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* Based on three programs on an £8.00 Compusette.
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PRACTICAL COMPUTING
February 1979

15
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What about Schools and Colleges? You can purchase a 380Z for your Computer Science or Computer Studies department at about the same cost as a terminal. A 380Z has a performance equal to many minicomputers and is ideal for teaching BASIC and Cessil. For A Level machine language instruction, the 380Z has the best software front panel of any computer. This enables a teacher to single-step through programs and observe the effects on registers and memory, using a single keystroke.

WHAT OTHER FEATURES SET THE 380Z APART?
The 380Z with its professional keyboard is robust, hardwearing equipment that will endure continual handling for years. It has an integral VDU interface—just plug a black and white television into the system in order to provide a display unit—you do not need to buy a separate terminal. The integral VDU interface gives you upper and lower case characters and low resolution graphics. Text and graphics can be mixed anywhere on the screen. The 380Z also has an integral cassette interface, software and hardware, which uses named cassette files for both program and data storage. This means that it is easy to store more than one program per cassette.

Owners of a 380Z microcomputer can upgrade their system to include floppy (standard or mini) disk storage and take full advantage of a unique occurrence in the history of computing—the CP/M industry standard disk operating system. The 380Z uses an 8080 family microprocessor—the Z80—and this has enabled us to use CP/M. This means that the 380Z user has access to a growing body of CP/M base software, supplied from any independent sources.

380Z mini floppy disk systems are available with the drives mounted in the computer case itself, presenting a compact and tidy installation. The FDS-2 standard floppy disk system uses double-sided disk drives, providing 1 Megabyte of on-line storage.

Versions of BASIC are available with the 380Z which automatically provide controlled cassette data files, allow programs to be loaded from paper tape, mark sense card readers or from a mainframe. A disk BASIC is also available with serial and random access to disk files. Most BASICS are available in erasable ROM which will allow for periodic updating.

If you already have a teletype, the 380Z can use this for hard copy or for paper tape input. Alternatively, you can purchase a low cost 380Z compatible printer for under £300, or choose from a range of higher performance printers.

*CP/M™ Registered trademark Digital Research.

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380Z Computer Systems are distributed by RESEARCH MACHINES, P.O. Box 75, Chapel Street, Oxford. Telephone: OXFORD (0865) 49793. Please send for the 380Z information Leaflet. Prices do not include VAT @ 8% or Carriage.

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Seeking three answers

I am in the initial stages of trying to acquire a personal computer, for serious use rather than game-playing, and need the answers to three questions. I am not sure if they come within the scope of your advice offer:

Where can I find information about what facilities the CP/M operating system offers? CP/M seems to be much referred to as a "good thing" but no-one gives details.

I will need eventually more than 64K bytes of store; if bank switching is used, can parts of store belong to more than one bank? Or if not, how does one communicate from bank to bank?

Using some form of assembler, rather than Basic, are there any figures available for how well the Z80, 6800 and 6500 make use of program store?

Advice offers:

Surely if they come within the scope of your answers to three questions. I am not sure if they do, and if they do not, how can I point out the direction of my questions?

W. Stones

Wokingham, Berkshire

CP/M really is a good thing. It is from a U.S. software house, Microsoft, which sells it to equipment vendors. You could probably try some of them e.g., Raif (tel. no. 01-836 4663) who have it on their Black Box, or Micro Focus (01-727 5814) which has Cobol running under CP/M. There is also an embryonic CP/M Users' Group being run by our Computabs Editor, Nick Hampshire. If you want more information write to him, care of us.

Sadly we do not understand what you mean by "bank switching". Presumably you are looking for a way to address more than 64K bytes with an 8-bit micro, in which case we do not know of any which can do it simply.

We cannot help you on your use-of-memory question, either.

Schools should be critical

Concerning your review of the 380Z micro in the December issue. For a system which claims to be suitable for education use, several important points were omitted. It surely must be admitted that a single-user system is inadequate for a class of, say, 20 O level students, so should we not be concerned with the multi-user system?

In particular, does it allow data files, multi-user assembler language, and what size of program can be used by eight users simultaneously? It seems reasonable to the CSE student that if programs can be listed on the printer, then so can results. Is this the case?

As one involved in computer education, it seems to me that schools should be rather more critical of micro systems, and expect the standards of software available on the mini systems of five years ago.

I hope that the "wet blanket" nature of my letter will not affect its printing in an excellent magazine. Surely we must have pros and cons.

M. Parr

Wombwell, Barnsley, S. Yorkshire

Versatile mailing list

We have mailing programs, page 17 of the December, 1978 issue. We run an SWTPC M6800 with 24K RAM and a MSI FD8 disc system. We have a mailing list of 1,000 addresses, each of which is in one of 15 categories of priority and of 12 separate geographical locations.

The program is run for a Model ASR43 printer with gummed labels. A sample run shows the versatility we have been able to build it. It is possible to select labels for any one or more of the categories in any of the regions or all.

For anyone interested we would be pleased to give further details.

S. J. Chatfield

Camborne, Cornwall

Calling users of PDP-11

I should be much obliged if, through Practical Computing, you could make it known that I am trying to start a PDP/LSI-11 users' group. Despite some publicity already, there is still only little support for the group. What I am trying to do is to form a basis for interchange of ideas, expertise and even software for PDP-11 users.

I would be interested to hear from anyone who uses a PDP-11 of any configuration, running under any operating system for any application. Since Digital tells us that it has sold 50,000 PDP-11s so far, there must be many people interested, and hopefully many of them read your magazine.

P. C. Harris

119 Carpenter Way

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Do you want to be an author?

We are a small but expanding publisher of technical text books. Our main interest is to publish a series of books related to computer applications the first being our Computer Programs That Work by Lee, Beech and Lee. This sold out after only eight months with the pleasant result that it is now being re-printed.

There is clearly a market for books such as this, based heavily on program listings with short descriptions. As our first book was orientated towards science and games, we are now interested in the non-science areas of business, information, linguistics and the like.

Other than that, our only requirement is that popular programming languages such as Basic in a widely-used dialect are used by our authors.

If your readers would like to share in our success, perhaps they could write to me with details of their ideas.

D. G. Beech

Sigma Technical Press

23 Dippons Mill Close

Tettenhall

Wolverhampton

Services on offer

Congratulations on an excellent magazine. I note that in both the November and December Feedback columns, there have been readers enquiring for mailing programs. My company can offer comprehensive mailing services which are used widely by auctioneers, art dealers, trade unions, mailing houses and trade associations.

D. M. Taylor

North Lincolnshire Data Services Ltd.

Rothwell

Lincoln

Where are those discounts?

Congratulations on a superb magazine; it is very informative. Your article on computing in schools is an illustration of what my friend and I would like to happen to our school, Liskeard Comprehensive. I want to make my career in computing—both hardware and software interests me—but I have no way of getting hands-on experience with a computer.

My friend and I approached the headmaster, who said a computer would probably be purchased by the school in about two years' time.

In two years time I will be at college. I realise the great potential of a computer at school, but I and others cannot make the school appreciate the point. The options form for lessons which I received at the
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PRACTICAL COMPUTING February 1979
end of the third year had Computer Studies on it; soon the course was can-
celled through lack of pupils and they also do not have a computer.

My aim is to try to get the school to purchase a worthwhile piece of equipment at a relatively low cost. For this I need a list of most of the possibilities of a com-
puter in school and also prices and details of educational discounts. Can you help?

R. J. Fiddick
West Looe
Cornwall

You probably will not secure any “educational discounts” from anyone if you are talking about a smallish system. Most of the small computer vendors are selling them hand over fist and do not need the extra business. Discounts may be offered by suppliers of bigger and more expensive micro systems, where the price is likely to be more than £2,000.

On the other hand, £800-£900 will buy a ready-to-go Pet or Tandy; £500 will buy a decent micro kit, plus a keyboard and cassette for use with a TV set.

These are not impossible sums, after all, it is only £10 each from 80 willing parents. If the school has a parent-teacher association, you ought to suggest it. We have heard of school children raising cash for computers by running jumble sales, sponsored walks and dances.

One good ploy we have come across is doing advance deals on business systems software; you approach local shopkeepers and small businesses and promise to write and run some fairly simple programs for them when you get your computer. They pay something in advance, of course.

Typical applications for this would be maintaining customer records, perhaps stock records, mailing lists and small businesses and promise to write and run some fairly simple programs for them when you get your computer. They pay something in advance, of course.

Problems such as ours must be common among schools and colleges entering the micro field and we are sure many are examining some of the systems we have mentioned. Your comments and advice would therefore be warmly received.

D. Sheppard
Department of Science
Barry College of Further Education
Barry, South Glamorgan

We have written to Mr Sheppard with our opinion. Anyone with further ideas or experiences of the machines listed may like to contact him to pass on their experiences.

Stock control problem

I see from Feedback in the November issue that advice on systems is available. Could you, therefore, please advise me on the following?

I am looking for a system which could provide stock control initially for 2,000 items but which could be increased when necessary by the addition of more units—price around £500-£700, either ready-built or to be assembled.

M. Page
Co. Antrim

Do you mean stock control or stock recording? If it is stock control you will find it difficult to implement it on a system in your price range. The two which spring first to mind are the Pet and the Tandy, both of which have some stock control/recording programs developed.

You should really be looking for a system costing around £2,000, many of which you will find listed in our Buyers' Guide. If you think about it, purchasing a £2,000 system would probably cost you about £20 a week, which might well be worthwhile—and it is tax-deductible if you are in business.

Incidentally in next month's issue we shall be examining systems available for stock control.

Computer courses

Can you suggest computer courses for two of our staff? The first problem they have to solve is to identify the most suitable computer for our purpose. They would be required to program and service as necessary.

Hodges & Moss Ltd
Shrewsbury

We don't usually like to recommend courses. Our sister magazine, WHICH COMPUTER? has, however, recently reviewed such a course and was favourably impressed. It was called Buying a Computer and was run by Accountants Weekly Courses, tel 01-402 4503. You might also like to contact the National Computing Centre which offers advice to new purchasers of computers. Tel 061-228 6333.

Anyone for chess

I am looking for a computer system for around £200. My main interest is compu-
ter chess. Do you know if there are any micros which are helpful in this area. Do you think that for a cheap system a full qwerty keyboard is necessary. I have my eyes on a 6800 but I have also heard of a 6809 system. Can you tell me anything about it?

Robert Davis
London WC1

Our Buyers Guide details systems like the Kim, Sym and Nascom all of which are within your price bracket and could be programmed to play chess. There is also the Chess Challenger which is a dedicated chess machine available at many toy shops for around £200. If you could spend a bit more money the Pet and Tandy both have very good chess programs which, we admit, have beaten us. As for the 6089, sadly we don't have much knowledge. Can any readers advise?
The Age of Affordable Personal Computing Has Finally Arrived

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Superboard II was designed specifically with low price and the first-time user in mind. It promises to be the most dramatic price and performance breakthrough to date, in the microcomputer industry. Ohio Scientific, with headquarters in Aurora, Ohio, are one of the leading manufacturers of complete computer systems—from hobbyist right up to business and OEM applications.

The single board construction and custom LSI chips used in the Superboard II result in large cost savings, and ease of use. In fact it has more features and better performance than some other systems that are selling at up to £1,000. In the early 70’s computers with inferior performance cost over £10,000.

The broad range of features include 8K BASIC in ROM, up to 8K of RAM on board (4K supplied), full 53 key computer keyboard, Kansas City cassette interface, video display interface (with graphics). Available options include an expander board for additional 24K RAM, dual mini-floppy interface port adaptor (for printer and modem). The Superboard II comes preassembled, and only needs a power supply and case. Any 5V supply at 3A will power it.

### Standard Features
- Uses the ultra powerful 6502 microprocessor
- 8K Microsoft BASIC-in-ROM
- Full feature BASIC runs faster than currently available personal computers and all 8080-based business computers
- 4K static RAM on board expandable to 8K
- Full 53-key keyboard with upper-lower case and user programmability
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### Extras
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- Assembler/editor and extended machine code monitor available

Fully built and tested. Requires only +5V at 3 amps and a videomonitor or TV and RF converter to be up and running.

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Lotus Sound have had so many questions about various aspects of Superboard II that in order to save time, and ensure your satisfaction, we are offering to return the full purchase price to anyone who returns their machine—in good order and original packing—within 15 days of delivery.

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Two word processing systems from Comart

COMART has introduced two new word processing systems, both for the Sol range of microcomputers, which the company imports from the U.S.

Solstar runs on the Sol 20/16 with mini-floppies. Corrections, additions, deletions and movement of characters, words, phrases or blocks are accomplished in a simple, direct manner, with all text copy displayed on the memory-mapped video display for ease and speed of assimilation.

Wordwizzard runs on a Sol 3 with 64K and a Helios dual disc drive. Advanced facilities include the ability to print-out one text while editing a second.

Cromemco System 3

The overall goal is to profit mutually from all members' knowledge of calculators and related fields, and create a forum which allows club members to meet and identify with each other's interest. The club needs volunteer members to act as officers in the editorial committee, correspondents, reporters and translators.

Club members speak or write English, French, German and Hungarian. This list will hopefully be expanded with readers in other countries. For more information, send large, self-addressed, stamped envelope to Gene Hegedus, PO Box 23, Oxnard, CA 93034.

Integrals unit

MICROCOMPUTER suppliers probably have more new products to launch than any other section of the industry, so it is not surprising that so many capitalised on the Compex exhibition for initial exposure.

ISG Data Sales of Maidenhead premiered a new development system and terminal from Futureadata Computer Corp of Los Angeles. Advanced Microcomputer Development System (AMDS) provides in one unit a c.p.u., keyboard and c.r.t., claimed to be the first such integral unit.

There is a choice of microprocessor c.p.u.—the 8080, 8085, 8086, 6800, 6802 and Z80 are offered; and a standard 64-key keyboard and 12in. display. Memory is expandable from 16–64K RAM.

A comprehensive set of packages is available for software development, including debug facilities, editors, assemblers and Basic compilers. There are also hardware facilities for debugging and simulation.

The 80-character display comprises 24 lines of 7 x 9 dot matrix with upper- and lowercase characters, enhanced video, reverse video, underlining, highlighting and line graphics.

A basic 16K system costs £8,000 from ISG Data Sales, Moorbridge House, 50-52 Moorbridge Road, Maidenhead, Berkshire.

Latest Lib is for the calculator user

THERE ARE genuine fears about machines taking over everything, but it is still a shock to find the machines apparently standing up for themselves.

Calculator Lib is, in fact, the title—probably meant to increase the paranoia of the most neurotic of us—of the newsletter of the Liberated Calculator-users' Club. Set up by Canadian, Gene Hegedus, it is: "a truly universal, independent, non-profit group of calculator users (regardless of the make of the calculator) dedicated to exploring the limits of the state-of-the-art of calculator-mathematics."

The overall goal is to profit display is flicker-free without the "ripple-through" effect of some c.r.t.s; and the equipment is designed stylishly to fit into an office or home environment.

The introduction of these systems, together with that of Cobol for Cromemco microcomputers, heralds the Comart entry into the commercial market; previously it has concentrated on scientific, educational and industrial applications.

The Cobol implementation is for Cromemco Z2-D and System 3 microcomputers with at least 48K bytes of memory. It is written to ANSI 1974 standard with all Level One features and the most useful ones of Level Two. It costs £85.

Also connected with the move into the business systems market is the agreement with Computer Field Maintenance to provide a nationwide field service for the Cromemco, North Star, Processor Technology, Dynabyte and Sol microcomputer systems Comart distributes in the U.K.

There will be a standard 48-hour or better response for an estimated cost of 12 percent of Comart list price for the product in question.

Service centres in London and Manchester will be followed by others in Glasgow and Nottingham.

Comart can be contacted for details of all its products and services at PO Box 2, St Neots, Cambridgeshire.

Graffiti winners

This month's winning entry is from Andrew White, aged 16, of 19 Greenpark Drive, Co Armagh, N. Ireland.

The micro in the corner,
Not used for o'er a week,
Is waiting for a program,
Is moping for a program.
Instead, inside that circuitry,
Computers aren't just steel,
Is something which can feel.
PEEK.
It's BASIC is getting hazy,
Through a boring lack of use,
Our micro has caught the land.
A customer enters,
The micro he is shown,
As 'cross the room the customer is blown.
Take heed, you micro traders,
Computers aren't just steel,
Instead, inside that circuitry,
Is something which can feel.
The runner-up is G. P. Dixon, of Windlesham.
Our micro has caught the disease,
Of charging its users large fees,
It says—"Look here, Gus,
I'm driving this bus,
Sit down—log in—tickets please".
PRACTICAL COMPUTING February 1979

'These 4K bytes, ROMs, up to 64K bytes, battery powered RAM boards, PROM programmer boards, mini and standard disc controllers, hard disc controllers, 3M cartridge controllers, video graphic boards, analogue I/O boards, keyboard/CRT controller boards, relay output boards, isolated input boards, communication I/O boards, and communications controllers.'

The arrival of the iSBC 86/12 reveals the purpose of several lines on the Multibus which were not needed by 8-bit minis. They are an additional eight data lines and four more address lines, increasing the number to 20 to cater for the one megabyte addressing capacity; and a byte control line, which allows both 8-bit and 16-bit CPUs to be used on the same Multibus system.

Employing the 8086 16-bit CPU, the 86/12 has a comprehensive instruction set which includes multiply and divide in binary, BCD of ASCII.

communications are handled by a separate V24 (RS232C) serial port, which will support virtually any communications protocol. Baud rates for this port can be software-selected from 75-9,600 in asynchronous mode, and from 1,760-38,400 in synchronous mode.

Other functions supported are event counting, timing and vectored interrupts—the board supports nine, expandable to 65, levels. The board also incorporates an auxiliary power bus and power failure interrupt control logic for employing battery supply to protect the contents of the read/write memory during a power failure.

Intel Corporation (U.K.) Ltd., 4 Between Towns Road, Cowley, Oxford OX4 3NB.

CCS Microhire

MICROCOMPUTER RENTAL SPECIALISTS

Before you buy a micro, why not hire it for a day or a weekend?

From £2 a day we hire out a range of micros for evaluation/experience or program development.

* Apple II
* Commodore Pet
* Nascom I or Micros
* Research Machines 380Z
* SWTC 6800 or MS 6800
* Tandy TRS 80

Protect your future investment.

Try out a system now.

For details write to

CCS Microhire, Freepost, Letchworth, Herts SG6 4YA

Bristol bound

THE Nascom-1 microcomputer system is now being distributed in the Bristol area by Target Electronics, one of the largest suppliers of semiconductors and electronic components in the area. The Nascom system is the only microcomputer the company handles.

Target Electronics, is at 16 Cherry Lane, Bristol BS1 3NG.

Harlow Z80 spot

HARLOW-BASED distributor Distronic is offering off-the-shelf Z80 microprocessors from Mostek. It also has full development facilities available.

Full software support is provided, with a strong emphasis on high-level languages and a disc-based development system offers advanced real-time debug facilities. The price for quantities of 1-24 is £231.03.


Kim 1 for less than £100

COMMODORE has reduced the price of its KIM 1 board including a Teletype interface, are ready for connection. If the Teletype has the facility, KIM can also handle paper tape input and output.

The range of peripherals for use with the system has been expanded in collaboration with distributors.

Options include a pocket terminal (£240), which allows input of the full ASCII character set from 40 dual-purpose keys; and a videoboard (£150) which allows a normal television to be attached as a video display device.

Kim also boasts excellent documentation of hardware and programming instructions, plus powerful software.

They include an Assembler/Disassembler/Editor package, an information retrieval system, a mailing list program for business use, and a variety of games. The prices of them range upwards from £12.
Near-total paralysis has not prevented Chick Smith developing his interest in computing.

100 times faster

TURN your Pet into a small business system. That is what a firm in Solihull is suggesting now that it has attached a mini-floppy disc system to the Pet.

Midland Micronics has bolted two 5½ in. floppy discs neatly on each side of the VDU. It is engineered very neatly so that it looks part of the machine.

The advantage of using floppy discs is that it is much faster than a tape cassette and you can hold more information. Midland says that each diskette can hold up to 81K bytes of data and is 100 times faster to access than the tape.

Connection of the drives is via the Pet memory expansion board and the system is complete with an additional plug in PROM permitting control of the disc system via Pet Basic USR instruction with simple commands from either the keyboard or under program control.

The floppy disc Pet is in two versions, 24K or 32K, and the starting price is £1,300. More from Midland Micronics, Oakfield House, Station Road, Dorridge, Solihull, W. Mids.

Chick Smith is a resident of the Thistle Foundation for the severely handicapped in Edinburgh. Near-total paralysis has not prevented him developing his interest in computing.

An Apple II and cassette recorder are mounted on a trolley beside his bed and operated via a specially-designed separate keyboard mounted on a frame over the bed.

Chick operates the keyboard using a perspex rod in his mouth. Control and shift keys have been modified to lock in position. His wife, Beth, changes cassettes when necessary.

A keen chess player, Chick first experienced the delights of micros after buying a Chess Challenger and rapidly discovering its limitations. He has received help in installing the Apple from staff of Edinburgh University and members of the Scottish Amateur Computer Society, but is almost entirely self-taught.

Programs he has written include a number of games programs and a chessboard display. He also has the Apple's voice-response unit for which he is still developing applications.

Micro interest via chess route

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Tiny Basic is here

TINY BASIC is not the managing director of a multinational trading empire but a new language for the beginner to microcomputer programming.

Written by the Golden River company the language is designed specifically for a microcomputer with minimal memory. It will accommodate approximately 100 statements in 2K bytes of Ram.

It includes all the basic functions of Basic, including a line editor, an assortment of error messages to the user and a surprising amount of processing capability.

Floating-point arithmetic, arrays, alphanumeric strings and other advanced facilities may be added via a machine language extension.

The ability to expand the language in this fashion makes it suitable for both novice and experienced programmers.

It is supplied resident in a 2716 EPROM, or fusible link PROM, ready to install in the Golden River Mk 4 microprocessor system or GRO430 single board computer. It is complete with a manual and costs, with chip, around £100.

Golden River is at Telford Road, Bicester, Oxon.

Christmas competition

NEXT MONTH we shall reveal who the nine lucky finalists are in our £5,000 Christmas computer competition.

By the closing date on December 31, our offices were absolutely swamped with entries with ideas galore for computer applications.

The nine finalists will then be asked to develop their ideas into a flowchart demonstrating how the system could work. Don't miss next month's issue out February 15.
MICROCOMPUTER TRAINING

Minicomputer and Microcomputer Systems: Management Assessment
- 5 March 1979
- 4 June 1979
- 1 September 1979
- 26 November 1979

Microprocessors: Assessment and Application
- 6-8 February 1979
- 1-3 May 1979
- 4-6 September 1979
- 30 October-1 November 1979

Minicomputer and Microcomputer Systems in Industrial Control and Automation
- 21-23 March 1979
- 20-22 June 1979
- 17-19 October 1979
- 5-7 December 1979

Microcomputer Programming and Design Techniques for Engineers
- 19-21 February 1979
- 14-16 May 1979
- 17-19 September 1979
- 12-14 November 1979

Microcomputers in Commercial DP
- 1-2 March 1979
- 24-25 May 1979
- 27-28 September 1979
- 22-23 November 1979

High Level Languages for Microprocessors
- 22-23 February 1979
- 17-18 May 1979
- 20-21 September 1979
- 15-16 November 1979

Microcomputer Techniques for Computer Systems Designers
- 26-27 February 1979
- 21-22 May 1979
- 24-25 September 1979
- 19-20 November 1979

Advanced Microcomputer Design Techniques
- 28 February-2 March 1979
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- 26-28 September 1979
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Please send me information on Microcomputer training

Name __________________________________________
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Return to:
Business packages

Many business packages are now coming onto the market. This month we look at some systems available for estate agents and for doctors.

HB COMPUTERS in Kettering has developed a package for estate agents for the Pet. The total system at around £710—the software selling for £15—was developed by HB with help from a local estate agent, Parkhouse and Partners.

It is a simple but effective way for estate agents to call broad details of a property on the screen while the potential customer decides immediately whether more information contained on filed broadsheets is required.

Input is typed-in at the end of a day from property detail sheets the agent completes during the day as he views each property. The main breakdown for each property is price; the other kinds of input data include type and location, number of rooms, number of bedrooms, garage, features, and so on.

When an enquiry on a property is received, the data tape of the appropriate price range is read totally into memory—each data tape can hold about 60 properties, depending on detail. As the customer decides his interest in each property, the folio number of each broadsheet in the files is noted and the pulled sheets are sent, or handed, to the potential customer.

HB claims that about 30–60 minutes’ training in the estate agent’s office, given by HB, is all that is needed to get the system started and running.

HB believes enhancements to the package will provide automatic collation and mailing of property details to customers. It would also like to see an inexpensive printer attached to provide alternative output.

Another estate agents’ package is being offered by Compec, of Berners Street, London, W1 on its Series 1 system for about £7,000, including the software. Bought over three years, it would cost about £60 per week. The package, similar to that used in the Altair 300 estate agents’ system, is more comprehensive in its facilities than the HB package, as its price indicates.

The Altair 300 is a multi-user system but this is a single-user, single-office system using a 64K machine, 1-megabyte floppy, a VDU and Qume printer. Some of its features include:

- Storage of up to 30,000 properties and applicants;
- Ability to match properties with applicants using up to 48 attributes;
- Applicant address labelling;
- Data analysis of stored items—e.g., number of properties notified, effectiveness of advertising, method of approach to the agent;
- Immediate backlog listing—e.g., 50 properties including price, address, office to contact, and brief description of property can be produced in less than four minutes;
- Automatic culling of applicants’ list after a pre-set review time;
- Modular system design means that a feature such as accounting or property management can be added later at a reasonable cost.

For doctors, we have uncovered two applications for micros—the Computer Workshop MICKIE and the Compelec Patient Accounting System.

Computer Workshop of Dover Street, London, W1, using software developed by the National Physical Laboratories, produced an application system for doctors called MICKIE—Medical Interviewing Computer.

To be used in five areas of DHSS to start, the systems set up a patient/machine interface where the patient answers questions on the screen using a "button box" with only four buttons. Making certain that the patient is first literate and can read the characters on the screen, the doctor leaves the patient to complete the questionnaire. The information obtained is stored and then printed-out on the MICKIE printer in whatever format suits the doctor.

Patients apparently seem to prefer to talk to the machine because they can take their time answering questions. An interview takes about 40 minutes and its length depends on the illness, the patient’s age, and so on.

West Middlesex Hospital is operating MICKIE for patients with abdominal pains and in the future will set up MICKIE for backache complaints. Doctors have praised the system because of the great savings in doctors’ and nurses’ time.

A different kind of doctors’ package is being offered by Compelec, of Berners Street, London, W1. The system, at about £6–7,000—the included software costs about £1,000—is for account management.

The system generates a patient ledger, charges and receipts, new accounts, recall reminder list/labels, aged debt analysis, delinquent reports, practice income statements, and a query function.

Aimed at the single-site, single-user market, the system has at its heart the Compelec Series 1. The number of accounts and patients’ data which can be held is dependent on the length of the record needed but the system should accommodate the number of patients within a normal partnership easily—say 1,000 patients.

Compelec expects to enhance the software to include insurance reports, treatment plan estimator, patient charts, appointment book, inventory control, and general ledger.

Conclusions

- At the micro end of the market the picture is relatively grim for users seeking a very inexpensive system with the application software already written, so praise for these items for at least a start in the right direction.
- There is a great opportunity for bright, innovative software houses to start attacking the industry application market. In the near future we will be looking at druggist’s systems, solicitors’ packages, client accounting, temporary employment agency systems, management consultants’ packages and perhaps publishers.
The idea of a group, completely independent of Commodore, was first conceived by Norman Fox of Welwyn, Herts. He contacted several Pet owners and circulated a newsletter to everyone he knew. The group had its first meeting last October, when members met to discuss what the group could do.

Obviously the most important role for the group is to facilitate communication between Pet owners and users. All over the country there must be users who are re-inventing the wheel over and over again. If the group can provide a forum for the circulation of information and ideas, then it will have been a success.

At the second meeting of the group in November, James Chambers, of the psychology department in London University, allowed us to see some of the ways Pets are used to help in experiments. Pets are the ideal method for teaching students programming, he said, and with the knowledge thus gained new ideas could be tried out.

We saw a Pet being used to operate a variety of experimental equipment; shutters, projectors, and stimulus-response measuring apparatus. The day is with us when the experimenter can set up the Pet, let it control the experiment and then produce all the statistical results without delay.

What IPUG offers

We hope that as well as regular meetings, IPUG will be producing a regular newsletter for Pet users. Anyone interested should send £2.50 (payable to the group) to the secretary, Mike Lake, at 9 Littleover Lane, Derby.

Thanks to the help of Julian Allason of Petsoft we have been able to circulate most Pet owners with information about the group. You don't have to be a Pet owner to join, though—just contact Mike.

Hardware: Mike's moans

Why is it that so many items we may wish to interface with Pet are so expensive? To take one or two examples: a TV interface has been offered by one or two companies at £75. My prototype which, incidentally, works well, cost less than £5. Even with all the connectors and switches I put on the final version, it cost only £10. Someone, somewhere is trying to rip us off.

Secondly, what about additional memory? Anyone who has compared the costs of commodore memory for Pet with the prices for the Tandy TRS-80 must be feeling sick. I know all about the problems of importing American boards but with an expanding market here, isn't it time someone made a good British-made board at a reasonable price?

Practical Computing will be having Plessey's Petite add-on memory for a hands-on test in the next few weeks; watch this space.

Connectors to the outside world from the Pet ports are still hard to obtain. Some are supplied without a cover. Not only is this not aesthetic, it could also create shorting problems. If suppliers of decent connectors will contact us we will print a list.

Now a moan at Commodore. The cassette unit has two irritating problems—it may sometimes partially erase the tapes used for writing on, and head alignment on different machines may be so far out that tapes produced on one Pet cannot be read on another.

These are not major defects to solve and it seems a pity that, after producing such a good machine, Commodore has not been a little more forthcoming on these issues.

A minor but equally irritating point which has been bothering a number of owners is keytop wear. If your Pet is used regularly, in a few months it will become impossible to read some of the keys—particularly RETURN and SHIFT. This is because the key label is only stuck on; a well-designed machine then becomes tatty through a relatively trivial problem.

We will print any decent solutions. Please send your suggestions quickly—Mike's keys are just beginning to give problems.

Simply software

On the subject of PEEK and POKE, try this in the middle of a program:

```
WAIT 59404.4
```

When everything goes dead, try pressing STOP. Surprise, surprise—nothing happens. To put yourself out of your misery, press SPACE. All should then be well. This could be a very useful device for preventing anyone stopping an important program in mid-flight. Perhaps you may be bold enough to try:

```
WAIT 59410.1.1 and WAIT 59410.2.2 and WAIT 59410.8.8 and WAIT 59410.16.16. I don't recommend WAIT 59410.32.32.
```

Here is another nice one:

```
POKE 59409.52
```

This will make the screen go dead. Now try:

```
POKE 59409.60
```

and all should reappear.

This is very effective in a program if you set up a screen of information with the screen POKEd out, then POKE it in again. An instant screenful will appear.

Music to our ears

Pet is not an excellent musician but it can play tunes. If you want it to start playing notes then it is very easy. First, connect up the user port like this:

![Connectors](image)

The output can go to a hi-fi or to a simple amplifier feeding headphones (Circuit next month if enough people want one).

Now the magic pokes:

```
POKE 59467.0 after use or
```

frequencies and poke codes next month.

Note by the use of a loop, or by checking the timer. I will give a full list of notes, port

```
POKE 59466,15 (or 53 or 85 try them all)
```

POKE 59464, any number 1-255

You should now hear a tone from the speaker. You can control the length of a note by the use of a loop, or by checking the timer. I will give a full list of notes, frequencies and poke codes next month. You MUST POKE 59467,0 after use or your cassette will not work.

Book bicker

A good deal of reading matter is available for those setting out with Basic, but what about those who wish to take up machine language programming on the Pet? The 6502 software manual is fine, but is written at a fairly advanced level.

(continued on next page)
There are four good independent U.S. newsletters for Pet:

- The Pet Gazette, Microcomputer Resource Centre, 1929 Northport Drive, Room 6, Madison WI 53704, U.S.A.
- Cursor, P.O. Box 550, Goleta, California 93017, U.S.A. (Monthly)
- The Pet Paper, P.O. Box 43, Audubon, Pa 19407, U.S.A. ($2 per copy, monthly)
- Pet Users' Notes, P.O. Box 371, Montogomeryville, Pa 18936, U.S.A. ($10 for six issues per year)

The Pet Gazette charges $2 per copy, monthly.

Independent information
A VITAL component of your processor is the memory. A single faulty bit in a 32 kilobyte system represents an error of only about 0.000381 per cent but can create chaos with your programs, giving complete program failure or, possibly worse, still inaccurate results.

Though the bits which make up each byte are often used in terms of "least significant", "most significant", and the like, a faulty memory cell is just as destructive to performance, whichever bit it represents. Fortunately, because of the nature of a processor, it is not necessary to resort to the use of oscilloscopes and logic probes to check each state of every cell; a suitable software routine will enable the system to check itself.

Test programs

The author first decided on producing a test program for his MK14, SC/MPII-based microprocessor unit and has since generated a number of variations. Reproduced here are the original simple approach listing for the SCMP and a more sophisticated version written in Pet Basic which is readily adaptable to other systems.

Both programs are based on the premise that it is necessary to test that all bits in all locations can still be retained, the choice being either a logical one or a logical zero. The approach chosen is first to write 01010101 (i.e. Hex. 55; Dec. 85) check the location(s), then write 10101010 (i.e. Hex.AA; Dec. 170) and again check the contents.

In the majority of cases this will produce an accurate indication of the quality of memory and enable fault conditions to be interpreted readily by examination of the value of the contents returned at the two checks.

If it is suspected that certain patterns of data are causing peculiarities, either program could be adapted readily to check this. In addition in certain cases, e.g. when using dynamic memory, it may be necessary to insert a delay between the write and read operations to allow a "leaky cell" to be detected.

SCMP is the first version with no attempt at auto checking. All memory locations specified in the program are loaded with Hex. 55; these locations are amenable to use for the original information to the memory storage of the program variables. Function, remembering to allow space for the storage of the program variables.

Note that as given the program restores the original information to the memory after checking; this allows for this program to be used as a subroutine, checking locations which contain program or data information. If desired, this, together with the various "presentation" prints, may be omitted, resulting in a shorter and faster program.

As the program takes about one minute to check one kilobyte of memory.

Running the program

As indicated, execution may be speeded by deleting lines 25 and 30 and the POKE statement of line 100. The FOR...NEXT loops in lines 40 and 70 act as delays of about 10 milliseconds as described in the text.

On a standard 8K Pet the following was obtained (initially? 8191-FRE(O) gave 1290, allowance for variables so START=1350)

\[ \text{MEMCHEK} 02, \text{WDMOCT78} \]
\[ \text{START ADDRESS} 1350, \text{END ADDRESS} 1891, \text{FRE} 0248 \]
\[ 9072 \]
\[ 4068 \]
\[ 5120 \]
\[ 6444 \]
\[ 1350 \]
\[ 1350 \]
\[ 6257 < 85 < 84 \]
\[ 6331 > 170 < 171 \]
\[ 6400 > 170 < 174 \]
\[ 6461 > 170 < 171 \]
\[ 1332 \]
\[ 8191-FRE(O) \]

As a result of using lines 30 and 70, the following was obtained:

\[ \text{MEMCHEK} 02, \text{WDMOCT78} \]
\[ \text{START ADDRESS} 1350, \text{END ADDRESS} 1891, \text{FRE} 0248 \]

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\[ \text{START ADDRESS} 1350, \text{END ADDRESS} 1891, \text{FRE} 0248 \]
Keen Computers, go SOFT!

A full range of Apple II software is now being developed:

**Software available at present:**

<table>
<thead>
<tr>
<th>Software</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incomplete record accounting</td>
<td>£250</td>
</tr>
<tr>
<td>Addressing &amp; Mailing program</td>
<td>£50</td>
</tr>
<tr>
<td>Word-processor</td>
<td>£50</td>
</tr>
<tr>
<td>Information retrieval system</td>
<td>£50</td>
</tr>
<tr>
<td>Chequebook</td>
<td>£10</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Software</th>
<th>Price</th>
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<tbody>
<tr>
<td>Shape-Create</td>
<td>£25</td>
</tr>
<tr>
<td>Co-Resident Assembler</td>
<td>£25</td>
</tr>
<tr>
<td>Matrix Inversion</td>
<td>£25</td>
</tr>
<tr>
<td>Full range of statistics packages available from</td>
<td>£35</td>
</tr>
</tbody>
</table>

In addition to these packages, we also offer a consultancy service.

**Hardware**

Keen Computers are the only Apple II dealer in the Midlands area.

The Apple II has to be the most advanced Micro on the U.K. market.

- It uses a 6502 microprocessor—a very updated version of the Motorola 6800.
- It has excellent colour graphics and a very comprehensive basic.

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<tr>
<th>Hardware</th>
<th>Price</th>
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<tbody>
<tr>
<td>Apple II computer (16k)</td>
<td>£985</td>
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<tr>
<td>Additional memory</td>
<td>£200</td>
</tr>
<tr>
<td>Disk unit with controller</td>
<td>£425</td>
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<tr>
<td>Disk unit without controller</td>
<td>£375</td>
</tr>
<tr>
<td>Applesoft ROM card</td>
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PRACTICAL COMPUTING February 1979
Construction never less than excellent

The Cromemco manufacturing company now makes a range of computers and boards using the Zilog Z-80 and the S-100 bus. A typical system with two mini-floppies and 32K bytes plus serial and parallel outputs will cost around £2,500. You can buy the 21-slot motherboard box containing the processor and a minimal amount of memory for £600. What you will be able to do with it is another matter.

The Cromemco equipment is more than just another S-100 micro box. There is a whole range of interesting boards and excellent software for the system. In this country the equipment is imported by Comart and distributed through a growing range of computer shops. Comart also makes MicroBox—an S-100 card frame (and a British S-100 product at last), which enables you to purchase a single-disc system for just over £1,000.

The Cromemco Z-2D is the top-of-the-range system with mini-floppies. A practical system to use the software efficiently would require 32KB memory. The processor and disc controller each occupy one slot of the S-100 box and there is a serial output as well on the disc controller, which means you can interface most terminals to your system immediately. Because of the way the software is configured, however, a second serial output probably is desirable if you want hard-copy output.

First, the good points. The standard of design and construction of the boards is never less than excellent. They are double-sided, solid and well-made.

The manuals from Cromemco are also very well-produced—Cromemco uses its own word processing software—and would put many minicomputer companies to shame. The quality of documentation in the microworld is often little short of disgraceful, so this is no small achievement.

The single worst point about the Cromemco Z-2D is also immediately apparent. The mechanical design of the frame has been structured to make it easy to construct but it is inadequate for practical use. Immediate modifications are required to put the front panel on hinges for easy board access. A front panel re-set button and on/off switch are also very necessary.

The processing chip is based around the familiar Z-80A, normally operating at 4MHz but with a switch to operate at 2MHz for slower memories. It is also switch-selected to jump at switch-on to any 4KB boundary. The board is also totally compatible both in hardware and software terms with the Altair and Imsai cards, the Adam and Eve of S-100 systems.

The memory boards Cromemco supplies are not competitive for price with those from the specialist manufacturers and so Comart normally will supply the system with the Dynabyte 16 or 32KB boards.

By any standards, and especially by those of the micro business, the 32K board has proved very reliable, despite the fact that it gets very very hot during normal operation. It is not possible to move the 32K board in memory very flexibly. While one board is a good basis for a system, care therefore should be taken about systems which require PROMs at particular positions in memory.

The Z-80 can address only 64K bytes of memory but the Cromemco processor has the ability to select one of eight pages of 64KB of memory. The 32K board is not configured to operate in this way but the 16K memory is—and it can also put each 4K block of memory at any point in the 64K memory area.

The semiconductor memory can be write-protected, set so it is possible only to read the contents and not to write into it—it sounds a buzzer if you try.

So, all in all, the 16KB board is much more flexible, even though it occupies twice as many slots. These points may be academic for a system which it is to operate untouched on a shelf but they are vital considerations if you expect to be altering or improving your system in the future—and who doesn’t?

The UK agent, Comart, is reported to

(continued on next page)
be generally reliable and helpful—a pleasant change. In the last few months the company has apparently been so overworked that the original level of good and rapid service has slipped a little, as it would admit itself. This seems to be one of the inevitable growing pains in the micro world and we would certainly not want to criticise Comart seriously because it has been significantly better than most micro firms with which our reviewer has dealt.

**Discs and Disc operating systems**

The Cromemco Z2-D uses two Wangco mini-floppies costing around £1,400 with a disc controller. They are rather slower than the North Star discs Comart supplied formerly but they seem to be very reliable.

The Wangco discs are file-orientated rather than memory-orientated, which was the case with North Star. The Cromemco software is linked to the Wangco disc and is now much better at disc handling than the North Star version. It would no longer be sensible to choose North Star discs.

Each diskette holds 81K bytes accessed through CDOS—Cromemco Disc Operating System. A system with one disc is not a really happy proposition unless finance, or lack of it, leaves you no alternative. The disc controller can handle three mini-floppies and has a serial and parallel port as well.

One particularly aggravating omission in the operating system is that there is no command for the complete copying of a disc from one system to another. On the other hand there is no specific “squeeze” command to compress the information on the disc to leave room for a large file; surprisingly, this happens entirely automatically.

CDOS has some sophisticated commands apart from the standard range you would expect. For example, the “batch” command enables the construction of a series of CDOS programming steps which will then operate in an unattended mode—very useful for repetitive clocking through of a series of commands.

There is also a more simple monitor called RDOS—Resident Operating System. It operates as a primitive operating system for those unhappy souls condemned to work without a disc.

**Disc controller**

The disc controller is a single S-100 card able to control any combination of up to three mini-floppies and four full-sized floppy disc drives. It contains a bootstrap PROM to enable CDOS to be extracted from the floppy disc automatically on power-up. Also on the board is a serial port for RS-232 or 20mA connection—and how is it all crammed on?

**Single-board computer**

The single board computer is an interesting card which, with the addition of a power supply, can act as a self-contained computer. The big advantage of this is that it is entirely S-100 compatible. The whole program can be developed on the S-100 bus and then transferred into PROM, to produce a fairly cheap stand-alone system for process control applications. The single-board computer can be tested inside the Z-2 box before being moved.

At present the board is expensive at £345, presumably the level the market will accept but it is certain to fall in price. Cromemco control Basic and a program can be stored in two ultra-violet erasable PROMs—which, of course, can be programmed directly from the working program. With programming becoming more and more expensive and memory becoming cheaper, this combination is a sensible approach to system design for systems where only a few boards are required.

The board contains:

- Z-80A processor chip.
- RS-232 serial input/output.
- parallel data port.

**TUART**

This lovely acronym references the Twin Universal Asynchronous Receiver/Transmitter—the standard Cromemco board for inputting to and outputting data from the Z-80 processor. A terminal, Teletype or line printer normally would occupy one of the four input/output ports.

The board is packed with functions—a single 10 in. by 5 in. card contains two serial ports (RS-232C or 20mA) and two parallel outputs with 10 software-programmable timers, all for £185.

The baud rate is programmable from 110 to 76,500, a really useful feature which prevents you having to grope in the computer’s innards to alter tiny switches.

There have been some reliability problems, however, with the TUART. This is strange because it seems well-constructed, even if rather full of components. David Broad of Comart told us that we had been unlucky and that there is no serious problem with the board. Indeed, the Cromemco equipment was voted the most reliable in a poll of U.S. computer shops last year.

It may seem like gilding the lily but in general it is our impression that the TUART could be improved significantly. If the board could store a buffer of, say, 128 characters while the processor is working, the programmer could type-in several lines of code which could run when the computer had finished accessing a disc. The mini-floppies used in the system are relatively slow and the operating system is configured so that the program

(continued from previous page)
grammer is often kept waiting for five to 10 seconds before something can be typed in mechanically; this could better be spent thinking constructively.

Despite this niggling criticism, though, this board is a marvel of technology and one of these boards is an understanding of the Basic program. Fortran, which is always kept waiting for five to 10 seconds before something can be typed in mechanically; this could better be spent thinking constructively. The line is also interpreted at that time and placed in memory; this saves the same line being interpreted every time the program goes round a loop.

This makes for a very good compromise between a compiling and an interpretative language. Little of the flexibility of Basic is lost, yet the processing time is decreased significantly. This version of Basic is very comprehensive and takes about 14KB for the interpreter, so to run a sensible system requires about 32Kbytes of RAM in total.

Among the features are extensive formatting capabilities (including the PRINT USING command); 14-digit precision, with the ability to reduce this if speed is preferred to accuracy; integer storage—very useful for storing large arrays; dynamic error trapping, which allows the printing of a pre-defined message on an error condition; easy interfacing to assembly language programs; and sensible disc input/output facilities. A full list of the Basic functions is included in the specification with this review.

Control Basic

This software is a "mini" version of Basic, useful for those with small bank balances and memory, but intended mainly for implementing small programs very quickly on single-board computers. Despite the fact that it occupies a mere 3KB it contains a good selection of Basic functions, although its command set is limited. Presumably Cromemco introduced investment in the form of programs in the language. This version conforms in full to the American National Standard Version of 1966 and so should be more or less compatible with any programs running on older machines.

If you intend running Fortran programs, the full-sized floppies, with 250KIB capacity, are probably a better bet than the mini-diskettes. Fortran always seems to finish by taking an enormous amount of disc space for one thing and another.

The compiling speed is several hundred statements per minute, surprisingly fast really. The Fortran program is composed using the Cromemco Text Editor, a program whose commands bear similarities to TECO, the de facto standard used by Digital Equipment; in one or two points the Cromemco editor is superior. Editors are used so intensively by programmers that it would be highly desirable to standardise on one set of shorthand commands for all editing systems. The same editing system is used for entering text for the text formatting software.

Macro assembler

Cromemco really went to town over this system for writing Assembly language programs and it is as good as any micro assembly software available. For a start, it is re-locatable—a very useful feature and difficult to implement because of the nature of today's micro-processors—both Intel and Zilog have learned the lesson for their new 16-bit machines.

A macro is a little set of assembly level instructions which can be grouped into one self-made instruction, which can then be used on its own. A library of common macros can then be formed and used. Macros have much in common with sub-routines but they may have significantly different effects in use.

The debugger, another chunk of software associated with this package, enables the disassembly of any program into the mnemonics of assembler language. Of course, neither the labels used by the original programmer nor the program source is available. It is not a disassembler and it is an extremely useful tool.

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in real time by typing in assembly language. Trace facilities enable the programmer to move slowly through the program at the machine instruction level. Break-points can be set to occur at suspicious points and the registers and memory examined.

Text formatting

Cromemco avoids the use of the term "word processing" because this software is not meant for people unfamiliar with the text editor. A day or two would be required to familiarise yourself with this software. A day or two would be required to familiarise yourself with this package but afterwards it will remove all the drudgery from report writing, especially if you are one of those people who always seem to need give one more correction to any piece of text. Right-hand margin justification, automatic page numbering, stopping the typewriter after each sheet has been processed, text in double columns—it all seems to be there.

A point worth noting is that the word processing software is written to take advantage of the Cromemco line printer, a parallel input device with great flexibility and high-quality daisy-wheel output. It can do things like underlining and over-printing, and it even adjusts the words in a justified line so that the spaces between printing, and it even adjusts the words in a justified line so that the spaces between

More columns—it all seems to be there.

Conclusions

- Cromemco has assembled and tested the flexible and high-quality daisy-wheel output. It can do things like underlining and over-printing, and it even adjusts the words in a justified line so that the spaces between printing, and it even adjusts the words in a justified line so that the spaces between

for any single piece of equipment, at least not for too long. If anyone should sneer at slight incompatibilities between some S-100 equipment, ask them to name equipment for their system you cannot get for the S-100 bus.

- The Cromemco kit is bulky, with 21 S-100 slots available. No power-supply problems are likely because of the conservative design of the equipment. The well-developed and well-presented software will make it a tempting proposition even if the size of the equipment is something of a deterrent.

- For someone who would be content with a smaller, neater, cheaper system with fewer slots, there are many alternative S-100 systems on the market which might make for a reasonable comparison.
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Payroll and the Pet

working-out the payroll is one of the most boring chores of any business. With the complexities of calculating PAYE and National Insurance, most organisations are only too willing to leave it to a book-keeper or accountant.

It is these repetitive calculations, however, together with the need to store data, which makes it an ideal application for a computer.

Many of the letters to our Feedback columns have asked how payroll could be handled cheaply. To be honest, to buy a computer just to work out payroll for fewer than 10 employees is hard to justify.

One of the cheapest approaches we have found is to use the Pet (£695) plus some payroll programs (£25) which have been written for it by an accountant. Although you could run your payroll without a printer, it is much simpler if you have one and the cheapest is around £400 mark at present—total cost, around £1,200.

Hire service

For that you would have a system which could handle up to 100 employees quite comfortably. Above 100 employees it is probably better to use a disc-based system, which would probably be handled cheaply. Above 100 employees it is probably better to use a disc-based system, which could handle up to 100 employees quite comfortably. Above 100 employees it is probably better to use a disc-based system, which could handle up to 100 employees quite comfortably.

Payroll, of course, is not the only application which a computer could run. Apart from playing games, you could run other accounting procedures on it, which helps to justify its purchase.

As an aside, you can now hire disc-based computers for around £40 a week and the resultant time-saving may well be worth the money.

The Pet payroll system is in two versions. Series A is for machines with only one cassette deck and Series B is for twin cassette deck operation.

The Series A suite will cope with 10 employees per cassette tape. It will work whether or not you have a printer and can handle monthly or weekly-paid staff. It can accommodate two overtime rates, short time (unpaid leave), staff loans and automatic deductions, and three National Insurance rates (A, B, or C).

The Series B suite will handle everything the A suite can do, plus hourly-paid employees, three overtime rates, hourly bonuses, non-taxable expenses and up to 100 employees per data tape.

The Series A suite of programs consists of three parts—create and change, copy and print, and payroll. Create and change is used to create and update the employee data file. Duplicate allows the user to take a back-up copy of the employee file on a separate cassette, so as to reduce the risk of losing valuable data.

The print function is used to obtain a print-out on hard copy of any employee data.

Payroll performs the calculations. It is done by typing-in the file name, the current week number, the number of employees held on the tape, after which the program prints-out an employee name and asks for variable data concerning the employee.

Depending on your computing experience of using the Pet and payroll, it is advisable that you begin with the Series A program, since it holds less information and if, an operational failure should occur, it will be easier to input data in again in the Series A program than the Series B program.

Updating

The system provides for placing output on a printer as well as a VDU. The output of the payroll program can be used directly to prepare payslips for the employees on the data file. If you do not own a printer, it is suggested that you prepare payslips in the format of the printout on the VDU, and copy the data as it appears on the screen.

Both programs are well-written, though rather complex to run. The complexity is not helped by the standard of the documentation which, though reasonable, has considerable scope for improvement. We are informed, however, that new and improved documentation is being written.

The programs require a great deal of manual manipulation which makes them, in computing time, rather slow. This, together with the complexity of running the program is principally the limitation of the complete system rather than the software.

Despite these minor criticisms, the program should enable the businessman with a Pet to reduce considerably the amount of time spent on payroll, as well as avoiding headaches due to excessive calculation.

The author of the programs also runs an updating service to take into account any new laws or changes to PAYE instructions. It costs £10 a year.

Postscript to Mastermind

The article, "How to Play Mastermind", in our November, 1978 issue described and presented a program for the 6502-based KIM microprocessor system to play the game Bulls and Cows, now better known as Mastermind.

Once the standard game has been mastered, a simple modification will convert the program to play a much more difficult variant of the game, known as Parity Bulls and Cows.

In this version the guesser is not told the numbers of Bulls and Cows between his guess and the code, but only whether each of these is odd or even; the reply is "1" if the number is odd and "0" if it is even.

Thus to a code string "0123" the reply would be "00" for the guesses "4567", "3266", "0166", or even "3210", whereas in the standard game they would all be distinguished by different replies. When the guess is correct, the reply "40" must be given. The modifications are as follows:

| 02D | 4C D6 03 | IMP PATCH |
| 034A | A5 D6 | LDA COWS |
| 02D | 29 01 | AND $1 |
| 034D | A4 | TAX |
| 02D | A5 D5 | LDA BULLS |
| 034E | A5 D5 | AND $5 |
| 034F | 60 | RTS |

When playing Parity Bulls and Cows the program needs, on average, about 10 guesses to get your code string.

The graph showing the performance of the original Bulls and Cows program over a sample run of 1,000 games was accidentally omitted from the original article, and is now reproduced here. The program needs on average 5.74 guesses and all the codes were guessed in nine guesses or fewer.

Finally, an error occurred in the program listing; the data at 0200 should be: 4C A8 O2 (not 4C 48 O2). The remainder of the listing as published is correct.
Avoiding major items of expenditure

For the small development company or indeed for the amateur, most of the microprocessor development kits require one major item of expenditure which can more than double the cost of a development system—the Teletype device used for the main human/microprocessor/human communication.

Even the ‘glass Teletypes’ (VDUs) now beginning to proliferate at lower costs are still not cheap enough by comparison with the cost of the actual user kit.

For example, it is possible to buy several micro systems at less than £500 each, while a new ASR33 Teletype or Silent 700 terminal will cost more than £1,000 and a VDU will cost about £500.

The micro was designed as a simple replacement for a box-full of TTL or even mechanical logic in such applications as control systems, amusement arcade games and intelligent data transmission systems. Obviously none of those products is likely to use a Teletype as the I/O medium in the finished article, so the use of a Teletype in the development of such products is not only expensive but also questionable.

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**Best approach**

Bywood Electronics was confronted with the problem of getting its own micro units up and running and at the lowest cost and although it had programmers on the staff, they had only IBM experience. It was decided eventually that the best approach was to take a micro chip and add as few extras as possible to get a minimum system running, so that the capabilities of micros could be investigated.

This simple system used LED lamps to show the status of the 8-bit data lines, the 12-bit address lines and four single-bit I/O lines; so as not to load the MPU busses unduly the LEDs were run from CMOS drivers.

Bywood is a company which specialises in the supply of LSI technology components to small-volume users. To ease the design of equipment based on these components, a set of simple kits was designed for such things as digital clock timing and counting circuits.

The typical customer was either an amateur constructor or a designer developing a larger piece of equipment who did not have the time or resources to investigate the chips from first principles.

One of the first applications for its own development kit, SCRUMPI, was to make the I/O of instructions and data by more experienced micro designers a little easier and faster. As the micro talks only in Hexadecimal codes, there are only 16 numeric keys required (0-9 and A-F) plus a few operation keys such as RUN, STEP, RESET, and the like.

The digital LED type of display used in some micro kits is limited by the number of digits (usually 6 or 8) and the fact that the seven-segment type of display severely limits the number of understandable non-numeric characters which can be displayed.

It sought a low-cost, quiet, legible output device capable of displaying textual messages which were not so stylised that a layman would have difficulty in understanding them. The idea of using a video output to a TV monitor or commercial TV set is new and as it had already designed and sold several types of VDU character-generation systems, it decided to cost a minimum configuration.

---

**Several basic units**

This type of VDU contains several basic units:

**TV synchronisation signal generation.**

This part of the circuit generates the line and frame sync signals used to synchronise the ‘picture’ on the screen. It has to generate a line sync and the necessary blanking signals every 64µs and the similar frame signals every 20ms (figures refer to 625-line TVs).

Within the visible 48µs horizontal time it has to define a number of character slots and similarly define a number of character rows in each visible vertical scan.

Within each character slot it has to define a number of horizontal dots and vertical lines, each to include inter-character spaces. Each character slot has to be able to display several (in fact, 64) characters, made up from light and dark dots and lines.

A memory is required to remember the character required at each of all the possible character locations defined in the second item. This memory must be accessible by the VDU and by the MPU.

The keyboard has to be low-cost, simple to assemble and use, but still give as many character code inputs as possible. Bywood decided to run the keyboard as a 16-key block, plus four ‘mode’ keys and an interrupt key.

---

**Decoding by micro**

The decoding of the code from the key depression(s) was to be done by the micro rather than using an external encoder to save on-costs, component count and to give maximum flexibility. Thus in the end-product the designations of the keys are controlled by the software and can be labelled to user requirements.

One example uses the INT key to simulate a Carriage Return/Line Feed function used to indicate the end of a human-to-micro command string or operation. The 16-key block is used to define characters in the 64-character ASCII set and three of the mode keys define which part of the ASCII set the 16-key block defines.

In this example it is possible to enter 65 codes by use of only 20 of the 21 keys available. The keys could be re-labelled for control functions which are completely unrelated to the ASCII character set.

---

**Single address location**

To the micro the port looks like a single address location at which it can read or write data; the micro addresses the port physically by decoding an address strobe from the address bus. Any time that this

(continued on next page)
address is accessed the strobe will become active and thus inform the port that it is being accessed and should thus take appropriate action.

To the engineer and to external equipment, the port looks like an 8-bit TTL latch. When used for output, the data on the micro data bus is latched into the port and thus appears latched at the port output pins; from there onwards these outputs can be assumed to have come from any similar TTL type of device.

When used for input the port becomes an 8-bit latch presenting its inputs to the external circuitry; usually one of the inputs or an additional control pin acts as the clocking input.

**Interfacing**

Data is presented to the port inputs and latched by strobing the clock input; the data at the inputs can then be released as the data is now held in the port. At the same time the micro is informed—or finds out for itself—that there is new data in the port; it can thus 'read' the port address which will enable the port outputs to deposit their data on to the data bus and thus into the micro chip.

In applications of this type, the micro would then signal to the port that it had read the data and that the port could input some more. This sequence of "I've got some data for you", "Thank you, I've read it" is called 'Hand-shaking'.

A very simple example of interfacing to a micro via a port is the type of hand control used in TV games for 'bat position'. This is a simple potentiometer and as such cannot be understood by a port or any other TTL circuitry. To interface a potentiometer to a micro we can use a simple monostable such as a 555 timer or a 74123.

With this type of IC a trigger signal causes an output signal to change state. After a time, this output will revert to its original state, the time being set by an external capacitor and resistor network.

Taking an example of such a circuit where at one end of the travel of the potentiometer the output changes state for 100mS and at the other end the delay is 200mS, there is a variation of 100mS. The trigger of the circuit is connected to a port input. The trigger can thus trigger the monostable and then delay for a fixed time to compensate the first 100mS. If the micro then performs a program loop which reads the port input bit until the monostable output reverts to its original state, there is:

**START:** Set Trigger.
**Delay 99mS.**
**Set Count to zero.**
**LOOP:** Read input bit.
If changed go to END.
Add 1 to count.
**Delay rest of 1mS.**
Go to LOOP.
**END:** At this point count contains 0-99 which represents a setting of the potentiometer.

The count at the end can be used as a variable in a program, which can thus know the current position of the potentiometer and even its rate of change.

The potentiometer obviously can be changed for any other form of variable resistor—thermistor, LDR, pressure transducer—or in a similar manner with variable capacitance, voltage or current. Similar circuits in reverse can be used to allow a micro to output a variable voltage and thus perform such tasks as heat or speed control, or something as simple as playing tunes.

**Simple tasks**

The more usual output requirement is as a switched output, either as a pulse train or as a single ON/OFF switch. The pulsed output can be used to input the TTL-type circuitry, such as a counter chain, for use in such things as IC testing. Here the CLOCK, RESET and LOAD signals can be simulated by the micro which can also test the outputs from the counters or other ICs and thus check a PCB or a single IC much faster than a human being.

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Circle No. 141
PUPILS AT Longfield School in Kent choose to stay regularly after school hours to use the school computer. That caused a certain amount of jaw-dropping in the reporter we sent to Kent, not least because her memories of her own school-days were rather different.

Longfield is a comprehensive with 1,400 pupils aged 11 to 18; it will soon become an Upper School for 13- to 18-year-olds. What makes it unusual is its thriving computer department, characterised by a high degree of pupil participation.

In June, 1977 the school acquired an ASR33 Teletype as the first step to a link with the county computer. It was soon discovered that this was unsatisfactory. The county computer was restricted to 16 inputs at one time; timetable clashes were inevitable; the method was clearly unsuitable for mass-teaching. Children require an instant response or they lose interest.

First step

Then, while on a trip to the U.S., maths teacher Mike St John saw the Altair 880B. He promptly bought a kit and assembled it during the summer holiday. The system was completed with two cassette units and an ex-ICL 30 cps printer. On October 27, 1977 the system was up and running and the first program was keyed in—it was a program written by a sixth-former to print multiplication tables.

The next step was to obtain some paper-tape punches, the aim being to give hands-on experience to as many children as possible. Hard copy of some kind is also necessary for examinations and assessment.

The Longfield method of acquiring extra equipment is remarkable. Very little public money has been spent. Parents have been able to help, either by giving the odd roll of Teletype paper or by finding donors of equipment; it seems that banks have been very generous, which rather belies their public image.

St John explained that the school can accept anything, modifying any piece of hardware to run on its system. Not only have people been generous with materials, they have also contributed a good deal of their time. For example, an ICL engineer who lives locally carries out repairs.

The need to time-share led to the acquisition of a disc drive. Two Soroc VDUs were also bought. They were all paid for by writing software, for local businessmen and for Altair.

A payroll program was written for Altair. It was broken into modular units; the students dealt with the parts and St John put together the program. Altair credits the school account, as it is not money but hardware which is needed.

The configuration now consists of the Altair 880B (64KB memory), twin floppy disc drives, cassette units, the Teletype printer terminal, the ICL 30 cps printer, two display terminals and six off-line paper tape punches.

St John explains that he chose the Altair because of its flexibility and multi-user capability. The system can support up to eight terminals and Altair is developing software which will handle up to 20.

He would like to see a classroom of pupils each with his/her own terminal. "Less than that", he says, "is only making do."

Full of praise

He is also full of praise for the supplier's "excellent service". The response in cases of downtime has been immediate and thorough—vital where youngsters are concerned.

Installed in a classroom, the system has three functions within the school—as a study in its own right; as a service to teaching; as an administrative tool.

The computer generates remarkable enthusiasm among the students. The school offers Computer Studies at O level; there are 28 on the course. In the sixth form, 14 students take computing as a "recreational" course.

Then there is a flourishing computer club. Surprisingly for a modern comprehensive, very few girls opt for computing; the one girl whose work was mentioned was writing a recipe program.

In the computer club the pupils

(continued on next page)
examine the history and basic principles of computing. They also learn what happens inside and develop engineering skills. Visits arranged for the eager hordes include the British Science Museum, the Kent County Council mainframe, and trips to offices and factories to see and compare manual and computerised methods of administration.

All programming is done in Basic, a powerful language with the advantage of being transferable easily between systems.

The computer room impressively organised. It is run like any commercial dp department, with a job specification sheet; every group using the computer has a system of job allocation. For example, each group has an environmental control officer, librarian, systems manager, software controller, supplies officer, and even a public relations officer.

In control

The staff members involved try and stay in the background and let the pupils "fire each other with enthusiasm". Gabrielle Hayes, who teaches English, considers the appeal of programming derives from the student's feeling that he or she is in control. The atmosphere in the computer room is lively, relaxed and friendly—traditional staff-student relations have disappeared in this area of school activity.

The fact that the computer runs 12 hours every school day must be some indication of its popularity. The students spend breaks, lunch hours, and after-school time keying-in and punching.

Children often write programs at home, not as homework, but on their own initiative.

Around 6 pm St John insists the system be handed over to him and Gabrielle Hayes, so that they can work on developing the computer's second role, that of a teaching aid.

Miss Hayes first had the idea of teaching through computers when she was working with disadvantaged children. She found that the stimulus of a computer resulted in real progress. With a child of any ability, the use of a computer, especially with a VDU, increases the pupils' attention and develops powers of concentration.

Moreover, the novelty of working with a computer pays off. Children behave for the reward of a turn at the keyboard. Also, as headmaster Harold Darby points out, computers have the same potential as typewriters in encouraging English skills.

Gabrielle is working on programs to be used in teaching English. Preliminary work has been done on the teaching of spelling, a lesson, she says, which can be boring and repetitive.

Spelling lessons

In any teaching program the first step is to familiarise children with the keyboard. The spelling lesson begins with an apparently easy exercise—write the alphabet.

A second exercise involves the placing of prefixes and includes an element of reinforcement when the student is asked to select definitions for the words he or she has just constructed. In all these programs, if a student makes more than a certain number of mistakes, he or she is told by the computer to return to teacher.

As a result of using the computer, children accept that they must spell correctly—unlike a teacher, the machine does not understand approximations.

The teaching programs have already interested publishers but the staff involved express the need for more time.

The third function of the school computer is to help with administration. The school houses a branch of Barclays Bank—accounts are handled by the computer.

Course options and form lists are already computerised and it is intended to have all the school roll on the computer.

A student is writing a program for the deputy head which will cope with the time-table—listing staff, classes, and rooms.

Pictures by Longfield sixth-former David Whitehead.
Basic program to operate interface
by ROLAND PERRY

LAST MONTH we looked at the hardware interface required to convert IBM Selectric typewriters into computer terminals and the principles behind the conversion. Part II describes a program in Basic (fig A) which accepts data in ASCII form, and operates the parallel interface to the Selectric driver electronics.

FIRSTLY, a code conversion is performed, using a look-up table and then the protocol of the handshake interface is followed. The Basic is fully commented, and the reader should follow it through for both a golf-ball and a non-golf-ball operation. Subroutine 20000 is called only once to set-up the look-up table, whereas subroutine 10000 outputs each string.

Note the carriage return code added to the string in line 20. As was mentioned in Part I, the Basic is given only to describe the program structure required, as it will run at only a few characters per second, causing both a slow print speed and an unnecessary amount of wear on the printer mechanism.

The subroutine should be converted in machine code for the computer hosting the terminal, and an example (fig B) is given for the Micropolis operating system running in a 32K 8080 microprocessor. Before running the driver routines the statement "MEMEND 16R7E7F" must be used to protect the upper section of memory from the Basic User space, otherwise a large program might over-write the drivers. The look-up table occupies 7E80-7EFF and the program 7F00-7F68, plus a few overlays for the existing MDOS printer routines.

Next month: modifications to the system for use as an input device.

Figure A. The BASIC.

```
LIST
20 GOSUB 20000
20 "(4,"THIS IS A TEST"
40 GOSUB 10000
50 END

10000
10010
10020
10030
10040
10050
10060
10070
10080
10090
10100
10110
10120
10130
10140
10150
10160
10170
10180
10190
10200
10210
10220
```

The circuit diagram (figure II) printed last month was incomplete. The amended version, along with the power supply for easy reference is printed below.
IBM typewriter conversion

Figure B. The 8080 machine code.

```
0000            LIM SYS01
0040            ORG 7E00
0040            DB 00H,00H,00H,00H,00H,00H,00H,00H
0160            ORG 88H
0160            DB 0AH,0AH,0AH,0AH,0AH,0AH,0AH,0AH
0280            ORG 65H
0280            DB 0CH,0CH,0CH,0CH,0CH,0CH,0CH,0CH
0300            ORG 4AH
0300            DB 0FH,0FH,0FH,0FH,0FH,0FH,0FH,0FH
0420            ORG 2AH
0420            DB 07H,07H,07H,07H,07H,07H,07H,07H
0540            ORG 05H
0540            DB 03H,03H,03H,03H,03H,03H,03H,03H
0660            ORG 86H
0660            DB 01H,01H,01H,01H,01H,01H,01H,01H
0780            ORG 67H
0780            DB 00H,00H,00H,00H,00H,00H,00H,00H
08A0            ORG 48H
08A0            DB 0E8H,0E8H,0E8H,0E8H,0E8H,0E8H,0E8H,0E8H
```

```
TECE EE C5 9F
TECE O8 95
TECE AC 88 BE
TECE 84 EE EE
TECE 98 EE
TECE CF 04 DE
TECE 00 00 00
TECE 75 19 40
TECE 49 40 4C
TECE 06 29
TECE 64 03 00
TECE 63 49 1F
TECE 44 15
TECE 1F 00 10
TECE 7A 4E 6B
TECE 4F 08 5E
TECE 00 00 00
TECE 00 00 00
```

```
10260 IF IN(16R54)<128 THEN 10400
10230 IF C9=0 THEN 10450
10390
10360 OUT(16R54)=255
10010
10210 OUT(16R54)=254
10500
10490
10410 OUT(16R54)=255
10420 IF FRAC(IN(16R54)/2)=0 THEN 10400
20130
20110
20090
20050
20180
20000
7E8E 00
7E86 00
7E80 00
7E7E 02
7E7C 01
7E7A 00
7E78 00
7E76 00
7E74 00
7E72 00
7E70 00
```

```
7EBE 00 RA
7E66 58 50
7EA3 FC D8 A5
7E9E 00 00 00
7E96 00 00
7E90 00 00 00
7E8E 02 01
```

```
NEXT P9
DATA 16R54, 16R99, 16RC0, 16RC9, 16RED.
DATA 16R00,16R00,16R00,16R00,16R00,
DATA 16R04.16840,16810,16R00,16R00,
DATA16800,16R00,16R00,16800,
```

ASCII 8 TO 127
```
```
UP THE LOOKUP -TABLE CIF CONVERSION CODES
```

```
IBM typewriter conversion
```

```
NEXT CHARACTER
```

```
MODIFY AND JUMP IF UPPERCASE
```

```
RAISE HANDSHAKE LINE
```

```
LOOP WHILE PRINTER BUSY
```

```
OUTPUT SHIFT -TO -LOWERCASE CODE
```

```
NEXT CHARACTER
```

```
STANDIGNS UPPER CASE
```

```
```
TEST CASE BIT
```

```
```
WHICH LOWERS STROKE LINE
```

```
```
COMPLEMENT CODE, BIT 7=0
```

```
```
COMPLEMENT CODE.
```

```
```
END
```

```
```
DUMMY TO SET CONDITIONS
```

```
```
IER CODE FOR SHIFT UP
```

```
```
IER CODE FOR RO_0_0\_0"
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WITH so many varied activities in a university city, operating a computer shop demands versatility. Cambridge Computer Store provides it for a broad spread of customers.

All this and a farm feed program, too

IN Emmanuel Street, Cambridge, not far from King's College and its impressive chapel, there is a small computer shop owned by Claude Cowan, which may seem a trifle out of place.

"On the contrary, it's natural to be here", says Cowan. "Being outside London has not affected business at all; as a matter of fact, we are doing extremely well. In Cambridge we have some of the finest physics and maths laboratories in the world. The university also has a computer laboratory where extensive software and hardware development is taking place. Cambridge is a fertile area for computing activity, and I could not consider being anywhere else!"

So be it. Cowan obviously must be sure of himself. His background stretches from university days when he graduated in electronics. Since then, he has worked as a systems engineer with extensive involvement in VDUs and now runs his shop while, at the same time, acting as a computer consultant.

How did he become involved with microcomputers? "I was thrown into it", he says.

His shop, before it became Cambridge Computer Store, started as a modest Tandy electronics outlet in November, 1975. It sold assorted audio hi-fi equipment, calculators, hobbyist electronic kits and a selection of electronic components, such as resistors, transistors and capacitors.

Gradual expansion

The shop expanded gradually, offering a wider range of electronic equipment, and microcomputers followed. Soon afterwards, a separate department evolved within the Tandy store until it changed its name to Cambridge Computer Store.

"It all happened rather suddenly", says Cowan. "What many people do not realise is that even though micros are just breaking the ice in this country, computing has been going on for a long time. There has been a large amount of research devoted to the subject and a great deal of it is taking place right here - in Cambridge."

One would tend to think that being in the "centre ring" of computer activity demands certain exceptional qualifications. Cowan feels he has them. He stresses the importance of being able to offer the customer what he calls 'a professional level of support'.

"When someone enters the shop, whether a beginner, businessman, student, hobbyist or professional, we want him to feel comfortable. Our shop is small. We carry three systems - Apple II, Tandy TRS-80 and North Star Horizon - but we find each system to be an excellent choice for a particular market. The Apple II is an excellent machine for educational purposes, while the North Star system acts as a powerful business machine."

Tandy is favourite

"The Tandy TRS-80 is our favourite and works well in education, business, home use and recently in farming for which we have developed a software program, Farm Rationing."

Cowan has written a program which determines proper rations of feed for dairy cattle. It has two parts. The first is Ration Formulation which allows the operator to prepare a trial ration. He does this by selecting 13 ingredients, like wheat, corn, barley and maize from a possible 25 to make up a particular ration of feed for his cattle. When he has chosen the ingredients and decided he has enough for a trial ration, he enters the cost of each ingredient, as well as the amount and the formulation program, and begins to produce a trial ration analysis.

The analysis shows the operator the resulting chemical percentage composition, the energy content and the cost of the trial ration. The results are displayed instantly on the screen and if this is not the optimised ration - not enough energy or too high a cost - the operator can alter the mixture until he has the desired ration. When he is satisfied, the program calculates the mixture and cost of the ration, and displays the results on the screen.

The second part is the budget forecast which prepares a schedule of ingredient requirements which will be needed over a six-month period. It can cover a herd of cattle and divide the herd into groups. Each group may require a different ration, since groups of cattle calve at different times.

In turn, each group goes through a cycle of rations. The program can also account for ration changes which may no longer be optimum in any particular group.

The program takes all information week by week for each particular group and works out the weekly requirement of each ingredient and also the total requirement over a six-month period.

This is an excellent example of the full use of a micro system such as the Tandy TRS-80 video screen. The file storage capability of the machine is used for recording chemical cost and energy content and its high-speed processing power carries-out ingredient analysis using three-dimensional array multiplication.

More development

Farm rationing requires a tremendous amount of computation. By more usual means, it would take at least a day or two. Using the micro program it is completed in five or six minutes. The program is in use and working effectively at Attleborough Dairy Farms in Norfolk.

Cowan speaks highly of the Tandy TRS-80. He sees it as a "fine piece of design with excellent, serious application use."

The shop plans to do more software development and has already added a full-time programmer to the staff to work on the Tandy and the Apple II.

Anyone is welcome to visit the shop for hands-on experience. It offers a variety of interesting demonstrations with a good selection of books and magazines, and most important of all, has professional experience.
WE LOOK at an idea this month for a game called Warlock Warren and detail an approach to setting it up on your system.

Warlock Warren

by T. J. Radford

"SOMEBWHERE nearby is Colossal Cave, where others have found fortunes in treasure and gold, though it is said that some who enter are never seen again. Magic is said to work in the cave. I will be your eyes and hands. Direct me with commands of one or two words."

I know of places, actions and things. Most of my vocabulary describes places and is used to move you there. To move, try words like forest, building, downtown, enter, East, West, North, South, up, or down. I know about a few special objects hidden in the cave. These objects can be manipulated using some of the action words I know.

"The objects have side effects, for instance, the rod scares the bird. Usually people having trouble moving just need to try a few more words. Usually people trying unsuccessfully to manipulate an object are attempting something beyond their capabilities and should try a completely different tack."

"You are standing at the end of a road before a small brick building. Around you is a forest. A small stream flows out of the building and down a gulley."

Thus reads the preamble to Adventure, a standard format residing on Digital.

D&D element

Cognoscenti of the games world will recognise an element of Dungeons and Dragons (D&D) in the invitation. Indeed, the lineage of Warlock Warren has the fantasy-role-playing class of games at its head.

D&D games have a free format in which players select the character they wish to assume and form an expedition party to seek adventure and treasure in a labyrinth of dungeons. The dungeons are devised by a gamesmaster, who does not do any exploring himself, but instead takes the part of umpire, or god.

In his design, the gamesmaster incorporates various undisclosed rules. During the game he describes to the players the situation in which they find themselves. They then decide what to do, using their imagination to any degree they choose, and he informs them of the outcome of their actions.

The gamesmaster's function includes a considerable amount of book-keeping and he is usually aided by dice of various "sidedness" and a pocket calculator. D&D has a wide and often fanatical following.

Here our geneology divides. In one branch of the family, computers are introduced to assume the role of gamesmaster. In the other, standard formats for the description of dungeons, characters and events are used to obviate the need for the gamesmaster entirely.

The first of the branches contains, among others, the game Adventure, originating at Stanford Research Institute. As indicated in the preamble to the program, the user is placed near a cave which he must locate and explore. There are hazards to overcome and there is treasure to collect.

Meeting strangers

The program, like the D&D gamesmaster, describes to the user the situation he is in and he must guess the best action to take. For instance, at one point he is confronted by a snake. If he has caught the bird, encountered earlier, releasing it at this point drives away the snake.

The same ploy is applied to the dragon guarding the Persian carpet, results in the poor bird being reduced to a cinder. The dragon has to be overcome bare-handed.

The other branch of the family includes an interesting games called Sorcerer's Cave. Again, the theme is the exploration of a cave. Unlike other games in this category, the cave is not predetermined.

By means of a large pack of "cave cards", the cave grows as it is explored. Each player, in his turn, chooses a direction to explore, takes a cave card from the face-down pack and places it in the chosen position.

A second pack of cards is used to reveal the presence of treasure, artifacts or "strangers", or may imply some random event, such as a cave-in which blocks the retreat.

A complex system of rules governs how strangers may be treated, what treasure may be carried, the use of artifacts and the interaction between players.

The two cognate lines meet again at the program here proposed. Both Adventure and Sorcerer's Cave can be fascinating and very distracting. A disadvantage of Adventure is that the cave is fixed. Once it has been explored fully and all the points have been gleaned, its interest wanes. All one can do is to try to obtain another program in the same family.

Another disadvantage is that it is strictly solitary, omitting all element of competition. The Sorcerer's Cave format suffers from neither of those deficiencies.

The game equipment, however, is somewhat unwieldy. Players find themselves crawling around large areas of floor, trying not to step on the cave cards.

Warlock Warren is intended to eliminate those disadvantages, largely using the format of Sorcerer's Cave, but applying the computer to the task of manipulating and displaying the game equipment.

Scenario

The warren is a series of caves created by a warlock as a repository for his ill-gotten gains. There, treasure and potent artifacts are guarded by a variety of creatures, though not all of these are the warlock's minions. Players form separate parties and set out to explore the caves.

In the course of exploration, "strangers" may be encountered, who may choose to join the search party. Each member of the party may carry a certain amount of treasure and any number of artifacts. Points are associated with all beings in the party and all treasure and artifacts. The player to regain the surface with the most points wins.

The program begins by asking for a list of the opponents' names and chosen colours. It allocates randomly the playing order and then asks each player in turn to select the composition of his party. This is done using a "menu", the player entering the numbers which correspond to the beings chosen.

Once the search parties are constituted, the game proper begins. Each player in turn is shown a map of the level on which his party is located, initially the first level. The map displays only that part of the level which has already been discovered and indicates the position of any party on the level, by colour.

Figure 1 shows a portion of such a map. Beneath the map, the lines of text will summarise the status of the current player's party, giving the number of (continued on next page)
beings in the party, their total physical strength, magical strength and spare carrying capacity.

There may be up to six exits from the location—North, South, East, West, up or down. The player may indicate the direction in which he wants to move by entering the appropriate initial letter.

Regular grid

The warren exists on a regular grid. Grid points can be either caverns or the tunnels which serve to connect caverns. Strangers, treasure and artifacts are found only in caverns and the few random events which may afflict a party can occur only on entry to a cavern.

If the section entered is a cavern, the turn continues. Any random event happens immediately.

Random events are relatively rare and once they are dealt with, a summary of the contents of the cavern is added to the text lines, giving the number of strangers present, their total physical and magical strengths, the probabilities of their being friendly, indifferent or hostile, respectively, the total value and weight of any treasure, and the number of artifacts.

The player may obtain a complete description of everything in the cavern by entering the command MAGNIFY. All commands are entered by initial letter.

The player may elect to GREET any beings encountered. The program determines their reaction based on the probabilities of their being friendly, indifferent or hostile. If they are friendly, they join the party. If they are indifferent, the turn ends and the player has the same options on his following turn. If they are hostile, combat ensues.

The player may choose to engage the strangers in combat, issuing the ATTACK command. The opposing lines are drawn up and the program determines the result of the combat. Any strangers surviving the onslaught remain hostile to the party and must be destroyed before any treasure may be taken. They may be attacked again on the following turn.

Certain artifacts may be deployed in combat, although some of them may be used only once during the game, after which their associated points will not be included in the final tally.

The player may choose to RETREAT from a strong group of strangers. This is done on the same turn as he entered the cavern, and the player must leave by the way he went in.

If there are no strangers present, or they have all joined the party or been killed, the CARRY command may be given. Any being in the party with spare carrying capacity may be assigned treasure and artifacts.

It is anticipated that most of the code will be written in Basic. Some of the details of representation, however, are at bit level and certain routines will thus have to be implemented at machine level. All frequently-performed routine tasks preferably should be written at low level as well.

One such task is the generation of random numbers, which are used to determine warren topology, cavern occupancy and combat results. This will employ a standard modulo-arithmetic, psuedo-random number generator.

The programming of WW breaks-down naturally into six sections. They are concerned with the topology of the warren, random events, the contents of the caverns, combat resolution, various extra commands and overall control.

The representation of the warren must define the connectivity of the cave and permit discrimination between tunnels and caverns. As the cells lie on a regular, three-dimensional grid, the warren can be represented by an array. Each element need indicate only whether or not the cell has yet been opened, and if so, whether the cell is a cavern or a tunnel, and in which directions movement is permitted. This information can be contained in a single byte, as follows.

<table>
<thead>
<tr>
<th>Bit</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>Area previously explored (bit set).</td>
</tr>
<tr>
<td>6</td>
<td>Cavern (set)/Tunnel (clear).</td>
</tr>
<tr>
<td>5</td>
<td>North</td>
</tr>
<tr>
<td>4</td>
<td>South</td>
</tr>
<tr>
<td>3</td>
<td>East</td>
</tr>
<tr>
<td>2</td>
<td>West</td>
</tr>
<tr>
<td>1</td>
<td>Up</td>
</tr>
<tr>
<td>0</td>
<td>Down</td>
</tr>
</tbody>
</table>

The total size of the warren depends ultimately on the amount of memory available. Another consideration is that certain entities have a certain reference to their location, and it might be desirable to limit the warren size to four levels, each of eight cells by eight. This would permit location information to be contained in a single byte.

For display purposes, each cell will occupy $5 \times 5$ colour-coded display points. The two kinds of cell are shown in figure 2. Green points represent space and blue points represent rock. Stairs occur only in tunnels and are red points. Their position in the display indicates their direction. The cells in figure 2 have all ways open. Closed ways are depicted as rock, thus the

(continued on next page)
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---

### Two kinds of event

There are two kinds of event. Some have immediate effect only, while others remain latent in the cavern and affect any party to venture that way. For example, a cave-in modifies the cave topology, creating an impassable cell, and is therefore inactive, although the modification is permanent. A trap, however, remains in the cell in which it occurred, affecting all parties which enter.

When a party enters a new cavern, the program determines whether or not a random event is sprung. The probability is low, but if so, it then determines which event it is. A small array is used to record the location of recurring events. This array is consulted every time a party enters a cavern and the appropriate subroutine is applied whenever indicated.

When a cavern is entered for the first time, its contents are determined. It may be occupied by a collection of creatures, treasure and artifacts. The number of occupants will correspond to the level on which the cavern is located.

The information required about the creatures and objects can be separated into specific information about each one, and general information about classes or types. The specific information needed is the location and state of each entity. The state of an artifact or piece of treasure refers to the creature carrying the object. The state of a creature is a byte carrying the following information:

- **Bits**
  - 7-6: Function
  - 5: Party in which creature travels
  - 4: Creature dead
  - 3: Creature asleep
  - 3-0: One bit per player: Creature hostile if bit set

The general information held about each type of creature or object is tabulated:

<table>
<thead>
<tr>
<th>Creatures</th>
<th>Name</th>
<th>Points</th>
<th>Identifying string</th>
<th>Contribution to the final tally</th>
</tr>
</thead>
</table>

---

(continued from previous page)
Games

(continued from previous page)

Friendly  Probability of being friendly.
Indifferent Probability of being indifferent.
Hostile  Probability of being hostile.
Strength  Normal combat strength.
Magic  Magical strength.
Capacity  Weight creature may carry.
Selection  Selection value in initial party composition.
Treasure  Identifying string.
Points  Contribution to final tally.
Weight  Load on carrying creature.
Artifacts  Identifying string.
Name  Contribution to final tally.
Combat  Contribution to combat, if applied.
Greeting  Contribution to befriending strangers.
Shots  Number of applications allowed.

Three arrays will hold the general information for creatures, treasure and artifacts respectively. A fourth will hold the specific information for all creatures and objects, in three-byte units. The first of the bytes will indicate the type, referring to an element of one of the arrays, and the others will hold the location and state. Numbers will be limited by memory considerations to about 85 entities in all.

Combat is resolved in terms of individual strengths. If both sides are of the same size, the opposing creatures are paired and each individual conflict is resolved independently. If one side is larger than the other, some of the skirmishes will be fought two against one.

No more than two creatures may fight a single creature, except that creatures with magical power may wield it from behind the lines, providing that they are not in the front line themselves.

Artifacts may be brought to bear in particular quarrels and some may influence the entire battle, applying to each individual conflict. The total combat points applied in any face-off, augmented by small, random "bonus" points given to each side, are compared. The side with the higher number of points wins and one of their immediate opponents is killed. Each group in the battle is dealt with this way. When a party engages in combat with a group of strangers, the strangers should align to their best advantage. To program this kind of requirement is usually awkward and space-consuming.

Other commands may be given at appropriate points, to accomplish certain operations. For instance, it may be desirable to re-distribute the object carried by members of the party. The LUGGAGE command facilitates this. To determine totals at the end of a game, the TALLY command is used, although this will happen automatically once all the players have left the warren.

Certain artifacts have associated commands which accomplish special feats. A magic carpet can FLY the party to any part of the warren, just once. The magic flute will lull certain creatures to sleep. The code associated with such commands will first check that the artifact is carried by a member of the party.

*T. J. Radford was a runner-up in our Apple competition.

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CHAPTER 3

THIS MAKES BASIC OBEY A SEQUENCE OF INSTRUCTIONS AGAIN & AGAIN

WE CALL THIS SEQUENCE A LOOP.

YOU CAN CREATE A LOOP BY SETTING A "COUNTER" (LET M = 3)
THEN SUCCESSIVELY DEDUCTING 1 (LET M = M-1)
TESTING THE REMAINING VALUE (IF M<>0),
AND "LOOPING" BACK (THEN 20) UNTIL THE COUNTER RUNS OUT.

BUT THE SAME RESULT MAY BE ACHIEVED MORE SIMPLY AS SHOWN HERE:

THE FORM OF THE INSTRUCTION IS:

ANY NUMERICAL VARIABLE
EXPRESSIONS OF ANY COMPLEXITY HERE

10 FOR M = 3 TO 1 STEP -1
20 READ X$ 30 PRINT M;X$ 40 LET M=M-1 50 IF M<>0 THEN 20 60 DATA "HENS", "DOVES", "PARTRIDGE"
70 DATA "PEAR TREE"
80 END

RUN
3 HENS
2 DOVES
1 PARTRIDGE
PEAR TREE

BUT THE SAME RESULT MAY BE ACHIEVED MORE SIMPLY AS SHOWN HERE:

THE FORM OF THE INSTRUCTION IS:

ANY NUMERICAL VARIABLE
EXPRESSIONS OF ANY COMPLEXITY HERE

10 FOR M = 3 TO 1 STEP -1
20 READ X$ 30 PRINT M;X$ 40 LET M=M-1 50 IF M<>0 THEN 20 60 DATA "HENS", "DOVES", "PARTRIDGE"
70 DATA "PEAR TREE"
80 END

RUN
3 HENS
2 DOVES
1 PARTRIDGE
PEAR TREE

YOU MAY JUMP OUT OF A LOOP:

DON'T ASSUME ANYTHING ABOUT THE VALUE OF THE LOOPING VARIABLE (L ABOVE) IF YOU JUMP OUT OF A LOOP BEFORE THE LOOP HAS RUN ITS COURSE. BUT IF YOU DROP OUT AT THE BOTTOM (IN THIS CASE TO LINE 110) THEN THE LOOPING VARIABLE (L ABOVE) MAY BE DIFFERENT THAN THE VALUE IT HAD AT THE TOP (IN THIS CASE 1). THIS IS EXPLAINED OVERLEAF.

ILLUSTRATING BASIC PAGE 43
CHAPTER 3

**FOR-NEXT**

This makes BASIC obey a sequence of instructions again and again. We call this sequence a **LOOP**.

You can create a loop by setting a "counter" (let \( M = 3 \)) then successively deducting 1 (let \( M = M - 1 \)) testing the remaining value (if \( M > 0 \)), and "looping" back (then 20) until the counter runs out.

But the same result may be achieved more simply as shown here.

\[
\begin{align*}
10 & \text{LET } M = 3 \\
20 & \text{READ } X$
\end{align*}
\]

**THE FORM OF THE INSTRUCTION IS**

\[
\begin{align*}
10 & \text{FOR } M = 3 \text{ TO } 1 \text{ STEP } -1 \\
20 & \text{READ } X$
\end{align*}
\]

If the step is +1 then you may simplify by omitting "STEP 1".

\[
\begin{align*}
100 & \text{FOR } N = P \text{ TO } Q
\end{align*}
\]

Illustrating BASIC Page 48

**Loops May Be Nested One Inside the Other**

There is always some limit to the permissible depth of nesting. A typical limit is about 10 which is ample depth for even the most complicated program.

Loops must not be interleaved.

Illustrating BASIC Page 49
CHAPETER

You should never jump into the middle of a loop:

```
120 IF A > 2 THEN 210
210 PRINT "*";
220 NEXT I
230 LET A = A - 1
```

But in most basics you may jump out of a loop and then back in again (not a very good practice).

```
150 FOR I = 1 TO 6
160 READ M$
170 IF M$ = "N" THEN 300
180 NEXT I
300 PRINT M$
310 GO TO 180
```

The jargon for this is a loop with extended range.

In general you should enter a loop through its "FOR" statement and either:
- Fall through at the "NEXT"; or
- Jump out and stay out.

If you need extended range then achieve it using the "GO SUB" instruction described on page 52.

If a program is not supposed to execute a loop at all under certain conditions then it is safest to test for those conditions, and if they apply, to avoid the loop altogether.

```
10 FOR V = 1 TO 5
20 READ C
30 PRINT C;
40 IF C <= 0 THEN 80
50 IF R = 1 TO C
60 PRINT "*";
70 NEXT R
80 PRINT
90 NEXT I
100 DATA 3, 0, -1, 4, 1
110 END
```

Although the concept seems simple there are hidden dangers with loops; different basics deal with them differently. Here is the interpretation in more than one standard basic.

Consider this loop:

```
10 FOR V = 1 TO 2 STEP 5
20 LET A, Z & B COULD BE COMPLICATED EXPRESSIONS
210 LET A = A - 1
```

The interpretation involves 3 variables which BASIC itself can use but which you, the user, can neither refer to nor change. Call them:

MARS VENUS & FISH

The interpretation involves 3 variables which BASIC itself can use but which you, the user, can neither refer to nor change. Call them:

MARS VENUS & FISH

In the loop "FOR V = 1 TO 3" becomes successively -2, -1, 0 then +1 on exit.

```
LET V = A
LET U = Z
LET F = S
```

```
EXECUTE BODY DOWN TO "NEXT V"
```

This logic implies no matter what changes you make to A, Z, or S in the body of the loop it will not affect the number of times round the loop. But you should never change the value of V in the body of the loop.

Remembering that many basics don't use this logic, never change anything in the body that could alter the value of V, A, Z or S. Keep the controls simple!
**Chapter 3**

**Loops (continued)**

**You should never jump into the middle of a loop:**

```
120 IF A > 2 THEN 210
200 FOR I = 1 TO 6
210 PRINT "*";
220 NEXT I
230 LET A = A - 1
```

BASIC would not obey a "NEXT" if it had not previously obeyed the matching "FOR".

But in most BASICs you may jump out of a loop and then back in again (not a very good practice).

```
150 FOR I = 1 TO 6
160 READ M$
170 IF M$ = N$ THEN 300
180 NEXT I
200 PRINT M$
210 GO TO 180
```

**The jargon for this is a loop with extended range.**

**In general you should enter a loop through its "FOR" statement and either:**

- Fall through at the "NEXT"; or
- Jump out and stay out.

If you need extended range then achieve it using the "GO SUB" instruction described on page 52.

If a program is not supposed to execute a loop at all under certain conditions then it is safest to test for those conditions and, if they apply, to avoid the loop altogether.

```
10 FOR I = 1 TO 5
20 READ C
30 PRINT C;
40 IF C < 0 THEN 80
50 FOR R = 1 TO C
60 PRINT "*";
70 NEXT R
80 PRINT I
90 NEXT I
100 DATA 3, 0, -1, 4, 1
110 END
```

**The reason for this precaution is given opposite.**

**Although the concept seems simple there are hidden dangers with loops; different BASICs deal with them differently. Here is the interpretation in more than one standard BASIC.**

**Consider this loop:**

```
10 FOR V = A TO Z STEP 5
40 NEXT V
```

Where A, Z & B could be complicated expressions.

The interpretation involves 3 variables which Basic itself can use but which you, the user, can neither refer to nor change. Call them:

| Mars | Venus | Fish |

The body of the loop is parsed as follows:

- `LET V = A`
- `LET Z = Z + 5`
- `LET S = S - 5`

`FOR V = 1 TO 3" becomes successively `-2, -1, 0` then `+1` on exit.

**This logic implies no matter what changes you make to A, Z or S in the body of the loop it will not affect the number of times round the loop. But you should never change the value of V in the body of the loop.**

Remembering that many BASICs don't use this logic, never change anything in the body that could alter the value of V, A, Z or S. Keep the controls simple!
IN MANY PROGRAMS A PARTICULAR SEQUENCE OF INSTRUCTIONS OCCURS SEVERAL TIMES. IN SUCH CASES YOU DON'T HAVE TO REPRODUCE THAT SEQUENCE SEVERAL TIMES; YOU MAY PARCEL IT UP AS A SUBROUTINE AND SIMPLY GO TO THAT SUBROUTINE FROM ANY LINE IN THE PROGRAM AND RETURN TO THE PLACE FROM WHENCE YOU CAME.

THE PROGRAM CALLED “OLD GLORY” ON PAGE 49 HAS A SEQUENCE OCCURRING THREE TIMES WHICH COULD BE PARCELLED UP AS A SUBROUTINE;

```
10 PRINT "OLD GLORY WITH GO SUB & RETURN"
20 FOR R = 1 TO 3
30 LET P$ = "*
40 IF R = 1 THEN 70
50 LET P$ = "*
60 LET B = 8
70 GO SUB 300
80 IF R - 2 * INT(R/2) = 0 THEN 130
90 GO SUB 300
100 LET B = 12
110 LET P$ = "*
120 GO SUB 300
130 PRINT
140 NEXT R
150 FOR R = 1 TO 3
160 PRINT
170 LET B = 20
180 GO SUB 300
190 PRINT
200 NEXT R
210 GO TO 900
```

AND THE PROGRAM “OLD GLORY” RE-CAST LIKE THIS:

```
10 PRINT "OLD GLORY WITH GO SUB & RETURN"
20 FOR R = 1 TO 7
30 LET P$ = "*
40 IF R = 1 THEN 70
50 LET P$ = "*
60 LET B = 8
70 GO SUB 300
80 IF R - 2 * INT(R/2) = 0 THEN 130
90 GO SUB 300
100 LET B = 12
110 LET P$ = "*
120 GO SUB 300
130 PRINT
140 NEXT R
150 FOR R = 1 TO 3
160 PRINT
170 LET B = 20
180 GO SUB 300
190 PRINT
200 NEXT R
210 GO TO 900
```

```
80 GO SUB 300
90
300 SUBROUTINE WITH ONE OR MORE "RETURN" STATEMENTS SENDS CONTROL BACK TO THE LINE IMMEDIATELY FOLLOWING "GO SUB". 340 RETURN
```

"GO SUB" MAY BE ANYWHERE IN THE PROGRAM; THE SUBROUTINE BEING CALLED MAY ALSO BE ANYWHERE (; NOT NECESSARILY ON HIGHER-NUMBERED LINES ). YOU NEED CAREFUL ORGANIZATION TO PREVENT AN IMPOSSIBLE TANGLE.

A FEW BASICS ALLOW DUMMY PARAMETERS IN A SUBROUTINE. ( THEY WORK IN THE MANNER EXPLAINED ON PAGE 26 IN CONNECTION WITH DUMMY ARGUMENTS OF FUNCTIONS — HERE AGAIN DETAILS VARY A LOT FROM BASIC TO BASIC AND YOU SHOULDN'T USE DUMMY PARAMETERS IF YOU WANT “PORTABLE” PROGRAMS .

TAKE CARE NOT TO “FALL” INTO A SUBROUTINE BY ACCIDENT. NOTICE LINE 720 OPPOSITE: IF THIS WERE OMITTED THERE WOULD BE SUCH A “FALL”.

CONTINUED OVERLEAF.
In many programs a particular sequence of instructions occurs several times. In such cases you don't have to reproduce that sequence several times; you may parcel it up as a subroutine and simply go to that subroutine from any line in the program and return to the place from whence you came.

The program called "Old Glory" on page 49 has a sequence occurring three times which could be parcelled up as a subroutine:

```plaintext
100 REM subroutine with B & P$
310 FOR I = 1 TO B
320 PRINT P$
330 NEXT I
340 RETURN
```

And the program "Old Glory" re-cast like this:

```plaintext
10 PRINT "Old Glory with Go Sub & Return"
20 FOR R = 1 TO 7
30 LET P$ = " "
40 IF R = 1 THEN 70
50 LET P$ = "+" Go to 300 returns to 90
70 LET B = 8
80 GO SUB 300
90 IF R - 2*INT(R/2) = 0 THEN 130
100 LET B = 12
110 LET P$ = "/"
120 GO SUB 300
130 PRINT
140 NEXT R
150 FOR R = 1 TO 3
160 PRINT
170 LET B = 20
180 GO SUB 300
200 PRINT
210 NEXT R
220 GO TO 300
900 END
```

"Go Sub" may be anywhere in the program; the subroutine being called may also be anywhere (not necessarily on higher-numbered lines). You need careful organization to prevent an impossible tangle.

A few basics allow dummy parameters in a subroutine. (They work in the manner explained on page 26 in connection with dummy arguments of functions.) Here again details vary a lot from BASIC to BASIC and you shouldn't use dummy parameters if you want "portable" programs.

Take care not to "fall" into a subroutine by accident. Notice line 720 opposite; if this were omitted there would be such a "fall".

Continued overleaf.
NOVICES TO PROGRAMMING MAY CARE TO SKIP THIS DOUBLE PAGE THE FIRST TIME THROUGH THE BOOK

"GO SUB" MAY APPEAR ANYWHERE IN A PROGRAM; LIKewise THE SUBROUTINE BEING CALLED MAY BE ANYWHERE. BASIC HAS No SURE WAY OF ASSOCIATING A "RETURN" WITH THE PARTICULAR "GO SUB" OF YOUR INTENTION. IT'S NOT LIKE "FOR V = FOLLOWED BY "NEXT V" WHERE THE "V" MAKES THE ASSOCIATION CLEAR. SO WE DESCRIBE BELOW HOW BASIC IS ABLE TO MAKE SUCH AN ASSOCIATION.

SOME BASIC/Ss DEAL WITH "GO SUB" By A TECHNIQUE CALLED STACKING. THE STACK WORKS LIKE THIS:

WHEN BASIC MEETS "GO SUB" IT NOTES THE NUMBER OF THE LINE IMMEDIATELY FOLLOWING "GO SUB" AND PUTS THIS NUMBER ON THE TOP OF THE STACK; THEN CONTROL GOES TO THE LINE NOMINATED AFTER "GO SUB".

WHEN BASIC MEETS A "RETURN" IT SIMPLY LOOKS AT THE NUMBER CURRENTLY AT THE TOP OF THE STACK; GOES STRAIGHT TO THE LINE HAVING THAT NUMBER; THEN THROWS AWAY THAT NUMBER FROM THE TOP OF THE STACK.

THIS LOGIC IMPLIES THAT IF BASIC MEETS A "RETURN" BEFORE THE VERY FIRST "GO SUB" THEN THERE WILL BE AN EMPTY STACK, HENCE NOWHERE TO GO TO "FALL" INTO A SUBROUTINE. ON THE OTHER HAND BASIC MAY KEEP MEETING "GO SUB" BUT NOT ENOUGH "RETURNS" RESULTING IN THE STACK FILLING TO CAPACITY (WHICH VARIES FROM BASIC TO BASIC BUT IS TYPICALLY 10).

ALTHOUGH NOT ALL BASICS USE THIS PRECISE MECHANISM FOR HANDLING "GO SUB" YOU MAY THINK OF IT THIS WAY WHEN TESTING THE PROPOSED LOGIC OF A PROGRAM YOU ARE GOING TO WRITE; WHEN TRACKING DOWN BUZZS IN A PROGRAM; AND WHEN TRYING TO FIGURE OUT THE LOGIC OF SOMEONE ELSE'S PROGRAM.

WHETHER OR NOT YOUR OWN BASIC HANDLES "GO SUB" USING A STACK IS ONLY IMPORTANT IF YOU WRITE A SUBROUTINE THAT CALLS ITSELF. THIS IS KNOWN AS RECURSion AND IS ONLY FEASIBLE WITH THE LOGIC OF THE STACK EXPLAINED ABOVE.

THE STACK SHOWS THAT THE LAST "GO SUB" TO BE OBEYED IS THE SAME AS THE PREVIOUS ONE, INDICATING THAT A SUBROUTINE HAS JUST CALLED ITSELF DIRECTLY. EARLIER A SUBROUTINE HAD CALLED ANOTHER WHICH, IN TURN, HAD CALLED THE FIRST ONE AS SHOWN BY THE * ON THE PICTURE. THUS A SUBROUTINE HAD CALLED ITSELF INDIRECTLY.

YOU MAY DISCOVER IF YOUR VERSION OF BASIC ALLOWS SUBROUTINES TO CALL THEMSELVES, TRY THE FOLLOWING LITTLE PROGRAM WHICH FINDS THE HIGHEST COMMON FACTOR OF TWO NUMBERS BY EUCLID'S METHOD.

```
10 PRINT "TYPE 2 POSITIVE INTEGERS"
20 INPUT M,N
30 GO SUB 70
40 PRINT M*N
50 GO TO 140
60 REM END OF PROGRAM
70 REM START OF SUBROUTINE
80 LET P=N
90 LET N=M-N*INT(M/N)
100 IF N=0 THEN 130
110 LET M=P
120 GO SUB 70
130 RETURN
140 END
```

IF YOUR BASIC ACCEPTS THE PROGRAM WITHOUT ANY ALTERATION TO LINE 120 THEN YOU MAY EXPERIMENT TO FIND THE LIMITING HEIGHT OF THE STACK; THUS IF YOU TYPE 85,204 THE PROGRAM WILL PRINT THE RESULT WHICH IS 17. BUT IF YOU TYPE 85,289 THEN THE ALLOWABLE STACKING HEIGHT WILL PROBABLY BE EXCEEDED ALTHOUGH THE ANSWER IS STILL 17.

TRY "PLAYING COMPUTERS" USING PENCIL, PAPER AND POCKET CALCULATOR. THIS SHOULD REVEAL EUCLID'S METHOD AND ALSO SHOW HOW THE STACK BUILDs UP AND COLLAPSES.
NOVICES TO PROGRAMMING MAY CARE TO SKIP THIS DOUBLE PAGE THE FIRST TIME THROUGH THE BOOK.

"GO SUB" MAY APPEAR ANYWHERE IN A PROGRAM; LIKEWISE THE SUBROUTINE BEING CALLED MAY BE ANYWHERE. BASIC HAS NO SURE WAY OF ASSOCIATING A "RETURN" WITH THE PARTICULAR "GO SUB" OF YOUR INTENTION. IT'S NOT LIKE "FOR V = " FOLLOWED BY "NEXT V" WHERE THE "V" MAKES THE ASSOCIATION CLEAR. SO WE DESCRIBE BELOW HOW BASIC IS ABLE TO MAKE SUCH AN ASSOCIATION.

SOME BASIC'S DEAL WITH "GO SUB" BY A TECHNIQUE CALLED STACKING. THE STACK WORKS LIKE THIS:

WHEN BASIC MEETS "GO SUB" IT NOTES THE NUMBER OF THE LINE IMMEDIATELY FOLLOWING "GO SUB" AND PUTS THIS NUMBER ON THE TOP OF THE STACK. THEN CONTROL GOES TO THE LINE NOMINATED AFTER "GO SUB".

WHEN BASIC MEETS A "RETURN" IT SIMPLY LOOKS AT THE NUMBER CURRENTLY AT THE TOP OF THE STACK, GOES STRAIGHT TO THE LINE HAVING THAT NUMBER, THEN TAKES AWAY THAT NUMBER FROM THE TOP OF THE STACK.

THIS LOGIC IMPLIES THAT IF BASIC MEETS A "RETURN" BEFORE THE VERY FIRST "GO SUB", THEN THERE WILL BE AN EMPTY STACK, HENCE NOWHERE TO GO "FALL" INTO A SUBROUTINE. ON THE OTHER HAND BASIC MAY KEEP MEETING "GO SUB" BUT NOT ENOUGH "RETURNS" RESULTING IN THE STACK FILLING TO CAPACITY (WHICH VARIES FROM BASIC TO BASIC BUT IS TYPICALLY 10).

ALTHOUGH NOT ALL BASIC'S USE THIS PRECISE MECHANISM FOR HANDLING "GO SUB" YOU MAY THINK OF IT THIS WAY WHEN TESTING THE PROPOSED LOGIC OF A PROGRAM YOU ARE GOING TO WRITE, WHEN TRACKING DOWN BUGS IN A PROGRAM, AND WHEN TRYING TO FIGURE OUT THE LOGIC OF SOMEONE ELSE'S PROGRAM.

WHETHER OR NOT YOUR OWN BASIC HANDLES "GO SUB" USING A STACK IS ONLY IMPORTANT IF YOU WRITE A SUBROUTINE THAT CALLS ITSELF. THIS IS KNOWN AS RECURSION AND IS ONLY FEASIBLE WITH THE LOGIC OF THE STACK EXPLAINED ABOVE.

ILLUSTRATING BASIC PAGE 54

THE STACK SHOWS THAT THE LAST "GO SUB" TO BE OBEYED IS THE SAME AS THE PREVIOUS ONE INDICATING THAT A SUBROUTINE HAS JUST CALLED ITSELF DIRECTLY. EARLIER A SUBROUTINE HAD CALLED ANOTHER WHICH IN TURN HAD CALLED THE FIRST ONE AS SHOWN BY THE * ON THE PICTURE. Thus A SUBROUTINE HAD CALLED ITSELF INDIRECTLY.

YOU MAY DISCOVER IF YOUR VERSION OF BASIC ALLOWS SUBROUTINES TO CALL THEMSELVES, TRY THE FOLLOWING LITTLE PROGRAM WHICH FINDS THE HIGHEST COMMON FACTOR OF TWO NUMBERS BY EUCLID'S METHOD.

IF YOUR BASIC ACCEPTS THE PROGRAM WITHOUT ANY ALTERATION TO LINE 120 THEN YOU MAY EXPERIMENT TO FIND THE LIMITING HEIGHT OF THE STACK. Thus IF YOU TYPE 85, 204 THE PROGRAM WILL PRINT THE RESULT WHICH IS 17. BUT IF YOU TYPE 85, 289 THEN THE ALLOWABLE STACKING HEIGHT WILL PROBABLY BE EXCEEDED ALTHOUGH THE ANSWER IS STILL 17.

TRY "PLAYING COMPUTERS" USING PENCIL, PAPER AND POCKET CALCULATOR. THIS SHOULD REVEAL EUCLID'S METHOD AND ALSO SHOW HOW THE STACK BUILDS UP AND COLLAPSES.

ILLUSTRATING BASIC PAGE 55
THIS IS AN INFURIATING GAME.
The program shown here was designed to play "MOO" and illustrate "GO SUB".

START BY THROWING TWO DICE, AS EACH DIE IS CAST TYPE IT'S SCORE ON THE KEYBOARD. (THIS MAKES SURE YOU DON'T PLAY THE SAME GAME EVERY TIME.)

THE COMPUTER Chooses A NUMBER WITH FOUR DIGITS < NO TWO ALIKE (NOTE: THE FIRST DIGIT COULD BE ZERO).

YOU GUESS WHAT NUMBER THE COMPUTER HAS CHOSEN AND TYPE YOUR GUESS WHEN INVITED TO DoSo.

THE COMPUTER NOTES HOW MANY OF YOUR DIGITS ARE RIGHT BUT IN THE WRONG PLACE EACH OF THESE IT CALLS A COW.

THE COMPUTER NOTES HOW MANY OF YOUR DIGITS ARE NOT ONLY RIGHT BUT ALSO IN THE RIGHT PLACE EACH OF THESE IT CALLS A BULL.

HAVING REPORTED YOUR SCORE OF BULLS & COWS THE COMPUTER INVITES YOU TO GUESS AGAIN AND SO ON UNTIL YOU SCORE FOUR BULLS AND NO COWS.

HERE IS THE PROGRAM:

```
5 REM THE GAME OF MOO
10 PRINT "THROW TWO DICE"
15 INPUT I, J
20 FOR K = 0 TO 6*I + J - 7
25 LET X = RND
30 NEXT K
35 REM HOW FOR THE PROGRAM PROPER
```

```
110 LET X=INT(10000*RND)
120 LET Y= X
130 GO SUB 1000
140 IF C > 0 THEN 110
150 REM NO COWS OR COMPARISON WITH SELF
160 PRINT "I HAVE CHOSEN A 4-DIGIT NUMBER"
170 LET T=0
180 LET T=T+1!
190 PRINT "WHAT'S YOUR GUESS" 
200 INPUT X
210 GO SUB 1000
220 PRINT B; "BULLS" ; C; "COWS"
230 IF B < 4 THEN 180
240 PRINT "THAT TOOK " ; T ; "TRIES"
250 PRINT
260 GO TO 110
265 REM STOP THIS GAME WITH 'BREAK' KEY
1000 REM SUBROUTINE
1010 LET B=0 < BULLS>
1020 LET C=0 < COWS>
1030 FOR I = 1 TO 4
1040 LET K = 10I
1050 LET L = INT((X-K*INT(Y/K)+1)/K)
1060 FOR J = 1 TO 4
1070 LET M=10J
1075 LET P=INT((X-Y-M*INT(Y/M)+1)/M)
1080 IF L <> P THEN 1130
1090 LET C=C+1
1100 IF I <> J THEN 1130
1110 LET C=C-1
1120 LET B=B+1
1130 NEXT J
1140 NEXT I
1150 RETURN
1160 REM
1200 END
```

RUN
THROW 2 DICE
? 6, 3
I HAVE CHOSEN A 4-DIGIT NUMBER
WHAT'S YOUR GUESS
? 1234
0 BULLS & 2 COWS
WHAT'S YOUR GUESS
? 5678
AND SO ON, EVENTUALLY
THAT TOOK 6 TRIES
This is an infuriating game.

The program shown here was designed to play "MOO" and illustrate "GO SUB".

Start by throwing two dice. As each die is cast type its score on the keyboard. (This makes sure you don't play the same game every time.)

The computer chooses a number with four digits, no two alike (note: the first digit could be zero).

You guess what number the computer has chosen and type your guess when invited to do so.

The computer notes how many of your digits are right but in the wrong place. Each of these it calls a COW.

The computer notes how many of your digits are not only right but also in the right place. Each of these it calls a BULL.

Having reported your score of BULLS & COWS, the computer invites you to guess again and so on until you score four BULLS and no COWS.

Here is the program:

```
5 REM THE GAME OF MOO
10 PRINT "THROW TWO DICE"
15 INPUT I,J
20 FOR K = 0 TO 6*I+J-7
25 LET X = RND
30 NEXT K
35 REM NOW FOR THE PROGRAM PROPER
```

Chapter 3

THIS IS AN INFURIATING GAME.

THE PROGRAM SHOWN HERE WAS DESIGNED TO PLAY "MOO" AND ILLUSTRATE "GO SUB".

START BY THROWING TWO DICE. AS EACH DIE IS CAST TYPE ITS SCORE ON THE KEYBOARD. (THIS MAKES SURE YOU DON'T PLAY THE SAME GAME EVERY TIME.)

THE COMPUTER CHOOSES A NUMBER WITH FOUR DIGITS, NO TWO ALIKE (NOTE: THE FIRST DIGIT COULD BE ZERO).

YOU GUESS WHAT NUMBER THE COMPUTER HAS CHOSEN AND TYPE YOUR GUESS WHEN INVITED TO DO SO.

THE COMPUTER NOTES HOW MANY OF YOUR DIGITS ARE RIGHT BUT IN THE WRONG PLACE. EACH OF THESE IT CALLS A COW.

THE COMPUTER NOTES HOW MANY OF YOUR DIGITS ARE NOT ONLY RIGHT BUT ALSO IN THE RIGHT PLACE. EACH OF THESE IT CALLS A BULL.

HAVING REPORTED YOUR SCORE OF BULLS & COWS, THE COMPUTER INVITES YOU TO GUESS AGAIN AND SO ON UNTIL YOU SCORE FOUR BULLS AND NO COWS.

HERE IS THE PROGRAM:

```
5 REM THE GAME OF MOO
10 PRINT "THROW TWO DICE"
15 INPUT I,J
20 FOR K = 0 TO 6*I+J-7
25 LET X = RND
30 NEXT K
35 REM NOW FOR THE PROGRAM PROPER
```

Chapter 3

HERE IS THE PROGRAM:

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30 NEXT K
35 REM NOW FOR THE PROGRAM PROPER
```

Chapter 3

HERE IS THE PROGRAM:

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5 REM THE GAME OF MOO
10 PRINT "THROW TWO DICE"
15 INPUT I,J
20 FOR K = 0 TO 6*I+J-7
25 LET X = RND
30 NEXT K
35 REM NOW FOR THE PROGRAM PROPER
```
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58
Proposal to replace Kansas City Standard

by Bert Martin

being read at the higher speeds as a higher frequency. Differences between individual machines must also be taken into account, and this is taken care of by a variable-pitch tone-generator which produces two tones in constant relationship with each other throughout their range.

It is proposed that the scale of the variable-pitch control should be graduated in seconds; to use the correct setting it would be necessary for the operator to perform a simple test on a sample C60 cassette.

The cassette is inserted in the recorder at the beginning of a full tape; the time to traverse the whole tape at FAST FORWARD speed is then taken, using a watch with a sweep hand; the time measured then becomes the figure selected on the pitch control for all subsequent tapes of any length, being the setting equivalent to that pitch which, when recorded at 1 ips, becomes the correct pair of pitches to be read by the machine when 'listening' to the tape on FAST FORWARD or FAST REWIND.

Total time needed to traverse a complete C60 cassette from end to end varies between roughly 36 and 135 seconds, over a wide range of machinery, requiring an original pair of tones lying between 80 and 300Hz for the lower frequency, and between 135 and 507Hz for the upper.

These would be transformed into tones of 2250 and 3800Hz when being read in the high-speed search mode, these values being the recommended new standard for the audio equivalents of 0 and 1 in the binary numbering scale.

Neither frequency bears a harmonic relationship to the other, thus allowing a wide-band filter in the 'listening' circuit, without any fear of mutual confusion, and ability to accommodate some considerable tolerance in the precise frequency, either recorded or read.

Cassette access time, when used as bulk storage, is determined by the relative position of the tape, when commanded, and the information location, and will seldom require anywhere near a full traverse, but will be a maximum of the times indicated in the previous paragraph. This is slow, when compared to floppy, but is very tolerable in relation to both price and total storage capacity.

Capacity is the product of baud-rate x 60 seconds x 30 minutes (= one side of the tape). Assuming the speed being used for information transfer as the fastest currently-available system of 2,400 bits per second, this equates to 4,320,000 bits per side—that is 540Kbytes. The cassette used in the system described is thus a 1 Megabyte memory device.

Having allowed 20 percent wastage in program or memory to gaps between blocks of information, plus the space needed for the tape to brake to a standstill, there is still a capacity of 432Kbytes. Logic and software control of the system may well result in less wastage than this, so that shorter tapes, such as the available C12 and C15, would often be sufficient and would have creditably short access times for a large range of applications, or for specific blocks of information-retention.

Having expounded the basic architecture of the system, its development would require contributions from a wide range of talents in computing and electronics, so that the logic and operating system may be brought to a standard, and that the interface with bus systems may be designed.

In deference to Kansas City CUTS, we shall choose a new location-name and acronym, and I suggest Solihull SLICEM for its place of origin, and a convenient meeting centre, and Stereo Logic in Cassette External Memory, CUTS and SLICEM both being rather sharp titles.

Anyone wishing to comment further, write to the Editor of Practical Computing. Bert Martin is 46, an avid writer—of letters, articles, romantic ballads and a first spy novel—and an electronics enthusiast. He picked up the latter interest in the RAF but has spent much of his working life in the furniture industry as a works study engineer and works manager. He is now with the Solihull Area Health Authority. A past secretary of the British Association of Inventors, he arrived at the Promised Land of Computers only in April, 1978—"since when I cannot stop goggling at every computer book and magazine I can lay my hands on".
## SYSTEM APPLICATION PRICE RANGE

### COMART
- **PO Box 2, St Neots, Cambridgeshire**
  - **Microbox, Min. size:** Chassis with three sockets.
    - **Max. size:** Chassis with six sockets.
    - **Application:** Aimed mainly at OEM industrial users and perhaps the serious hobbyist. Manufactured in Britain by Comart, it will take Cromemco, North Star and other processors and software. **£70-£195**

- **Cromemco System Two, Min size:** Processor alone with six sockets in kit form.
  - **Max size:** 21 sockets; 512K of memory; up to three mini-diskettes of 90K bytes each.
  - **Software:** Extended Basic; Fortran IV; Cobol; Macro-assembler; Word-processing, DBMS. American system suggested for systems development. **£395 to around £5,000**

- **Dynabyte, Memory board for any S100 bus system. Available in 16-32K units.** **£275-695**

- **Cromemco System Three, Min size:** 32K memory; terminal and printer interface; dual 250K-byte IBM compatible floppy discs.
  - **Max size:** 128K memory; two-three terminals.
  - **Software:** Same as System Two. Suitable for a wide range of commercial and scientific applications. Theoretical maximum of 512K of memory. **£4,174-£10,000-plus**

- **Horizon, Min size:** 16K memory; serial interface; one mini-diskette drive with 90K bytes; power supply.
  - **Max size:** 48K memory; three diskettes; hardwired pointing board.
  - **Software:** Extended Basic; disc operating system; monitor; access to CP/M range. Manufactured by North Star Computers of the U.S. Aimed at educational and small business users. **£995-£3,500**

- **SOL 20/16, Min size:** 16K memory; integral keyboard and monitor; serial and parallel interface; cassette unit.
  - **Max size:** 64K memory; up to 1MB disc capacity.
  - **Software:** Extended Basic; Fortran; Focal; Assembler; Editor; Games. Another American system from Processor Technology Corp aimed at the small business and education markets. **£1,785-£5,000-plus**

### COMMODORE SYSTEMS DIVISION
- **London NW1**
  - **PET, Single unit containing screen, tape cassette and keyboard. Memory is expandable from 8-32K.** **From £695**

- **Kim 1, Min size:** Processor (6502 chip); small calculator-type keyboard; LED six-digit display; built-in interfaces for audio-cassette and Teletype; 1K RAM; 2K ROM.
  - **Max size:** Can add: Kim 4 motherboard; Kim 3B 8K RAM (up to 64K); Kim 2 resident assembler.
  - **Software:** Basic; Games; Business packages. The British subsidiary of Commodore Systems of the U.S. sells Pet for home, educational and small business applications. Reviewed in the October issue of Practical Computing: there are more than 50 dealers throughout the U.K. **£129-£600 (+VAT)**

### DYNABYTE
- **107 Kilburn Square, Kilburn High Road, London NW6**
  - **Altair System 1300, Min size:** 32K memory; dual mini floppy discs, 71K bytes each formatted; serial interface.
    - **Max size:** 64K memory; 4 serial ports.
    - **Software:** Basic (single and multi-user); Fortran; Cobol. The hardware for the Altair systems is from Pertec in the States, but the software is Anglo-Dutch. For educational and small business systems. **£3,000-£5,500**

- **Altair System 70, Min size:** 33K memory; dual floppy discs, 300K bytes each.
  - **Max size:** 64K memory; provision for up to 8 VDUs.
  - **Software:** Single and multi-user Basic; Fortran; Cobol; APL. Aimed exclusively at business applications; packages are available for general and sales and purchase ledger, payroll, word processing, stock control, estate agency, hotel or small airline reservations, transport management and freight costing. A point-of-sale package will soon be ready. **£4,500 to £10,000-plus**

- **Altair System 300, Typical size:** 64K memory; 1MB disc drive; turnkey processor; VDU; Qume daisywheel printer and disc unit.
  - **Software:** Single-user Basic; Fortran; Cobol. The same packages as for the System 70 are available for this top-end-of-the-market-business, orientated system. Compelec has its own office in Birmingham, but a full distributor network is being set up. **£10,000-plus**

### COMPUTERBITS LTD
- **40 Vincent Street, Yeovil, Somerset**
  - **System 8, Typical size:** 64K memory; 1MB disc storage; serial I/O port for VDU; parallel port to printer; CP/M operating system.
    - **Software:** Basic; Pascal; Fortran. This British-manufactured microcomputer system is almost exclusively for business applications. **£3,000-£5,000**

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(continued on next page)
**COMPANY**

**COMPANY**

**SYSTEM**

**APPLICATIONS**

**PRICE RANGE**

**COMPUTER MART LTD**

38 St Faiths Lane,
Norwich.
0603 615089

VDP-80, Typical size: Single desk-top unit housing a 12 in. display, dual standard floppy disc drive, processor, power units, cooling system and fully-programmable keyboard containing 62 alphanumeric, 12 numeric and 12 cursor controls in separate keypads. Normally sold with 32K memory and 1.2M bytes of disc storage but may be expanded.

Software: Included in the price is a sophisticated operating system with Commercial Basic. A range of commercial application packages is available, including word processing if required.

£9,500

**COMPUTER WORKSHOP**

38 Dover Street,
LondonW1
01-491 7507

System 1, Typical size: 40K memory; dual 8 in. floppy discs, total storage capacity 1-2MB; Ricoh daisywheel printer.
System 2, Typical size: 24K memory; dual minifloppy discs of 80K bytes each; Centronics 779 dot matrix printer; VDU.
System 3, 12K memory; cassette interface; 40-column dot matrix printer.

Software: Standard—Basic Interpreter (includes random and sequential access), disc operating system and monitor; Options—Basic Compiler, Fortran, Cobol, and Pilot. The system is suitable for commercial, educational and scientific applications. Application software for general commercial users.

System 1—£5,000. System 2—around £3,000; System 3—from £1,350

**EQUINOX COMPUTER SYSTEMS LTD**

32-35 Featherstone Street,
London ECIY 8QX
01-253 3781/9837

Horizon, Min size: 16K memory; Z80A processor; single minifloppy disc drive.
Max size: 64K memory, three minifloppy disc drives, any acceptable $100 peripheral boards.

Equinox 300, Min size: 48K memory; dual floppy discs giving 600K bytes of storage; 16-bit Western Digital m.p.u.
Max size: Up to 256K memory; up to four 10MB hard discs.

Software: Basic, Lisp, Pascal, Macro Assembler, Text Editor and Processor. All software is bundled. The system is a multi-user, multi-tasking, time-sharing system for 2-12 users. Application software is available for general commercial users.

£5,000—£40,000—plus

**MICRONICS**

1 Station Road,
Twickenham,
Middlesex
01-892 7044

Micros, Typical size: 1K monitor; 47-key solid state keyboard; Interfaces for video, cassette, printer and UHF TV; serial I/Os; dual parallel I/O ports; 2K RAM; power supply.

Software: Extended Basic; Pascal. A British-designed and manufactured system which is being enhanced rapidly. Already available are a 40-column impact printer using plain paper at £360; what is claimed to be the cheapest data terminal around—a system with an acoustic coupler and VDU for £1,020. Prospective applications: small businesses, process controllers and hobbyists.

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**THE HORIZON COMPUTER**

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much has been said of chess and other games but although everyone knows noughts and crosses, it has been unfairly forgotten. Noughts and crosses is not so easy to play as you might think. Making the computer play a watertight game involves recognising patterns, which we have achieved by some algorithms and some sledge-hammer techniques using IF statements.

The program is based on a machine-language program written by the author in 1973 for a Texas 960 minicomputer. Translating to Basic was not easy, as Basic is really not suitable for this kind of work. String matrices are hard to use, since only one result is allowed from an IF statement.

You are O, the computer is X, and you play first. A matrix of nine numbers is displayed representing the nine squares. You must enter the number of the squares you want to enter and the appropriate square is changed to a zero. At the same time the computer's square is changed to an X.

The matrix is displayed again and you then choose your next square. If you win an X is blocked or of Xs (to win) and enters an X whenever -1 is encountered. If you lose, the game must have ended in a draw.

Translation

The only string variable is S$ which is used as a status indication which can be printed. If your Basic does not have string variables, use different values for IX to IY and then use IF statements to print different messages.

ELSE: If your Basic does not have this feature you will have to add extra lines, e.g. 391 GOTO 430 deals with line 390. To deal with 400 and 420 move them to 401 and 421. At 400 and 420 write P=8: 210 and 430 will need additional IF statements.

EXIT: This is needed to get out of a FOR loop early without causing a stack error. Some Basics will allow GOTO instead, without causing an error. Otherwise if you don't have EXIT you can push P over the FOR limit then add another NEXT. For example to deal with line 460 change "EXIT 490" to "GOTO 490". Then at 4170 P=9:NEXT P=GOTO 490.

SPACE: If you run out of it then reduce the dimension of S$, cut down the matrices and delete the REMs. You could also try deleting one or more of the rules, which will increase your chance of winning. For example, lines 250-280, or 290-360, or 370-420, or even all of 230-440 which will make it very easy to win.

Operation

10:50: dimensions of the matrix, initialises the status word (literally) S$ and puts the values 1-9 in the matrix. Note that element 0 is not used.

80: is where the program loops back on each play. F is made = 1 when the computer blocks a row to prevent another entry in lines 210 onwards.

100: calls 690 to see if anyone has won.

130-160: inputs the user's square, checks with only two entries, either of Os (to be blocked) or of Xs (to win) and enters an X in the remaining square.

210: If the above tests fail the computer tries for the centre square.

250-280: biases the computer's moves to the corners.

290-360: checks L-shapes. If the user has entry in lines 210 onwards.

370: Implements the decisions made in 250-280, if possible. If not then...

400: If you don't have EXIT you can push P over the FOR limit then add another NEXT. For example to deal with line 460 change "EXIT 490" to "GOTO 490". Then at 1170 P=9:NEXT P=GOTO 490.

SPACE: If you run out of it then reduce the dimension of S$, cut down the matrices and delete the REMs. You could also try deleting one or more of the rules, which will increase your chance of winning. For example, lines 250-280, or 290-360, or 370-420, or even all of 230-440 which will make it very easy to win.

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10:50: dimensions of the matrix, initialises the status word (literally) S$ and puts the values 1-9 in the matrix. Note that element 0 is not used.

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Operation

10:50: dimensions of the matrix, initialises the status word (literally) S$ and puts the values 1-9 in the matrix. Note that element 0 is not used.

80: is where the program loops back on each play. F is made = 1 when the computer blocks a row to prevent another entry in lines 210 onwards.

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Moving software from one micro to another

Mark Witkowski looks at how to overcome the difficulty of moving software written for one make of computer to another. The main method of attacking this problem is to disassemble and relocate the program so that it fits on to your own computer. In this and next month’s issue he will describe how to tackle this task, which is not as difficult as it may seem, and which is applicable not only for the 6800.

Disassemblers are a most useful software tool for microprocessors. A good deal of software available on the current range of micros is supplied only in object form. If the original code was written in assembly language, the program source listing will probably be too bulky to be supplied.

Not providing a listing also protects the author’s effort in programming. If the user’s set-up is not identical to that available to the author, however, substantial changes may be called for if the program is to run satisfactorily. A typical instance might be that the user’s system has read-only-memory-based code at locations which contained random access memory when the program was devised.

Different monitors will assume different stack locations and monitor routines will be at different addresses. Most programs use at least the monitor transport routines. Any of those things will prevent the program running properly.

Correcting these deficiencies involves understanding how the program works and then altering the code. When high-level programming languages become common on microprocessors, even if the program listing is supplied, there will still be times when understanding what is happening at the machine level is essential.

Simple process

Plodding through a hexadecimal dump constitutes an almost impossible task. In any case, it is far more difficult than it need be. A disassembler, and there are many available, will translate the hex number into the original mnemonic form of the assembly language. For example, “E7” becomes “STAB” or “54” to “LSRB”, which is of far more value.

The process is a simple one. In the Motorola M6800 instruction set, each of the 256 possible instructions either maps on to a mnemonic or is totally unused. By setting-up a table of such ‘words’ and then using the corresponding numeric value of the instruction as a key to select the correct one, it is a trivial matter to print the instructions in the helpful mnemonic form.

The disassembler discussed here is coded in the Basic programming language. There are numerous disadvantages to using Basic for disassembly, compared to writing it directly in assembly code. The program is much larger, the resident interpreter is required, the whole taking nearly 16K bytes. A hand-coded version would only take about 1.5K.

More than necessary

Basic uses all the resources inefficiently. The program is stored in random access memory as literal lines or text. The list of mnemonics is stored as 255 string variables in an array. SWTP Basic fixes the string variable storage length at 18 characters, even though the program uses only the first five in each string, at most. Therefore the mnemonic table alone uses 4,596 bytes, about 3,500 more than it needs.

If space were at an absolute premium, the mnemonics could be packed three to a string but the code would be made more complex as a result. Further, the mnemonics are stored twice, once in the source program in DATA statements and again in the string variables.

Considering the trouble involved in inputting the table for each run of the program, I am content to leave the DATA statements. Basic also executes code very slowly. There must be a factor of several hundred in run-time speed for the Basic over well-written assembly code for this application. This is not surprising when one considers that the interpreter must look at each character in the source before doing anything, and that the arithmetic is done on numbers accurate to 10 places.

Worse than these, which are bad enough, the Basic interpreter and program sit between locations zero and 16K—just where most programs to be disassembled will be themselves. One could use the
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disassembler to re-locate the Basic somewhere else in memory. In fact, the dual considerations of patching the Basic to work on our system, and the possible need to re-locate it, provided most of the impetus to do this work. It was also something of a challenge to write a program in Basic to disassemble itself.

On the advantage side, the single fact that this program, written in a high-level language, is so much easier to write, debug and describe goes all the way in counter-balancing the disadvantages. Those are among the reasons given most often for using a high-level language.

In time- or space-sensitive applications the algorithm—which is generally language-independent—may be tried and tested using the high-level languages and then be re-coded carefully, possibly with a slight overall reduction in the time it takes to go from the input data to the use of the final printout, rather than going 'from cold' directly in assembler.

This route certainly gives a greater understanding of the problem and its solution. Whenever a program is used and then re-coded in this way, minor, and sometimes major improvements become apparent and are incorporated in the final program.

The problem with which we are faced is to take an apparently arbitrary collection of binary digits and restore them to a readable form. How can a hexadecimal string such as "9F0D207A8D" and the like be presented in a usable way? Each manufacturer produces, with every processor family, an assembly language for- mat. Motorola is no exception. Each instruction to the microcomputer to perform an action is given a mnemonic.

Clearly related

This is related clearly to the English description of the action. Thus, Store the current contents of the A-accumulator into the location pointed to by the contents of the stack pointer, and then decrement the contents of the stack pointer register by one. The mnemonic maps first to "PSHA" and then to the hex "36".

It would not be impossible to devise a program thus to expand machine code. The result would be extremely verbose and ultimately, therefore, about as much use as the binary. Mnemonics—literally an "aid to memory"—provide a useful compromise. Because these mnemonics map so closely to the actual machine code the programmer has a considerable degree of control over the processor. In assembly language an instruction is written in the form: label, separator, operator (mnemonic), separator, operand, separator, comment. In most cases the separator is one or more spaces. So:

NEXT JMP BACK

means 'this instruction is called NEXT, if it executed jump (transfer control) to the instruction called BACK'. For those

machine instructions with an operand, and some which do not, it is stored in the one or two bytes following the instruction byte.

There are 72 mnemonics and 172 instructions for the M6800. This disparity is accounted for by each mnemonic being used in a number of modes. Motorola describes seven modes—inherent, relative, immediate, extended, direct, indexed and accumulator. For a full description of the modes, the M6800 Microprocessor Programming Manual should be consulted.

Briefly, inherent mode is a single-byte instruction and therefore has no operand. They will be used to affect the internal registers. The next instruction is found in the next byte.

Relative mode will be used to transfer control if some specific bit pattern exists in the condition codes. The operand is a single-byte signed number, which is added to the current program location to determine the next instruction to be executed. If the required bit pattern is not present in the condition code register, two is added to the program counter and the program continues with the next instruction. In both inherent and relative mode instructions there is only one mode for each mnemonic.

Immediate mode

With immediate mode instructions the operand, always an expression which can be reduced to a single number, is placed in the next byte(s) and will be used as a constant. "ADDA #123" adds the number to the A-accumulator. Immediate mode is indicated in the assembly language by preceding the operand by the "#" character.

With direct mode, the operand will specify the address of the machine location in which the number to be used can be found. "ADDA 3" means add the number stored in address 'three' to the A-accumulator. The operand is stored in one byte and therefore the range of addresses to manipulate the data is limited to the first 256 bytes of the microprocessor address space. Extended mode allows a two-byte operand and so the address specified to contain the data can be anywhere in the 65536-byte address space.

Indexed mode provides a 16-bit wide-index-register, the X-register, whose contents will specify the location at which the data is to be found. The one-byte operand consists of an unsigned binary number which will be added to the X-register before the program is used to retrieve or store the data. This mode is denoted in the assembly language by placing the characters "X" directly after the operand.

Accumulator mode will specify which of the two accumulators, A or B, will be affected by a particular operation. In the language "A" or "B" may be placed directly after the operator field.

Subtract ("SUBB") is an example of an
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function "PEEK", (st. 640). The value returned is used to pick one of the mnemonics (st. 670) and its mode (st. 660) from the table. If that location contained zero (st. 650) it is a "No Instruction", otherwise the mode (in variable A) transfers control to one of the eight code blocks with a computed goto (st. 680).

‘No Instruction’ mode (st. 1100 to 1110) prints a message, followed by a request for a new start location (st. 300). For the remaining seven modes the instructions are printed in a style as close to the original assembler code as possible. The label is replaced by the actual address of the instruction. Then the operator mnemonic is printed. With the exception of inherent mode (st. 1200 to 1215), which has no operand, the operand field is printed next. For immediate mode (st. 1300 to 1355) a “#” is printed before the one-byte operand value. If the operand is between 32 and 125 it could be interpreted as a printing ASCII character.

In assembly notation an immediate ASCII character is denoted by preceding it with the string “#”. This is placed in the operand field, as a useful guide (st. 1345). For direct (st. 1400 to 1435) and extended (st. 1500 to 1540) modes the operand is printed as a one- or two-byte number directly.

For relative mode (st. 1600 to 1645) the value of the operand is calculated from the comment field, as a computed goto (st. 1615). The operand is then the actual address to which control will transfer.

After the operand in indexed mode (st. 1700 to 1735) the string “X” is printed. Extended immediate mode (st. 1800 to 1835) is like ordinary immediate mode but with a double-byte operand. Printing the ASCII character equivalent is also meaningless then, so that code is omitted.

The program counter (P1) is always incremented by the correct amount before the control jumps back to statement 440 and the next instruction is tackled. All numbers are printed in hexadecimal. Since the PEEK function returns a decimal number, a subroutine to convert decimal to hex had to be written, subroutine 4000. This routine will cater for both one- and two-byte numbers, provided the number is in the correct range.

Division

The number is divided by 4,096, or 256 if it is one byte. The quotient is in the range zero to 15 and is converted to an ASCII character digit by statements 4080 to 4110 if it is between zero and nine. Ten to 15 get converted to “A” to “F” by statements 4120 to 4150. If the original number is too large this quotient will be 16 or greater, the output string (DS) will

The task for the disassembler is to take the hex digits shown on the right, and to produce the text shown on the left. For this program the method chosen is to store the relevant mnemonic for each of the 256 possibilities and then to use the numeric value as the subscript for the correct string array element.

Careful analysis of the operator values shows that each mnemonic is classed together according to the binary value of the operand. Thus for “SUB” bit 7 is always set, bit 0, 1, 2 and 3 are always unset and bits 4, 5 and 7 carry the mode information (10000000). The trade-off between the amount of code required to extract the mnemonic in this way and the storage gains is scarcely justified the storage gains.

Stored with each mnemonic in the data string is a digit which describes the addressing mode of the instruction. These are not identical to the ones described by Motorola, but are related closely. Inherent “2”, immediate “3”, direct “4”, extended “5”, relative “6” and indexed “7” remain the same. Accumulator mode is dispensed with, because they are explicitly mentioned in the stored string.

New mode

A new mode, extended immediate “8”, is added to cater for three instructions which do not follow the usual immediate mode rule of a single-byte operand. “CPX #”, “LDX #” and “LDS *” all load or compare the 16-bit index and stack registers with a two-byte operand. Even when writing assemblers they have to be tested-for individuality and it seems strange that Motorola admits to their being different.

Undefined operator values are given the mode “1” and will cause the disassembler to print a “-q-NO INSTRUCTION” message. This should not be confused with the inherent “NOP” (no operation) instruction, which has the effect of moving program control to the next byte. Taking two machine cycles in the process, ‘No Instruction’ will cause the processor to cease computing, almost always requiring a re-set before it will continue. If such a byte is encountered while disassembling code, then it has gone past the end of the program, or has run into the program data areas. The disassembler, after it has read the mnemonic table into the string array Q5, begins by requesting a ‘Start Address’. It proceeds to the content of the memory machine location with the Basic system

(continued from previous page)
be loaded with four exclamation marks, to denote a number format error.

Having thus determined the first digit the remainder is extracted and multiplied by the divisor (256), to give an integer remainder. The divisor is then divided by 256, so 4,096 becomes 256; 256 becomes 16; and 16 becomes 1, to extract the remaining digits, which are successively concatenated to the string D$ as they are produced. After the final stage this string contains the answer.

By starting at 4000, and a divisor of 16, two-digit hex numbers are formed. By starting at 4040, a divisor of 4,096, four-digit numbers are obtained.

To maintain consistency with the assembly language, a dollars symbol is placed before each hexadecimal number in the operand. If the user prefers to work in decimal, each call of GOSUB 4000 or 4040 could be replaced by D$=STR$(P6), in which case the dollar symbol should be dispensed with. Should octal be your preferred number base, R1 will be set to 512 for one-byte and 32768 for two-byte numbers. Division by 8, not by 16, is called for at statement 4200. Also the prefix should be replaced by the 'commercial at' sign "@" to denote an octal number.

Conversion
Subroutine 5000 converts a hexadecimal number stored in H$ into a decimal in P1, making the input of the start address easier. Each digit is taken in turn, converted by the ASCII system function (st. 5040) and statements 5050 to 5080 if "0" to "9" and 5900 to 5910 if "A" to "F" into a decimal number between 0 and 15. This is then added to a running total, which is multiplied by 16 prior to each addition. So OAEF is 0 × 4096 + A × 256 + E × 16 + F × 1.

Figure 1 shows a portion of the disassembled listing. The first start address is originally, one is present on the listing. If a statement had a label reserved. The aim is to produce a listing well. Further, it should need only a single instruction, the new start address can be chosen from the operand of any program control change statement, JMP, JSR, or any branch instruction.

Each output line takes about three seconds to compute, not including the printout time. This is mainly due to the slow speed of the decimal to hex conversion routine. Figure 1 shows how useful this technique can be for understanding an object loaded program.

Compare this to figure 2, which is a listing produced by the 'I' command of the MSI monitor. This lists bytes in memory in instruction/operand format. The choice between a one-, two- or three-byte instruction is achieved in the MSI monitor with a merely 28 bytes of program code, not including the command interpreter and print routines.

Figure 1 is still far from what is required. It would be much better if the listing produced by the disassembler re-constituted all four fields, the label as well. Further, it should need only a single start address, deciding automatically from where to continue disassembling. While it is about it, it could say where data locations were, and how many bytes were reserved.

By taking careful note of the values of the operands for particular modes of instructions, this is all possible. In part two techniques for full disassembly will be discussed. If a statement had a label originally, one is present on the listing. If not, this optional field is left blank. If a location was declared as data, then data is reserved. The aim is to produce a listing which would be fed directly back into an assembler, re-located if necessary.

(continued from previous page)
Stock record by bubble method

by Paul Woolley

In last month's article I described how to re-order a list of records using a Bubble Sort. Most commercial applications which require data to be sorted usually have the data organised as records. By a record I mean a group of related data items, such as the details found on a payslip or stock list.

A stock record in a stock control list (continued on next page)
application may comprise part number, description quantity in stock, unit price and location in a warehouse. Such records normally are stored in part number sequence but if, for example, there is need for the data to be printed in warehouse location number sequence, the data will have to be sorted.

To perform a bubble sort the data has to be in memory, and because each record is made up of several items of data a two-dimensional array (table) is required to hold the records. Using the record suggested previously, the table may be shown pictorially.

There are five data items to a record and the maximum number of records is denoted by n.

The chosen data item which decides the sorted sequence is known as the key, which in this example is warehouse number. One way of performing the sort might be to compare keys and when two have to be exchanged, swap over the other four data items in each record at the same time. This unfortunately would result in more time being spent moving data than is acceptable.

The solution I propose requires the key to be put into another array with the position of the record-row number in the first array.

These tables may be shown thus:

### $s(n,5)$

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Description</th>
<th>Quantity In Stock</th>
<th>Unit Price</th>
<th>Warehouse Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
<td>(5)</td>
</tr>
</tbody>
</table>

### $l(n,2)$

<table>
<thead>
<tr>
<th>Row No.</th>
<th>Warehouse Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td>(2)</td>
</tr>
</tbody>
</table>

Records are usually made up of a mix of alphabetic and numeric data which could necessitate the use of three arrays if numeric items are to be processed. One array would hold alphabetic data, the second would hold numeric data and the third would hold the keys.

In my example, I wish to sort only the data so that it can be printed in warehouse number sequence. After sorting, the array holding the keys is used as an index to access the second array holding most of the data. The data to be used is:

<table>
<thead>
<tr>
<th>Part No.</th>
<th>Description Qty in Stock</th>
<th>Unit Price</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>1426</td>
<td>Product A</td>
<td>100</td>
<td>7168</td>
</tr>
<tr>
<td>1429</td>
<td>Product B</td>
<td>37</td>
<td>3873</td>
</tr>
<tr>
<td>1507</td>
<td>Product C</td>
<td>3106</td>
<td>1990</td>
</tr>
<tr>
<td>1861</td>
<td>Product D</td>
<td>28</td>
<td>4878</td>
</tr>
<tr>
<td>1943</td>
<td>Product E</td>
<td>87</td>
<td>9011</td>
</tr>
<tr>
<td>2086</td>
<td>Product F</td>
<td>72</td>
<td>504</td>
</tr>
<tr>
<td>3166</td>
<td>Product G</td>
<td>13</td>
<td>1006</td>
</tr>
</tbody>
</table>

It can be seen from the listing that the sort routine needed only a few alterations so that it handles tables instead of a list.

<table>
<thead>
<tr>
<th>LISTING</th>
<th>BUBBLE SORT</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 REM</td>
<td></td>
</tr>
<tr>
<td>20 REM</td>
<td></td>
</tr>
<tr>
<td>30 REM</td>
<td></td>
</tr>
<tr>
<td>40 DIM D$(7,4), (7,2)</td>
<td></td>
</tr>
<tr>
<td>50 GOSUB 100</td>
<td>INPUT</td>
</tr>
<tr>
<td>60 GOSUB 200</td>
<td>'SORT</td>
</tr>
<tr>
<td>70 GOSUB 400</td>
<td>PRINT</td>
</tr>
<tr>
<td>80 GO TO '600</td>
<td></td>
</tr>
<tr>
<td>90 REM</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>INPUT ROUTE</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>110 FOR R = 1 TO 7</td>
<td></td>
</tr>
<tr>
<td>120 FOR P = 1 TO 2</td>
<td></td>
</tr>
<tr>
<td>130 READ D$(R,C)</td>
<td></td>
</tr>
</tbody>
</table>

It is proposed that the two-dimensional array is used to store data items in this sequence but that the data items can be moved about in each array as the program directs.

### $D(n,4)$

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Description</th>
<th>Quantity In Stock</th>
<th>Unit Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
</tr>
</tbody>
</table>

### $l(n,2)$

<table>
<thead>
<tr>
<th>Row No.</th>
<th>Warehouse Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td>(2)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DATA</th>
<th>PRINT ROUTE</th>
</tr>
</thead>
<tbody>
<tr>
<td>900</td>
<td>READY</td>
</tr>
<tr>
<td>400</td>
<td>RETURN</td>
</tr>
<tr>
<td>500</td>
<td>REM</td>
</tr>
<tr>
<td>600</td>
<td>END</td>
</tr>
</tbody>
</table>

### $l(n,2)$

<table>
<thead>
<tr>
<th>Row No.</th>
<th>Warehouse Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td>(2)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>RUN NH</th>
<th>PRODUCTG</th>
</tr>
</thead>
<tbody>
<tr>
<td>13</td>
<td>28.47</td>
</tr>
<tr>
<td>5106</td>
<td>0.60</td>
</tr>
<tr>
<td>72</td>
<td>0.28</td>
</tr>
<tr>
<td>27</td>
<td>9.11</td>
</tr>
<tr>
<td>1861</td>
<td>2.18</td>
</tr>
<tr>
<td>1426</td>
<td>1.25</td>
</tr>
<tr>
<td>1943</td>
<td>5.00</td>
</tr>
<tr>
<td>RUN NH</td>
<td>PRODUCTE</td>
</tr>
<tr>
<td>67</td>
<td>9001</td>
</tr>
</tbody>
</table>
Epic games—some ideas

by Nick Hampshire

WHEREVER there is a computer you will find at some time or another people playing games on it. To many, this is a waste of computer time but there is no doubt that playing games can be a mentally stimulating and totally absorbing experience.

Computer games are of all kinds from the very simple to the highly complex. The simple games are mastered quickly by the average person and, once mastered, lose most of their attraction. This accounts for the fact that the classics among computer games, like chess and Startrek, are long, complex and far from predictable, and as such are never lacking in fascination or challenge.

Real experience

A group of games which fall into this category are the so-called epic games. The real classic of them, known only to those with access to large machines, is Adventure, written by Will Crowther in Forran and occupying more than 120,000 words (36-bit) on a PDP-10.

By itself, however, this would not be enough to allow the running even of a very primitive epic program on an 8K machine, so we must look for other methods.

One could write the whole program in machine code but this is not recommended for anyone but the most ardent enthusiast, so a method is needed to reduce the size of the Basic program.

In an epic game we use a great deal of descriptive narrative, all of which is contained in Data statements. Reduction of the number of words in each description would result in a reduction of processing time. This method of sorting records is not difficult to program but is slow in operation. The other problem in using the bubble sort is that, as all the data is held in memory, the quantity of data which can be processed at any one time is dependent on the amount of free space.

In the Kim project article in Issue 4, the word resistor appeared instead of register in several instances.
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Dams Items for Pet

DAMS of Liverpool not only stocks other people's equipment but also produces its own accessories for the Pet system. They include a joystick unit, page printer and 625 external video adaptor.

The joystick with its machine code program gives full-control of screen printing, games and position-sensing. Averaging routines in the software improve stability and accuracy and more than one unit can be connected simultaneously.

The page printer unit allows a standard ASCII printer running a 20mA loop interface to be driven by the Pet. A machine-code program causes the screen to be copied to the printer, though not the special Pet graphics.

The video adaptor allows the Pet screen to be displayed on a standard UHF television set (tuned to channel 36), by connection to the aerial socket only. A 2M co-ax lead and plug are supplied. Internal adjustments, factory pre-set to standard TV, allow connection to a wide variety of models.

All three pieces of equipment have edge connectors and cables, cost £25 plus VAT, and have a delivery of 2-3 weeks.

Dams (Office Equipment) Ltd, 30/36 Dale Street, Liverpool L2 5SF.

PRACTICAL COMPUTING February 1979
**PPX-Plus is universal in concept**

If the concept of a truly universal programmer, using swappable personality modules to interface with different machines, makes you think of some demon-coder with electrodes in his head, you're probably in the wrong business.

Either that, or of much too literal cast of mind to cope with the Stag Electronic Design personification of its PPX-Plus firmware programming system.

PPX-Plus can program any programmable device, such as Proms, Fplas or single chip microprocessors, in any device technology.

It consists of a mainframe containing power supplies, drive circuits, interface electronics, a VDU and keyboard, controlled by a microprocessor CPU.

The 'personality' module, which matches the programmer to the device to be programmed, is inserted at the front of the machine, making it extremely easy to convert from one device to another. The module contains specialised circuitry and device-specific information, such as voltages and timings.

Most of the electronics for doing the programming remains in the mainframe of the PPX-Plus. The software is divided into two operating systems, one controlling the programming of Proms and Pals, and the other of Fplas, Fpgas, Fpl's and so on. The appropriate operating system is automatically chosen by the software in the 'personality' module.

The information to be programmed into a device is stored in the RAM and may be loaded via an 8-bit parallel interface, a serial RC232C or 20mA current loop interface, from a master device of from the keyboard.

There is a number of input formats, including those of the most common microcomputer development systems and they can be selected from the keyboard. If interfaced to an MDS via its RS232C interface, the PPX can input directly from the MDS, avoiding the need for punched tape.

Data in the RAM may be output via the parallel or serial interface to generate hard-copy printout or punched tape.

Editing of data in the RAM is achieved by changing it via the keyboard, or using a re-locate mode to move around blocks of data.

Program patterns can be checked easily by using a list mode to display the contents of master or slave VDUs, and the RAM.

Before programming a device, the PPX first will check it is unprogrammed. It then programs it to the manufacturer’s recommended specification. When programming is complete, the device is verified against the RAM using the supply voltages and leads specified by the manufacturer.

Normally all the locations of the device are programmed but should it be desired to program only part of it, the address or P term range to be programmed can be set manually. The programmer will then only check, program and verify the locations within this range.

The PPX-plus can operate as a powerful stand-alone system, or as a terminal to a microcomputer development system or minicomputer. It is able to support a variety of peripherals, such as tape readers, punches, teletypes and printers.

Stag Electronic Designs is at Fellowship House, Tewin Road, Welwyn Garden City, Herts.
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**Retinal display is Magic Wand for £5**

by NICK HAMPSHIRE

AN EXHIBIT mysteriously entitled the Magic Wand attracted a great deal of attention at the West Coast Fair in Los Angeles (Practical Computing, January, 1979). The reason for the interest lay in the fact that the exhibit was for a very ingenious, low-cost alphanumeric computer display.

To look at, it was eight small light emitting diodes on the end of a piece of spring steel. Unless one knew, one could well be excused for thinking it a leg-pull in claiming that it was a computer display—until the piece of spring steel was deflected, making it oscillate so that the LEDs traversed an arc a few inches long.

Then, instead of the LEDs appearing to be on continuously, a line of text appeared in the area traversed by the diodes. What one was seeing was an example of what is known as a retinal display.

Retinal display is a perfect example of a new technology being coupled with an old principle to create a new field of applications for that technology. The principle is that on which the whole of the film industry relies—the fact that the eye retains an image for a short time after the image has been removed.

Thus, if you move a light rapidly across your field of vision, rather than seeing a moving point of light you will see a line of light. The image at any one instant is retained long enough in the retina so that it merges with all the other images which follow in the fraction of a second it takes to move the light.

False image

The result is a false image. That effect is produced with one LED and the piece of oscillating spring steel. What is seen is an arc of red light apparently hanging in the air.

A LED has a great advantage over an incandescent lamp; it can be switched off and on very rapidly without having to warm up or cool. This fact makes it possible to play some interesting games with LED and spring steel. If the LED is turned off and on rapidly, instead of an arc of light there is a series of dashes. If the frequency is increased a chain of dots of light is produced. Further increase in frequency returns us to what appears to be an arc of light. It is this ability to produce a chain of dots of light which is the foundation of this display device.

Placing eight LEDs one above the other on the end of the piece of spring steel and turning them off and on synchronously at a certain frequency gives a display of eight parallel chains of dots of light. This gives a matrix of dots and is the basis on which an alphanumeric display could be constructed.

To do so, certain particular dots within the matrix would have to be turned off to produce visible characters, and to do this a computer is essential. Each column in the matrix is formed by the row of eight LEDs all on at the same instant. Not all the LEDs, however, need be on during the on phase—that would produce an off dot in the matrix. Thus by turning on or off the LEDs selectively in a precisely-timed manner, a display can be produced of, say, a line of text.

Simple display

A parallel eight-bit user port on the computer can be connected via some drive circuitry to the eight LEDs, allowing the timing and control to be done entirely by software. One further piece of circuitry is required to sense the reversal of direction of the piece of spring steel at the end of each sweep, this can be done by an inertial switch connected to an input line.

An inertial consists of a cantilevered piece of wire of the correct mass and flexibility, which is forced to make a connection at the end of each sweep by its own inertia. That input triggers the computer after a suitable delay to display the line of text. For optimum viewing, this input should occur not less than 25 times per second.

The software in its simplest form consists of outputting, to the parallel port, byte by byte, the contents of a block of memory. If it is required to display a line of 40 characters, with each character occupying an 8×8 matrix, it would require 320 bytes of memory. Character generators could be built into the software but, of course, this kind of display is not limited to alphanumeric characters; by increasing the number of I/O ports and

(continued on next page)
The Super 6 dual-trace oscilloscope has a bandwidth of 200 MHz (3 dB) and 10 MHz can be displayed over the full screen area. A versatile triggered timebase with 16 calibrated ranges of 1 μs to 100 ms/cm completes the equipment. The Super 10 costs £219 plus VAT, and the Super 6, £162 plus VAT.

Both instruments are fully transistorised, provide excellent performance parameters and are always calibrated. The fully-triggered timebase guarantees that the operator not only obtains 100 percent steady reliable trigger from sine and square waves, but also from more complex wave forms such as pulse trains, while the instrument maintains its calibration. Calscopes are available from Maplin Electronics Supplies, PO Box 3, Rayleigh, Essex; Audio Electronics, 301 Edgware Road, London W2; and Marshalls Electronic Components, Kingsgate House, Kingsgate Place, London NW6.

**Essential items**

**AN ESSENTIAL** piece of equipment for any serious hobbyist is an oscilloscope. Two British-made instruments providing high quality at a price most people can afford are now available from Calscope.

The Super 10 dual-trace oscilloscope has two vertical amplifiers with 10 mV/cm sensitivity and a bandwidth of DC-10 MHz (3 dB) and 10 MHz can be displayed over the full screen area, a feature not usually available with low-cost instruments.

**Reliable**

Complementing the versatile amplifiers is a fully-triggered timebase with sweep ranges from 200 ns/cm to 100 ns/cm. Stabilised power supplies ensure reliable performance and an unmatched accuracy of three percent for both voltage and time measurement.

The Super 6 single-trace has a vertical amplifiersensitivity of 10 mV/cm to 50 V/cm in 12 calibrated ranges; again, the bandwidth of 6 MHz can be displayed over the full screen area. A versatile triggered timebase with 16 calibrated ranges of 1 μs to 100 ms/cm completes the equipment. The Super 10 costs £219 plus VAT, and the Super 6, £162 plus VAT.

Both instruments are fully transistorised, provide excellent performance parameters and are always calibrated. The fully-triggered timebase guarantees that the operator not only obtains 100 percent steady reliable trigger from sine and square waves, but also from more complex wave forms such as pulse trains, while the instrument maintains its calibration.

Calscopes are available from Maplin Electronics Supplies, PO Box 3, Rayleigh, Essex; Audio Electronics, 301 Edgware Road, London W2; and Marshalls Electronic Components, Kingsgate House, Kingsgate Place, London NW6.

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PRACTICAL COMPUTING February 1979
Failsoft

Failsoft is essentially the same as graceful degradation but provides less scope for double entendres. Failsoft is a noun. As an adjective, a system is failsoft if it switches itself off in the event of breakdown, so that no important data is lost. Failsoft usually implies that things can be re-started from the point at which the system broke down. Some machines fail softer than others.

Fairchild

The Fairchild Instrument Co is one of the big fish in the micro sea, though like many large corporations it has not exactly seized the opportunities open to it, which is why Fairchild has a perfectly respectable line of microcomputers (deriving from the F8) without setting the world on fire.

That might be about to change. Fairchild has suddenly become very active in this area, and is in the process of litigation with Data General, whose Nova instruction sets are used by Fairchild's latest 16-bit micros.

Fairchild's other significance lies in its proximity to Silicon Valley. As a result, its alumni have spawned most of the top micro and mini companies in the area, including Intel.

Fault

You will not believe this, but a fault is what happens (or doesn't happen) when something doesn't work. In practice, the term usually refers to a physical malfunction, which means a hardware defect like a short-circuit, a duff piece of soldering or a broken wire. By contrast a bug (qv) is usually a fault specifically in software.

FDX

Conventional abbreviation for full duplex (qv).

Feed

What happens to the sea-lions at 1430 hrs. Or how cards and paper get into the computer. A card feed is the mechanical device which (wait for it) feeds cards into a card reader. A paper feed is the mechanism whereby paper is fed into a printer. A front-feed is a particular device which allows you to stack a pile of single sheets on a printer, dropping a sheet at a time automatically into the printer.

Feedback

The easiest way to get feedback is to try giving an obnoxious, infantile, and petulant piece of software a piece of your mind. It happens with any electrical transmission device—frequently between electric guitars and amplifiers. A big hand, pleasing to Jimi Hendrix and Pete Townsend who pioneered its deliberate use in that department.

A second, more abstract, meaning of feedback is the getting of information from one operation which can be used either to alter that first operation or to initiate another. This is why the letters page of Practical Computing is called Feedback.

Ferranti

Historically significant in Britain. Ferranti's present interest is in military and process control systems with its Argus minis and the F100 micro, which was one of the earliest 16-bit micros.

Failsoft is essentially the same as graceful degradation but provides less scope for double entendres. Failsoft is a noun. As an adjective, a system is failsoft if it switches itself off in the event of breakdown, so that no important data is lost. Failsoft usually implies that things can be re-started from the point at which the system broke down. Some machines fail softer than others.

Fairchild

The Fairchild Instrument Co is one of the big fish in the micro sea, though like many large corporations it has not exactly seized the opportunities open to it, which is why Fairchild has a perfectly respectable line of microcomputers (deriving from the F8) without setting the world on fire.

That might be about to change. Fairchild has suddenly become very active in this area, and is in the process of litigation with Data General, whose Nova instruction sets are used by Fairchild's latest 16-bit micros.

Fairchild's other significance lies in its proximity to Silicon Valley. As a result, its alumni have spawned most of the top micro and mini companies in the area, including Intel.

Fault

You will not believe this, but a fault is what happens (or doesn't happen) when something doesn't work. In practice, the term usually refers to a physical malfunction, which means a hardware defect like a short-circuit, a duff piece of soldering or a broken wire. By contrast a bug (qv) is usually a fault specifically in software.

FDX

Conventional abbreviation for full duplex (qv).

Feed

What happens to the sea-lions at 1430 hrs. Or how cards and paper get into the computer. A card feed is the mechanical device which (wait for it) feeds cards into a card reader. A paper feed is the mechanism whereby paper is fed into a printer. A front-feed is a particular device which allows you to stack a pile of single sheets on a printer, dropping a sheet at a time automatically into the printer.

Feedback

The easiest way to get feedback is to try giving an obnoxious, infantile, and petulant piece of software a piece of your mind. It happens with any electrical transmission device—frequently between electric guitars and amplifiers. A big hand, pleasing to Jimi Hendrix and Pete Townsend who pioneered its deliberate use in that department.

A second, more abstract, meaning of feedback is the getting of information from one operation which can be used either to alter that first operation or to initiate another. This is why the letters page of Practical Computing is called Feedback.

Ferranti

Historically significant in Britain. Ferranti's present interest is in military and process control systems with its Argus minis and the F100 micro, which was one of the earliest 16-bit micros.

FF

Conventional abbreviation for form feed.

Field

A file consists of records, a record consists of fields. It is easy enough to produce a logical definition of a field—something like "an area where data of a given type will be found for processing or storage as a single entity". In practice, the definition is likely to be practical and obvious. For instance, membership records might comprise fields for name, address, membership number, and membership fees paid. Or you might set up the system at a greater level of detail plus one field for surname, two for first names, one each for house number, street, town, county, postcode, country and so on.

FIFO

I smell the blood of a jargon-monger. This whimsical term stands for "first in—first out"—a method of storing items of data so that the first one entered is the first one retrieved. The average use of the term is for a FIFO buffer, which is typically a sequential list of things queuing for processor's attention—instructions to be executed, perhaps, or events in the outside world.

Firmware

Is it a coral? No. Is it a toupée adhesive? No. Is it a hardwired program? Yes. Firmware is essential to the hardware--without it, your computer is in Read-only Memory (ROM). For example, the operations instructions may be held on ROM—as they are in the Pet; or a computer which controls traffic lights may have its program permanently resident in the same way.

Because it is in ROM, firmware executes very quickly—getting instructions from ROM is much quicker than from ordinary read-out memory. Since it is difficult or impossible to alter the contents of ROM, firmware has to be right before it is committed to ROM.

File

An attempt to organise related information; or a collection of records. In practice, a file in computer terms is the essential input for a processing program. Some systems require you to set up your programs as individual files; others (the (program) file into memory, and that file contains all the instructions you need. Data files contain all the data a particular program needs; a subscription program might use one file of subscriber records, another with subscription rates.

Filling system

All but the smallest computers have system software which includes at least some method of organising files. The filling system lays down the rules about how you store and retrieve files. In particular, it tells you how to relate the organisation and structure of a file to the patterns of access, but for an exposition of this you'll have to wait for indexed sequential (qv).

Fill

A field (qv) may be larger than the information you put into it. An address field, for instance, may be set up to cater for large addresses with up to seven lines of 35 characters apiece; so a short address won't take up all the space available. Some systems and some applications require at least some data in the unfiled area—so you have to "fill" it, usually with meaningless zeroes. This may also be called padding or packing.

Fixed disc

Floppy discs are in a range of sizes from 5½ in. mini-floppies to double-sided, double-density, full-size floppies. A normal mini-discette holds about 71KB; a double-sided, double-density mini holds four times that—280KB. Average 8 in. floppies go from a minimum of 250-315KB to a maximum of around 1.26 megabytes.

Access time for floppies is reasonably fast: they are not expensive; they are easy to handle and to store. Rumour has it that the hole in the middle bends, too.

Flowchart

A flowchart is a graphic representation of a system or a program. As a concept it is brilliant. It is very explicit an easily understood description of what is happening—or what ought to happen, since flowcharts are usually produced after you have done some thinking but before you write any code.

It is difficult to over-estimate the importance of drawing a flow-chart. Everyone should learn flowcharting before they learn a programming language.

Flowcharts use a limited number of conventional symbols. The important ones are "process" boxes and "decision" lozenges.
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