each of its two data ports and hence needs to be programmable. Programming the required function into the data ports is achieved by sending sequences of control bytes to the respective control ports.

The four operating modes are selected by sending a control byte to the PIO of the form:

XX001111

where the two most significant bits (XX) determine the mode as follows:

a. Mode 0 (XX = 00)
In this mode all eight bits of the addressed port are used as output lines. All output from the PIO is at standard TTL levels (ie 0 and +5 volts). The information output to the PIO from the Z-80 Central Processing Unit (CPU) appears and is latched immediately on the data port output leads. At the same time the READY lead goes high to tell the peripheral device that there is data byte waiting to be read. Once the peripheral has completed its action on the data it can then acknowledge this fact with a signal on the STROBE lead which can be used to interrupt the CPU to tell it that the peripheral is ready for more data. (Interrupts will be discussed later.)

b. Mode 1 (XX = 01)
In this mode all eight bits in the selected port are used as inputs. The peripheral device places its data onto the data leads and then activates the STROBE lead. This has the effect of telling the PIO to read the contents of the data leads into its internal register ready to be read by the CPU. The STROBE signal can be read by the CPU. The STROBE signal can also be made to interrupt the CPU to tell it that there is data to be read. When the CPU reads the data the PIO takes the READY line high to tell the peripheral that the data has been accepted and that more data may now follow.

c. Mode 2 (XX = 10)
This mode is only available on port A as all four handshake leads are required (two from each port). When Mode 2 is selected for port

A, port B must operate in Mode 3 (described below) as no handshake leads are needed in this mode. In Mode 2 all eight data leads are bidirectional, that is, they can be used as inputs or as outputs. The function performed by the data leads at any given instant in time is controlled by the handshake leads as follows. Port A handshake leads are used for output control as in Mode 0 and port B handshake leads are used for input control as in Mode 1 so that Mode 2 operation is effectively a combination of Modes 0 and 1.

d. Mode 3 (XX = 11)

This is the mode that will concern us for the rest of the article. Mode 3 can be used on either port and in Mode 3 all eight data bits have their transmission direction individually specified. This is achieved by sending a second control byte immediately following the first. The second byte should contain a binary '1' in each bit that is to be used as an input lead and a binary '0' in each bit that is to be used as an output. No handshake leads are required on a port if it is working in Mode 3 but interrupts are still possible as we shall soon see.

Just using the facilities of the PIO already described it would be fairly easy to design a system where two computers could be connected back to back over two PIOs and used to communicate information to each other.

If such a system were used however, there would be a fairly large overhead in programming effort and in processor time getting the two systems to repeatedly look at the contents of their respective PIO input registers to detect any incoming data, and to wait for fairly long periods of time (in computer time-scales) after outputting data to their PIOs to ensure that the other processor has had the chance to read the data before it is altered.

I suspect that even though this option is quite difficult to implement, it is the one that a lot of users would choose simply because its function is easier to understand than the main alternative — Interrupts.

INTERRUPTS

The basic idea behind interrupts is that the CPU should be executing a program without paying any attention to the peripheral, say a keyboard, and that as long as no data from the peripheral (key being pressed) needs to be processed the program should continue to be executed indefinitely. When a key is pressed on the keyboard the PIO recognises that there is data to be transmitted and sends a signal to the CPU on the interrupt line. The CPU upon receipt of the interrupt finishes the machine instruction that it is currently executing and then does a call to a special subroutine somewhere in memory called an interrupt service routine. This routine accepts the input form the peripheral (keyboard) and stores the character in memory for the main program to fetch when it is ready. When the CPU accepts the interrupt it automatically disables its capability to accept interrupts so that no further interrupts can occur while the first interrupt is being dealt with. This means that the last thing the interrupt service routine must do before it finishes is to re-enable the interrupts. The interrupt routine is terminated with a special sort of return statement which not only returns control of the CPU to the main program but also resets the PIO ready for the next interrupt. This is achieved, by the PIO monitoring the CPU data bus looking for the special return instruction to be read in by the CPU for execution.

This all sounds fairly complex when the description has to be written down, but when writing the software the main program needs to know nothing of the existence of the interrupt routines and, after saving the main CPU register contents, the service routine is free to use all of the facilities of the machine without regard to where it was called from. In this way more efficient use may be made of the machine, as the CPU is only looking at peripherals when there is something there to see.

This sounds a fine scheme, but as with everything else there is a price to pay. The PIO is such a versatile device that several more control words need to be specified if interrupts are to be used.

Firstly, suppose for a moment that there are several PIOs and that there are different interrupt procedures for each port (this is the most likely case). We need some method of telling the CPU where to find the interrupt service routine associated with each particular port. This is achieved on the Z-80 by selecting its interrupt Mode 2 for multiple ports and using something with the grand sounding name 'Interrupt Vector'. This vector is basically a table of two byte numbers contained in the computer's memory. The first entry in the table must begin on a 256 byte page boundary in the memory map. This is because the memory page to be used for the table is selected by the eight bit 'I' (interrupt) register inside the Z-80. That is, the Z-80 'I' register provides the high order eight bits of a 16-bit address. As you may have guessed by now the low order eight bits are supplied by the interrupting device. The 16-bit number we now have is the address of one of the elements in the interrupt vector table. The contents of that element are the address of the interrupt service routine for the interrupting device. Read this paragraph a second time if you thought it didn't make sense ▶

(like I am!) and all should become clear.

The outcome of all this is that we need to load the PIO with its share of the interrupt vector address. As all of the elements of the interrupt vector table are two bytes long and as the table must start on a 256 byte page boundary, the least significant bit of the 16-bit interrupt vector address must always be a binary '0'. This binary '0' is always the least significant bit of the eight bits to go into the PIO and so the format of the control word used to program the interrupt vector is:

VVVVVVV0

where VVVVVVV is the variable part of the vector address. This convention causes no confusion in the PIO, as the interrupt vector is the only control command word that is allowed to have a binary '0' in the least significant bit position.

ENABLING INTERRUPTS

Before the PIO can generate an interrupt request the interrupt system of the PIO needs to be enabled. In Mode 3 where no handshake leads are used, the PIO has a very flexible arrangement for generating interrupts depending on the conditions of one or more of the data leads.

The interrupt control word sent to the PIO has the following format:

ABCD0111

If 'A' is a binary '1' then the PIO may generate interrupts otherwise interrupts are disabled.

If 'B' is a binary '1' then interrupts may only be generated if all of the data lines being monitored become active. If 'B' is a binary '0' then interrupts may be generated if any of the monitored data lines become active.

The bit 'C' in the control word determines the logic state that the PIO will consider to be the active state. A binary '1' for 'C' defines the active state as high and a binary '0' makes the active state low.

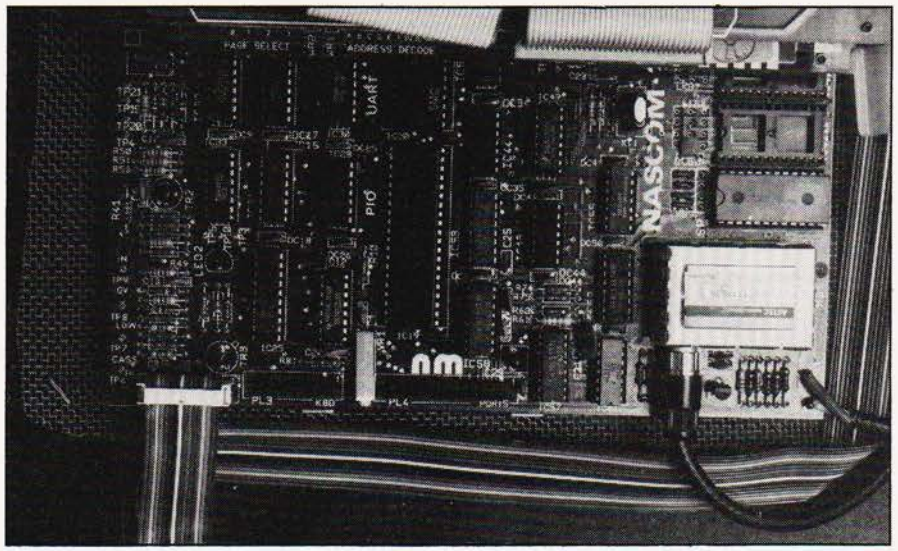
The bit 'D' determines which data lines will be monitored for interrupt control. If 'D' is a binary '0' then this means that all eight data lines will be monitored. If 'D' is a binary '1' this means that another byte (a mask) will follow immediately in which the bits are set to a binary '0' will define the leads to be monitored.

For interrupt operation in modes other than Mode 3 the handshake leads are used for interrupt control and interrupts may be enabled or disabled without modifying the rest of the interrupt control word by sending a port control word of the form:

A0000011

where the 'A' bit has the same significance as in the last case.

There is now only one thing left to do to get the interrupts up and running and that is to allow the CPU to respond to interrupt requests by enabling the interrupts in the CPU itself. This is achieved with an EI instruction in the software.



The interior of the NASCOM showing the peripheral input/output port located under the nm sign.

GETTING IT TOGETHER

Armed with all this information we are now ready to consider how to get two computers connected together and communicating with each other. There are so many different possible ways of connecting two machines together that we shall take a look at just one of them. This particular arrangement uses Mode 3 interrupts and was chosen because it demonstrates most of what we have been discussing. In addition the same arragement has been chosen for the software to be presented next month to show that all these theories also work in practice.

Our communication arrangement needs three parallel data bits in each direction. This means that eight different pieces of information can be transmitted, from binary code '000' to binary code '111'. If all eight of these combinations are to be usable then there is no combination that can be used as a 'no information' state, so there are no conditions that we can look for and use to generate interrupts. To overcome this problem we have decided to use a fourth (not FORTH) data lead in each direction which can be used and monitored to generate interrupts.

This means that we will need a total of eight data leads, four inputs and four outputs, and that one of the leads in each direction will be monitored for interrupt purposes. This sounds though it was just designed for Mode 3 operation (which it was), and so this is the method we chose.

To make the software easier to write and also to ensure that the same software can be used at each end of the communication link we have decided that data leads 0-3 on both machines will be used as outputs and data leads 4-7 will be inputs. Both machines will set data lead '3' to binary '1' when they wish to interrupt the other computer and both machines will accept a binary '1' condition on data lead '7' as an interrupt. To achieve this all that is needed is a four-bit twist in the eight-bit lead connecting the two machines together (ie bits 0-3 and bits 4-7 at one end of the lead will be a connected to bits 4-7 and bits 0-3 respectively at the other end of the lead.)

The software listing with which we finish this month is written in standard Z-80 assembly code. Do not worry if you don't understand Z-80 code: the listing is amply commented and, with reference to the previous discussion, should be fairly easy to follow. One last point, in the listing numbers that have a '#' symbol in front of them are in hexadecimal.

That's all for this month. Next month we will carry this idea much further and present a really exciting game using most of what we have seen so far.

```
;
; The PIO we will program is assumed to occupy
; port spaces 4-7. Port 4 is the port A data
; port, port 5 is port B data. Port 6 is port A
; control port and port 7 is port B control.
; As we only need eight data leads we will only
; use port A.
;
;
; Define PIO port A data as port 4
DATA    EQU     $04
;
; Define PIO port A control as port 6
CTRL    EQU     $06
;
; Put interrupt vector on 256 byte boundary
        ORG     $1000
;
; Define interrupt service routine address in
; the interrupt vector table
VTABLE  DEFW    INT1
;
;
; The next section of code needs to be executed
; once to initialise the PIO after power on.
; when finished this routine jumps into the
; main program loop.
;
;
; Disable interrupts during initialisation
; (ie CPU will not now accept any interrupts)
; then put the CPU into interrupt mode 2
BEGIN   DI
        IM      2
;
; Load 256 byte page no. into accumulator (A)
; and then load interrupt register (I) from A
        LD      A,$10
        LD      I,A
;
; Load A with the control word for PIO mode 3
; then output A to the control port
        LD      A,$CF
        OUT     (CTRL),A
;
; A mask must now follow to show which leads
; are inputs and which are outputs
        LD      A,$F0
        OUT     (CTRL),A
;
; Set interrupt vector. (ie output low eight
; bits of address in vector table)
        LD      A,$00
        OUT     (CTRL),A
;
; Set interrupt control word in the PIO.
; Bit 7 set to enable interrupts
; Bit 6 reset to interrupt if any lead active
; Bit 5 set to say active condition is high
; Bit 4 set to say monitor mask follows
        LD      A,$B7
        OUT     (CTRL),A
;
; Send mask to say which bits to monitor
        LD      A,$7F
        OUT     (CTRL),A
;
; Enable interrupts and jump to main loop
        EI
        JP      MAIN
;
;
; The interrupt service routine follows.
; In this simple example the routine just reads
; the data port and stores the value in a
; memory location for the main program loop to
; pick up
;
;
; Save original content of A register by
; pushing it onto the stack.
INT1    PUSH    AF
;
; Read PIO A port data and store this in memory
        IN      A,(DATA)
        LD      (STORE),A
;
; Restore old contents of A and return to main
; loop after re-enabling interrupts.
        POP     AF
        EI
        RETI
;
;
; The main loop follows. (As you can see it
; does nothing here - next month it will).
;
;
MAIN    NOP
        ; The main loop
        ; code fits here
        JP      MAIN
;
```

BUSINESS AND PLEASURE ON THE 64!

The Commodore 64 is the ideal machine to combine business with pleasure. It has a typewriter keyboard and lots of memory — ideal for word processing or financial planning — plus some rather clever colour and sound chips that are just what you need for realistic arcade action.

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Ian Hickman

MAKING MUSIC

Making music can be slow in BASIC so here it is combined with a machine code program to get the pace hotted up.

I recently decided that it would be interesting to experiment with computer music and found that there was no shortage of firms willing to sell me add-on goody boards for my Compukit UK101 for this very purpose. But I did not feel sufficiently certain that my interest was not just a passing phase, and was therefore reluctant to purchase a music generator board before at least trying out some simple musical experiments without the cost of additional aids.

The Compukit UK101 uses a 6850 ACIA for the cassette interface, and the 6850 has an RTS (Ready To Send) output, pin 5, which is intended for handshaking in asynchronous data exchange protocols. The RTS output follows bit 6 of the ACIA's control register and can therefore be set to 1 or 0 by loading the register with $40 or $00. In the UK101 with either the old or new monitors, the ACIA is located at $F000 and $F001. The first of these addresses corresponding to the Status and Control registers and the second to the Receive Data and Transmit Data registers. Depending on which of these addresses is placed on the address bus, a Read accesses the Status or Receive Data register. Thus by POKEing 64 and then zero into memory location 61440 (corresponding to F000 Hex), the RTS output can be set to 1 followed by 0. If we arrange this to happen 440 times per second we have the note A above middle C, at concert pitch. The obvious way to do this is to arrange for a FOR...NEXT loop as a delay between setting RTS to 0 and then 1, with the same delay also before setting it back to 0 again, resulting in a 5 V squarewave output at the RTS output pin. It was but a matter of moments to write a BASIC program to do just this, but alas, with a sensible value for the delay loop, the RTS flag flopped up and down at around 1 cycle per second, like a windsock in a fitful breeze. Even expunging the delay loop from the program entirely only resulted in a note at about 190 Hz — the G below middle C!

ASSEMBLING NOTES

Obviously BASIC was far too slow, so the mechanism for generating notes would have to be written as a machine code subroutine. To see how much faster than the BASIC program this would run, I hand coded a routine to toggle the RTS flag, again without any delay loop. At 66 KHz, the resultant note was well into the supersonic region! This was encouraging enough to want to add a variable delay loop so that any required pitch could be called up, but hand coding is very time consuming. However, I borrowed the excellent Assembler which is available for the UK101, and after learning how to use it, found that writing machine code (or, more strictly, 'source code', ie the actual machine code) both easy and fascinating.

Armed with this new tool, it seemed best to entrust the whole job of actually playing a tune to machine code. Earlier experiments had shown that if the machine code were used only to generate the actual notes, with the parameters (length and pitch) of each note being POKEd into the machine code subroutine by BASIC in between notes, the successive notes always had an umusically large gap in between. This was paricularly objectionable on short repeated notes, which always sounded stacatto. Another problem was encountered with the lengths of notes of different pitches. If the pitch of a note is deermined by the length of a wait loop before next toggling the RTS flag, and the length of a note is determined by the number of times the flag is toggled, it follows that a crotchet at one pitch will become a quaver when played one octave higher: the higher the pitch, the shorter the period of time for which the note is sounded. This was solved by assigning two length; eg crotchet, the other being the 'compensation length' which is made inversely proportional to the pitch.

PLAY THAT TUNE

Since the intention was now to write the whole of the 'Playtune' subroutine in assembly code, the next step was to draw a flowchart to express clearly how the subroutine was intended to operate. This flowchart is shown in Fig. 1. The first step is to initialize a parameter counter to zero. In fact, four parameters are assigned to each note, namely, the note length (musical), the compensation length (depends on pitch), a parameter N/R which determines whether a 'note' is to sound or will be a rest, and the pitch parameter. Next, the program is readied to read the four parameters of the first note into a working store, this point being labelled NTRY (note ready). The parameters are then loaded (LDNT loop) from the area holding the parameters of all the notes. Next a check is run, to see if the note just loaded is a note to be played, or a dummy note used as the 'end of tune' marker. The end of tune marker is a note where the pitch parameter has been set to zero. If

the note is to be played, the program proceeds to the PLNT (playnote) section. This consists of nested loops. The RTS flag is set low and a delay loop (its length set by the pitch parameter) is executed — this represents one half cycle of the required waveform. Next, RTS is set low again, or high, according to whether N/R indicates a rest or a note, and the delay loop run again making one complete cycle of the waveform. Further cycles are generated, as often as is called for by the compensation counter, by returning to NXCY (next cycle) after decrementing the compensation counter. This whole sequence is then repeated as often as called for by the note length counter, by returning to PLNT after decrementing the length counter. At the end of the note, the program returns to NTRY in preparation for loading the parameters of the next note.

UP AND RUNNING

Listing 1 shows both the source code implementation of the flow chart in 6502 mnemonics, and also the assembled object code (machine code) ready to run. It should run on any 8K personal computer which uses a 6502 CPU running at a 1 MHz clock rate, though of course if the ACIA location is not $F000-1 the code will need adjusting accordingly. It should not be too difficult even to translate the source code into the corresponding mnemonics for another microprocessor, and given the required Assembler to produce the necessary machine code. The clock rate should be 1 MHz and further adjustments would be necessary if the number of machine cycles in the execution of the PLNT loop is different — NOPs (no operation instructions) can be added or removed as required.

Note that the jump to $1300 in the last line was put there to cause the program, on completion of execution, to jump to the entry point of the Assembler program. This was handy when the machine code Playtune routine had just been assembled into memory and was being run with the Assembler still present. The jump address can be set to any address required, eg to the machine code mode entry point of the resident monitor ROM ($FE00 for the UK02 new monitor.)

The labels in the source code in Listing 1 correspond to those on the flowchart. The four parameters for the first note are loaded into $F100 — $F103, those for the second note into $F104 — $F107

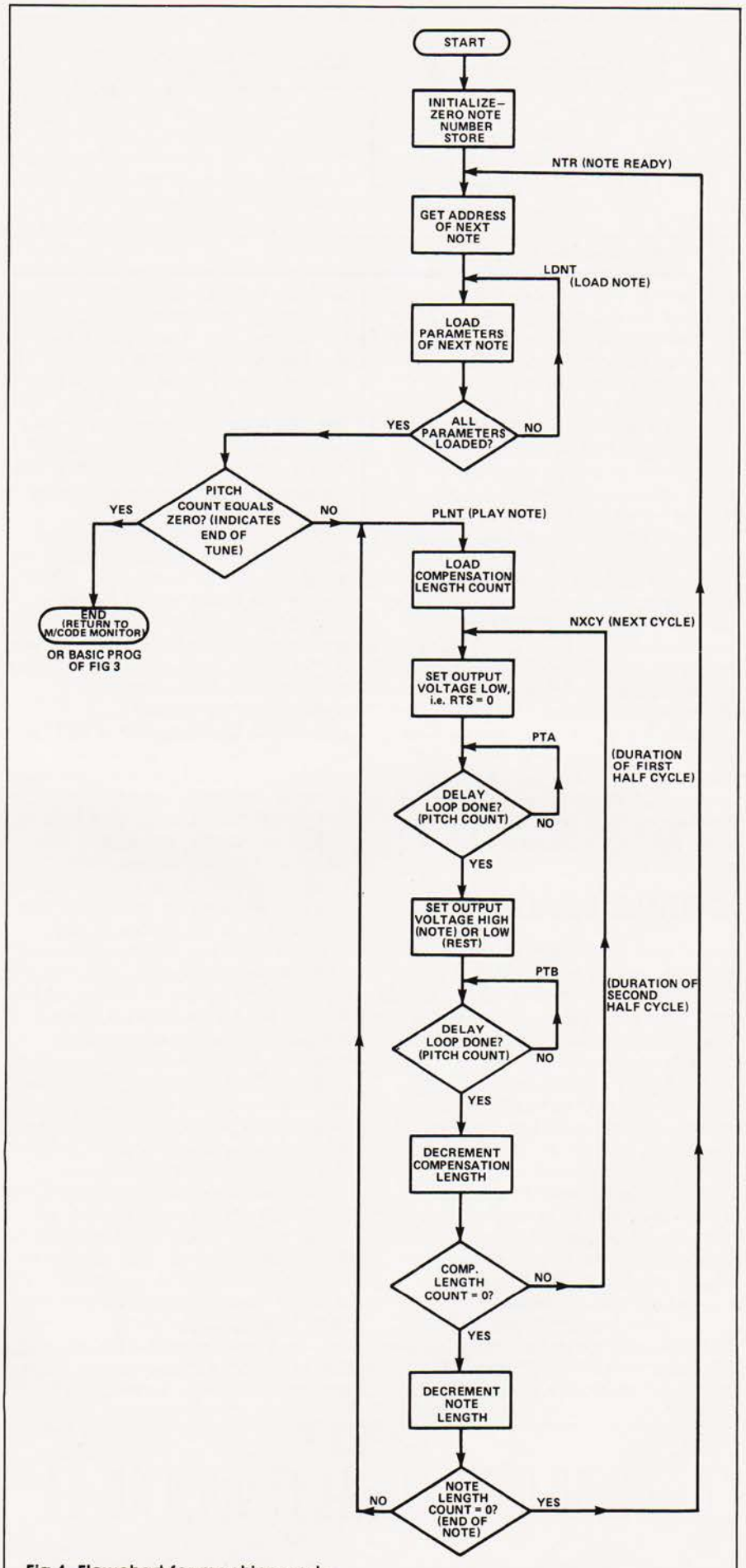

Fig.1. Flowchart for machine code PLAYTUNE routine.

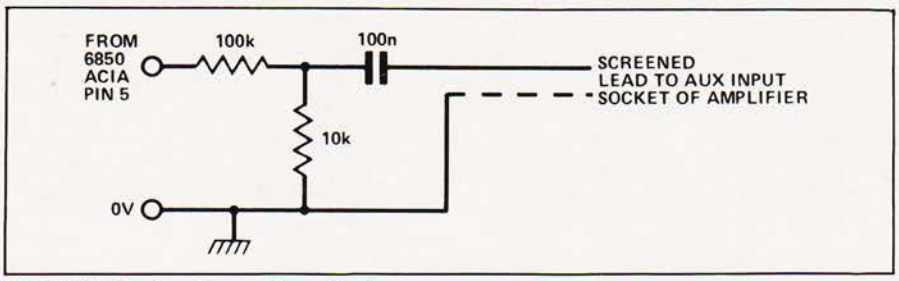

Fig.2. Interfacing the audio output.

and so on, the last entry being a dummy note with the pitch parameter set to zero: the program tests for this condition which terminates the subroutine. The Playtune subroutine itself is located at $1E10 onwards, and uses locations $1E00 — $1E03 as temporary stores to hold the parameters of the current note. $1E04 holds the note parameter counter which increments by four in the process of loading a note. Thus the parameters of the first note (length, compensation length, N/R and pitch) in $1F00 — $1F03 are loaded into $1E03 — $1E00 respectively. The reversal of order is due to the indexed load and store of parameters, the parameter counter being incremented whilst the Y index register is decremented to zero to load the next four parameters. The operation of the rest of the code should be clear from the flowchart operation outlined earlier.

GETTING LOADED

I now had a working Playtune routine, which would accept up to 64 notes and rests (256 parameters) and then play them. However, it was decidedly not user friendly — the parameters had to be individually loaded into memory locations $1F00 onwards, using the machine code monitor. Further, the pitch, length etc of a note had first to be translated into the appropriate parameter values. These though are activities that are performed off line, and so a BASIC loader program to perform this chore would be ideal, speed of execution being immaterial.

It was decided that the BASIC Noteloader should be not only user friendly, but also (as far as possible) musically correct. Thus, to cope with accidentals occurring in keys far removed from C major (ie having lots of sharps or flats in the key signature) the BASIC Noteloader should cope with double sharps and double flats. Note lengths from demisemiquavers to semibreves should be accepted and a dotted or double dotted note should be accepted as a single note length. (Thus a dotted crotchet can be entered as such rather than a crotchet followed by a quaver on the same note. This makes the limitation of 63 notes plus END much less serious than it would otherwise be.) Development of the BASIC program was routine stuff and the final version is reproduced in Listing 2. It includes a fair number of REMarks and with the aid of these its operation should be decipherable, so no flowchart is given.

A note is entered as a five character string, a number followed by four letters. The number is 1 or 2 (or possibly 3, see below), depending upon whether the note is in the lower or the upper of the two octaves covered. The range is actually from Abb (A double flat) ie the G above middle C to A𝄪, ie the third B above middle C. The first two letters indicate the degree of the musical scale eg AN is A natural etc, see lines 40 to 120. The final two letters indicate the note length and whether simple, dotted or double dotted. The program will not accept a dotted demisemiquaver or a double dotted semiquaver, as these would imply the presence of a semidemiquaver. The ability to handle this musical rarity is omitted from the program for the sake of simplicity.

To keep down the length of the BASIC program one or two other minor restrictions have been accepted. Thus the G♯ and G below the bottom of the lower octave can only be accessed as A♭ and A♭♭, ie 1AFXX and 1AEXX. But the top B♭ and B can be called up either as 3ASXX and 3ATXX or as 3BFXX and 3BNXX. Higher notes are not available and any attempt to enter them will result in an error message. Thus the range covered is just over two octaves, and this is about the practical limit. For higher notes the pitch parameter P becomes so small that it is not possible to select values which give notes that are passably in tune.

MEMORY SHORTAGE

No attempt has been made to squeeze down the number of lines. If your memory is a little short, you can change the GOTO 130 in line 800 to GOTO 40, and the explanation of the note entry format will then be printed on the screen before each note is entered. Having entered the parameters corresponding to all the notes and rests, and recognized and loaded the END marker, the BASIC program then proceeds to POKE the Playtune machine code subroutine into RAM starting at $1E10 — lines 810 to 890 inclusive. The machine code is identical to that in Listing 1 with one exception, the JMP $1300 in the last line is replaced by RTS (ReTurn from Subroutine). Having loaded the Playtune subroutine, the tune is played and the RTS returns control to the BASIC program. This gives the operator the choice of playing the tune again or entering additional notes. In the latter case, the number of the last note entered is given. If it is desired to alter a note already entered, this is easily achieved by setting the ammended note. The Loader program has no END, to return to BASIC command mode simply press CR when requested for input.

AMPLIFICATION

So now we have a machine code Playtune routine and a BASIC Loader and Control program but how do we interface the computer output to a Hi-Fi? The necessary circuitry is shown in Fig. 2, and must represent just about the cheapest possible add-on music board. Indeed, the necessary components can be mounted on the main board, which has the advantage that if the output is accidentally short circuited there is no possibility of damaging the ACIA. The output (just over 100 mV RMS) is simply connected to

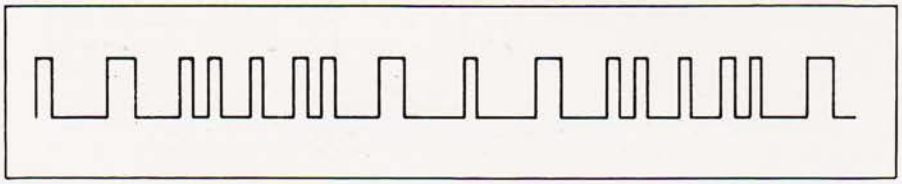

Fig.3. Two interleaved pulse trains of different frequencies. Frequency ratio shown: 5:6. Pulse width is exaggerated for clarity.

the auxiliary input at the back of a Hi-Fi amplifier or music centre and the volume adjusted to the required level.

With a little practice entering tunes from sheet music is very quick and easy. However, there is a slight inconsistency in conventional musical notation that is worth noting. It will be found that if two successive crotchets are written at the same pitch, when played using the program they sound virtually indistinguishable from a minim, and this is correct if no rest intervenes. But on a conventional musical instrument, the player would deliberately interpose a very short rest in order to ensure the separate articulation of the two notes. That is how an organist would play it, whilst a violinist would achieve the same effect by playing one note on the down bow and the other note on the up bow. On a piano the separate sound of the two notes is of course ensured by the very nature of the instrument. When using the program, the effect can be achieved by substituting a double dotted quaver for the first crotchet. Thus a certain well known tune would become: 1ANQZ 1ANCX 1BNCX 1AFCY 1ANQX 1BNCX. . .

The program is monophonic, that is to say it can play only one note at a time — like a woodwind or brass instrument. If you can get together with other owners of Compukit UK101s then duos, trios or quartets become possible. But a further avenue for experiment is programming the computer to play two notes at once. To play two notes at once on the computer, the trick is to generate not squarewaves but narrow pulses. By arranging for a composite pulse train consisting of two pulse trains of different repetition frequencies to be generated, as shown in Fig. 3, it should be possible to achieve the desired result. I suspect that the fact that the pulse height does not double when two pulses are coincident represents a nonlinearity which might result in the production of sum and difference tones, with the possibility of three or four part harmony!

```
 10 1E10           *=$1E10
 20 1E10           END=$1E53
 50 1E10 A900      LDA #$00
100 1E12 8D041E    STA $1E04
110 1E15 A003      NTR LDY #$03
120 1E17 AE041E    LDX $1E04
130 1E1A BD001F    LDNT LDA $1F00,X
140 1E1D 99001E    STA $1E00,Y
150 1E20 E8        INX
170 1E21 88        DEY
180 1E22 10F6      BPL LDNT
185 1E24 8E041E    STX $1E04
186 1E27 AD001E    LDA $1E00
187 1E2A F027      BEQ END
190 1E2C AE021E    PLNT LDX $1E02
193 1E2F A900      NXCY LDA #$00
200 1E31 8D00F0    STA $F000
210 1E34 AC001E    LDY $1E00
220 1E37 88        PTA DEY
221 1E38 EA        NOP
230 1E39 D0FC      BNE PTA
240 1E3B AD011E    LDA $1E01
250 1E3E 8D00F0    STA $F000
260 1E41 AC001E    LDY $1E00
270 1E44 88        PTB DEY
271 1E45 EA        NOP
280 1E46 D0FC      BNE PTB
290 1E48 CA        DEX
300 1E49 D0E4      BNE NXCY
310 1E4B CE031E    DEC $1E03
320 1E4E D0DC      BNE PLNT
330 1E50 4C151E    JMP NTR
340 1E53 4C0013    END JMP $1300
```

Listing 1. PLAYTUNE machine code routine. Line 340 is shown as it was during program development using the the Assembler program. For use with the program in Listing 2, line 340 should be changed to RTS.($60).

```
10 REM MONOPHONIC TUNE PROGRAM
20 REM C 1981 IAN HICKMAN
30 I=0
40 PRINT"DX=DEMISEMIQUAVER, SX=SEMIQUAVER"
50 PRINT"DY=DOTTED QUAVER, CZ=DOUBLE DOTTED CROTCHET"
60 PRINT"MX=MINIM, BX=SEMIBREVE"
70 PRINT"AN=A NATURAL, BS=B SHARP, CF=C FLAT"
80 PRINT"DE=D DOUBLE FLAT, ET=E DOUBLE SHARP ETC"
90 PRINT"RN=REST"
100 PRINT"e.g. 1CSCY=C SHARP DOTTED CROTCHET IN THE"
110 PRINT"LOWER OCTAVE; TWO OCTAVES AVAILABLE"
120 PRINT"AFTER LAST NOTE ENTER 'END' AS ANOTHER NOTE"
130 R=64
140 INPUT"NEXT NOTE";A$
150 IF A$="END" THEN POKE7936+4*I+3,0:GOTO 820
160 L$=RIGHT$(A$,2): REM NOTE LENGTH ROUTINE
170 IF ASC(L$)=68 THEN L=1:GOTO 240: REM L=LENGTH
180 IF ASC(L$)=83 THEN L=2:GOTO 240
190 IF ASC(L$)=81 THEN L=4:GOTO 240
200 IF ASC(L$)=67 THEN L=8:GOTO 240
210 IF ASC(L$)=77 THEN L=16:GOTO 240
220 IF ASC(L$)=66 THEN L=32:GOTO 240
230 PRINT"ERROR IN NOTE LENGTH, NOTE";I:GOTO 130
240 IF RIGHT$(L$,1)="X" THEN 280
250 IF RIGHT$(L$,1)="Y" THEN L=L*1.5:GOTO 280
260 IF RIGHT$(L$,1)="Z" THEN L=L*1.75:GOTO 280
270 GOTO 230
280 IF L<>INT(L) THEN 230
290 OCT=ASC(A$)-49: REM NOTE PITCH ROUTINE
300 IF OCT<0 THEN 400
310 N$=MID$(A$,2,2): REM N GIVES PITCH NUMBER H
320 IF LEFT$(N$,1)="A" THEN H=3: GOTO 410
330 IF LEFT$(N$,1)="B" THEN H=5: GOTO 410
340 IF LEFT$(N$,1)="C" THEN H=6: GOTO 410
350 IF LEFT$(N$,1)="D" THEN H=8: GOTO 410
360 IF LEFT$(N$,1)="E" THEN H=10: GOTO 410
370 IF LEFT$(N$,1)="F" THEN H=11: GOTO 410
380 IF LEFT$(N$,1)="G" THEN H=13: GOTO 410
390 IF LEFT$(N$,1)="R" THEN R=0: GOTO 410
400 PRINT"NO SUCH NOTE: NOTE";I:GOTO 130
410 IF RIGHT$(N$,1)="N" THEN 470
420 IF RIGHT$(N$,1)="S" THEN H=H+1: GOTO 470
430 IF RIGHT$(N$,1)="T" THEN H=H+2: GOTO 470
440 IF RIGHT$(N$,1)="F" THEN H=H-1: GOTO 470
450 IF RIGHT$(N$,1)="E" THEN H=H-2: GOTO 470
460 GOTO 400
470 H=H+12*OCT
480 IF H=1 THEN P=179: C=30: REM P IS PITCH LOOP COUNT
490 IF H=2 THEN P=170: C=31: REM C IS COMPENSATION LENGTH
500 IF H=3 THEN P=161: C=33:REM A
510 IF H=4 THEN P=152: C=35
520 IF H=5 THEN P=143: C=37: REM B
530 IF H=6 THEN P=135: C=39: REM C
540 IF H=7 THEN P=128: C=42
550 IF H=8 THEN P=122: C=45: REM D
560 IF H=9 THEN P=113: C=48
570 IF H=10 THEN P=105: C=51: REM E
580 IF H=11 THEN P=100: C=54: REM F
590 IF H=12 THEN P=95: C=57
600 IF H=13 THEN P=89: C=61: REM G
610 IF H=14 THEN P=83: C=65
620 IF H=15 THEN P=78: C=69: REM A'
630 IF H=16 THEN P=74: C=72
640 IF H=17 THEN P=70: C=76: REM B'
650 IF H=18 THEN P=66: C=80: REM C'
660 IF H=19 THEN P=62: C=85
670 IF H=20 THEN P=58: C=92: REM D'
680 IF H=21 THEN P=55: C=98
690 IF H=22 THEN P=51: C=104: REM E'
700 IF H=23 THEN P=48: C=110: REM F'
710 IF H=24 THEN P=45: C=117
720 IF H=25 THEN P=42: C=124: REM G'
730 IF H=26 THEN P=40: C=131
740 IF H=27 THEN P=38: C=136: REM A''
750 IF H=28 THEN P=36: C=144
760 IF H=29 THEN P=34: C=151: REM B''
770 IF H>29 THEN 400
780 POKE 7936+4*I,L:POKE 7936+4*I+1,C: REM LOAD NOTE PARAMS
790 POKE 7936+4*I+2,R:POKE 7936+4*I+3,P
800 I=I+1: GOTO 130
810 REM MACHINE CODE LOAD ROUTINE
820 DATA 169,0,141,4,30,160,3,174,4,30,189,0,31,153,0,30
830 DATA 232,136,16,246,142,4,30,173,0,30,240,39,174,2,30
840 DATA 169,0,141,0,240,172,0,30,136,234
850 DATA 208,252,173,1,30,141,0,240,172,0,30,136
860 DATA 234,208,252,202,208,228,206,3,30
870 DATA 208,220,76,21,30,96
880 FOR J=1 TO 68:READ A
890 POKE 7695+J,A:NEXT
900 RESTORE
910 POKE11,16:POKE12,30
920 X=USR(X): REM PLAYS TUNE
930 INPUT "PLAY AGAIN, YES OR NO";U$
940 IF LEFT$(U$,1)="Y" THEN 920
950 PRINT"LAST NOTE WAS ";I
960 GOTO 130
```

Listing 2. Monophonic tune program.

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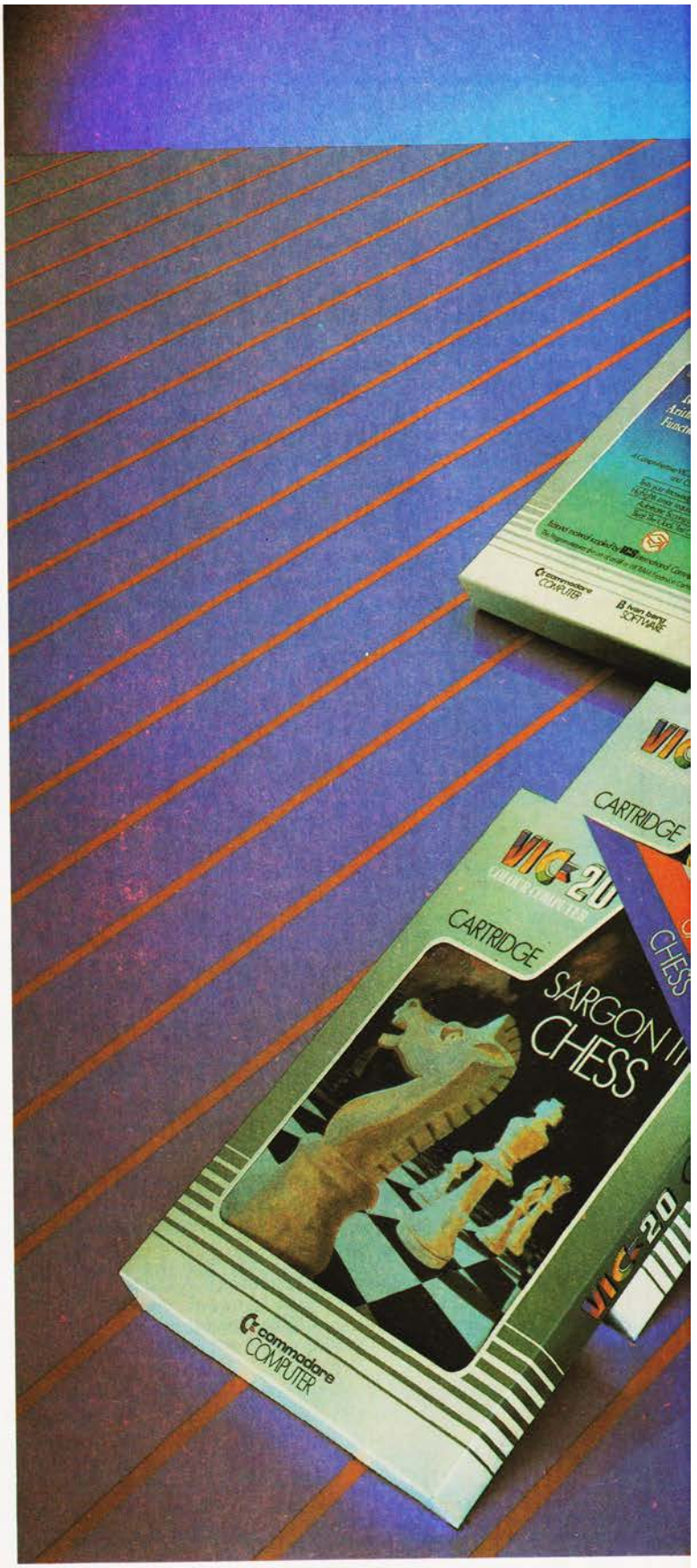

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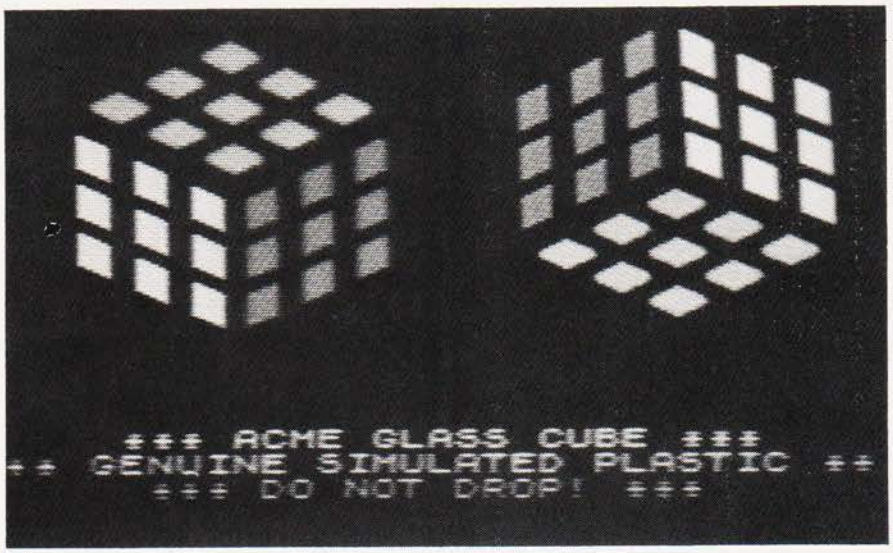
left from anyone in the box on the right.

Iolo Davidson

TUBE CUBE

Trying to solve Rubik's Cube will never be quite the same when you've tried our 3-D colour version for the ZX Spectrum.



Computing Today was first on the scene with a Rubik's Cube simulation at the height of the craze way back in August 1981. Colour computers were few and far between at that time, and the original program was for the black and white Triton, using letters to represent the colours, and a folded out flat display which some people found confusing. Furthermore, the program was in machine code, which has many advantages, but is difficult to rewrite for other machines. Now that the cheap colour computer is with us, the popularity of the cube has declined, but not disappeared, at least not in the computer world, as occasional requests for a version to suit various machines would indicate. Therefore we present the all-singing, all-dancing, 3-D musical colour version in BASIC for the 16K or 48K ZX Spectrum.

In addition to allowing the manipulation of the cube in the usual manner, the program provides the facility to return to a fresh cube at any time. It will do this either immediately or by backspacing through the move sequence, and the backspacing can be halted at any point to allow further manipulation. This backspacing facility requires storage space, and to keep this as large as possible, (over 500 moves in the 16K Spectrum,) the program listing is devoid of REM statements. However, as a service to the intellectually hyperactive and those wishing to attempt to rewrite for a different computer, a description of the program operation is appended below.

GRAPHICALLY SPEAKING

The ZX Spectrum's user defined graphics are used, and in order, again, to save space, the bit of program needed to POKE the graphics data into place is presented separately. This should be entered and RUN first, before the main program is typed in, and it should be removed with a 'new' statement before entering the main program. The graphics will be saved automatically by using line 9000 in the main program, (enter 'RUN the 'USR 'A'' rather than an absolute address. The 16K and 48K machines store their UDGs in different places, but this type of instruction will work on both. Indeed, it allows graphics saved on a 48K machine to be loaded correctly into a 16K machine and *vice-versa.*

The graphics as they appear in the listing are no help to anyone typing in the program, so list them below with the line numbers wherein they are used.

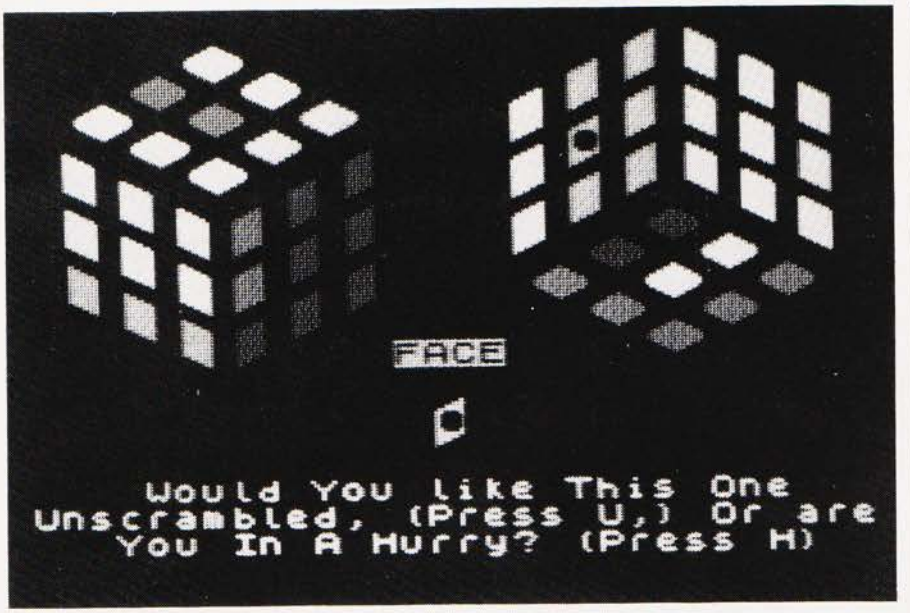
```
1510 GRAPHICS ABCD
1520 GRAPHIC  IJKL
1550 GRAPHIC  EFGH
5030 GRAPHIC  MN, GRAPHIC
     OP
6010 GRAPHIC  MN
6020 GRAPHIC  OP
```

Owners of no-doubt-quite-good-really computers not bearing the blessing of Saint Clive, (you can tell I got my Spectrum from Smiths and not mail order, can't you,) who wish to modify the program will have to make their own arrangements for graphics. The Spectrum graphics are eight pixels by eight, and four of them are used to print each cubie, but the program handles them as a string array, so any graphics or characters put in the A$ array at line 1500 would be output in the same way. This array only keeps track of the shape of the cubies, the colour being held in the numeric array A. The Spectrum's sophisticated string slicing is used when printing array A$, in lines 2020, 2140, and 2220. Computers lacking string arrays or slicing, or those with a screen width less than the Spectrum's 32 columns, will probably find it much easier to use a single graphic character per cubie.

VARIABILITY

Many of the variables used are only markers in FOR . . .NEXT loops and require no discussion. Sometimes I assign the value of a complicated function to a variable for speed purpose, as in line 2655, where variable G is used to keep a calculation out of the 'T' loop where it would be calculated unnecessarily three times as often. The permanent program variables are as follows:

K$ =	Last key pressed, used mostly for selection of cube face and direction of rotation.
K =	Cube face selected, 0 if none.
M$ =	String holding sequence of moves.
A$() =	String array holding graphics for different cubie shapes.
A() =	Numeric array holding the current state of the cube, and the order that the faces are dealt with, (crucial in moving edge cubies from face to face).
B(), C() =	Buffer arrays used during rotation.
D() =	Array identifying the cubies required from each face adjacent to the rotating face as edge cubies
U() =	Array holding screen addresses for displaying cubies.

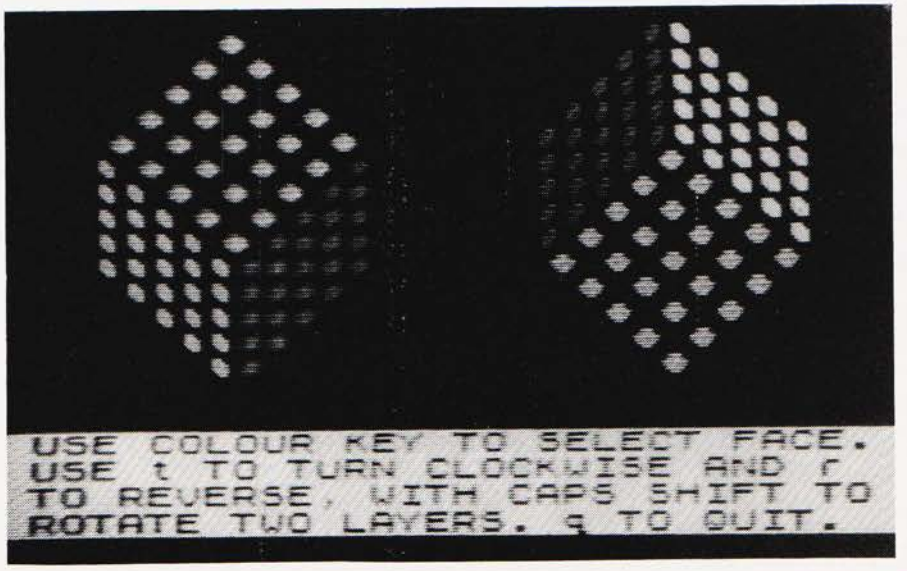


M, N, O, P, V, W, and Y are used at one point to make the display of the turned face move in the right direction, but some of them are also used temporarily elsewhere.

The following functions of various sections of the program are as follows:

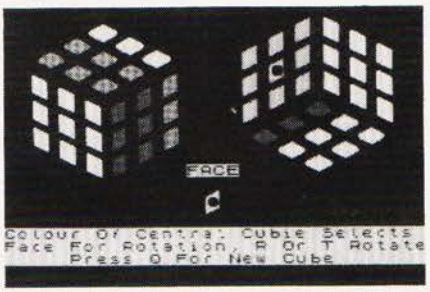
500	Quit routine — selects rerun or unscramble
1000	Initialise variables and arrays
2000	Display of moved cubies only
2500	Main loop for manipulation
2600	Rotate widdershins
2800	Rotate clockwise
3000	Get input
4000	Load buffer arrays
5000	Print identification of selected face
6000	Mark selected face (also unmark, using print over)
7100	Store each move for unscramble
7200	Unscramble, backspaces through move sequence

Some of the above are not essential to the purpose of the program. Those wishing to rewrite for a different computer need only puzzle out routines from 1000 to 4000, adding their own frills later if wanted. They will also need to know how the Spectrum display works. 'Print at X,Y' moves the print position to line X, column Y, and this facility is used to place a box of four graphics making up each cubie at the proper place on the screen, according to array U. The colours used correspond to the numbers 2 to 7, and hence the cube sides, numbered 1 to 6 in array A, are given the initial colour corresponding to the side number plus one, which simplifies the input routine. For those who don't know, the central cubie on each face does not travel, but only turns in its socket, so the initial colour remains the means of identification for each face, and the colour keys (2 to 7) are the inputs to select the face for rotation. The paper and ink instructions have to do with the colours printed and are related to the input or cubie colours in array A. The rest is pretty well standard BASIC.



Above: The cube unscrambling itself.

Below: You can Rotate or Twist the faces of the cube.



TAKING IT FURTHER

For those of you who think this is clever, imagine a cube based on a 5 by 5 by 5 system. Impossible you say, it couldn't be made . . . And of course you're right. But there's nothing to stop you doing it in software. Interested? Of course you are. And in a mad moment of generosity we decided to give away this 5 by 5 by 5 cube (we call it Pentacube).

There's got to be a catch of course: it comes at the end of the tape of Tube Cube that ASP are selling for the miserably low price of £5.95. Tube Cube on the tape also includes the facility to randomly scramble your cube to a starting position plus the capability to save and reload your current status from tape. It runs on both 16K and 48K machines. Send a cheque payable to ASP Ltd, to 145 Charing Cross Road, London, WC2H 0EE for your tape of Tube Cube. ▶

```
    0>REM *      TUBECUBE      *
          * by IOLO DAVIDSON *
    1 GO TO 100
    5 LOAD "set"CODE USR "a"
  100 BORDER 6: PAPER 0: INK 9: B
RIGHT 1
  110 CLS
  120 PRINT AT 17,2; INK 6;"  ***
 ACME GLASS CUBE ***"
  130 PRINT INK 5;"** GENUINE SIN
ULATED PLASTIC **"
  140 PRINT INK 4;"      *** DO NO
T DROP! ***"
  200 GO SUB 1000
  210 GO SUB 2000
  225 INK 9: PAPER 1
  230 PRINT AT 17,0;"   Press Col
our Key To Select  "
  240 PRINT "  Face- Then Press K
ey T Or R   "
  250 PRINT " To Turn Clockwise C
r Otherwise "
  270 FLASH 0: PAPER 0
  300 LET k=0: LET a$="": GO TO 2
500
  500 IF a$="" THEN RUN
  505 PRINT AT 17,0;"     Would Y
ou like This One  "
  510 PRINT " Unscrambled, (Press
 U,) Or are "
  520 PRINT "    You In A Hurry?
(Press H)  "
  530 GO SUB 3000
  540 IF k$="h" THEN RUN
  550 IF k$="u" THEN GO SUB 600:
GO SUB 7200: GO SUB 5000: GO TO
2500
  560 BEEP .5,-40: GO TO 530
  600 PRINT AT 17,0;"   Hold Down
 H To Halt Action   "
  610 PRINT "    Or Hold R To Regs
in Control  ";TAB 31
  620 RETURN
 1000 DIM a(6,14)
 1010 FOR e=1 TO 9
 1020 FOR c=1 TO 6
 1030 LET a(c,e)=c+1
 1040 NEXT c
 1050 NEXT e
 1060 FOR f=1 TO 6: FOR e=10 TO 1
4
 1070 READ a(f,e)
 1080 NEXT e: NEXT f
 1090 DATA 2,3,4,5,6,3,1,5,6,4,1,
2,6,4,5,6,5,1,3,2,4,6,2,1,6,5,4,
3,2,1
 1100 DIM u(54,2)
 1110 FOR e=1 TO 54
 1120 FOR f=1 TO 2
 1130 READ u(e,f)
 1135 BEEP .008,e
 1140 NEXT f: NEXT e
 1150 DATA 7,8,6,10,5,12,7,12,9,1
0,10,11,8,9,8,8,10
 1160 DATA 1,7,2,9,3,11,4,9,5,7,4
,5,3,3,2,5,3,7
 1170 DATA 7,18,5,18,3,16,2,20,1,
22,3,22,5,22,6,20,4,20
 1180 DATA 7,23,8,25,9,27,10,25,1
1,23,10,21,9,19,8,21,9,23
 1190 DATA 11,6,10,4,9,2,7,2,5,2,
6,4,7,6,8,4
 1200 DATA 3,28,5,28,7,28,6,26,5,
24,3,24,1,24,2,26,4,26
 1500 DIM a$(6,4)
 1510 LET a$(1)="▟▛ "
 1520 LET a$(2)="▜▟ "
 1530 LET a$(3)=a$(1)
 1540 LET a$(4)=a$(2)
 1550 LET a$(5)="▙▜ "
 1560 LET a$(6)=a$(5)
 1600 DIM b(8): DIM c(4,3): DIM d
(4,3)
 1650 FOR s=1 TO 4: FOR t=1 TO 3:
 READ d(s,t)
 1660 NEXT t: NEXT s
 1670 DATA 5,4,3,3,2,1,7,6,5,1,8,
7
 1680 RETURN
 2000 FOR f=1 TO 6
 2010 FOR e=1 TO 9
 2015 LET z=e+9*f-9: INK a(f,e)
 2020 PRINT AT u(z,1),u(z,2);a$(f
,1 TO 2): PRINT AT u(z,1)+1,u(z,
2);a$(f,3 TO 4)
 2025 BEEP .006,f*e
 2040 NEXT e
 2050 NEXT f
 2055 INK 9
 2060 RETURN
 2100 FOR e=0 TO p STEP y
 2110 LET f=a(k,e+9)
 2120 FOR c=m TO n STEP y
 2130 LET z=f*9-9+d(e,c): INK a(f
,d(e,c))
 2140 PRINT AT u(z,1),u(z,2);a$(f
,1 TO 2): PRINT AT u(z,1)+1,u(z,
2);a$(f,3 TO 4): BEEP .004,z
 2150 NEXT c: NEXT e
 2200 FOR p=v TO w STEP y
 2210 LET z=k*9-9+p: LET f=k: INK
 a(k,p)
 2220 PRINT AT u(z,1),u(z,2);a$(f
,1 TO 2): PRINT AT u(z,1)+1,u(z,
2);a$(f,3 TO 4): BEEP .004,z
 2230 NEXT p
 2240 INK 9
 2250 RETURN
 2500 GO SUB 3000
 2505 IF k$="q" THEN GO TO 500
 2510 IF k$="t" AND k<>0 THEN GO
SUB 2600: GO TO 2500
 2520 IF k$="r" AND k<>0 THEN GO
SUB 2600: GO TO 2500
 2530 IF k$<"2" OR k$>"7" THEN BE
EP .5,-40: GO TO 2500
 2535 GO SUB 5000
 2540 IF k<>0 THEN GO SUB 6000
 2545 LET k=VAL k$-1
 2550 GO SUB 6000
 2560 GO TO 2500
 2600 GO SUB 7100
 2605 GO SUB 4000
 2610 FOR s=1 TO 8
 2620 LET t=s+2: IF t>8 THEN LET
t=t-8
 2630 LET a(k,s)=b(t)
 2640 NEXT s
 2650 FOR s=1 TO 4
 2655 LET g=a(k,s+9): LET x=s+1:
IF x=5 THEN LET x=1
 2660 FOR t=1 TO 3
 2670 LET a(g,d(s,t))=c(x,t)
 2680 NEXT t: NEXT s
 2690 LET v=8: LET w=1: LET o=4:
LET p=1: LET m=3: LET n=1: LET y
=-1
 2700 GO SUB 2100
 2710 RETURN
 2800 GO SUB 7100
 2805 GO SUB 4000
 2810 FOR s=1 TO 8
 2820 LET t=s-2: IF t<1 THEN LET
t=t+8
 2830 LET a(k,s)=b(t)
 2840 NEXT s
 2850 FOR s=1 TO 4
 2855 LET g=a(k,s+9): LET x=s-1:
IF x=0 THEN LET x=4
 2860 FOR t=1 TO 3
 2870 LET a(g,d(s,t))=c(x,t)
 2880 NEXT t: NEXT s
 2890 LET v=1: LET w=8: LET o=1:
LET p=4: LET m=1: LET n=3: LET y
=1
 2900 GO SUB 2100
 2910 RETURN
 3000 IF INKEY$<>"" THEN GO TO 30
00
 3010 IF INKEY$="" THEN GO TO 301
0
 3020 LET k$=INKEY$
 3030 BEEP .01,40
 3040 RETURN
 4000 FOR s=1 TO 8
 4030 LET b(s)=a(k,s)
 4040 NEXT s
 4060 FOR s=1 TO 4
 4085 LET g=a(k,s+9)
 4090 FOR t=1 TO 3
 4100 LET c(s,t)=a(g,d(s,t))
 4110 NEXT t: NEXT s
 4120 RETURN
 5000 PRINT AT 14,0;TAB 31;TAB 29
;TAB 28;TAB 32
 5004 PAPER VAL k$
 5005 PRINT "Colour Of Central Cu
bie Selects "
 5006 PRINT "Face For Rotation, F
 Or T Rotate"
 5007 PRINT "     Press 0 For Nea
 Cube  "
 5010 PRINT AT 12,14;"FACE": PRIN
T AT 14,15; PAPER 0; INK VAL k$;
a$(VAL k$-1,1 TO 2);TAB 15;a$(VA
L k$-1,3 TO 4)
 5020 INK 8: PAPER 8: OVER 1
 5030 PRINT AT 14,15;" ▄ ";TAB 15;
"▀ "
 5100 OVER 0: INK 9: PAPER 0
 5500 RETURN
 6000 LET qb=u(k*9,1): LET qb1=u(
k*9,2)
 6005 INK 8: PAPER 8: OVER 1
 6010 PRINT AT qb,qb1;" ▄ "
 6020 PRINT AT qb+1,qb1;"▀ ▀ "
 6040 INK 9: OVER 0: PAPER 0
 6050 RETURN
 7100 IF a$="" THEN GO TO 7130
 7110 IF k=VAL a$(1) AND k$<>a$(2
) THEN LET a$=a$(3 TO ): RETURN
 7130 LET a$=k$+a$
 7140 LET a$=STR$ k+a$
 7150 RETURN
 7200 GO SUB 6000
 7230 LET k=VAL a$(1)
 7240 LET k$=STR$ (k+1): LET t$=a
$(2)
 7245 LET a$=a$(3 TO )
 7250 GO SUB 5010: GO SUB 6000
 7260 IF t$="t" THEN GO SUB 2605
 7270 IF t$="r" THEN GO SUB 2805
 7275 IF INKEY$="h" THEN GO TO 75
75
 7277 IF INKEY$="r" THEN RETURN
 7280 IF a$<>"" THEN GO TO 7200
 7290 RETURN
 9000 SAVE "tubecube" LINE 5
 9001 SAVE "set"CODE USR "a",168
```

Listing 1. The Tube Cube program.

```
 5000 REM
   ************************
   *  user defined graphics  *
   *     routine and data-   *
   *  destroy after running  *
   ************************
 8010 FOR i=USR "a" TO USR "p"+7
 8020 READ a: POKE i,a
 8030 NEXT i
 8040 STOP
 8100 DATA 0,0,0,3,15,31,31,31,0,
48,240,240,240,240,240,240,31,31
,31,31,31,28,16,240,240,240,240,
240,192,0,0,0
 8110 DATA 0,12,15,15,15,15,15,15
,0,0,0,192,240,240,240,240,15,15
,15,15,3,0,0,0,240,240,240,240,2
40,240,56,8
 8120 DATA 0,0,0,1,7,31,127,255,0
,0,0,128,224,248,254,255,255,127
,31,7,1,0,0,0,255,254,248,224,12
8,0,0,0
 8140 DATA 0,0,0,0,0,3,7,7,0,0,0,
0,0,192,224,224,7,7,3,0,0,0,0,0,
224,224,192,0,0,0,0,0,0
```

Listing 2. Graphics generation program.

Two fast little movers. Newly arrived. From Epson.

Epson has always been associated with a superb range of top quality computer printers. A tough act that even our most ardent competitors simply cannot follow.

Well, here's some news for you. We've got them beaten.

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Take the RX-80. 100 characters per second with features like dot addressable graphics, condensed and double width printing. Centronics compatible interface comes as standard or choose from the optional RS-232C and IEEE interfaces.

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The RX-80 is tractor-fed for exact alignment and the FX-80 is both tractor and friction fed.

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RX-80
FX-80
PRINTING MACHINES

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BEATING THE RS232 BLUES

A serial interface should be the simplest way to connect two pieces of computer gear together. Unfortunately, RS232 complicates matters.

Only two pieces of wire are needed to allow one computer device to talk to another, and three if you want a two-way conversation. So you would think that hooking together computer equipment with serial interfaces would be easy — provided, of course, that the various equipment manufacturers had adopted a standard for their interfaces. And herein lies a problem.

The 'standard' which was adopted for serial interface was one known as 'RS232'. RS232 is a standard of the American Electronics Industries Association, and was originally intended for the interface between 'Data Terminal Equipment' (DTE — in other words a computer 'dumb' terminal) and 'Data Communications Equipment' (DCE — equipment which facilitates communication to a remote computer, like a modem).

The standard specifies the electrical characteristics of the interface signals, along with the shape and pin assignments of the connectors to be used. In addition there are certain other conventions which go along with this standard, like the commonly used data rates and formats.

Now, although it's possible to borrow the electrical and timing conventions from this standard, many aspects are ambiguous. As mentioned above, RS232 specifies two different 'sexes' of equipment, terminal equipment and communications equipment, each with their own sex of connector, and their own connector pin assignments. But the standard is now being applied also to computers, printers, plotters, digitising tablets, speech synthesisers and so on, which don't fall conveniently into the category of either sex. Consequently any particular piece of equipment has a more or less arbitrary sex assignment.

Furthermore, RS232 contains specifications for using its connectors and signals for a large number of different applications. Since today's equipment needs only the simplest of such arrangements, most of RS232's features are not used, and in fact merely add to the confusion as manufacturers arbitrarily select the few features they need for their interface.

OK, the fact that the interface is somewhat arbitrary on any particular piece of equipment would be compensated if the equipment manual told you how it worked. Not the case. In fact the description of how the RS232 interface works is ***almost universally the worst described part of the manual,*** ranging from extremely ambiguous to downright wrong.

SERIAL INTERFACE BASICS

There are many possible ways to make a serial communications 'channel'; RS232 is just one method. Let us examine serial interfaces in general, and see how RS232 implements the various features involved.

I should point out here that many of these features are not strictly a part of RS232, but are conventions which are used with it. The best way to declare something as a 'convention' is by referring to data on the ICs used to implement RS232 serial interfaces, namely the 'UART' which formats the data (such as the National 5303 and similar), and the 'line drive' and 'receiver' which actually send and receive the electrical signals on the serial cable (National LM1488 and 1489 respectively).

Suppose we are dealing with the simplest type of interface, one in which there is a 'sender' and a 'receiver', such as may be the case where a computer sends data to a line printer. Two wires connect the two devices, one wire being 'Ground' or zero volts, the other wire carrying the data.

ONES AND ZEROS

The first task is to decide how to represent the binary 'one' and 'zero' as voltages. A TTL logic IC regards a voltage less than 0.4 V as a logic zero, and a voltage greater than 2.8 V as a logic one. A TTL output is not, for various reasons, suited to sending data down a long wire, so RS232 does things differently. A 'zero' is represented by a 'high' voltage between +3 V and +12 V (for some reason also called 'space'), while a 'one' is represented by a 'low' voltage between −3 V and −12 V (also called 'mark'). The range between −3 V and +3 V is undefined.

Next we must decide in what order and with what timing the bits are to be sent down the wire. RS232 calls the unit of data transmission a 'character', even though the data sent may not actually represent a character. A particular device may be set to transmit or receive 5, 6, 7 or 8-bit characters, with seven being the most common (because seven bits will represent the entire ASCII set of 128 characters), and eight the next most popular. These characters are sent **least significant bit first.** Using the scheme as I have so far described it, the letter 'B', which is ASCII 42 Hex, or 66 decimal, would appear on the line as (see also Fig. 1):

High low high high high high low
(7-bit code)

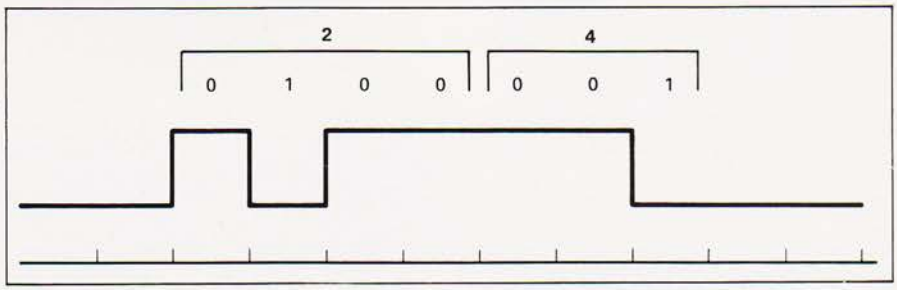


Fig. 1. The letter 'B' (42 Hex) is here represented as a sequence of voltage levels, as used by RS232 devices.

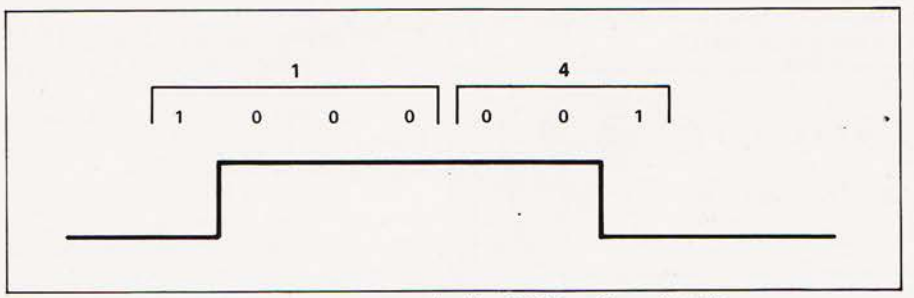


Fig. 2. The letter 'A' (41 Hex) is represented in RS232 voltage levels.

How does the receiver know when a particular character starts? We could use a third wire to signal that a character is starting on the second wire. This is a form of 'synchronous' communication and is generally not used with personal computer equipment. Instead RS232 has a way of telling the receiver that a character is starting. It works as follows.

START BIT

Suppose the receiver receives the above letter 'B'. Normally the communications line sits at 'mark' or low. Along comes bit one, which is a high, and immediately the receiver knows a character is coming in. Now, assuming that the receiver and sender are set so that they agree as to how long each bit is, the receiver will be able to recognise a high, then a low, then another low and so on, until the whole 'B' has been received.

However, suppose that instead the letter 'A' was sent, which is 41 Hex, and therefore is represented (also see Fig. 2) as:

Low high high high high high low

This time, by the time the receiver finds out something is happening, it's already on the second bit! And what if you had a character composed entirely of lows?

The way around this problem is to prefix every character with a 'start' bit, which is invariably high.

STOP BIT

This still leaves one problem. Suppose we send several hundred characters in a row. It would be unreasonable to expect that the sender and receiver agree as to the time-per-bit to such great accuracy that they would still be in step after so many bits. To overcome this each character is suffixed with one or two (according to how the devices are set) 'stop' bits, which are always low. After each character we always have a low-to-high transition which can be relied upon to keep the two devices in step.

Notice that there is nothing particularly special about the start and stop bits. They look like any other bits, except that there is always a low-to-high transition at least once per character, and it's between these two bits. I point this out because it means, for example, that if you are sending serial data to a printer, if the signal is momentarily disconnected (transmission continuing but reception interrupted) then upon reconnection the printer will probably not be able to interpret the incoming stream of highs and lows. The printer will be confused until the next pause in transmission, unless the combination of received characters enables the printer to determine where the stop-start location is.

TRANSMISSION SPEED

Naturally, both sender and receiver must be set to the same nominal communications speed. This speed is measured in bits-per-second, a unit also, and wrongly, known as baud. Commonly used rates are: 110 and 133 (for Selectric terminals, for example), 300 baud (modems communicating via telephone), 600, 1200, 2400, 4800 and 9600 baud.

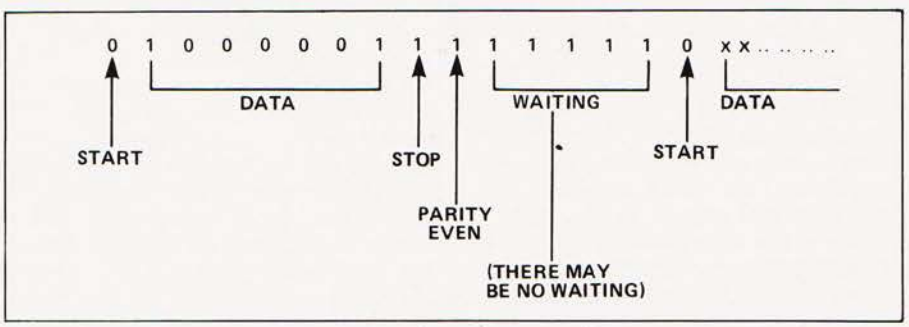


Fig. 3. This is a representation of the letter 'A' in seven-bit even parity code. Note that a '1' is a low voltage and a '0' is a high. The line normally sits at low or '1'.

PARITY

An embellishment which is occasionally seen is the use of 'parity' as an error checking method. In a seven-bit code, for example, an extra bit may be added after the last bit (but before the stop bit). The sender counts the number of 'one' bits in the character, and if the answer is even it sets the parity bit to 'one', if not it is made 'zero'. (This is the even parity convention. There's an equally little-used odd parity convention which makes the parity bit 'one' for an odd total.)

When the receiver gets the character it does the same arithmetic and compares its answers to the parity bit received with the character. If it has the same answer it knows all is well; if the answer is wrong an error has occurred somewhere. For example, suppose an 'A' is transmitted (seven-bit, even parity). This would be represented as in Fig. 3.

Now if one of those bits were accidentally changed somewhere along the way, there would be either one or three 'I's, which is an odd number and does not agree with the parity bit. (And of course if the parity bit was accidentally changed, it wouldn't agree properly either.) You can probably see that this scheme cannot show where the error occurred or how to fix it, nor does it signal double errors. It is basically a warning device.

In fact parity is generally ignored, since most personal computer equipment has no convention for requesting that the sender resend the faultily received data. (Often the receiving device may be set to expect the parity bit but not use it.) However I have included this description so that you know what parity is when the equipment has a switch to select or deselect its use.

LOTS OF OPTIONS!

As you can see, even thus far there are plenty of options to choose from. In a typical device many of these options may be switch selectable, usually miniature DIP switches inside the box, or perhaps soldered jumpers. In some cases, such as terminals and computers, some of these features may be ▶

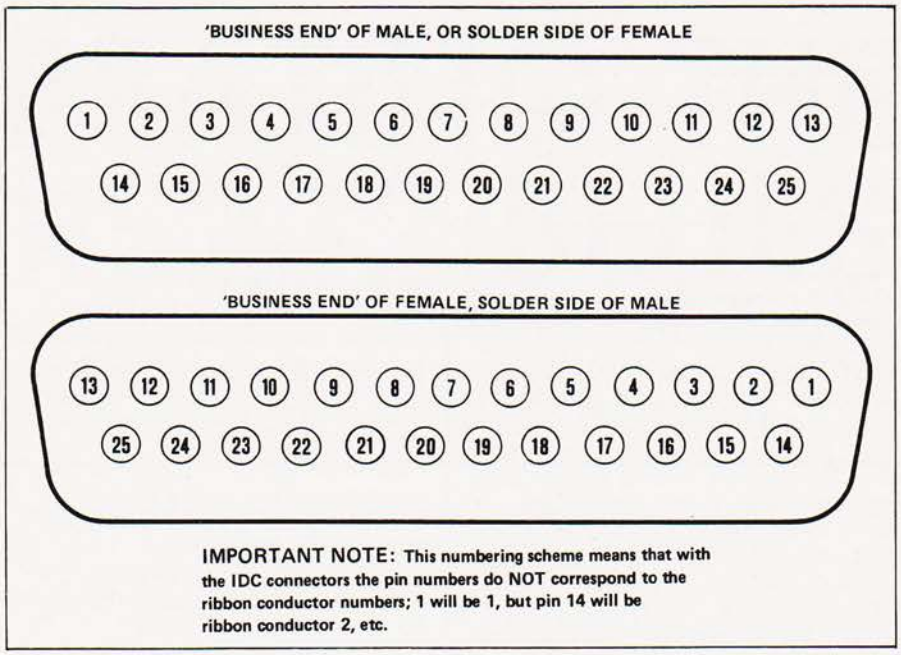


Fig. 4. DB25 contact numbering.

programmed from the keyboard or from software.

So there are plenty of ways in which your two little darlings won't be able to talk to each other! But wait, there's much more!

HOW MANY DUPLEXES?

Although not strictly of direct concern in the RS232 interface, some equipment, particularly terminals and modems, provide a 'Full/Half Duplex' switch.

'Full Duplex' means that when the terminal transmits a character to the remote computer the computer immediately echoes the character back to the terminal, whereupon it appears on the terminal's screen (or paper, if a teletype). If there is no echo then the character you typed will not appear on the terminal's screen. This is a kind of insurance method to let you know that the computer is listening.

In 'Half Duplex' set-ups it is assumed that the computer will not echo the characters from the terminal, and thus the terminal puts the typed characters on the screen whether or not the computer is awake.

The surprise comes if you have your terminal (or modem) set to Half Duplex, **and** the computer you are talking to echoes the characters. Then if you type 'FRED' you'll see 'FFRREEDD'.

NOT SO FAST!

A commonly needed feature is the ability to tell the sending device to slow down. I don't mean to send at a lower baud rate, but rather to pause for a moment. A typical situation where this occurs is in slow printers. When the carriage reaches the end of the line the printer must tell the sender to wait until the carriage returns before sending more characters.

Such a signalling system is known as 'handshaking'. Typically this is implemented by adding an extra wire to the interface cable. The receiver maintains this wire at a 'high' signal level while it's OK for the sender to send, pulling it 'low' to tell the sender to halt the flow of data. Sometimes an interface will have handshaking lines both ways, so that either device can halt the other.

A complete two-way interface would consist of two data wires, two handshaking wires and ground — a total of five wires. Most RS232 hook-up problems occur because one piece of equipment needs some of these signals which the other does not provide, or because the wires in each piece of equipment are not connected to the corresponding pins in the interfacing connectors.

NOT SO FAST TYPE TWO

A quick note here that on some intelligent printers handshaking is carried out using a method called 'X-on, X-off'. Instead of a separate handshaking wire, the printer has a data output wire (normally printers only receive data). If the printer wishes to halt the sender the printer sends a control character to the sender (usually control-S, 13 Hex, which is also known as 'Direct Control 3'). Subsequently sending the same character will restart the data. Note that this is the same character which you use in CP/M (and Apple) to stop and start a continuous display to the screen from the keyboard.

'Official' Signal Name	Abbrev(1)	Pin No.	DTE 'Terminal'	DCE 'Modem'	Comments
Protective ground	PG	1	—	—	Optional
Signal ground	SG	7	—	—	Necessary
Data:					
Transmitted data	TxD	2	Out	In	
Received data	RxD	3	In	Out	
Handshaking:					
Request to send	RTS	4	Out	In	Basically
Data terminal ready	DTR	20	Out	IN	same use
Clear to send	CTS	5	In	Out	Basically
Data set ready	DSR	6	In	Out	same use
Connector Sex:			Male(2)	Female	

(1) Note that the handshaking lines are sometimes indicated as inverted signals (eg: DTR). The idea is that if for the data a low is a '1', then if the data terminal is ready it should send out a '1'. In fact it sends out a high, which corresponds to a zero, hence the desire to use inverted signal notation. This refers, however, to the identical signal. In contrast there is the rare occasion when the equipment actually does put out an inverted signal, ie: low means ready, high means not ready. Yeah, I know, but don't complain to me!

(2) In fact almost all terminals use female chassis mount connectors. (A notable exception is the Heathkit H19). It seems that it is almost standard practice to use female on equipment chassis, and male on cables (except for much DEC equipment, which uses male chassis mounts on equipment, and female connectors on cables). Note that this means you can't tell the DTE/DCE gender from the sex of the connectors.

Table 1. A table of signals showing what they do and connection pin assignments.

HANDSHAKING AND BUFFERS, ETC

How necessary is handshaking in practice? A major sore point in the small computer industry has been the need for handshaking in printers. The Epson MX-80, for example, was available at one time with a serial interface known as 8141. This interface could only remember a maximum of two characters as they arrived from the computer. Since the 'line-feed' time exceeds the time of two characters, even at the slowest baud rates it was necessary for the interface to signal a halt after each line. The Exidy Sorcerer and the standard Apple printer interface board do not have any handshaking inputs, and consequently it would be impossible to make this combination of equipment work serially. (This particular problem rarely comes up since the MX-80 has a parallel input which is usually used).

A solution to this dilemma which is finding widespread adoption is to incorporate a 'buffer' into the serial interface. An example is the Epson 8145 interface, which has a 2000-character (approx.) buffer. Since the MX-80 chugs along at 80 characters-per-second (cps), if the computer transmits at 300 baud (approx. 30 cps) the buffer is normally virtually empty. At line-feed time the buffer fills up a little as the computer continues to transmit. But the MX-80 catches up on the next line. There is thus no need for handshaking. You can, however, get into trouble if the computer sends a large number of form-feeds, which take a long time.

WIRE, CONNECTORS AND STUFF

The connector used with RS232 is known as a 'DB25', which has 25 pins in the male, and 25 receptacles in the female, the pin numbering is shown in Fig 4.

RS232 was endowed with a pile of features, and these were implemented using most of the 25 pins. Now very few of the pins are used. The extra pins provide two opportunities for confusion and problems, however. One problem is that with such a profusion of pins it can be difficult to figure out which ones you are supposed to use for your application.

The second problem area is that with all those extra pins available and otherwise doing nothing, many manufacturers use the 'spare' pins for other purposes. Exidy uses them for the cassette interface. IDS, in their Paper Tiger printers, use the same DB25 for both serial and parallel interfaces.

That's fine except that if between such units you use a cable with too ***many*** wires implemented (and this can easily be the case if you use a standard RS232 cable in a set-up which does not use handshaking) then you are likely to blow something at one or both ends!

The pins which ***are*** commonly used are shown in Table 1. Note that the naming convention can result in a variety of confusions. If the equipment is masquerading as a DCE the manual may tell you that, for example, pin 2 is 'Transmitted Data', which strictly speaking is an ***input***. However, the manual writer may not know this and instead call it 'Received Data', intending 'Received' in a looser sense.

FIGHTING BACK

The first thing to do before connecting ***anything*** is to make yourself a chart like the one in Fig. 5 for each piece of equipment you may have to connect together. This is ***especially*** important if you are involved with many different units. I have a whole binder full of such charts on the equipment I work with. Using this binder I can almost instantly connect any two units with few problems.

The point to this chart is that for each of your pieces of equipment (and I assume you're working with at least two!) it serves to collect the titbits of information you will glean from the manuals, the schematic and so on. You end up with the info in the same format for each unit, where it can be simply compared to give you the best idea of how to wire things up ***before*** you blow anything, and before you have the frustrating experience of having the system not work.

If handshaking lines are provided, try to find out if they actually do anything, or if they are dummies. For example, one printer may have an output which signals the sending computer to halt. Another printer may claim to have the same handshaking output, but it is actually internally wired

PIN NO.	SIGNAL ABBREV.	SIGNAL NAME	IN/ OUT	OPEN OK?	COMMENTS
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					

EQUIPMENT TYPE: _____ CONNECTOR SEX ON EQUIPMENT: _____ DATE: _____

Fig. 5. Interface chart to save you headaches.

permanently high, and is provided merely for supposed compatibility to a computer which may need such an input so as not to halt. Got that?!

WIRING UP THE CABLE

You will notice that if one of your units is a true DTE and the other a true DCE then a standard cable (pin 1 goes to pin 1, 2 to 2 and so forth, which is called a 'straight-through') will work. You are unlikely to see this situation very often, which is something you should know before you buy such a cable made up (they're likely to be expensive ready-made), or before you get convinced by the salesman that the printer hook-up is trival.

So you decide to wire your own cable. First, of course, you must obtain the appropriate sexes of connectors to mate with what you have on the equipment, and a cable with a sufficient number of conductors. If it's over 20 feet you may wish to use shielded cable, but I've used unshielded up to several hundred feet.

Next, no matter what the equipment involved, wire pin 7 to pin 7. If it's a straight-through you are making, then go right ahead, 2 to 2, 3 to 3, etc.

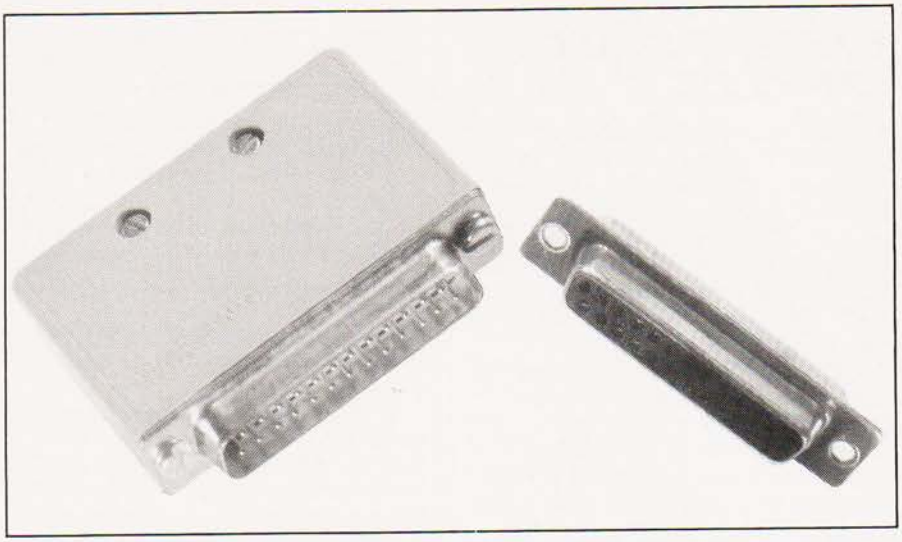
The next-most-delightful situation is where the two units are of the same sex and need no handshaking lines. For the data lines simply wire 2 to 3 and 3 to 2.

If handshaking lines ***are*** needed then determine which handshaking outputs actually mean something (as opposed to the dummies). Then connect these to the handshaking inputs of the opposite units.

You may have a sender which is sending to a receiver which does not need to halt the sender. If ths is the case you need to decide what to do with the sender's handshaking input. In some units it can merely be left open (unconnected), and this is seen as the same as 'high'. On other units open is taken as a 'low' and halts transmission. The handshaking input may be wired permanently high by jumpering it to a handshaking ***output*** on the ***same device***.This is normally done inside the plug on that unit's end of the cable. Fig. 6 shows some typical cable configurations.

THE INITIAL HOOK-UP

Armed with the appropriate (we hope) cable, plug in and see if it works! It probably won't, so refer to Table 2 which is a summary of all the things to check to make the two pieces of equipment compatible communicators.



A typical pair of DB25 connectors.

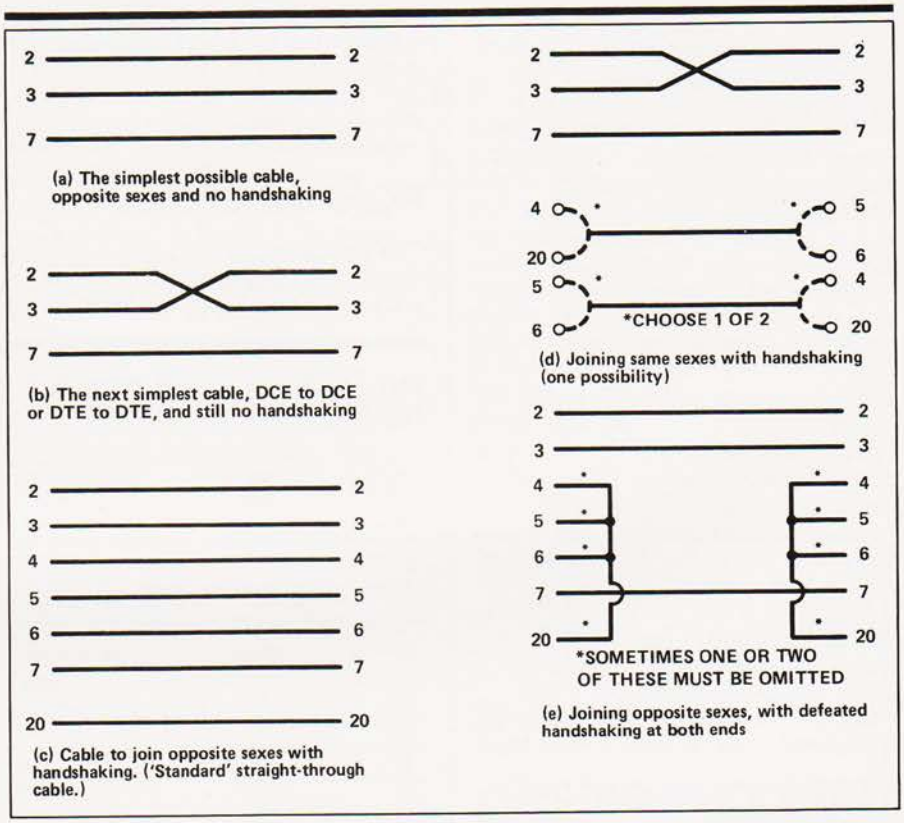


Fig. 6. Here are some typical cable hookups.

1. Number of ***bits per character***: 5, 6, 7, or 8.
2. Number of ***Stop bits:*** 1 or 2.
3. ***Baud Rate***: 110, 150, 300, 600, 1200, 1800, 2400, 4800, 9600 or other.
4. What to do with ***Parity***:
   On transmission: No Parity, Even Parity, Odd Parity, Parity bit set on 0, or Parity bit set to 1.
   On reception: No Parity expected, Ignore Parity, Expect Odd, or Expect Even.
5. ***Full*** or ***Half Duplex***.
6. Make sure machines are ***On Line*** if they have the ability to be off line.
7. A rather rare final item which can cause problems is an option on a few machines which allows for the inversion of the polarity of the data signals and/or handshaking signals. You should set these to: Negative Mark for the data lines, and handshaking lines should indicate OK to proceed with a high level, STOP with a low level.

Table 2. List of quick checks to make when hooking up two pieces of gear for the first time.

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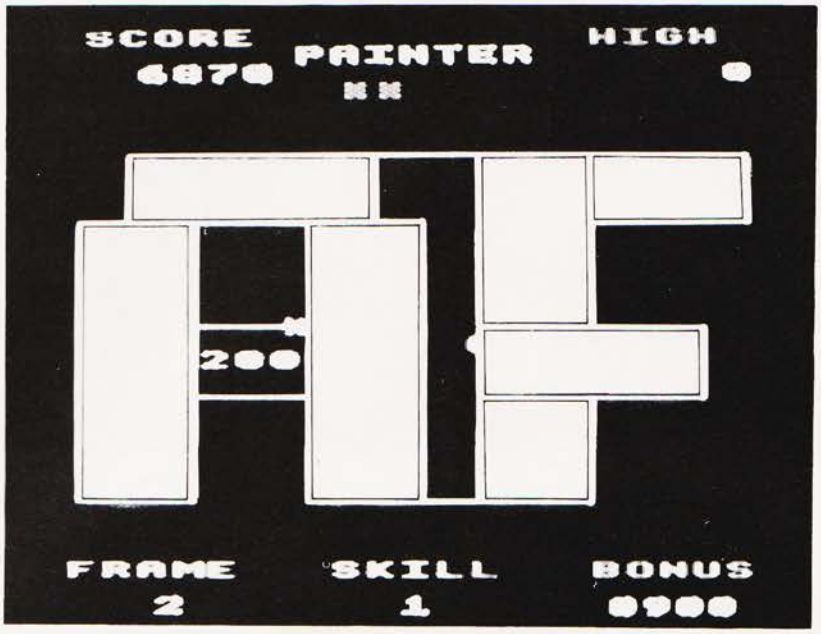
PAINTER £8-00



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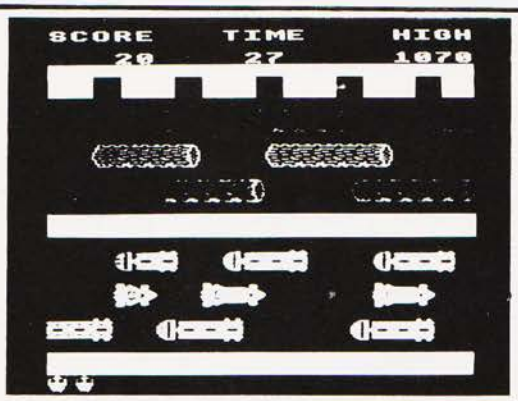

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Henry Budgett

#FILE

Is it a 'plane? Is it a bird? No, it's the Editor giving us the benefit of his opinion on topics divers!

Some things make me MAD! Those observant enough to have already established that I'm probably already a suitable case for treatment can keep quiet, thank you! No, it's just that a couple of things have happened this month which are just so ludicrous as to make me begin to wonder whether I'm losing my marbles or certain manufacturers are trying to pull a proverbial fast one.

The first crack came when, whilst attending a Press launch for a certain brand of calculator the company kept using the phrase "improving people's numeracy". Now, I thought numeracy meant that one had the facility to deal with numbers, in the sense of being able to do simple arithmetic. Indeed, the **Concise Oxford Dictionary**, our standard of reference, quotes "numerate: Acquainted with basic principles of mathematics and science; hence numeracy".

As far as I can make out, the implication is that if you own a calculator you are numerate! Er, I don't quite believe that somehow. You may be capable of pressing buttons to get results but unless you know what order to press the buttons in the results are going to be rather unpredictable. Perhaps if you were familiar with the way in which numbers operate it might help? Yes, you all cry, but then you would be numerate! Somehow I think that this little argument could eventually tie itself in knots so if you either share or object to the view that calculators don't make humans numerate your comments would be welcomed, if only to convince me of my incipient insanity!

BASIC WALES

No, this has got absolutely nothing to do with the recent BBC Television series on the Paras and their extremely uncomfortable training but is rather more micro connected. In fact it's the second lunacy of the month, which probably makes it somewhat closer to the recent . . .

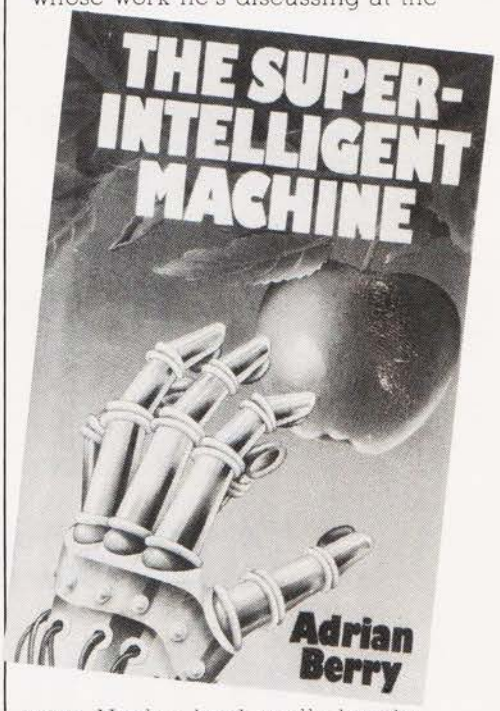
What, pray, is a computer language? It's a series of formal instructions with a very precise grammatical structure that enables a human to communicate with a computer. OK, so that's fairly straightforward — it's just like French to a Spaniard or Italian to an Englishman if you take the 'natural' example. Now, for many, many years there has been a language called BASIC. The French use it, the Germans use it, the Italians use it and even the Japanese use it. They learn it just like they would learn the rules and grammar of another, foreign language. So, why do the Welsh have to go and produce a Welsh version of BASIC? Believe me, I've nothing against the Welsh, I live rather too close to the border for that, and I respect their culture and their endeavours to establish (or rather re-establish) their national identity but surely Welsh BASIC is going just a little too far? Mind you, perhaps it's a subtle method of program protection in that only those fluent in 'Welsh' could understand it!

Still, for those of you with a sufficiently nationalistic bent I can reveal that the name of the product is BASIC CYMRAEG and it will work on the Sharp MZ-80A and K systems. If you want one it will cost you £6 from your local dealer or direct from David Computer Software at 38 South Parade, Bramhall, Stockport SK7 3BJ.

READ ALL ABOUT IT

A couple of thick, general interest books have thudded onto my desk in recent weeks, both of which are worth a few words. The first is **The Super Intelligent Machine** by Adrian Berry, probably better known to you as the Science Correspondent of the Daily Telegraph, and the other is **The Intimate Machine** by Neil Frude. Both are remarkably similar in that they are really collections of references about other people's work in the fields of computing, artificial intelligence etc, etc.

Of the two I prefer the Frude book, mainly because he raises some rather interesting points and is not afraid to pass judgement whereas the Berry volume seems reluctant to take any other viewpoint from that of the person whose work he's discussing at the



time. Neither book really breaks any new ground, indeed the Berry book is at times positively apocryphal, but it is quite handy to have all this sort of information in one volume. For those interested in cracking puzzles I can reveal that the dedications in **The Super Intelligent Machine** are directly related to the first person mentioned in the acknowledgements, they are his wife and son, but I'll leave the problem of the crashing BASIC program on p47 to the more observant of you — it will never run more than about 26 times but can you spot why?

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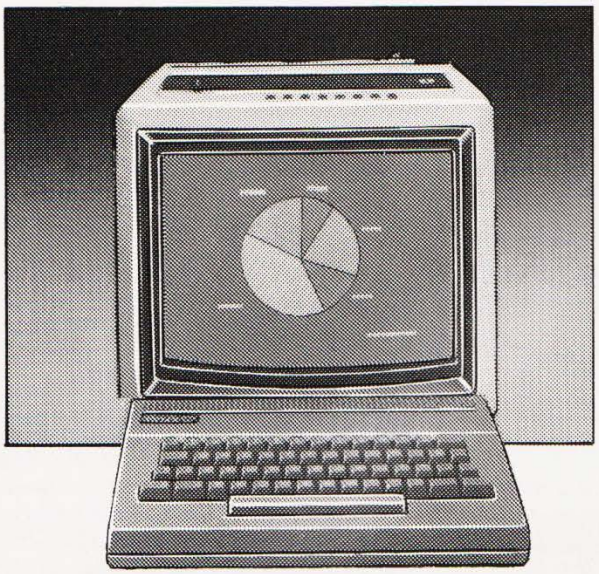

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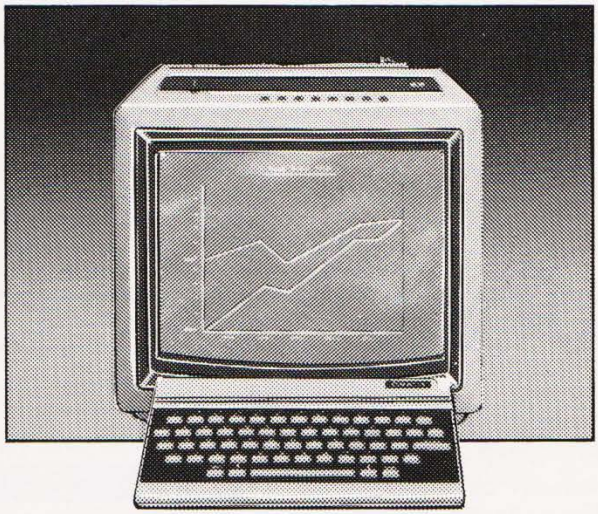

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PRINTOUT

Dear Sir,

I run a Nascom 3 with the Nascom discs and an Epson MX-80 Type 2, and I am considering adding CP/M; it presently runs NasDos. The objective is to gain access to an even wider range of software. I wonder if you can help with what appears to be several potential problems.

Firstly, I need to add an 80-column video card. Several options are available, including Nascom's AVC, the Gemini IVC, and the recently advertised card from MAP 80. Nascom offer CP/M to be used with their discs and AVC; Gemini offer CP/M for their IVC but in conjunction with their own disc unit. Are versions available that are compatible with the other combinations, or is it easy to modify CP/M to accommodate them?

Will all of these cards drive a normal TV or is a monitor essential? Will I still be able to run my present software under NasDos, and if so, will the display be 48 or 80 column? Obviously a switch is required to change the memory map etc but Nascom have issued some advice on how to do this.

Lastly, if I finally get CP/M up and running, will it really make a lot more software available? The Nascom disc units are double density and double track, so can discs from, say, a Superbrain QD be used directly? I have not seen many adverts for software in Nascom CP/M format.

I should emphasise that I am extremely pleased with NasDos, but fancy exploring the famous CP/M.

Yours faithfully,
Colin Case,
Rugby

(*Unless anyone else can help I'd suggest that you write to Lucas Logic Ltd, Welton Road, Wedgnock Industrial Estate, Warwick CV34 5PZ for Nascom details, I'm sure they'll be glad to give you the information you require. Ed.*)

Dear Sir,

I would like to draw your attention to an error in your article 'Elegant Programming' in the January issue. The listing given on page 59 from the program to reverse a set of numbers requires lines 50 and 60 to be as follows:

```
50 LET S(P)=N
60 LET P=P+1
```

Often such errors are the cause of much frustration but sorting them out can be a very useful and educational process for the learner.

Yours faithfully,
William J Davis
County Dublin

Dear Sir,

The letter from H P Hart (February 1983) suggests that Australia doesn't know about 'Dungeons and Dragons'. Thought the place was strange and remote but well, ye gods, clearly a Spell of Enlightenment must be cast!

Yours faithfully,
Barrie L Martindale,
Alias Milton,
(4th Level Cleric),
Village of Hommlet

Dear Sir,

I have read with great interest the articles published in your magazine by Mr Mike James about advanced programming in BASIC.

In the January issue Mr James introduced, among others, the concepts of dynamic data structures. He constructed as an example a stack structure using an array to implement it.

When I decided to use a stack for integers in one of my programs I found that in BBC BASIC the problem can be solved in a more 'elegant' way by using indirection operators (see page 409 of the Beebs User Guide).

In order to implement the stack structure (supposing we want a stack that can hold NDATA% integers) we must reserve NDATA% 4 bytes for the stack by DIM S% NDATA%* 4 and we must use a procedure PROCINITIALISE to initialise the variables we need to control the stack. Then we need a procedure PROCPUSH(Z%) to push data whenever we want into the stack and a function FNPULL to pull data out of the stack. Here are those procedures. (The line numbers are completely unimportant).*

```
5000 DEF PROCINITIALISE
5010 T%=0:N%=0:ENDPROC
5020 DEF PROCPUSH(Z%)
5030 IF N%=NDATA% PRINT"STACK FULL" ELSE
     S%!T%=Z%:T%=T%+4:N%=N%+1
5040 ENDPROC
5050 DEF FNPULL
5060 IF N%=0 THEN=0 ELSE N%=N%-1:T%=T%-4
5070 =S%!T%
```

In these procedures T% is a pointer to the top of the stack, N% indicates the number of integers currently held in the stack and the function FNPULL will return the value 0 in case the stack is empty while the procedure PROCPUSH will print STACK FULL and return in case it finds the stack full

In a completely analogous way and with only a little more complication we can create a queue to hold NDATA% integers (it is necessary to reserve NDATA% 4 bytes for the queue first by including DIM BOTTOM%NDATA%*4 first). Here are the procedures PROCINITIALISE to initialise the queue and PROCJOINT(Z%) used to load data into the queue and the function FNLEAVE to take data out of the queue.*

```
5000 DEF PROCINITIALISE
5010 ATOP%=BOTTOM%+NDATA%*4
5020 START%=BOTTOM%
5030 AEND%=ATOP%:N%=0
5040 ENDPROC
5050 DEF PROCJOINT(Z%)
5060 IF AEND%=ATOP% AEND%=BOTTOM%-4
5070 IF N%=NDATA% PRINT"QUEUE FULL" ELSE
     N%=N%+1:AEND%=AEND%+4:!AEND%=Z%
5080 ENDPROC
5090 DEF FNLEAVE
5100 IF N%=0 THEN=0
5110 S%=START%:N%=N%-1
5120 IF START%=ATOP% START%=BOTTOM% ELSE
     START%=START%+4
5130 =!S%
```

These programs should be very easy to understand to anybody with some knowledge of BBC BASIC after reading Mr James article and the chapter of the User Guide mentioned before. In the same way other data structures, like trees or linked lists, can be fairly easily implemented using the BBC indirection operators and its capacity to reserve a portion of memory to hold these structures.

Yours faithfully,
Antón Civit Balcells
Sevilla, Spain

Dear Sir,

I have some issues of **Computing Today**, *but am not a regular buyer. I buy the issues according to whether the program suits or not and often the deciding factor is looking through the index to see if a computer type is mentioned next to the program. If there is no*

program shown for my type of computer I do not buy the magazine. I rarely go from page to page checking each program. This means that although a program may be for my computer I do not buy the magazine as it is not shown in the index.

Yours faithfully,
Mr R Mather
London

Dear Sir,

I wonder if you or any of your readers have experienced difficulty in saving/loading programs from/to the Casio FX702P via the FA2 interface unit; I must have tried some seven different (and new) cassette recorders with total lack of success, and have been informed by my local agent that many others have had identical problems, and can make no recommendations as to a suitable cassette recorder. Can you or any reader help?

Thanks for a well written and informed magazine.

Yours faithfully,
Nicholas J Fitten,
The Netherlands

Dear Sir,

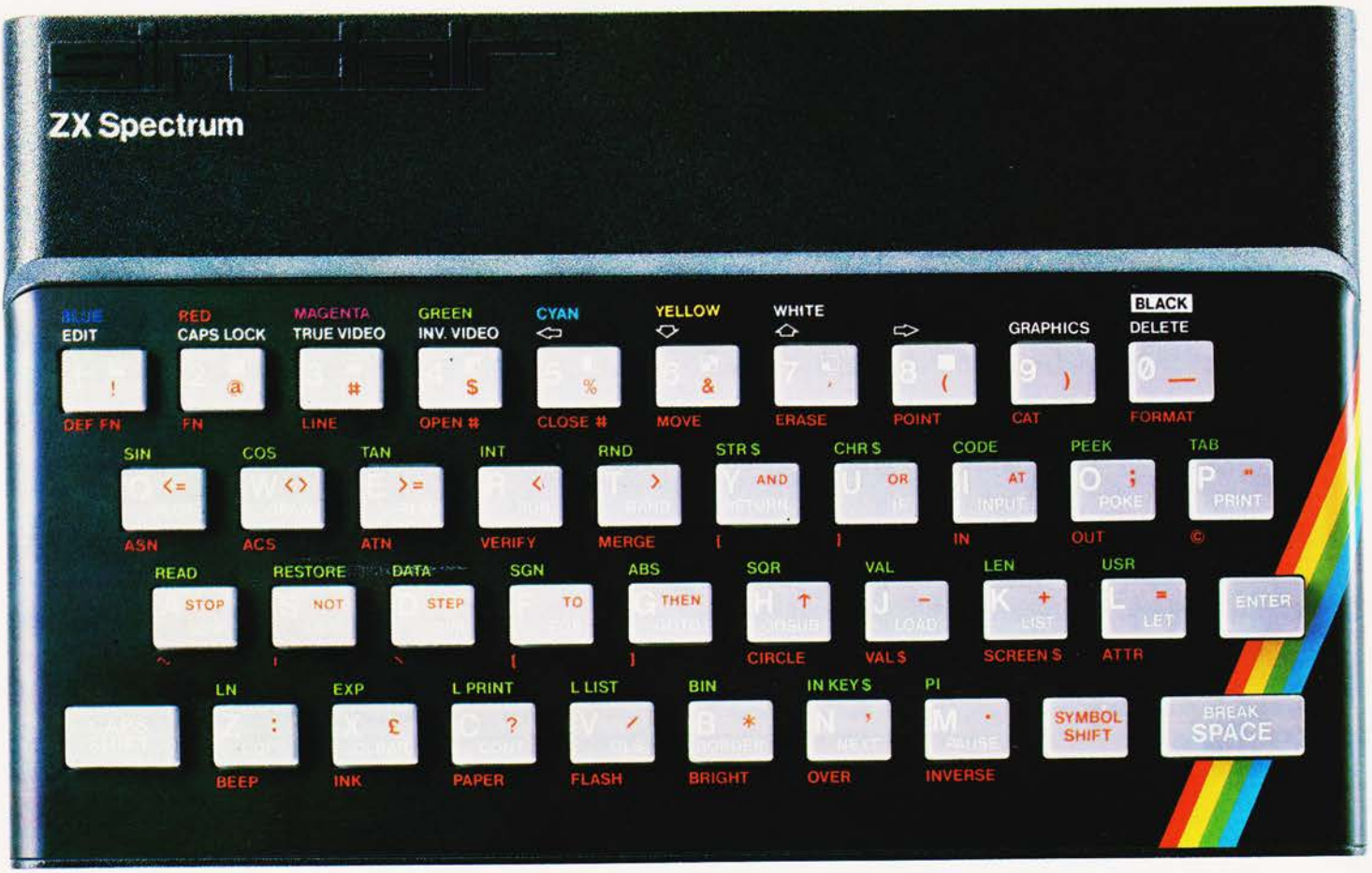
A group of teachers and ex-pupils of the Tabor High School, Braintree have set up an organisation called 'Taborsoft'. We are partially funded by the MEP to produce Biological Software for schools. As well as producing packages for the MEP we are able to supervise programmers as they produce other work for us.

I'm writing this letter to you to let you know of our existence. Obviously because we're supported by the MEP and the teachers at the same time, we have no particular need to be commercial and therefore rather give a service to teachers or anyone else interested in software for the BBC computers.

Perhaps you can let your readers know of our existence and also that we have available a few programs which we are sure will be useful. Our aim is to produce a suite of programs which will give a total revision for any student at school doing 'O' and 'A' levels. The two we have produced already are one on the heart and one on transpiration, and our latest which is a massive program on Classification which basically will classify any animal or plant you happen to name simply by answering questions and put it in its appropriate group. It's a 28K package. What we're going to do is sell these for £2.50 each. We will provide the cassette providing the buyer provides a SAE. Our name is 'TABORSOFT' and cheques can be sent to the above address. You are of course under no obligation to print this, but if you think this would be useful to your readers, either as students or teachers, we would be more than happy for you to do so.

Yours faithfully
Christopher J Smith
Braintree

Sinclair ZX Spect



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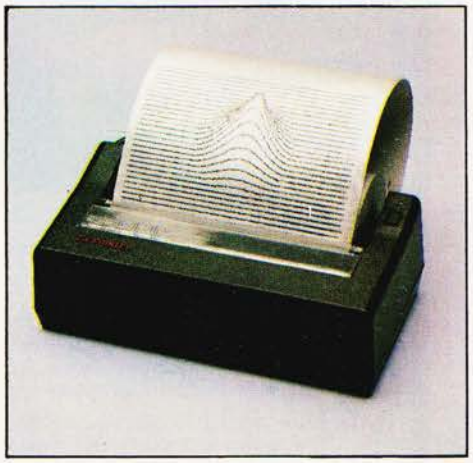

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Don Thomasson

MISSING LYNX

A new machine in a variety of ways that has been eagerly awaited, but does the Lynx really come up to scratch?

If a new product follows current fashion, it must show some advantage in price or performance if it is to compete successfully with other devices. High powered publicity has been used as an alternative with some success, but that is liable to yield to hard facts in the long run.

It is therefore tempting to try an alternative approach, by-passing the competition by striking out into new territory and relying on novelty and innovation to attract the attention of potential purchasers. The danger here is that there may be very good reasons why no one else has gone in that direction. There may be hidden penalties that outweigh the advantages.

The Lynx has taken the innovative path in several respects, and has thereby gained ascendancy, but only at the cost of imposing some limitations. In assessing the overall value of the machine it is necessary to balance the gains against the losses, and the verdict will depend to some extent on the way the machine is to be used.

FIRST IMPRESSIONS

When it emerges from its box, the chunky hard plastic case of the Lynx looks workmanlike, and the separate power supply in a metal case has a more professional air than that of a smoothly styled sealed unit which is clearly unrepairable. The sight of real keys is welcome, and a tentative play with them gives a pleasant feel, though there can be a slight clatter if fingers move fast.

The power supply is fed into the main unit through a DIN connector, which caused some eyebrows to rise slightly. As more than one power supply is used, it is advisable to make sure that power is switched off before the connector is inserted or withdrawn.

Power up, and the Lynx gives a subdued 'beep' to say that it is alive. If the television set is correctly tuned a small logo in white on black will appear at the top left of the screen. Provision is made for driving a colour monitor, but this was not tested, no suitable monitor being available.

Start to key in a simple program, and you may well find that syntax is checked when the lines are entered. You may also find that lines which look correct are rejected, and it is necessary to check the manual to find out why.

THE MANUAL

The manual was put together in something of a hurry at a time when neither the firmware nor the hardware were completely finalised. It is laid out in a somewhat confusing manner, with different subjects grouped together in a slightly odd order. The first chapter tells you how to set up the system, including the cassette recorder, but the data on the cassette leads fails to match the leads actually supplied, a discouraging start.

The second chapter is headed 'The Keyboard', but after a brief summary of special key meanings there is a diversion to a short discussion of the memory. Then comes a chapter on 'The Computer as a Calculator', which outlines the many operations that can be carried out in direct mode, and the fourth chapter is called 'Starting to Program'. Here, at last, we begin to find out what was wrong with our syntax.

The AUTO numbering facility is described, and the maximum line length is given as 240 characters. After some information on PRINT and PRINT TAB, the section on variables is reached, and it emerges that variable names must be in the form of single letters, upper and lower case being treated as different variables. This allows 52 variables, just enough for The Valley and, therefore, adequate for most purposes. String variables are more limited, only upper case letters being allowed, and strings longer than 16 characters must be predimensioned, with a maximum length of 127 characters.

There are good reasons for these limitations, but the manual states only the facts, without explanation, seeming to dwell on the disadvantages without stressing the resulting advantages.

THE EDITOR

One of the good features of the Lynx is the screen editor. The last line entered can be recalled by Control Q earlier lines being brought back by Control E followed by the line number. Thereafter, a cursor can be moved by the four arrow keys, up arrow selecting the line start and down arrow selecting line end, and insertion or deletion at the point indicated by the cursor is then straightforward. As the keyboard has an auto-repeat feature, editing is made simple.

Once again, however, there are unusual features. As the 'calculator mode' allows numbers to be input without associated commands, it is not feasible to delete a line by typing in its number alone. The function DEL has to be used, DEL xxxx deleting line xxxx, while DEL xxxx,yyyy deletes lines xxxx to yyyy inclusive. This is logical, and when the function is properly understood it is seen to be useful, but it is a departure from normal practice.

Because of this kind of difference, the Lynx needs more explanation than some new computers, ▶

and since that was not available from the manual another source of information had to be sought. This was obtained by taking the firmware apart and looking at the relevant routines, a process which revealed some interesting and illuminating facts, many of which could have been mentioned in the manual to the general benefit of all concerned.

THE DISPLAY

The display uses 32-column hardware to generate a 40-column screen format, by the simple expedient of using a 6 by 10 character matrix instead of the more usual 8 by 8 pattern. This allows the 40 columns to be covered by 240 bits, where other systems use 256 bits for 32 columns. The concept is simple, but its consequences are not, especially as three complete screen RAMs are used, one for each primary colour.

Because the six-bit character patterns have to be packed into eight-bit screen RAM locations, a special masking procedure has to be used when setting up fresh data. The existing contents of a location are read, bits to be replaced are masked out, and the new data is ORed in. This allows the superimposition of one character on another, to add accents or underline, for example, but it means that all screen accesses, which in any case involve a change of store bank, are much more complex than usual. Where a six-bit pattern overlaps the boundary between two eight-bit locations, two screen accesses are necessary. Overall, an average of 45 accesses are needed to set up a character, where the more common system requires only eight or nine.

This accounts for the impression that listings in black and white were rather leisurely. Then it was found that the table of reserved words contained a command 'TEXT', which was not mentioned in the manual. The response was found to be a green on black screen which ran significantly faster than black and white. The command had disabled the red and blue screens, reducing the number of accesses per character to 15.

This ability to disable one or more screen RAMs is also accessible by the PROTECT command, which allows the contents of the protected RAM to remain unchanged during subsequent screen accesses. A background format in blue, for example, can be kept intact while text is written over it in red, green or yellow. Every dot position on the screen can be coloured independently from the range of eight colours from white to black.

The working area of the screen can be altered by the 'WINDOW' command, which sets up new maximum and minimum values for the line and column pointers. These pointers are very precise.

The column can be set to 128 values, positioning characters at two-dot horizontal intervals, the line can be set to 256 different values. This means that superscripts and subscripts can be displayed in exactly the right position, and that very exact displays can be set up with a little patience.

There is even an alternative green screen RAM which can be used by machine code routines, but the protocol for accessing this is not stated.

These facilities match, and perhaps exceed, what might be expected from an add-on board with its own processor. The use of the main processor, plus a specialised display chip, means that action is necessarily slower. One of the worst penalties is that the screen does not scroll, wrapping around vertically instead, but this is usually relevant only to listings and dumps.

Plans are in hand to double the screen RAM size and allow the production of an 80-column display, but this is in the future. It might be wiser to aim at a 32/64 column format, which would be faster and use less of the valuable ROM space.

THE KEYBOARD

Fifty seven keys are laid out round a QWERTY core, and though pleasant to use they produce some odd quirks, such as a Break key that appears to do nothing in particular, the Escape key being used for breaking into programs.

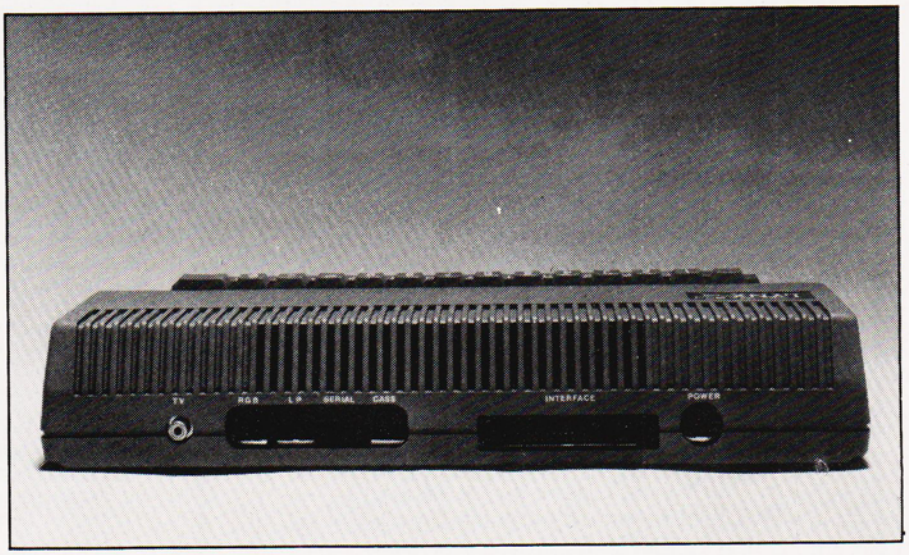
The Shift Lock key does not lock, but each time it is pressed the action of the Shift key on codes above 40 Hex is reversed. As the two keys are side by side, it is only too easy to press Shift Lock inadvertently, causing momentary confusion, but that is nit-picking.

The action of the Control key is not quite as might be expected. For example, code 03 Hex is generated by Control C and Control 1, but is used only to switch in and out of Graphics Mode, in which the eighth bit of the generated code is set to 1. Some ASCII codes, those just below 5F Hex and 7F Hex, are not generated at all. Keys engraved with square brackets, for instance generate the codes for round brackets.

There is no Reset key, and as it is unwise to pull out the power supply connector with power on there may be a need to keep a mains switch within reach. The initialisation procedure does not distinguish between warm and cold start, so provision of a reset facility would have limited value.

Delete generates code 08 Hex, usually identified as Backspace, but understood as erase by the Editor. (Not you, Henry, sit down.) The four arrow keys act only on the Editor, cursor movements otherwise being controlled by VDU functions.

Despite the slightly individualistic approach in some areas, the keyboard is difficult to fault for convenience of use. While overt multiple meanings for the keys have been avoided, it is possible to input commands in abbreviated form, C. sufficing for CLS (clear screen) and LI. for list. Enough letters must be used to avoid ambiguity, and a full stop must be added. (This produces an oddity, as 5*.2 is interpreted as 5**2, so the zero before the decimal point is necessary.) There are also a number of commands that can be entered by pressing Escape and an alphabetic key simultaneously. Hence many of the advantages of single key entry are available, but there is no compulsion to use them.



THE MEMORY MAP

The memory is nominally arranged in three 64K banks, though not all these are fully implemented in the standard model.

The main bank contains 16K of ROM from 0000 to 3FFF Hex, and there is room for a further 8K of ROM at 4000 — 5FFF Hex. RAM runs up from 6000 to 9FFF Hex, and can be doubled in size, to 32K, by using higher density memory chips. What happens to the last 8K is not clear.

The screen bank contains 8K for each primary colour, plus another 8K for the 'alternative green' area. It is accessed by outputs to port FF7F Hex and port 80, which control the enable lines. The ROM can be selected and active while the screen bank is in use, but there is no provision for passing data from bank to bank except via processor registers.

Provision of CP/M would presumably entail adding the third bank, but it is not yet clear how this would be linked in with the first two banks.

There is no question of trading screen resolution for working RAM. The present machine has 16K of available RAM, of which the BASIC interpreter claims 2380 locations for dedicated workspace, including variable storage and the pointers for array and strings. The statement that the Lynx is a '48K machine' is thus quite true, but perhaps may be misunderstood. The possibility of making full use of the stated 192K capacity must also be questioned, in view of the difficulty of communication between banks, which takes about 25 uS per byte.

However, until the third ROM has been programmed, there are a number of open questions in this area. From the existing ROMs, it can be seen that the extension will contain a DISC routine, but there are no other hard links to it.

THE MONITOR

Most recent machines seem to have been designed on the assumption that no one in his right mind would want to work in machine code, but the Lynx, once again, takes a different view. The Monitor is so complex that it really needs a special manual to itself, and its capabilities can only be touched on here.

When the Monitor is entered, all registers, including the alternate set, are copied into an area of RAM. The contents of the current registers are displayed. It is then possible to set up a breakpoint and run a machine code program, which will re-enter the Monitor when the breakpoint is reached.

Setting up the program in the first place can use either the 'Type into Store' function or 'Modify', which displays the current contents. Simple and intelligent copy routines for areas other than the BASIC program.

One advertised facility, Single Step, has not been implemented, due to a hardware problem. It was intended to use the non-maskable interrupt, but that came up too soon, and incorporation of a delay was not considered feasible.

There are other functions in the Monitor, but these brief notes should give an impression of the facilities. The only thing missing is a resident assembler.

THE BASIC

The BASIC interpreter is, taken as a whole, quite novel, though some of its features have been seen elsewhere. It is fast, the first seven Benchmarks being second only to the BBC Micro in order of merit, though the eighth rather spoils the picture, being distinctly slow. The figures given were taken over 10,000 iterations, instead of the usual 1000, as it was found that this gave consistent results, minimising human reaction time. However, the results were then scaled to match up with the usual form.

The slowness of the eighth Benchmark, which involves the more complex functions like LOG and SIN, may be due to the floating point format used, which is binary-coded decimal, like the Atari version. This is very convenient for input and output, but perhaps less so for complex calculations. It provides a resolution of eight decimal places.

When a new line is entered, it is radically altered by the 'creator'. Commands and functions are tokenised, and extra delimiters are added to mark the limits of expressions. Variables are converted to indices which access the variable store locations as displacement pointers, and the expressions are arranged in Reverse Polish form. This makes interpretation simple and fast.

One resulting problem is that a 'recreator' is necessary when a line is to be displayed or listed, and this swallows up a lot of ROM space. The main reason for limiting arrays to single dimensions is concern over the need to provide a suitable recreator routine, but that may be overcome.

The system allows the provision of some very friendly features. A mistake like 'PR INT' for 'PRINT' does not cause a Syntax Error, and the subsequent listing shows the command correctly. The command 'LET' is assumed if no command is given.

Other features are less acceptable. Only one statement is normally allowed in a line, though DIM and LET can be followed by several dimensioning or assignment statements separated by commas. There are special tricks needed to obtain full string comparison facilities. On the other hand facilities like TRACE and SPEED allow for easy debugging of BASIC, by allowing programs to be run at slow speed with a listing of the numbers of the lines executed.

The range of commands and functions is much larger than in some recent versions of BASIC, and this means that it may take longer to become familiar with the possibilities. For example, a special stack is used for loop return links, and jumping out of a FOR loop can soon fill this stack, but there is no need for this rather doubtful practice when the other loop functions WHILE...WEND and REPEAT...UNTIL are available. The need here is a fully adequate set of documentation which guides the user through the unfamiliar paths involved. ▶

SOUND AND GRAPHICS

A small internal loudspeaker is provided, in association with a D/A converter that also comes into use with SAVE and LOAD, when it generates sine waves from a table in ROM. The D/A can be driven in two ways for sound generation. First, there is a BEEP command specifying 'wavelength', number of cycles, and loudness, the last varying from very quiet to inaudible. Secondly, the SOUND command allows bytes to be read from an area of memory at a specified rate, so that a complete waveform can be specified.

The sound system is rather weak, and though the signal can be brought out at the cassette port by a little trickery that is not an advertised feature.

In addition to definable graphics, the Lynx provides DOT, MOVE and DRAW facilities, either on an absolute or relative position basis. In combination with the lavish screen facilities, this opens up many possibilities, providing that speed is not essential.

SHORTAGES

The four examples of the Lynx which have been examined, two supplied as review models and two in private hands, do not meet the published specification in full. The printer driver needed to implement LLIST, LPRINT, and LINK does not exist. A rather glaring bug in 'multiply' has now been cleared, but ARCSIN and ARCCOS still give each other's values for unity, and there are other more subtle bugs still to be removed.

The CP/M compatibility which is claimed has yet to be demonstrated, and there may be difficulty in linking CP/M with the BASIC system, due to the limitations on inter-bank transfers. Some revision to the keyboard coding would be necessary to meet CP/M standard requirements.

The standard of quality control needs to be improved. One machine was delivered with a short-circuited video lead, and another with random failures at least partly due to short circuits in wiring modifications. There are so many such modifications that one cynic insists on calling the machine 'The Links', but some changes are inevitable in the early stages.

The problem is compounded by the fact that the available ROM space is very nearly full, and more space must be found before the missing items can be written in.

It must therefore be suggested that the Lynx is not yet completely market-ready. For many purposes, it will do a useful job, but it will not do all that is claimed for it. It could be seen as a flawed jewel, for it has a number of virtues, but even the curate's egg was 'good in places'. If the less satisfactory aspects can be put to rights, it could prove to be a very popular machine. That, however, could entail some sacrifices.

BENCHMARK	*BM1	*BM2	*BM3	*BM4	*BM5	*BM6	BM7	BM8	Average
TIME	0.94	3.5	11.8	8.3	9.4	15.7	21.6	86.3	19.7

Table 1. Benchmark test results for the Lynx. All benchmarks were timed by use of beep. In cases marked *, 10,000 iterations were used to minimise human response delay, and the results divided by 10.

FACTSHEET

CPU	Lynx Z-80A
ROM	16K
RAM	48K
Language	Camputers BASIC
Keyboard	QWERTY
Display	Text: 24 lines of 40 characters; Graphics: 248 by 256; Eight colours
Cassette I/O	1200 baud
Sound	Serial port; expansion bus
Costs	Single channel Lynx £225
Supplier	Camputers Limited, 33A Bridge Street Cambridge CB2 1UW

ALPHA and GRAPHIC return the current pointers to the normal and graphic character pattern areas, which can be changed by poking into RAM.

BNAND, BNOR and BNXOR operate in 16-bit binary.

CALL accesses a machine code subroutine. One form is CALL LCTN xxxx, where xxxx specifies the number of a line using the CODE command.

CCHAR sets up two ASCII codes determining the alternating cursor characters.

CFR determines the cursor flash rate.

CODE indicates that the rest of the line contains machine code in explicit hexadecimal form.

DEG is a multiplier converting from radians to degrees.

DIV is divide with integer result.

ERROR generates a specified error code.

EXT 'allows for extensions of BASIC', but is not yet implemented.

FACT calculates factorials.

FALSE returns zero.

FRAC returns the fractional part of the argument.

GETN and GET$ return the ASCII code and character, respectively, of a key depressed, waiting if no key is active. The companion functions KEYN and KEY$ are the same, except that they do not wait for a key to be pressed.

INK and PAPER as commands set colours. As functions, they determine what the colours are. This allows contrasting pairs to be set automatically.

LINK couples display and printer outputs. (Not implemented)

MEM checks free RAM space, HIMEM checks top of memory.

HL reads the contents of the processor HL register at the return from a CALL.

MOD gives the remainder of an integer division, e.g. 15 MOD 4 returns 3.

MON calls the Monitor.

MOVE sets a start point for graphics DRAW.

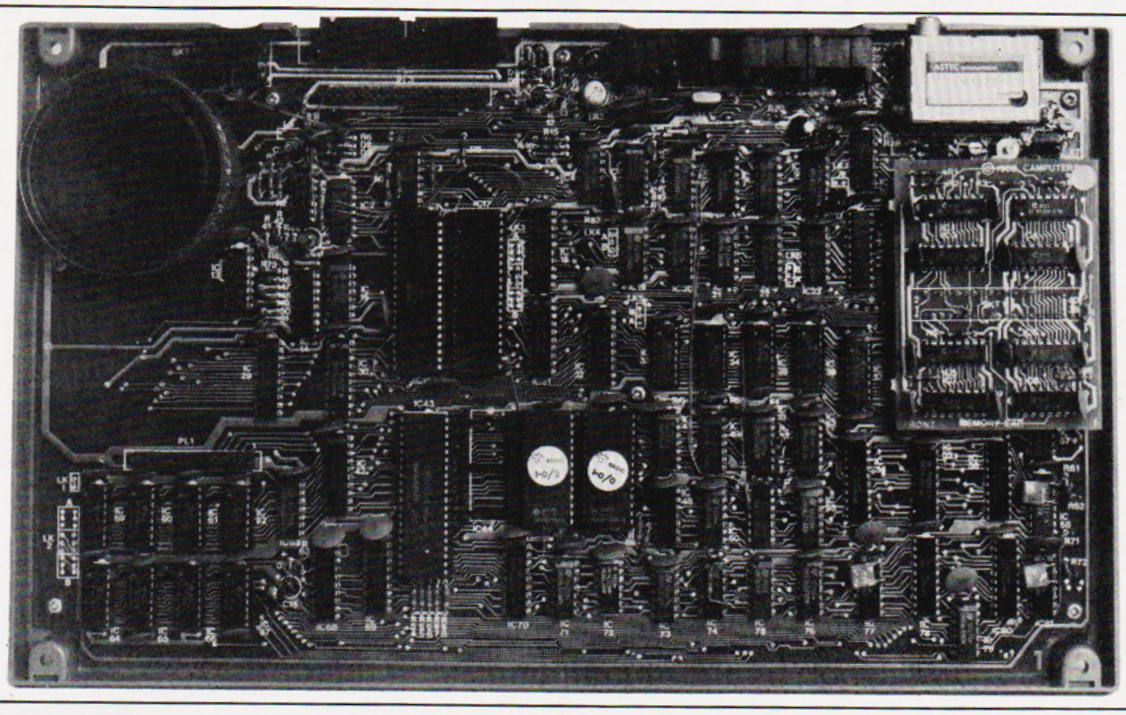
RESERVE brings the effective top of memory down to a given location.

TAPE sets tape baud rate (600-2100)

USER0 — USER4 access link points in RAM.

WINDOW sets active screen area.

Some unusual commands and functions in the Lynx BASIC.



CONCLUSION

For all its faults, the Lynx has inspired a certain amount of affection. Davis Jansons (not David, as one review called him) has shown tremendous ingenuity in the way he has tried to come to terms with difficult requirements, his program having some pleasant twists, but the problems facing him were very difficult indeed. Thanks are due to him and to his wife, Sue, for much enlightening information that has helped to show the why and wherefore of the machine. Hopefully, Sue will forgive the criticism of the manual, which she wrote under conditions of extreme pressure.

The Lynx is already behind schedule, but a little more delay used to polish the edges would be better than trying to sell it as it stands. Perhaps before long there will be a chance to review an updated model without the need for any reservations at all.

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Richard Marks

GETTING ADVENTUROUS

Solving the mysteries in games can be a fun but frustrating business, but maybe we can help.

In this article, I want to bring to your attention the Mysterious Adventures, written by Brian Howarth. I also want to use one of these as an illustration of how to set about solving Adventures in general. Even if you never play these particular games I hope to give some hints, tips and suggestions that will be of use in many other situations.

Playing a new adventure by a new author is always a challenge. The Mysterious Adventure series, published by AJ Harding, looked at first sight like a straight rip-off of Scott Adams' work. The screen format is the same, the general presentation is similar, and it would be fair to admit they have a lot in common. It is inevitable that they would be compared to others, and really they stand the comparison quite well. The first difference is that Mysterious Adventures are British. This is of more than mere Jingoistic interest, as it means the stories, phrases and language are all fully comprehensive.

With the exception of the first in the series, economy of memory is used to great effect, cramming as much story as possible into the memory available. The first wastes a huge chunk of memory giving you the 'story so far': this memory is saved in others by putting it on a separate sheet. As a slick piece of salemanship, the blurb for the entire series is sent with each one you order, whetting your appetite for the others.

JOINING THE CIRCUS

A good place to start is by looking at Circus, in the middle of the range. The instruction sheet tells you that your car has broken down in the middle of nowhere. The scene is set for you to arrive in a deserted Circus, and the program implies that it is a dark and starless night, with a chill wind whistling through the rigging.

On arrival at the circus ring, you find that it is dark inside the Big Top anyway, and you won't get far unless you find something to light your path. This little problem turns up in some form or other in lots of Adventures, and there are only two solutions. One is to find a lamp, torch, candle or flashlight to illuminate your way. Alternatively you can search 'in the dark', by bumping into things.

On the subject of torches, it's worth remembering that the batteries may only last a limited time, and before you switch it on it would be worth saving the game. It's also worth switching it off when you no longer need it!

You have to get about half way through this story before you really know what you are doing. The best initial plan is always to make a map of the easily explored terrain. you will spend a fair bit of time looking at your map, and it is a great help if you spend a bit of time getting it right. The biggest mistake is to make your map too small. A large sheet of paper is an absolute essential.

Maps should also include as much detail as possible. When you get to an unopenable door, it is always helpful if you make a note of what you've used to try and open it, and what is successful. The easiest thing to open a door with is a key, but you can't always find one straight away. Actually, there might not even be one, and you might need to smash it open with a sledgehammer! If you despair of finding a key, try simply ▶

Photograph courtesy of Warner Bros. Inc.

typing GET KEY. The response will either be "It's not here" or "What is that?", and this latter is your cue to start battering the door with bricks or chanting incantations at it. You will manage it eventually.

Circus is written in such a way that there are a great number of little problems each with a solution. Some of the solutions are not apparent until the end of the game, but some are found much sooner. Quite early on in the game, you can see a cannon, and after a few violent deaths it becomes easy for you to use the cannon to fly through space. So far so good, but why should you ever want to do this when you have a perfectly good pair of legs? There is a perfectly good reason, but it isn't until much later on in the game that you realise the advantage of flying.

It is possible to save the game on cassette. It is simply not possible to save a game too often. Whenever you try something new, it is worth doing a SAVE. You will then quickly be able to get back to the point you were at, with all the objects you have unearthed and all your achievements to date immortalised on tape.

In order to get anywhere in life, it is necessary to be correctly dressed, and adventures mirror this. In Circus, you will discover a pair of slippers, and you can wear them, which should make it easier to keep your balance when treading a delicate path.

When you play an adventure, you are not usually alone in the world you inhabit. There is someone else in the deserted circus. When you meet another person, there are two things that can happen. He may attack you, robbing you of a vital possession or even taking your life. He may also give you something, a helpful object or piece of information. It might be necessary to kill him first. In Circus, a clown appears and gives you a note. Reading this note is useful, but the clown follows you when you come out of the closet. He could probably do something else, or help you to do something you are too ignorant or feeble to manage unaided. If a character follows you about, it is a propitious idea to try again to solve all your outstanding problems. Chances are that he may be able to lend a hand.

Regrettably, violence is also a part of the world. This is used against both people and inanimate objects. If a door or cupboard doesn't open, kicking, bashing or hitting with a hammer all offer you a chance to release your tension, and may even help.

THE PLOT THICKENS

The Mysterious Adventures are well-constructed tales, with all the necessary features and obeying the rules of logic. They can be warmly recommended to experienced players and novices alike. In the first of the series, The Golden Baton, you are sent on a mission to recapture this valued relic. You will find various other objects if you examine the casually placed forests and piles of ostensibly useless junk. If you find something when you search a place, don't assume there is nothing else there – keep looking until you find no more. The second Adventure continues your tale.

'Feasibility Experiment' is set in more than just one scenario. Parts are set millions of years in the future. Other sections are set more recently, and if you aren't careful in some you will be thrown to the lions. Incidentally, there are plans for another 10 in the series, some by different authors.

The author of the Mysterious Adventures, is himself a keen player of adventures, deriving both enjoyment and inspiration from other people's work. The games are published by AJ Harding, who strive to promote a 'family industry' atmosphere in all their activities, and claim almost paternalistic pride when talking about these programs. The company seem particularly pleased that they are selling well across the Atlantic, and they are actively pushing sales there.

In some of the Mysterious Adventures there are small mazes. For the inexperienced, mazes are a source of confusion, defeat and many wasted hours! You can generally get into the maze easily enough. Go North and the maze extends. Continue to go in the same direction, and you are still in the maze! In desperation, you take another half dozen paces forward, and you still don't seem to have got anywhere. At this point, try dropping an article you are carrying (NOT your torch!!!). Go North, and it is still there! By leaving a trail of objects behind you, it is relatively easy to find your way about. It should be possible to make a complete plan of the maze, which will ultimately be quite revealing.

GIVE US A CLUE

Adventure writers have developed ways of giving you clues and hints. Sometimes these are subtle, but from time to time they get lazy, and they just write something on a signpost or gorgon parchment. If you READ the signpost, it will deliver its message. It may be that you can't read it without suitably modifying your lighting or eyesight.

The clue may be a Magic Word, and if you can't think what a ZRYKA is, it could be magic. Magic words usually exert their effect when spoken aloud, sometimes only in certain situations.

Hint sheets are printed to go

with the programs but are sold separately. The psychology of this is interesting: some people adopt almost a defeatist attitude right from the start, and order a hint sheet when they buy the programs. Others buy them a week or two later. Hardings believe strongly in customer support, and claim that they will give anyone hints, over the telephone, if players get stuck whilst trying their programs. I feel that this is a brave move on their part, but it is nice to know that help is available 'on line'. The staff must find it amazingly frustrating when the same customer phones again and again, each time only a small step forward in what is to be a long trail.

Mysterious Adventures are currently available for the TRS-80, Genie and BBC Micros, rewritten for this by the original author. There are future plans to transpose them to the Apple II and Atari 400 and 800. Mr Harding says it would be too difficult to rewrite them for any Sinclair computers, but I note that Digital Fantasia, Mr. Howarth's company based in Blackpool, advertise that versions are being prepared for the ZX Spectrum and ZX81. It seems a great shame that Sinclair users have so far been denied access to most of the major adventure series, and you can get further details from Digital Fantasia.

Photograph courtesy of RKO Radio Pictures Ltd.

There were times when I got really stuck in Feasibility Experiment, and to vent my spleen I typed in '***** OFF'. In a flash, the reply came back 'There's no need to use language like that.' I spent a childishly happy five minutes discovering exactly which four-letter words the author expected me to use!

When all else fails, it becomes necessary to take desperate measures to cheat! This is, I should say, a ploy which is really rather naughty, a bit like looking at the end of a book or peeping when playing Blind Mans Bluff. However, if your lack of progress gets you into a mild psychosis, you can cheat by PEEKing into your computer memory. The way you do this varies from machine to machine, but a crude way is to type something on the lines of FOR I=1 TO 32000:PRINT CHRS (PEEK(I));:NEXT (details vary from machine to machine). Along with screenfulls of garbage, you will see the entire vocabulary of the program: this may give you a clue! I've noticed that recently, many programs have been written so that this technique is unusable, and quite honestly I think that's right and proper. If you don't like the suspense involved in playing adventures, you should try something less mentally taxing like slumping in front of the TV!


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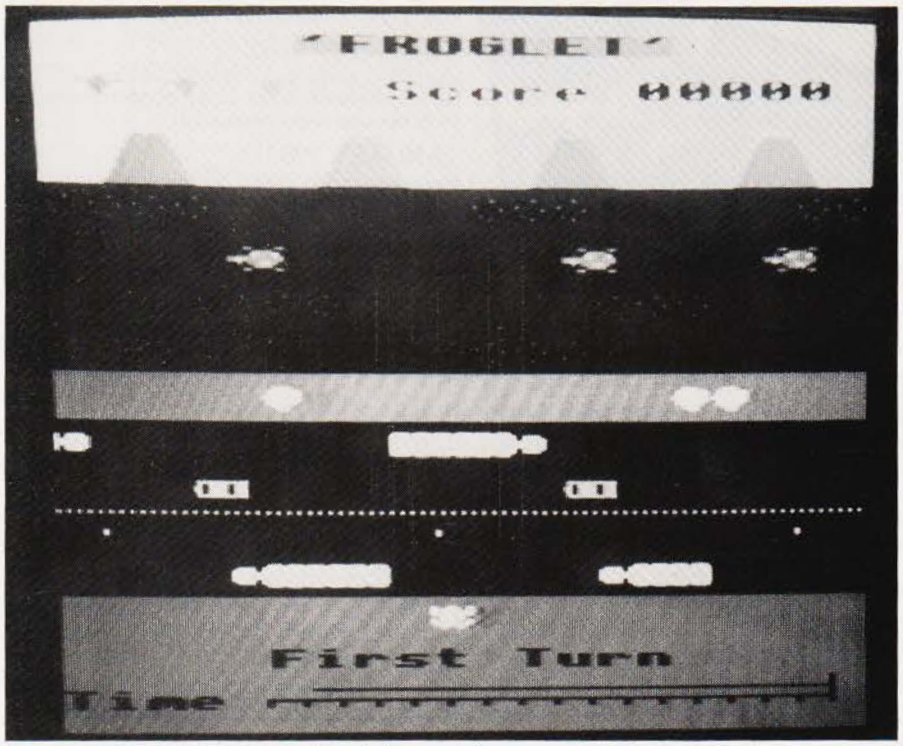
Henry Budgett

UPDATING FROGLET

Our Arcade Action game for the BBC Micro fell into the MOS trap so, to redress the balance, here are the updates.



Your response to our Froglet game has been so overwhelming that we have decided to sort all the problems out once and for all. In the original listing, which works perfectly on 32K machines fitted with the MOS version 0.1, two minor errors were made. The first of these is a missing bracket at the end of line 1710, the machine usually manages to report this fault to you with a 'Missing bracket' error message. The second mistake is that the very last line of the program should be numbered 25000 and not 24060. The eagle-eyed among you may have also noticed that the number at the top left of Fig. 1 should have been &8000 and not &800 as printed.

OTHER OPERATORS

The major problems with the program start to arise when you have an MOS other than 0.1 fitted to your machine or when you have discs. Fortunately all these problems are quite easily solved by making the following alterations. If you are not quite sure as to which MOS is fitted to your BBC Micro the following command will reveal all:

*FX0

The following five lines need to be amended:

```
13040 VDU 5,18;15:MOVE X%*64,Y%*64+252:VDU 224,4
16020 VDU 5,18;13:MOVE x%*64,y%*64+252:VDU 225,4
17010 READ Bar$
17030 Freq%=4*(ASC(MID$(Bar$,J%+1))-48):
      Len%=3*(ASC(MID$(Bar$,J%+2))-48)
17060 IF RIGHT$(Bar$,1)="4" RESTORE 24000
```

NOW FOR THE CLEVER BIT

Whilst the above alterations and amendments will, as far as we can establish, ensure that your Froglet program will load from tape and run quite happily on any current BBC machine there is still the perennial problem of what to do if you have discs fitted. The simple but boring way to solve the problem is to put the system back to tape operation by typing *TAPE and then paging out the offending area of RAM by typing PAGE=&E00. Now, while this gives you Froglet it certainly doesn't give you Froglet on disc!

But, owing to the sterling efforts of Ian Trackman, we can now offer a solution to even this problem. What the extra modification does, in effect, is to establish for itself exactly where there is free memory in the system you have and then go and appropriate it for the display files – a sort of RAM-seeking program if you like. The changes are fairly extensive. So we have prepared a completely tidied and renumbered version of the Froglet program which incorporates all these changes. If you want a copy of that listing send an SAE at least 9½" by 6½" together with £1 (to cover photocopying costs) to us and we'll let you have one post haste.

THE TAPE SOLUTION

For those of you who simply can't face typing in all that code there is an easy way out, buy the tape! ASP Software will, for a mere £5.99, save you hours of keyboard bashing and provide the whole thing on a cassette. Needless to say, the tape version will run on any of the current BBC variants and you can even transfer it onto disc by the usual method. "What method?" comes the instant reply! Simple, type *TAPE, LOAD the first program into the computer but do not RUN it. Type *DISC and then SAVE "FROG". The change of name is important as the BBC's FDS recognises "FROGLET" and "Froglet" as being the same thing with somewhat disconcerting results. Now type *TAPE again, LOAD the second program into the machine but don't RUN it. Type *DISC again and SAVE "Froglet". You now have both programs safely on your disc and to play the game simply type CHAIN "FROG" and the program will do the rest.

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Owen Bishop

INDEXER

Compiling an index for a book can indeed be a tedious task. The data management program described here can make things a lot easier and can even be applied to other similar problems.

A data management program accepts separate entries or records and stores them under key words, listed in alphabetical order. A small business, for example, might want to list its customers in alphabetical order, with various items of data relating to each customer, such as address, telephone number, and account number. At home you could use the system as an address-book of friends and relatives. The data could include not only their addresses and telephone numbers but also such essential facts as whether or not they sent you a card last Christmas.

MANUAL PROBLEMS

The program was written for the esoteric purpose of indexing a book. Normally the author reads through the book from beginning to end, noting all topics that should be included in the index and the pages on which they are mentioned. There are two ways of doing this with paper-and-pencil. One of these involves very large sheets of paper which soon become covered with incomprehensible scribblings which inevitably are only partially in alphabetical order. The other method results in the floor being covered with innumerable small pieces of paper in some semblance of order, but certain to be disarranged by the slightest breath of air. Following either of these methods there is the tedious task of typing a fair copy, trying hard not to omit any item or get the page numbers wrong, only to find at the end that there are still at least two entries not in the proper order. This program avoids all the hassle and (provided you have a printer) produces a perfectly neat and ordered index.

PROGRAMMING THE SOLUTION

Once the program was written it became apparent that it has far more uses than its intended one. The reader can probably add several examples to the few quoted above. The program runs on a Level II TRS-80 with 16K. With a smaller memory the number of entries that can be stored is rather limited. The program provides for 250 entries, each of about 30 characters. With fewer entries you can have many more characters in each.

On running the program the user is first asked if data is to be loaded from tape. This allows records to be stored on tape and loaded either for referring to them, to add new records, or to modify or delete existing records. Note that in line 60, and in all similar instances, the user may type either an upper-case or lower-case response.

If the recorder is to be used, and it is ready, the data is loaded from tape. This takes a fair amount of tape if the list is lengthy. You may need a tape rather longer than the usual C-10 cassette.

Next, the word 'Entry?' appears on the screen. In response to this, type in the key word (or words, but do not use commas or colons), under which the entry is to be indexed.

Should you accidentally 'shift' the initial letter of a key word, this will be registered as a lower-case letter. Any person used to a typewriter is likely to do this unintentionally, causing a failure of the sorting procedure. For this reason, an initial letter which is 'shifted' is automatically restored to its 'unshifted' equivalent in line 160, and also at line 660. Entries ***must*** begin with a letter, though numerals and other signs (except commas and colons) may be used later in the entry.

Finally, the user is asked to type in the reference. If you are preparing a book index, this is where the page numbers go. You can use various formats: page numbers, page X - Y, page X FF, or a cross reference to other entries. Once again, do not use commas or colons. The program inserts commas automatically. For other applications the reference would be the address, telephone number, catalogue number, etc.

As an alternative to entering a key word, you can enter a command, as follows:

— causes the list of key words and their references to be displayed on the monitor. They are displayed 10 at a time. Press any key to view the next 10.

% — causes the list to be printed on the line printer.

! — causes the list to be saved on tape.

Using the single command symbols given above results in a complete display, recording or print-out, from A to Z. In the case of # and %, the symbol may be followed by a single capital letter. If this is included in the command, only the entries appearing under that letter of the alphabet are displayed or printed.

If you are using a printer and do not use shifted letters, the index or listing is printed out in capitals. If you want to make use of lower-case on printing out, hold the Shift key down while typing entries. The use of shifted letters does not affect the routines used for putting the entries in alphabetical order, once the initial letter has been found.

DELETION

One other command may be used at 'Entry?'. This is the symbol @, which allows deletion of key words and their reterences. After typing this you will be asked to type in 'Matching letter(s)' (line 650). If you type a single letter, you will be presented with all items listed under that letter. As each one is displayed you type D, to delete it, or any other key to retain it. This procedure may be shortened by typing in two or more matching letters. For example, if you type 'Ant', all entries beginning with 'Ant. . .' will be presented for deletion or retention. Matching letters should begin with a capital, but should you accidentally type a lower-case initial letter, it is converted to upper case in line 660. This feature in the program is the result of the author's most frequent error in trying out the early version of the program!

THE PROGRAM

The flow charts explain the ▶

essential features. With the help of these, readers should find no difficulty in translating the program to other machines. It makes no use of fancy graphics, the most common cause of problems in translation. For determining alphabetical order it makes use of string comparisons (line 210). The 'greater than' operator (>) when used with string variables means 'follows alphabetically'. If your version of BASIC does not allow this, it is possible to substitute an alphabetical sorting routine, using the ASC function. it will be seen that when searching through the entries, the program examines each in turn until it no longer finds one which the current entry follows (line 210). If the next item is the same as the current entry (E), it simply adds the new reference to the existing reference, separated by a comma (line 220). If the next item is not the same as E, then E is

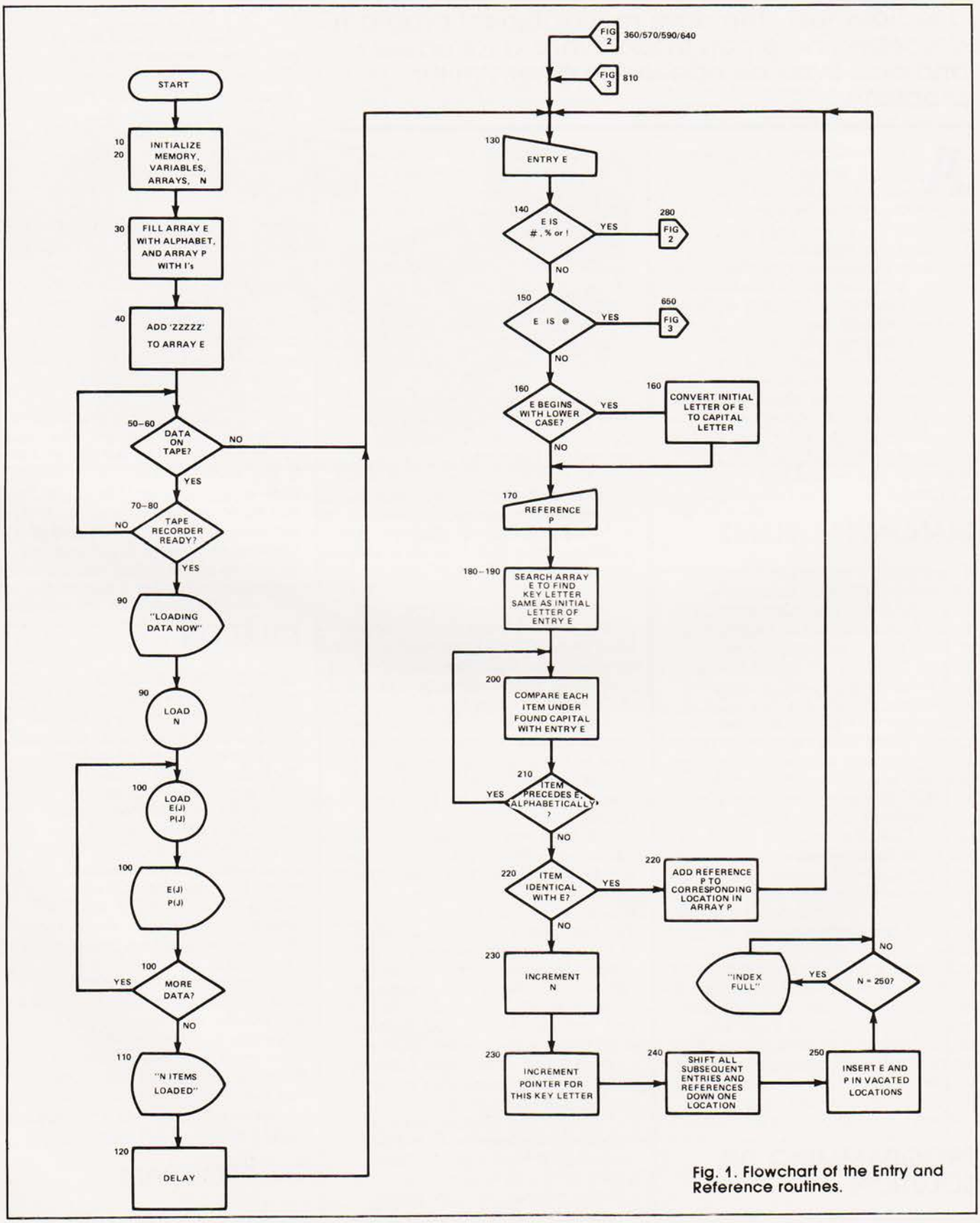

Fig. 1. Flowchart of the Entry and Reference routines.

a new entry. The following items are shifted down to make room for the new entry and its reference.

With a large number of items it could take a long time to search through the whole list. The program avoids this by going almost directly to the letter of the alphabet under which the entry is to be found or entered. When array E is initialized, the letters of the alphabet are registered there in order (line 30). These key letters are later to be displayed or printed out as headings for each section of the index or list. Each of these has a corresponding location in the reference array (P) which is not to be printed out. It is here that we hide away a pointer which indicates how many items are listed under each key letter. If you displayed the ***whole*** of array P (as is done during loading and saving from tape), you would see the pointers we have hidden, It should look like:

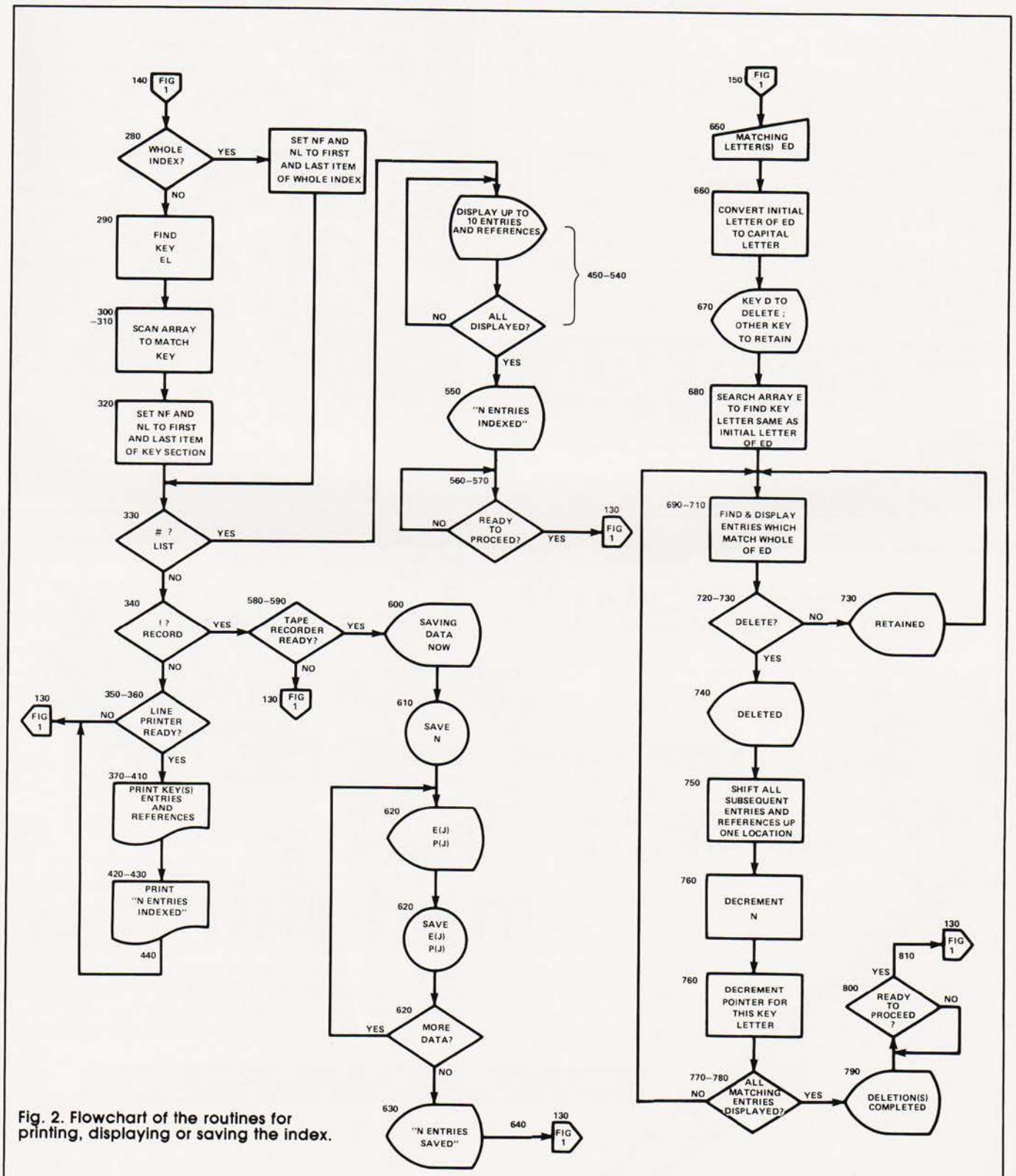

Fig. 2. Flowchart of the routines for printing, displaying or saving the index.

Fig. 3. Flowchart of the routine for deleting entries.

A	2
Ant	45
Antarctic	3-7
B	1
C	5
Cod	66
Code	78, 89
Code word	67
Cryptography	see Code
Cryptomeria	111
D	45

. . .and so on.

The figures following the words are page numbers, but the figures following the key letters are pointers. When the program first scans the list it uses only the initial letter of the entry. It first comes to A, and if the entry does not begin with A it evaluates the pointer. This has value 2, so the program jumps two steps, landing at B. There are no entries under B, so the pointer is 1, taking the program to C. Assuming the entry does not begin with C or D, the program then skips five steps to D, then 45 steps to E and so on, until it eventually finds the letter which is the same as the initial letter of the entry. From this point on it scans the list for the required number of steps, using the < operator as described above.

POINTING THE WAY

The use of pointers means that the whole list can be scanned from A to Z in a maximum of 26 steps.

When the list is to be displayed or printed, the pointers are not shown, and the key letters are used as headings for each section. Letters under which there are no entries (eg letter B in the example above) are not included. The list given above would be displayed or printed out like this:

A	
Ant	45
Antarctic	3-7
C	
Cod	66
Code	78,79
Code word	67
Cryptography	see Code
Cryptomeria	111
D	

. . .and so on.

Readers who are of a lethargic disposition may be interested but disappointed by the final entry in the index (line 40). This is needed so that there is a 'word' at the end of the list to follow alphabetically such words as 'zymurgy' and 'Zyxomma' (a genus of Indian dragonflies). This allows the logic of the program to be maintained to the very end of the list. Even though it is never printed out, perhaps a word or sound such as 'ZZZZZ' is most appropriate at the end of such a boring and tedious task as the compiling of an index.

Variable	Function
E	array of 250 entries, also E the current entry
ED	one or more matching letters, in deletion routine
EL	key letter selected for display or pintout
EP	string made up from E and its corresponding P, for display or printout
EQ	letter keyed in reply to a query (y/n, etc)
J,K,L	loop counting variables
LE	length of E
N	number of entries in the list, including the 26 alphabetical key letters
NF	array location of first entry to be displayed or printed
NL	array location of last entry to be displayed or printed
NN	number of entries displayed on monitor (max 10)
P	array of 250 references (data), also P the current reference

Table 1. A list of variables (all are integers, except E and P, which are strings).

```
  10  CLEAR 8000:DEFINT J-N:DEFSTR E,P
  20  DIM E(250),P(250):N=27
  30  FOR J=1 TO 26:E(J)=CHR$(64+J):P(J)="1":NEXT
  40  E(27)="ZZZZZ"
  50  CLS:INPUT "Data on tape (y/n)";EQ
  60  IF EQ<>"Y" AND EQ<>"y" THEN 130
  70  INPUT "Tape recorder ready (y/n)";EQ
  80  IF EQ<>"Y" AND EQ<>"y" THEN 50
  90  PRINT "Loading data now":INPUT#-1,N
 100  FOR J=1 TO N-1:INPUT#-1,E(J),P(J):PRINT E(J);", ";
      P(J):NEXT
 110  PRINT N-27;"Entries loaded"
 120  FOR J=1 TO 2500:NEXT
 130  CLS:INPUT "Entry";E
 140  IF LEFT$(E,1)="#" OR LEFT$(E,1)="$" OR
      LEFT$(E,1)="!" THEN 280
 150  IF E="@" THEN 650
 160  IF ASC(LEFT$(E,1))>90 THEN E=CHR$(ASC(LEFT$(E,1))
      -32)+MID$(E,2)
 170  INPUT "Reference";P
 180  J=1
 190  IF LEFT$(E,1)<>E(J) THEN J=J+VAL(P(J)):GOTO 190
 200  FOR K=J+1 TO J+VAL(P(J))-1
 210  IF E>E(K) THEN NEXT K
 220  IF E=E(K) THEN P(K)=P(K)+", "+P:GOTO 130
 230  N=N+1:P(J)=STR$(VAL(P(J))+1)
 240  FOR L=N TO K+1 STEP-1:E(L)=E(L-1):P(L)=P(L-1):
      NEXT L
 250  E(K)=E:P(K)=P
 260  IF N=250 PRINT "Index full - no more entries
      accepted"
 270  GOTO 130
 280  IF LEN(E)=1 THEN NF=1:NL=N:GOTO 330
 290  EL=MID$(E,2)
 300  J=1
 310  IF EL<>E(J) THEN J=J+VAL(P(J)):GOTO 310
 320  NF=J:NL=J+VAL(P(J))-1
 330  IF LEFT$(E,1)="#" THEN 450
 340  IF LEFT$(E,1)="!" THEN 580
 350  INPUT "Line printer ready (y/n)";EQ
 360  IF EQ<>"Y" AND EQ<>"y" THEN GOTO 130
 370  FOR J=NF TO NL-1
 380  IF LEN(E(J))=1 AND VAL(P(J))>1 THEN LPRINT E(J):
      GOTO 410
 390  IF LEN(E(J))=1 AND VAL(P(J))=1 THEN 410
 400  EP=E(J)+", "+P(J):LPRINT TAB(5)EP
 410  NEXT J
 420  LPRINT CHR$(138)
 430  IF LEN(E)=1 LPRINT N-27;"Entries indexed"
 440  GOTO 130
 450  FOR J=NF TO NL-1
 460  IF NN<10 THEN 500
 470  PRINT TAB(20)"Press any key to view next section of
      index"
 480  IF INKEY$="" THEN 480
 490  NN=0:CLS
 500  IF LEN(E(J))=1 AND VAL(P(J))>1 THEN PRINT E(J):
      GOTO 540
 510  IF LEN(E(J))=1 AND VAL(P(J))=1 THEN 540
 520  NN=NN+1
 530  EP=E(J)+", "+P(J):PRINT TAB(5)EP
 540  NEXT J
 550  IF LEN(E)=1 THEN PRINT:PRINT N-27;"Entries indexed"
 560  IF INKEY$="" THEN 560
 570  GOTO 130
 580  INPUT "Tape recorder ready";EQ
 590  IF EQ<>"Y" AND EQ<>"y" THEN 130
 592  L=1
 593  PJ="":FOR K=1 TO LEN(P(L))
 594  P=MID$(P(L),K,1)
 595  IF P="," THEN P="[SPC]"
 596  PJ=PJ+P
 597  NEXT K
 598  P(L)=PJ
 599  L=L+1:IF L<N THEN 593
 600  PRINT "Saving data now"
 610  PRINT#-1,N
 620  FOR J=1 TO N-1:PRINT E(J),P(J):PRINT#-1,E(J),P(J):
      NEXT J
 630  PRINT N-27;"Entries saved"
 640  GOTO 120
 650  CLS:INPUT "Matching letter(s)";ED
 660  IF ASC(LEFT$(ED,1))>90 THEN ED=CHR$(ASC(LEFT$
      (ED,1))-32)+MID$(ED,2)
 670  J=1:PRINT:PRINT "Key D to confirm deletion of each
      item. Press any other key to retain item."
 680  IF LEFT$(ED,1)<>E(J) THEN J=J+VAL(P(J)):GOTO 680
 690  LE=LEN(ED):FOR K=J+1 TO J+VAL(P(J))-1
 700  IF ED<>LEFT$(E(K),LE) THEN 780
 710  EP=E(K)+", "+P(K):PRINT EP;
 720  EQ=INKEY$:IF EQ="" THEN 720
 730  IF EQ<>"D" AND EQ<>"d" THEN PRINT " - Retained":
      GOTO 780
 740  PRINT " - Deleted"
 750  FOR L=K TO N:E(L)=E(L+1):P(L)=P(L+1):NEXT L
 760  N=N-1:P(J)=STR$(VAL(P(J))-1)
 770  GOTO 700
 780  NEXT K
 790  PRINT "Deletion(s) completed"
 800  IF INKEY$="" THEN 800
 810  GOTO 130
```

Listing 1. The indexing program, producing an upper case printout.

```
 391  EJ=LEFT$(E(J),1)
 392  FOR K=2 TO LEN(E(J))
 393  A=ASC(MID$(E(J),K,1)):IF A>64 AND A<90 THEN
      EX=CHR$(A+32):GOTO 396
 395  EX=CHR$(A)
 396  EJ=EJ+EX
 397  NEXT K
```

Listing 2. To produce a lower case printout, insert these lines into the indexing program.

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CT STANDARDS

Our regular page explaining the meaning of the various symbols we use to make programs portable.

It has been very encouraging to see the number of programs submitted using our standard codes for graphics and other non-printable characters. However, it has also become increasingly clear that some of our readers haven't heard of them and this page is intended to set them out once again.

All standards tend to be irksome to adhere to but the ones laid out here are fairly simple and tend to make software easier to maintain by the programmer and simpler to understand for others.

CONTROL THAT CURSOR

Our original standards have now grown with the times. Machines such as the Commodore VIC which have a dual Shift capability can now be incorporated, as can those systems which use Control key functions.

The recently introduced BBC system offers pre-programmed function keys which, we are glad to say, can also be handled by our original coding system. It's nice to see just how well adapted the original standards have become over the last two years! (Indeed, a whole series of books is using them as its ***de-facto*** standard.) The standards for the cursor controls are given in Fig. 1.

headaches. This is really specific to the PET where the character set can be displayed in reversed video. On machines which don't have this facility you should either find a character in the set which is the reversed image of the one you want and use that or simply ignore it and use anything else you fancy! Don't forget, you may have to look up and alter the values used elsewhere in the program.

THE GRAPHIC SOLUTION

It soon became obvious that the techniques applied to the confusing cursor controls could also be applied to the graphics symbols. The following standard is now in general use in programs published in *Computing Today*.

If a graphics character or characters are to be displayed in a listing (as opposed to POKE codes or CHR$( ) codes) then they are indicated by the method shown in Fig. 2.

Several people have asked what the relationship between the POKE value for a character and that of its shifted graphic might be. In general the shifted version of any character will be 64 greater than the value of that character. This applies to both PET and MZ-80K systems in all cases.

[CLS]	CLear Screen
[HOM]	HOMe cursor
[CL]	Cursor Left
[CR]	Cursor Right
[CU]	Cursor Up
[CD]	Cursor Down
[REV]	REVerse video on
[OFF]	Turn it OFF
[SPC]	SPaCe
[CTL]	ConTroL key
[fn]	Function key (BBC)
[G<]	Graphic left (VIC/MZ-80A)
[G>]	Graphic right (VIC/MZ-80A)

Fig. 1. Our extended set of cursor control standards includes four new functions.

To indicate more than one of the above, an optional number can be placed within the brackets; [4 CL], etc.

The use of square brackets has raised one or two queries. The reason for this choice is that ***most*** of the common microcomputer BASICs don't use them for specific functions. In fact, at least one machine provides an added bonus by returning a Syntax Error if they are found, a useful check in case you type them in by mistake.

The code [SPC] was added to the list of cursor control codes to get over the problem of indicating just how many spaces are contained in the gap in the printout. The other common variant of the code for spaces is used by the ZX people. Their choice was '_' and this crops up in the various newsletters they publish.

The code [RVS] has caused a few

This can be taken further to include machines which use a pixel graphics set rather than pre-programmed PET-style characters and the series of codes for these is given in Fig. 3. As is nearly always the case there is one machine to which the standard shown in Fig. 3 does not apply — Tangerine's Microtan/Micron. This machine uses a four by two cell structure for its pixel graphics instead of the Prestel/Teletext three by two cell. The method for calculating the value to assign to 'P' is shown in Fig. 4, and is fortunately nice and simple.

MAKING REMARKS

Many people scorn the use of REMs within programs but, during the development at least, they are extremely useful. One of the documentation methods that we use is to keep our back-up copy of our programs on a 300 Baud CUTS tape with all the REMs in place: the working copy, be it on tape or disc, is REMless in order to save space.

It is also good programming 'manners' to give your REMs odd line numbers:

```
3999 REM ** CRASH PROOF INPUT
4000 INPUT "THE NUMBER OF ENTRIES ";A
```

A remarkable number of submitted programs have jumps that go not to the relevant point in the program, but to the REM statement. This can cause severe problems when re-numbering after removing the REMs.

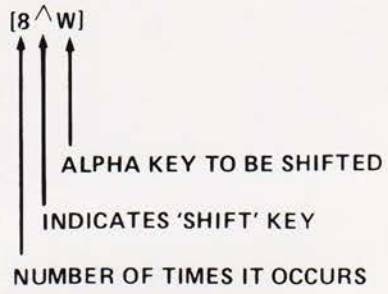

Fig. 2. The way we indicate block graphics on machines like the PET and Sharp. The VIC system of Shift Left and Shift Right is shown in Fig. 1.

1	2
4	8
16	32
64	128

Fig. 4. To convert a Tangerine pixel code into its blocks, simply decode the number into its binary or Hex value and fill in the relevant squares.

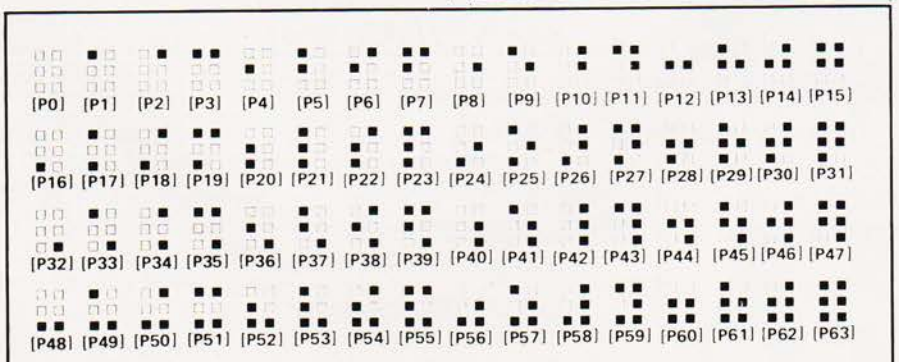

Fig. 3. The standard pixel codes; they will work on most computers which employ this technique as well as for Teletext and Prestel.

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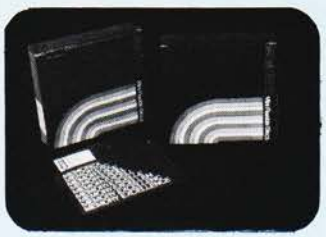

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