Practical Computing

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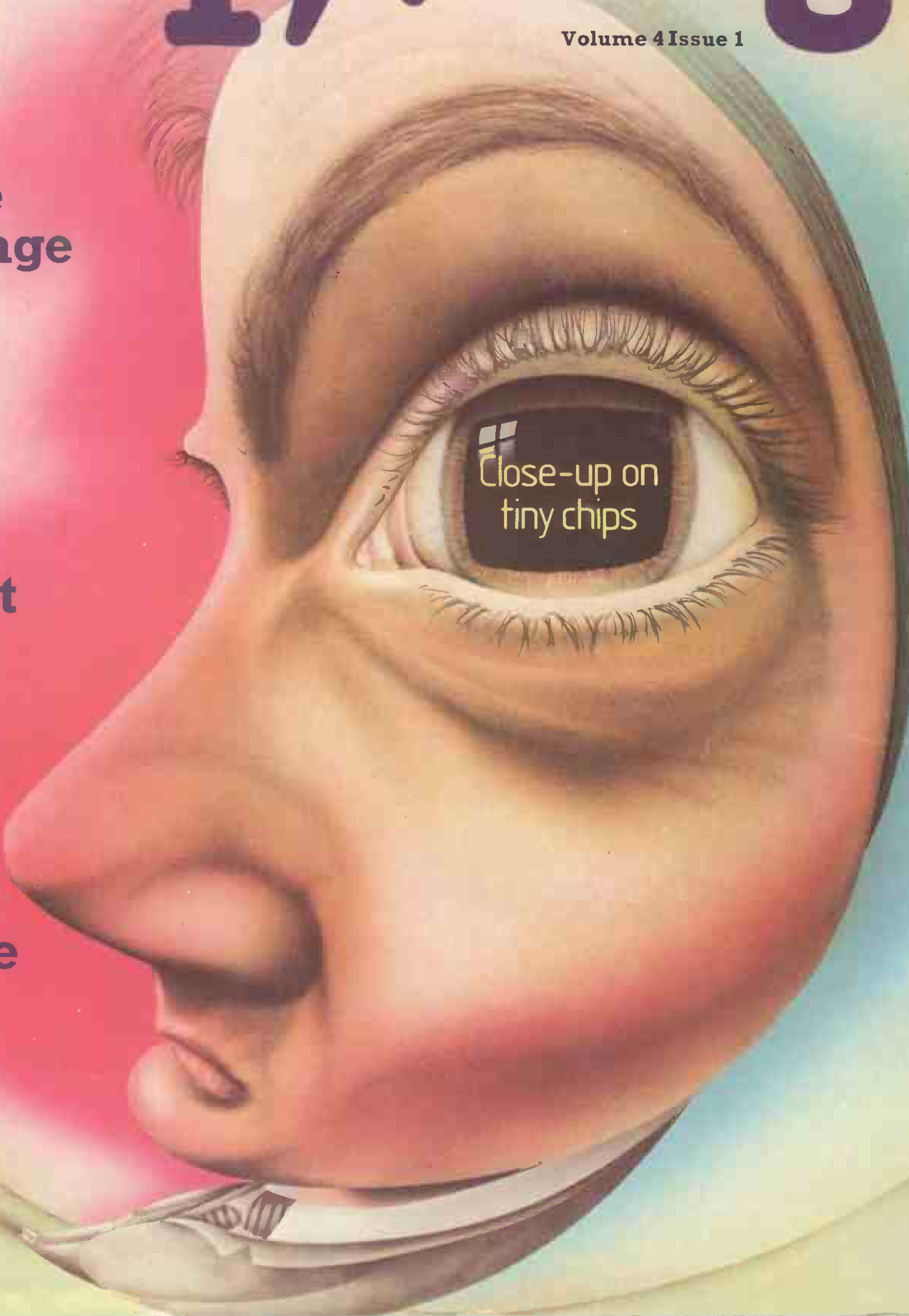

Chips in the submicron age

Reviews:
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PetDOS
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SBC-100

Estate agent on a micro

Software for maths teaching

New—Micromouse page

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● **Circle No. 101**

Mark Wilkinson

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Prestel page number 45631

The b

TRS 80 Model I Microcomputer Here's the push button brain, the entertainer, the tutor, the timesaver. Fun for the children, a helper for the businessman and the teacher, a catalogue for the housewife, an analyser for the investor and an informer for the salesman.
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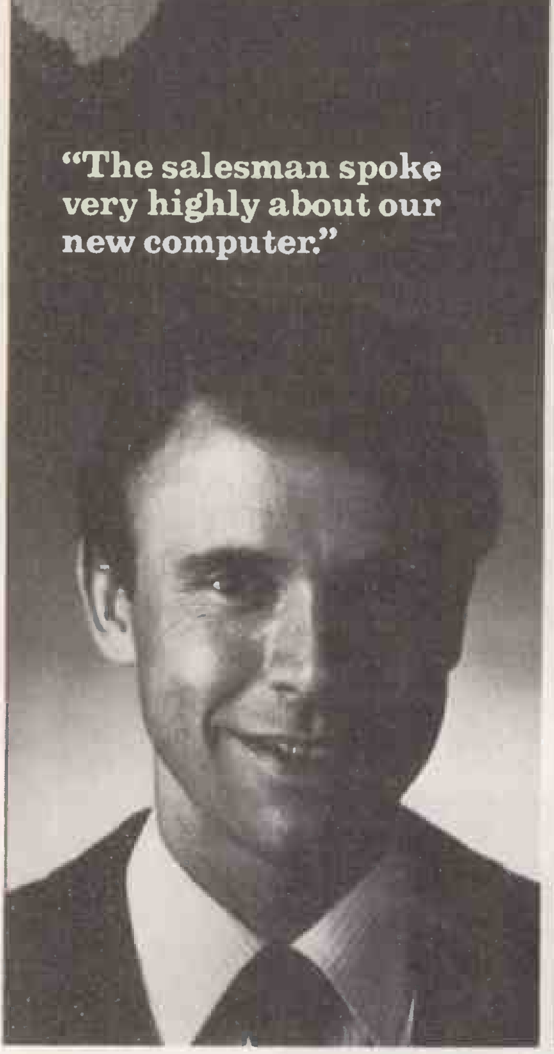

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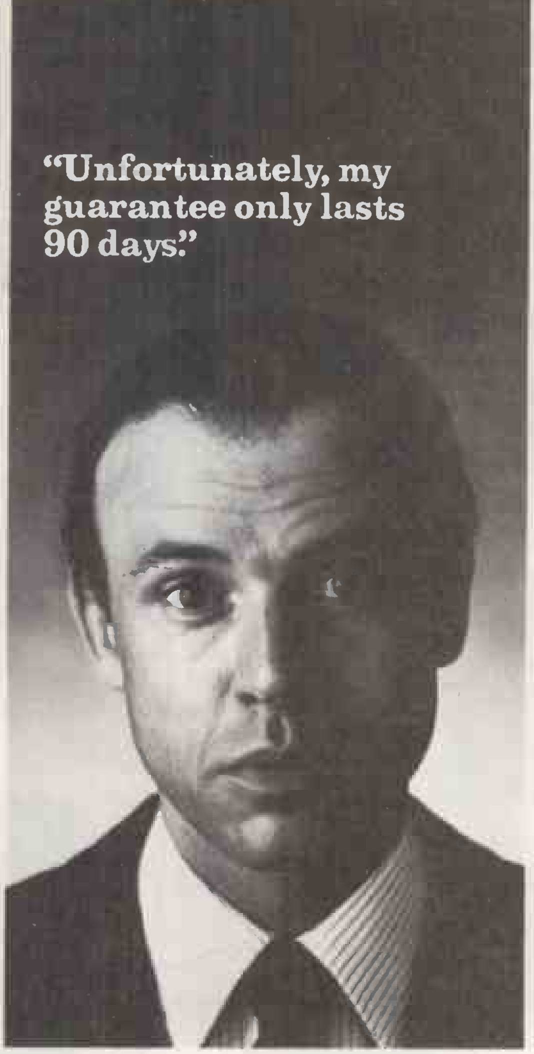

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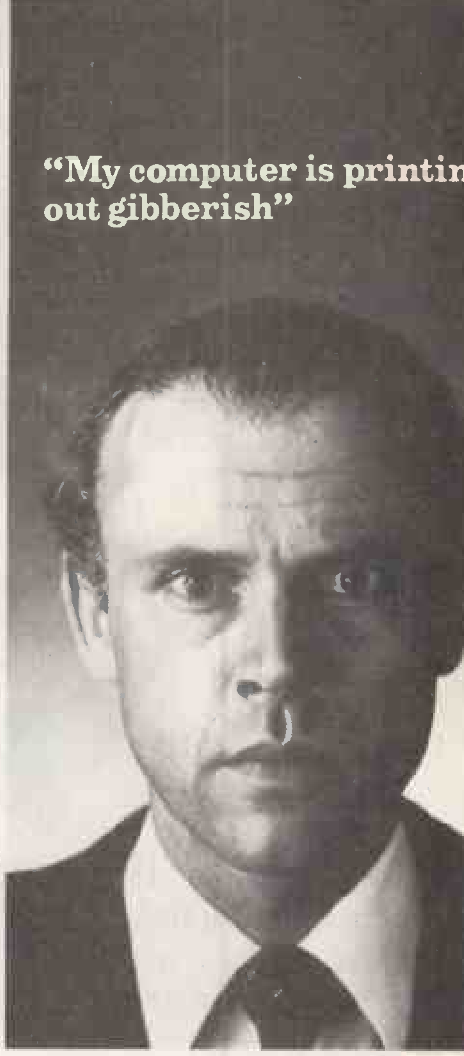

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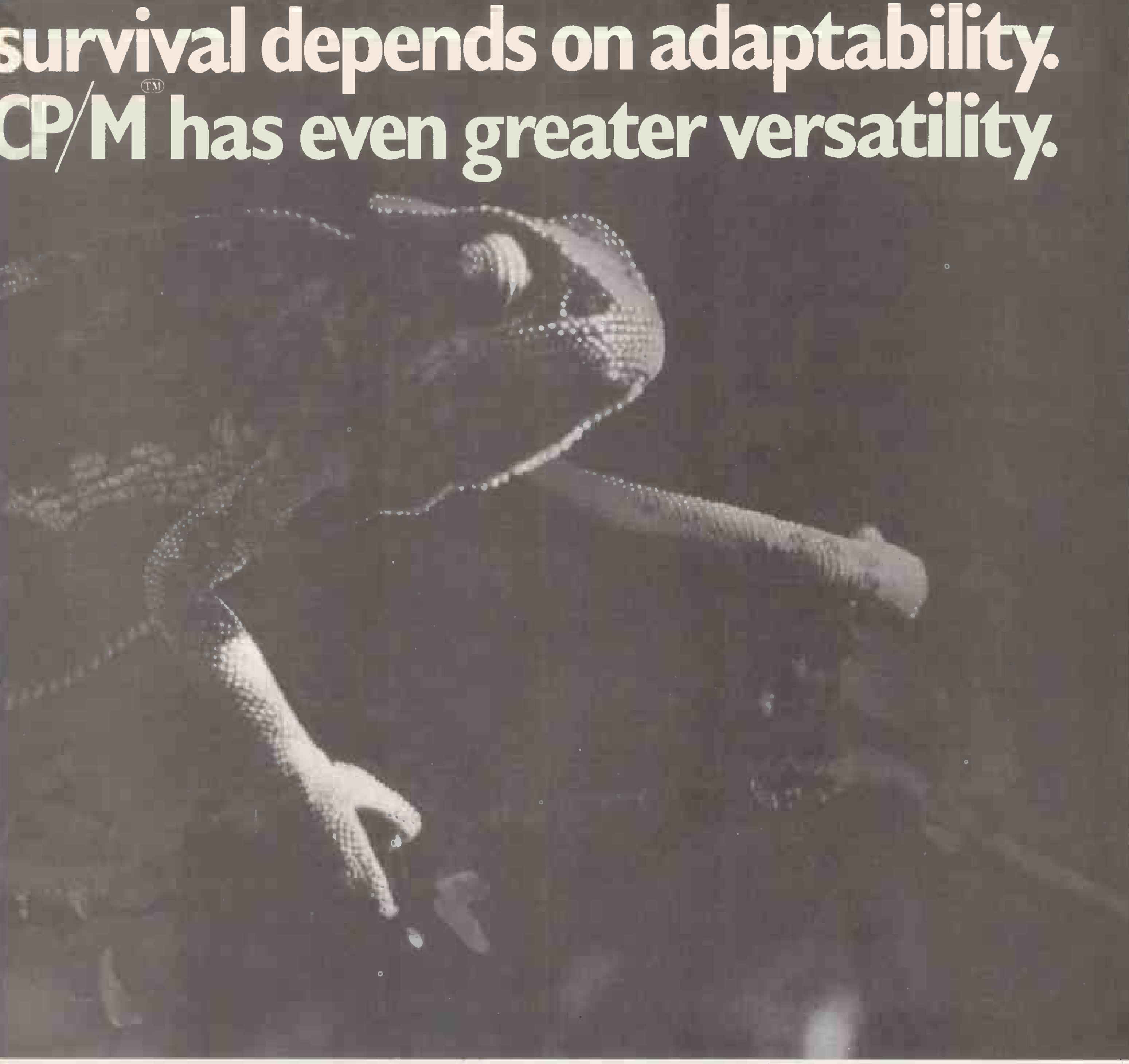

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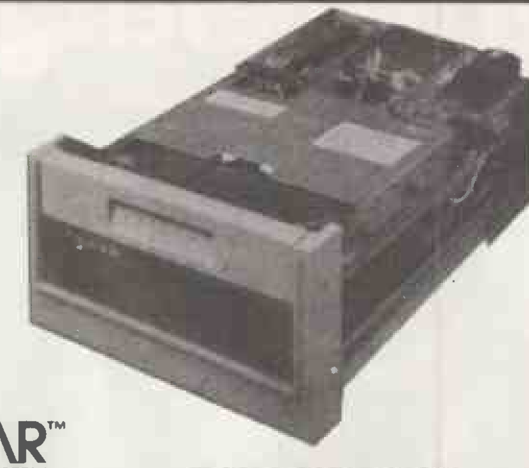

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06 = *ENTER 'UPDATE INVENTORY ....
07 = *ENTER 'UPDATE ORDERS ....
08 = *ENTER 'UPDATE BANKS ....
09 = *REPORT SALES LEDGER ....
10 = *REPORT PURCHASE LEDGER ....
11 = *INCOMPLETE RECORDS ....
12 = *USER DBMS AREA ....
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14 = *PRINT SUPPLIER STATEMENTS ....
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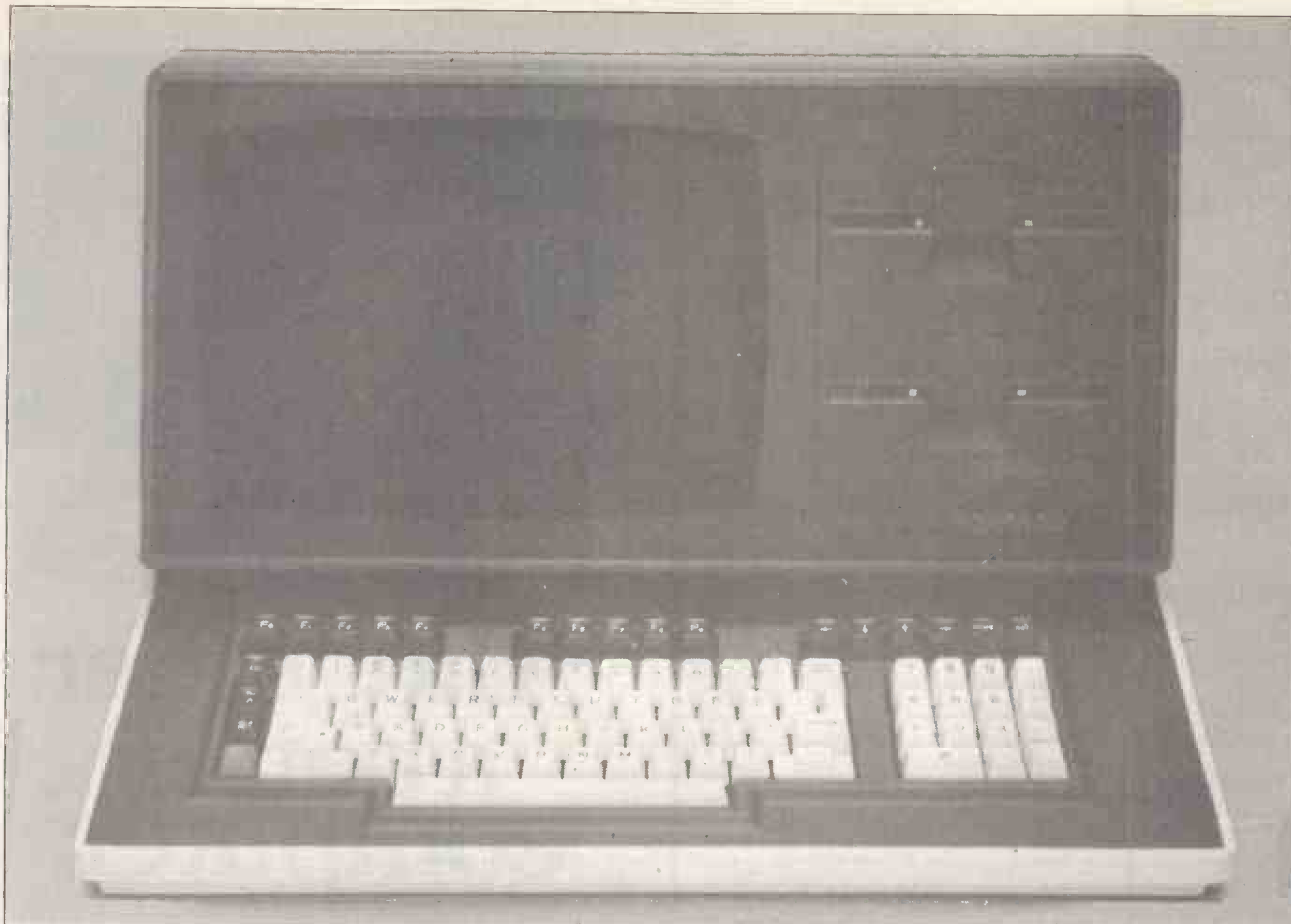

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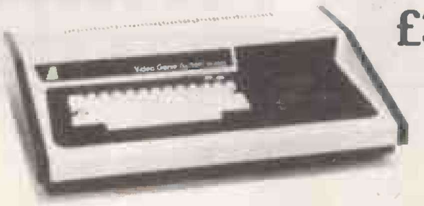

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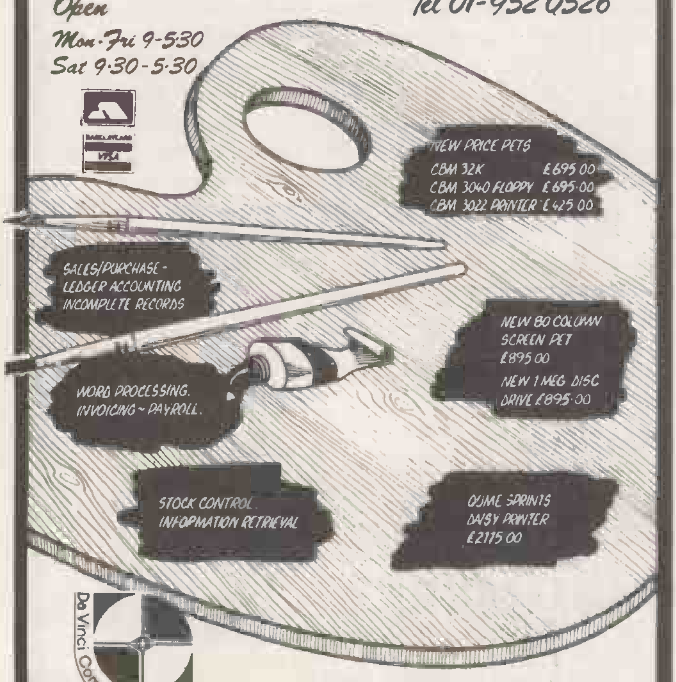

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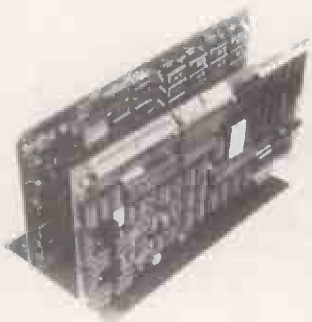

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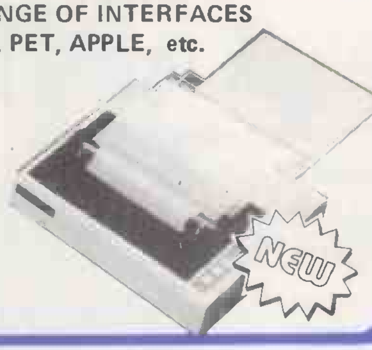

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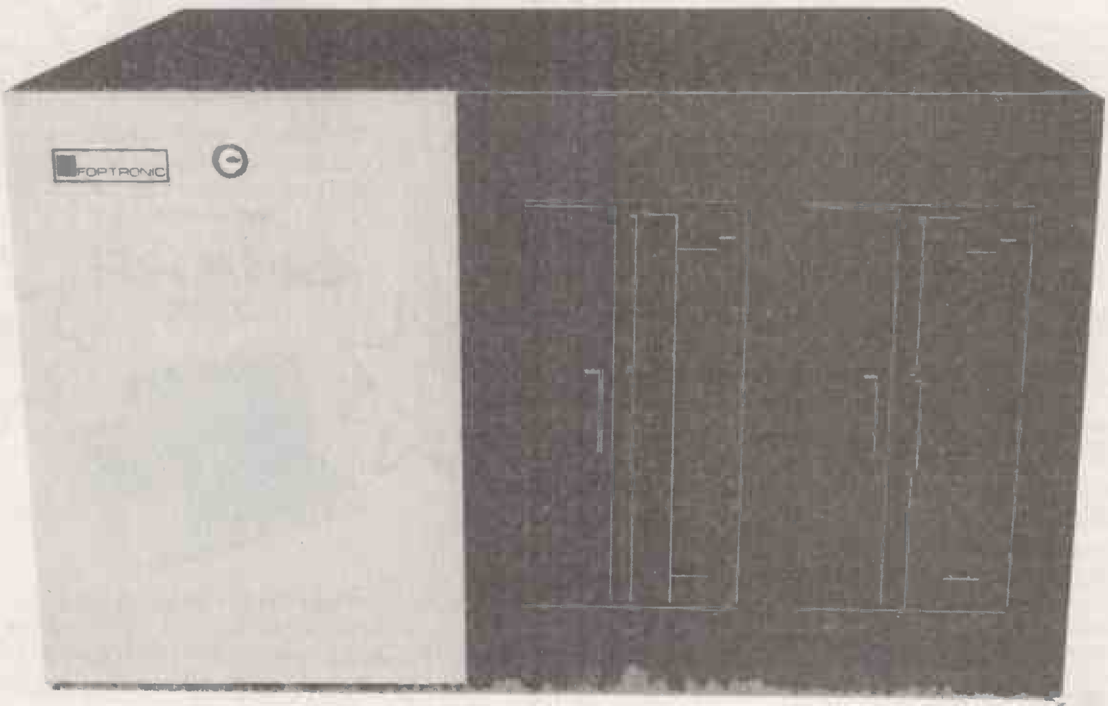

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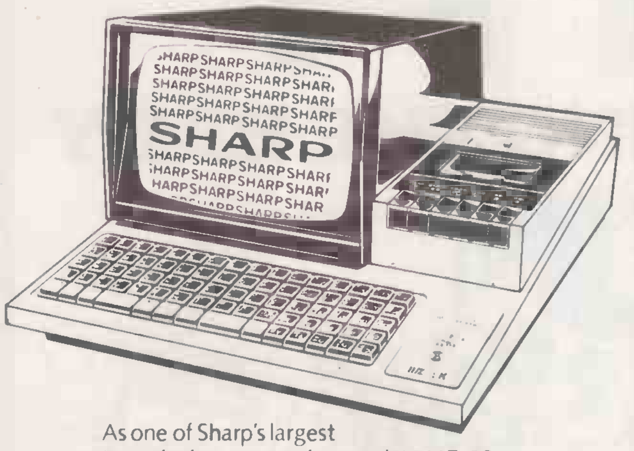

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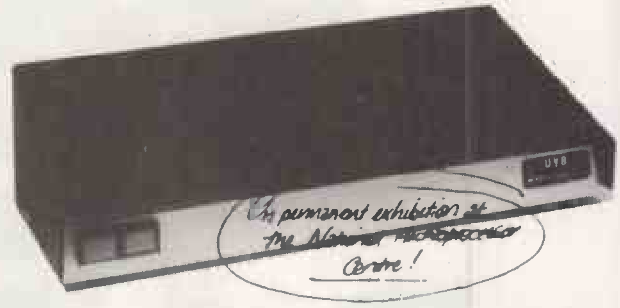

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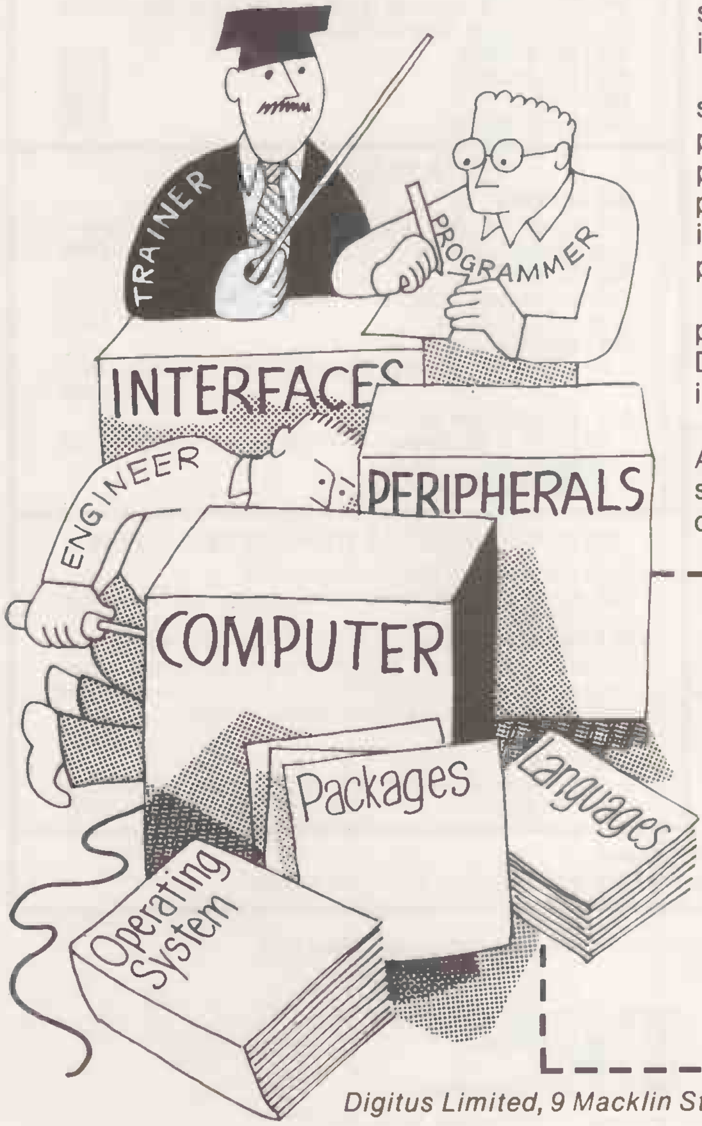

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IT IS NO secret that a major factor in the advance of microelectronics — or its destructive progress, depending on your point of view — is the education of the citizenry to cope with computers. At the moment, that is happening in a spasmodic fashion in all kinds of places.

There are people who go or are sent on courses of all kinds and many, no doubt, return the wiser for them. There are those who find that computers have been wished on them and are obliged to learn. Often, their stories are worth hearing. There is a raggledy generation of schoolchildren — some from schools which have heard there is such a thing as a micro, but have never seen one; and others where daily life is deluged in silicon.

There are still children learning computing by punching cards and sending the packs to the local university computer centre and trying to decode the error messages for the next two weeks. As Kutuzov, the man who, in partnership with Generals Janvier and Février, saved Russia from Napoleon said: "Train hard, fight easy". They will be the children to watch in the eighties.

BBC and ITV are each working on their own computer literacy projects and so two generations of TV computer buffs will arise. Already, there are squabbles about the design of machines to be offered with these projects — at laughably low prices — and over the standard languages they are to employ. As ever, attempts to produce unity will probably result in even worse confusion. It is part of the rich warp and woof of life.

Slowly, unevenly, like the tide rolling-in over a great expanse of sand that looked flat when dry, but now admits little rivers of sea and divides into bays and headlands; so familiarity with computing spreads slowly and unevenly through the people.

It is not a subject which can be learned like many others. When engineering became a force in the world in the early 1800s, it was finitely learnable. Even today's engineering products cannot contort themselves into that many different states. After all, a washing machine has a limited number of legal conditions — it is in the middle of a hot wash and now doing the third rinse, or it is warming the water for delicates and blankets. There are also only a few ways it can go wrong.

A computer is quite different. It is physically impossible to test even the hardware thoroughly, and to test the simplest in all its possibilities out of the question. That has all kinds of interesting consequences. The first is that there is no hard-and-fast boundary between hardware and software constructors and their customers.

The makers cannot do more than sketch roughly how they think their wares should work; their customers must test them and extend them because there are not enough hours in the day for anyone else to do it. The second is that the experts disappears. He can no longer rely on an accepted, total, complete body of knowledge. He, like everyone else, is swimming in a sea of opportunities — but also of ignorance — that computing has brought.

A favourite example is the linguist. If you had asked any competent linguist 10 years ago whether he understood the structure of the English sentence, he would reply that, thanks to Noam Chomsky, the subject was an open book.

Ask any competent and honest linguist now and he will tell you that many sentences are understood, but that the whole of English is an enormous mystery. It is the computer that has killed his certainty. Programs have been written to parse sentences according to the infallible recipes of the experts — and they do not work.

All kinds of things which experts said they knew, now appear, thanks to the spread of computing, not to be known after all. One can expect that trend to intensify as more subjects become computerised, as more people grow used to them, as more skills of human existence are sacrified to the mindless test of program execution. If you understood, the program will run; if you did not, it will not.

The microcomputer is intensely anarchic. It is not surprising that in some schools the people hindering computer education are the computer teachers. Their role has been dilluted from: "Face the front, pay attention to me", to: "Is there anything I can do to help? Thank you for asking".

The impact of computing, or rather the straightforward, commonsense approach to solving problems which computing imposes, gradually teaches us that many revered intellectual skills were empty shams — shams which survived because only the experts had ever been able to devote the time to processing the data or knew how it had been processed.

As another example, consider the *Limits to Growth* program in November *Practical Computing*. Like many, I had been worried by the original Club of Rome forecasts of 1972. Now that I see the crudeness of the assumptions which underlie the work, I wonder that anyone was taken in. The world is clearly a great deal more complicated and although it may be going to hell in a handcart, it is by no means such a simple handcart as the pessimistic millionaires may have thought.

As a corollary to this, consider just the U.K. economy. Economists will no doubt confide that they understand how the economy works. Whether that assertion is so or not can be tested easily by letting them write computer programs to predict how the economy is about to perform. They do, avidly, and one has to report one uniform fact about the resulting programs: they do not work.

It seems that the usefulness of computers at the highest levels of government and industry is extremely limited. Yet, it is not the computers which are no good, but our understanding of how government works which is deficient. How is Mrs Thatcher to reduce inflation? No computer can tell her because a computer would know only if someone understood how the economy works — and they do not.

The availability of these intellectual drudges has shown us that we understand, in the sense that we can write a computer program to do it, precious little. Furthermore, since those things we do understand can be written in some language, and since any moderately intelligent person can understand anything anyone else understands. Understands in the sense that he can write an accurate, necessary and sufficient account of how to do it — whatever it is.

So the advent of computing divides human knowledge into two clearly-defined areas: the known and trivial and the unknown and baffling. The frontier is always advancing, like a torch shone in a dark attic. The exciting and mysterious objects guessed at by the dim light filtering under the eaves turn out to be boring old coal scuttles when you take them over by the trapdoor in the light. The lighting torch of computing turns the thrilling and unknown into the known and banal.

Widespread computer education may not progress as supposed and its results may be totally different from what many hope. It may produce a new generation of thrusting youth, ready to carry this tired old country into economic health and a respectable place in the family of nations. It may, in the process, dissolve all our intellectual ivory towers like so many sandcastles as the tide comes in.

Our Feedback columns offer readers the opportunity of bringing their computing experience and problems to the attention of others, as well as to seek our advice or to make suggestions, which we are always happy to receive. Make sure you use Feedback—it is your chance to keep in touch.

Currency interest

THERE ARE certain important factors missing from Dr Taylor's strategy for buying foreign currency which appeared in the September issue.

Firstly, there is the matter of interest differentials. If, for example, one incurs overdraft interest now — or forfeits deposit interest receivable — on a pound sterling account to buy Swiss francs for a winter sports holiday early next year, there is the brunt of pound sterling interest rates to beat.

The interest receivable through placing the Swiss francs bought in a deposit account would be negligible. Were a forward contract for a small sum to be available through a foreign-exchange dealer, the interest factor would be reflected in his charges.

A probable area for economy would be a study of the buy/sell margin rates, which tend to widen during periods of crises or uncertainty. For example, a currency could be quoted during a period of stability at 8.80/9.20 to the pound sterling, giving a mid-point of nine.

During a spell of uncertainty the quote could become 8.50/9.50 still having the same mid-point. Thus anybody buying 20,000 units of this currency would pay an additional £80 through buying in this period. It pays to monitor the margin, expressing the buy rate as a percentage of the sell rate and to buy when the percentage is reasonable.

Roger Standing,
Geneva,
Switzerland.

Commodore stars

I READ WITH great interest your September editorial on British failings. While I followed most of the sentiment and reasoning you put forward, I believe there may be some bright stars on the horizon.

Indeed, some exciting British software is being produced at Commodore for the Pet and we have just started to export a major amount from the U.K. to Commodore companies overseas. It might interest you to know that the following packages are now to be marketed on a worldwide basis by Commodore:

- Pascal Compiler
- Wordcraft
- Anagram Stock Control
- Communicator — Pet-to-deck intelligent terminal package
- Ozz — a user-definable database product

It pleases me that these packages form a very important part of our range of software for the Pet — British software talent is expanding and the U.K. is becoming a centre for development in the Pet micro field. So perhaps: "We British, in our sturdy pragmatic way, are doing better".

Kit Spencer,
Commodore Business Machines,
Slough,
Berkshire.

Sorcerer storage

IN HIS article on the Presidential Election program, October 1980, Alan Bayliss suggested that by loading the Basic as single-key instructions, less store space would be occupied. In case that misleads anyone, it should be said that the Sorcerer stores the instructions as the codes for the single-key form, however the lines are entered.

Perhaps what Bayliss had in mind was that the shorter form occupies less screen space and that could be relevant to a program so densely packed as his.

We have been too busy converting Supertank, July and August 1980 issues, for the Sorcerer to make a start on the election program, but it looks interesting. Now our monitor-listing task is complete, we will probably defer digging into the Basic ROMPAC until we have tried the Presidential battle.

Don Thomasson,
Harrow,
Middlesex.

Basic burial

I WRITE to bury Basic, not to praise it. I cannot see how any computer user — whether on a mainframe, a mini, or a micro — can think that Basic is superior to the other high-level languages available today. Although I do not know Pascal, the main rival of Basic in the micromarket, I have programmed with Basic, Fortran, and assembly language, and I find Basic to be the most unsatisfactory of the three.

Assembly language aside, Fortran and other similar languages are far better programming aids than Basic. Fortran boasts alpha-numeric variables up to six characters, line labels only where needed, maths capabilities far beyond those of Basic, more powerful if statements, more varied data types, better control over I/O and I/O format, and more direct control over variables, therefore eliminating all string variables and the STR$, CHR$, etc., functions.

Moreover, the Fortran subroutine and function handling simplifies program development considerably, for, unlike Basic, parameters are passed easily between the sections of the program, and as subroutines have names, there is no need for the totally meaningless and confusing "GOSUB 10560."

Not to be overlooked in languages such as Fortran, Pascal, Cobol, and APL is the fact that they all use a compiler. While it may be more complicated for the beginner to use, an hour of practice with the compiler will have even the inexperienced user working smoothly.

The most obvious advantage of a compiler is that the compiler code executes much faster than interpreted Basic, and good compilers will produce code which is almost as fast as if the program were written in assembly language, therefore eliminating the need to jump to a machine-code routine when speed is necessary. The compiled code also occupies less core/disc/tape space than ASCII Basic, so larger programs can be run on small machines.

I feel that anyone who has used both Basic and another high-level language extensively will find that while Basic is a satisfactory language with which to learn programming, and that is what it was designed for, it simply cannot compete with the more advanced languages. I hope *Practical Computing* and its readers will help to make the change to these languages, and so advance microcomputer programming.

John TeSelle,
Oxford.

TRS-80 true colours

IN YOUR article on page 46 in the October 1980 issue, you refer to the Model III as a colour computer; it is not. There will be a new computer added to our range which is colour and will be called, TRS-80 Colour Computer.

E A Russel,
Tandy Corporation,
Wednesbury,
West Midlands.

Landscape architecture

I AM a fifth-year student of landscape architecture studying at Leeds Polytechnic. As a part of my studies, I am preparing a dissertation which will fall within the broad title area of the application of microcomputers to landscape architecture, although the finished work will probably have a more specific title.

I am writing a program to aid landscape architects in the selection of plant materials and although my programming experience is very limited — I have used an Apple II and Research Machines 380Z — I am encouraged to see the potential use of a micro even to a novice such as myself.

As a part of my research, I hope to

(continued on page 44)

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(continued from page 42)

identify other users in similar fields to investigate their successes and failures in putting their programs into operation.

I have listed some of the potential operations which I may investigate with respect to computers:

- A selection system for plant material — trees, shrubs, etc. — storage of large quantities of complex data which is easily and quickly accessible.
- Contouring exercises; calculation of cut and fill — use of graphics tablet to measure irregular areas and volumes; conversion from plan to section or elevation.
- Planting design; planting plans drawn to scale on a graphics tablet; Calculation of areas, densities and plant quantities; production of planting schedule.
- Suppliers' index; relatively simple file of suppliers; lists of available species, sizes and prices; regular editing and additions essential.
- Word processing; production of large documents, specification and contracts requiring constant ammendments.
- Production of sections, elevations and perspectives; advanced graphics programs, perhaps unfeasible at present on micros, but of relevance in terms of future development.
- I would be grateful for any information from any users or user groups who could share useful experiences, or of any publications which are of a more specific relevance to people within my field or similar professions.
- I was, of course, interested to read the applications story by Martin Hayman in the October issue concerning the Syon Park Garden Centre and hope to contact the centre in the future.

Chris Sterry,
Leeds,
West Yorkshire.

Job safeguard

WITH reference to the interview of Neil Macfarlane, Under-Secretary at the Department of Education and Science in the October edition, I would like to say that during the past year, I estimate that the school of which I am a pupil has spent more than £4,500 on micros and peripherals — **all** U.S. or Japanese.

I would like to suggest that schools, colleges and other educational establishments should buy those items only if manufactured in the U.K. That would help safeguard British jobs.

D Maltby,
Sheffield,
South Yorkshire.

Challenge of ZX-80

FIRST I MUST congratulate you on your unbiased articles and the excellent review, July isue, of the ZX-80. It is also good to see that you now have a regular club page for this popular little computer.

However, I feel that I must take issue with those who would wish to overcomplicate the programming of the ZX-80. I believe that its main asset is its uncluttered simplicity which make the programs a joy to write and a challenge to conceive without resorting to complicated methods.

I have written and taped a modest library of 11 programs, seven are dedicated to basic education and are used by my 9½-year-old son, who finds them much more fun than school homework.

Of the remaining programs, one is an enhancement of the ZX-80 manual's die throwing which enables double dice — U.S. crapps — to be played.

To fit the program into the on-board 4K RAM, no REM statements have been used and, where applicable, the left-hand die is always assumed to carry the higher number. With extra RAM, either of the dice could assume the higher value simply by reversing the sequences contained in line groups 300 to 2130 and changing the value of X to RND(37). That would give the game 15 more random chances. Obviously, lines in the 400; 800; 1400; and 1900 groups cannot be altered as both dice are displaying the same number.

Finally, another contribution to the already much-written-about topic of LOADing and SAVEing programs on cassette tapes. Having suffered the same disappointments as many others when trying to LOAD from tape, I contacted Science of Cambridge which sent me a copy of its leaflet which states, among other things, that an AC output peak-to-peak voltage of at least six volts is required at the EAR socket before LOADing can be successful.

Consequently, I took my machine to be tested only to find that it had a DC bias which was effectively cancelling the required AC.

Along with the cassette recorder, I received a good tip and some valuable advice. The tip concerns the remote socket to be found near the MIC socket in most recorders. If a locking push-to-make, push-to-break switch is wired to a 2.5mm. jack plug, the plug, when inserted in the remote socket enables the record and play operations to be controlled by the switch. It is not recommended for re-wind or fast forward. Obviously, the required keys must first be depressed but, if that is done with the switch in the off position, they do not work until the switch is pushed to on.

There are two advantages; first, with the button mounted near the keyboard, control is easier and second, the use of the method disconnects the internal microphone so that no motor hum or stray noise is picked up during the silent pause before the program starts.

The last piece of advice I was given was that many recordings and play-backs, including those of programs, can be spoiled by the fact that the tape is not allowed the second or two it needs to reach the correct speed before either recording or playing back. A good idea is to count a slow one before hitting the new-line key in both cases.

The ampersand signifies a space which must be keyed. The graphic character used throughout is SHIFT 'F'

```
10 LET A$ = "&▗&"
20 LET B$ = "▗"
30 LET C$ = "&&▗"
40 LET D$ ="▗&▗"
50 LET X = RND(22)
60 CLS
70 GO TO X* 100
100 GO TO 50
200 PRINT
210 PRINT A$,A$
220 GO TO 2250
300 PRINT B$
310 "&",A$
320 PRINT C$
330 GO TO 2250
400 PRINT B$,B$
410 PRINT
420 PRINT C$,C$
430 GO TO 2250
500 PRINT B$
510 PRINT A$,A$
520 PRINT C$
530 GO TO 2250
600 PRINT B$,B$
610 PRINT A$
620 PRINT C$,C$
630 GO TO 2250
700 PRINT D$
710 PRINT "&",A$
720 PRINT D$
730 GO TO 2250
800 PRINT B$,B$
810 PRINT A$,A$
820 PRINT C$,C$
830 GO TO 2250
900 PRINT D$,B$
910 PRINT
920 PRINT D$,C$
930 GO TO 2250
1000 PRINT D$
1010 PRINT A$,A$
1020 PRINT D$
1030 GO TO 2250
1100 PRINT D$,B$
1110 PRINT "&",A$
1120 PRINT D$,C$
1130 GO TO 2250
1200 PRINT D$, B$
1210 PRINT A$
1220 PRINT D$,C$
1230 GO TO 2250
1300 PRINT D$
1310 PRINT D$,A$
1320 PRINT D$
1330 GO TO 2250
1400 PRINT D$,D$
1410 PRINT
1420 PRINT D$,D$
1430 GO TO 2250
1500 PRINT D$,B$
1510 PRINT A$,A$
1520 PRINT D$,C$
1530 GO TO 2250
1600 PRINT D$,B$
1610 PRINT D$
1620 PRINT D$,C$
1630 GO TO 2250
1700 PRINT D$,D$
1710 PRINT A$
1720 PRINT D$,D$
1730 GO TO 2250
1800 PRINT D$,B$
1810 PRINT D$,A$
1820 PRINT D$,C$
1830 GO TO 2250
1900 PRINT D$,D$
1910 PRINT A$,A$
1920 PRINT D$,D$
1930 GOTO 2250
2000 PRINT D$,D$
2010 PRINT D$
2020 PRINT D$,D$
2030 GO TO 2250
2100 PRINT D$,D$
2110 PRINT D$,A$
2120 GO TO 2250
2200 PRINT D$,D$
2210 PRINT D$,D$
2220 PRINT D$,D$
2250 INPUT X$
2260 IF X$ = ""
THEN GO TO 50
```

The game can be played by two or more players, there is no upper limit. The combination shown when 'RUN' is pressed is discounted. To throw, press NEWLINE. At the beginning, each player has one throw, the one with the highest combination starts.

The player who has the dice keeps them until he or she throws a losing combination. Each turn may consist of one or more throws as defined. The following, if thrown on the first 'throw' of a 'turn', are losing combinations:

Double one
Double six

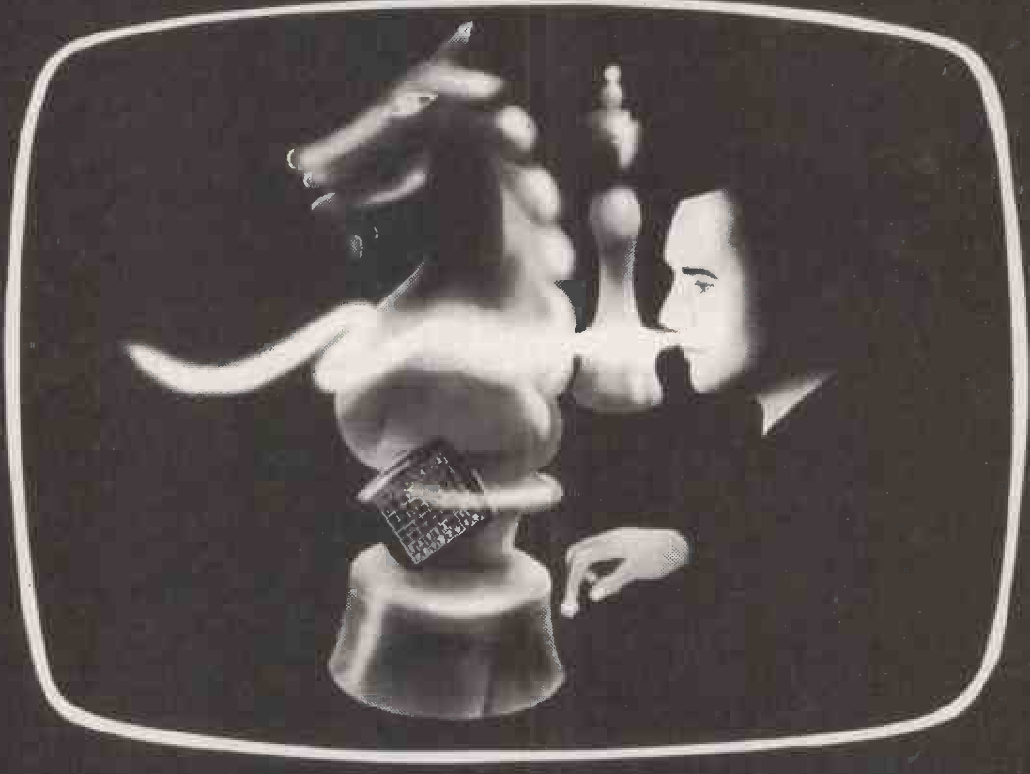
The following, if thrown on the first throw of a turn, are winning combinations:

Any combination to make seven
A six and a five — 11

If any other combination is thrown on the first throw of a turn, the player throwing continues the turn until one of the following occurs:

- The same number, in any combination, is thrown, in which case this is considered to be a win and the same player starts a new turn.
- Any combination to make a seven or an eleven is thrown, in which case this is considered to be a lose and the player hands over the dice to the next player in rotation.

Neville Falkiner,
Leeds,
West Yorkshire.



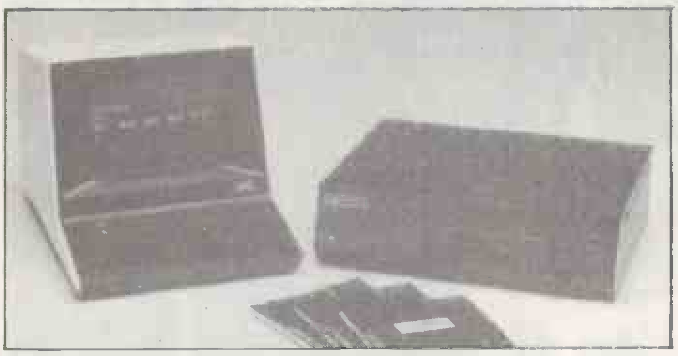
Four models in Rair Black Box III range

A NEW range of British-built microcomputers has been launched including one with an integral 5¼in. Winchester disc system. The Black Box III range is the latest in the line of microcomputers to emerge from the London-based manufacturer Rair Ltd since it introduced its first microcomputer in 1978. The 5¼in. discs have an unformatted capacity of 3.5 or 6.9MB and the system will sell from £3,500.

There are four models in the new range, all of which based on the 8085 chip from Intel. The Model 3/10 starts with 32Kbytes of RAM expandable to 512KB with single mini-discs drive support and dual serial I/O ports. Mid-range systems, the 3/20 and 3/30 add dual mini discs and built-in 5¼in. Winchester discs, while the top of the range, the Model 3/40, incorporates an 8in. Winchester disc.

The basic RAM of each model can be expanded in 16 or 64KB increments to a maximum of 512KB. Up to eight Winchester discs can be connected to a single computer, giving a total on-line storage capacity of up to 200MB on one system.

According to Rair managing director, Mark Potts, the Black Box III range offers almost as much power as some minicomputers but at five to 10 times less cost. He believes that one of the key features of the new range is its multi-user, multi-terminal networking capability. Up to 16 serial I/O ports can be added to each model in the range. From basic single-user support, each model can be expanded to provide multi-user, multi-terminal support on a single system or in a network, using shared processor and file resources in a multi-computer distributed processing system on any size. More details from Rair on 01-836 4663.



News of Cobol and Coral 66

COBOL and Coral 66 are now available for the Apple for the first time. MicroFocus is offering both CIS Cobol and its Coral 66 compiler on the Apple under Digital Research CP/M operating system. Both the products run in conjunction with the Z-80 Softcard, developed by Microsoft, which makes the Z-80 instruction set available in addition to the native Apple 6502 processor.

CIS Cobol is an ANSI 1974 Cobol compiler designed for interactive use on small computer systems; it supports an optional screen formatter/program generator. Coral 66 is a real-time programming language and is the British standard for defence computing.

Brian Reynolds, chairman of MicroFocus is clearly aiming the products at the world market for Apples: "With more than 150,000 Apples installed, we see a tremendous market opportunity", he says. MicroFocus is based in London and further information from 01-722 8843.

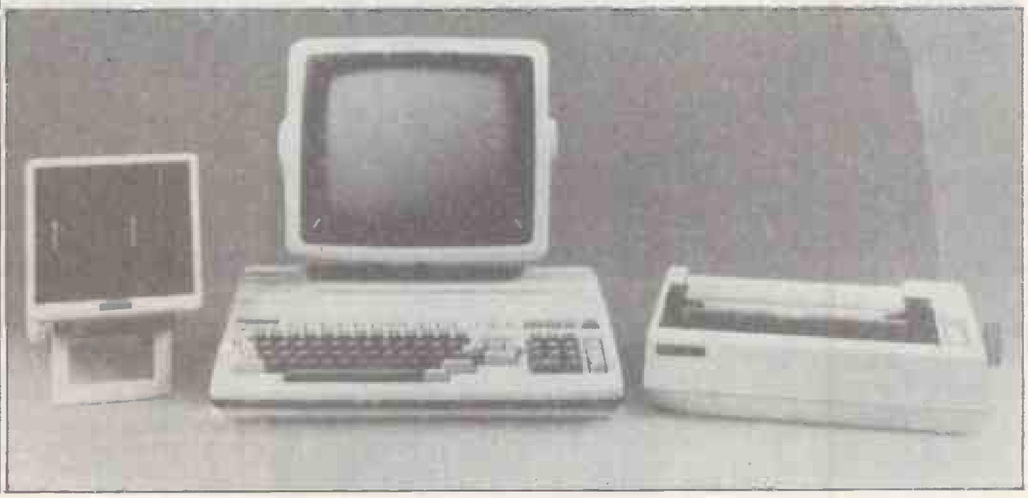
PC-3200 leads the Sharp attack on business computer market

THE JAPANESE are beginning to show that they really mean business where the task of developing new microcomputers is concerned. In the last 18 months, Sharp has introduced the hardy MZ-80K, sound and solid if not exactly innovatory, the novel PC-1211 hand-held computer, or calculator programmable in Basic, and now has produced a new computer, the PC-3200, designed, and aimed at the business market, which seems to show how far and fast the company ideas about computers have developed.

The PC-3200, like the MZ-80K, is based on the Z-80A chip but it has a separate alphanumeric keyboard and 80-column screen, with selectable 40 or 80 characters per screen, two discs and a printer. There is 64K of RAM and 32K of ROM which can be expanded up to 72K. The Basic is held in the ROM.

The double-sided, double-density mini-floppies and the 80- or 132-column printer is supplied with the complete system which will be sold for less than £3,000.

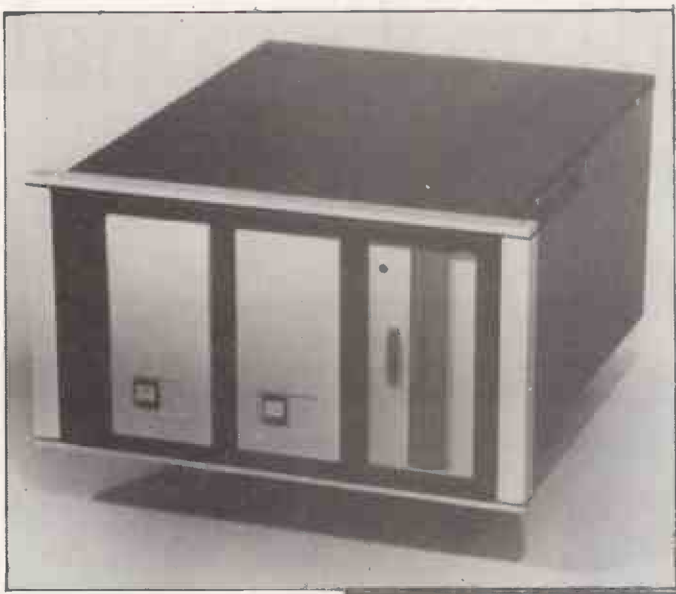
Developments to the PC-3200 are already being discussed and some of future Sharp plans have been announced. They include 8in. floppy disc with 1MB, an RS232 port, a general-purpose I/O card and a RAM upgrade to 96K, all of which should be ready by the summer.



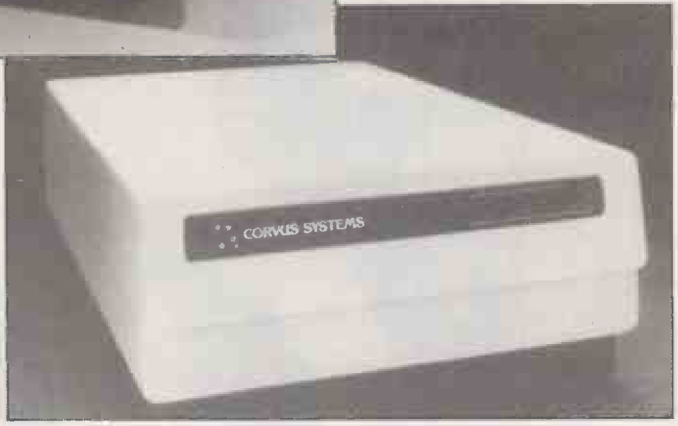
Megastore 8in. drive

IT HAS, of course, been possible to link 8in. discs to the Apple by a variety of means, but now Vlasak Electronics has produced some 8in. drives specifically designed for the Apple.

The Megastore is supplied for plug-in-and-go use with Apple increasing its on-line storage capacity to 1MB. The case is styled to match the Apple and costs £1,970.



The Super Gemini from the General Robotics Corporation of Wisconsin in the States, includes an 8in. 8MB Winchester drive and a single 1.25MB floppy drive and will be sold in the U.K. for slightly more than £8,000. The system is based on the LSI-11/2 chip and includes 64K of RAM. As an option, one can buy the Super Gemini based on the LSI-11/23 chip and with 256K RAM for £11,460. Wilkes Computing Ltd in Bristol has been appointed the U.K. distributor for all the General Robotics computers. Telephone: (0272) 25921.



The latest addition to the growing range of intelligent peripherals is a new 20MB version of the Corvus Winchester disc system. While providing twice the capacity of the 10MB discs, the new system will cost only 20 percent more.

MUSE opens advice centre for teachers

MUSE, Microcomputer Users in Secondary Education, has started a national information and advice centre for teachers using small computers in schools. The Centre will be located in Birmingham and will be manned full-time by a teacher and supporting research and secretarial staff.

Bob Trigger has been seconded from Marsh Hill Comprehensive School, Birmingham, and will take up the post of Information Officer from January 1, 1981. Bob Trigger teaches computer Studies and has recently been involved in a software development project for computer-assisted learning.

The funding for the centre has been provided as part of the Government £9million Microelectronics Development Programme for schools and colleges. The address of the new centre is MUSE, Freepost, Bromsgrove, Worcestershire, B61 7BR.

4K RAM for Aim 65

AIM 65 users can obtain a 4K RAM extension in addition to the 4K already available, a 4K EPROM socket with switchable address, an additional VIA giving 16 I/O lines in addition to the 16 already available and a Eurocard connector all by removing the 6502 chip from its socket on the Aim and plugging in the Eurocard-sized CUBIT card into the exposed socket and then replacing the 6502 chip on the CUBIT.

CUBIT has been developed by Control Universal Ltd, costs £75 and is available on Harlow (0279) 31604. For an extra £15 one can add a crystal and a 6502 chip and one has a very effective, small single-board computer.

New Gemini 801s have RAM-held programmable character sets

A NEW U.K. microcomputer company, Gemini Microcomputers, has been founded by John Marshall, ex-managing director of Nascom which went into receivership earlier this year and is now under a new owner.

The Gemini range of microcomputers includes three models, the basic 801 and two versions of this, the 801A and 801B, all of which have been designed on a consultancy basis by Specialist Micro Design, a company formed by ex-Nascom engineers after it went into receivership.

The 801 is a Z-80-based desk-top system which can run the Digital Research operating system CP/M. For £1,075 plus VAT, it is supplied with 64K of RAM and twin 5in. double-sided double-density floppy discs offering 630Kbytes of on-line storage. It can run an 80- or 40-column screen and has an ASCII keyboard, an RS232 interface and an optional parallel interface.

One interesting feature is that the character set is held in RAM and can, therefore, be programmed to suit the user. For example, the 801 could act as a low-cost terminal for an APL system. A CRTC chip gives a good graphics capability.

Systems 801A and 801B use cassette rather than floppy disc storage and have 8K Basic rather than CP/M. The 801A costs £695 plus VAT and the 801B £575 without an enclosure. According to Marshall, the systems are available in January. An S-100 bus interface is planned for next year.

Versawriter makes full use of Apple graphics facility

ONE OF the most popular features of the Apple has been its graphics facilities but it has often proved expensive and cumbersome to make full use of them. A new product from the States and now available from Apple dealers should help solve the problem.

The Versawriter is a simple version of the Apple graphics tablet, and resembles a draftman's pantograph, with a levered bar which can be moved to any point on the tablet. The software supplied with it gives the user a range of commands and special shapes for use in drawings. They include electronic, electrical, circuit lay-out, architecture, landscape, chemical apparatus, chemical symbols, plumbing and others.

Drawings can be scaled-up and down and rotated; there is a choice of 123 colours and text can be added in five sizes and four colours. The whole unit with the software is available at a one-off retail price of £149 from Micro Management on (0473) 57871 and substantial discounts are available for dealers and others who intend to buy in quantity.

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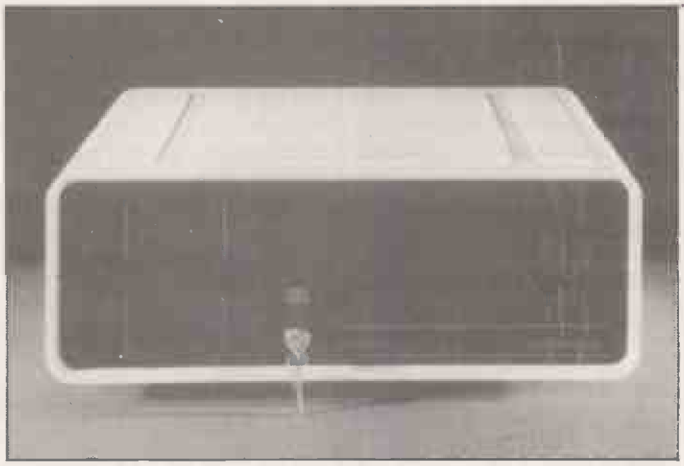
• Circle No. 151

Comart Communicator may help stem tide of foreign imports

U.K. manufacturers of microcomputers seem to be gearing themselves for a stronger attack on the market at a time when the share of the market taken by Japanese and U.S. computers is still rising. The latest microcomputer to be announced is from one of the strongest microcomputing groups in Britain — Comart. Its new Communicator CP-100 has been built round many of the standards which have emerged in the microcomputing industry; a Z-80A chip, S-100 bus and CP/M. There is space for an additional seven S-100 cards and its disc controller is prepared for up to four disc drives.

The design of the Communicator indicates that one its intended is with Prestel, Datel and viewdata telecommunications systems. David Broad, managing director of Comart claims that components have been selected which will be compatible with disc storage requirements in future 8in. and hard-disc models. The basic model will be sold for £2,295.

Comart is still a privately-owned company and has a turnover of over £4million pa. It has the distributorships for a number of well-known microcomputers and, early in 1980, bought the Byte Shop Computerland chain of stores. The company also owns Xitan Systems, a specialist south-coast computer company and Bytesoft, a software house based in Leicester. Details from Comart (0480) 215005.



New Pasca 640 system

ANOTHER Japanese computer is to be launched on to the U.K. market. The Pasca 640 is a Z-80A-based system with 64K of RAM, twin 8in. floppies and a screen built into an integral unit and is sold for the competitive price of £3,300.

The computer will run CP/M version 2.2 and will include a number of special keys which could be used as dedicated keys by users running the Wordstar word-processing package.

According to Barry Motton, of Westrex, about 50 of the new units will be shipped into the U.K. each month from the beginning of 1981. When asked about the competition for the sytem, he claims: "It is not dissimilar to the Panasonic". Westrex can be contacted on 01-578 0950.

Most micros bought for business in U.K., Europe's top market

DESK-TOP and personal computers are finding their way into the business and professional community, with their original markets in science education and the home sliding into second place according to a study of the European market by the International Data Corporation of London.

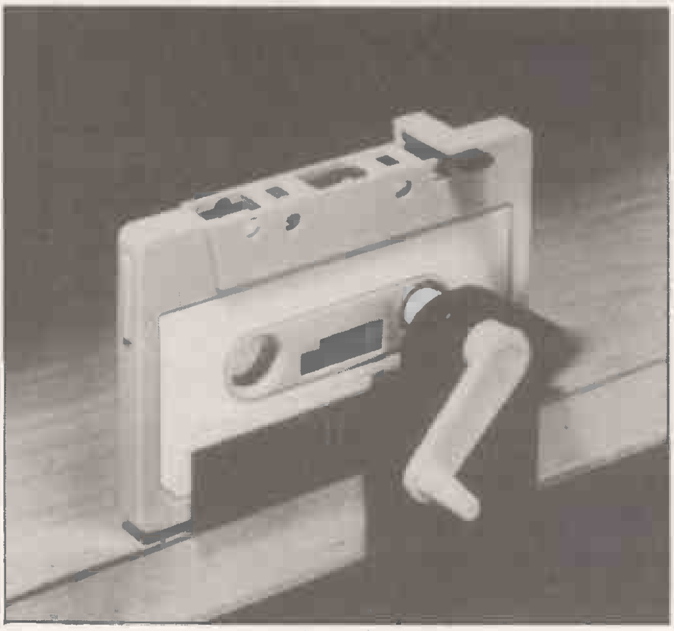
Last year 78,000 desk-top computers were shipped in Western Europe, with 52 percent going into the business sector. By 1983, total shipments are expected to reach 425,000 with 64 percent going to the business community.

IDC claims that Britain has the most developed market in Western Europe due largely to the concentration of efforts by the major U.S. vendors. At least 60 percent of the small computers are already being sold into the business market, 24 percent to the scientific market and only nine percent to the home market. The market is forecast to grow at an annual average rate of 43 percent until 1983 when the business sector will take 74 percent of all the units shipped.

In the rest of Europe, West Germany is the most advanced with nearly 35,000 systems installed while fewer than 15,000 systems have been installed in France, primarily because of resistance to foreign products.

The main advantage that Britain has is the availability of software packages and the dealer/distributor network, although business users still complain of having to re-write substantial sections of programs to run them properly. Copies of the IDC report are available for £995 from IDC on 01-995 9222.

If a pencil is not good enough, try FIXOTAPE as an answer to the perennial problem of tangled cassette tapes. Available for £1.99 from Jorephani Exports, Park Lane, Corsham, Wiltshire (0249) 714855.



CP/M-86 for Intel micros

DIGITAL Research, which developed the widely-used CP/M operating system for 8080- and Z80-based microcomputers, and the MP/M multi-user operating system, has announced CP/M-86, and operating system for Intel 8086/8088-based microcomputers.

CP/M-86 is the first of the Digital Research 16-bit products and has been designed to take advantages of the 8086 address space and speed, while expanding upon the facilities of standard CP/M.

The file format of CP/M, release 2, has been retained for compatibility. CP/M-86 can also function as a slave node in a CP/NET network. MP/M-86 and PL/I-86 will be announced shortly.

Vision-80 keeps electronic eye on your security operations

A SOFTWARE and hardware package called Vision-80 that, it is claimed, makes an ordinary TV camera into an almost universal input device for a micro has been announced by Southdata. The package consists of a digitising board which divides the TV picture up into pixels, a video-output board which displays the results on a monitor and a program written in Z-80 machine code running undr CP/M which scans the picture for moving objects.

The system can, it is claimed, detect objects moving in the picture and classify them according to size, speed and direction of movement. For example, a TV camera might be set to watch a lorry park at night; Vision-80 can be programmed to report the movement of lorries but to ignore the movement of people, cars and animals which would otherwise cause false alarms.

The security industry is an obvious user for Vision-80, but it should have applications as well in production and the military. Southdata has a working prototype and are hoping to find licensees to put the system into production systems. Southdata Ltd, 221 Portobello Road, London.

New scheme for shares

YOUNG HIGH-technology companies in search of venture capital and who are unwilling or unable to approach the Stock Exchange new Unlisted Securities' Market can now try turning to the over-the-counter market in shares, and in particular to a new scheme run by Harvard Securities Ltd which is aimed at young, high-technology companies seeking long-term risk capital to finance expansion and growth. Ring 01-928 8691.

Inexpensive fibre optics

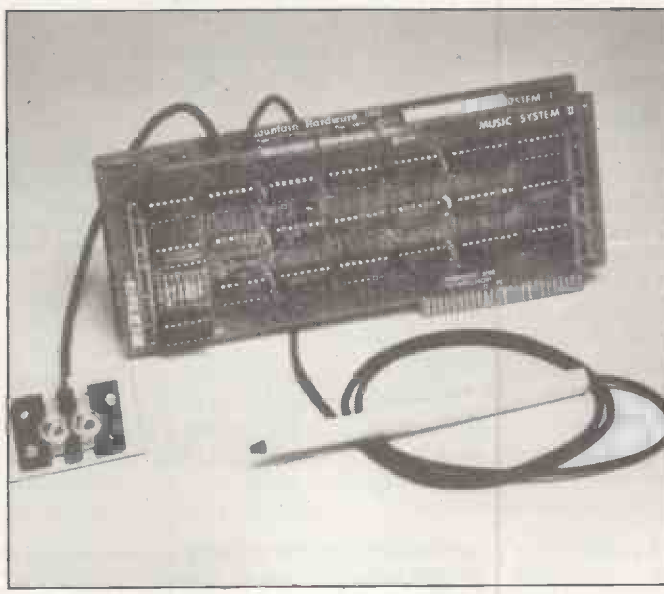
FOR A long time fibre optics have had the air of solutions no-one could afford to problems nobody could quite formulate. That was due largely to their high cost and reputation for trickiness. However, the Japanese have stepped in and removed the difficulties.

Their plastic fibres, are fine for short runs. For instance, 10 foot of fibre with diode receiver and transmitter at each end, costs about £6. Interfacing to digital equipment can be done with standard chips costing another £2 giving a noise-free communication link running at several 100 kHz for less than £10. Call Optronics on (0223) 64364.

Apple II digital synthesiser can mimic musical instruments

A NEW digital music synthesiser has been introduced for the Apple II computer by a U.S. company and is now available in the U.K. from Microsense through its network of 250 Apple dealers. The Music System, it is claimed, can create the sounds of real musical instruments.

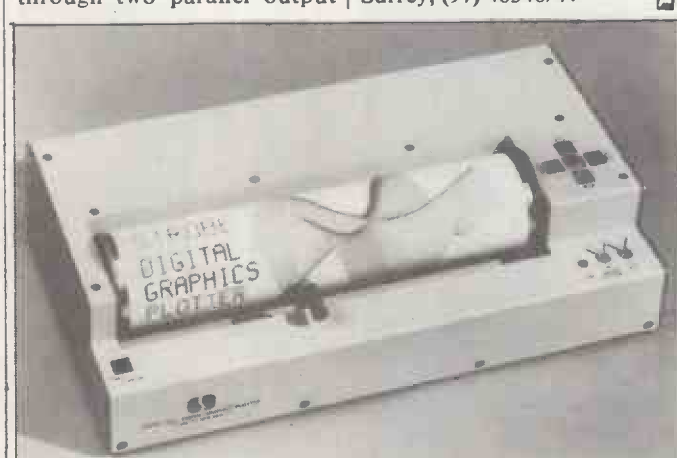
An editor program permits the graphical input of sheet music with standard musical notation. The polyphonic musical compositions can be played, in stereo, through the user's stereo amplifier and speakers or directly from card with stereo headphones. The card costs £294 from Microsense on (0442) 48151.



Model 100 graphics plotter has wide range of hardware interfaces and software drivers

A VERSATILE graphics plotter using A4 paper with an 0.004in. step has been introduced by Hal Computers and is available for £550. The Model 100 is manufactured by Strobe Inc and has hardware interfaces and software drivers for the Apple II, TRS-80, Pet and S-100 bus computers. An optional software package, providing vector generation and alphanumerics, which runs with most versions of Basic and Fortran, is also available.

The Model 100 plotter has an interactive digitising mode, allowing the user to enter directly into the host computer XY co-ordinates corresponding to the pen location. It is controlled by the computer through two parallel output ports and one parallel input. Hal Computers is based in Surrey, (97) 48346/7.



Aim, Sym video control

A VIDEO controller board for the Aim, Sym and Kim range of microcomputers has been released by Portable Microsystems of Brackley. The Video plug adjusts automatically to 40-by-20 or 80-by-20 screen widths and can be programmed for display formats up to 100-by-20 or 48-by-20.

The operating software is available on cassette, with the Aim and Kim tape formats supported, or in EPROM and has been designed to run with the Aim, Sym or Kim monitor programs without modifications to either the editor or the Basic. The card costs £196 from PMS on (0280) 702017.

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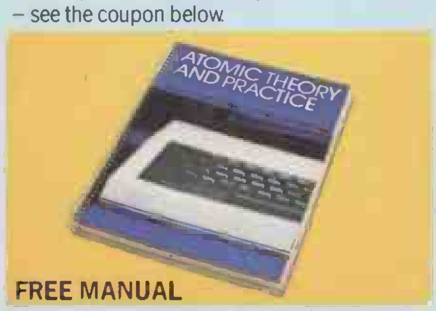
Just connect the assembled computer to any domestic TV and power source and you are ready to begin. (Power requirement: 8V at 800mA). There is an ATOM power unit available – see the coupon below.



FREE MANUAL

Free with every ATOM, kit or built, is a computer manual. The first section explains and teaches you BASIC, the language that most personal computers and the ATOM operate in. The instructions are simple and learning quickly becomes a pleasure. You'll soon be writing your own programs. The second section is a reference manual giving a full description of the ATOM's facilities and how to use them. Both sections are fully illustrated with example programs.

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SOFTWARE

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Still no clear precedent in software copyright cases

SOFTWARE suppliers of all kinds will applaud recent developments in copyright protection highlighted by several recent court cases — though some civil liberty campaigners may not be so cheerful. In one case, AJ Harding (Molimerx) of Bexhill sought and had obtained, an injunction restraining Chesterfield-based Kansas City Systems from allegedly pirating tapes of a version of Basic and a monitor.

Program check

The dispute between Harding — and Microsoft — and Kansas City Systems centres around Level IV Basic which originated from the now-defunct California-based GRT Corporation. Harding and Microsoft had been marketing the program and monitor for some time when they noticed a new firm offering a Level IV Basic.

When they checked the program, which was underselling their own Level III by a considerable margin, they found, claims Anthony Harding, that it was fundamentally the same.

Kansas City's Tom Crossley disagrees. He says that there are four extra commands in Level IV added by his own programmer Laurie Shields, which make it a substantially more powerful program than Level III, and contends that in any case, he bought the rights to the program legitimately from Sorrell B Chapman — after GRT Corporation had folded.

In the event, two judges disagreed with Crossley's story. The first, Mr Justice Graham, granted Harding an *ex parte* injunction against Kansas and also made a so-called Anton Pillar order against Crossley. That meant that Harding's agent was able to go to the premises of Kansas and seize relevant evidence. He did not, though, confirm the injunction; a second judge, Mr Justice Fox, subsequently extended the injunction until the case resumes and he makes a final order.

The problem is that a final order is unlikely ever to be made. Harding and Crossley settled "at the courtroom door" — with Crossley agreeing to pay a £2,000 contribution towards Harding's costs and undertaking not to market Level IV. Crucially, there was no admission on Crossley's part that Level IV and the monitor were obtained any other way than legitimately.

While the judge, on the one hand, seems to imply that — despite legal pundits' predictions to the contrary — a computer program falls fully within the definition of the existing Copyright Act by granting the Anton Pillar order, the point has still not been tested in law.

When, early in 1980, Microsoft and AJ Harding had noticed that Kansas City Systems were offering 'Level IV Basic' for £34 — about half of their own price of Level III, they obtained a copy of the program and found that the listing was substantially similar. That point is not in dispute, since both Harding and Kansas's Tom Crossley agree that the source of the program was the GRT Corporation.

Official agents

Microsoft and Harding were the official agents for Level III in the U.K. The loss of business was hurting, so Harding instructed his solicitor, Robert Mitchell,

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The Anton Pillar Order

THE ANTON Pillar order, which instructs the person on whom it is served to allow his premises to be searched for evidence relevant to a case of alleged deliberate infringement of copyright, dates from only 1976 and has already been used "several 100 times", mostly in cases of record or radio broadcast piracy according to one estimate.

Alistair Kelman, a barrister who specialises in copyright problems, is concerned that there are inadequate safeguards on this type of order, which he describes as a "judicial invention". It has never been debated by Parliament and, points out Kelman, not even the police have the power to walk into an individual's premises "for the purpose of discovery" of evidence.

The order is so called because it was first used in the case of a German, Anton Pillar, who was a manufacturer of emulators for IBM. Unbeknownst to Pillar, British distributors of the utility were secretly copying them and distributing them at cut price. This was losing IBM a good deal of business.

To put a stop to this practice, the plaintiff Anton Pillar sought an injunction and argued, successfully, that to seize the evidence, it would be necessary to take the offenders by surprise; if averted, he argued, they would simply dispose of the evidence.

Hence, in a case of alleged infringement of copyright, the plaintiff may apply to a judge *in camera* for an *ex parte*, injunction, along with an Anton Pillar order for the purposes of discovery of evidence. The two points to which Kelman objects are that:

- The order is granted on affidavit evidence. Kelman submits that the plaintiff should be cross-examined.
- The plaintiff is required to make only a "substantial undertaking" that he can compensate the defendant if the evidence fails to yield any sign of infringed copyright. Kelman suggests that the plaintiff be required to pay in a sum of around £10,000 to the court against that eventuality.

Damages in this kind of search could be substantial: the order empowers the plaintiff's agent to take away "articles and documents which relate to the allegedly pirated work made in breach of any copyright owned by one or more of the plaintiffs" and store it in his own custody. That, indeed, is what has happened in the case of Molimerx v. Kansas City Systems.

Since it is the issue of copyright which is at stake, it is

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Alistair Kelman, the barrister who specialises in copyright cases.

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to obtain at the beginning of November last, the *ex parte* injunction against Kansas City Systems — along with the Anton Pillar order which permits the plaintiff to seize relevant material.

What that meant in practice was that Harding's solicitor Robert Mitchell, Kansas City's solicitor and two other local Chesterfield solicitors were appointed officers of the court and went to Kansas's premises where they were empowered to search for, and remove, any relevant evidence. They spent most of the day there and took away two suitcases full of tapes and correspondence.

This evidence is, according to the provisions of the order, to be dealt with "in accordance with the wishes of the parties concerned" when, and if, a final order is made. That is now unlikely to happen.

Both parties

That seems to suit both parties concerned. As Crossley says: "Put it this way: I've sold 150 of those programs at £34 a time", so whether or not he bought the suite in good faith from an ex-GRT employee by the name of Sorrell B Chapman in late 1979 is not really the point at issue.

Meanwhile, the software copyright laws are being bypassed by the police in favour of conspiracy. In the case of Graham Dorian Software, police are investigating the alleged theft and dishonest handling of software owned by the U.S. firm. The firm's U.K. chief Paul Joyce has said that he "will see through to the end" the alleged theft of some of Dorian's source codes.

A third case involves Compshop which is alleged to have copied the design of the Pet Toolkit by its official British distributors Zynar, and marketed it at cut-price. Zynar wrote to Compshop implying the possibility of obtaining an injunction, but Compshop promptly gave Zynar the required undertaking to cease marketing the device: so it appears that the law of copyright with respect to firmware also has yet to be tested.

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curious that the plaintiff should be given the *de facto* power of adjudicating what is, or is not, infringing. He is also allowed to inspect and photograph accounts and ledgers and mailing lists, all of which may contain perfectly legitimate transactions as well as the allegedly infringing ones.

Some may argue that the threat to civil liberties implied by the Anton Pillar order are more illusory and theoretical than real, since most of the people in software know the game and will give way when confronted with the reality of their competitor's solicitor walking through the door with what amounts to a search warrant.

They would be wrong. By way of example, the British Phonographic Society, which has seized on the order and vigorously exploited it to pursue record and radio pirates, has shown some extraordinary misjudgments; we have already seen the unedifying sight of a butterfly being crushed on a wheel in the case of a young "trader", Richard Piggott-Sims, whose entire collection of nearly 500 radio concert tapes was taken away by an "officer of the court".

He was not using them merely for gain — he is only 17 years old — but swopping them for like tapes with penfriends in the U.S. France and West Germany. Although the judge agreed BPI's submission on a point of law that Sims-Pigott was in breach of the Performers Act 1958 by "trading by way of barter", he was impressed by the young man's "sincerity, musical ability and technical skill" and ruled that he was doing it for "private pleasure not personal gain", and that these pleasures would not interfere with BPI's commercial interests.

One can easily imagine just such circumstances arising in the case of software tapes. Many people already copy tapes without or with modifications; a user group copying session could very well find itself the subject of such an order.

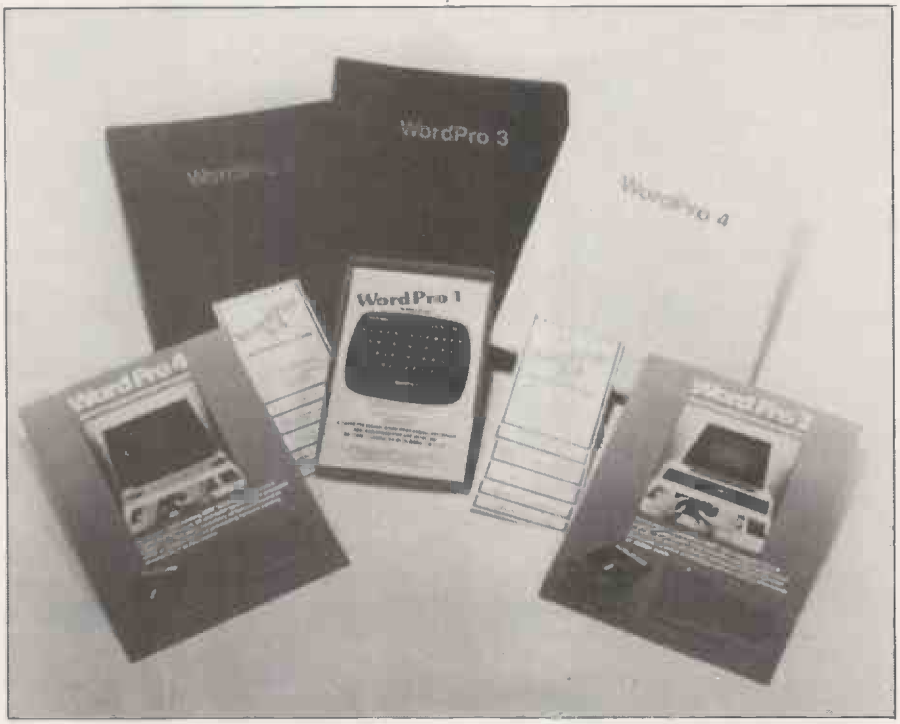
WordPro 4 with 8032 Pet can rival dedicated WP systems

WordPro 4 is the latest word-processing package from Professional Software designed to run on the new 80-column screen Commodore Pet. Nick Hampshire delivers his verdict.

WRITTEN in 6502 machine code, WordPro is, like its predecessors WordPro 1, 2 and 3, a very professional package.

The combination of improvements incorporated in the latest version and the new hardware make the Pet a very attractive proposition for serious word processing. For less than £3,500, the 8032 Pet with a one megabyte 8050 disc drive and daisywheel printer, running WordPro 4, rivals many systems costing more than four times the price.

The system required for running WordPro 4 is an 8032 Pet with either an 8050 or a 3032 with DOS 2.4 upgrade ROMs. The printer can vary from a Commodore 3032 tractor printer to the most expensive daisywheel; output can be specified by the software for either a CBM printer, NEC Spinwriter or an ASCII printer.



Suitable interface

If a Spinwriter or ASCII printer are used, a suitable interface unit will be required to convert the output of the Pet IEE 488 port into serial RS232 form. Multiple key-station system can be configured easily using a device like the MuPet which allows up to eight Pets to access a single disc drive and printer — an ideal proposition for the larger office.

The software is supplied on disc together with a 128-page manual in an attractively-presented ring binder. Also included is a protection ROM which prevents the software from being run on any machine not fitted with the ROM. The protection ROM is mounted in one of the two spare sockets provided within the machine, and can be fitted very easily by user or Commodore dealer.

The documentation is a considerable improvement on that provided with earlier versions of WordPro and is, by general standards of documentation, reasonably good. Designed as a combination of reference manual and self-teaching course with lessons and exercises, each function is clearly explained with examples.

Function sections

The manual has been divided into sections each describing increasingly complex functions — a good idea as it allows WordPro 4 to be used for the majority of simple operations afer a minimum of reading. Understanding of the more advanced functions can then be achieved while using the machine for every-day word-processing work. In my opinion, the average typist will be able to use this word processor after an hour or so of reading the manual and typing the machine.

To help the user understand the various operations, there are several sample text files included on the disc, which will resolve many questions. There is no index in the manual which is unfortunate. There is, however, a reasonably good table of contents which to some extent makes up for this omission.

First procedures

The first procedures to be executed when the program is loaded and run, are to set-up the system parameters. They are; first to determine the size of the main text area, the memory available for storage of text within the processor is divided into two sections, main text and extra text with a total combined size of 169 screen lines.

Main text can be between 85 and 146 screen lines long — each screen line is 80 characters — and is used for entry of the text file being worked on. Extra text memory is principally used to store variables and blocks of text which are to be dynamically inserted into the main text area, it can be between 23 and 84 lines.

The next parameter required is the printer device number which is determined by the hardware in the printer or interface and is usually set to four. Also required is the printer type — CBM, ASCII, or Spinwriter — again, the choice is dependent on the system configuration of the hardware. Lastly, the disc drive device number is required which is set in hardware and is usually device eight.

Having entered the system parameters, the word processor is ready. The screen will be blank except for the top line which is used to display the status, current command mode and line and column position of the cursor. Text can be entered straight from the keyboard, all the cursor-control and editing keys function as normal.

Control key

Certain keys have been assigned special functions; the most important is the OFF/RVS key which, under the word processor, functions as a control key and is used to access all the control characters used.

Single-character insertion and deletion can be done with the INST/DEL key which can also be used to insert or delete

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complete lines of text by depressing the control key. If you want to insert a few sentences within a block of text, the insert mode can be used, which is initiated by pressing shift and control. Each time you press a key, the text in front of the cursor is pushed forward one character and the character just entered inserted.

The principal feature of word processors is their ability to format the output text which is done in WordPro 4 by using format control lines within the text. There are 21 format commands — in table 1 — which give the user a very wide control over how the text will be printed.

A string of format commands is always preceded by a check-mark generated by pressing the control key, then the back-slash key. The format commands consist of two characters followed by a numeric variable and are separated from each other by a colon.

A typical pair of formatting commands are those which set the text margins; "rm70" will set the right margin for printing at column 70 on the printer and "lm10" will set the left margin at column 10. When the text is printed, it will be a maximum of 60 characters wide starting at column 10 and ending at column 70.

The paging-format commands allow the user to set the length of each page and the number of lines to be printed on the page. The appearance of the printed text can be improved by commands such as "on" which centres a word or sentence on the page. "Ju", the justify command, converts the normal ragged right margin of typed text into a straight line by padding the line with extra spaces.

Once the text has been entered, together with the format commands, it can be output to either the screen or a printer in its formatted form. By outputting to the screen first, the formatting of the text can be checked before outputting the final copy to paper, thus saving paper.

Principal new feature

Outputting the formatted text to the screen is the principal new feature of WordPro 4 and has been made possible by the introduction of the 80-column screen 8032 Pet. The output can be either for a single-page or a multi-page continuous document — using paging and automatic page numbering and heading-format commands — and can be either for a single copy or multiple copies — up to 255.

The quality and type of output depends very much on the printer used. With a CBM printer, format commands can be used to produce enhanced characters, but with a daisywheel format commands can give underlining and up to 10 special characters, e.g., the pound sign, £.

File-mode saving

Any text entered into the machine can be saved on to disc by setting the machine into the file mode, which is accomplished by pressing the shift and CLR/HOME key. The status line will prompt whether you want to recall, memorise or insert. To save the text, press 'm' for memorise, then, when prompted, enter the drive number and the file name.

To load a file from disc, load the directory — press control and the drive number — put the cursor in front of the file name to load, enter the file mode and press the back-slash key and return — the desired text file will then be loaded.

To aid the use of discs, all the disc-drive commands are available to the user allowing discs to be initialised, formatted, copied, etc., by the user when required, without affecting the current text entry.

WordPro 4 offers a range of advanced

Summaries

Summary of <CONTROL> functions

Name	Enter by	Use	Cancel
Append function	<CONTROL> a	Append lines from extra text	yes
Print variable block	<CONTROL> b	Put a variable block on screen	no
Clear tab	<CONTROL> c	Clear tab at cursor position	no
Delete	<CONTROL> d	Delete words and sentences	yes
Erase	<CONTROL> e	a = erase all r = erase remainder l = erase line	yes
Find	<CONTROL> f	search for a given string	yes
Goto	<CONTROL> g	Go to a specified line number	yes
Hunt	<CONTROL> h	Re-start a local find function	no
Fill variable blocks	<CONTROL> i	Fill in variable blocks	no
Clear all tabs	<CONTROL> k	Clear off all the tabs	no
Dupliate lines	<CONTROL> l	Dupliate the range of lines	no
Modify	<CONTROL> m	Modify search replace strings	yes
Numeric mode	<CONTROL> n	Turn on or off numeric mode	no
Output	<CONTROL> o	Enters the output function	yes
Range	<CONTROL> r	Sets a range of lines	no
Set tab	<CONTROL> s	Sets a tab at cursor position	no
Transfer	<CONTROL> t	Transfer the range of lines	no
Variable characters	<CONTROL> v	Appends groups of characters	yes
Extra text	<CONTROL> x	Switches in and out of extra text	no
Dellmiter	<CONTROL> z	Enters a delimiter for list data	no
Global copy	<CONTROL> *	Copies of files in a codument	yes
Send disc	<CONTROL> .	Send a command to the disc drive	yes
Read error channel	<CONTROL> ,	Read the error channel	no
Special character	<CONTROL> +	Enter a special character	yes
Underline	<CONTROL> [	Turn on underline	no
	<CONTROL>]	Turn off underline	
Hyphen	<CONTROL> —	Enter a hypen symbol	no
Find variable block	<CONTROL> TAB	Find a variable block — go to it	no
Empty a variable	<CONTROL> ARROW UP	Delete the contents of variable block	yes
Home data	<CONTROL> HOME	Clear data pointer to home position	yes
Re-start	<CONTROL> <SHIFT> STOP	Re-start program	no
Directory	<CONTROL> 0	Drive#0 directory	no
	<CONTROL> 1	Drive # 1 directory	
	<CONTROL> 2	Both directories	
Re-start global find	<CONTROL> CSRS RIGHT	Re-start a global find function	no
Search and replace	<CONTROL> @	Enter search and replace function l = locally g = globally	yes
Check mark	<CONTROL> /	Enter a check mark on the screen	no
Line delete	<CONTROL> DEL	Delete a full line	no
Line insert	<CONTROL> <SHIFT> DEL	Insert a full line	no
Other functions			
Insert mode	<SHIFT> <CONTROL>	Enter/exit insert mode	N/A

Summaries

Summary of formatting commands.

Command	Name	Parameters	Default
cm	Comment	—	—
cn	Centring	1 = on, 0 = off	off
fp	Forced paging	none = immediate 1—255 = conditional	—
ft	Create page footer	—	—
hd	Create page header	—	—
hl	Head left margin	1—163	lm
hr	Head right margin	2—164	rm
ju	Justification	1 = on, 0 = off	off
lf	Send line feed to printer	1 = on, 0 = off	off
lm	Left margin	1—163	5
ln	Do a specified number of line feeds	1—255	—
ma	Margin release	1—163	—
nx	Link next file	filename	—
p #	Set page number	2—254	1
pg	Set paging	Less than pp	—
pp	Set printer page	Page Length	—
pt	Set pitch	10 = 10 Pitch 12 = 12 Pitch	10
ra	Right alignment	1 = on, 0 = off	off
rm	Right margin	2—164	75
sp	Set line spacing	1, 2, 3	1
vp	Vertical Positioning	1—pp	0

editing features, such as the ability to move blocks of text within a file or search for and replace every occurrence of a particular character, word or sentence, with another entry. The search-and-replace facility is invaluable for updating text files and the search-without-replace mode could prove very useful in the compilation of indices.

Inputting text can be facilitated by tabs which can be set at any position within the 80-character screen width; as many tabs as required can be set. Once a tab has been set, pressing the tab key will move the cursor to the next tab position.

Numerical entry

Entry of numbers in column form is made easier by setting the machine into the numerical entry mode which, in conjunction with tabs set for each column of numbers, allows the right-justification of all numerical columns by placing the numbers to the left of the cursor.

To facilitate the production of standard letters, WordPro 4 incorporates an area of extra text memory. In that text area, one can store variable blocks of text for insertion into a standard letter. It might contain a series of names to personalise and replace the normal "Dear Sir" of standard letters.

The standard letter or piece of text in which variable blocks are inserted is stored in the main text area and the position of the variable designated by a control b character. In the output mode, the word processor can be set to insert the variable text into the standard letter automatically, print it, and then insert the next item of variable text and so on until a complete set of letters has been produced — each identical except for the blocks of variable text.

Full formatting

That feature, combined with the very neat output possible with full formatting and justification on a word processor, plus the fact that each letter is typed individually, will increase greatly the response from direct mail shots and replies to advertising enquiries.

If the word processor is to be used for writing lengthy documents, the global command feature of WordPro 4 will prove invaluable. Global commands mean that one can link files together. Each file on disc has a maximum length of about three single-spaced A4 pages, thus a document of about 100 pages will require more than 30 disc files. By linking each of them together, the whole document can be printed-out without having to load each file individually.

Page headers

Files are linked to each other by having the last line of a file with the command nx: followed by the file name which is to be loaded next. The format commands are carried from one file to the next and thus once defined, need not be re-defined for each file unless they are to be changed.

That means that page headers and page-numbering format commands will continue in the correct sequence across different text files. One can print not only an entire file in the global mode but one can also search or search and replace strings throughout the document.

Conclusions

• WordPro 4 is in my opinion an excellent piece of software, both user-friendly and apparently very robust.

• Mistakes may ruin text but have no effect on the program.

• One thing which particularly pleased me as a user of the previous versions of WordPro is that my text files generated on those old versions can still be used on WordPro 4, although they require the addition of new format commands to take full advantage of the extra features available.

• It may sound obvious that files should be compatible between different versions of a software package — however, that is regrettably not always so.

• For the programmer, the file structures are explained fully in an appendix which offers the user the potential capability of integrating WordPro 4 with other applications packages like a mailing list.

• A word-processing system based on the package together with an 8032 Pet and an 8050 disc drive plus a reasonably good daisywheel printer such as a Spinwriter seems to be a good investment for any business.

Speed and clear commands combined in SCDS PetDOS

UNTIL RECENTLY, most Pet users have only had the choice of a range of mediocre software which may have led some to try to write better programs themselves. There have been exceptions and the first real quality program to appear was probably Microchess. Apart from being an exceptionally good game, Microchess offered other attractions. It contained a good security system to prevent illegal copying which in itself must have intrigued many. Secondly, and most important, it is in machine language, not just a small routine, but a full-length program, which is very fast in execution.

Now, both in the field of games and business, more good programs are available. The best are in machine code — the latest is SCDS PetDOS. It has a comprehensive instruction manual, which is very complete and of a high quality. It goes to some lengths to explain that PetDOS is not just an assembler, but a complete DOS. The aim is to build a library of largely technical and business programs, and it has gone beyond most in creating its own DOS for the purpose. Future programs are all likely to run under the newly-created disc-operating system. Indeed a word processor is almost complete.

Easily amendable

On checking, we found that SCDS PetDOS relies to a minimum on the Pet ROM already available. Apparently, that is to overcome some inherent problems and to make it easily amendable in the future as systems change. That must be forward thinking, as the new 80-column 8032 Pet and Computhink disc will require some amendment no doubt. Experience has already shown that there was little modification required to the software for the two CompuThink disc units required for old- and new-ROM, 40-column Pets.

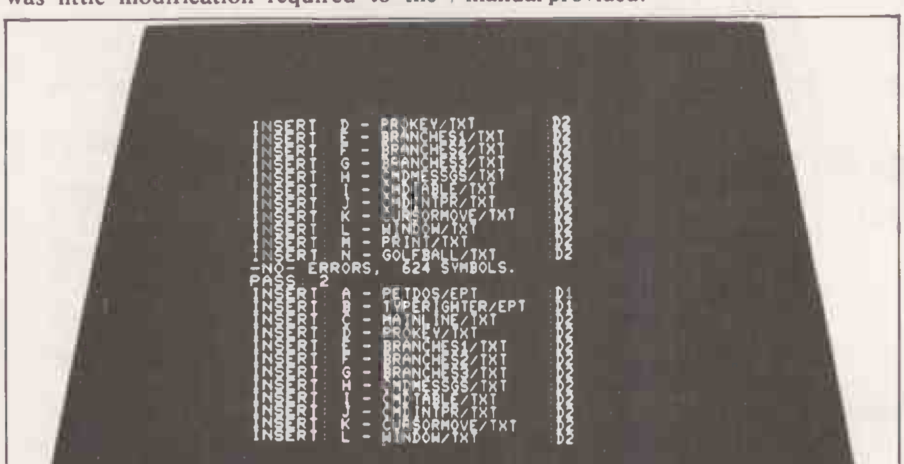
With any new software, time is required to become acquainted with the new instructions. Once familiar, using SCDS PetDOS is like space travel compared to Lindberg's first crossing of the Atlantic by aeroplane. The speed of assembly is dazzling, particularly when compared to assemblers written in Basic. There is more, much more available to make the programmers' task more straightforward.

by Andrew and David Trott

One of its biggest attributes is that the full 32K of RAM is available for addressing, including zero page. That is made possible as it does not assemble into core but direct on to disc.

As one might expect, the full package is supplied on the normal 5in. diskette. The system is available for use with single- or double-density and single- or double-sided disc systems. Although a complete disc-operating system, no hardware changes are necessary. Furthermore, where Diskmon and SCDS PetDOS overlap, they are entirely compatible.

As always with the CompuThink system, the initialisation 'SYS45056' is required. That, together with the instruction $X,D,"PETDOS.GO", or equivalent for old Diskmon system disc units, is the last seen of the standard commands previously available. Incidentally, D stands for the device number. Indeed, as one might expect, some keys have modified use and they are both logical and clearly-explained in the manual provided.



Once under SCDS PetDOS command, the first entry required is the date in the form DDMMMYY. It is possible to bypass it by use of the return key. Immediately following is the call 'Enter time' in the form HRS:MINS:SECS. In this case, there is no optional return key override. This is the only point we found irritating in the whole system. Both the date and time are required primarily for hard-copy printouts and in those circumstances, dated and timed-references would be helpful. Very frequently one may wish to enter source code, assemble and print to screen without producing a hard copy.

Options available from the READY are:

EDIT
UNISAM
PRINT
APP
MAKEGO
CAT
BACKUP
COPY
KILL
NEWDRIVE
LOOKCLOCK

LOOKCLOCK was provided presumably because the facility was already used as a reference when making printouts. With only slight modification, a real-time clock could be provided easily. Maintaining reasonably accurate time is somewhat difficult with a CompuThink disc system attached to a Pet as the Pet way of maintaining time is switched off each time the disc unit is addressed. All these options may be entered as such or with the suffix /CMD. In effect, the PetDOS.GO routine may be considered a menu through which the various utilities may be approached.

Simple entry

The simple entry, EDIT FILENAME, calls the required routine. Alternatively, if known, the drive number may also be entered, but that is not essential. If the drive number is not entered, the directory of each disc is searched in turn. If no such file exists, the question "CREATE THE FILE (Y/N) ?" is displayed. An entry of 'N' will return to DOS for the correct file name or other details to be inserted.

One useful point is the use of the stop key, often immobilised on other programs. It gives greater control and security of mind. There are one or two occasions when it is not usable and one such time is during MAKEGO. In this case, it is, however, difficult to foresee circumstances when one would wish to stop. After all, the program by this time should be tested thoroughly through the DOS system.

The first time the EDIT text editor

routine is used, one may be surprised to find that displayed on the left-hand base of the screen is a very poor artist's impression of a skyscraper complete with arrow at the base pointing to the underground carpark. It becomes obvious that the arrow points really to the last line of entry, which in this case is obviously nothing. The skyscraper is, in fact, constantly indicating free memory so that as it grows taller and nearer the top of the screen, one can see how free memory is being used.

Memory monitor

Each time another floor is added, there is 1K less memory available. As there is 16K available at the start, there is a great deal of text editor to fill. Finally, when full, a message "BUFFER FULL" is displayed. The skyscraper display is certainly a novel way of monitoring buffer-free memory.

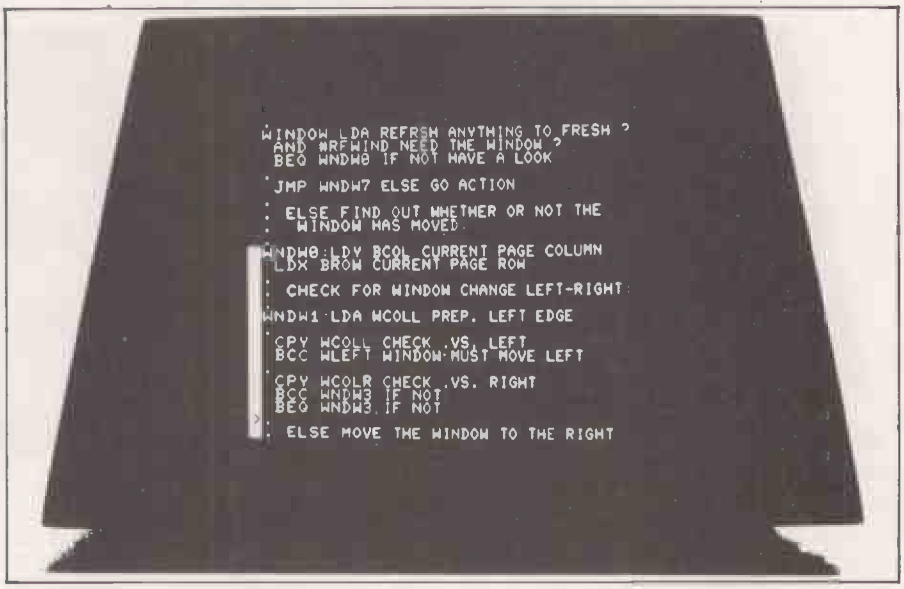
Text may be scrolled-up or down the screen and deleting lines or inserting a new line at any point is simplicity itself. A repeat key would have been a useful feature and it might perhaps be provided in a future upgrade. One useful convention throughout the system is the cancellation of any line of input by pressing 'RVS'. The use of line numbers would be useful in defining portions to be deleted, etc. Apart from that, all the frills one could wish for are supplied with simple instructions.

The more interesting and unusual are a find instruction which will locate occurrences of a quoted string; a repeat instruction which will repeat a section of defined text; a multi-line delete function; a change facility which will, for example, change label names throughout the source text, etc.

Insert facility

Possibly, the most important could be an approximation to a macro facility referred to in SCDS PetDOS as the insert facility. It enables routines already written, tested and in a text file to be called whenever required. Such routines may be used in a final program exactly where required in the text. It also provides the possibility of assembling programs up to the full limit of RAM.

One discipline which must be acquired



is that of putting a blank space before each opcode entered, while putting a label in the first available column. After a short time, one grows used to that form of entry. Apart from that, the form of entry is as for other editors.

There are two ways of exiting from EDIT. The first is by entering :E. which will update the file on the previously-specified disc, or if not specified, on the disc from which the text was first entered. The alternative is :0. Writing time is approximately five seconds per 2K for a double-density system.

Important feature

One of the most important features of a complex program is that it should follow logical and simple conventions. Having to check constantly in the manual is both time-consuming and frustrating. This program follows clear logic. Perhaps one of the best illustrations of that is when addressing the assembler. The instruction is:

UNISAM FILENAME/1:Dd,FILENAME/2: Dd, ...

The dotted line is included to represent up to a further three filenames making FILENAME/5:Dd the last possible. FILENAME/1 refers to the source text filename which will later be suffixed /TXT. FILENAME/2 refers to the DOS-assembled version which is normally known as /ABS or absolute. FILENAME/3 refers to the print filename later to be suffixed /PRT and the filenames 4 and 5 refer to files concerning labels and entry points which will be used by advanced programmers.

In each case, the small 'd' refers to the device of the filename concerned. The fourth and fifth filename will be omitted frequently, but so too may be the second and third. Each file will be stored on disc with a four-digit suffix denoting type and preventing accidental overwriting.

If the only filename entered is the text filename, no file will be created, but the routine will continue for the purpose of exposing assembly errors. There are many more options which all make for ease of use and the minimum of typed input.

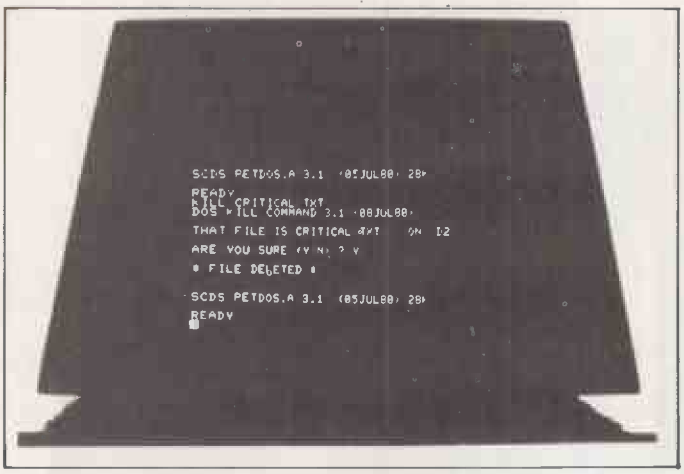
Symbol table

The assembler symbol table is held in core and there is, therefore, a limit of 928 symbols available. That seems more than adequate for any foreseeable situation. For the professional coffee drinkers of this world, new excuses will be necessary to pursue their addiction. A two-pass assembly and creation of print file takes about one minute per 1,000 bytes of finished machine code. Clearly, the content of the text file can greatly affect the assembly speed, but tests were made

(continued on next page)

```
PAGE:    2 - UNISAM 3.2 (08SEP80)  CODESET: 6 5 0 2  MICRO - TRIAL/TXT

          1.  0401                    *=    $0401
          2.  0401 A200    TRIAL      LDX   #0
          3.  0403 A9A0               LDA   #$A0
          4.  0405 9D0080  LOOP1      STA   $8000,X
          5.  0408 9D0081             STA   $8100,X
          6.  040B 9D0082             STA   $8200,X
          7.  040E 9D0083             STA   $8300,X
          8.  0411 CA                 DEX
          9.  0412 D0F1               BNE   LOOP1
         10.  0414 60                 RTS
         11.  0415 0401               .END  TRIAL
 -NO- ERRORS,     2 SYMBOLS.
```



(continued from previous page)

on what might be considered a typical assembly using the insert facility which slows the assembly process to some extent. Thus Microchess could be assembled in approximately eight minutes.

However, the absolute file is not the final .GO-type program and one might be forgiven for wondering why. Apparently, one reason is that of space. To put both UNISAM and MAKEGO together would reduce the number of symbols available, and remember, the program is capable of creating machine-code programs for use anywhere in RAM with a large symbol table available. It will be run frequently under its own DOS. In these circumstances, the MAKEGO facility is superfluous. It is a very powerful system which gives many advanced options. In any case the time required to MAKEGO is only a further 20 seconds per 1,000 bytes.

Reconciliation error

It is possible that some will feel that insufficient error messages are used for the assembly process. Indeed one of the seven provided, reconciliation error, is difficult to understand. When a label address is used on pass one, and prior to defining its address, which will naturally be known on pass two, three bytes will be reserved. However, if page zero is the area of addressing, only two bytes will be required and the assembler flags the error. Conventions exist to overcome the problem, but when first encountered, the problem may be difficult to diagnose.

It might, too, be helpful to modify some of the error messages; LDA # 0F and LDA ($00),X are both expression errors. We feel, as they are different types of error, they require different messages to describe them. A branch out of range is also flagged as an expression error which is clearly not the case. Nevertheless, errors are flagged and it could well be that some of these points are expressions of personal preference more than anything else.

Following successful assembly, it is likely that programs just written will be tested. That may be done without the use of the debug routine, but is unwise unless very short and almost certain to be correct. If programs have been written for use in areas between $1A00 and $7FFF, they may be tested without modification. Those lower than these locations will encounter the PetDOS working area and a modified file will need locations assembling with the lowest RAM address occupying $1A00. Later when correct, all that will be required is to alter the load address.

Assuming, therefore, that the debug is required, it must be called up with the '#' followed by the return key. For a start, all the registers may be examined by pressing 'R', but the main use will be to set break points in the newly-written program. That is done by pressing 'M' followed by the required address. To increment by one place, press 'HOM'. A modification to the program is possible by amending as though through the monitor.

Providing only break points are required, it is straightforward. Pressing 'E' will return to DOS where the program may now be run, a segment at a time. We did not find the debug a very powerful tool as it is somewhat slow to implement in that way, but it is a feature of testing programs written in machine code. As with all programming it pays to be right first time; there is no easy alternative.

Page length

Unfortunately, we were able to test this routine on only two types of printer. One, the Commodore 3022 using the IEEE 488 port, did not work satisfactorily. The printout was understandable but not well formatted. On the other hand the Texas 810 printer, using the RS232 port and ADA 1200 interface, performed well. Undoubtedly, the performance on the Pet printer needs improvement and is the only point we found short of perfect.

When printing on the Texas printer, the page length is set to 66 lines of which print is displayed on 60. The width required is 80 columns although we understand that a modification would be possible for 40-column printers. Furthermore, it might be possible to have a different number of lines per page if there was a demand. That could be set each time in response to a question through the screen. The lay-out is perfect and line numbers omitted from the screen display on edit are now shown. When printing-out a large program with the INSERT facility in use, each INSERT will still be printed in full and not just by reference as one might expect.

Important utilities are available such as BACKUP which copies discs through DOS. Surprisingly, the normal Diskmon DISKCOPY routine will not copy discs. KILL is the equivalent of Diskmon 'Erase' and CAT will display the directory to the screen. In this case, more information is available than when calling $DIR on Diskmon. NEWDRIVE will modify the scope of search for files and may be used to protect an area containing files of the same name.

The standard of documentation is exceptionally high. All too often, a good program receives insufficient attention in that area. Apart from approximately 160 full pages of instructions, the manual has been conceived by a perfectionist and professional. If there is any criticism at all, it must be that as with all perfectionists, they tend to allow for every situation. That can mean that although every situation seems to be covered in the manual, one sometimes has to search for the answer. That situation is preferable as it is most annoying when answers are implied rather than detailed. The price of the package is likely to be about £150.

Conclusions

- **PetDOS is a thoroughly professional and well-thought-out program.**
- **Commands are always clear and logical throughout the software's own DOS.**
- **It is written totally in machine language — there are no routines in Basic.**
- **The assemblies are very fast and so are an excellent way to increase productivity.**
- **The package prints neatly to RS232-interfaced printers.**
- **Some improvements ought perhaps be made in its performance for printers using IEEE 488 ports.**
- **The instruction manual is extremely comprehensive and the package as a whole is supported by all the necessary utilities.**

Apple Price List

Product Code	Description	Price (£)
	HARDWARE	
A2S1016P	APPLE 16K VIDEO OUTPUT ONLY	695.00
A2M0003	DISC DRIVE WITHOUT CONTROLLER	299.00
A2M0004	DISC DRIVE WITH CONTROLLER	349.00
A2M0016	16K ADD ON RAM	69.00
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A2T0013	MICROCHESS 2.0 CHESS CASSETTE	15.00
E2D001	VISICALC DISC & BOOK COMPLETE	125.00

Product Code	Description	Price (£)
	DOCUMENTATION	
A2L001A	APPLE II REFERENCE MANUAL	11.00
A2L0002	6502 HARDWARE MANUAL	9.00
A2L0003	6502 SOFTWARE MANUAL	9.00
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Sord M223 mark II's strong suit is design and compactness

THE SORD M223 mark II is an attractively-styled microcomputer made in Japan by Sord Computer Systems Inc, and distributed in the U.K. by Midas Computer Services Ltd of 2 High Street, Steyning, Sussex. The computer is supplied with an integral keyboard, video screen, and two Teac mini-floppy disc drives.

Processing is performed by a Z-80 chip running at 4MHz, and the system has 64K of RAM. The S-100 bus is used, and three spare slots are accessible via a removable panel at the rear of the unit where users may insert their own cards. An IEEE 488 interface is optionally available using the GP-IB control board. Also at the rear of the unit are two serial I/O ports, giving RS232C connections for a printer, or to another VDU, via 25-pin D connectors.

Two DIP switches allow the setting of baud rates for data transmission between 110 and 9,600 baud. The keyboard is well constructed, and in addition to the usual alpha-numeric keys, there is a numeric keypad, a set of four user-programmable function keys, allowing eight pre-defined functions, and 11 keys which provide 22 pre-programmed functions, mostly for use with Basic systems.

Unusual feature

An unusual feature is the set of seven sense switches which light-up when depressed and provide an extra set of inputs to a program. The state of the sense switches can be monitored by the program and can be used to control the flow of the program or to aid program debugging by switching-on or off trace facilities.

Another unusual feature is the character set, which is a variant of ASCII, and includes standard upper- and lower-case characters, normal punctuation marks, a number of graphics symbols, and a set of Japanese Kana characters. The integral VDU has a green screen, and displays 24 lines of 80 characters.

For high-resolution graphics work, there is an optional facility giving 512 × 256 point resolution. It requires the addition of two boards for colour, or one board for black and white, and a TV monitor.

The power switch takes the form of a key with off, on and lock positions, allowing the machine to be locked in the power-on state. In that state, pressing the re-set key has no effect, preventing an operator from inadvertently re-setting the machine and so making it suitable for turnkey applications.

When the machine is switched-on, the user is asked to load a diskette in drive 0, and to strike any key. That initialises the disc-operating system. The screen takes a few seconds to warm up, and displays good-quality characters. While the machine is running, there is a slight noise from a cooling fan at the rear of the unit.

The disc-operating system offers a reasonable range of commands for performing useful activities such as listing directories, initialising discs, copying

by David Martland

discs, deleting files, and so on. It is somewhat strange to be able to obtain error messages from the operating system in Japanese — the command SYSTEM/K causes all operating-system messages to be displayed using the Kana character set.

Oddly, the option does not apply to the Basic systems tested. The operating system performed satisfactorily apart from on quirk — pressing the edit key which should be done normally only in a Basic system, crashed the system.

A variety of software is available for the Sord computer, including three versions of Basic from Sord, Fortran and Cobol from Sord, and CAP MicroCobol. The Basic systems are denoted EBasic, CBasic and MBasic, which stand for extended Basic, compiled Basic, and matrix Basic respectively.

The documentation supplied with the equipment refers mostly to Basic, and the keyboard lay-out suggests that the machine has been designed specially with Basic in mind. The only systems tested were the EBasic and CBasic systems.

For a personal computer, the instruction manual is very comprehensive, although at its price, the device might be considered more suitable for business use, and by the standards of other business equipment the documentation is not very voluminous.

The manual appears to be a translation from Japanese, is difficult to read, and in places, inaccurate. With some determination, it is possible to extract enough useful information from the manual to start the system working, but really the documentation needs completely re-writing for English-speaking buyers. An U.S. re-write is promised for the near future.

Style example

As an example of style, the following comment refers to the processor:

"The processor controls all the computer system. It is false to think the processor and the main memory are solidified. Computers cannot run more than programming by programs".

EBasic has a number of interesting features, including logical operators, timer routines, Time and Sleep, and

double-precision arithmetic. Low-resolution graphics are available using cursor control within print statements. It takes time to absorb the differences between the Sord Basic and standard Basic. LET and PRINT do not work in immediate mode which causes problems when trying to test programs interactively, but the special commands, SET and TYPE, do what is needed in that mode. It is not possible to use any other commands in immediate mode, nor can system commands be used in Basic programs, as in some other systems.

With an appropriate Basic disc loaded, the user types EBasic or CBasic to enter a Basic system. There is not a great deal of difference between the Basic systems apart from the fact that CBasic appears to compile the program before running it, while EBasic is a straightforward interpreter.

Developed programs

Developed programs can be compiled under CBasic and stored in their compiled form. Entering Basic programs is rapid, using the Basic function keys. Most commonly-used Basic keywords are available on the keys, and others can be set-up on the user-programmable OPKEYS. Available keywords are:

LEN(	ATN(	GOSUB	RETURN
USING	INPUT	END	THEN
LN(	GOTO	TAN(	PRINT
EXP(	LIST	CLOSE	SAVE
DELETE	OLD	ABS(	

Most of the keys cause the required text to be displayed, but the End key also terminates the current line. The rub-out key removes only single characters of the keyword, so if the wrong keyword is typed, it is more tedious to remove it than it was to enter it.

Using the Auto instruction for automatic line numbering, programs are input very quickly. Users who already know a Basic system will probably find the keyword facility takes time to grow used to, though users with little experience of computers should find it helps a good deal. That criticism has been levelled at machines other than the Sord, but it is hardly the fault of the machine if users find it hard to forget the skills they already possess in favour of an easier method of program entry.

Syntax errors

Syntax errors are reported as they are typed, and the method of handling such errors is at first difficult to see, but in many cases allows continuation of the line by correcting the incorrect syntactic unit. Sometimes, the line up to the point of error is displayed, but not always.

Apparently, that is because part of the line has already been accepted as a valid syntactic unit. What is disturbing is that an attempt to type the whole line again correctly may fail, because the system expects the user to type only the corrections.

Nevertheless, the method prevents a large number of potential errors from being incorporated into programs. Run-time error reporting is less satisfactory, with messages of the form

ERROR NO 512 AT THE LINE 10

The user must look up the details of the error in the manual. On a disc-operating system with adequate space for a file containing the error messages, that is primitive, though not uncommon. A worse feature is that not all errors are detected — in particular, divide by zero is not detected. Thus the program

```
10 LET X=1
20 LET Y=0
30 LET Z=X/Y
40 PRINT "DONE"
```

will print the message "DONE" without detecting the error at line 30. If the variable Z is printed-out, it will most likely have some very large value in the region of 10 raised to the power 74. An ON ERROR statement will trap that error, but it is a surprise to see such non-fatal errors slipping through without special treatment.

The system supports files, both sequential and random-access for serious processing of data held on disc storage. In other respects, the Basic performed reasonably well — but not significantly faster or slower than other Basics. CBasic is faster, but that is not apparent while developing programs because of the extra time spent compiling the program.

Conclusions

- **The Sord M223 Mark II is a well-designed piece of hardware which would suit users who like the idea of having all their computer equipment contained in one box.**
- **However, for use as a personal computer, the price seems likely to deter all but the very affluent hobbyist.**
- **The machine seems to have been designed primarily to support programming in Basic, a language which is not really appropriate for many applications.**
- **For business use, the machine might meet competition from machines such as the Cromemco Series 3, and the provision of languages other than Basic seems essential.**
- **Fortran and Cobol from Sord are available, but if they are like the Basic, other systems may perhaps offer more advantages.**
- **However, CAP MicroCobol is available, and as a reasonably standard piece of software, the machine may prove to be a good buy using this software for business applications.**
- **Midas Computer Services has produced versions of the computer to run multi-access systems, and is negotiating for the CP/M operating system to be made available for the model.**
- **CP/M should greatly enhance the utility of the equipment by enabling a very much wider range of software of more certain quality to be run.**
- **The quality of the software and the documentation of the system tested did not live up to the potential of the hardware.**
- **The price of the Sord M223 Mark 2 is £4,250; the price of the GP-IB interface board is £348.**
- **The high-resolution graphics option costs about £600; the price for most Sord software is about £300 and CAP MicroCobol costs £2,000.**

Personalised system giving flexibility and reliability is SBC-100's best role

by Andrew Stephenson

THE SBC-100 is a single-board Z-80 computer manufactured by SD Systems of the U.S. whose product range includes hardware and software for complete microcomputer systems. Although based on the pre-IEEE S-100 bus, the board has been used successfully in combination with Godbout Econoram — 48K total — North Star single-density disc controller and the Vector Graphic Flashwriter II video board, so there is no great danger of becoming tied to one manufacturer. Obviously, the usual care must be taken, as when linking all pre-IEEE S-100 boards from different sources.

Also available is a 2K SD monitor which is a natural adjunct of the SBC-100. It is important to stress that the SBC-100 is not a true single-board computer in the sense that, say, either of the Nascoms are. For a start, it lacks both a keyboard and a video monitor driver. What we have is more of an embellished CPU aimed at serious-but-small systems, with these major features:

- Z-80 CPU at approximately 4 MHz;
- Z-80 four-channel counter/timer circuit (CTC);
- Synchronic/asynchronic SI/O — USART — for RS232 and 20mA loop;
- Separate parallel input and output ports — PI/O;
- 1K static RAM;
- Four sockets, for 1K/2K/4K/8K each;
- Jump-on-re-set — auto-start.

Revision B — the review machine — seems to date from summer 1978 and is, therefore, about as modern as is desirable for normal applications. It has been on the market long enough to have had the bugs removed and is readily available.

Supplied either as a kit — approximately — £155 or assembled — approximately — £197 — it is neatly constructed on a double-sided solder-masked pcb. Gold-plated edge connectors — S-100, 26-way USART and 26-way PI/O — plated-through holes, and sockets for integrated circuits, mean that mechanical reliability is likely to be good; and that, should an otherwise awkward component such as an integrated circuit fail, it can be replaced easily and without damage to the board.

Helpful tables

Of the numerous options, only ROM select — on-board-memory space allocation — and part of the auto-start address are equipped with wire-wrap headers. Other options must be selected by soldering and/or cutting of factory-pre-set printed circuit links.

To assist the user, there are numerous helpful tables in the handbook — or Operations Manual as it is somewhat grandly titled. The document is well printed but must be studied closely for there is an extraordinarily diverse choice of configurations of ROM, RAM, CTC, PI/O, USART, auto-start, not to mention the software-selected options in the CTC, PI/O and USART. There are also a few minor typographical errors, most of which will readily betray themselves, especially if one refers to the CTC and USART data sheets, which must be obtained separately.

Kit builders will find that assembly instructions are straightforward, if not exactly lavishly detailed. As the handbook says, the kit version is intended for those people who have had some prior experience with kit building and digital electronics. Raw beginners should keep their soldering irons away from its compact corners.

Some thought has been given to real-world applications: for example, the crystal-controlled clock runs at 2,457,600 Hz — or 4,915,200 Hz if a link is moved, although that option is offered mainly to facilitate the changing of crystal frequency, if desired. Consequently, the USART can be set accurately to all common speeds from 110 to 9,600 baud by a software command.

SD monitor details not given in handbook.

- There are signs that it requires most of the RAM space from FFAC to FFFF.
- Users' stack is established at FF60. Available depth is uncertain but use of lower addresses by monitor was not apparent in tests.
- Useful addresses:

E000: entry only after re-set.
E003: normal re-entry.
E006: test if character received by USART
E009: USART character input routine.
E00C: USART character output routine.

Power needs are satisfied by the standard S-100 lines. No current consumption figures are quoted by SDS but the unit, loaded by a 2716 monitor ROM and the RS232 link to a terminal, took 560 mA from the +8V line. the two 16V lines are used solely by the USART I/O buffers: each drives a 12V zener regulator through a 150 ohm resistor.

Thus, if no other part of the system requires either 16V line, and if no use is to be made of the serial I/O, a single +8V supply would suffice. Bearing in mind the other features, it would not be unrealistic to see the SBC-100 as the heart of one of those distributed domestic control systems so beloved of microcomputer propagandists. At least it is worth considering.

Also worth considering is the SBC-200, essentially a 4MHz version with a few modifications to accommodate forthcoming upgrading of the SDS line, such as bank switching. A monitor is not yet officially available, but Computer Centre can provide a specially-adapted and EPROMed version of the standard monitor. Prices for the SBC-200 are around £182 for the kit or £242 assembled and tested.

All on-board memory addresses are relocatable. Furthermore, if the on-board option has been used, the SBC-100 hardware takes priority over off-board hardware, in the event of an address clash.

Useful scratchpad

The memory of 1K of static RAM — two 2114s — offers a useful scratchpad for system variables. Stand-alone operation is further simplified by the four empty ROM sockets, suitable for several kinds of popular 5V 1K, 2K, 4K and 8K ROM. The factory-fresh type option is for 2716. Although that restriction to +5V only excludes the 2708, the 2758 can be used — a little judicious re-wiring of supplies could remedy the shortcoming.

The normal procedure is, first, to define the ROM size — 1K, 2K, etc. — then to select or deselect the various sockets. RAM, too, can be deselected, as it is mirrored to fill a block as large as that defined for the ROMs and might, therefore, use an unduly large memory area. Memory-start addresses can be set to whole-ROM-size values; e.g., 2K boundaries if 2K ROMs are defined. That may seem complicated at first sight, but the handbook tables make it reasonably easy.

Auto-start jumps

Auto-start can jump to any 4K boundary but is pre-set to E000 or F000. The choice between the two is made by a plug link. The handbook says that auto-start jumps must arrive at the instructions

Address xØØØ = JP xØØ3
Address xØØ3 = IN A, (7F)

which re-set the auto-start hardware; but all that is necessary is IN A, (7F) or OUT (7F), A, so that feature is simple to implement.

For USART, the user should obtain the Intel 8251 data sheet. It has its own 26-way printed-circuit edge connector wired so that a ribbon cable to a D-25 socket results in the correct pin-out for a modem look-alike. RS232 and 20mA loop — whose transmitter has a floating current source — operate simultaneously.

The USART baud rate is defined by a value programmed into channel 0 of the CTC, which provides the USART clock, unless the user decides otherwise and changes links. The SD monitor, incidentally, determines the correct baud rate from the duration of the start bit of the first character received after a cold re-start — usually a carriage return — and sets the USART accordingly.

Links select from a menu of asynchronic mode — pre-set; synchronic mode, with external clock; external baud-rate clock; and refinements of these. Software selects from five, six, seven or eight data bits; parity bit odd, even, or absent; one, one and a half, or two stop bits; and a few extras.

PI/O has separate 8-bit output and input, each with two handshake lines. Another 26-way connector brings out those lines, along with 0V and the regulated on-board +5V.

Output stobe

Links determine whether outputs can be switched on/off by handshake; polarity of the output strobe; whether the output strobe is cleared by handshake or by software; whether the input latch is always open or is gated by input strobe. Status bits and handshake outputs use the same control port address.

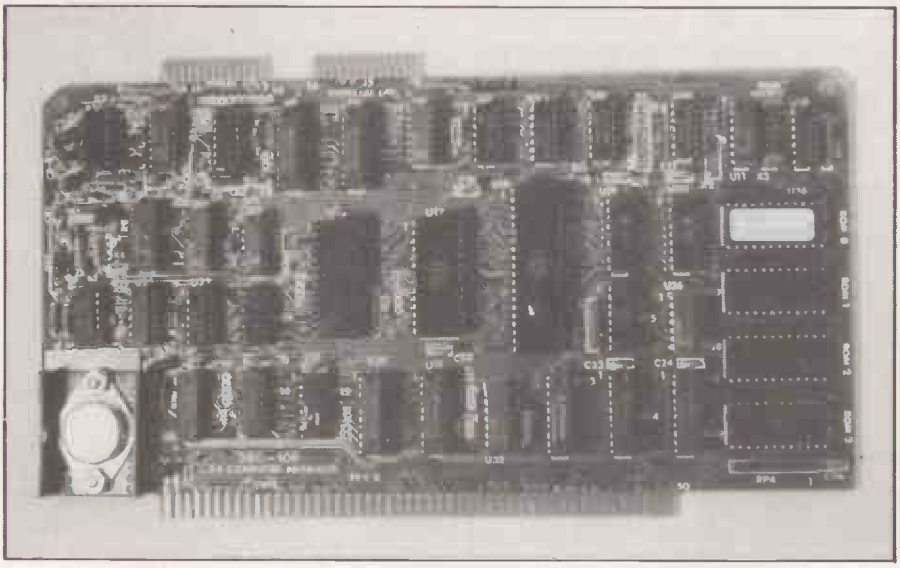
For the CTC, the user should obtain Mostek MK3882 or Zilog Z-80 CTC data sheet. It has four independent channels, each of which may be programmed to generate vectored interrupts at zero-count; divide the system clock by a specified value — up to 2^{16}; or count external trigger inputs. Links allow for several configurations, including trigger I/O via S-100 bus and USART-originated vectored interrupts. That is a powerful circuit block which, among other possibilities, simplifies real-time clocks.

The tailor-made SD Monitor is supplied on a 2716 to run from a base address of E000 and is priced at about £18.40. It offers:

SBC-100 allotted port numbers.

Port	Circuit block	Function
78	CTC	Channel 0 — normally supplies USART.
79	CTC	Channel 1
7A	CTC	Channel 2
7B	CTC	Channel 3
7C IN	USART	Rx Data
7C OUT	USART	Tx Data
7D IN	USART	Status
7D OUT	USART	Control
7E	PI/O	Data
7F	PI/O	Handshake: status and control; also clears auto-start hardware after Initial jump-on re-set.

- Automatic USART baud-rate selection.
- Memory functions: display block — in Hex and in ASCII, if printable; examine and change specified locations, with address increment or decrement afterwards; fill block with a given Hex code; move block; locate a given string of up to six bytes length within a given memory area; test RAM between given limits; verify, i.e., compare two blocks.
- I/O functions: read from a given port a given number of times and display the inputs; output a Hex byte to a given port a given number of times; examine and change a port — that resembles the memory-examine function.
- Program control: maintains in RAM from FFE6 to FFFF a map of all the Z-80 registers and flags, and displays it as required, say, on encountering the single breakpoint which may be set; after any single-step operation; after each register-examine order. Additional functions are go to a given address and begin execution; display sum of, and difference between, two Hex four-character values.
- Disc commands: they are of interest only to owners of SD computer systems, as they interwork with the SDS Versafloppy controller board and SBC-100 BIOS PROM at F000. They handle CP/M boot-up, read/write from/to disc, and formatting of discs.



SDS offers good value for money where the hardware is concerned. It is soundly made, offers considerable flexibility, and is reliable: my unit has been in steady use for almost a year now and has yet to fail. Up to a point, that is all most users want to hear.

It is in its supportive documentation that SDS falls down. Every handbook of which I have studied — SBC-100, SD monitor, VDB-8024, PROM-100 — gives most of the useful information, yet spoils the effect by omitting important — even, one might say, vital — data.

For example, adventurous programmers could suffer some headaches when using the monitor, whose RAM usage is not made at all clear. The annoying fact is that most of the missing information could have been included so easily.

Attractive notion

Computer Centre says that this is because the various SD products were intended to be sold and operated together, hence the system documentation as a whole would furnish those details. Attractive though the notion is, it may not be a good idea for a manufacturer of such complex products to sell them separately without supplying complete and individually-appropriate back-up information. In the case of the SBC-100, fortunately, that should cause few problems.

Of course, that failing is by no means confined to SDS; it is a blot in the copy-book of the microcomputer industry as a whole; some manufacturers are, of course, better than others.

While on the subject of the monitor, it seems worth mentioning that the locate function appears prone to a mystery bug, in that it has been known to alter the user's stack pointer — in the register map — and occasionally corrupts the contents of low RAM — apparently below 100 Hex. However, it locates the given string, and the bug is very hard to reproduce. That is true of version 2.1; later versions may be cured.

A minor monitor idiosyncrasy is that it requires an output device line length of at least 71 characters for some functions, such as 256-byte display. That does not suit the popular 64-columns-by-16-lines size. Fortunately, there are ways round it. The rest of the functions, particularly those involving the register map, are a delight to use.

Conclusions

- **To use the SBC-100 as, say, a domestic systems controller would be to undervalue the board by a wide margin.**
- **If a user needs a personalised system, compiled from parts individually-selected for their suitability, the SBC-100 may offer a soundly configured and reasonably-priced starting point.**

Thinking big in a world where smallness matters

Already, the Japanese are talking about capturing the power of an IBM 370 — a computer which fills a large room — on a single chip .25in. square. What are the realities behind those developments? What constrains them and how soon will such feats be realised? Peter Laurie reports.

NO SOONER has the wonderchip burst on an astonished, and in many cases, less-than-delighted world, than it promises to soar to yet more extraordinary heights of power and complexity.

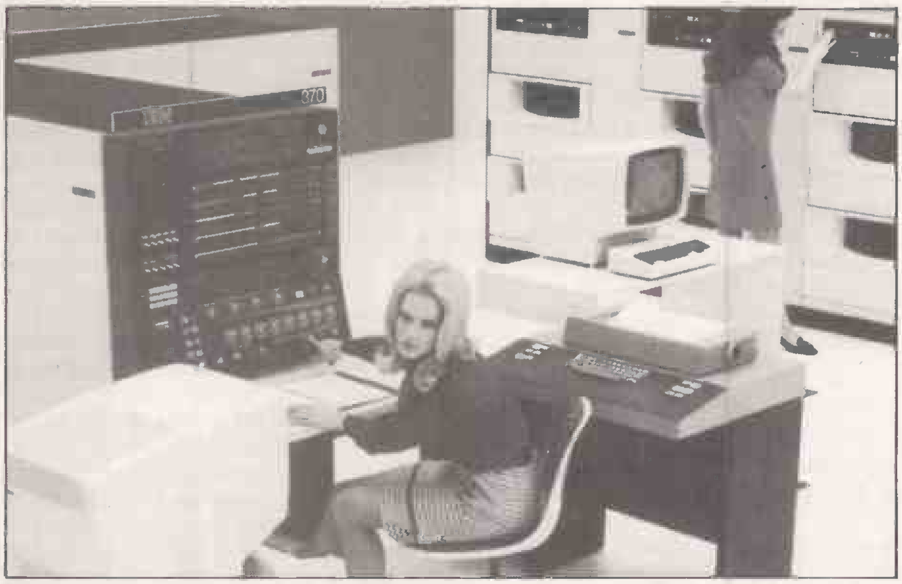
It is no secret by now that the most important aspect of the new electronics is its smallness. Everything is micro — a word derived from the Greek letter omicron, which for a long time has been the scientific abbreviation for one-millionth.

Why does the smallness matter? It makes possible beautiful photographs of wonderchips sliding through eyes of needles, or of ants wrestling with whole processors, but is that all? Would not a microcomputer be just as useful — or useless — if its processor were 6in. or a 1ft. square instead of .25in.? It would indeed — but you would not be able to buy it. The reason why smallness matters is buried deep in economics and physics. To see why, we first have to look at what a chip is and how it is made.

A chip, say, a microprocessor, is simply a very great many switches which control each other in various ways. If you had the money, patience and space, you could create a device which accomplished the same things but rather more slowly from old-fashioned Post Office relays. Each switch is a metal oxide semiconductor — MOS — transistor. A transistor is so simple a thing that one does not know whether to laugh or cry that the future of the world should depend on something so apparently easily manufactured.

To make an MOS transistor and change the world, follow this simple recipe.

- Take a polished wafer of pure silicon.
- Cover it with a thin layer of silicon oxide. The easiest way to do that is to heat it in an atmosphere of oxygen.
- Lay a narrow conductor of polysilicon — poly — on the oxide.
- Cut a path through the oxide at right-angles to the poly to reveal the underlying silicon.
- Heat the whole chip in an atmosphere of arsenic, antimony or phosphorous vapour so that the atoms of those elements diffuse into the exposed silicon and dope it.
- Remove, test, package and sell — figure 1.

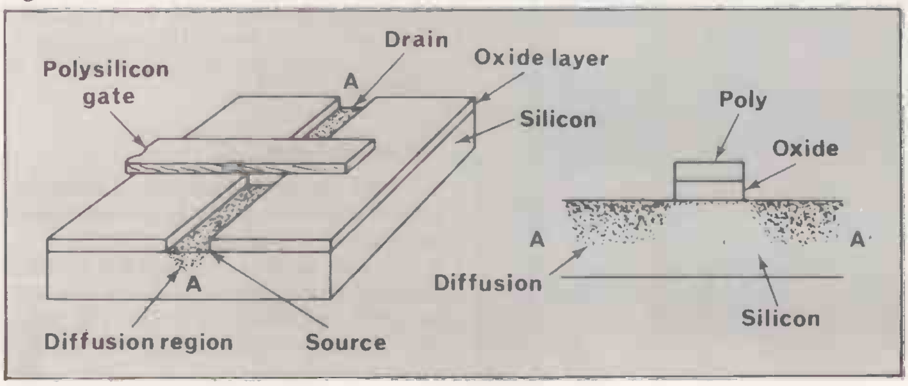


Within a few years, it should be possible to put a complete IBM 370 on a single chip, .25In. square.

The silicon substrate immediately under the polysilicon strip does not become doped since it is protected by the poly and the oxide from the dopant atoms. Consequently, although both poly and doped silicon — the diffusion zone — conduct electricity like wires, there is no connection between the diffused zones on either side of the poly, until a voltage is put on the poly.

Then, by the mysteries of semiconduction, it is possible for a current to flow from the one doped area to the other giving a very economical, electrically-controlled switch. It is economical since the polysilicon gate conductor is insulated from the other two by the oxide layer and there is no easy way electrons can leak from it.

Figure 1.

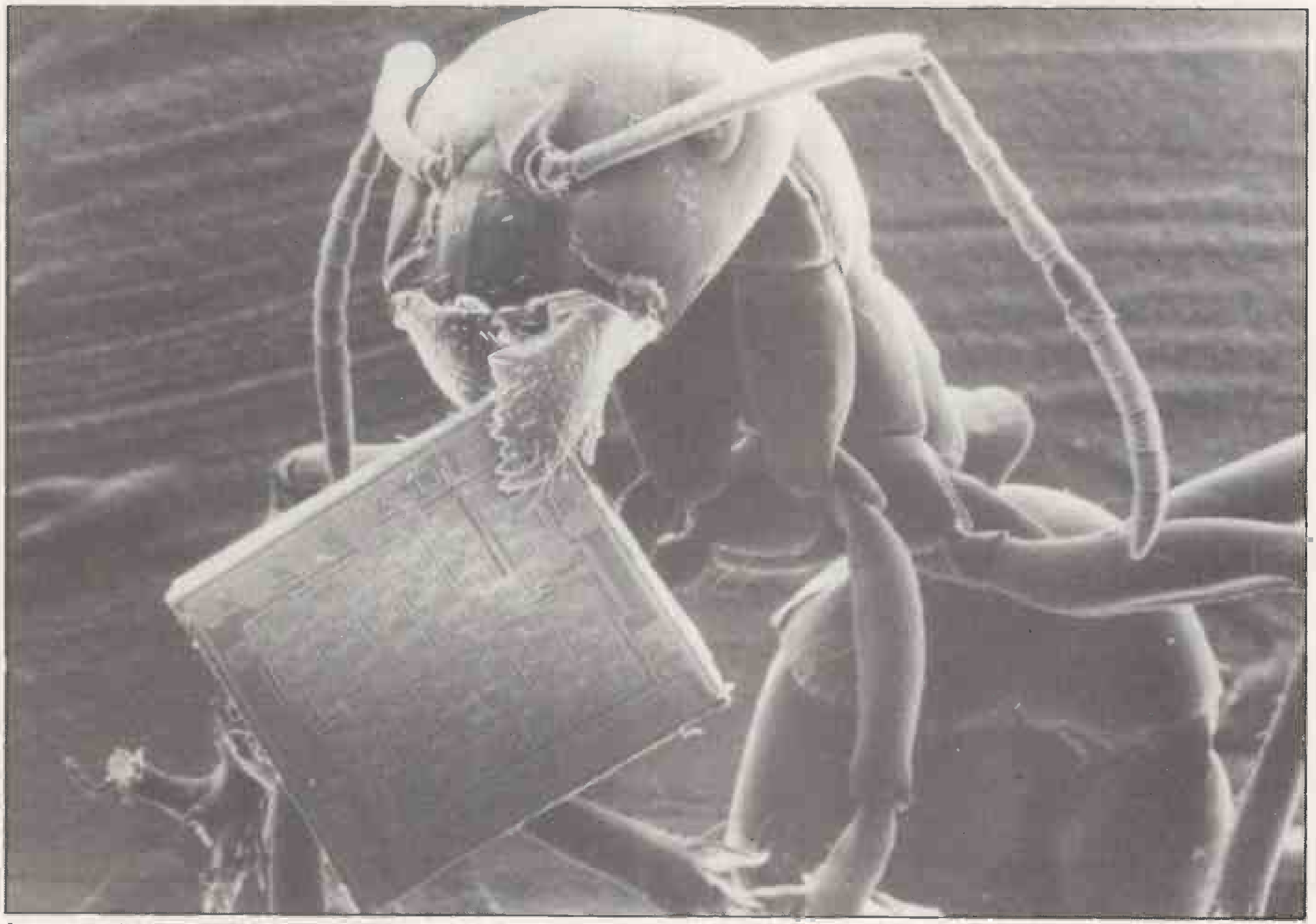


High impedance

In terms of electronic engineering, the gate has an enormously high impedance. That is the main reason why so much computer can be crammed on to so small a chip — the gates draw no current, consume no power and a device consisting of many 1,000 transistors can work without melting itself. That would not be true of the older bi-polar transistors — figure 2.

To make a useful logic gate, a few more things are required; a resistor to make an output possible. That is accomplished by putting a slightly different transistor above it — a depletion mode device — which works like a resistor when its gate is connected to its drain — figure 3.

What happens now? A voltage on the input — I/P — gate makes the lower transistor conduct and connects the output — O/P — to ground. Only a limited amount of current can flow



An ant carrying the IBM 370 of the future?

through the upper device — the resistor — so the output voltage falls to zero. If the gate voltage is removed, the transistor turns-off, the output is now connected only to the + supply rail and its voltage rises. We have a logic inverter which turns logic 1 to logic 0 and vice versa.

Logic gates

It is now easy to make the two basic logic gates; MAND and MOR. One more element is necessary — memory. Since the gate of a MOS transistor has such a high resistance, once a charge is put on it, it will remain for a long time which in this context means a few thousandth of a second — figure 4.

That is all ordinary dynamic RAM is — rows of transistors which are either on or off and remain that way until the processor returns a few thousandths of a second later to read the state of each memory cell and re-write it — to refresh it. Each cell of static RAM consists of two cross-connected transistors.

At any time, one is on and the other off. They are wired so that they hold each other in the state in which they were left. That is all there is to MOS technology; one conductor switches another on and off. It has the characteristic simplicity of a truly great idea.

The usefulness of a processor or a memory consisting of some 10,000s of these transistors depends on two things: how many there are and how fast they work.

The speed of operation depends on two things: the transition time of a transistor — the time it takes to switch from on to off, or vice versa; and the time it takes to send the resulting signal to the next transistor. The conductor which connects the output of one transistor to the input of

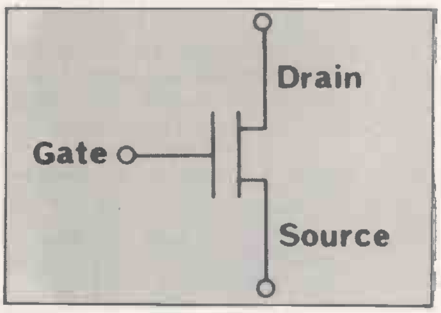


Figure 2.

the next is also a capacitor, and, like any capacitor, it takes a certain amount of time and energy to charge or discharge it.

Perhaps surprisingly, the main limitation to the speed of semiconductor devices is not so much the switching speed of the devises, but the time penalty in charging inter-transistor connectors. The shorter and narrower those lines are, the quicker they operate. That also holds true for the transistors themselves — the smaller they are, the more quickly they switch.

So, a most important measure of the performance of a device is the size and packing of the transistors in it. A convenient measure is the line width — the widths of the various strips that constitute the devices. In 1978, the smallest width used in production was about 6 μm — the paper on which *Practical Computing* is printed would allow parallel conductors in its thickness — and that is what we now have in microcomputers.

Silicon area

The process of putting various conductors and devices on to silicon is done rather like printing on paper. Just as a printing works can print only a certain number of acres of paper a day — a number determined largely by the initial investment in machinery — so a silicon chip factory can process only a certain area of silicon a day — an area limited by the amount of very expensive masking, etching, baking and testing equipment it has.

The cost of a chip is mainly proportional to its area, and has very little to do with how complicated it is. In other words, it is just as expensive to produce a 6in. diameter of wafer of silicon carrying

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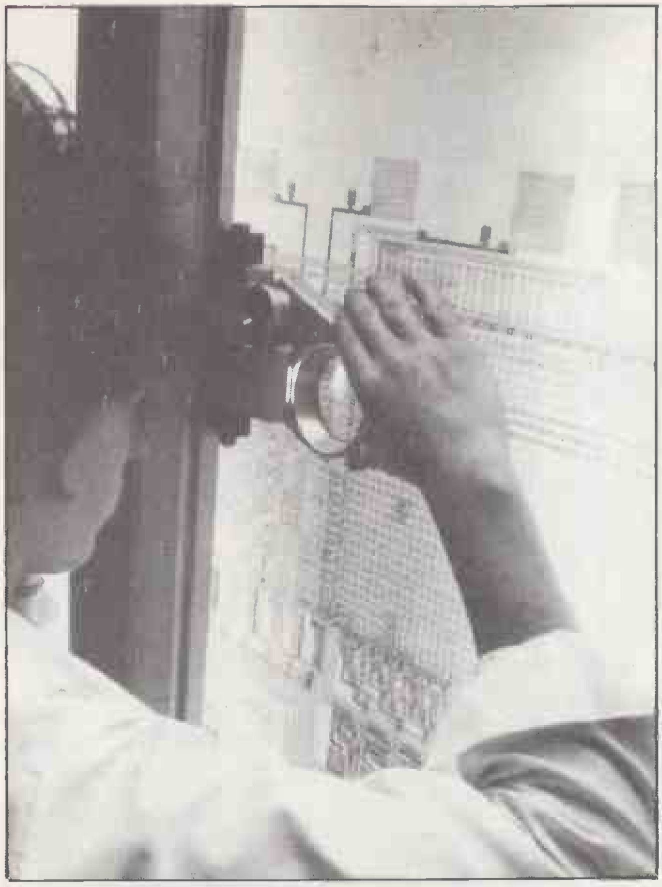
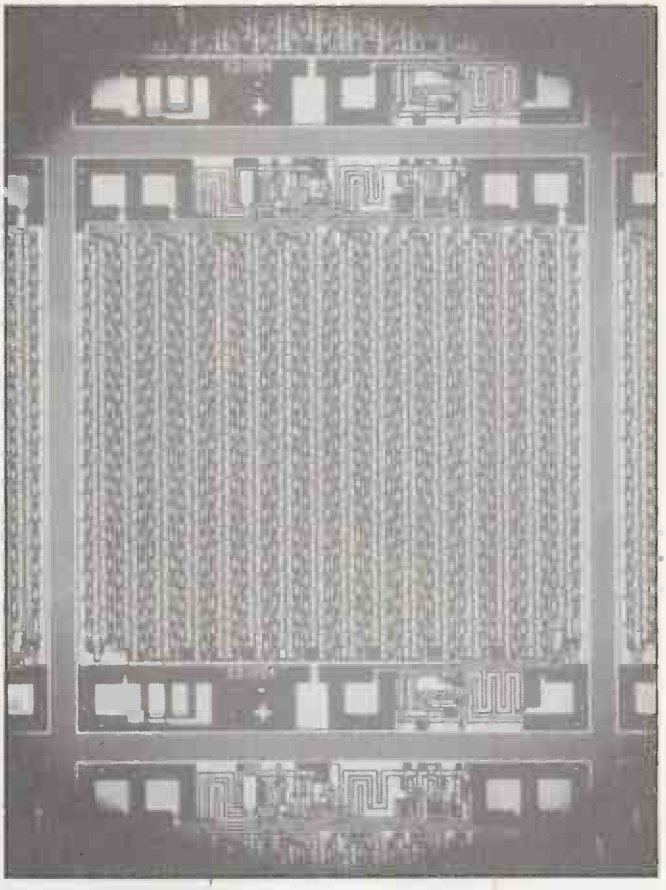


Checking one of the many masks, drawn several 100 times final size.



Close up of a single chip.

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a single transistor as it is to put 400 devices on it, each consisting of 100,000 transistors. U.S. chip makers talk about the area of silicon they can process as the real estate.

Now we can see why smallness is important in microelectronics. Since it does not matter to the final cost how many transistors are on a chip, the more there are, the cheaper each one is — or, you can offer more computing power at the same price.

Improved factors

Even if that were the only plus, it would be well worth going for smaller devices, but, there is more. As transistors become smaller by a factor n so a number of things improve:

- Switching times improve by n.
- Capacitance of lines decreases by n.
- The power consumption decreases by n^2.
- The number of devices on a chip increases by n^2.

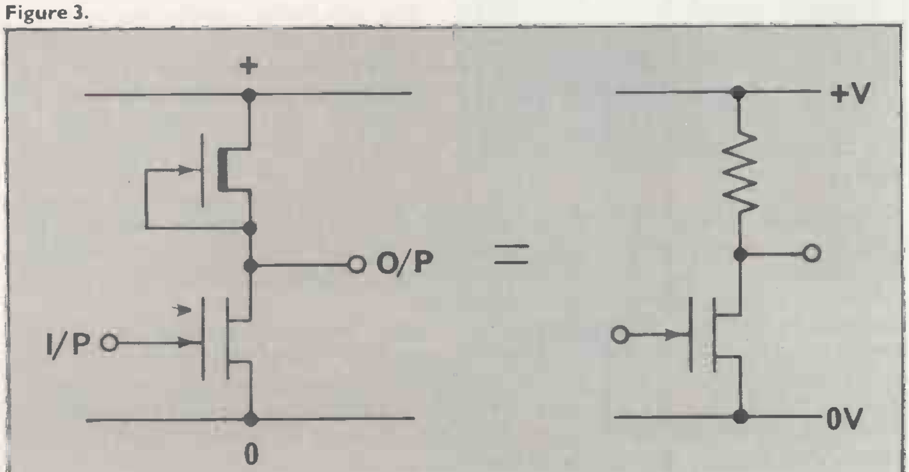
Generally, if you measure computing power as the product of the number of devices times the clock speed, it improves by n^3. That means a new device with lines half as wide as an old one will be, other things being equal, eight times as powerful at the same cost.

Even more surprisingly, there is still a good deal of downhill running to go. While it is apparent that at some small size, the bulk electronic effects relied on to make transistors work will give way to other quantum effects, it does not look as though that will happen before lines get to about .25-.1 μ m wide.

To give an idea of the density of the technology: if a map of London were engraved with .1μ m lines on a 6in. diameter wafer it could show every house, street, alley and detail down to the scale of lamp-posts and man-hole covers.

That gives us a scaling factor of up to 60 on current technology, so we can expect processors with roughly 40^3 = 216,000 times of today's power. Since device densities have roughly doubled each year since 1960, we can reasonably expect the pocket computer with the processing power of a quarter of a million Z-80s by 1990. Yet, as they also say in the States, there is a downside to this interesting prospect, and that is caused by human fallibility.

Figure 3.



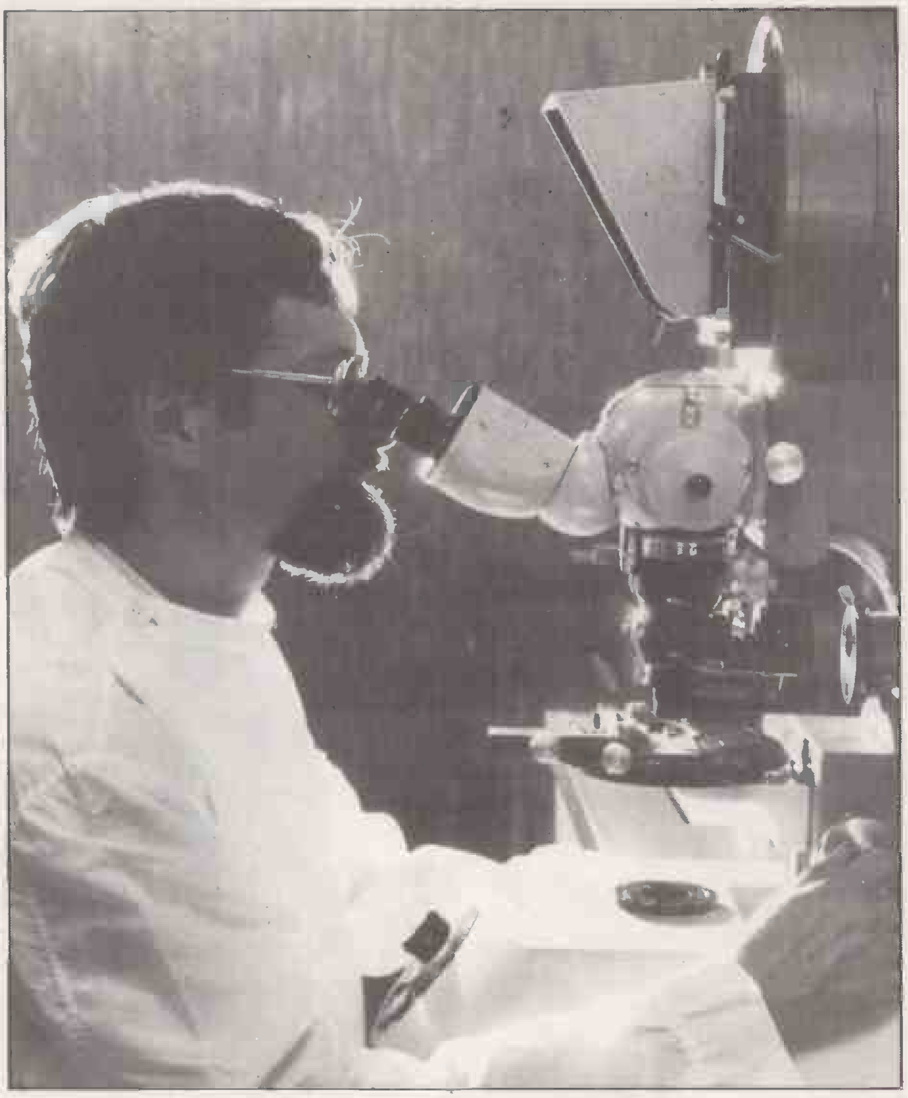
Device yield

Naturally enough, the proprietor of the silicon chip factory will prefer to see as many as possible of the little chips he makes in the morning emerge as fully functional, tested, packaged and brand-named products by the evening.

Any chips which fail to make the grade are so much wasted real estate and increase the price of the survivors in proportion. The number of useful devices which emerge at the far end of the whole process is called the yield.

A yield of 30 percent is considered

good. In other words, of the 400 or so chips made on a single wafer, some 280 are thrown away. The rest meet the standards and are sent on to consumers. Today's processors and memories are so complicated that it is not practical to test more than a few of their possible functions and states. In fact, to test every possible state a Z-80 processor chip could enter would take longer than the life of the universe. More complicated chips will be even less testable.



Examining the reasons for failure.

Fatal flaws

Now, if the effect of scaling on computing power seemed uncharacteristically benign of Mother Nature, we begin to see why. She has a much better joke up her sleeve. A rough sum about yield suggests that if N is the number of fatal flaws per unit area of chip, and A is the area of each chip, the yield of good chips is given by the Poisson distribution:

$$Y = e^{-NA}$$

What causes fatal flaws? Dust, imperfections in the underlying silicon, errors in the masks, lack of registration of one mask with another, caused by the differential contraction of silicon and the subsequent layers. Also, from time to time, someone drops a complete wafer.

If one makes the reasonable assumption that, using the same fabrication technology, the probability of misalignments, dust particles, flaws in the silicon being enough to kill a chip is inversely proportional to the square of the line width, halving the line width reduces the yield from 30 percent to one percent. If errors in the third dimension are equally fatal, the probability of obtaining a good chip goes down to one in 15,000, or .006 percent.

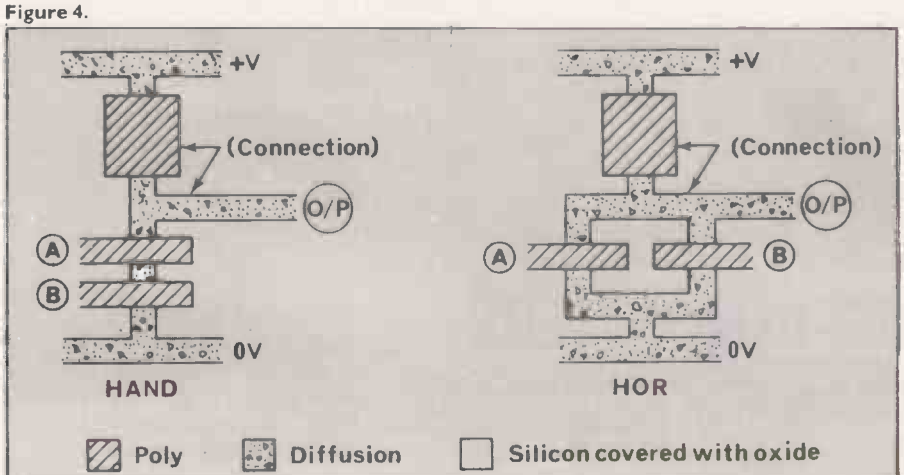
Scale of problem

Of course, the fabrication technology is not the same, but that may be give some idea of the scale of the problem. It may explain why, for instance, instead of obtaining 100 or so good chips per wafer, Zilog was, for a while, reportedly processing many wafers to gain one good Z-8000.

It may explain why, although the Z-8000 should in theory, cost the same as the Z-80, it costs some 30 times more. It may explain why, although the 64K RAM was announced with tremendous fanfare nearly two years ago, very few have ever seen one, and even fewer use one every day.

That simple analysis demonstrates the chip-maker's problems. While the value of his products increases with the cube of the smallness, their yield, and hence what he must charge for each one, is subject to a much fiercer law. There is a long step from a prototype wonder device, made with agonising care in the laboratory to a production line making thousands a day despite hangovers, laziness and bad temper among the work-force.

Figure 4.



Layer patterns

At the moment, chips are made using a photo-lithographic process. The patterns for each layer of the chip are drawn few of hundred times full-scale and repeated 400 times for each wafer. Light is then projected through the finished masks on to photo-sensitive resists on the wafers: the exposed resist is washed off and the underlying material etched with acid.

As line widths become smaller, problems arise. The first problem is the registration of one mask with the pattern formed by earlier masks. If the whole chip is printed as one, the problem of differential expansion and contraction as poly is

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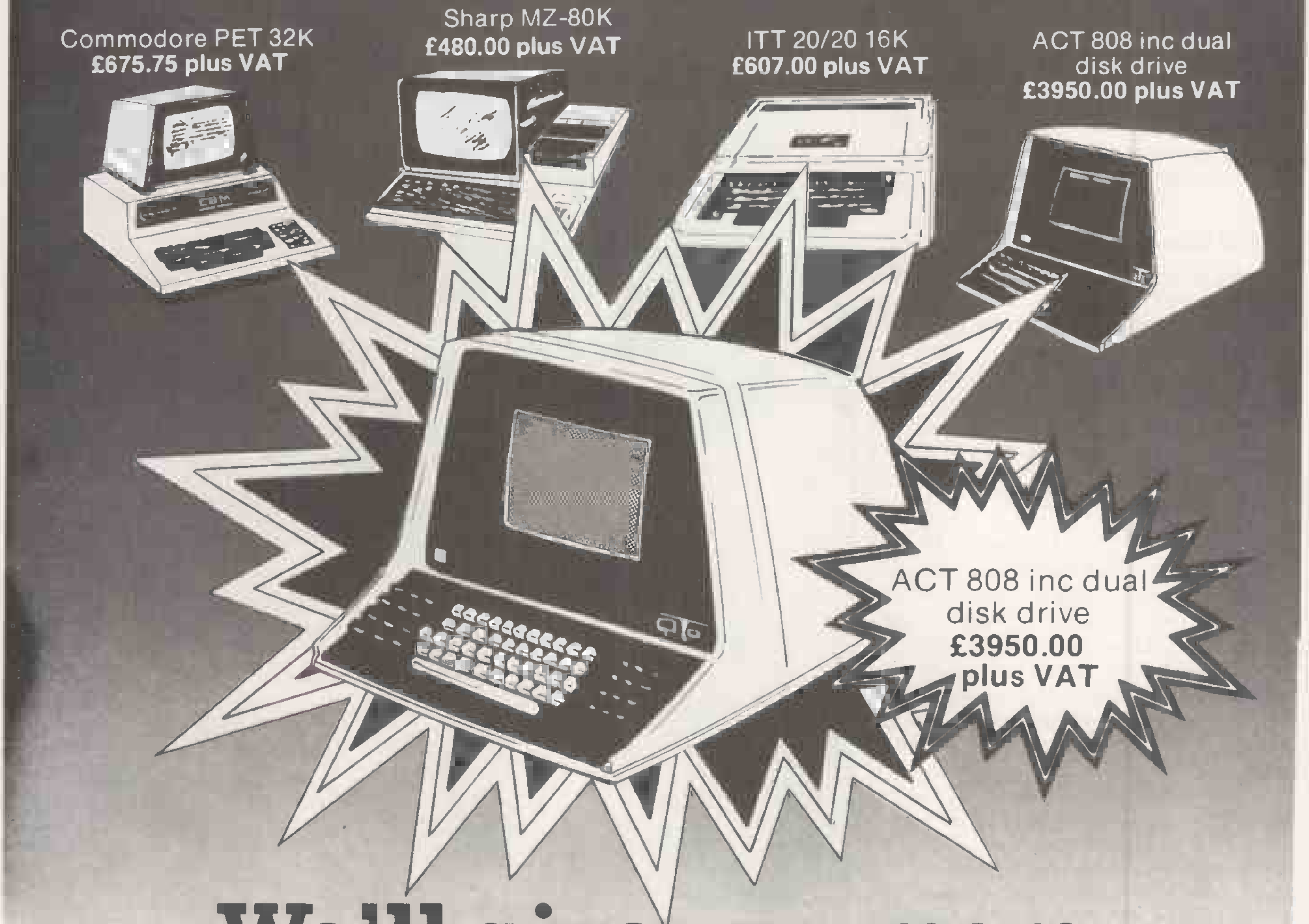
Buying Computers?



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(continued from page 71)

laid down or silicon etched away can throw the outermost masks out of register even though those in the centre are perfect.

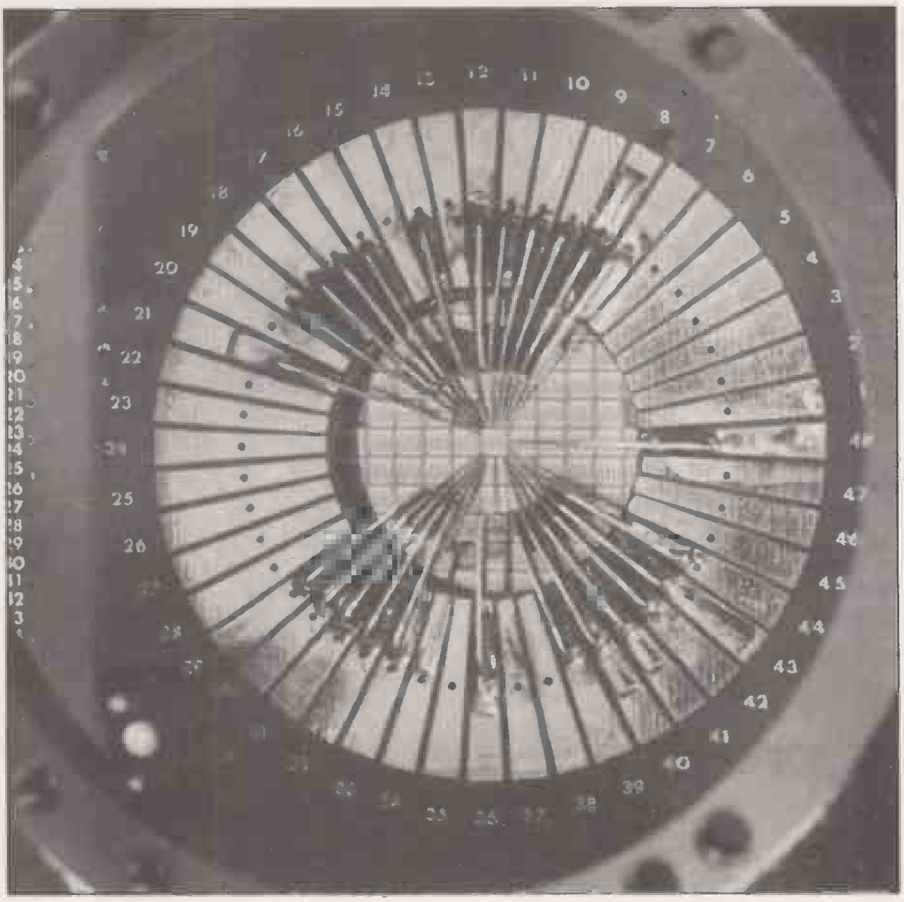
The solution is to print only in the centre of each wafer, or to use a single mask repetitively for each chip on the wafer and register it in each of 400 positions. Either solution drastically reduces yield and throughput.

The next problem is that as line widths grow smaller, they become an appreciably small multiple of the wave-lengths of the light used to print them and, in consequence, become fuzzy at the edges. The practical line width limit using visible light is .5 μ m. Below that, it is necessary to use either X-rays — the synchrortron radiation from an electron storage ring such as the Rutherford Laboratory is building at Daresbury — or an electron beam.

Gold masks

X-ray lithography is much like the visible light process, except that masks have to be made from gold or platinium. Electron-beam lithography is amenable to direct control — instead of printing the beam through a mask, it can be steered by a computer, so that the various layers of a chip are written on to the silicon just as graphics on to a piece of paper. Moreover, the computer can sense the existing pattern and distort the next layer to fit. The difficulty is in drawing such complicated shapes quickly enough using feasible data rates.

One of the arguments in favour of Inmos is that — unlike its U.S. competitors — it is unencumbered with expensive but outdated — by at least two years — masking equipment. It is going in for electron-beam lithography. Those who wish it well will hope that the complicated sums about yield and speed of processing will prove to be correct.

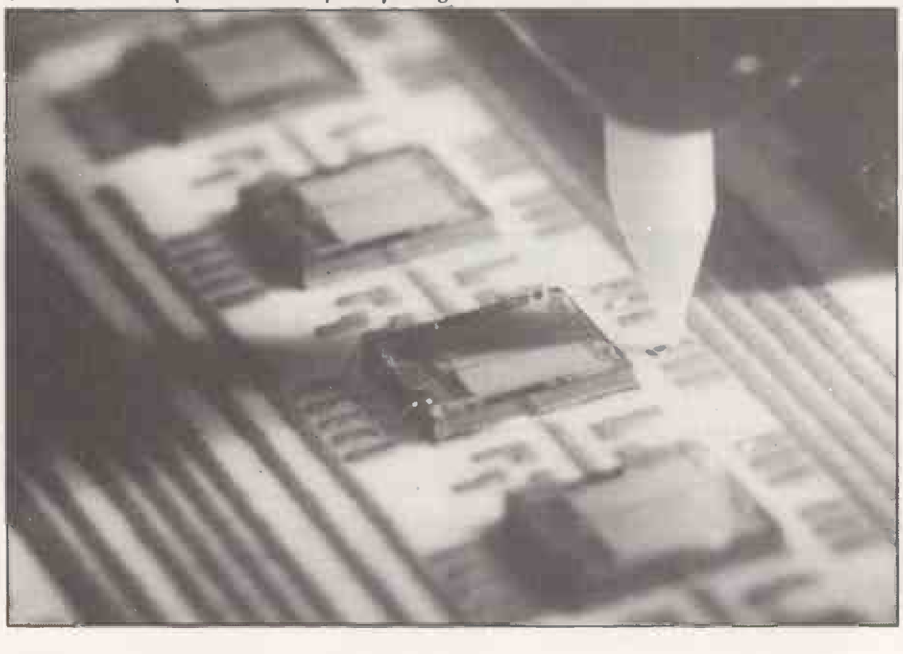


Testing each chip in turn.

A incidental advantage of equipping oneself with electron-beam equipment is that it can be used either to write directly on to the chip, or to make masks for optical or X-ray lithography.

The upshot of the whole argument is that the .1 μ m line-width goal, at which physics of conventional electronic devices starts to go wrong, is well within the current conceptual horizon. The pot of gold is definitely there; but it is not quite so clear at the moment which rainbow to slide down to find it, and how expensive the final product will be once it is achieved.

The successful chips are divided up and packaged.



Although the MOS transistor is so simple and relatively easy to make, it may not be what is inside the wonder machine of 1990. There are two obvious rivals on the scene. Although neither of them has been used to make a computer yet, neither has either had the benefit of the frantic development devoted to MOS technology. The first uses the Josephson Junction as its switching device.

The Josephson junction — named after the young Ph.D. student at Cambridge who discovered the effect in the 1960s — relies on the well-known quantum effect of tunnelling. While electrons in bulk are stopped dead by insulators, at very small scales there is a finite probability that an electron in a conductor will jump through a very thin insulator and appear on the other side. That is a consequence of its nature.

Probability clouds

Although one tends to think of electrons as small billiard balls, they are small clouds of probability. Most of the time the electron will be where you think it is — at the centre of the cloud, but there is a definite probability that it will be found somewhere else. Naturally, the further away one looks from the centre, the less

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likely the electron is to be found there.

Josephson junctions work at superconducting temperatures. Electrons in a conductor fly round and round, unhampered by ohmic resistance. If they are hindered by a sufficiently thin insulator, they also fly straight through it. The insulator has to be very thin indeed. At .005 μm, it is one of the smallest things anyone has ever proposed to make on a production line.

Now, the point of the trick is that a small magnetic field will stop the electrons tunnelling through the thin insulator. The field can be just the magnetic field which surrounds any conductor carrying a current of electricity. To switch the insulator on and off, we must put a modest current through a conductor near it, resulting in an electronically-controlled switch — the basic computing element.

The real reward is that switching takes place in pico seconds — 10^{-12} secs — some 3,000 times faster than today's MOS and still much faster than the .1 μm MOS projected for 1990. Moreover, because Josephson circuits use so little power — being mainly in the super-conducting state — the designers of a computer using them can afford to terminate the lines properly with resistances to prevent reflections.

Execution time

That means that such a machine is not restrained by instabilities on the lines and can operate with a clock running at 100 MHz — i.e., an instruction execution time of 10 μs. However, in that time light moves only 300cm. To prevent the different parts of the computer becoming out of step with each other, the whole device cannot be more than 30cm. long, wide or high.

The disadvantage to Josephson technology is that the circuits seem somewhat more complicated than MOS versions, and may, therefore, be less economical in the all-important real estate. Also, such a machine must be kept in liquid helium, and even though the liquidiser may be no bigger than a domestic fridge, it adds an extra complication.

The problem with conventional computing is that it uses electrons as abacus beads. Small and light though electrons are, it takes appreciable amounts of power to hurl them about as fast as a computer designers would like.

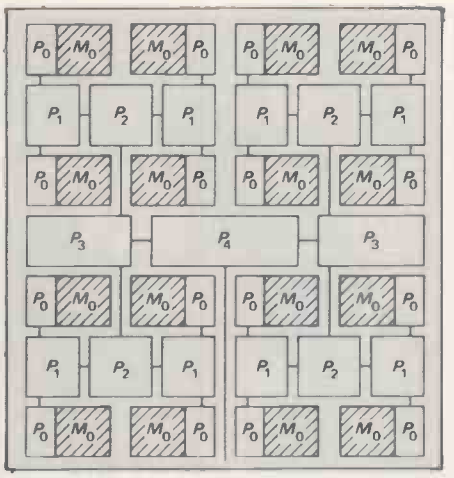


Figure 5. Lay-out for a binary processor tree.

The solution may be to turn to smaller and lighter beads — photons, the weightless, though not momentum-less, particles of light itself. There is a means of generating light in the semiconductor laser, and a way of making one beam switch another in the transphasor being developed at Heriot Watt University in Edinburgh, but at the moment only single switches have been made and the devices measure millimetres rather than micrometres.

Though it seems that conventional electronics will work at line widths of about .1 μm, beyond that the puzzles start. Bulk effects like resistance cease to apply. Electronics must be considered as wavicles rather than billiard balls, and a whole host of new problems arise, of which not the least is the electron's probalistic nature.

When circuits become really small, for a good deal of the time, the electron you thought was in one conductor will be in its next-door conductor, or over on the other side of the chip which makes for confused computing. A great deal of work is being done, mainly in the U.S., of course — but also in the U.K. by Dr John Barker and his team at Warwick University — but no-one expects real results for 10 years.

Whatever the technology of the switches in the computer of the 1990s, it will still be a main consideration of the designers to speed it by reducing the lengths of conductor between the active devices. One promising way to do that seems to be to re-design the architecture of the whole machine.

We are used to serial computers in which a single processor moves very quickly through a long queue of instructions and data. Although that works, it is clear that it is not how nature computes. It is also clear that it forces the designer to employ very long line lengths — how far is it in nanometres, from your CPU to the average RAM cell? For both of those reasons, people are considering very hard parallel-processing systems in which a hierarchy of processors, each with its own morsel of memory attacks a problem at many levels at once — figure 5. See Carver Mead and Lynn Conway, Introduction to VLSI Systems, Wesley Addison, 1979.

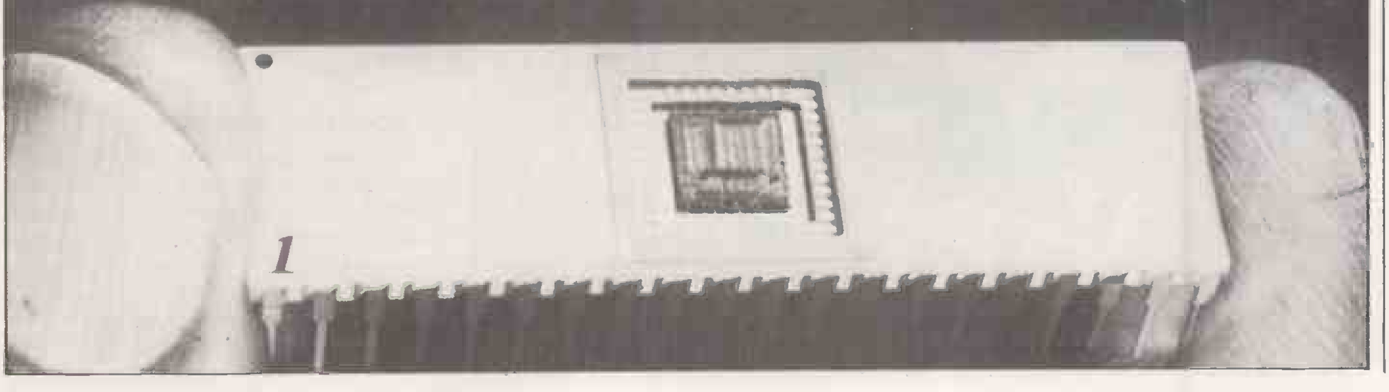
Four levels

One scheme is to have four levels on a chip. Each processor controls two in the level beneath; the processors at the fourth level have access to a piece of RAM each. Such a machine can act as a conventional single processor single block of RAM combination by making the intermediate level processors repeat their inputs. Or it can function as 16 parallel processors by making the higher-level processors transparent, or in any configuration in between.

That encapsulates the present state of play. Hardware is rapidly ceasing to be a problem. Soon, we will have vast amounts of processing power and memory. What we do not yet have is the software to begin to take advantage of it. It has been justly said that if hardware development stopped today it would take 10 years for software to take full advantage of everything the 8-bit processors can do. Hardware will not stop today, or any day for at least the next two decades.

So the software business is going to have unlimited scope for ingenuity and development. If we think there is a programmer bottleneck now, it will be insignificant beside what is to come. The future is exceptionally challenging and intriguing.

The final product in the chip-making process.



Sharper competitive edge for computerised estate agency

Martin Hayman met Colin Yarwood and Chris Murphy, one an accomplished estate agent, the other a computer professional, and discovered how they developed the successful estate agents' package, Microbase.

COLIN YARWOOD was already a successful estate agent in the Oxfordshire partnership, Buckell and Ballard, when he discovered the micro. He had risen with some alacrity to become a branch partner in the pleasant, thriving country town of Wallingford. In his mid-thirties, he found himself with a capable staff whom he had more or less trained to take over his own job of selling houses; the prospect of an increasingly sleek and torpid lifestyle presented itself. Then the micro arrived.

Less than three years later, much has changed about Yarwood's life. He has a new business as an Apple dealer and consultant, has a partner in the enterprise who is busy negotiating with Government agencies for new software contracts; and within his own business of estate agency he finds himself courted by famous estate agents, such as Bristol's Bruton, Knowles, who arrived from all over the country to see how his wonderful computer-assisted system works.

Change and expansion in all around he sees; where a few years ago, the reward of unswerving devotion for the rest of his natural would perhaps have been the chairmanship of the company as he approached retirement age.

Two worlds

On the face of it, there could scarcely be two more different businesses than houses and microcomputers. The former is traditional, the latter seems at times to have not only no tradition, but no rules either. In estate agency, nothing is done by coercion, all by the gentleman's agreement — estate agents are not allowed to form themselves into limited companies but must remain partnerships.

When the subject is micros, any innovation is worth examination, and maybe serious consideration; in houses, people have the most rigorously conservative idea of what they want. If what they want is a suitable heated cupboard for the dog and a porthole-style window next to a Purbeck-stone chimney, they are prepared to stand doggedly by that ideal. That kind of conservatism seems to be reflected by the estate agents.

The initial impetus for a computer system at Buckell and Ballard's, the Wallingford branch, was from the accounts department, which was having difficulty coping. At first, Colin Yarwood scanned the professional journals for whatever the major manufacturers of office equipment would produce. The results were a nasty, expensive surprise: "We were given a quote of about £60,000 split 50/50 between hardware and software. Now there is no way that kind of expense is going to be acceptable to a company like ours, which is a partnership".

Further investigation

Yarwood investigated further and decided a computer might not only relieve pressure on the accounts department — but also tackle some rather cleverer stuff which would match the requirements of an applicant — someone who has arrived at the estate agent with a request to be supplied with details of houses and its reverse: finding suitable applicants from their lists to whom to send details of newly-listed properties.

In the latter case, it is a considerable advantage to be able to supply those details to the applicant before another agent does. That way you are more likely to make the sale and collect the percentage. From that point of view, a system which would print-out details after sorting suitable applicants, and then address the labels, was the ideal towards which Yarwood — and I daresay, estate agents over the years — have been striving.

After six months, Yarwood had looked at IBM, Hewlett-Packard, Sperry Univac, ICL and other business equipment manufacturers. Then, the whisper single-board computer reached him from one of his Round Table acquaintances, who ironically enough dealt in radio and TV. He pointed Yarwood in the direction of ITT, which in its turn, suggested he contact the ITT dealer for the area, Microsense. At Microsense, he was introduced to Chris Murphy, a computer professional who had worked for Burroughs and was now doing software development.

Yarwood detailed his requirements to Murphy and together they worked on a draft version of the estate agents' package, which was to become Microbase. The development was done on an ITT 2020 but for commercial use it went straight on to an Apple 2 with no modifications — and with no problems either.

Thermal printer

Out went the old Elliot Addressed cut-card system with its noise and its heavy, expensive, cut cards; in its stead was the Apple with a thermal printer for quietness. Within a quarter of an hour of his return to the office, a negotiator would have entered the details of a house for whose sale Buckell and Ballard had just received the agency and the Apple would have matched the house to applicants and

Chris Murphy and Colin Yarwood.

the printer would be producing the address labels of those applicants along with the necessary number of sets of particulars.

Even allowing for the vagaries of the postal system, it was a real lead time over the opposition in the case of non-exclusive agency. To obviate waste of effort and money, a routine was incorporated to send a reminder card to each applicant after a certain lapse of time which, if not returned, meant the mailshots would be discontinued.

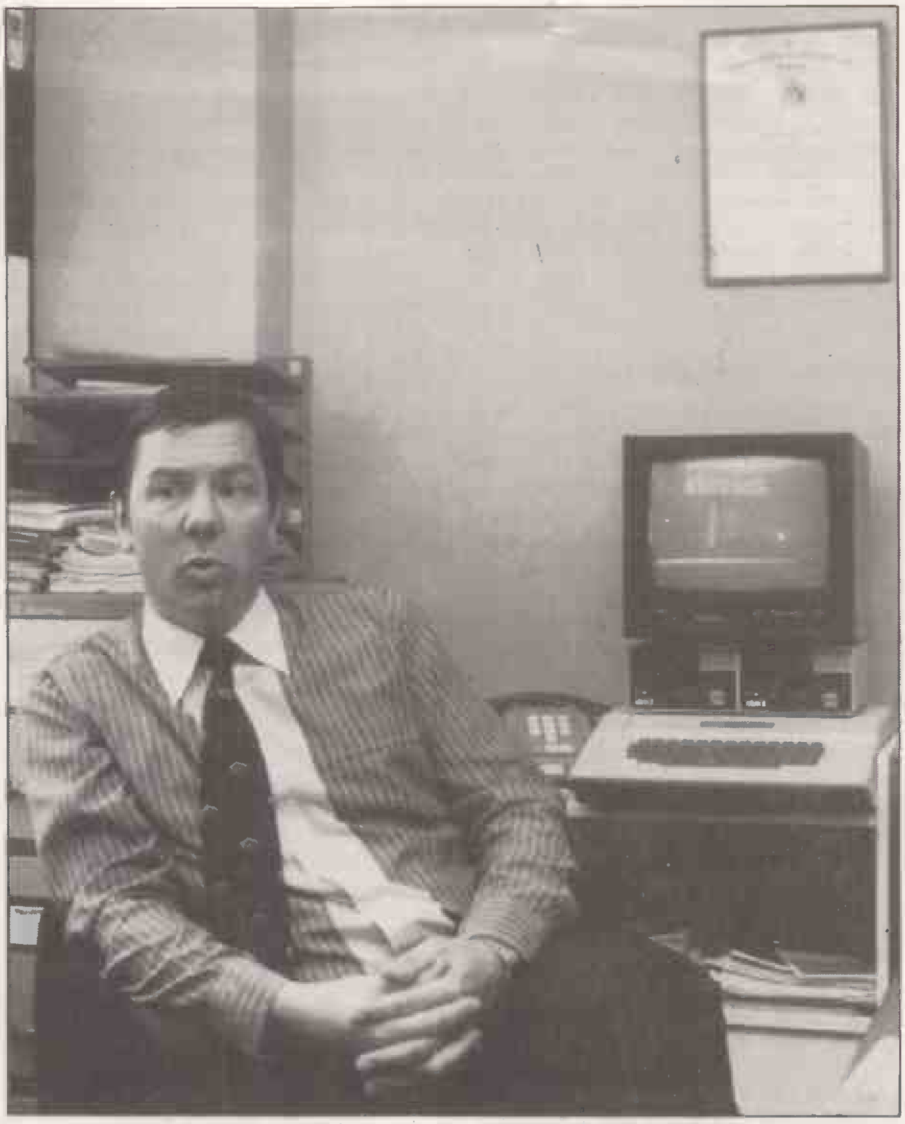
Soon there were interested parties queueing to see the Cyderpress system at work. Colin Yarwood enjoyed playing a game with the people who arrived to look at the system during the winter of 1979: he asked them how much they thought it cost. The answers ranged from £5,000 all-in, to £10,000 a year. The first, lowest answer is about right, and includes the residential software package and the necessary two or three days' training at Cyderpress in Wallingford.

By February, three such systems had been sold and it was rapidly becoming apparent that there was real money to be made. Up until this point, Yarwood and Chris Murphy, whom he had persuaded to join Cyderpress from Microsense, had set-up the software and training but left supply and installation to an Apple dealer in the neighbourhood. Why should they not actually supply as well as install the machines, hence the dealer's margin too? So they did.

On the whole, Yarwood was against marketing the system aggressively, figuring that word-of-mouth recommendation would bring the customers, unsolicited, to him. He was especially wary of what he refers to as the photocopier salesman syndrome and which, he feels, characterises the efforts of the software houses whose writers are first and foremost programmers and who do not bother to discover the customer's business needs.

The results, he thinks, are programs which may in themselves work well enough, but do not present what he refers to as a logical enhancement of what the customer is already doing. Obviously, with a decade of partnership behind him, and with a program developed by an Apple specialist to run on an Apple, Yarwood can permit himself such aspersions. He admits that he did try a canvas letter to 60 estate agents and — as he had expected — failed to elicit a reply from a single one.

In the meantime, Chris Murphy had been progressing with improving and updating the Microbase package to bring it up to date. The new version of Microbase is different enough for Cyderpress to call it exclusively its own, though the original package, developed by Chris while he was still at Microsense, belongs to them; and, in theory, Cyderpress would also pay royalties to Microsense on the new Microbase if it were sufficiently similar to be regarded as the same program.



Colin Yarwood of Cyderpress.

Fortunately, this gentlemanly agreement seems to work on a "you scratch my back, I'll scratch yours" basis; Cyderpress is still selling plenty of systems for Microsense, which in turn refers any enquiries from estate agents to Cyderpress. Obviously, with only two staff, fully occupied at that, Cyderpress is not able to undertake installations outside the Thames Valley and South Midlands area. So, it is in the process of appointing agents for its software packages; enviably, because of Murphy's connection with Microsense, it is in a good position to know which Apple dealers are suitable.

Dealer's profit

Of course, it means that it will be losing the dealer's profit on installation; on the other hand, Chris Murphy did not want to become involved in establishing a nationwide support network and in any case, the countrywide availability of the software should help to reduce its price. Murphy is, in any case, development manager and seems to be able to spend most of his time on programming in the tiny lair down an alley which Cyderpress has taken over from a home knits shop.

One of the aspects which needs attention, and which relates to what Colin Yarwood said on business practice, is that estate agents do not operate in precisely the same way throughout the U.K. The system, as conceived by Colin Yarwood and Chris Murphy and implemented in the first place for Buckell and Ballard, is for a mixed multi-branch estate agency with town and country properties.

A London estate agent would require different systems software: he would have a great many more properties in a much smaller area being chased by fewer applicants, which means that far more storage is needed for properties — typically three properties' disc to one applicants' disc — and much more work for the printer. In Scotland and the north of England, things are different again, where exclusive agencies are the rule, and the seller is charged recoverable costs whether or not the agent sells his house.

As a result, the seller takes far more care about his choice of agent, and the

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agent in turn must be able to bill recoverable costs independently. Those are the kind of wrinkles which Cyderpress builds into each program supplied and which, claims Colin Yarwood, give Cyderpress a competitive edge over systems which are not, shall we say, synergistic? Those, in any case, which do not spring directly from an understanding of the work the machine is likely to be required to do.

Related disciplines

Nevertheless, Cyderpress is chancing its arm with packages written for other but related disciplines. Yarwood is pleased with the most recent development, an auction and saleroom system which allows the user to enter details from the registration of lots through to printing the vendor's accounts at the end of the sale. There are packages for commercial letting and renting, for accountants and for publishers.

The company had a stroke of luck, too, when it acquired — free — several extremely detailed modelling and analysis programs, written for quantity surveying jobs for the Pet, and which Murphy was able to convert without too much difficulty.

Now Murphy's sights are rising further, with the promise of another staff member to relieve him of some of the installation and maintenance work, and he has been angling — along with, let it be said, just about every other software house in the country — for work at various Government institutions nearby — Oxford is well supplied with them — such as the Institute of Hydrology.

That is not to say that he does not find time to maintain the existing Cyderpress programs. He confesses to being unable to leave a program alone and is always looking for new ways to trap errors and reduce the length of programs. He says that this is self-indulgent perfectionism to some extent, since many of the customers who have already taken Microbase cannot even be bothered to send in their disc for an improvement to the disc controller — that kind of modification would cost typically between £20 and £60 and would take 24 hours to turn round.

The wide range of applications possibilities keeps Murphy rooting for the Apple; another is its ability to support Pascal, with the implications of upward compatibility with for example the Alpha Micro. He feels that for the purposes of Microbase and associated programs, Pascal is the best solution because it is structured in a modular fashion so that particular routines can be stored as blocks and called at will when needed, just with the parameters re-defined.

That also allows more compaction on any given disc and so has a very real effect on the bottom line of the balance sheet. He also thinks that Pascal is currently more portable than Basic: "Unless, of course, you are operating under CP/M which I do not think is really a very good first-user language — not sufficiently user-transparent". For his purposes, he describes the principal advantages of Pascal as: faster execution speed; better utilisation of disc store; and greater software protection.

He concedes that in system-design terms, it is slower to work with because of its highly-structured nature and the pedantry of compilers, but advantageous because some system functions are procedures which can be called in and bound together as an application. From a purely selfish point of view he approves of the Apple sharing Pascal machine code and Fortran, which make a good complementary duo for development work — editing and number-crunching.

Challenge to PDP-11

The fact that the Alpha Micro, which promises to offer as much computing power as a mini of a few years ago, will support Pascal, looms largely in Cyderpress plans. With the possibility of ½MB, plus up to 90MB storage, and three workstations plus printer, Murphy believes that that kind of machine is going to challenge the PDP-11 and send operations like Cyderpress into the relatively big time.

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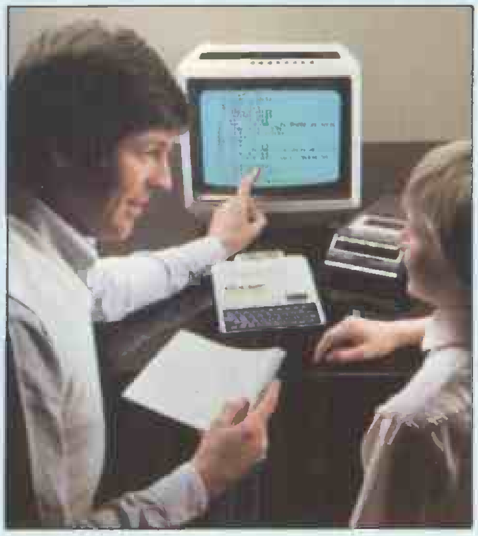

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Incorporating a control-key function into your programs

Jonathan Dick presents two programs — one in Basic, the other in assembler — which use the run-stop key as a control key to generate control characters.

CONTROL CHARACTERS are normally used in computers for controlling output and for communication purposes. In the Pet, some are used for controlling the position of the cursor. The normal control characters have ASCII values between zero and 31. Only a few can be generated directly from the keyboard on the Pet using the cursor control keys. One which can be generated is control-Q which, when printed between quote marks, appears as a reverse-field 'Q'. That character is used to move the cursor down one line.

The programs I have written to enable the run-stop key to be used as a control key are subroutines designed to be incorporated into your own programs. The Basic version is called with 'GOSUB 10000'. That command will replace the 'GET' command you would normally put in the program. The subroutine returns with the variable KY$ set to the character that was entered.

The first task the subroutine performs when called is to disable the break-in function of the run-stop key; that is done with the usual POKE. If your Pet has old ROMs, you will have to change it to POKE 537, 136. At line 10010, once a key has been pressed line 10020 checks to see if it is the run-stop key which has been pressed. The run-stop key has an ASCII value of three as can be seen from the listing.

Instead of putting CHR$(3) in the program, it would have been possible to replace it by typing a quote and hitting the run-stop key. That would have produced a reverse-field 'C' which would have done just as well for the comparison.

It would, however, not have shown as well in the listing. If you have not pressed the run-stop key for the 'GET' in line 10010, you must have typed a normal character. The break in function is restored — for old ROMs, change to POKE 537, 133 — and a return is executed.

If you have pressed the run-stop key, the program waits for another key to be pressed which is done in line 10030. That key is the control character you want to generate. The valid control characters are: 'Control: @ , A-Z, [/]↑←'. They produce the control codes zero to 31 respectively.

If you type any other character, the program loops back to the start and waits for you to press a key again in the loop at line 10010. If you have pressed the run-stop key again, you have cancelled the control-shift mode and the program loops back to 10010.

When you have entered a correct Control character, 64 is subtracted from its ASCII value to make it fall in the range zero to 31. The break in function is the re-enabled as described earlier and a return is executed.

The first version of the program was written so it would be possible to have a control key in assembler programs. It follows the same method as the Basic program, except it does not disable the break-in function as that is not operative for machine-code.

The character typed is returned in location Hex B2 — for old ROMs, use any free location for this; location six would be a good one. The 'GET' subroutine location does not have to be changed as the jump into it is in the same location in the old and new ROMs.

A full list of the names of the control characters is given on page seven of the Pet manual, second edition. An example of one of the names is the one given to control-A. It is called 'SOH', start-of-header, and is often used when terminals are communicating with a central computer. It indicates a useful function for the control-key programs.

That is when you are writing a terminal emulator program to communicate with a central mainframe computer via a modem. Several of the control characters are used in those computers for file editing and other functions making a control key on the terminal essential.

```
0000                ;****************************************
0000                ;*                                      *
0000                ;* ASSEMBLER VERSION OF 'GET' SUBROUTINE *
0000                ;* USING STOP KEY AS CONTROL KEY        *
0000                ;* PROGRAM IS FULLY RE-LOCATABLE        *
0000                ;* CHARACTER RETURNED IN LOCATION $B2   *
0000                ;* WRITTEN BY JONATHAN J DICK           *
0000                ;* COPYRIGHT (C) JJ DICK 4/9/80         *
0000                ;*                                      *
0000                ;****************************************
0000                ;
0000                ;
0000                GET    = $FFE4          ;GET A CHARACTER
0000                STOP   = 3              ;ASCII VALUE OF STOP KEY
0000                CHAR   = $B2
0000                ;
0000                       *=$033A
033A                ;
033A  20 E4 FF      GETKY1 JSR GET          ;GET A KEY
033D  F0 FB                BEQ GETKY1       ;NO KEY PRESSED
033F  C9 03                CMP #STOP        ;IS IT STOP?
0341  F0 03                BEQ GETKY2
0343  85 B2                STA CHAR         ;NO, STORE CHARACTER AND
0345  60                   RTS              ;RETURN TO CALLER
0346  20 E4 FF      GETKY2 JSR GET          ;GET NEXT KEY
0349  F0 FB                BEQ GETKY2       ;NO KEY PRESSED
034B  C9 03                CMP #STOP        ;STOP KEY?
034D  F0 EB                BEQ GETKY1       ;YES CANCEL CONTROL SHIFT
034F  C9 40                CMP #'@          ;GREATER THAN BOTTOM OF RANGE?
0351  90 E7                BCC GETKY1
0353  C9 61         OK     CMP #97          ;LESS THAN TOP OF RANGE?
0355  B0 E3                BCS GETKY1
0357  38            OK2    SEC
0358  E9 40                SBC #64          ;MAKE CHAR A CONTROL CHAR
035A  85 B2                STA CHAR
035C  60                   RTS              ;RETURN TO CALLER
035D
035D                       .END

ERRORS = 0000

SYMBOL TABLE

SYMBOL VALUE
 CHAR      00B2    GET       FFE4    GETKY1    033A    GETKY2   0346
 OK        0353    OK2       0357    STOP      0003

END OF ASSEMBLY

READY.

 9990 REM *** 'GET' SUBBROUTINE USING 'RUN-STOP' KEY AS CONTROL KEY ***
 9992 REM *** CHARACTER RETURNED IN 'KY$' ***
 9994 REM *** WRITTEN BY JONATHAN J DICK ***
 9996 REM *** COPYRIGHT (C) JJ DICK 6/9/80 ***
 10000 POKE 144, 49
 10010 GET KY$:IF KY$ = "" THEN 10010
 10020 IF KY$ <> CHR$(3) THEN POKE 144, 46: RETURN
 10030 GET KY$:IF KY$ = "" THEN 10030
 10040 IF KY$ = CHR$(3) THEN 10010
 10050 IF KY$>="@"ANDKY$=<"←"THENKY$=CHR$(ASC(KY$)-64):POKE 144, 46:RETURN
 10060 GOTO 10010
READY.
```

Poor-quality maths software causes irreparable damage

If bug-riddled maths packages make computers seem complicated and capricious, the damage to pupils' confidence and enthusiasm will be irrevocable — M P Thorne's indictment of currently-available software.

IT IS OFTEN said that mathematics is the obvious area in the curriculum where microcomputers could be used successfully to considerable educational advantage. If that is the case, the poor quality of the range of software available for teaching mathematics suggests that we are a long way from the successful use of microcomputers as teaching aids in other, less obvious areas of the curriculum — Latin, for instance. Much of what is currently available may be classed as poor on the basis of three criteria:

- Does the program achieve its educational objectives? Many catalogues offer software which, they claim, teaches a topic and yet which gives only practice.

As a violin teacher will tell you, practising mistakes can be harmful. Even if a given program is not helping the educational development of a pupil, the pupil may well be learning about computers which seems ideologically pure enough in these troubled economic times. That brings us to the second criterion.

- Does the program reinforce the widespread view that computers are complex and unpredictable machines, understood by and for the use of a privileged few? If it does, it is the last thing we want in our classrooms with industry and commerce poised to plunge deep into microcomputer technology, regardless of any other educational qualities it may have. In a recent Open University survey, more than one-third of the adults talked to described a particular experience in the early stages of learning to use a computer which had given them a permanent fear of computer technology.
- Is the use of the program cost-effective? If the program and computer together can cope with only one pupil at a time and the teacher has to interrupt what he is doing with the remaining 29 every few minutes to assist either computer or pupil using it, clearly not. As one of the 29 other pupils in the class, I would be very upset to see the teacher spending more time with the machine than with me. Teachers are an expensive commodity; so are computers. There seems little point in spending £1,000 on classroom computing equipment which distracts the teacher's attention from his pupils because the £15 program has errors in it or because what the pupil using it has to do is poorly explained by the program or demands unpredictable responses from him.

Most software available to teachers of mathematics from commercial sources is of the drill and practice in arithmetic variety. That is hardly surprising since it is easy, in principle at least, to program that kind of application and the list of possibilities for such treatment is substantial, including

Fundamental operations with signed or unsigned integers
Factorisatiion of integers
Common fractions and reduction to lowest terms
Decimals
Percentages
Simple algebraic manipulations
Solving linear equations in one variable
Ratio, proportion
Systems of linear equations
Graphs
Sets

What is surprising is just how many commercial programs contain programming errors. Many teachers take time to find and correct them rather than sending them back. Thus, software houses may wait an long time before hearing of basic flaws in their goods. We know of no other product on the market for which schools would pay between £10 and £20, find the product did not work on arrival and pass it to a teacher to correct.

Of those free of programming errors, none even attempts to include a teaching element as you see from our brief, but representative, survey. It would be easy to program a routine which looked at a wrong answer and made helpful comments like

"Third digit is too large"
"I think you forgot the (a) carry"
"Your answer is too big (small) (long?) (short?)"
"Did you pay back the one you borrowed"?

At the moment, a pupil who obtains the wrong answer receives no help from the computer. One program simply says: "You have attained the correct answer", if you are right and: "You have not attained the correct answer", if you are wrong. Note how the programmer has gone to great lengths to talk to the children in their own language. That, too, is typical. Programmers have never been famous for their grammar: "Your now going to do 10 addition sums", and: "It doesn't matter which one", being but two endearing examples from current commercial software.

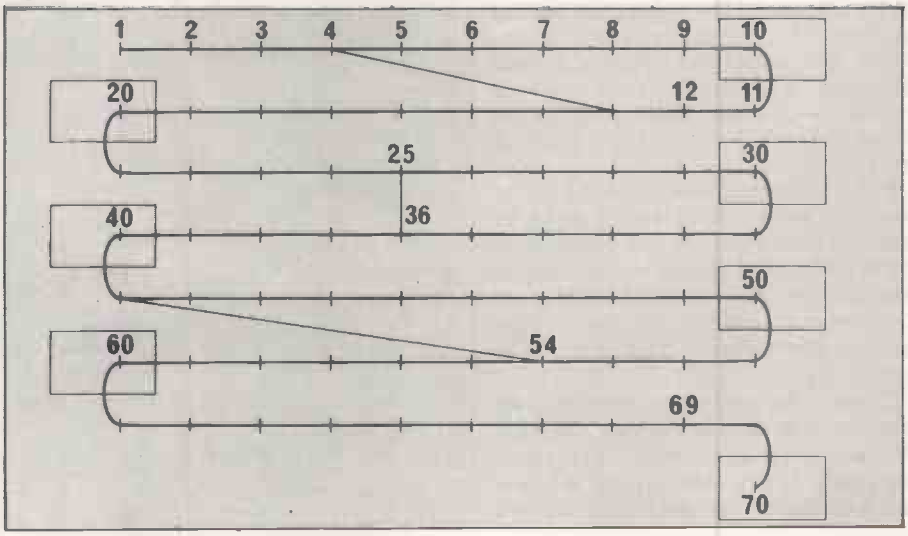
Some packages allow you to correct typing errors only at the end of the whole sum. Often you have to do the whole thing again having waited to be told that your answer was wrong — which you knew anyway.

There is little point in drill and practice if the teacher cannot keep track on how pupils are performing. Most packages display a pupil's score at the end of the session in terms of the number correct — possibly after up to three attempts — and the number wrong. It is up to the teacher to make a written record of the pupil's progress — or for the trustworthy pupil to record the score himself.

The computer keeps no record of which sums were attempted by that pupil though there is often a choice to be made of the level of difficulty of the sums presented. Here are six typical packages with some comments:

Package A: Totals delivered at the end of the session disappear after 20 seconds. Two wrong answers from 10 give 79

Figure 1.



percent correct and 19 percent incorrect. If a sum is wrong, this cryptic response appears: "No that's wrong. The answer is six. When you have seen your mistake type any key for the next problem".

Package B: The only package of the six to insist that answers are entered as units first, then tens, then hundreds and so on. Thus, for 24+1, you type 5 then 2. In other packages, the pupil is expected to respond to the sum

$$\begin{array}{r} 17+ \\ \underline{4} \end{array}$$

by typing 3 then 1.

Package C: It contains programming errors. Drill and practice, it says, is offered in any of the four basic arithmetic operations, but it has no minus or oblique signs. Inspection of the program reveals that it chooses at random between offering you + or *. Selection of another of its options results in the screen message "DIVISION BY ZERO" followed by a program crash.

Package D: It claims to adjust the problems automatically to fit your ability. Indeed it does, but one typing error will strip the pupil of the honours of 78+94 and reduce him to 1+2. If you have a wrong answer, the correct answer appears for an interval of time over which you have no control. Spot your mistake in the next five seconds or —. If you have all the sums right, a score of 87 percent appears. The summaries of a pupil's performance defied comprehension even when they were shown to a group of experienced maths teachers.

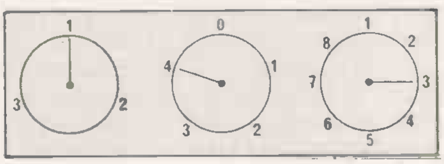


Figure 2.

Package E: Will not allow the pupil to move to next sum until he obtains the correct answer for the present one. Schools who buy this package should doubly insure their computer.

Package F: The only package of our six to make anything but primitive use of the graphics. One face of each of two dice are displayed; each face has up to 12 dots. The pupil must add the numbers of dots on each face. If the number of dots on the right-hand die is zero, a programming error draws the right-hand die twice.

Package F is one of several programs available which offer pupils arithmetic drill and practice rather less formally than, say, presenting 20 multiplication sums. Often, there is a game to be played which involves two players — two pupils, boys v. girls — and offers the teacher a choice between working with the whole class and typing answers himself or sending two pupils off together, rather than just the one.

Perhaps the pre-eminent success in this area is the program Jane from ITMA at the College of St Mark and St John, Plymouth. Jane will be available soon for both 380Z and Pet and possibly others. The computer — operated at the front of the class by the teacher on instructions from the pupils — gives two numbers, say, three and seven, and the pupils have to discover the relationship between the first and the second number which involves two arithmetic operations.

More number pairs can be called to verify or contradict an hypothesis from the children. The teacher can control which arithmetic operations are used to form the relationship. Simple but effective use of graphics adds an appealing human element.

Jane has a close relation in a game, How the West was won, which is unavailable on microcomputers, at least from commercial sources. It was invented up by one of the members of the Plato project team. The board for the game appears in figure 1.

The object of the game is to land exactly on 70 and there are two players — represented on the computer screen by a □ and a X. At each turn, the computer presents three numbers on three dials — figure 2.

The player whose turn it is to move may combine three numbers — 1, 4 and 3 — in any way using only one each of the four basic arithmetic operations, and possibly parentheses. Thus, the actual move of the player's counter on the board may be 2 (=1+(4—3)) or 13(=1+(4*3)) or 15 (=(1+4)*3) — of course, the teacher could vary what is allowed. That part provides the drill and practice, but strategy is involved, too, since there are other rules to make it more interesting:

- Towns occur every 10 spaces. If you land on a town you advance automatically to the next one.
- There are shortcuts, e.g., landing on four allows you to slide down to 12.
- Landing on a space occupied by your opponent means he is bumped back two towns unless he is on a town.

Again the teacher can vary what is allowed for a particular teaching point or for the ability of the class.

Thus, the player who obtains 1, 4, 3 from the dials and is at present on space 28 on the board and whose opponent is on 29 has options which include move one and bumping his opponent back, move two and landing on a town, and move 13 and taking the shortcut.

Jane is based on what used to be called the discovery method of teaching. Instead of a teacher delivering rules and the pupils practising them, the pupils are allowed to discover the rules themselves. Perhaps the microcomputer would be helpful in discovery, the machine and teacher guiding the pupils. A typical example might be solving quadratic equations. The machine might request guesses of the solutions of

$$\square^2 + 6 = 5\text{x}\square$$

which are 2 and 3, and then ask for guesses for solutions of

$$\square^2 + 4 = 5\text{x}\square$$

which are 1 and 4, and so on until they realise that the sum of the solutions in each case is 5, and similarly for the product rule — the product of the solutions is always the number on the left-hand side.

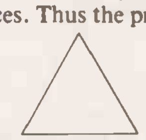
We hope it will not be long before Logo is commercially available. Logo is a programming language which was designed by Seymour Papert of the Massachusetts Institute of Technology as a means of teaching children mathematics through programming. Edinburgh University has a version for the Terak micro.

However, there is an implementation of possibly the most famous part of the Logo system — the Turtle graphics — as part of the UCSD Pascal system for the Apple II. Perhaps two examples will serve to demonstrate Turtle graphics to those unfamiliar with this system.

Two commands drive an imaginary turtle across the screen; as it moves, it drags a pen along to produce a picture. At the start, the turtle is in the middle of the screen facing to the right. The first command has the form TURN(x) where x is a number.

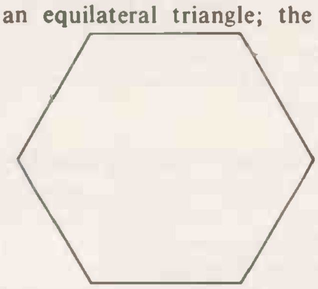
Thus, TURN (90) would turn the turtle to face in a direction 90° anticlockwise from where it was facing previously. The other command is of the form MOVE(y) and moves the turtle y units in the direction it faces. Thus the program

```
MOVE (50)
TURN (120)
MOVE (50)
TURN (120)
MOVE (50)
```



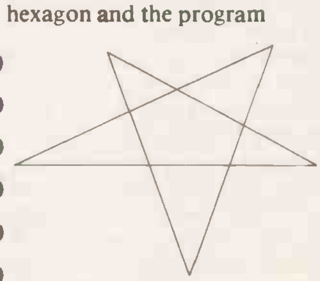
will draw an equilateral triangle; the program

```
MOVE (65)
TURN (60)
MOVE (65)
TURN (60)
MOVE (65)
TURN (60)
MOVE (65)
TURN (60)
MOVE (65)
TURN (60)
MOVE (65)
```



will draw a hexagon and the program

```
MOVE (50)
TURN (144)
MOVE (50)
TURN (144)
MOVE (50)
TURN (144)
MOVE (50)
TURN (144)
MOVE (50)
TURN (144)
MOVE (50)
TURN (144)
MOVE (50)
```



will draw the pentagram

Judged even by three very basic criteria, it seems harder to produce good commercial software for mathematics teachers than might otherwise be suspected. What is available seems to lack, among other things, enough thought and originality at the design stage and enough careful error checking at the programming stage.

How to format invoices and letters printed from screen

Rex Tingey demonstrates the formatting of an invoice printed directly from the screen using the Commodore printer and then letter printing directly from the screen. He also reveals a letter-writing technique using a line-by-line approach, and a circular writer.

THE technique of transferring a full screen of information directly to the printer is extremely useful since all the information can be checked and corrected before the transfer takes place, ensuring a correct invoice or letter is printed.

With my technique, the whole screen is not transferred since some space must be left for the transfer commands and statements — only the bottom few lines are required for this purpose. By extra internal programming, the information can be transferred with formatted lines included here and there for the invoice, the lines of which need not appear on the screen, but are positioned correctly on the final printout.

With the letter-to-screen transfer, the text can be formatted as either a 40-symbol line, as on the screen, or as a double-screen line of 80 symbols, printed-out on the printer as a single line.

Both the screen-to-printer programs use double quotes as field terminators; whenever the quote symbol appears on the screen, the program will automatically stop transferring information. The quote symbol is used as there is little reason to use the symbol, any quotation required can use the single mark symbol, ', next to the % key, as is required within a program.

Information gathering

The method used to gather information from the screen is to peek each screen memory location, and to form character strings from the coded information discovered. Thus, the information could be all spaces — blank screen — and the string formed of those characters. When the length of the string is complete, the string information is sent to the printer before the next line-set is read from the screen locations.

The transfer process is started by GOTO 200, but if that is written within the print-effective screen area, being read, the command will not be obeyed but printed on the printer. If the GOTO 200 is written on the screen print-effective area and a carriage return made, the whole effective area, including the command will print-out.

Through all the string formation process, a search is made for the double-quote character, which, when found, halts the string formation and the printing. So, double quotes followed on the next line by the GOTO 200, and a carriage return will terminate without the command printing-out.

Use two double quotes to take the screen from the quote mode. Otherwise take the cursor down to the first non-printing line, and carriage return over the preformed statement and command.

The # symbol is also searched for during the string formation; that is so that it can be changed to the pound sign whenever it is encountered. That is particularly useful in business programs where constant use is made of the sign, but where a dollar sign may also sometimes be required.

The circular and the line-by-line programs provide different methods of letter writing. The line-by-line presents a simple screen presentation for typing one line of a letter but after the program has already printed-out a letter-head and the date.

Personal heading

That method of letter writing may be preferred for letters printed with a carbon copy, when the printing program is not required to be saved, on tape or disc. The line information for the previous line is lost as each new line is written and printed.

The information for the personal heading is programmed in open-block form to be transformed into the required letters of the alphabet, as shown, to give a bold presentation. Any of the commercial-print programs could have that type of bold header inserted.

The circular letter program requires a letter to be typed, where it is saved on a definite line or step number, as print information. When the letter is complete and run, the printer continues printing letters until all clients have been printed one copy each, according to the data listing. The program can be saved on tape or on disc, complete with letter and list, but with the line-numbering, first part, cancelled.

The first writes formatted invoices directly from the screen, with a personal heading on each invoice. The day's date need be entered only once, at the first use of the program during the day. The program turns over for each new invoice, leaving the date intact.

Only one printed copy is obtained, and a carbon copy system should be used where duplicates are required. The pound sign is printed wherever the # sign is encountered on the screen. The arrows of the display show the right limits of the written text, and the space behind the arrows used for the monetary amounts, overwriting all the information text at the top of the screen.

First homing the cursor will always make available the maximum usable screen area. The format on the printer gives double-spacing throughout, and so double-spacing on the screen should be avoided, particularly between the invoiced items.

Overwrite down to the "0=1:GOTO 200" only, giving a carriage return on that line, which gives a continuation of the invoice. Writing the double quotes on a line for termination, GOTO200 and carriage returned will print-out and also draw the terminating formatting line across. To draw the same line after printing a full screen, write GOTO700 and C-Return.

On the screen, use only upper-case, figures and shifted-figure graphics, or an error may result — usually the printout of no symbol a shift to the right of the next symbol. Do not make a carriage return while typing to the screen, or a syntax error will result. However, if that does occur, the cursor can be lifted and the error characters overwritten before any transfer is made.

Direct program

A program similar to the invoice one, but without the line formatting. The program prints a personal heading and the date, as entered, before offering the screen for typing, apart from the bottom transfer lines, and when the screen is overwritten, the text can be transferred to the printer. The program re-starts at the beginning, so that the date must be re-entered for the next letter.

Either a 40-character line, or a double, 80-character line can be selected for print-out. Remember, the first line of the first pair of lines, when printing 80-character lines on the printer, starts with a home cursor, otherwise the wrong lines will pair together. Otherwise, the rules are the same as for the invoice.

The line-by-line program first writes a personal heading and the entered date. Then a line is screened for overwriting after a string symbol, equals, and quotes. That can then be transferred for printing on the printer, to write the letter, one line at a time. When the written line is carriage-returned over it becomes the new string with an added quote; the cursor passing to another pre-written screen line which now needs a carriage return to transfer the string line for print-out. The next carriage return clears the line for the next screen input, and the cycle is repeated.

Upper- and lower-case can be used, employing the cursor symbols for the changeover, printer-style. Other graphic symbols may be used, but make a trial printout to check which ones transfer successfully. The alphabet made from the graphics, as shown, can be used to transform your headings. There are, of course, many other forms and possibilities.

A program for writing the same letter to any number of clients with each letter printed with a different client's name as "Dear so and so", at the start of the letter. Once the letter has been written to the program format, and the line-making part self-cancelled, the program prints-out the series of letter automatically without stopping.

The names of clients must be written into the data bank at the end of the program, from line 30000 onwards. At present, there are 26 names in data, as a guide, one under each letter of the alphabet. If, say, 120 names are in the bank, in line 10000 change the IF P<26 to IF P<120, or whatever the number happens to be.

To check the letter for error or for justifying, without the program printing the total list, type a number greater than the number of clients in data. For example, "P=10000:GOTO 50" and carriage return, then just one letter addressed to the first name in data will be printed, for your checking. After checking, the length of each letter sheet can be adjusted in line 9000 by altering the value 10 in "S = 1 TO 10", increasing it for a longer page or decreasing it for a shorter page.

That will be dependent upon the size of the line-flow paper used, and the number of print lines in the letter. Otherwise, the rules allow upper- and lower-case using the printer-type symbols, and the limited graphics as before.

A useful complementary program to the circular writer is one which writes address labels for each client. The data must necessarily be longer with name, address, perhaps building's name, town or city, and county, perhaps postal code. That means that data should be in groups of six, at least, with data groups entered with blanks, if an address has less than six elements. Each address can then be picked up as six separate strings for transferring.

```
SCREEN TO PRINTER

1 TI$="000000":GOSUB2000:GOSUB3000
2 PRINT"   A PROGRAM TO TRANSFER SCREEN CONTENT
4 PRINT" DIRECT TO THE PRINTER, WITH FORMATTED
6 PRINT"SPACING TO CORRECT A 40 CHARACTER LINE.
8 PRINTSPC(11)"***************
10 PRINT"USE NO GRAPHICS, NOR PRINTER UPPER/LOWER
12 PRINT"   CASE, OR ERROR WILL HALT PROGRAM.
14 PRINT"USE DOUBLE QUOTES AS TERMINATOR IN FIELD
16 PRINTSPC(11)"***************
20 PRINT"   COPYRIGHT(C):REX L TINGEY:JAN'80
30 IFTI$<"000006"GOTO30
40 GOSUB3000:PRINT"TYPE TODAY'S DATE ON ASTERISKS
50 PRINT"155 PRINT#4,,,,,,"CHR$(34)"****************
52 PRINT"GOTO70:REM-RETURN OVER THESE
60 PRINT"":END
70 GOSUB3000:PRINT"CUSTOMERS ORDER NUMBER":INPUTB$
80 PRINT"INVOICE NUMBER":INPUTC$
90 PRINT"CUSTOMER'S ADDRESS WITH COMMAS(A,B,C,D)":INPUTD$,E$,F$,G$
100 OPEN4,4:PRINT#4:OPEN6,4,6:PRINT#6,CHR$(24):PRINT#4:PRINT#4:PRINT#4
110 PRINT#4,,CHR$(1)CHR$(1)"PERSONAL HEADING HERE
130 PRINT#4,,"  ____________________________________________________
140 PRINT#4,,"    YOUR ADDRESS GOES IN HERE WITH SPACES TO MATCH HEADING  "
150 PRINT#4,,"  ____________________________________________________
152 PRINT#4
155 PRINT#4,,,,,,"***************
160 PRINT#4,,"CUSTOMER'S ORDER NO: "B$
170 PRINT#4,,"INVOICE NO: "C$:PRINT#4,,,,,"      TO: "D$:PRINT#4,,,,,,E$
174 PRINT#4,,,,,,F$:PRINT#4,,,,,,G$
180 B$="":C$="":D$="":E$="":F$="":G$="":PRINT#4
196 PRINT#6,CHR$(18)
198 PRINT#4,,"┌─────────────────────────────────────────────┬──────┐
199 R=0:S=39:CLOSE4:GOTO800
200 T=S-8:FORZ=RTOT:GOSUB1000:NEXT
210 T=T+1:FORZ=TTOS:GOSUB1100:NEXT:OPEN4,4:P=0
220 PRINT#4,,"|    "B$,"    |  "C$"  |"
230 PRINT#4,,"|                                             |      |
240 A$="":B$="":C$="":CLOSE4:P=1:R=R+40:S=S+40:IFS>910GOTO700
250 GOTO200
700 R=0:S=39:IFP=1THENOPEN4,4
710 IFO=1GOTO800
720 PRINT#4,,"└─────────────────────────────────────────────┴──────┘
730 PRINT#4:PRINT#4:CLOSE4:PRINT#6,CHR$(24):CLOSE6:CLOSE5:GOTO70
800 PRINT"O=1:GOTO200:REM-RETURN ON THIS ↑
801 PRINT"TYPE GOTO700/RET AT END.#=POUND↑←":O=0
```

(continued on page 89)

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```
802 PRINT"PRESS CLEAR/HOME : OVERWRITE TO↑←        G0TO200 ONLY",," ↑"
808 CLOSE4:END
1000 X=32768+Z:A=PEEK(X):IFA=35GOTO1010
1004 IFA=34GOTO700
1006 A=A+64:A$=CHR$(A):B$=B$+A$:GOTO1020
1010 B$=B$+CHR$(254)
1020 RETURN
1100 X=32768+Z:A=PEEK(X):IFA=35GOTO1110
1104 IFA=34GOTO700
1106 A=A+64:A$=CHR$(A):C$=C$+A$:GOTO1120
1110 C$=C$+CHR$(254)
1120 RETURN
2000 OPEN5,4,5:DATA9,63,73,73,65,33:FORP=1TO6:READQ:Q$=Q$+CHR$(Q):NEXT
2010 PRINT#5,Q$:RETURN
3000 PRINTSPC(4)"■■ SCREEN TO PRINTER ■ DIRECT INVOICE
3010 RETURN
```

SCREEN TO PRINTER ■■■■■■■■

```
1 R=0:S=39:CLOSE5:GOSUB2000:PRINTSPC(4)"■■ SCREEN TO PRINTER ■ DIRECT
2 PRINT"■■  A PROGRAM TO TRANSFER SCREEN CONTENT
4 PRINT"■ DIRECT TO THE PRINTER, WITH EITHER ONE
6 PRINT"■ LINE OR A DOUBLE 80 CHAR LINE PRINTED.
8 PRINTSPC(10)"■***************
10 PRINT"■USE NO GRAPHICS, NOR PRINTER UPPER/LOWER
12 PRINT"   CASE, OR ERROR WILL HALT PROGRAM.
14 PRINTSPC(10)"■***************
16 PRINT"■FOR 40 CHAR LINE PRESS 1 - 80 PRESS 2.
18 PRINT"■USE QUOTES IN FIELD TO TERMINATE PAGE.
20 PRINT"■■■   COPYRIGHT(C):REX L TINGEY:JAN/80
30 GETJ1:IFJ1=0GOTO30
100 B$="":C$="":OPEN4,4:PRINT#4
110 PRINT#4,,CHR$(1)CHR$(1)"PERSONAL HEADING HERE
130 PRINT#4,,"________________________________________________________________
140 PRINT#4,,"■    YOUR ADDRESS GOES IN HERE WITH SPACES TO MATCH HEADING      ■
150 PRINT#4,,"________________________________________________________________
160 PRINT#4:PRINT#4:PRINT#4:CLOSE4:GOTO800
200 FORZ=RTOS:GOSUB1000:NEXT:R=R+40:S=S+40
210 FORZ=RTOS:GOSUB1100:NEXT:OPEN4,4:IFJ1=2THENPRINT#4,B$C$:GOTO240
230 PRINT#4,,,B$:PRINT#4,,,C$
240 A$="":B$="":C$="":CLOSE4:R=R+40:S=S+40:IFS>770GOTO700
250 GOTO200
700 R=0:S=39:END
800 PRINT"■■■■■■■■■■■■■■■■■■■■■■■GOTO200:REM-CURSOR ON THIS LINE-RETURN
801 PRINT"PRINTS THE ABOVE ON PRINTER.(#=POUND)■
802 PRINT"PRESS CLEAR/HOME : OVERWRITE DOWN TO THEG0TO200 ONLY
804 IFJ1=2THENPRINT"■■■■■■■■■■■■■■■(80 PRINT SELECTED)":GOTO808
806 PRINT"■■■■■■■■■■■■■■■(40 PRINT SELECTED)
808 END
1000 X=32768+Z:A=PEEK(X):IFA=35GOTO1010
1003 IFA=34GOTO1
1006 A=A+64:A$=CHR$(A):B$=B$+A$:GOTO1020
1010 B$=B$+CHR$(254)
1020 RETURN
1100 X=32768+Z:A=PEEK(X):IFA=35GOTO1110
1103 IFA=34GOTO1
1106 A=A+64:A$=CHR$(A):C$=C$+A$:GOTO1120
1110 C$=C$+CHR$(254)
1120 RETURN
2000 OPEN5,4,5:DATA9,63,73,73,65,33:FORP=1TO6:READQ:Q$=Q$+CHR$(Q):NEXT
2010 PRINT#5,Q$:Q$="":RESTORE:RETURN
```

(continued on page 91)

(continued from page 89)

```
LINE-BY-LINE ■■■■■■■■

10 TI$="000000" PRINT"■■■ LINE BY LINE  ■ WITH LETTER-HEAD
20 PRINT"■■PROGRAM TO PRINT LETTER LINE-BY-LINE
30 PRINT"■WITH FULL PRINTER GRAPHICS USING CURSOR
40 PRINT"■UP AND DOWN. NO POUND SIGN THIS TIME!
50 PRINT"■■■LINE OF DOTS GIVES LIMIT OF LINE. BUT
60 PRINT"■CASE & OTHER SIGNS WILL SHORTEN PRINTED
70 PRINT"■LENGTH  SO USE INSERT TO ASSIST.
80 PRINT"■■■  COPYRIGHT(C) REX L TINGEY  JAN '80
90 IFTI$<"000006"GOTO90
98 PRINT"■GOTO100■■" PRINT"CURSOR UP AND TYPE ■DATE■ RETURN HOME C SP■■RETURN
99 PRINT"■■■" LIST155
100 OPEN4,4 PRINT#4, OPEN6,4,6 PRINT#6,CHR$(18)
106 PRINT#4,"[illegible]
110 PRINT#4,"[illegible]
120 PRINT#4,"[illegible]
130 PRINT#4,"[illegible]
140 PRINT#4,"[illegible]
148 PRINT#4,"
150 PRINT#4,"■  YOUR ADDRESS GOES IN HERE WITH SPACES TO MATCH HEADING   ■
151 PRINT#4,"
152 PRINT#6,CHR$(80)
155 PRINT#4,,,,,'◆◆◆◆◆◆◆◆◆◆◆◆◆◆◆◆
160 PRINT#6,CHR$(80) FORI=1TO2 PRINT#4 NEXT
190 S$="................................................................................
200 PRINT"■■■■A$="CHR$(34)S$
220 PRINT"■■PRINT#4,,A$ REM-JUST RETURN OVER THESE 3
300 PRINT"■■ PRINT"CHR$(34)"■" PRINT"■"
10000 REM-AVOIDS FILE NOT OPEN ERROR
```

```
LETTER WRITER ■■■■■■■■■■■

1 GOSUB20000:PRINT"■ENTER DATE-NO PUNCTUATION":INPUTZ$:A=198:L=9:GOTO4
2 PRINT"■":PRINT,"■CANCEL WITH'RETURN'■■":PRINT"1",,,,"2",,,,"3",,,,"4",,,,"5"
3 PRINT"6",,,,"7",,,,"8",,,,"9",,,,"RUN■":STOP
4 PRINT"■■■":B=0:A=A+2:B=B+1:IFL>5THENPRINT"155 PRINT#4,,,,,,"CHR$(34)Z$
5 L=0:A=A+2:B=B+1:IFB=11GOTO7
6 PRINTA;"PRINT#4,,                                                  ":GOTO5
7 PRINT"A="A"-4:GOTO4":PRINT"GOTO2:REM-CHR$(254)=POUND$■":IFA>210GOTO9
8 IFA<210THENPRINT"■CHECK DATE &'RETURN'■"
9 END
50 OPEN5,4,5:DATA9,63,73,73,65,33:IFQ=1GOTO100
60 FORA=1TO6:READZ:Z$=Z$+CHR$(Z):NEXT:PRINT#5,Z$
100 Q=1:OPEN4,4:PRINT"■":PRINT#4
110 PRINT#4,TAB(10)CHR$(1)" PERSONAL HEADING HERE"
140 PRINT#4,," FOLLOWED BY YOUR ADDRESS AND OTHER DETAILS":PRINT#4
200 PRINT#4:READA$:PRINT#4,,"■DEAR■ "A$",":PRINT#4
9000 PRINT#4:PRINT#4:PRINT#4,,,,,"Y■OURS FAITHFULLY,
9000 FORS=1TO10:PRINT#4:NEXT
10000 CLOSE4:CLOSE5:CLOSE6:P=P+1:IFP<26GOTO50
10010 END
20000 TI$="000000":PRINT"■■■ CIRCULAR LETTER "
20010 PRINT"■■ THIS PROGRAM PROVIDES A FACILITY FOR
20020 PRINT"■WRITING A CIRCULAR LETTER TO BE SENT TO
20030 PRINT"■ THE CUSTOMERS WHOSE NAMES ARE DATA AT
20040 PRINT"■THE END OF THE PROGRAM. EACH NAME PRINTS
20050 PRINT"  IN ONE LETTER, IN ORDER, MAKING THE
20060 PRINT"■MAILING SIMPLE- USE AN ADDRESS LABELLING
20070 PRINT"   SYSTEM TO ADDRESS YOUR ENVELOPES.
20072 PRINT"■CIRCULAR WRITING SAME AS'SAVE A LETTER'
20074 PRINT"■       IN RUN AND WRITE DETAILS.
20080 PRINT"■■ COPYRIGHT (C) REX L TINGEY  JAN '80
20090 IFTI$<"000006"GOTO20090
20100 RETURN
30000 DATA"M■R ■A■RMSTRONG"
30100 DATA"M■RS ■B■ENNETT"
30200 DATA"M■R & ■M■RS ■C■ARTWRIGHT"
30300 DATA"M■R ■D■OWNHAM"
30400 DATA"J.H.E■ALING & ■S■ONS"
30500 DATA"S■IR ■C■HARLES & ■L■ADY FFOLKES"
30600 DATA"M■RS ■G■ATLING"
30700 DATA"M■R ■H■ENDERSON"
30800 DATA"M■R & ■M■RS ■I■NGLE"
30900 DATA"A.V.J■OHNSON & ■C■OMPANY"
31000 DATA"M■R ■K■ING"
31100 DATA"M■R ■L■ONGFELLOW"
31200 DATA"M■R ■M■OORHOUSE"
31300 DATA"M■ISS ■N■IGHTINGALE"
31400 DATA"M■RS ■O■LIPHANT"
31500 DATA"M■ISS ■P■IGGY"
31600 DATA"M■R ■Q■UENTIN"
31700 DATA"M■RS ■R■OBINSON"
31800 DATA"M■ISS ■S■INGLETON"
31900 DATA"L■ORD ■T■HOMPSON"
32000 DATA"M■R ■U■NWIN"
32100 DATA"M■R ■V■INCENT"
32200 DATA"L■ADY ■W■INDEMERE"
32300 DATA"XL S■TEEL ■C■OMPANY"
32400 DATA"Y■ANKEE ■F■ISH ■L■IMITED"
32500 DATA"M■R & ■M■RS ■Z■OOT"
```

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Serial-printer drive routine for Tandy TRS-80

ONE OF the attractive features of the TRS-80, after the pleasure of finding that you have 16K of usable RAM and 12K of Basic for less than the price of an 8K Brand X, is the ease with which a printer can be driven.

There is not much doubt that a printer is the first essential accessory, assuming that you start with a reasonable amount of RAM. The low-price printers, such as the Nascom Imp or the Epson are serial printers. The natural companion to the TRS-80 is the Centronics, which uses a parallel port, but the Centronics costs considerably more than a complete TRS-80, and if it happens to carry the Radio Shack label, it may cost even more.

Fortunately, serial printers can be interfaced to the TRS-80 through the cassette port, using a very simple interface consisting of little more than a 741 integrated circuit, a rectifier bridge, and a few resistors and capacitors. The total cost of the interface, if you build it yourself, is about £2.

If you are not in the hardware business, however, you will be asked for about £40

by Ian Sinclair

for an interface which presumably must use a very expensive plug and socket. Some of the cost of the commercial effort is the software which accompanies it, because the use of the cassette port for serial printer output is not one of the considerations which Tandy had in mind when it assembled its package.

There are many serial-printer drive programs, ranging from a bare 100 bytes all the way to fully-fledged printer, screen and keyboard controllers, like the excellent KVP Extender from Microcomputer Applications.

I wanted more than a straightforward routine, because I like to keep listings as I develop programs and nothing is more awkward than keeping long rolls of paper. Since I keep the original program notes on A4 and in A4 files, it seems logical to keep the listings there as well, which means that I needed a left-hand margin, to allow room for the punch-holes.

As the Nascom Imp printer starts well over to the left-hand side on listings, that obviously was a software task. In addition, using A4 files meant that the listing should be in groups of 66 lines, so that I could divide the Teletype roll into pages. That in turn meant a lines-per-page counter in software which could be re-set so that I could set top-of-page when I started a listing, instead of having to accept a random number of lines before a page break.

At that point in the specification, a few bells and whistles started to be added. I wanted to be able to slow down the listing on the screen with a simple command — I hate having to poke numbers into memory — just as that other computer does, and I wanted the usual keyboard delay because my TRS-80 is an old one with keybounce.

To make the specification more awkward, I originally wanted the program re-locatable, so that I could place it anywhere in memory. There was only one way of obtaining all this, and that was to write the program myself.

Since the TRS-80 uses the Z-80 CPU, there is a version of the Zen assembler-editor-debugger available for it. If there are still people who run Z-80 machines and have not encountered Zen, I believe it is the best editor/assembler package available.

It is simple to use — which means that you can stop thumbing through the instructions after a few hours, which means I make for more use of it than of the package I used before.

As an assembler/editor, it is very versatile, allowing quick and easy assembler program writing without having to watch the size of spaces or the length of label-names; editing is very simple. It even permits assembler programs to be combined from tape, and, of course, writes object code tapes in TRS-80 standard code.

In addition, Zen has full monitor facilities, allowing you to read machine-code

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Figure 1.

```
                    ;LPRINT ROUTINE WITH LHS MARGIN
                    ;66 LINES/PAGE AND 72 CH/LINE
                             ORG   7F11H
                             LOAD  6F00H
                    CHRSLN:  EQU   4029H
                    LNPGE:   EQU   4028H
7F11 E5                      PUSH  HL
7F12 21347F                  LD    HL,LPRT
7F15 222640                  LD    (4026H),HL
7F18 21F27F                  LD    HL,KBFIX
7F1B 221E40                  LD    (401EH),HL
7F1E 2ADE7F                  LD    HL,(CHRLN)
7F21 222940                  LD    (4029H),HL
7F24 21DF7F                  LD    HL,TOPPAG
7F27 227D41                  LD    (417DH),HL
7F2A 21E77F                  LD    HL, DELAY
7F2D 228341                  LD    (4183H),HL
7F30 E1                      POP   HL
7F31 C37200                  JP    0072H
7F34 F3             LPRT:    DI
7F35 79                      LD    A,C
7F36 F5                      PUSH  AF
7F37 D5                      PUSH  DE
7F38 FDE5                    PUSH  IY
7F3A CD3300                  CALL  0033H
7F3D FDE1                    POP   IY
7F3F D1                      POP   DE
7F40 F1                      POP   AF
7F41 FE0D           ENDLN:   CP    0DH
7F43 2805                    JR    Z,RELOAD
7F45 FE20                    CP    20H
7F47 D8                      RET   C
7F48 181C                    JR    START
7F4A E5             RELOAD:  PUSH  HL
7F4B F5                      PUSH  AF
7F4C 21DE7F                  LD    HL,CHRLN
```

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tapes, examine the contents, change code, copy tapes, copy code from one memory location to another — which is why I like re-locatable programs — and it can even load code into memory as it is assembled, without having to make a tape first.

I used Zen to create the assembler program of figure 1 which is why the line numbers follow the 1,2,3 order and are placed at the start of each line, rather than the convention used by Radio Shack. Those line numbers, incidentally, are not recorded when you tape an assembler program; they are allocated by Zen when the program is loaded, which is why programs can be merged, no matter what line numbers they used.

It does mean, though, that the Zen assembler tapes are not compatible with tapes created by a disassembler operating to Radio Shack standards.

The program is not annotated. Notes occupy a good deal of memory and tape, and I prefer to keep copious notes on a separate sheet. For the benefit of anyone who wants to modify the program either for the TRS-80 or for another Z-80 based machine, here is an outline of the program operation.

The baud rate is set at 300, since that is the maximum rate recommended for a serial printer operated over a single line, with no provision for handshake — no signals can pass back from the printer to the computer to control the rate of transmission.

Program origin

The origin of the program as shown is 7F11H, 32529D, and two of the printer-control RAM addresses in the TRS-80 are used. They are, of course, not part of the 16K user RAM, but a separate section of about 3K of RAM which can be used for a remarkable range of control operations, and which are an Aladdin's cave for machine-language programmers.

Location 4029H (16525D) is used to store the number of characters per line, and 4028H (16524D) is used for the number of lines per page. Four addresses in the program space itself are also used, and they can be Poked so as to alter the print format as desired. As set up, the program prints 72 characters per line and 66 lines per page, with six blanks between pages to allow for cutting.

The first section of the program from 7F11H to 7F2FH loads the locations in low RAM. 4026H is the address for the start of the printing routine. The address which is normally loaded into 4026H, 4027H is 058DH, the ROM routine for a parallel printer, and we have to substitute 7F34H, so that the LPRINT and LLIST commands of the TRS-80 direct the print commands to our routine starting at 7F34H. 401EH is the start address location for the screen-write routine, normally 0458H, but now changed to 7FF2H.

That allows us to put a delay into the screen-print routine, and performs two useful functions — it allows slow-listing to be controlled, and it also debounces the wretched keyboard of my old TRS-80 — new models seem to have a new keyboard with no bounce problems. The number of characters per line is loaded into 4029H; no figure is loaded into 4028H because it is set at 66 lines per page by the TRS-80

(continued from previous page)

```
 37 7F4F 3A2940           LD   A,(CHRSLN)
 38 7F52 77               LD   (HL),A
 39 7F53 21DC7F           LD   HL,LNCNT
 40 7F56 35               DEC  (HL)
 41 7F57 200B             JR   NZ,RUN
 42 7F59 2A2840           LD   HL,(LNPGE)
 43 7F5C 22DC7F           LD   (LNCNT),HL
 44 7F5F 21DD7F           LD   HL,ENDPAG
 45 7F62 3606             LD   (HL),06H
 46 7F64 F1      RUN:     POP  AF
 47 7F65 E1               POP  HL
 48 7F66 F5      START:   PUSH AF
 49 7F67 E5               PUSH HL
 50 7F68 C5               PUSH BC
 51 7F69 0609    AGAIN:   LD   B,09H
 52 7F6B 37               SCF
 53 7F6C F5               PUSH AF
 54 7F6D F5               PUSH AF
 55 7F6E 2101FC           LD   HL,0FC01H
 56 7F71 CD2102           CALL 0221H
 57 7F74 CD797F           CALL DLY
 58 7F77 1809             JR   ROUND
 59 7F79 21DE00  DLY:     LD   HL,00DEH
 60 7F7C 2B      DLY1:    DEC  HL
 61 7F7D 7C               LD   A,H
 62 7F7E B5               OR   L
 63 7F7F 20FB             JR   NZ,DLY1
 64 7F81 C9               RET
 65 7F82 F1      ROUND:   POP  AF
 66 7F83 1F               RRA
 67 7F84 F5               PUSH AF
 68 7F85 3005             JR   NC,OUT1
 69 7F87 2102FC           LD   HL,0FC02H
 70 7F8A 1805             JR   OUT2
 71 7F8C C600    OUT1:    ADD  A,00H
 72 7F8E 2101FC           LD   HL,0FC01H
 73 7F91 CD2102  OUT2:    CALL 0221H
 74 7F94 CD797F           CALL DLY
 75 7F97 10E9             DJNZ ROUND
 76 7F99 2102FC           LD   HL,0FC02H
 77 7F9C CD2102           CALL 0221H
 78 7F9F CD797F           CALL DLY
 79 7FA2 F1      OUT3:    POP  AF
 80 7FA3 F1               POP  AF
 81 7FA4 FE0D             CP   0DH
 82 7FA6 2022             JR   NZ,TEST2
 83 7FA8 21DD7F  TEST1:   LD   HL,ENDPAG
 84 7FAB AF               XOR  A
 85 7FAC B6               OR   (HL)
 86 7FAD 2812             JR   Z,BLNK
 87 7FAF 35               DEC  (HL)
 88 7FB0 3E0D             LD   A,0DH
 89 7FB2 18B5             JR   AGAIN
 90 7FB4 C1      OUT4:    POP  BC
 91 7FB5 21DE7F           LD   HL,CHRLN
 92 7FB8 35               DEC  (HL)
 93 7FB9 201D             JR   NZ,OUT5
 94 7FBB E1               POP  HL
 95 7FBC F1               POP  AF
 96 7FBD 3E0D             LD   A,0DH
 97 7FBF 1889             JR   RELOAD
 98 7FC1 21DB7F  BLNK:    LD   HL,LHSPCE
 99 7FC4 3603             LD   (HL),03H
100 7FC6 3E20             LD   A,20H
101 7FC8 189F             JR   AGAIN
102 7FCA 3ADB7F  TEST2:   LD   A,(LHSPCE)
103 7FCD B7               OR   A
104 7FCE 28E4             JR   Z,OUT4
105 7FD0 3D               DEC  A
106 7FD1 32DB7F           LD   (LHSPCE),A
107 7FD4 3E20             LD   A,20H
108 7FD6 1891             JR   AGAIN
109 7FD8 E1      OUT5:    POP  HL
110 7FD9 F1               POP  AF
111 7FDA C9               RET
112 7FDB 03      LHSPCE:  DB   03H
113 7FDC 42      LNCNT:   DB   42H
114 7FDD 00      ENDPAG:  DB   00H
115 7FDE 48      CHRLN:   DB   48H
116 7FDF E5      TOPPAG:  PUSH HL
117 7FE0 21DC7F           LD   HL,LNCNT
118 7FE3 3642             LD   (HL),42H
119 7FE5 E1               POP  HL
120 7FE6 C9               RET
121 7FE7 F5      DELAY:   PUSH AF
122 7FE8 3AF67F           LD   A,(KBFIX+4)
123 7FEB EE10             XOR  10H
124 7FED 32F67F           LD   (KBFIX+4),A
125 7FF0 F1               POP  AF
126 7FF1 C9               RET
127                       ORG  7FF2H
128 7FF2 F5      KBFIX:   PUSH AF
129 7FF3 C5               PUSH BC
130 7FF4 012000           LD   BC,0020H
131 7FF7 CD6000           CALL 0060H
132 7FFA C1               POP  BC
133 7FFB F1               POP  AF
134 7FFC C35804           JP   0458H
135                       END

SYMBOL TABLE

AGAIN   7F69 BLNK    7FC1 CHRSLN  4029 CHRLN   7FDE
DLY     7F79 DLY1    7F7C DELAY   7FE7 ENDLN   7F41
ENDPAG  7FDD KBFIX   7FF2 LNPGE   4028 LPRT    7F34
LHSPCE  7FDB LNCNT   7FDC OUT1    7F8C OUT2    7F91
OUT3    7FA2 OUT4    7FB4 OUT5    7FD8 RELOAD  7F4A
RUN     7F64 ROUND   7F82 START   7F66 TEST1   7FA8
TEST2   7FCA TOPPAG  7FDF
```

ROM when the machine is switched-on.

The remaining two loadings are luxury items. When a disc system is not in use — several commands, such as FIELD, PUT, GET etc., will return "L3 ERROR" if you use them in Basic. According to the manual, that is because they are Disc Basic commands, which can be used only with a disc system.

In fact, each one of those commands causes the ROM to look in RAM for the address of a routine, and if you poke in your own address and your own routine, you can make use of any of the commands — there are 28 of them from which to choose. In the program, I have used the FIELD command to re-set the printer program to top-of-page, so that it will print a full 66 lines before putting in its six blank lines.

Delay times

The address of a page-re-set routine at 7FDFH is, therefore, loaded into 417DH, the address for the FIELD command. Similarly, I have used PUT to change the delay time, by loading the address of a delay-byte insertion routine to 4183H. By typing PUT and entering from Basic, the TRS-80 screen-access speed is considerably slowed so that all operations which involve the screen are run at low speed and that obviously includes listing.

If the TRON command, part of standard TRS-80 Basic, has been entered, so that the line numbers are printed as the program executes, PUT allows me to watch a program executing in slow motion — a most useful debugging aid for elusive faults. Typing PUT for a second time and entering restores normal running speed.

That delay, incidentally, can also be implemented by using the keyboard address, but the screen routine is preferable, because the delay is then operative only when the screen is accessed — the keyboard is scanned continually, and any delay in the keyboard routine slows the computing rate considerably unless the keyboard is disabled during computing time. By this time, re-locatability was abandoned.

The loading section ends with a jump to ØØ72H, which returns to Basic. That is not the address given in the older Radio Shack manuals, incidentally. The address in the old manuals is not so suitable, and can cause error messages to appear; later editions give this correct address of ØØ72H.

The print routine starts at 7F34H, with a DI command so that the routine cannot be interrupted in mid-character by the break or any other key. The printer routines of the TRS-80 place the character byte in the C register, so that is transferred to the accumulator, A, for subsequent operations. The section of program from 7F36H to 7F4ØH saves registers, and calls the screen-print routine, so that whatever is printed is also echoed on the screen. That is a useful feature, since most dot-matrix printers conceal what is being printed. Curiously enough, that, along with the delay, causes odd effects — a "z" is printed in place of the least significant digit of the line number — when that routine is used along with Zen, so that the version of the program which I have tacked into Zen has 7F3AH and 7F3BH both set at ØØ, forming a set of NOP instructions.

At ENDLN, the byte in the accumulator is checked to see if it is a carriage return (ØDH), in which case the program branches to RELOAD so as to re-set the memory location which governs the number of characters per line and to decrement the number-of-lines count in location LNCNT.

If at ENDLN, the byte in the accumulator has a value less than 2ØH and is not a carriage return, the program returns for the next character, since the other control characters are not used in this program. For any other character, the program jumps to START.

The registers are saved, and register B is loaded with a bit count — one byte plus a space. A mark bit is sent out by loading FCØ1 to HL and calling Ø221H, which sends the bit in the L register to the cassette port. Incidentally, I have used Ø1 for mark and 1Ø for space, because this gives a much larger output signal than the conventional Ø1 and ØØ.

To establish the correct baud rate, a delay must follow, and that is achieved in the subroutine labelled DLY. The byte ØØDEH which is loaded into HL for the delay subroutine determines the baud rate, so that if you are writing for 110 baud, a larger number must be loaded — try Ø267H.

Carry position

At the label ROUND, the lowest bit of the byte is rotated into the carry position by the RRA command, and the other bits are similarly shifted in the accumulator. If the bit in the carry position is Ø, C is re-set, and the program jumps to OUT1 to send a space bit. If the bit in the carry position is a 1, hl is loaded with FCØ2H, the space bit which is output by the routine at OUT2. Those routines are followed by the DLY subroutine to keep the baud rate correct.

The DJNZ command at 7F97H keeps the rotate-and-output routine going until the B-register is decremented to zero in the usual action of the DJNZ command. A final delay subroutine follows, and then at OUT3, which is the end of the main section of the print routine, the original unrotated byte is recovered and compared to the carriage return byte, ØDH. If the byte was a C/R, the program skips to TEST2, otherwise at TEST1 the byte from ENDPAG is loaded, and the accumulator is cleared.

Now if the lines-per-page count reached zero earlier in the program, at RELOAD, there will be a six in ENDPAG, so that the OR(HL) step will give a non-zero answer, and the program will continue to decrement ENDPAG, load in a carriage-return character and run it through the print routine again until ENPAG is zeroed.

If the line/page count has not reached zero, the step at 7FADH directs the program to BLNK, where the store LHSPCE is loaded in with the number 3. The accumulator is loaded with the ASCII blank character, 2ØH, and the printing routine repeated, so that a space is printed at the left-hand side of the page.

That continues until the store LHSPCE is decremented to zero, giving the left-hand margin which prevents the listing from being mangled.

When the character in A is not a carriage-return, the test routine is TEST2. That tests for the byte in LHSPCE to see if more spaces need to be printed, otherwise the retreat is sounded by jumping to OUT4. At OUT4, the characters/line count is decremented and, if the count is zero, the accumulator is loaded with a carriage return character and re-cycled. If the byte is not at the end of a line, the next stage in the countdown is OUT5, where the registers are restored and the routine returns for the next character.

Storage bytes

The bytes from 7FDBH to 7FDEH are storage bytes for the left-space, lines/page, end-of-page space, and characters/line respectively. At TOPPAG, a short routine restores the lines/page count. That is the routine which is called by typing FIELD and entering. Similarly at 7FE7H, a short routine inspects the delay byte at 7FF6H and XORs it with 1ØH. If the delay byte was Ø, it is replaced by 1ØH, if it was 1ØH, it is replaced by Ø, such being the action of the XOR command.

The routine is called from Basic by the PUT command. It, like FIELD, can be called from a running program, so that a program which prints to the screen can be slowed in mid-run and speeded up again as needed — useful for instructions. Finally, at 7FF2H, the video delay consists of saving registers, loading BC with the delay bytes, calling the TRS-80 delay subroutine at ØØ6ØH, restoring and then jumping to the screen routine at Ø458H.

It has been a very useful routine for me, and its usefulness has been enhanced by a short program from A J Harding (Molimerx), which transforms the machine code of a routine into DATA lines of a Basic program. In that way, I can poke it in from any Basic program, so that I do not need to load a separate object code tape.

Furthermore, if I ever need it to be fully re-locatable, I can place the DLY subroutine and the store bytes into low memory between 4Ø5C and 4Ø7F — that is used only when the TRS-80 is first switched-on. At present, however, the ease with which I can generate object code with Zen makes strict re-locatability unnecessary.

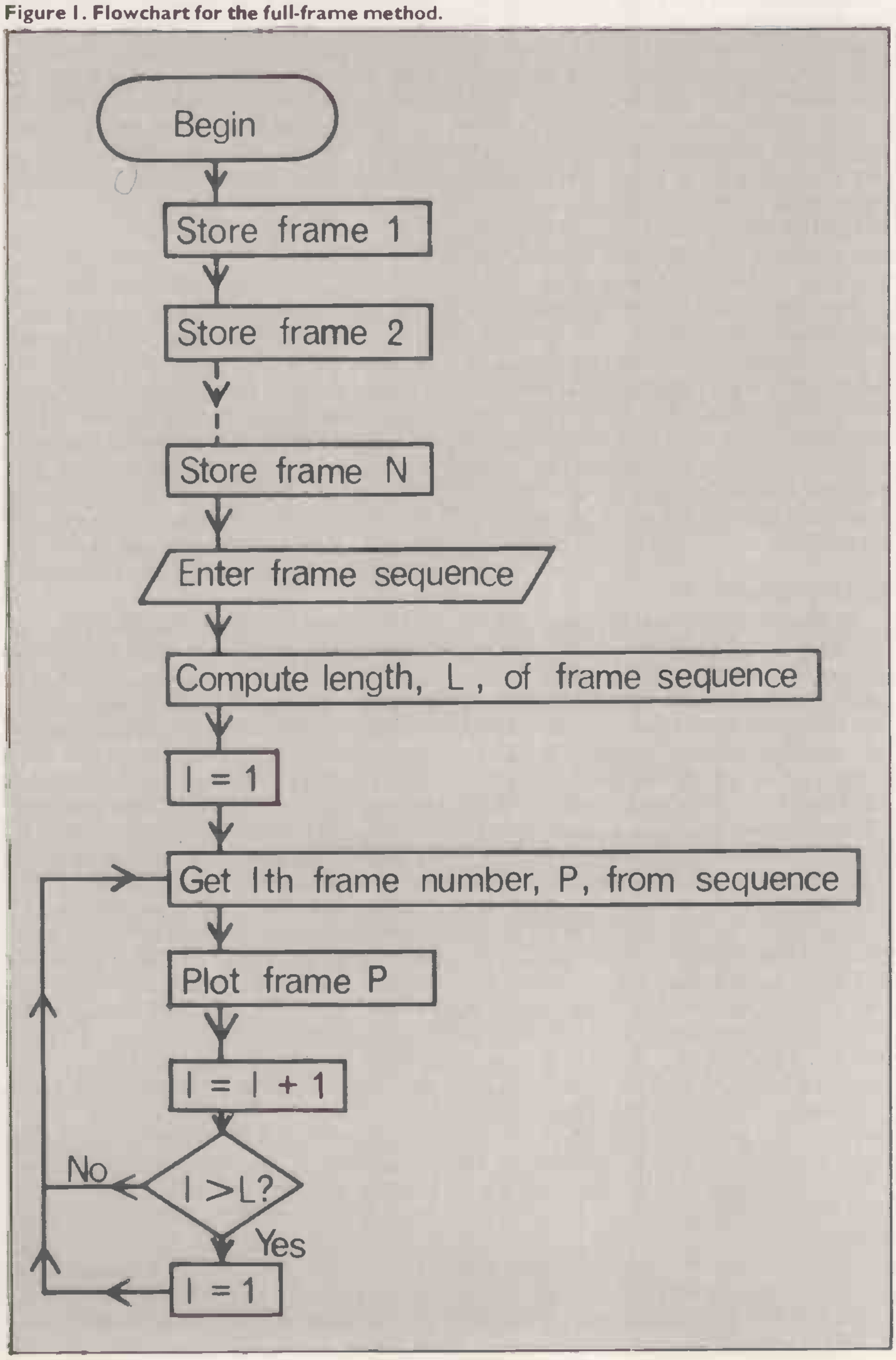
Execution speed is crucial for realistic mobile displays

G J Marshall describes and compares a variety of techniques for producing mobile displays on a memory-mapped screen. The programs are written specifically for the Pet but the methods involved are appropriate for any microcomputer with a memory-mapped screen.

WHEN STILL pictures are shown successively at a sufficiently high rate, they produce an illusion of continuous movement. All moving-picture systems, including films and television, depend on that subjective effect, which results from several human characteristics, including the attribute of the persistence of vision.

The major problem in achieving realistic mobile displays with a computer is to produce successive static displays sufficiently quickly. Consequently, the execution speed of the system used assumes considerable importance.

Figure 1. Flowchart for the full-frame method.



The programs presented here are written in Basic. One natural way to increase the speed at which a task is executed is to program in machine code rather than in Basic. While that may be the ultimate solution to the speed problem, we hope to show that by modifying brute-force algorithms for the production of mobile displays, with some care and ingenuity, considerable increases in speed can be obtained still programming in Basic. Also programs in Basic are more easily understood than if they had been written in assembly code.

Machine code

In any event, since the actual algorithms are presented, they can be implemented in any suitable way. When the methods described here are implemented in machine code, they usually result in displays which change too quickly, so that delay routines must be introduced.

Ultimately, it should be possible to produce mobile displays of a required quality using the techniques described and implementing them in a suitable language.

The full-frame method of achieving mobile displays is essentially analogous to television or film techniques. First, each frame, or individual picture is stored; then the sequence in which the frames are to be shown, or displays, is entered, and finally, the program plots the pictures successively in the required sequence.

It is more satisfactory if the sequence of frames is plotted repeatedly. An algorithm for that, which stores N frames and repeatedly plays a sequence of them is given in figure 1.

Two implementations

There are two implementations of the algorithm. The first uses POKE instructions to display each frame, and the second uses PRINT instructions. The frames occupy a rectangle of nine rows by seven columns in the centre of the screen. In this case, three frames are stored; they are illustrated in figure 2.

In implementation one, the frames are plotted by using the POKE instruction to place each frame element in the correct place on the screen. Thus, the frames themselves are stored using two-dimensional arrays with nine rows and seven columns to contain the Pet codes used by the POKE instructions.

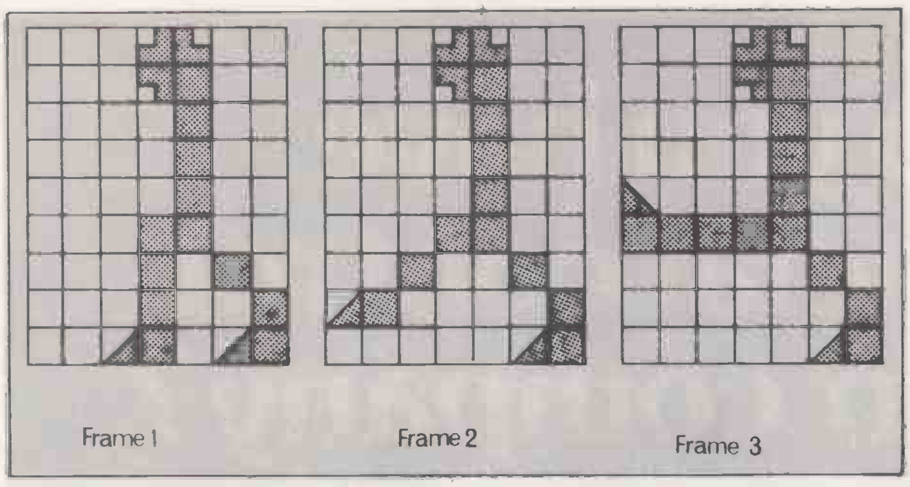


Figure 2. The frames used in the examples.

The respective frames are plotted by subroutines starting at lines 1000, 2000 and 3000. That is more effective than using a single subroutine for plotting since a considerable time would then be spent in transferring the nine-by-seven arrays. The program implementing the full-frame method in this way is given in figure 3. The positioning of the frame on the screen is determined at line 345.

In implementation two, the algorithm can be implemented using PRINT instructions rather that the POKE instruction to implement the frame display. In that instance, each member of a one-dimensional array of string variables contains a complete row of the frame. Again, each frame has its own plotting routine. The program listing is given as figure 4.

Frame position

The positioning of the frames on the screen is controlled by the variables that are initialised in lines 13 and 17. The vertical positioning is determined by Z$ and the horizontal positioning by Y$.

In both implementations, the way in which the ON statement at line 350 behaves makes it advisable to precede it by an instruction to test that the frame sequence does not contain a reference to a non-existent frame. A suitable instruction is

```
349 IF (P < 1) OR (P > 3) GOTO diagnostic
    segment
```

When the full-frame method is used, each new frame is plotted in its entirety. However, if an illusion of continuous motion is to be created, it is essential that successive frames be similar. If they are not, a jerky effect is inevitable. The three frames illustrated in figure 2 are reasonably similar.

Plotting strategy

Consequently, a strategy of plotting only the differences between successive frames can be adopted to advantage. That requires considerably less plotting than the full-frame method and gives a corresponding increase in speed. In fact, for the frames illustrated in figure 2, the average number of places in which any pair differ is approximately seven.

Thus, if differential frame plotting is implemented using POKE instructions, on average only seven POKE instructions are needed to create the next frame, whereas with the full-frame method, $7 \times 9 = 63$ are necessary. Consequently, an increase in speed by a factor of 9 can be expected.

At least one frame must be stored and plotted in its entirety to initiate a sequence of frames plotted differentially. The special algorithm stores frame 1 and always plots it first regardless of the frame sequence. The plotting sequence then continues with the second frame in the sequence, and follows the sequence faithfully for the remainder of the first pass and for all subsequent passes.

If the difference plotting is done by subroutines, there must be a subroutine for each pair of frames. Thus, when there are N separate frames, there must be N^2 subroutines. However, N of those subroutines are trivial, representing the cases when a frame is paired with itself — that is, when a frame follows itself in the plotting sequence.

A basic program for differential frame plotting of sequences of the frames illustrated in figure 2 may be constructed. The inclusion of a test on the range of the variable SW in the ON statement is more important with differential than with full-frame plotting.

A program for differential frame plotting using implementation two is essentially similar. However, problems of positioning the changes mean that on the whole, it is as effective to print the entire line where a change is necessary as to print a positioning string and a single replacement character.

Table 1 gives the average duration of the frame-plotting subroutines for each of the methods described above when plotting sequences of the frames illustrated in figure 2. The unit of time in the table is a jiffy, or one-sixtieth of a second.

Table 1.

Plotting method	Average frame duration
Full frame, implementation one	46
Full frame, implementation two	19
Differential frame, implementation one	5
Differential frame, implementation two	9

The speeds of the two full-frame methods essentially reflect the execution times for, respectively, 63 POKE instructions and nine PRINT instructions. The timings for the differential frame methods are entirely characteristic of the frames being plotted. In implementation one, differential plotting requires only seven POKEs on average to update a frame, while full-frame plotting always uses 63. With implementation two, about half the rows in a frame, on average, need to be re-printed to update it.

Figure 3. Basic program for implementation one of the full-frame method.

```
10 DIM A(9,7),B(9,7),C(9,7)
20 FORI=1TO9
30 FORJ=1TO7
40 READ A(I,J)
50 NEXTJ
60 NEXTI
70 DATA160,160,160,126,124,160,160,160,160,160,123,32,160,160
80 DATA160,160,160,160,32,160,160,160,160,160,160,32,160,160
90 DATA160,160,160,160,32,160,160,160,160,160,32,32,160,160
100 DATA160,160,160,32,160,32,160,160,160,160,32,160,160,32
105 DATA160,160,105,32,160,105,32
110 FORI=1TO9
120 FORJ=1TO7
```

(continued on page 99)

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```
130 READB(I,J)
140 NEXTJ
150 NEXTI
160 DATA160,160,160,126,124,160,160,160,160,160,123,32,160,160
170 DATA160,160,160,160,32,160,160,160,160,160,160,32,160,160
180 DATA160,160,160,160,32,160,160,160,160,160,32,32,160,160
190 DATA160,160,32,160,160,32,160,105,32,160,160,160,160,32
195 DATA160,160,160,160,160,105,32
200 FORI=1TO9
210 FORJ=1TO7
220 READC(I,J)
230 NEXTJ
240 NEXTI
250 DATA160,160,160,126,124,160,160,160,160,160,123,32,160,160
260 DATA160,160,160,160,32,160,160,160,160,160,160,32,160,160
270 DATA95,160,160,160,32,160,160,32,32,32,32,32,160,160
280 DATA160,160,160,160,160,32,160,160,160,160,160,160,160,32
285 DATA160,160,160,160,160,105,32
290 I=1
300 PRINT"CINPUT PICTURE SEQUENCE"
310 INPUT A$
320 L=LEN(A$)
330 P$=MID$(A$,I,1)
340 P=VAL(P$)
345 S=32768+8*40+15
350 ON P GOSUB 1000, 2000, 3000
360 I=I+1
370 IF I>L THEN I=1
380 GOTO 330
1000 FOR J=1TO9
1010 FOR K=1TO7
1020 POKE S+K,A(J,K)
1030 NEXTK
1040 S=S+40
1050 NEXTJ
1060 RETURN
2000 FOR J=1TO9
2010 FOR K=1TO7
2020 POKE S+K,B(J,K)
2030 NEXTK
2040 S=S+40
2050 NEXTJ
2060 RETURN
3000 FOR J=1TO9
3010 FOR K=1TO7
3020 POKE S+K,C(J,K)
3030 NEXTK
3040 S=S+40
3050 NEXTJ
3060 RETURN
```

Figure 4. Basic program for implementation two of the full-frame method.

```
10 DIM A$(9),B$(9),C$(9)
13 Z$="SQQQQQQQQ"
17 Y$="          "
20 FORI=1TO9
40 READ A$(I)
60 NEXTI
71 DATA"Q   ■ "Q  ■","Q    ■ Q  ■"
72 DATA"Q    ■ Q  ■","Q    ■ Q  ■"
73 DATA"Q    ■ Q  ■"
81 DATA "Q    ■  Q  ■","Q   ■ Q ■ Q ■"
82 DATA "Q    ■ Q  ■ ","Q  ■ Q ■ "
90 FORI=1TO9:A$(I)=Y$+A$(I):NEXTI
110 FORI=1TO9
130 READB$(I)
150 NEXTI
161 DATA"Q   ■ "Q  ■","Q    ■ Q  ■"
162 DATA"Q    ■ Q  ■","Q    ■ Q  ■"
163 DATA"Q    ■ Q  ■"
171 DATA"Q   ■  Q  ■","Q ■ Q  ■ Q ■"
172 DATA"■ Q    ■ ","Q     ■ "
180 FORI=1TO9:B$(I)=Y$+B$(I):NEXTI
200 FORI=1TO9
220 READC$(I)
240 NEXTI
251 DATA"Q   ■ "Q  ■","Q    ■ Q  ■"
252 DATA"Q    ■ Q  ■","Q    ■ Q  ■"
253 DATA"■Q    ■ Q  ■"
261 DATA"       Q  ■","Q    ■ Q ■"
262 DATA"Q       ■  ","Q     ■ "
270 FORI=1TO9:C$(I)=Y$+C$(I):NEXTI
290 I=1
300 PRINT"CINPUT PICTURE SEQUENCE"
310 INPUT A$
320 L=LEN(A$)
330 P$=MID$(A$,I,1)
340 P=VAL(P$)
345 S=32768+8*40+15
350 ON P GOSUB 1000, 2000, 3000
360 I=I+1
370 IF I>L THEN I=1
380 GOTO 330
1000 PRINTZ$
1010 FORJ=1TO9
1020 PRINTA$(J)
1030 NEXTJ
1040 RETURN
2000 PRINTZ$
2010 FORJ=1TO9
2020 PRINTB$(J)
2030 NEXTJ
2040 RETURN
3000 PRINTZ$
3010 FORJ=1TO9
3020 PRINTC$(J)
3030 NEXTJ
3040 RETURN
READY.
```

(continued on next page)

(continued from previous page)

Figure 5. Basic program for implementation one of the differential frame method.

```
10 DIM A(9,7)
20 FORI=1TO9
30 FORJ=1TO7
40 READ A(I,J)
50 NEXTJ
60 NEXTI
70 DATA160,160,160,126,124,160,160,160,160,160,123,32,160,160
80 DATA160,160,160,160,32,160,160,160,160,160,160,32,160,160
90 DATA160,160,160,160,32,160,160,160,160,160,32,32,160,160
100 DATA160,160,160,32,160,32,160,160,160,160,32,160,160,32
105 DATA160,160,105,32,160,105,32
280 LP=1
290 I=2
300 PRINT"□INPUT PICTURE SEQUENCE"
301 INPUT A$
302 L=LEN(A$)
305 S=32768+8*40+15
306 FORJ=1TO9
307 FORK=1TO7
308 POKE S+K,A(J,K)
309 NEXTK
310 S=S+40
320 NEXTJ
330 P$=MID$(A$,I,1)
340 P=VAL(P$)
350 SW=LP+3*(P-1)
355 S=32728+8*40+15
360 ONSWGOSUB 1000, 1500, 2000, 2500, 1000,3000, 3500, 4000, 1000
370 LP=P
380 I=I+1
390 IF I>L THEN I=1
400 GOTO 330
1000 FOR Z=1TO 50:NEXTZ
1020 RETURN
1500 POKE S+1+40*8,160
1510 POKE S+2+40*8,160
1520 POKE S+4+40*8,160
1525 POKE S+3+40*7,160
1530 POKE S+3+40*9,105
1540 POKE S+4+40*9,32
1550 POKE S+4+40*8,32
1560 POKE S+4+40*7,32
1570 RETURN
2000 POKE S+1+40*6,160
2010 POKE S+2+40*6,160
2020 POKE S+3+40*6,160
2030 POKE S+1+40*5,160
2040 POKE S+3+40*9,95
2050 POKE S+4+40*9,32
2060 POKE S+4+40*8,32
2070 POKE S+4+40*7,32
2080 RETURN
2500 POKE S+2+40*8,32
2510 POKE S+1+40*8,105
2520 POKE S+4+40*8,160
2530 POKE S+3+40*9,160
2540 POKE S+4+40*9,160
2550 POKE S+3+40*7,32
2560 POKE S+4+40*7,160
2570 RETURN
3000 POKE S+1+40*6,160
3010 POKE S+2+40*6,160
3020 POKE S+3+40*6,160
3030 POKE S+1+40*5,160
3040 POKE S+1+40*8,95
3050 POKE S+2+40*8,32
3060 POKE S+3+40*7,32
3070 RETURN
3500 POKE S+3+40*9,160
3510 POKE S+4+40*9,160
3520 POKE S+4+40*8,160
3530 POKE S+4+40*7,160
3540 POKE S+1+40*6,32
3550 POKE S+2+40*6,32
3560 POKE S+3+40*6,32
3570 POKE S+1+40*5,105
3580 RETURN
4000 POKE S+1+40*8,160
4010 POKE S+2+40*8,160
4020 POKE S+3+40*7,160
4030 POKE S+1+40*6,32
4040 POKE S+2+40*6,32
4050 POKE S+3+40*6,32
4060 POKE S+1+40*5,105
4070 RETURN
READY.
```

3D noughts and crosses in 2K

by WN James

OWNERS OF 4K RAM microprocessors are probably aware that although it is reasonably straightforward to program arcade-type games, it is much more difficult to produce a game with any intellectual content — unless you write in machine code.

As a recent convert to computing, I was interested in writing a program which would satisfy the following criteria:

- It could play a game and beat me — thus giving some long-term challenge.
- It would not use too much memory.
- It would make its move rapidly.
- It could be written in Basic — I am not yet confident enough to embark on a long machine-code program.
- Its parameters could be adjusted to give players of differing abilities a reasonable game.

After some thought, I produced this program to play 3D noughts and crosses on a four by four by four board. Although the subject matter has been tackled many times before, most commercially-available programs for the game occupy 8K and upwards.

The program meets all the requirements stated, and uses only 2K of RAM. It plays a good game and usually wins with the given parameters, despite always playing second.

The game is played on a four by four by four cube, the object being to achieve a straight line of four noughts or four crosses in any direction. The simplest representation is to show the four horizontal planes of the cube adjacent to each other on the VDU.

Two arrays of 64 elements each are set-up. The array M holds the state of the game — a one represents an empty cell, a two represents an X, and a three a 0. The array N holds the priority values for each cell; the program chooses for its move the cell which has the highest value in this array.

Initially, all elements in array M are set to one, indicating empty cells. At the same time, all elements of array N are set to zero, except those elements corresponding to the corners of the cube and the central eight cells of the cube — they are set to 10, lines 50-120.

The cells described lie on seven lines within the cube, whereas all other cells lie on only four lines — obviously the more lines a cell lies on, the more valuable it is.

Figure 1. Variables used.

A(0) to A(8)	Nine most important line situations.
B(0) to B(8)	Nine priority values added to total priority values in array N.
M(0,0,0) to M(3,3,3)	State of cells array — empty, nought or cross.
N(0,0,0) to N(3,3,3)	Total priority values for cells.
P,R,C	Plane, row, and column co-ordinates for move cell.
P1,R1,C1	Plane, row, and column co-ordinates for cells in line with move cell.
D	Line situation for a particular line — compared to A(N) to find the appropriate priority value B(N) for cells in that line situation.
S	Set equal to the appropriate B(N), and added to the total priority values in the array N.
MC	Move count — game drawn if this reaches 64.
HV	Highest priority value found when all elements of array N are examined.

The player always starts and always has 0. There is no necessity for that, but the program assumes an air of superiority when it wins consistently despite playing second. The move is input in the order plane, row, column: respectively P, R, and C.

Elements in the arrays are in fact numbered from (0,0,0) to (3,3,3). It seems unnatural to have a 0th row or 0th column, hence lines 150 and 190 are included to convert co-ordinates so that all numbers lie between 1 and 4 rather than between 0 and 3.

Figure 5. Illustrative game.

For convenience, plays are only considered on the top plane. The player moves first with 0 — the program replies on all even-numbered moves with X. Note that on all its moves the program has a choice of moves, as several cells have N(P1,R1,C1) of the same value. After every move N(P1,R1,C1) is updated as explained in the text, but only for cells in line with the move cell. Examination of each move in conjunction with figure 4 will make the process clear.

Move	New position	N(P1,R1,C1)			
	• • • •	10	0	0	10
Start of	• • • •	0	0	0	0
game.	• • • •	0	0	0	0
	• • • •	10	0	0	10
(1) 1,1,1	0 • • •	20	10	10	20
	• • • •	10	10	0	0
	• • • •	10	0	10	0
	• • • •	20	0	0	20
(2) 1,1,4	0 • • X	10	0	0	38
	• • • •	10	10	14	14
	• • • •	10	14	10	14
	• • • •	34	0	0	34
(3) 1,2,1	0 • • X	108	0	0	38
	0 • • •	118	20	24	24
	• • • •	108	14	10	14
	• • • •	132	0	0	34
(4) 1,4,1	0 • • X	10	0	0	138
	0 • • •	20	20	124	24
	• • • •	10	114	10	.14
	X • • •	148	14	14	48
(5) 1,2,2	0 • • X	108	10	0	138
	0 0 • •	118	226	222	122
	• • • •	10	124	108	14
	X • • •	148	24	14	146
(6) 1,2,3	0 • • X	108	10	14	1138
	0 0 X •	20	128	1138	24
	• • • •	10	1124	122	14
	X • • •	1148	24	28	146

Note that N(P1,R1,C1) is updated even for already-occupied cells: checks could be introduced to avoid that, but the saving in time would probably not be very great.

After the player's move has been input, it is checked for legality — lines 140-170. The lines on which the move cell lies are now identified one by one in subroutine 1000. For example, considering only the first plane — figure 2 — it is clear that all cells lying on the top-left to bottom-right diagonal have R = C. Line 1050 tests for such cells. Cells on that diagonal in other planes also have R = C — only the plane number will differ.

There are 13 possible lines on which a cell may lie, and subroutine 1000 tests for them all. If a cell is found to be on a particular line, Q is set to an appropriate number to identify what kind of line, and the program moves to subroutine 4000.

This subroutine does two things; with the flag F initially at zero, subroutine 4000 identifies all the elements in a line and multiplies them together, storing the result in D. Depending upon which line the move cell lies, the temporary variables P1, R1 and C1 take different values — lines 4000-4170 — they are the co-ordinates of all cells lying in a particular line with the move cell. The values of M(P1,R1,C1) for those cells are multiplied to give D — line 4180.

Figure 3 shows the computation which would take place after the player has input his move and in doing so created the line 0 * 0 *. It is clear that any line which gives D a value of nine must contain two 0s, though not necessarily arranged in the order of figure 3.

The value of D thus identifies the situation in a line. On the first pass through subroutine 4000, the value of D for the line being considered is found. The flag F is now set to one, and subroutine 5000 is used to compare D to the nine most important line situations stored in A(0) to A(8). Each of these line situations has a value associated with it, B(0) to B(8) — figure 4.

The first part of subroutine 5000 checks that the game has not been won by the last move. If D equals 16 or 81 there is a row of four crosses or four noughts respectively. If that does not occur, the subroutine searches until the line situation is identified. S is set equal to the appropriate value in array B — line 5050 — and subroutine 4000 now adds S to the priority values in array N — line 4180.

Line 4210 sets the flag F back to zero, and subroutine 1000 is returned to identify any other lines the move cell lies on and repeat the process described.

When all lines on which the move cell lies have been identified and had their priority values N(P1,R1,C1) changed by an appropriate amount, subroutine 3000 determines which of N(P1,R1,C1) has the current highest value, and the program plays its move at this cell.

After making its move, the program

again uses subroutine 1000 to adjust N(P1,R1,C1) for the cells in line with its move. The game now proceeds until either a win is recorded or the move count reaches 64, in which case all cells have been filled and the game is drawn — line 210.

To summarise: after every move, the program first identifies all cells in line with the move cell in a particular direction; it then determines the situation in that line by multiplying the cell values M(P1,R1,C1) together; finally, it adds a value S to the priority values N(P1,R1,C1) for the cells in the line, S depending upon the line situation determined previously. Figure 5 illustrates the method, with plays take place only in the top plane from the start of a game.

The program has been written deliberately to be machine-independent, and offers several opportunities for changes. Subroutine 2000, which draws the board after every move, could be revised using PEEK and POKE to give a static display.

If line 3050 is deleted, the program will now play the same replies in a new game if the player repeats moves from a previous game. Various strategies can be examined to determine the program's weaknesses.

For an alternative game, reverse the inequality signs in lines 3030 and 3040. The program will now play anti-noughts and crosses, trying to avoid creating lines of four. Remember also to change lines

Figure 2. Top plane of cube.

0,0,0	0,0,1	0,0,2	0,0,3
0,1,0	0,1,1	0,1,2	0,1,3
0,2,0	0,2,1	0,2,2	0,2,3
0,3,0	0,3,1	0,3,2	0,3,3

Figure 3. Computation of D.

Situation in line:	0	*	0	*
Value of M(P1,R1,C1):	3	1	3	1
Value of D =	3 × 1 × 3 × 1 = 9			

Figure 4. Priority values for line situations.

Line situation	Line value A(N)	Priority value B(N)
0 * * *	3	10
X * * *	2	14
0 0 * *	9	98
X X * *	4	100
0 0 0 *	27	900
X X X *	8	1000
0 X * *	6	—14
0 0 X *	18	—98
X X 0 *	12	—100

Note that the last three values of B(N) are used only at certain times. If a line was already blocked, neither B(7) or B(8) is used — line 5040. If 0 X * * is preceded by 0 * * *, S is set to —10 — line 5030.

5000 and 5020. If lines 140-170 are deleted, and this line substituted:

```
140 gosub 3000: PRINT: PRINT " YOUR
    MOVE IS ";:PRINT P + 1; R + 1; C + 1
```

the computer will take both sides and play itself.

Experimentation is possible with the program playing both parts with different versions of B(N). If the losing values of B(N) are modified while the winning values are retained, the program becomes self-teaching and will eventually improve.

The values of B(0) TO B(8) are not optimal and can be varied easily to change the program's play — the only changes required are in line 20.

With a few extra lines, values of B(N) can be arranged to vary according to, say, the name of the player. That opens the way to easy wins for yourself by making B(N) for X X X * and 0 0 0 * have low values when you play. It is then clear to any friends watching that the program is a very poor one, as you romp through a number of easy wins.

When they use the program, however, the values given in line 20 are used — it is extremely frustrating to struggle through a game after seeing someone else win with little difficulty.

The program is written as far as possible to be machine-independent, but a few minor changes may be necessary. The Ohio Scientific Superboard II normally has a 72-character line width, so some of the longer lines — such as 4040 — may have to be broken-down into two lines on other machines.

The board, drawn in subroutine 2000, is 25 characters wide, as that is the screen width for the Superboard. Empty cells are denoted by an apostrophe — line 2070 — but any appropriate symbol may be substituted. Line 3050 contains the RND function — that chooses a number between 0 and 1 in Ohio Scientific Basic: that line may have to be re-written.

```
  10 REM SET UP BOARD AND INITIALISE VARIABLES
  20 DATA 3,10,2,14,9,98,4,100,27,900,8,1000,6,—14,18,—98,12,
     —100
  30 DIM M(3,3,3), N(3,3,3)
  40 D = 1 : A$ = "ROWS"
  50 FORP = 0TO3: FORR = 0TO3: FORC = 0TO3
  60 IF P = R AND P = C THEN 110
  70 IF P = C AND P = 3—R THEN 110
  80 IF P = 3—C AND R = C THEN 110
  90 IF P = R AND P = 3—C THEN 110
 100 GO TO 120
 110 N(P,R,C) = 10
 120 M(P,R,C) = 1: NEXT C: NEXT R: NEXT P
 130 FOR N = 0 TO 8: READ A(N), B(N): NEXT N: GOSUB 2000
 140 PRINT "INPUT YOUR MOVE ";
 150 INPUT P,R,C: P = P—1: R = R—1: C = C—1
 160 IF P>3 OR R>3 OR C>3 OR P<0 OR R<0 OR C<0 THEN 140
 170 IF M(P,R,C)>1 THEN PRINT "CELL OCCUPIED ":
     PRINT: GO TO 140
 180 M(P,R,C) = 3: GOSUB 1000: GOSUB 2000: GOSUB 3000
 190 PRINT "MY MOVE IS "; P + 1; R + 1; C + 1: MC = MC + 2
 200 PRINT: M(P,R,C) = 2: GOSUB 1000: GOSUB 2000
 210 IF MC = 64 THEN PRINT "THE GAME IS DRAWN": END
 220 GO TO 140
 990 REM FIND ON WHICH LINES THE MOVE CELL LIES
1000 FOR Q = 1 TO 3: GOSUB 4000: NEXT Q
1020 IF P<>R AND P<>C AND R<>C THEN 1060
1030 IF P = R THEN Q = 4: GOSUB 4000
1040 IF P = C THEN Q = 5: GOSUB 4000
1050 IF R = C THEN Q = 6: GOSUB 4000
1060 IF P<>3—R AND P<>3—C AND R<>3—C THEN 1130
1070 IF P = 3—R THEN Q = 7: GOSUB 4000
1080 IF P = 3—C THEN Q = 8: GOSUB 4000
1090 IF R = 3—C THEN Q = 9: GOSUB 4000
1100 IF P = R AND P = 3—C THEN Q = 10: GOSUB 4000
1110 IF P = C AND P = 3—R THEN Q = 11: GOSUB 4000
1120 IF P = 3—C AND R = C THEN Q = 12: GOSUB 4000
1130 IF P = R AND R = C THEN Q = 13: GOSUB 4000
1140 RETURN
1990 REM DRAW BOARD
2000 PRINT SPC(10); "COLUMNS": PRINT
2020 PRINT SPC(4); "1234 1234 1234 1234"
2030 FOR R = 0 TO 3: PRINT MID$(A$, R + 1, 1); R + 1;
2040 FOR P = 0 TO 3: FOR C = 0 TO 3
2050 ON M(P,R,C) GO TO 2070, 2080
2060 PRINT "0";: GO TO 2090
2070 PRINT " ' "; :GO TO 2090
2080 PRINT "X";
2090 NEXT C: PRINT " ";: NEXT P: PRINT: NEXT R: PRINT:
     PRINT: RETURN
2990 REM FIND CELL WITH HIGHEST PRIORITY VALUE
3000 HV = 0: FOR P = 0 TO 3: FOR R = 0 TO 3: FOR C = 0 TO 3
3020 IF M(P,R,C)>1 THEN 3060
3030 IF N(P,R,C)< HV THEN 3060
3040 IF N(P,R,C)> HV THEN HV = N(P,R,C): P1 = P: R1 = R:
     C1 = C: GO TO 3060
3050 IF RND(8)>0.5 THEN HV = N(P,R,C): P1 = P: R1 = R: C1 = C
3060 NEXT C: NEXT R: NEXT P: P = P1: R = R1: C = C1: RETURN
3990 REM ADD PRIORITY VALUES TO TOTAL PRIORITY
     VALUES
3995 REM FOR CELLS IN LINE WITH MOVE CELL
4000 FOR T = 0 TO 3: P1 = P: R1 = R:C1 = C
4020 ON Q GO TO 4050, 4060, 4070
4030 P1 = T
4040 ON Q—3 GO TO 4060, 4070, 4100, 4110, 4120, 4130, 4140,
     4150, 4160, 4170
4050 P1 = T: GO TO 4180
4060 R1 = T: GO TO 4180
4070 C1 = T: GO TO 4180
4100 P1 = P: R1 = T: C1 = T: GO TO 4180
4110 R1 = 3—T: GO TO 4180
4120 C1 = 3—T: GO TO 4180
4130 P1 = P: R1 = T: C1 = 3—T: GO TO 4180
4140 R1 = T: C1 = 3—T: GO TO 4180
4150 R1 = 3—T: C1 = T: GO TO 4180
4160 R1 = 3—T: C1 = 3—T: GO TO 4180
4170 R1 = T: C1 = T
4180 IF F = 1 THEN N(P1,R1,C1) = N(P1,R1,C1) + S: GO TO 4200
4190 D = D*M(P1,R1,C1)
4200 NEXT T: IF F = 0 THEN F = 1: GOSUB 5000: GO TO 4000
4210 F = 0: RETURN
4990 REM FIND NEW PRIORITY VALUES TO BE ADDED
5000 IF D = 16 THEN GOSUB 2000: PRINT: PRINT "I WIN": END
5020 IF D = 81 THEN PRINT: PRINT "YOU WIN": END
5030 IF D = 6 AND M(P,R,C) = 2 THEN S = —10: GO TO 5070
5040 IF D/M(P,R,C) = 6 THEN S = 0: GO TO 5070
5050 FOR N = 0 TO 8: IF D = A(N) THEN S = B(N): GO TO 5070
5060 NEXT N
5070 D = 1: RETURN
```

Using Hamming distance as basis for self-correcting code

THE AVERAGE man in the street frequently blames computer for making ludicrous mistakes such as sending an electricity bill for £0.00 or £1,000,000, though they are usually the fault of the person entering the data, or a badly-written program.

The fact still remains that computers do make mistakes — one hopes infrequently — because an occasional bit is misread from a peripheral device or memory. Two established methods of detecting such errors are parity bits and check sums.

Parity checking is achieved by reserving one bit called the parity bit in each word. The parity bit is used solely for checking

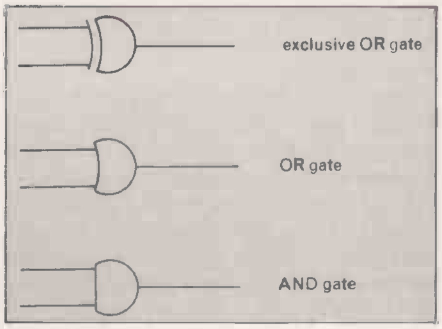


Figure 1.

the data stored in the rest of the word. A computer may be constructed equally well to use either odd or even parity. If one considers an even-parity machine, the parity bit in each word is set to 0 or 1 to make the total number of 1s in that word into an even number.

If any one bit in a word is misread, the total number of 1s in the word will become an odd number. That can be checked, and shows that an error has been detected. Should two errors occur within one word, that will not be detected — though the chance of it happening is remote.

Check sums provide a less precise method of confirming that a whole file or a large block of information has been read correctly. At the time the file was written, an additional piece of information called the check sum was calculated and stored. The check sum is calculated by adding together all of the words in the file.

When the file is subsequently read, the check sum is again calculated and compared with the original stored value. If the two values differ, one or more errors have occurred. If the two values agree, it is assumed that file has been read correctly, but it is remotely possible that compensating errors have occurred.

The two methods detect an error but they do not indicate exactly what is wrong or how to correct it, except by re-reading the entire file. That is particularly time-

by John and Timothy Lee

consuming with low-speed peripherals such as cassette readers or paper-tape readers, and if the error was generated while writing the original file, all attempts to read it will generate an error.

A system which could both detect and correct errors is highly desirable. That can be done, but for every four bits of data stored, a further four bits of checking information must be stored to permit correction of a single error within those eight bits. That is a significant overhead in the total amount of data stored.

At first sight, storing each four bits twice might appear to provide a simple solution. That would provide for error detection, but since it would not indicate if the error had occurred in the first or second set of four bits, error correction would not be possible. To enable the correction of one bit in an eight-bit word, one must store four bits of data followed by four bits of correction code.

The choice of the correction code is critical since, firstly, it must allow the original data to be generated from the correction bits and secondly, it must distinguish between all possible errors. The second of those requirements is the more difficult to fulfil, for example, with just one mistake each of the following eight bit words

11001100 and 11101110

could both be misread as

11101100

It follows that a code which allows both of the original bit patterns is not capable of self-correction, because the original two patterns are too nearly identical. The usual way of defining how different are two binary words of equal length, is to quote the Hamming distance. That is simply the number of positions in which the two words differ. For example the Hamming difference between the original two words is two.

11001100
11101110

A fuller discussion of Hamming code theory is given in Information representation and manipulation in a computer by E S Page and L B Wilson second edition Cambridge University Press, 1978, and

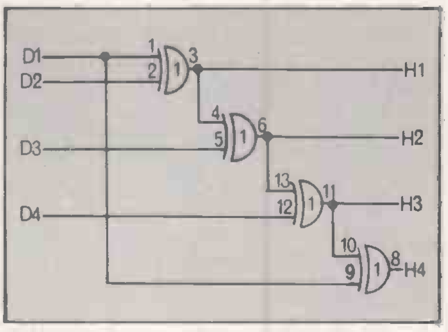


Figure 2.

interesting articles have appeared in *Computer Design*, September 1978, and *Byte*, February 1979.

It is a prerequisite for a self-correcting code which will handle a single error, that the Hamming distance between the two valid coded words must be three or more. In the example, the Hamming distance was only two, hence ambiguity could arise with a single error — making self-correction impossible.

In theory, any code which fulfils the condition of a minimum distance of three could be used for error correction. Most such codes are impractical because it is difficult to re-generate the correct word when an error occurs. Here is a code which is particularly useful because of the simplicity of the error correction algorithm.

A byte, eight bits, of data is split into two four-bit nybbles. The first nybble is stored together with four correction bits, and the second nybble is treated similarly. The following rules define a Hamming

Table 1.

Data Bits				Correction Bits				Hex Equivalent	
bit 1	bit 2	bit 3	bit 4	bit 1	bit 2	bit 3	bit 4	Data	Correction
0	0	0	0	0	0	0	0	0	0
0	0	0	1	0	0	1	1	1	3
0	0	1	0	0	1	1	1	2	7
0	0	1	1	0	1	0	0	3	4
0	1	0	0	1	1	1	1	4	F
0	1	0	1	1	1	0	0	5	C
0	1	1	0	1	0	0	0	6	8
0	1	1	1	1	0	1	1	7	B
1	0	0	0	1	1	1	0	8	E
1	0	0	1	1	1	0	1	9	D
1	0	1	0	1	0	0	1	A	9
1	0	1	1	1	0	1	0	B	A
1	1	0	0	0	0	0	1	C	1
1	1	0	1	0	0	1	0	D	2
1	1	1	0	0	1	1	0	E	6
1	1	1	1	0	1	0	1	F	5

code which will permit single error correction:

- The first correction bit is a parity bit for the first two data bits.
- The second correction bit is a parity bit for the first two data bits.
- The third correction bit is a parity bit for the first three data bits.
- The fourth correction bit is a parity bit for the first three data bits.

In practice, the latter is calculated as the parity of data bits 1, 2, 3, 4 and 1 for reasons which will become obvious. That code depends on even parity. The correction bits for the 16 possible data nybbles are shown in table 1.

Inspection of the eight-bit words produced from the four data bits and the four correction bits shows that any pair of eight-bit words in the table differ by at least three bits, i.e., the Hamming distance between any pair of words is at least three. That satisfies the first condition for a self-correcting code for one error per word.

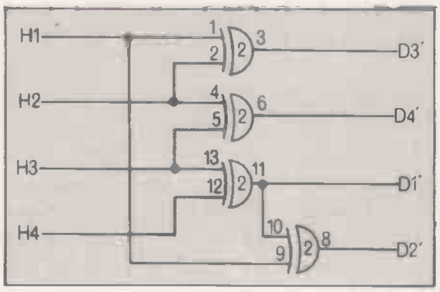


Figure 3.

The code permits the correction of one error whether it occurs in the data bits or the correction bits, since the data bits can be calculated from the correction bits as follows:

- Correction bit one is the parity for data bits one and two.
- Correction bit two is the parity for data bits one, two and three.

Thus the parity for correction bits one and two is the parity for data bits one and two, and one, two and three, which reduces to data bit three. Similarly

- Data bit four is the parity for correction bits two and three.
- Data bit one is the parity for correction bits three and four.
- Data bit two is the parity for correction bits one, three and four.

Here is a procedure which guarantees the correct assignment of values to the data bits:

1. The data bits and the correction bits are read.
2. The correction bits are initially assumed to have been read correctly. Using the correction bits, the corresponding data bit values are calculated using the rules.
3. The calculated data bit values are compared to the actual values. Three possibilities may occur:

- The two sets of values agree, in which case both the data bits and the correction bits have been read correctly.

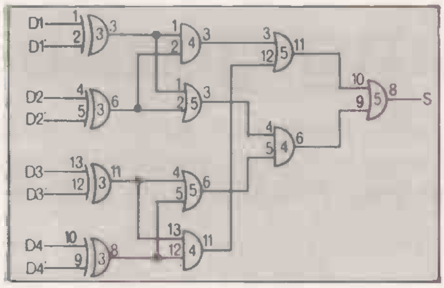


Figure 4.

- The two sets of values differ by one bit, in which case an error has occurred in the data bits. The data value calculated from the correction bits will be correct, and should be used.
- The two sets of values differ by more than one bit, in which case an error has occurred in the correction bits and the values for the data bits are correct.

As an example of the operation of those rules consider the data nybble seven and its associated correction nybble B.

Case a. 7B read correctly as 0111 1011.

Step two calculated data nybble as 0111.

Step three the difference between the calculated and observed data nybble is 0 — the byte has been read correctly.

Case b. 7B read as 0110 1011. Data nybble incorrect.

Step two gives calculated data nybble as 0111.

Step three, there is one difference between calculated and observed data nybbles. One error implies that the data nybble has been read incorrectly — use in this case, the calculated value of 0111.

Case c. 7B read as 0111 1001. Hamming nybble incorrect.

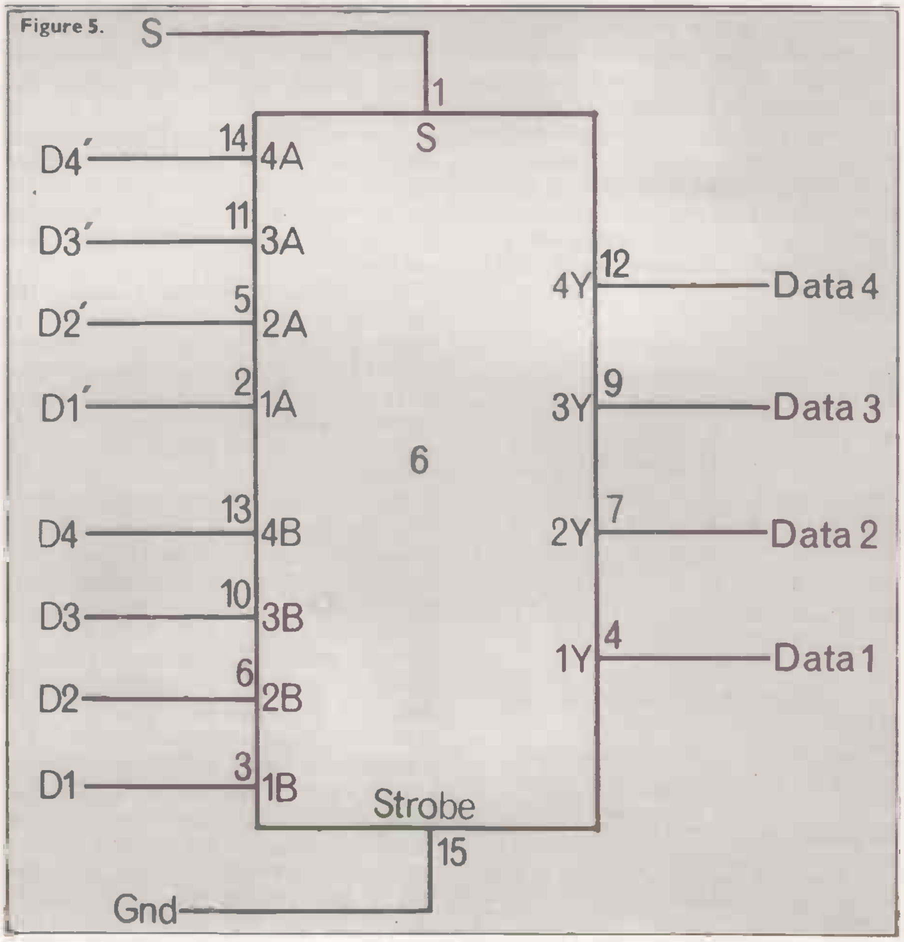
Step two gives calculated data nybble as 1010.

Step three, three differences between observed and calculated data nybbles. More than one error implies that the correction nybble is incorrect and the data nybble is correct as read.

Those ideas on a self-correcting code could be implemented relatively easily using low-level system software, and that would have the advantage that on transfer to external media such as a cassette recorder, the existing serial interface components — UART and input/output port — would be used unchanged.

An alternative is to provide a hardware solution — either within the machine or using a parallel output port, though the latter would require an additional UART and associated circuitry. Here are some ideas on a hardware solution. The standard symbols are shown in figure 1. The circuitry to generate correction bits H from data bits D is shown in figure 2. The circuitry to calculate expected data bits D from correction bits H is shown in figure 3. The circuitry to perform the necessary comparisons between the data bits D and the expected data bits D is illustrated by figure 4.

S is set high if there is more than one difference. If S is set, the observed data bits are correct and should be used, otherwise the calculated data bits are used.

Figure 5.


Representing game positions

Mark Josephs explains the various methods with which a game position can be represented in a computer for analysis by move generation and evaluation algorithms. They are of practical value to anyone contemplating writing a program for games such as chess, backgammon and draughts.

LET ME first clarify what I mean by a game position: not only to the specifications for the game board and the positions and types of the pieces, but also to such factors as the colour to move and any special considerations, e.g., a pawn which may be captured *en passant* in a game of chess.

ROW NUMBER								
8	—4	—2	—3	—5	—6	—3	—2	—4
7	—1	—1	—1	—1	—1	—1	—1	—1
6	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0
2	1	1	1	1	1	1	1	1
1	4	2	3	5	6	3	2	4
	1	2	3	4	5	6	7	8

COLUMN NUMBER

The initial set-up on a chessboard represented by an 8 × 8 array. To ensure that square (x,y) is on the board, the conditions x*(9—x) > 0 and y*(9—7) > 0 must be satisfied.

Figure 1.

It may be insufficient to represent the board by a straight conversion from squares to storage locations. To prevent pieces being moved from the board, either extra tests can be included in a program or a boundary can also be represented where boundary squares are unoccupiable.

To illustrate that, a chessboard may be represented by an eight-by-eight array — figure 1 — or by a 120-element vector — figure 2. Positive numbers can be used to represent pieces of one colour and negative numbers pieces of the other colour, while zero means an empty square. However, that requires that numbers representing boundary squares must change sign after each move or be given a special value.

Figure 2.

110	7	7	7	7	7	7	7	7	7	7
100	7	7	7	7	7	7	7	7	7	7
90	7	—4	—2	—3	—5	—6	—3	—2	—4	7
80	7	—1	—1	—1	—1	—1	—1	—1	—1	7
70	7	0	0	0	0	0	0	0	0	7
60	7	0	0	0	0	0	0	0	0	7
50	7	0	0	0	0	0	0	0	0	7
40	7	0	0	0	0	0	0	0	0	7
30	7	1	1	1	1	1	1	1	1	7
20	7	4	2	3	5	6	3	2	4	7
10	7	7	7	7	7	7	7	7	7	7
0	7	7	7	7	7	7	7	7	7	7
Sum gives element number	+1	+2	+3	+4	+5	+6	+7	+8	+9	+10

The initial set-up on a chessboard represented by a 120-element vector. The number "7" indicates a boundary square.

By implementing that method, using a single vector — figure 3 — both sides move in the same direction. The disadvantages of the method are that a normal move requires altering the contents of four locations instead of two and that the board occupies more storage space.

These descriptions demonstrate methods which hold information about the pieces as the contents of the squares of the board. It necessitates searching through the board array for pieces of the colour to move. An alternative arrangement is to compile a list of pieces in which the location of each piece is stored — figure 4. It creates some problems in determining the contents of the square to which a piece moves — the piece list has to be searched.

By combining these two techniques, it is possible to identify immediately the pieces of the colour to move and to determine whether they may move to a given square. However, a large amount of updating and some additional storage space are required.

As a compromise, in a chess program, the positions of the kings and queens can be kept along with the board array: that is useful because a routine to find attacks on the king or queen is included in most chess programs.

It is now worth considering a design for the representation of a backgammon position. The 24 points can obviously have 24 corresponding elements in an array. The contents of a location would represent the number of pieces on a point, e.g., —4 = 4 black pieces and +3 = 3 white pieces.

The bar could best be represented by two elements — to contain the number of pieces on the bar for each colour. Six extra points after each home table might be represented to facilitate bearing off — having the values ±2 or 0 — and one element could be used to contain the colour to move — +1 = white to move and —1 = black to move.

As a challenge to the reader, try writing a program to solve a Solitaire problem. Unlike chess, a tree search to the full depth is possible provided some pruning techniques are used. Do not feel too disconsolate if your micro is not up to the task — my program took more than 30 minutes to solve the centre-hole problem, time-sharing and in interpreted Basic on an Eclipse minicomputer system.

In conclusion, the method of representing a game position to the computer is of prime importance and deserves careful consideration before writing a program to play a game of strategy.

Figure 3.

210	—1	—1	—1	—1	—1	—1	—1	—1	—1	—1
200	—1	—1	—1	—1	—1	—1	—1	—1	—1	—1
190	—1	4	2	3	5	6	3	2	4	—1
180	—1	1	1	1	1	1	1	1	1	—1
170	—1	0	0	0	0	0	0	0	0	—1
160	—1	0	0	0	0	0	0	0	0	—1
150	—1	0	0	0	0	0	0	0	0	—1
140	—1	0	0	0	0	0	0	0	0	—1
130	—1	—1	—1	—1	—1	—1	—1	—1	—1	—1
120	—1	—1	—1	—1	—1	—1	—1	—1	—1	—1
110	—1	—1	—1	—1	—1	—1	—1	—1	—1	—1
100	—1	—1	—1	—1	—1	—1	—1	—1	—1	—1
90	—1	4	2	3	5	6	3	2	4	—1
80	—1	1	1	1	1	1	1	1	1	—1
70	—1	0	0	0	0	0	0	0	0	—1
60	—1	0	0	0	0	0	0	0	0	—1
50	—1	0	0	0	0	0	0	0	0	—1
40	—1	0	0	0	0	0	0	0	0	—1
30	—1	—1	—1	—1	—1	—1	—1	—1	—1	—1
20	—1	—1	—1	—1	—1	—1	—1	—1	—1	—1
10	—1	—1	—1	—1	—1	—1	—1	—1	—1	—1
0	—1	—1	—1	—1	—1	—1	—1	—1	—1	—1
Sum gives element number	+1	+2	+3	+4	+5	+6	+7	+8	+9	+10

The initial set-up on a chessboard represented by a 220-element vector. 0 to 110, the board from black's point of view; 100 to 210 for white's.

Figure 4.

	LOCATIONS OF WHITE'S PIECES	LOCATIONS OF BLACK'S PIECES	ROW NUMBER
PAWNS	32	82	1
	33	83	2
	34	84	3
	35	85	4
	36	86	5
	37	87	6
	38	88	7
	39	89	8
KNIGHTS	23	93	9
	28	98	10
BISHOPS	24	94	11
	27	97	12
ROOKS	22	92	13
	29	99	14
QUEENS	25	95	15
KING	26	96	16

The initial set-up on a chessboard represented by a "piece list".

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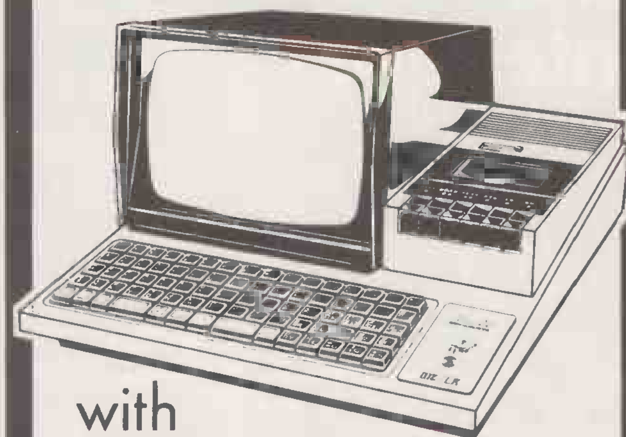

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Inverse-field characters

A USEFUL facility several micros, including Pet and Apple possess, are reverse field characters writes Jerry Hudson of Bedford. That can also be achieved on the Sorcerer by laboriously defining each user-defined key with its inverse field counterpart.

This machine-code routine will define each graphic character with its inverse field equivalent in the user-defined character keys. To obtain a particular graphic character, press graphic and character keys; to obtain its inverse equivalent press graphic-shift-character keys.

To define reverse field alphabet, change 0104 to 08; 0105 to FA. That will place the inverse characters in alphabetical order in the user-defined keys: not QWERTY order, i.e.,

REVERSE FIELD A = GRAPHIC-SHIFT-A
—"— —"— B = —"— -—"—-B

Once defined, the reverse field characters can be accessed from Basic, using ASCII numbers for the user-defined keys and of course directly from the keyboard. The program must be run to define the keys before a Basic program is loaded, as the area of memory it occupies in the Basic control area.

Invert graphics routine number 1.

```
0100H  01 FF 00  Set byte counter
0103H  21 00 FC  First graphic address
0106H  11 00 FE  First destination address
0109H  CD 10 01  Invert first 32 characters
010CH  CD 10 01  Invert second 32 characters
010FH  C9        Return to monitor
0110H  7E        Graphic character to accumulator
0111H  2F        Complement accumulator
0112H  12        Accumulator to address in DE
0113H  13
0114H  23
0115H  10        Jump if byte counter 0
0116H  F9
0117H  C9        Return to mainflow.
```

Invert alphabet routine, number 2.

```
0100  06 1A 00     Load character counter B
0103  21 08 FA     Load HL with first ROM character address
0106  DD 21 50 01  Load IX with data address
010A  CD 25 01     Call invert single character routine
010D  C9           Return to monitor
0125  DD 56 00     Load data
0128  DD 5E 01     Pointer DE
012B  D9           Exchange registers
012C  06 08        Set byte counter B'
012E  D9           Exchange registers
012F  7E           Non-inverted character to accumulator
0130  2F           Complement accumulator
0131  12           Accumulator to address in DE
0132  13           Increment DE
0133  23           Increment HL
0134  D9           Exchange registers
0135  10 F7        Jump to 012E if B' 0
0137  D9           Exchange registers
0138  DD 23        Increment IX
013A  DD 23        —"—
013C  10 7E        Jump to 0125 if B 0
013E  C9           Return to loop caller

0150 FE D0 FF 58 FF 48 FE E0 FE
     80 FE E8 — DATA
015D FE F0 FE F8 FE A8 FF 00 FF
     08 FF 10 — DATA
0169 FF 68 FF 60 FE B0 FE B8 FE
     70 FE 88 — DATA
0176 FE D8 FE 90 FE A0 FF 50 FE
     78 FF 40 — DATA
0183 FE 98 FF 38
```

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Unsigned numbers

I HOPE that the following routine, which multiplies a 16-bit unsigned number in the DE register pair by an eight-bit unsigned number in the A register, will be of interest writes Dominic Dunlop of Maidenhead, Berkshire.

```
                        MULTIPLY_16x8
 LOC    OBJ    SOURCE STATEMENT

0000   21000D MULT:    LD  HL,0     ;CLEAR RESULT
0003   CB3F   LOOP:    SRL A        ;TEST LSB OF ACC
0005   3D04            JR  NC,NOADD ;NO ADD IF ZERO
0007   19              ADD HL,DE    ;ADD FACTOR
0008   D8              RET C        ;OVERFLOW EXIT
0009   1801            JR  SHIFT    ;
000B   C8     NOADD:   RET Z        ;FINISHED YET?
000C   CB23   SHIFT:   SLA E        ;SHIFT LEFT OF
000E   CB12            RL  D        ;  MULTIPLIER
0010   18F1            JR  LOOP     ;NEXT BIT PLEASE
```

The program shows the power of the Z-80 shift instructions, and may be loaded anywhere in memory — the relative jump instructions make it position-independent. Since the routine terminates as soon as the factor corresponding to the most significant bit in the A register has been added to the product, it executes more quickly, on average, than multiplication routines which examine blindly all bits of the multiplier before terminating.

On exit, the product is in the HL register pair. If the carry flag is clar, the result is valid, but if it is set, overflow occurred, aborting the calculation. The result in this case is invalid.

Varying line length

IN BASIC, screen width is determined by the byte at location 322 decimal (0142 H), writes Ian Bowden of New Barnet, Hertfordshire. That is always set to 64 decimal — 40 H — by a cold-start but, being in RAM, it can be changed to any value you choose between 1 and 255.

That allows you to use more width on a printer, although you cannot see the extra characters appear on the screen. It does not alter the maximum numbers of characters in a Basic statement. It is effective only on the LIST and PRINT functions.

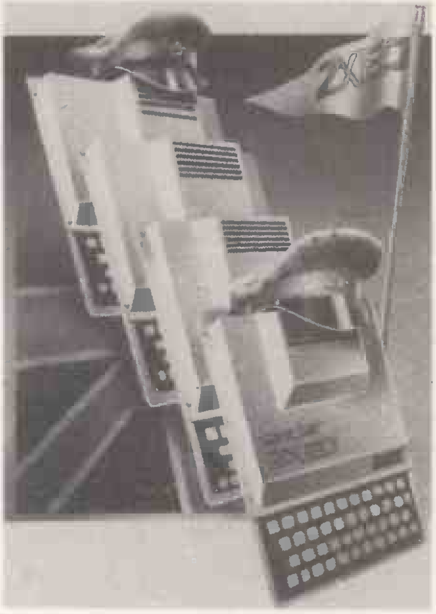
Computamind

I WOULD like to submit a program which is a version of Mastermind, writes Stephen Cronk of Litlington, Hertfordshire. I am fully aware that the program can be condensed, but I designed it to demonstrate string manipulation on the Nascom 2, and so considered it worth the extra length.

The program will run on most machines with Microsoft extended Basic. The only problems are likely to be CLS, clear screen, and CLEAR, re-set variables, but these are easily overcome.

```
1 D=6
2 DIMG$(20),G(4),C(4),B(20),U(20)
6 CLS:
7 PRINT"        -----------
10 PRINT"        COMPUTAMIND
20 PRINT"        BY S. CRONK
25 PRINT"        -----------
30 PRINT
34 FOR H=1TO2000:NEXT H
40 PRINT"FIGURE OUT A FOUR DIGIT CODE
50 PRINT"USING NUMBERS FROM 1TO6
55 PRINT
70 PRINT" A 'ROM' INDICATES A CORRECT DIGIT"
75 PRINT
80 PRINT" A 'RAM' INDICATES A CORRECT DIGIT
120 PRINT"YOU MAY REQUEST A SUMMARY AT"
130 PRINT"ANYTIME BY TYPING'S'"
135 PRINT
150 PRINT"ARE YOU READY TO START?";
160 INPUTA$
170 IF LEFT$(A$,1)="N"THEN PRINT"YOU'RE NO FUN":END
180 FOR J=1TO1000
190 NEXT J
195 CLS
200 FOR J=1TO4
210 R=INT(D*RND(1))+1
220 C$=C$+MID$(STR$(R),2,1)
230 NEXTJ
240 PRINT"I HAVE CHOSEN MY NUMBER"
250 G=G+1
255 IF G>20 THEN 1140
260 PRINT"GUESS NUMBER";G;
270 INPUT A$
280 IF LEFT$(A$,1)="S"THEN800
290 IF LEN(A$)<>4THEN 1170
294 FORT=1TO2000:NEXTT
295 IFA$=C$THEN910
300 FOR J=1TO4
310 R=VAL(MID$(A$,J,1))
320 IF R<10 RR>6 THEN1170
330 NEXTJ
340 FOR J=1 TO 4
350 G(J)=VAL(MID$(A$,J,1))
360 C(J)=VAL(MID$(C$,J,1))
370 IF C(J)<>G(J)THEN410
380 B=B+1
390 C(J)=0
400 G(J)=0
410 NEXT J
420 FORJ=1TO4
430 IF C(J) =0 THEN 530
440 H=0
450 FORK=1TO4
460 IF C(J)=0THEN510
470 IF C(J)<>G(K)THEN 510
480 H=1
490 G(K)=0
500 C(J)=0
510 NEXTK
520 U=U+H
530 NEXTJ
540 G$(G)=A$
550 B(G)=B
560 U(G)=U
570 PRINT"YOU GOT";B;"ROMS"
575 PRINT"AND " ;U;"RAMS"
576 U=0:B=0
580 PRINT
590 IF G<7 THEN GOTO 250
600 PRINT"THAT IS YOUR LIMIT OF GUESSES"
700 PRINT"*** HARDLUCK***"
710 END
800 REM SUMMARY
805 IF G<>1THEN 810
806 PRINT"NO GUESSES YET"
807 GOTO 260
810 CLS
820 PRINT"GUESS NUMBER "
830 PRINT"NUMBER CHOSEN ROMS RAMS
840 PRINT"----------------------------
850 FOR J=1TOG-1
860 PRINT TAB(3);J;TAB(9);G$(J);TAB(17);
870 PRINTB(J);TAB(25);U(J)
880 NEXT J
890 PRINT"----------------------------
900 GOTO 260
910 CLS:PRINT"THAT WAS IT
920 PRINT"YOU GOT IT IN ";G;"GUESSES
930 IF G=I THEN 1050
940 IF G<3 THEN 1030
950 IF G <5 THEN 1010
960 IF G<6 THEN 990
970 PRINT"I HAVE SEEN THE RAVENOUS BUG BLATTER"
975 PRINT"BEAST OF TRAAL PLAY BETTER"
980 GOTO 1060
990 PRINT"KEEP PRACTISING
1000 GOTO 1060
1010 PRINT"MOYEN-I THINK
1020 GOTO 1060
1030 PRINT"NOT BAD AT ALL"
1040 GOTO 1060
1050 PRINT"I WISH I COULD PLAY LIKE THAT"
1060 PRINT
1070 PRINT"HOW ABOUT ANOTHER GAME";
1080 GETZ$
1085 IF Z$="" THEN 1080
1090 IF LEFT$(Z$,1)="N" THEN ENDS
1100 CLS
1110 CLEAR
1120 GOTO 510
1140 CLS:PRINT"THAT IS YOUR LIMIT OF GUESSES"
1150 PRINT"MY NUMBER WAS ";C$
1160 GOTO 1060
1170 PRINT"BING,BONG
1175 PRINT"ERROR SYNTAX ENTRY
1180 GOTO 260
```

We have had so many requests for advice about software for the little ZX-80 that we have decided to start a club page devoted to the machine. If you have a contribution to make, write to *Practical Computing* marking your letter ZX-80 Line-up. We pay £5 for contributions published.



Direct running

THIS PROGRAM enables programs to be run directly after being loaded writes Ian Logan of Skellingthorpe, Lincolnshire. This feature has been available on other micros for some time but I believe that the enclosed program will be a first for the ZX-80.

I wrote it in response to a question posed by a purchaser of the ZX-80 Companion, second edition in which I wrote the chapter on the monitor.

The technique used is to copy the existing load routine from the monitor, and then add a patch, in machine-code, which closely follows the continue subroutine. The result is that once a program has been loaded, there is no need to press RUN, as the program will start running itself when loading is complete.

```
 10 PRINT
 20 PRINT
 30 PRINT "∇∇DIRECT-RUN∇PROGRAM
    ΔLOADER"
 40 PRINT
 50 PRINT ,"IAN∇LOGAN"
 60 PRINT
 70 PRINT "∇∇LINCOLN,∇OCTOBER
    ∇1980"
 80 PRINT
 90 PRINT
100 FOR I = 504 TO 597 (copy LOAD routine)
110 POKE 16780 + I,PEEK(I)
120 NEXT I
130 LET I = 17266
140 POKE I,205 (clear screen)
150 POKE I + 1,71
160 POKE I + 2,7
170 POKEI + 3,253 (set run flag)
180 POKE I + 4,203
190 POKE I + 5,1
200 POKE I + 6,222
210 POKE I + 7,253 (set statement number
220 POKE I + 8,54     to zero — 2 bytes)
230 POKE I + 9,2
240 POKE I + 10,0
250 POKE I + 11,253
260 POKE I + 12,54
270 POKE I + 13,3
280 POKE I + 14,0
290 POKE I + 15,195 (jump to Basic return)
300 POKE I + 16,71
310 POKE I + 17,4
320 POKE I + 29,24 (jump to the above patch)
330 POKE I + 30,225
340 POKE I + 99,132 (change a CALL)
350 POKE I + 100,67
360 PRINT "1.SET TAPE TO START OF
    PAUSE"
370 PRINT
380 PRINT "2.PRESS PLAY"
390 PRINT
400 PRINT "3.PRESS NEWLINE"
410 INPUT Z$ (input Z string)
420 LET K = USR(I + 33)
```

LEN functions

IT IS good news indeed for thousands of ZX-80 owners, writes Eric Deeson of Harborne, Birmingham, that ZX-80 Line-up is a regular feature; may it grow and grow.

The author of Character manipulation, September 1980, notes that the Sinclair offers no LEN(A$) function. LEN has a number of uses; its absence made the substring retrieval program you printed unnecessarily convoluted.

Use the following program to give LEN(A$), called L as is common.

```
10 INPUT A$
20 PRINT A$
30 LET L = 0
40 LET A$ = TL$(A$)
50 LET L = L + 1
60 IF NOT A$ = "" THEN GO TO 40
70 PRINT "ΔHASΔ";L;"Δ
   CHARACTER(S)."
```

The program may be reduced readily to a short and valuable subroutine as follows.

```
1000 LET L = 0
1010 LET A$ = TL$(A$)
1020 LET L = L + 1
1030 IF NOT A$ = "" THEN GO TO 1010
1040 RETURN
```

Re-sequencing programs

THIS PROGRAM is used to re-sequence program lines writes Egidio Debono of Qormi, Malta. Ideally, the program should first be loaded from cassette and then one starts keying one's own program, and, at any instant, RUN 9000 would call the software which asks for the number to be given to the first line.

The second prompt is for the increment required between lines. Lines 9000 to 9140 must be deleted before the re-sequenced program is SAVEd on tape. If, however, one wants to re-sequence a program which is already saved, the user's program must first be loaded from tape and, then, the software is entered manually.

It is important that the user's program should have its line numbers less than 9000. Line 9120, in fact, checks whether it has reached line 9000 when it lists the entire program. Care should obviously be taken for any GO TOs and GO SUBs as the target address is not changed. They have to be amended before the program is SAVEd.

The software has been written as short as possible. Firstly, so that as little space as possible is used from the RAM, and secondly, so that it would not make it a tedious job entering the program through the keyboard. As a matter of fact, and for curiosity's sake, I have expanded the program to cater for GO TOs and GO SUBs, but there is hardly any space left for entering another program in the ZX-80 configuration.

```
9000 PRINT "STARTING FROM";
9010 INPUT S
9020 PRINT S;"IN STEPS OF"
9030 INPUT T
9040 LET A = 16424
9050 POKE A,S/256
9060 POKE A + 1,S
9070 LET S = S + T
9080 LET A = A + 2
9090 IF PEEK(A) = 118 THEN GO TO 9120
9110 LET A = A—1
9110 GO TO 9080
9120 IF PEEK(A + 1) = 35 AND PEEK(A + 2)
     = 40 THEN LIST
9130 LET A = A + 1
9140 GO TO 9050
```

Long-string handling

UNLIKE ITS larger and more expensive sisters, the ZX-80 has no facility for handling long INPUT strings and it has no file-creating ability other than to store the string variables in a program writes R Urquhart of Romford, Essex. This routine obviates the first problem and solves the second by providing the user with a short program which, together with its string variables, can be stored on tape and recovered when required. By creating separate sets of records for each version of the same program stored, an almost limitless size of file can be built-up on tape.

My particular requirement was to set-up an index of magazine references which I could keep up to date from time to time. In practice, I have kept the records to the length of one print line as a maximum but there is no need for a limit. It will be seen that, as a check after each data entry, the previous entry is printed above the invitation to input the next record. I have provided for 21 records, A to U, per program which means that I can store more than 200 records on a 57p digital tape cassette.

One word of warning: the program must be keyed exactly as shown and any new lines added at the end of the program. You start with the normal RUN command but once all 21 records are cleared, the command GO TO 240 must always be used otherwise the records will be lost.

(continued on next page)

(continued from previous page)

It pays to store the program immediately the records are written and checked by a GO TO 240 so that if a mistake is made subsequently, the programs and variables can be re-loaded. Only a GO TO 240 restores the original listing.

There is no need to insert something at every invitation to type. Hitting NEWLINE will clear the loop to 'DATA END'. It may help, however, to key the appropriate alpha character so that amendments or additions can be inserted. To do that, key line 315 INPUT ⁄⁄ $ where ⁄⁄ is the alpha character of the string variable to be inserted. 'GO TO 240' will reveal the amendment or insertion but immediately remove line 315 or it will be over-written next time.

```
 10 PRINT"ENTER DATA"
 20 INPUT A$
 30 LET A = PEEK(16443)
 35 IF A = 58 THEN GO TO 200
    [IF A = U THEN 200]
 37 LET B = PEEK(16442)
 40 IF B = 244 THEN GO TO 65
    [IF B = PRINTTHEN 65]
 50 POKE 16442,244
    [IF B ≠ PRINT INSERT "PRINT"]
 55 CLS
 60 GO TO 20
 65 POKE 16442,238
    [IF B = PRINT INSERT "INPUT"]
 75 POKE 16443,A + 1
    [A,B,C,D ETC]
 80 GO TO 10      [LOOP]
200 PRINT "DATA END"
    [A NOW EQUALS U]
235 STOP
240 PRINT A$
275 LET D = PEEK(16582)
280 IF D = 58 THEN GOTO 305
    [IF A = U THEN 305]
285 POKE 16582, D + 1
    [A,B,C,D ETC]
295 GO TO 240
305 POKE 16443,38  [SET BOTH Us
310 POKE 16582, 38   back to A]
```

The program also enables the user to create one of those displays popular with retailers. Using the graphics symbols, the display, ZX-80, in 2in. high letters can be printed.

Positron bombers

HERE IS a game which will run on the standard 1K ZX-80 writes Nicholas Meadows of Apperley, Gloucestershire. It uses PEEK and POKE; PEEK to find the start of the display file, and POKE to modify the display file. Since the program uses a large display file, 285 bytes, modifying it with POKE rather than using PRINT statements makes the program run much faster.

As the positron bombs shower from space, you must guide your spaceship across from right to left.

- N Newline moves on step to the left.
- M Newline moves back one step to the right.
- Newline stays stationary.

Your objective is to reach home in the left-hand column. There are a maximum of 15 bombs at any one time, and your task becomes increasingly difficult, because, as you progress further to the left, all 15 bombs concentrate over your spaceship.

```
 10 LET A = 1
 20 DIM A(15)
 30 LET Z = 299
 40 FOR I = 1 TO 15
 50 FOR J = 1 TO 19
 60 PRINT " ";
 70 NEXT J
 80 PRINT
 90 LET A(I) = RND(19)
100 NEXT I
110 FOR I = 1 TO 15
120 GO SUB 900
130 POKE A + A(I),147
140 NEXT I
150 POKE A + Z,3
160 INPUT I$
170 FOR I = 1 TO 15
180 GO SUB 900
190 POKE A + A(I),0
200 NEXT I
210 POKE A + Z,0
220 IF I$ = "N" THEN LET Z = Z—1
230 IF Z = 281 THEN GO TO 350
240 IF I$ = "M" THEN LET Z = Z + 1
250 FOR I = 1 TO 15
260 LET A(I) = A(I) + RND(8) = 20
270 IF A(I)>280 THEN GO TO 300
280 NEXT I
290 GO TO 110
300 LET A(I) = A(I)—20
310 IF A(I) = Z THEN GO TO 420
320 IF A(I)>280 THEN GO TO 300
330 LET A(I) = RND(Z—280)
340 GO TO 280
350 GO SUB 900
360 LET A = A + Z
370 POKE A,173
380 POKE A + 1,180
390 POKE A + 2,178
400 POKE A + 3,170
410 STOP
420 GO SUB 900
430 LET A = A + Z
440 POKE A,181
450 POKE A + 1,180
460 POKE A + 2,188
470 STOP
900 LET A = PEEK(16396) + PEEK(16397) =
    256
910 RETURN
```

Battleship game

BATTLESHIPS uses the POKE instruction to produce a display writes R J Goddard of Bath, Avon. The computer randomly generates the position for the three ships, each ship three characters across. The positions of the ships cannot be on the left-hand edge, or upper edge of the screen, thus lines 100 to 155 reject those positions.

Lines 160 to 180 put the three positions of the ships into arrays U, V, W. Lines 190, 250, 310, decide whether the two other characters which compose each ship should be to the left, or above those already put into the arrays.

Lines 370-550 print the grid on the screen; lines 530, 535, decide whether or not a row of spaces or dots will be printed. Alternate rows of spaces and dots appear clearer than dots alone. Line 560 nominates the character to be POKEd, an "X" for a miss.

At line 570 both the X and the Y co-ordinates can be input at once, X first. Numbers less than 10 should have a "0" in front of them, and the two numbers should be separated by a character.

Line 640 converts the two co-ordinates into the co-ordinate for subsequent poking. Lines 630 to 690 check to see if a hit has been scored, in which case the character to be poked is changed from "X" to an inverse space. Line 700 pokes this character on to the screen. "S" is input to stop.

```
 10 DIM U(2)
 20 DIM V(2)
 30 DIM W(2)
 40 LET U1 = RND(725)
 50 IF U1< 137 THEN GOTO 40
 60 LET V1 = RND(725)
 70 IF V1 < 137 THEN GOTO 60
 80 LET W1 = RND(725)
 90 IF W1 < 137 THEN GOTO 80
100 FOR H = 0 TO 17
110 LET H2 = 137 + H*33
120 LET H3 = H2 + 27
130 IF U1>H2-6 AND U1<H2 OR U1>H3
    AND U1<H3 + 6 THEN GOTO 40
140 IF V1>H2-6 AND V1<H2 OR V1>H3
    AND V1<H3 + 6 THEN GOTO 60
150 IF W1>H2-6 AND W1<H2 OR W1>H3
    AND W1<H3 + 6 THEN GOTO 80
155 NEXT H
160 LET V(2) = V1
170 LET W(2) = W1
180 LET U(2) = U1
190 IF RND(2) = 1 THEN GOTO 230
200 LET U(1) = U(2)—1
210 LET U(0) = U(2)—2
220 GOTO 250
230 LET U(1) = U(2)—33
240 LET U(0) = U(2)—66
250 IF RND(2) = 1 THEN GOTO 290
260 LET V(1) = V(2)—1
270 LET V(0) = V(2)—2
280 GOTO 310
290 LET V(1) = V(2)—33
300 LET V(0) = V(2)—66
310 IF RND(2) = 1 THEN GOTO 350
320 LET W(1) = W(2)—1
330 LET W(0) = W(2)—2
340 GOTO 370
350 LET W(1) = W(2)—33
360 LET W(0) = W(2)—66
370 PRINT " ";
380 FOR A = 0 TO 2
390 FOR B = 1 TO 10
400 PRINT A;
410 NEXT B
420 NEXT A
430 PRINT " ";
440 FOR C = 1 TO 3
450 FOR D = 0 TO 9
460 PRINT D;
470 NEXT D
480 NEXT C
490 FOR F = 0 TO 19
500 IF F<10 THEN PRINT "0";
510 PRINT F;
520 FOR E = 1 TO 15
530 IF NOT (F/2)*2 = (F*2)/2 THEN PRINT
    " . ";
535 IF (F/2)*2 = (F*2)/2 THEN PRINT " ";
540 NEXT E
550 NEXT F
560 LET Y = 61
570 INPUT X$
580 IF X$ = "S" THEN STOP
590 LET X1 = (CODE(X$)—28)*10 + (CODE
    (TL$(X$))—28)
600 FOR G = 1 TO 3
610 LET X$ = TL$(X$)
620 NEXT G
630 LET Y1 = (CODE(X$)—28)*10 + (CODE
    (TL$(X$))—28)
640 LET X = 69 + (Y1*33) + X1
650 FOR I = 0 TO2
660 IF X = U(I) THEN LET Y = 128
670 IF X = V(I) THEN LET Y = 128
680 IF X = W(I) THEN LET Y = 128
690 NEXT I
700 POKE PEEK(16396) + PEEK(16397)*
    256 + X,Y
710 GOTO 560
```

25 Ways to use VISICALC Software

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1. A Birmingham sales rep. uses VisiCalc to do his sales reports, sales summaries and expense accounts.

2. A farmer in Wiltshire compares budgeted and actual expenditure, analyzes transactions and solves numerous other business problems.

3. A Louisiana shipyard manager does inventory pricing, cost estimating, and stability and tonnage calculations.

4. A City financial analyst, who computes and prints trust fund reports for his clients, says, "VisiCalc is paying for itself over and over again. An excellent money maker."

5. A California real estate and financial planner automated much of his work with VisiCalc's powerful features. For example, he has created an array of 13 certificates of deposit with varying base amounts, term periods, and interest rates, with associated calculations for required "break-even" terms and interest rates when current date and available money market rates are entered. Penalties for early withdrawal are applied and gain/loss shown if proceeds reinvested. Daily compounding of interest is provided for.

6. A ceramic tile manufacturer has "new applications all the time," including costing model, budget preparation, ceramic empirical formula calculations and financial analysis. Says, "VisiCalc is dynamite."

7. The financial director of a Newcastle company does his budgeting and planning.

8. A professional translator using VisiCalc for cost/profitability comparisons, budgeting and income tax, says VisiCalc is the "best microcomputer application program I've ever seen."

9. A chemical research scientist keeps weekly budget planning, tax records (income and deductions), medical expenses and personal inventory.

10. An Australian manufacturing firm manager's uses include factory production reports, labour costing, calculation of recent price increases, and "a race horse selection program that is yet only moderately successful."

11. A Swiss retail food store manager uses VisiCalc for profit centre calculations, enabling him to know the net profit of every store on a monthly basis with the input of only three reference numbers.

12. A life insurance agent, who already prepares client proposals combining insurance and other investments and quotations on small group plans, says, "I can't wait until I really learn how to use VisiCalc - it's outstanding."

13. A Norwich company secretary appreciates VisiCalc's "ease of use" while doing corporate budgeting, sales forecasts, production forecasts, financial report analysis and ratios, and construction cost analysis.

14. A London management consultant's uses include analysing key financial ratios and balance of business planning and modelling business performance, and management training.

15. An electrical engineer does his business plans, balance sheets, cash flow analysis and sales forecasts. Says he likes VisiCalc's "protection from errors and mistakes."

16. An Oregon medical laboratory director does his workload calculations and space forecasting.

17. A New York finance manager does balance sheet forecasting and keeps a five-year income statement.

18. A Surrey teacher likes the built-in formula calculations when doing statistical research, charts, football statistics, classroom marking and home budget projections.

19. An anesthesiologist calculates gas flows on anesthesia equipment, plus a running record of income tax, pending orders and computer hardware and software expenditures.

20. An executive of a major management consultancy explains how they had used an expensive time-sharing service which tied up a programmer/analyst to create and run the models, so there was always someone between their needs and the final results. "We attempted to duplicate what we had at the service bureau and surprised ourselves that we could do it easily and without specialised programming skills. Now we have evolved far more sophisticated forecasting and modelling tools that go well beyond enything we originally envisaged. These analyses are used by us on behalf of our clients or prospective clients and they help us get more business."

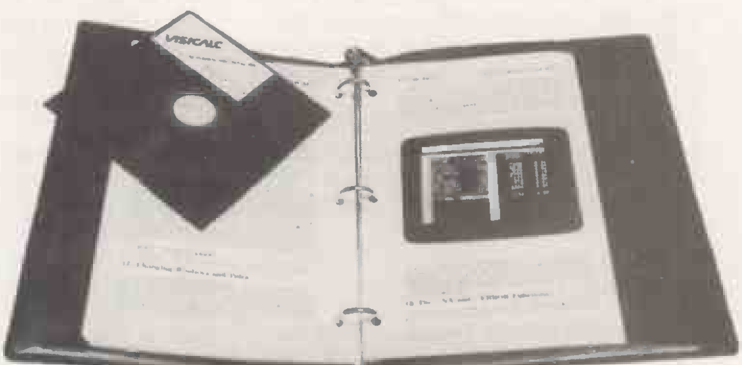
21. A Manchester optician took the hand calculations out of his budgets and sales projections.

22. A senior financial analyst does his balance sheet financial analysis (ratios, rates, yields, etc.) and financial modelling such as profit plans.

23. The president of a New York retail business is using VisiCalc to figure out how he can pay for his personal computer. (He should talk to the guy mentioned in number 4!)

24. The co-owner of a Nuneaton restaurant calculates food costs, bar costs and total operation cost projections.

25. A Massachusetts student is crunching numbers at Harvard Business School with VisiCalc....straight to the head of the class.



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TANDY FORUM is devoted to the Tandy TRS-80. Sometimes we will use it to pass on news about the TRS-80 but, above all, it is for users, and would-be users, of the well-established model I and now the new model II. With your tips, queries, moans and comments, this page can become a market-place for TRS-80 information.

Screen whitener

THIS PROGRAM designed for a TRS-80 level II, when called, whitens the entire screen writes N Brickell of Plymouth. That provides a quick and useful display function and dispenses with other slow methods, such as "SET" and "POKE".

```
10 REM * SCREEN FILL ROUTINE *
20 FORN=16512 TO 16523
30 READA:POKEN,A:NEXT
40 DATA 33,0,48,17,0,60,1,0,4,237,176,201
50 NEW
User Call:
POKE 16526, 128: POKE 16527,64:X=USR(0)
```

The machine-code program resides in the level II Basic RAM area, thus using no RAM.

```
10 REM *** DECIMAL TO HEXADECIMAL
   CONVERTER ***
20 CLS: INPUT"ENTER DECIMAL
   NUMBER (0-65535)";A
30 H1=FIX(A/4096):A$=STR$(H1):X1$=
   A$:IFH1>9 GOSUB 100 ELSE 40
32 X1$=B$
40 B=(A—H1*4096):H2=FIX(B/256):A$
   =STR$(H2):X2$=A$
42 IFH2>9 GOSUB100ELSE50
44 X2$=B$
50 C=(B—H2*256):H3=FIX(C/16):A$=
   STR$(H3):X3$=A$
52 IFH3>9 GOSUB100ELSE60
54 X4$=B$
60 D=(C—H3*16):H4=D:A$=STR$(H4):
   X4$=A$
62 IFH4>9 GOSUB100ELSE70
64 X4$=B$
70 CLS:PRINT"DECIMAL";A;"=HEX"
   X1$" "X2$" "X3$" "X4$"
80 R$=INKEY$:IFR$=" "THEN80ELSE20
100 IFVAL(A$)=10THENB$="A"
110 IFVAL(A$)=11THENB$="B"
120 IFVAL(A$)=12THENB$="C"
130 IFVAL(A$)=13THENB$="D"
140 IFVAL(A$)=14THENB$="E"
150 IFVAL(A$)=15THENB$="F"
160 RETURN
```

The program converts a decimal number — 0 to 65,535 — into its Hexadecimal counterpart. It was designed for a TRS-80 level II but should run on most microcomputers.

Enter the decimal number and in about a second, the Hexadecimal number should be returned. Once the answer is back, pressing any key will allow a new decimal entry.

Generating music

THIS ARTICLE — by Tony Lacy of Willenhall, West Midlands — serves two purposes, firstly, it presents a useful module to incorporate programs, secondly, it is a demonstration of an alternative method of embedding machine-code subroutines in main programs written in Basic.

I needed a self-contained routine which I could incorporate into programs to generate sound effects using an amplifier plugged into the cassette jack he writes.

The technique uses the concept of hiding machine-code subroutines in single-dimension integer arrays. TRS-80 Basic stores that kind of variable as contiguous pairs of bytes, each byte pair representing an element.

We can assign values to those byte pairs such that, if the processor knows where to start execution, it will run just like any other average machine-code program.

A program using the method lists normally and, what is more, values can be passed to and from the subroutine by operating directly on the array elements. In fact, the structure of the subroutine could be modified from the calling program. No system loads or reserved memory areas are necessary.

Line 20 is necessary only in disc Basic; it executes a disable interrupt if that is not included, the tone output is interrupted every few milliseconds, making it sound ragged.

Line 40 is the decimal equivalent of listing 2. Here is an easy way to generate decimal values from a Hex listing:

1. Load the Hex code in using T-BUG or system, making a note of the start and end addresses.
2. Basic, write this one-line program and run it.

```
10 FOR X=START TO END:PRINTPEEK
   (X);:NEXT
```

The required decimal values will be printed. Line 70 is needed because of the way that integer values are stored in MSB LSB form.

Computers represent negative integer by allocating values in the range 7FFFH and FFFFH. To enter such values, we need to make our number negative — for a more thorough explanation, see TRS-80 Assembly Language Programming by William Bardon and published by Radio Shack. Line 90 allocates the value to the array element.

Put your program in the place of line 110, L is the note duration, T is the frequency, as that line stands, it will generate random notes of random duration.

If you examine the assembly-code listing, you will see that the first operation does not seem to make sense. That is rectified in line 150, the element I% (1) is given a value derived from L and T before the subroutine is called. That demonstrates the ease with which values can be transferred into and out of subroutines using this method.

Line 160 contains the dreaded VARPTR feature which is used to tell us where the array is in memory. That information is needed for the next process — the call.

USR calls are analogous to GOSUB, except that the subroutine being called is written in machine-code. The computer has to be told where to go and that is the main use of the VARPTR feature. It is done in disc Basic using the DEFUSR function — line 180 — in level II Basic however, values have to POKED as in lines 200 to 220.

Line 230 is the call; the return from the call by a simple machine-code RET instruction and line 240 completes the loop.

Finally, if you do not find the short explanation very helpful, use the program as it is and experiment with line 110.

Listing 1. Complete music generator program

```
10 'LINE 20 ONLY NEEDED IN DISK
   BASIC
20 'CMD"T
30 DIMI%(11)
40 DATA0,33,0,0,62,1,211,255,69,16,254,
   62,2,211,255,69,16,254,37,200,24,238
50 FORI1=0TO10
60 READB:READA
70 C=256*A+B
80 IFC>32768THENC=C—65536
90 I%(I1)=C
100 NEXT
110 L=RND(200)+55:T=RND(200)+55
120 IFL>255ORL<1ORT>255ORT<1THEN
    110
130 A=256*L+T
140 IFA>=32768THENA=A—65536
150 I%(1)=A
160 V=VARPTR(I%(0))+1
170 'USE LINE 180 IN DISK BASIC AND
    DELETE 200-220
180 'DEFUSR=V
190 'LINES 200-220 ARE FOR L2 BASIC
    ONLY
200 MSB=INT(V/256)
210 LSB=V—256*MSB
220 POKE16526,LSB:POKE16527,MSB
230 X=USR(A)
240 GOTO110
```

'IS TRS-80 shorthand for REM

Listing 2. Assembler listing for USR subroutine.

```
7000          00100        ORG  7000H
 ;CODE IS RELOCATABLE
7000  210000  00110 FIRST  LD   HL,0
 ;TWO BYTES LOADED WHEN
      00115
 ;I% (1) ALLOCATED
7003  3E01    00120 START  LD   A,1
 ;PORT LOW
7005  D3FF    00130        OUT  (255),A
 ;OUTPUT IT
7007  45      00140        LD   B,L
 ;GET DELAY VALUE FOR FREQUENCY
7008  10FE    00150 LOOP1  DJNZ LOOP1
 ;TIME DELAY
%00A  3E02    00160        LD   A,2
 ;PORT HIGH
700C  D3FF    00170        OUT  (255),A
 ;OUTPUT IT
700E  45      00180        LD   B,L
 ;GET DELAY AGAIN
700F  10FE    00190 LOOP2  DJNZ LOOP2
 ;TIME DELAY
70011 25      00200        DEC  H
 ;NOTE DURATION TIMER
7012  C8      00210        RET  Z
 ;BACK TO BASIC IF TIME UP
7013  18EE    00220        JR   START
 ;IF NOT GO ROUND AGAIN
7000          00230        END  FIRST
 ;ENTRY POINT DEFINED
00000 TOTAL ERRORS

FIRST  7000  00110 00230
LOOP1  7008  00150 00150
LOOP2  700F  00190 00190
START  7003  00120 00220
```

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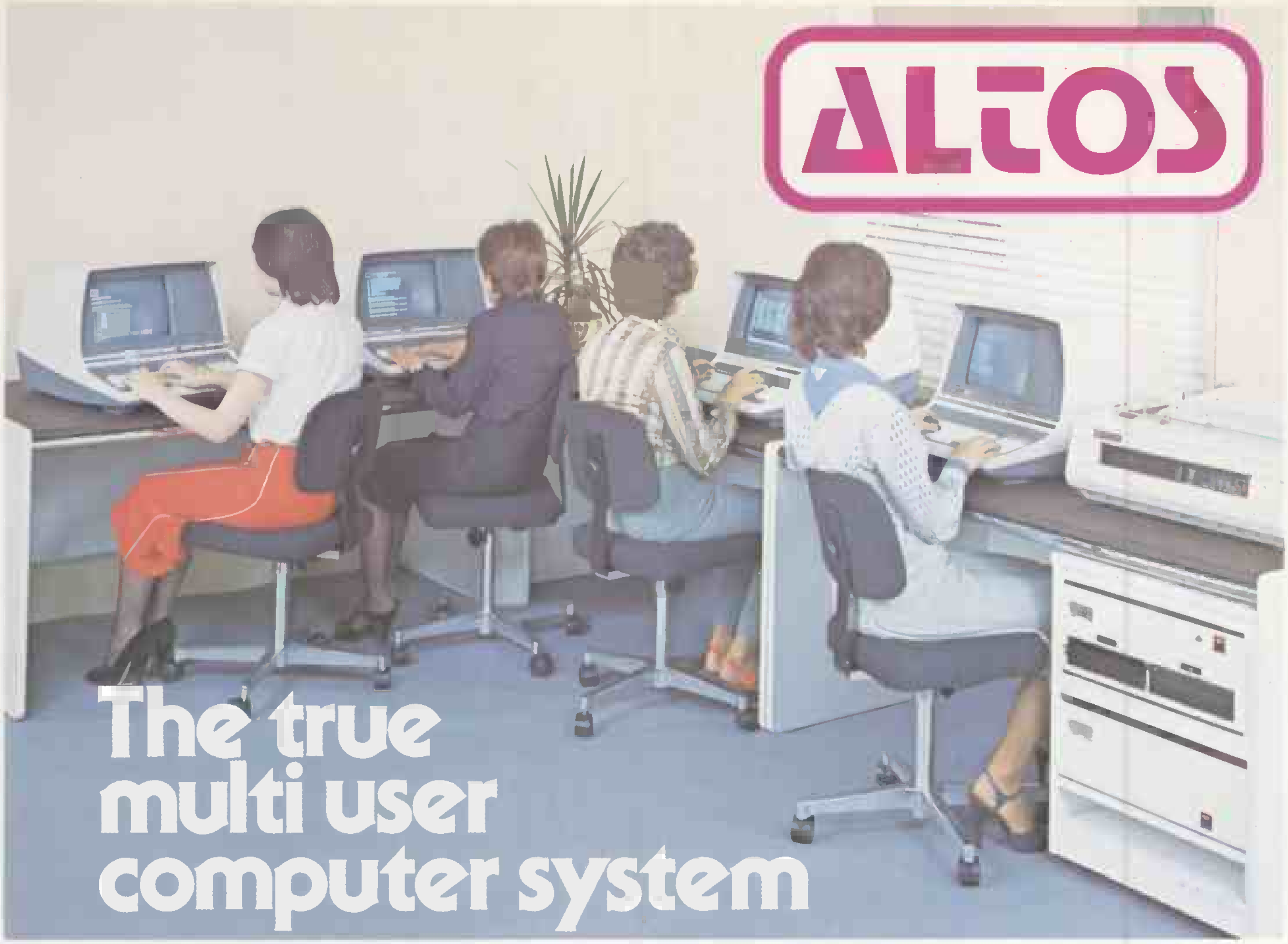

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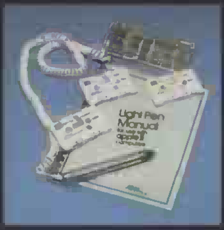

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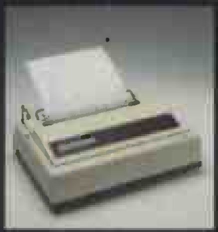

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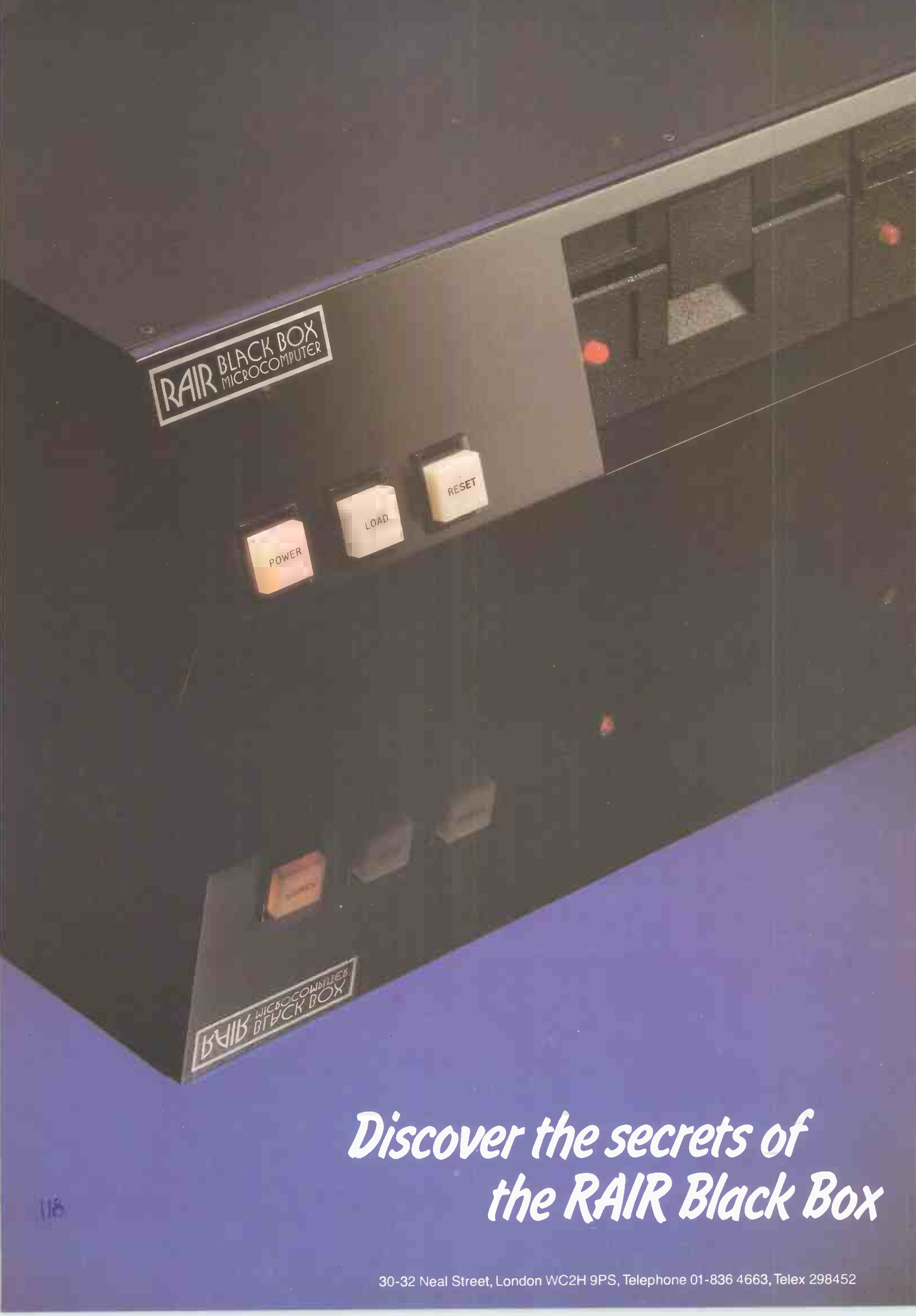
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Garbage collection

ALL OWNERS of the UK101 are aware that if your Basic program has a DIM statement for a string, asking the question FRE(X) will cause a hang up writes Roger Cuthbert of Maidenhead, Berkshire.

My investigations have shown the fault to be in the garbage collection routine. Memory size was set at 1,024 for this demonstration. The two-line program asks for three strings to be input and when first RUN, I have used Ann, Joe and Bill. They are placed at the end of RAM space mentioned.

At GOTO 20 the program is re-entered but without re-setting-up and we can see what happens when the value of each string is changed. Starting at $03E9 there are six strings, and only the last three entered have references in the string array CB$.

Starting in $03E9 is 'HARRY' reference in $033F first byte is length second and third address.
In $03EE is 'TIM with reference in $033B.
In $03F1 is 'PENNY' with reference in $0337.
In $03F6 is 'BILL' but with no reference.
In $03FA is 'JOE' again with no reference.
In $03FD is 'ANN' also with no reference.

This table of references starts in $032C with the variable CB but the B has the value $80 added to the ASCII value of 'B' making C2, that is to indicate that the variable is a string. The next byte, 17, shows how long the table is and the other data concerns the dimension of the array, i.e., 1 2 or 3.

Each string uses four bytes as reference, string length, start address of the string and then a null.

CB$(0) is referenced in $0330 to $0333, here a null string.
CB$(1) is referenced in $0337
CB$(2) is referenced in $033B
CB$(3) is referenced in $033F

Each time the string of a particular variable, e.g., CB$(1), is altered, the string is placed in the next available space at the end of RAM. If we now look at page zero and note the locations which keep tabs on Basic.

a. Start of Basic in $0079/A
b. End of Basic in $0085/6
c. Start of variables $007B/C
d. Start of array table $007D/E
e. Next byte after end of all variables $007F/80
f. Start of string space $0081/2

In this case, c and d are the same because we have only one variable. We can now see that every time a string variable has its string changed, the available space will fill, but should the new string be in danger of overwriting the variables, we enter the garbage collection routine automatically.

Since we may well have strings in the string area which are no longer referenced, it is the job of the routine to move all strings in use down the data area to maximise the available space. That is exactly what you are doing by asking FRE(X), it ensures that you are informed of the maximum space available and to do that, it forces a garbage collection.

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In the second table, I have first asked PRINT FRE(0), thus causing garbage collection. If you now check the same references for Harry, Tim and Penny you will see that these three — the only valid strings — have been moved to the end of RAM, thus maximising the available data space.

We now arrive at the correction of the faulty garbage-collection routine. That is in Basic ROM three and starts at $B147. Examination — playing computers with pencil and paper to the small hours — shows that when it checked through the string table, it expected the references to occupy only three bytes. Only three are needed with length and start address but the table uses four — the last is a null.

The changes are small as shown in the printout but incorporation is not. I had to build an EPROM programmer on an expansion board using two 6522 VIAs and a long Basic program. Even with an EPROM — 2716 5V — it will not replace the ROM directly. My solution was to wire wrap a socket on an expansion board using the same address having of course removed the offending ROM.

However, I offer an alternative but also a solution which slows Basic some 50 times or so. The Basic program will POKE in a machine-code routine to $0230 which is called by NMI — non-maskable interrupt.

Two wires and a switch are needed to activate the NMI. Join one to pin five of IC17 and this pin goes low when Basic ROM three is selected. The second wire is joined to pin six of the 6502, i.e., the NMI pin. Connect the two wires with the switch, open to start with. Enter the Basic program and RUN. Now close the switch. From now on, every time Basic ROM three is selected by the address lines a NMI will cause the machine-code routine you have just entered to be used.

That routine will now check to see if you were about to use the incorrect section of the garbage-collection routine and if so, it substitutes the correct version. Note that NMI will be active for every instruction in ROM three and even for every byte, thus some instructions will cause more than one interrupt.

It would be better to cause interrupt only when the bad section is to be used but that would mean a more complicated hardware address decode for the NMI, by which time it will be quicker and easier to wire-wrap on an EPROM.

When using my EPROM version I have never had a garbage collection of more than 10 seconds but remember, the more strings, the longer it will take. However, using the NMI solution will slow that considerably and can approach 20 minutes.

EPROMs require select-low while ROM select-high; that part is easy as the inversion is done by IC16e but there are other hardware changes if the EPROM is to use the same socket as the ROM.

```
QB1BC                              QB21E

B1BC 200BB2 JSR $B20B              B21E 2902   AND #$02
B1BF E6A0   INC $A0                B220 18     CLC
B1C1 EA     NOP                    B221 A8     TAY
B1C2 EA     NOP                    B222 85A2   STA $A2
B1C3 EA     NOP                    B224 B19C   LDA ($9C),Y
B1C4 EA     NOP                    B226 65AA   ADC $AA
B1C5 EA     NOP                    B228 85A6   STA $A6
B1C6 E4A5   CPX $A5                B22A A5AB   LDA $AB
B1C8 D004   BNE $B1CE              B22C 6900   ADC #$00
B1CA C5A4   CMP $A4                B22E 85A7   STA $A7
B1CC F0BB   BEQ $B189              B230 A581   LDA $81
B1CE 20D7B1 JSR $B1D9              B232 A682   LDX $82
B1D1 F0F3   BEQ $B1C6              B234 85A4   STA $A4
B1D3 C8     INY                    B236 86A5   STX $A5

LIST

 10 DIM CB$(3)
 20 INPUT CB$(1),CB$(2),CB$(3)
OK

RUN
? ANN
?? JOE
?? BILL

OK
GOTO20
? PENNY
?? TIM
?? HARRY

OK

D0000,0100
      0  1  2  3  4  5  6  7  8  9  A  B  C  D  E  F
0000  4C 74 A2 4C C3 A8 05 AE C1 AF 4C 88 AE 00 00 48
0010  38 78 03 48 41 52 52 59 00 00 33 3A 96 36 31 34
0020  34 30 2C 31 36 00 34 00 2C 31 36 00 24 28 33 29
0030  00 FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
0040  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
0050  FF FF FF FF FF FF FF FF FF FF FF 22 22 00 00 FF
0060  00 00 00 FF 00 68 65 00 06 92 A1 FF FF FF FF FF
0070  FF 92 A1 47 B9 FF 04 00 FF 01 03 2C 03 2C 03 43
0080  03 E9 03 EE 03 00 04 14 00 FF FF 28 03 FF FF 00
0090  03 18 00 43 C2 3F 03 3F 03 FF FF 00 FF FF 68 00
00A0  03 4C FF 00 33 03 0E 02 00 00 2C 03 06 92 68 00
00B0  00 00 00 00 00 00 00 00 92 A1 98 A1 E6 C3 D0 02
00C0  E6 C4 AD 28 03 C9 3A B0 0A C9 20 F0 EF 38 E9 30
00D0  38 E9 D0 60 80 4F C7 52 FF FF 00 F0 DC 00 00 01
00E0  FF FF FF FF FF FF FF 00 FF FF FF FF FF FF FF FF
00F0  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF

:D0300,0400
      0  1  2  3  4  5  6  7  8  9  A  B  C  D  E  F
0300  00 0E 03 0A 00 85 20 43 42 24 28 33 29 00 29 03
0310  14 00 84 20 43 42 24 28 31 29 2C 43 42 24 28 32
0320  29 2C 43 42 24 28 33 29 00 00 00 FF 43 C2 17 00
0330  01 00 04 00 00 00 00 05 F1 03 00 03 EE 03 00 05
0340  E9 03 00 FF FF FF FF FF FF FF FF FF FF FF FF FF
0350  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
0360  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
0370  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
0380  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
0390  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
03A0  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
03B0  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
03C0  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
03D0  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
03E0  FF FF FF FF FF FF FF FF FF 48 41 52 52 59 54 49
03F0  4D 50 45 4E 4E 59 42 49 4C 4C 4A 4F 45 41 4E 4E

PRINT FRE(0)
 176

OK

D0000,0100
      0  1  2  3  4  5  6  7  8  9  A  B  C  D  E  F
0000  4C 74 A2 4C C3 A8 05 AE C1 AF 4C 84 AE 00 00 48
0010  38 00 F0 97 20 B1 28 30 29 00 52 00 28 30 29 00
0020  34 30 2C 31 36 00 34 00 2C 31 36 00 24 28 33 29
0030  00 FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
0040  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
0050  FF FF FF FF FF FF FF FF FF FF FF 22 22 44 00 FF
0060  04 00 00 FF 00 68 65 00 06 92 A1 FF FF FF FF FF
0070  FF 92 A1 47 B9 FF 04 00 FF 01 03 2C 03 2C 03 43
0080  03 F3 03 EE 03 00 04 14 FF FF FF 28 03 FF FF 00
0090  03 18 00 43 C2 12 03 3F 03 FF FF 00 3F 00 68 00
00A0  03 4C 00 00 43 03 E9 02 FD 00 43 03 06 92 68 00
00B0  20 00 00 80 00 00 20 00 92 A1 98 A1 E6 C3 D0 02
00C0  E6 C4 AD 19 00 C9 3A B0 0A C9 20 F0 EF 38 E9 30
00D0  38 E9 D0 60 80 4F C7 52 FF FF 00 F0 DC 00 00 01
00E0  FF FF FF FF FF FF FF 00 FF FF F1 FF FF FF FF FF
00F0  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF

D0300,0400
      0  1  2  3  4  5  6  7  8  9  A  B  C  D  E  F
0300  00 0E 03 0A 00 85 20 43 42 24 28 33 29 00 29 03
0310  14 00 84 20 43 42 24 28 31 29 2C 43 42 24 28 42
0320  29 2C 43 42 24 28 33 29 00 00 00 FF 43 C2 17 00
0330  01 00 04 00 00 00 00 05 F8 03 00 03 F8 03 00 05
0340  F3 03 00 FF FF FF FF FF FF FF FF FF FF FF FF FF
0350  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
0360  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
0370  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
0380  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
0390  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
03A0  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
03B0  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
03C0  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
03D0  FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
03E0  FF FF FF FF FF FF FF FF FF 48 41 52 52 59 54 49
03F0  4D 50 45 48 41 52 52 59 54 49 4D 50 45 4E 4E 59

LIST

 1 REM *** NMI INTERUPT ROUTINE - TO CORRECT BASIC GARBAGE ***
 2 REM *** COLLECTION PROGRAM ERROR                         ***
 3 REM
 4 REM *** BY  ROGER CUTHBERT   JUNE 1980                    ***
 5 REM
 6 REM
 10 DATA 72,138,72,186,189,5,1,201,177,240,8,201,178,240,33,104
 20 DATA 170,104,64,189,4,1,201,188,240,6,201,204,208,241,240,37
 30 DATA 169,201,157,4,1,104,170,104,40,32,11,178,130,160,8,64
 40 DATA 189,4,1,201,30,208,216,169,33,157,4,1,104,170,104,40
 50 DATA 41,2,24,8,64,104,170,104,40,240,2,8,64,8,72,138
 60 DATA 72,186,169,137,157,4,1,104,170,104,64,-99
 70 K=560
 80 READ X
 90 IF X<0 THEN 120
 100 POKE K,X
 110 K=K+1:GOTO 80
 120 POKE 304,76
 130 POKE 305,48
 140 POKE 306,2
 999 END
OK.
```

(continued on next page)

(continued from previous page)

```
0000            ; Interupt routine to correst BASIC garbage collection
0000            ;*****************************************************
0000            ;
0000            ;
0000                      START=$0230
0230                      *=START
0230            ;
0230 48         START     PHA
0231 8A                   TXA
0232 48                   PHA
0233 BA                   TSX
0234 BD0501               LDA $0105,X   ;Totest where NMI came from.
0237 C9B1                 CMP £$B1      ;High byte.
0239 F008                 BEQ NEXT1
023B C9B2                 CMP £$B2
023D F021                 BEQ NEXT2
023F 68         GOBACK    PLA           ;Return when required.
0240 AA                   TAX
0241 68                   PLA
0242 40                   RTI
0243 BD0401     NEXT1     LDA $0104,X   ;Low byte.
0246 C9BC                 CMP £$BC
0248 F006                 BEQ FOUND
024A C9CC                 CMP £$CC
024C D0F1                 BNE GOBACK
024E F025                 BEQ NEXT3
0250 A9C6       FOUND     LDA £$C6      ;Change return address.
0252 9D0401               STA $0104,X
0255 68                   PLA
0256 AA                   TAX
0257 68                   PLA
0258 28                   PLP
0259 200BB2               JSR $B20B     ;New section.
025C E6A0                 INC $A0
025E 08                   PHP
025F 40                   RTI
0260 BD0401     NEXT2     LDA $0104,X   ;Test low byte.
0263 C91E                 CMP £$1E
0265 D0D8                 BNE GOBACK
0267 A921                 LDA £$21      ;New low byte address.
0269 9D0401               STA $0104,X
026C 68                   PLA
026D AA                   TAX
026E 68                   PLA
026F 28                   PLP
0270 2902                 AND £$02      ;New section.
0272 18                   CLC
0273 08                   PHP
0274 40                   RTI
0275 68         NEXT3     PLA
0276 AA                   TAX
0277 68                   PLA
0278 28                   PLP
0279 F002                 BEQ NEWADD    ;New - Test zero.
027B 08                   PHP
027C 40                   RTI
027D 08         NEWADD    PHP
027E 48                   PHA
027F 8A                   TXA
0280 48                   PHA
0281 BA                   TSX
0282 A989                 LDA £$89      ;New address.
0284 9D0401               STA $0104,X
0287 68                   PLA
0288 AA                   TAX
0289 68                   PLA
028A 40                   RTI
028B            ;
028B            ;
028B            ;Section to setup NMI vector.
028B            ;------------------------------
028B            ;
028B                      HIGHBT=START/256*256
028B            ;
028B 209702               JSR SETUP     ;Entry for COLD START BASIC.
028E 4C11BD               JMP $BD11
0291 209702               JSR SETUP     ;Entry for WARM START BASIC.
0294 4C74A2               JMP $A274
0297 A930       SETUP     LDA £START-HIGHBT ;Forms low byte.
0299 8D2302               STA $0223
029C A902                 LDA £START/256
029E 8D2402               STA $0224
02A1 A90C                 LDA £$0C      ;Clear screen code.
02A3 2057FA               JSR $FA57     ;To screen print.
02A6 60                   RTS
```

High resolution

HAVING no previous experience in computing, apart from a very rewarding three-year relationship with a TI-59 programmable calculator, I at last decided on an Apple II plus, Auto-start ROM, 48K, six months ago writes Christian Borup of København, Denmark.

My dream, and partly my reason for the choice, was to use both high-resolution screens in conjunction with extensive programs to compare high-resolution plotted horoscopes — I work in the field of astrology.

I was stunned by the awkward placement of the two 8K high-resolution screens in the middle of the memory-range, dividing the usable RAM-area into two blocks of 6K and 24K each — no DOS. I was confident that a big program could be loaded above the HGR2 area in memory. The dream turned to a nightmare. The LOMEM-command did not permit it, although the Applesoft manual shyly mentions LOMEM in connection in this context.

So I sat sadly, with an expensive 48K machine, no knowledge of machine-code, a 18K program which used both high-resolution screens, but absurdly, nowhere to put it.

My first attempt to solve the problem consisted of typing 100 lines of REM-statements, checking with the monitor to be sure that the program proper started at location 24576. I found that after a HGR-statement, Applesoft ignored my laborious attempts, leaving me with a 6K program consisting of REM-statements.

This section is open to the Apple user. In every issue we hope to print ideas, hints and comments about the Apple and its suppliers. They must come from you, so write and tell us what you know.

Deeply distressed, I telephoned the firm where I had bought the machine. Not having encountered the problem before, the software consultant advised to type in 22K of REM-statements, and hope for the best. That was exactly what I had so painstakingly done with a striking lack of success.

After two days of trial and error, trying to discover what happened in the different locations in the zero-page, a practical and wonderfully-simple solution dawned on me.

Locations 1Ø3 and 1Ø4 — 67 and 68 in Hex — contained the pointer to the address where the program started. By POKEing a start address into those two locations, a program could be LOADed into any part of the RAM-area.

To load a program above HGR, POKE 1Ø3,Ø : POKE 1Ø4,64. To load a program above HGR2, POKE 1Ø3,Ø : POKE 1Ø4,96, before loading your program.

When manually entering a new program, type two lines, SAVE on tape, POKE the chosen start-addresses into locations 1Ø3 and 1Ø4, and LOAD again, then no harm will come to you or your program, and you can continue typing. POKEing before you start typing in a new program causes your program to crash when run, but creating a wonderful tattered effect on the GR-screen.

The lower unused 6K can, of course, be used for big machine-code subroutines or shape-table definitions.

Cross-reference program

Edward McGeough of Aberdeen offers a program which produces a listing of a program together with a cross-reference of the variables used.

Having entered the program and saved on disc, he writes, the program is run once to create an Execute file named 'EXEC-XREF'. The execute file is used thus:

- Load the program for which a listing is required: LOAD YOURPROGRAM.
- Execute the Exec file: EXEC EXEC-XREF
- Lines 60000-60071 are appended to the program loaded, run from 60000 to store all variable names and the line numbers in which they are used, then sorted and a listing of the program with cross-references is produced on the printer.

The listing enclosed should be modified in lines 60009 and 60063 to make the highest line number referenced to 59999 — from 60071.

The printer is assumed to be in slot two with width 76 — line 60063 — set W to 40 for screen output, and remove reference to slot two.

```
0  REM  'XREF'
10  REM  RUNNING THIS PROGRAM,WILL SAVE
20  REM  THE LINES 60000-60071 IN AN
30  REM  EXEC FILE 'EXEC XREF' WHICH MAY
40  REM  BE EXECUTED DIRECTLY ON A PROGRAM
50  REM  IN MEMORY TO GIVE A CROSS-REF
60  REM  LIST OF THE PROGRAMS VARIABLES
70  REM
90 NF$ = "EXEC-XREF"
100 D$ =  CHR$ (4)
110  PRINT D$;"OPEN ";NF$
120  PRINT D$;"DELETE ";NF$
130  PRINT D$;"OPEN ";NF$
140  PRINT D$;"WRITE ";NF$
150  LIST 60000 - 60071
160  PRINT "RUN 60000"
170  PRINT D$;"CLOSE ";NF$
180  STOP
60000  REM  EXTENDED BY E.MCGEOUGH FROM PROGRAM BY RAY CADMUS,MICRO,AUG 1980
60001  HOME
60002  PRINT "VARIABLE LISTER": PRINT : PRINT
60003  PRINT "EXTRACTS AND PRINTS BASIC VARIABLES": PRINT : PRINT
60004  PRINT "AFTER THE FIRST PASS THROUGH"
60005  PRINT "PROGRAM - SORTS - THEN LISTS
60006  PRINT "ALPHABETICALLY
60007  FOR D = 1 TO 1999: NEXT
60008  HOME
60009 LL = 60071: REM  ** HIGHEST LINE TO EXAMINE - SET TO 59999
60010 PD$ = "          "
60011  DIM T$(1000)
60012  REM  ** FIND FIRST LINE **
60013 NL = 2049
60014 P = 2049
60015  REM  ** RETURN HERE FOR NEXT LINE **
60016 NL =  PEEK (P) +  PEEK (P + 1) * 256
60017  IF NL = 0 THEN 60053
60018 P = P + 2
60019 LN =  PEEK (P) +  PEEK (P + 1) * 256:P = P + 1
60020  IF LN > LL THEN 60053
60021 LAB$ = ""
60022  GOSUB 60032: REM  GET NEXT ALPHA
60023 LAB$ = LAB$ +  CHR$ (CH)
60024  GOSUB 60041: REM  GET NEXT CHAR
60025  IF CH > 64 AND CH < 91 THEN 60023
60026  IF CH > 47 AND CH < 58 THEN 60023
60027  IF CH = 36 OR CH = 37 THEN 60023
60029  GOSUB 60046
60030  GOTO 60021
60031  REM  ** GET ALPHA CHAR
60032  GOSUB 60041
60033  IF CH = 34 THEN  GOSUB 60036: GOTO 60032
60034  IF CH < 65 OR CH > 90 THEN 60032
60035  RETURN
60036  GOSUB 60041
60037  IF CH <  > 34 THEN 60036
60038  REM GOSUB60041
60039  RETURN
60040  REM  ** GET NEXT CHAR
60041 P = P + 1
60042  IF P = NL THEN  POP : POP : GOTO 60015
60043 CH =  PEEK (P): IF CH = 178 THEN P = NL: POP : POP : GOTO 60015
60044  RETURN
60045  REM  ** STORE LABEL
60046  PRINT LN;" ";LAB$
60047 X = X + 1
60048 T$ = LAB$
60049 LN$ =  STR$ (LN)
60050 T$ =  LEFT$ (T$ + PD$,5)
60051 T$(X) = T$ +  RIGHT$ (PD$ + LN$,5)
60052  RETURN
60053 Y = X:M6 = Y: PRINT "SORTING -- WAIT": REM  ** SHELL SORT **
60054 M6 =  INT (M6 / 2): IF M6 = 0 THEN 60061
60055 K6 = Y - M6:J6 = 1
60056 I6 = J6
60057 L6 = I6 + M6: IF T$(I6) <  = T$(L6) THEN 60059
60058 HH$ = T$(L6):T$(L6) = T$(I6):T$(I6) = HH$:I6 = I6 - M6: IF I6 >  = 1 THEN 600
57
60059 J6 = J6 + 1: IF J6 > K6 THEN 60054
60060  GOTO 60056
60061  REM  ** END OF SORT **
60062  REM  ** LIST VARIABLE TABLE **
60063 W = 76: HOME : PR# 2: POKE 33,30: LIST 0 - 60071: POKE 33,40: REM  LIST0-5999
9
60064  FOR C = 1 TO X + 1: IF  LEFT$ (T$(C - 1),4) <  >  LEFT$ (T$(C),4) THEN  PRIN
T S$:S$ = T$(C): GOTO 60066
60065 S$ = S$ +  RIGHT$ (T$(C),6): IF  LEN (S$) > W THEN  PRINT  LEFT$ (S$,W):S$ =
 RIGHT$ (PD$ +  RIGHT$ (S$,6),10)
60066  NEXT C
60067  PRINT  CHR$ (12): PR# 0
60068  INPUT "LIST AGAIN SLOWLY ? ";Z$
60069  IF Z$ = "Y" THEN  SPEED= 150: GOTO 60064
60070  SPEED= 255
60071  END

C     60064 60064 60064 60064 60065 60066
CH    60023 60025 60025 60026 60026 60027 60027 60033 60034 60034 60037 60043
      60043
D     60007
D$      100   110   120   130   140   170
HH$   60058 60058
I6    60056 60057 60057 60058 60058 60058 60058 60058
J6    60055 60056 60059 60059 60059
K6    60055 60059
L6    60057 60057 60058 60058
LAB$  60021 60023 60023 60046 60048
LL    60009 60020
LN    60019 60020 60046 60049
LN$   60049 60051
M6    60053 60054 60054 60054 60055 60057 60058
NF$      90   110   120   130   140   170
NL    60013 60016 60017 60042 60043
P     60014 60016 60016 60018 60018 60019 60019 60019 60019 60041 60041 60042
      60043 60043
PD$   60010 60050 60051 60065
S$    60064 60064 60065 60065 60065 60065 60065 60065
T$    60011 60048 60050 60050 60051 60051 60057 60057 60058 60058 60058 60058
      60064 60064 60064 60065
W     60063 60065 60065
X     60047 60047 60051 60053 60064
Y     60053 60053 60055
Z$    60068 60069
```

Stock market game

HERE IS a program by Alan Grey of Banbury, Oxfordshire, for a stock-market-type game. It fits easily into an 8K computer and I have added brief instructions, but playing the game would make you understand it more he writes. The program incorporates many problems associated with true investment, i.e., tax, company failure, etc. Brief instructions:

```
10 PRINT "[CLR] (14 SPACES)
   INSTRUCTION (14 SPACES)"
20 PRINT "FOUR MINING
   COMPANIES EXIST FOR INVEST-
   MENT"
30 PRINT "THEY ARE GOLD 1 TIN2
   ZINC 3 LEAD 4"
40 PRINT "YOU START WITH 1000
   CREDITS AND TO WIN"
50 PRINT "MUST SURVIVE TO MAKE
   THIS TO 1000000"
60 PRINT "USE THE CODE NUMBERS
   SHOWN ABOVE WHEN"
70 PRINT "INVESTING, OBEY ALL
   INSTRUCTIONS"
80 PRINT "GIVEN AND.... GOOD
   LUCK!"
90 PRINT "PRESS ANY KEY TO
   START"
100 GET A$:IF A$ = " "THEN 100
110 H5 = 1000:L$ = LEAD:L = 10
120 Z$ = ZINC:Z = 50:T$ = TIN
130 T2 = 250:G$ = GOLD:G = 1250
140 B$ = BANK:B = 20%:Y$ = YOU HOLD
150 H1 = 0:H2 = 0:H3 = 0:H4 = 0
160 GOSUB 11000:GOSUB 20060
170 PRINT"MARKET....NEWS"
180 PRINTL$:GOSUB 11000
190 LETL$ = XZ$:LETL = MB:GOSUB
    1000:LETH1 = HH$
200 LETMB = L:IFT = 1 THEN GOSUB
    5000
210 H$ = INT(RND(1)*9)
220 YI = L/5:PD = H$—(0.4*YI)
230 PC = INT(PD*YI)
240 IF T = 1 GOTO 270:L1 = L*PC:LET
    L1 = MB2
250 LET L = MB:GOSUB 20000
260 LET L = MB2:MB2 = 0:MB = 0:
    GOSUB 11000
270 PRINT Z$:GOSUB 11000
280 LETZ$ = XZ$:LETZ = MB:GOSUB
    1000:LETH2 = HH$
290 LETMB = Z:IFT = 1 THEN GOSUB
    5000
300 H$ = INT(RND(1)*9)
310 YI = Z/25:PD = H$—(0.4*YI)
320 PC = INT(PD*YI)
330 IF T = 1 GOTO 360:Z1 = Z + PC:
    LET Z1 = MB2
340 LET Z = MB:GOSUB 20000
350 LET Z = MB2:MB2 = 0:MB = 0:
    GOSUB 11000
360 PRINT T$:GOSUB 11000
370 LET T$ = XZ$:LET T2 = MB:GOSUB
    1000:LET H3 = HH$
380 LET MB = T2:IF T = 1 THEN GOSUB
    5000
390 H$ = INT(RND(1)*9)
400 YI = T2/125:PD = (H$—(0.4*YI))
410 PC = INT(PD*YI)
420 IF T = 1 GOTO 450:T1 = T2 + PC:LET
    T1 = MB2)
430 LET T2 = MB:GOSUB 20000
440 LET T2 = MB2:MB2 = 0:MB = 0:
    GOSUB 11000
450 PRINT G$:GOSUB 11000
460 LET G$ = XZ$:LET G = MB:GOSUB
    1000:LET H4 = HH$
470 LET MB = G:IFT = 1 THEN GOSUB
    5000
480 H$ = INT(RND(1)*9)
490 YI = G/625:PD = H$—(0.4*YI)
500 PC = INT(PD*YI)
510 IF T = 1 GOTO 540:G1 = G + PC:LET
    G1 = MB2
520 LET G = MB:GOSUB 20000
530 LET G = MB2:MB2 = 0:MB = 0:
    GOSUB 11000
540 PRINT B$
550 PRINT B:GOSUB 12000
560 GOSUB 1000:IF T = 1 THEN GOSUB
    5000
570 H5 = H5 + H5/100*B
580 PRINT Y$
590 PRINT H1;"  ";L$
600 PRINT H2;"  ";Z$
610 PRINT H3;"  ";T$
620 PRINT H4 "  ";G$
630 PRINT H5 "  ";B$
640 GOSUB 20060
650 GOSUB 10000 : GOTO 170
1000 R INT(RND(1)*10)
1010 IF R<>4 THEN RETURN
1020 PRINT "NEWSFLASH":T = T + 1:
     RETURN
2000 PRINT "PRESS ANY KEY TO
     CONTINUE"
2010 GET A$:IF A$ = "   " THEN 2000:
     RETURN
3000 PRINT "SHARE TAKE OVER"
3010 PRINT "SELL AT":X = INT((RND
     (1)*1000)—700)
3020 IF X>300 THEN 3010: GOSUB 3040:
     IF TZ$ = 0 THEN RETURN
3030 PRINT X:LET ZN$ = X:H5 = H5 + X:
     RETURN
3040 PRINT XZ$:IF HH$<1 THEN
     GOTO 3060
3050 TZ$ = 1:HH$ = HH$—1:RETURN
3060 PRINT X:RETURN
4000 PRINT "MARKET....FAILS"
4010 PRINT "BANK TAKEOVER"
4020 PRINT L$ "SELL AT":GOSUB
     4120:PRINT XX$
4030 H5 = H5 + (XX$*H1):XX$ = 0
4040 PRINT Z$ "SELL AT":GOSUB 4130:
     PRINT XX$
4050 H5 = H5 + (XX$*H2):XX$ = 0
4060 PRINT T2$ "SELL AT":GOSUB
     4140:PRINT XX$
4070 H5 = H5 + (XX$*H3):XX$ = 0
4080 PRINT G$ "SELL AT":GOSUB
     4150:PRINT XX$
4090 H5 = H5 + (XX$*H4):XX$ = 0
4100 PRINT Y$;H5;B$
4110 PRINT "GAME ENDED":END
4120 XX$ = INT(RND(1)*20):RETURN
4130 XX$ = INT(RND(1)*100):RETURN
4140 XX$ = INT(RND(1)*500):RETURN
4150 XX$ = INT(RND(1)*2500):RETURN
5000 T1 = INT(RND(1)*2)
5010 R1 = INT(RND(1)*11)
5020 IF R1 = 1 THEN PRINT
     "SUSPENDED":RETURN
5030 IF R1 = 2 THEN PRINT "TIN BONUS
     ISSUE":H3 = H3 + 1:T = 0
5040 IF R1 = 3 THEN PRINT "LEAD
     BONUS ISSUE":H1 = H1 + 1:T = 0
5050 IF R1 = 4 THEN PRINT "ZINC
     BONUS ISSUE":H2 = H2 + 1:T = 0
5060 IF R1 = 5 THEN PRINT "GOLD
     BONUS ISSUE":H4 = H4 + 1:T = 0
5070 IF R1 = 6 THEN GOSUB 3000
5080 IF R1 = 7 THEN GOSUB 4000
5090 IF R1 = 8 AND IF T1 = 1 THEN
     GOSUB 6000
5100 IF R1 = 9 AND IF T1 = 1 THEN
     GOSUB 7000
5110 IF R1 = 10 THEN GOSUB 8000
5120 IF R1 = 11 THEN PRINT "MARKET
     ....SUSPENDED" THEN GOTO 170:
     RETURN
6000 PRINT "TAX BONUS":TT = INT
     (RND(1)*100)
6010 PRINT TT " % ":GOSUB 6040:
     IFNZ = 1 THEN RETURN
6020 H5 = H5 + H5/100*TT
6030 RETURN
6040 TZ = INT(RND(1)*10)
6050 IF TZ = 2 THEN PRINT "TAX
     BONUS SUSPENDED"
6060 TT = 0:TZ = 0:NZ = 1
6070 IF TZ<>2 THEN NZ = 0:RETURN
7000 PRINT "SUPER TAX":TT = INT
     (RND(1)*100)
7010 PRINT TT" %":GOSUB 7040
7020 H5 = 5—(H5/100*TT)
7030 RETURN
7040 TZ = INT(RND(1)*10)
7050 IF TZ = 2 THEN PRINT "SUPER
     TAX SUSPENDED"
7060 IF TZ<>2 THEN RETURN:TT = 0:
     TZ = 0:RETURN
8000 PRINT XZ$ " BONUS":TT = INT
     (RND(1)*100)
8010 PRINT TT " %":GOSUB 8040
8020 MB = MB + MB/100*TT
8030 RETURN
8040 TZ = INT(RND(1)*10)
8050 IF TZ = 2 THEN PRINT "BONUS
     SUSPENDED"
8060 IF TZ<>2 THEN RETURN:TT = 0:
     TZ = 0:RETURN
9000 PRINT "TO SEE BANK BALANCE
     PRESS $":FOR N = 0 TO 2000:NEXT N
9010 GET A$:IF A$ = "   " THEN GOTO
     9000:IF A$ = "$" THEN GOSUB 9030
9020 RETURN
9030 PRINT "BANK BALANCE IS ";H5
9040 RETURN
10000 GOSUB 9000
10010 PRINT "FOR MARKET NEWS
      PRESS A":GET A$
10020 IF A$ = "A" THEN GOTO 170:FOR
      N = 0 TO 2000:NEXT N
10030 INPUT "PLEASE TYPE NUMBER
      OF UNITS" ZI$
10040 INPUT "PLEASE TYPE CODE
      NUMBER" XI$
10050 INPUT "PLEASE TYPE BUY OR
      SELL" Y2$
10070 IF XI$<1 OR >4 THEN GOSUB 10240
      THEN 10040
10080 IF XI$<> INT XI$ THEN GOSUB
      10240 THEN 10040
10090 IF XI$ = 1 THEN LET XI$ = GOLD
10100 IF XI$ = 2 THEN LET XI$ = TIN
10110 IF XI$ = 3 THEN LET XI$ = ZINC
10120 IF XI$ = 4 THEN LET XI$ = LEAD
10130 PRINT Y2$;"  ";ZI$;"  ";XI$
10140 GOSUB 9000
10150 IF XI$ = GOLD THEN XI$ = G THEN
      LET VV$ = H4
10160 IF XI$ = TIN THEN XI$ = T2 THEN
      LET VV$ = H3
10170 IF XI$ = ZINC THEN XI$ = Z THEN
      LET VV$ = H2
10180 IF XI$ = LEAD THEN XI$ = L THEN
      LET VV$ = H1
10190 TE = INT(RND(1)*10)
10200 IF TE = 1 THEN RETURN
10210 IFY2$ = BUY THEN GOTO 10220
10220 IF Y2$ = SELL THEN GOTO 10260:
      GOTO 10050
10240 IF (VV$*2L$)—H5<0 THEN PRINT
      "OVERDRAWN" THEN GOTO 10030
10250 H5 = H5—(XI$*ZI$):GOTO 10250
10260 PRINT "FRAUD":RETURN
```

```
10270 VV$ = VV$ + ZI$:GOTO 10310
10290 IF ZI$>VV$ THEN PRINT "FRAUD"
      THEN 10030
10300 IF ZI$<>INT ZI$ THEN PRINT
      "FRAUD" THEN 10030
10310 H5 = H5 + (XI$*ZI$)
10320 VV$ = VV$—ZI$:GOTO 10310
10340 H5 = H5 + H5/100*B:GOSUB 11000:
      GOSUB 20060
10350 GOTO 170
11000 T = 0:OZ = 0:R = 0:XX = 0:H$ = 0:YI =
      0:TT = 0:PC = 0:R1 = 0:T1 = 0:NZ = 0:
      TZ$ = 0:RETURN
12000 TV$ = INT(RND(1)*20):GET TV$:LET
      B = TV$:RETURN
20000 IF MB>MB2 THEN OZ = MB—MB2
      THEN GOTO 20040
20010 IF MB<MB2 THEN OZ = MB2—MB
      THEN GOTO 20050
20020 IF MB = MB2 THEN PRINT
      "HOLD ";MB2
20030 RETURN
20040 PRINT OZ;" DOWN ";MB2:RETURN
20050 PRINT OZ;" UP ";MB2:RETURN
20060 PRINT "(40 shifted eights)":RETURN
```

Snoopy plotter

I WAS playing about with Pet, when I suddenly realised that there was no pound sign writes Jeremy Cook of Leicester. As I desperately needed one for a printout, I dragged out my old magazines looking for an article which, I vaguely remembered, gave details of a printer pound sign.

I found it at last in the February issue of *Practical Computing* and, as soon as I realised how easy it was, I started experimenting with my own characters. It did not take long to realise that a picture any size could be formed from an arrangement of dots on the printer. Grabbing a sheet of graph paper, I started looking for something to draw.

The first thing I found was a picture of Snoopy so I traced the outline on to my sheet of millimetre-squared graph paper and started to fill in every square where a line crossed. That game a picture of Snoopy consisting of little squares. When that was done, I divided the picture into seven by six characters, 195 of them, and started the laborious job of converting the characters into data.

I drew the first line with the top of Snoopy's goggles as an enlargement on a coding farm. In binary code, 00000011 = 3; translating the picture into data is no more complicated. The first five characters are blanks so the data is 0,0,0,0,o,o for each character — one number for each column.

The sixth character has two blank columns, then a column with two dark squares corresponding to binary 0000011 the next dark square — binary 0000100 — and so on, giving the sixth character defined in data as 0,0,3,4,11,20. Every data statement is formed in that way, rather laborious, but worthwhile.

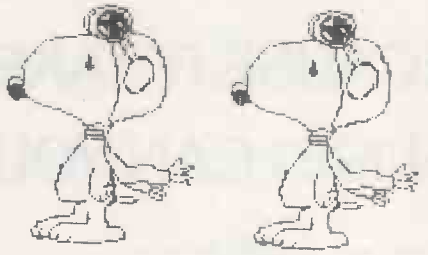
The program occupies lines 100-200 and works like this: PRINT#6, CHR$(9) gives a line feed of one character so that each line will be exactly touching the line above, then the line feed is reduced so that the paper will not move by PRINT#6, CHR$(1) while a line of print is set-up.

The printer head will go back and forth seven or eight times to create each line. That must be done because if you try to send all the defined characters at once, only the last one sent will be printed repeatedly. The paper is then fed for the next line.

The first line of program contains constants used throughout the program and are the only items which may need to be altered to make the program work for your particular picture which you want to print. L is the number of lines in the picture — 15 in this case. W is the width in characters of the program. Note WXL gives the total number of pre-defined characters as a check.

The constants N and CO give the number of copies across and down respectively. The variable R8 which occurs on line 160 and 170 is a time saver and stops the printer working when it has a blank to print. If you want to increase the spacing between individual pictures, line 185 FOR D = B + 1 TO W + 1 can be changed to FOR D = B + 1 TO W + X where X is an integer greater than 1. That will increase the horizontal spacing. To increase the spacing vertically, line 195 PRINT#6, CHR$(24) can be changed to PRINT#6, CHR$(Y) where Y is an integer between 25 and 255.

It should be easy to print almost anything using this method, your own drawings photographs if you can trace through the graph paper, and pictures from magazines are just some suggestions. However, it should be remembered that from millimetre-squared graph paper, the image is reduced to approximately a quarter of the original size.



```
S N O O P Y

READY.

 100 L=15:W=13:N=5:CO=5
 110 OPEN4,4:OPEN6,4,6:OPEN5,4,5
 111 FORF=1TOCO
 115 PRINT#6,CHR$(1)
 130 RESTORE
 140 FORA=1TOL:PRINT#6,CHR$(9):PRINT#4:PRINT#6,CHR$(1)
 150 FORB=1TOW:R$="":RS=0
 160 FORC=1TO6:READR:R$=R$+CHR$(R):RS=RS+R:NEXTC
 165 IFRS=0THEN190
 170 PRINT#5,R$
 175 FORE=1TON
 180 FORD=1TOB:PRINT#4," ";:NEXT:PRINT#4,CHR$(254);
 185 FORD=B+1TOW+1:PRINT#4," ";:NEXT:NEXTE
 186 PRINT#4
 190 NEXTB
 194 NEXTA
 195 PRINT#6,CHR$(24):PRINT#4:NEXTF
 200 CLOSE4:CLOSE5:PRINT#6,CHR$(24):CLOSE6:END
1000 DATA0,0,0,0,0,0
1010 DATA0,0,0,0,0,0
1020 DATA0,0,0,0,0,0
1030 DATA0,0,0,0,0,0
1040 DATA0,0,0,0,0,0
1050 DATA0,0,3,4,11,20
1060 DATA24,35,39,45,93,89
1070 DATA95,95,95,47,47,47
1080 DATA51,51,12,3,0,0
1090 DATA0,0,0,0,0,0
1100 DATA0,0,0,0,0,0
1110 DATA0,0,0,0,0,0
1120 DATA0,0,0,0,0,0
1130 REM 2
1140 DATA0,0,0,0,0,0
1150 DATA0,0,0,0,0,0
1160 DATA0,0,0,0,0,0
1170 DATA0,0,0,0,0,0
1180 DATA1,1,1,1,1,1
1190 DATA2,2,114,10,126,6
1200 DATA2,123,109,102,114,123
1210 DATA127,127,127,63,31,89
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the correspondent

by R. Wagner

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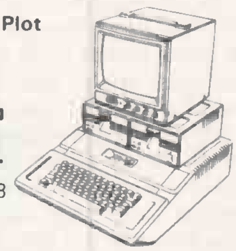

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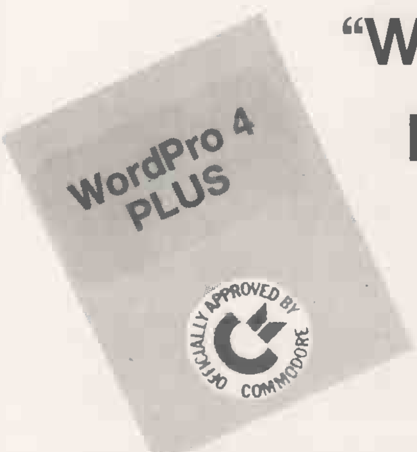

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• Circle No. 182

The Micromouse page is for anything that moves. It is edited by Nick Smith who won the 1980 European Micromouse Competition. The aim is to help readers who do not have a clue where to start, learn enough to enter, and perhaps win, the 1981 competition. We will pay the usual £5 for each idea published.

Mice in the aftermath

AFTER THE weeks, if not months, of frantic activity for the 1980 Micromouse competition, by now all the competitors should have returned to earth. Some mice will undoubtedly have been flattened by frustrated handlers. Others, like Sterling Mouse, will have been hidden away in plastic bags, to re-emerge for special occasions.

I know that Brainy Bricks — built from Lego — has been dismantled and returned to its owners' children. Yet while some old contestants are saying never again, others are already plotting new surprises for the 1981 competition. I am told there are already 10 new entrants on the path which may lead to potential divorce, despair, frustration and elation.

In 1980, there were about 200 enquiries, 100 entries, but only nine mice at the finals. At a preliminary trial in July there were five, but of these only two survived to fight again at the finals. The statistics should convince you that the competition is not a joke or a game. It is very serious, very hard work, great fun and very rewarding if you live to tell the tale.

There is nothing quite like building something with your own hands and seeing it move for the first time. Obviously, one cannot compare an electro-mechanical mouse to anything alive. Nevertheless, every mouse has its own character which can be moulded by adjustments to its hardware and software. By the end of the three days leading to the London final, I believe I could have named more than half the mice by their sound alone.

Anyone who saw the competition or read the reviews will know that the performance of the mice left much to be desired. Over the three days, only Sterling Mouse reached the centre of the maze and knew it had arrived there.

It also found the shortest route from start to finish on the test maze, though it crashed irretrievably in the finals. Brainy Bricks discovered the centre of the maze once in practice by thrashing about at random for a long time. None of the others ever had any success.

Secrets of success

What went wrong? What is the secret? People could be forgiven if they believed the secret was not working for a major electronics company or university, and not having any money or resources. Sterling Mouse — built by my next door neighbour Geoff Pike and myself — cost about £150.

Brainy Bricks, the other private entry — built by Phil Yeardley and Pete Gissings — cost less than £100. Midnight Sun, the entry from Finland, and the mouse I would most like to own — excluding Sterling — cost £2,500 and will be worth every penny if they ever resolve the steering problems.

Everyone said that if they started again they would do it all differently. What that means in practice is that the mice will be the same next year but the owners will have swapped. I believe the answers are lack of time, lack of thought, and an inability to learn from experience and advice.

You cannot expect to build a successful mouse in a few weeks and then hope to make it work by clever software as most of the teams seemed to think. You must conceive the total entity properly from the start.

Best example

You must learn from experience and be prepared to re-build some or all of your mouse. The best example of that is the Plessey mouse. At the July trial, I was very pleased to see that the sensors on Fred, the Plessey mouse, were badly located. Imagine my dismay when John Billingsley, the competition organiser, told the Plessey team where to put their sensors in his review of the trial, but they failed to heed his advice.

What is the secret? I believe it is to spend a long time on the overall design of the mouse. That means software as well as hardware. It is obtaining the correct balance between the two which can make life easy or next to impossible. I was fortunate in that I knew nothing about motor control or electronics when I started building Sterling Mouse.

That meant I had to spend a long time thinking about design and trying to minimise the electronics content. At the same time, being an analyst and programmer by trade, I found it natural to think about how the software could make most use of the hardware knowledge I had. Had I known more about electronics or had more resources, I would almost certainly have made the mistake of designing and building a mouse with the fond belief that I could write the software to make it work later.

Skidding problems

On a more detailed level, the biggest problem, after software, was undoubtedly skidding. A learning mouse has to know exactly where it is all the time. That is usually monitored by counting wheel revolutions. A skidding wheel is therefore fatal. While on the subject of wheels — do not expect the floor of the maze to be flat.

If you have more than three wheels, and no suspension, at least one wheel — probably a drive wheel — will be off the ground. The Swiss mouse was trapped in a dip. Midnight Sun had wall sensors with a limited operating range. Unfortunately, the steering algorithm could not keep the mouse within the operating range of the sensors. The moral is; do not assume you need sensors only for fine tuning. Make them operate over the maximum possible physical movement of the mouse.

Sterling Mouse was not perfect in the sensor department either. Sterling's sensors were mechanical wings pressing against the side walls. What I forgot was the enormous amount of friction that generated, not to mention the notches and lumps in the walls literally pulling the mouse off course.

That is important if you are using stepper motors which do not generate much power. At the lowest level Brainy Bricks used microswitches with long thin flexible wire feelers. Unfortunately, the wire had a nasty tendency to catch in joints in the maze walls.

If I have not put you off yet, I have one last piece of advice. Having designed and planned your mouse, build-in a crash-recovery routine. No matter how hard you try, or how inconceivable it is, something unexpected will always upset your mouse; they are temperamental beasts.

Software king?

ARE YOU a software king and are looking for your ideal partner — an electronics expert — or the other way round? Are you looking for someone of a like mind to talk to, because your wife does not understand you? The Micromouse Marriage Bureau could be the answer. Write, with your vital statistics, i.e., software, hardware and mechanical abilities, and I will try and put you in touch with an ideal partner.

Programming the Z-8000

By Richard Mateosian published by Sybex 1980, ISBN 089588-032-6.

MATEOSIAN introduces the techniques, skills and information required to program the Z-8000 series of microprocessor. Many of the chapters are written round specific problems in which the techniques and information required for the solution to the problems are presented.

In that way, the concepts of flowcharts, algorithms and subroutines are dealt with in the earlier part of the book. The instruction set is introduced in the same manner together with addressing modes. That technique is used finally to present sample programs to perform tasks such as user terminal control and time-sharing monitor functions.

Within many of the chapters are exercises which give the reader a chance to test his newfound knowledge — answers to selected exercises are given.

The book starts with a brief introduction to number systems such as Hex arithmetic, two's complement representation for signed numbers and floating-point format. Concepts such as algorithms and flowcharts are also introduced.

That is followed by a chapter on the Z-8000 internal registers, dealing with the general-purpose registers and their configurations, the status and control-word structure and describing interrupt trap handling. Programming is dealt with by building a program for encryption of data. A chapter describes the instruction set and gives full details of each instruction and of addressing modes and a treatment of software techniques for input/output functions.

The remainder of the book consists of sample programs to cover applications such as text handling from a terminal and time-sharing operating systems. A brief mention is made of utilities such as assemblers, text editors and debug routines.

Although the book builds-up from simple concepts, it moves quickly to complex information presentation and some knowledge of the simpler structure of eight-bit microprocessors would help the reader understand the more sophisticated operation of the 16-bit machine.

Conclusions

- **The book is a comprehensive description of the Z-8001 and Z-8002 micros.**
- **Some familiarity with microprocessor terminology is useful.**
- **A good source of sample programs.**

Brian White

Living with the micro

by Martin Banks, published by Sigima Technical Press, 1980, 150 pages soft cover, £4.50. ISBN 0-905104-11-0.

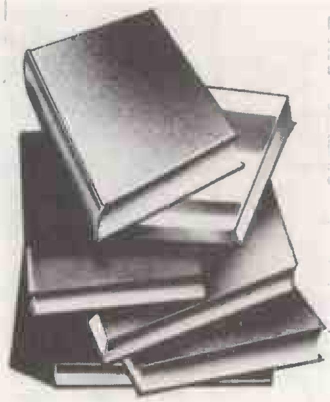
MANY newcomers to computing must wonder where on earth to start; how to learn enough of the basics to be able to read the magazines and books at their local shops; how to understand enough to know if they want to learn some more.

Increasingly, the small businessman finds himself needing that understanding. Can the new machines save time and money? How much time? How much money? What are the snags? Until recently most introductions to computing assumed you wanted to learn to program. Chapter one discussed binary long-division and the differences between ASC11 and EBCDIC; few small businessmen ever reached chapter two.

During the last year or so, however, publishers have rushed to fill the gap. Several books have appeared aimed at the small businessman but equally useful to any interested novice. Those books fit a standard pattern — they start with some history, give a description of computer architecture at a high-enough level to be equally applicable to ENIAC or a Z-8000, describe a few systems — Apple, Pet, TRS-80 are almost certain to be included — and peripherals, touch on programming and languages and then move on to applications packages, custom-built programs and do-it-yourself.

That is scarcely surprising — they are the difficult topics which are important for the intended readers, and it is difficult to present the same information in a way which is totally different from the other books on sale.

Martin Banks has written a good example of that kind of



book; one which can be recommended to anyone wanting some insight into computing and the potential of microprocessors. It covers teletext, viewdata and communications as well as stand-alone computing, wrapping it up in the grand name of information technology.

That tempts the author into occasional jargon; for example: "The microprocessor has fundamentally changed the cost-benefit equations by incorporating within the physical and financial confines of the integrated circuit the functional capabilities of a computer".

The book is intended for the novice. It is deliberately superficial, so that it is readable and can cover a good deal of ground. It would be mistaken to expect every detail to be correct; that is not important, and a pedantic attention to trivialities might spoil the flow and structure of the narrative; For the intended reader it will make a splendid introduction.

Conclusions

- **A good introduction to the new technology for the small-business user or other interested novice.**
- **It should be used only as an introduction, however.**
- **Readers wanting detailed information about any topic should read the books listed in the bibliography, or recommended by a trusted advisor.**

Martyn Thomas

The CP/M handbook with MP/M

by Rodnay Zaks Sybex.

THE CP/M Handbook is precisely what is says, and is more nearly what the CP/M manual should be than it is. The handbook is a thick document — 320 pages — but the naive reader should not be deterred by that — the parts of CP/M that one uses mainly need only a few pages.

It assumes no more than that you have a computer and that the room light is on. There is, for instance, a photograph of how to put a disc into the drive — and that is no trivial matter for someone who does not know, since the disc has four edges and two sides and there are consequently eight different ways to put it in, of which only one is right.

It takes the reader through all the functions of CP/M 1.4 and 2.2 and MP/M — MP/M is the system for computers with multiple terminals — not to be confused with a network system which links multiple computers together. The treatment is narrative in the first half of the book, and in the second half each command has a page to itself and is defined formally. To finish with, there are a number of summary tables and an indices.

Conclusions

- **The professional programmer will probably not sit up all night with this book.**
- **It would be worth having around if inexperienced people have to use CP/M systems.**

Peter Laurie

Computers and microprocessors made simple

By G H Olsen and I Burdess. Published by W H Allen, October 1980, at £2.50 paperback. ISBN 0 491 02793 1. Also available hardback at £4.95, ISBN 0 491 02893 8.

THIS introduction to computer logic and hardware design is the latest addition to the Made Simple Educational Books series. As usual with the series, it represents excellent value for money, providing a great deal of factual information at a price which even sixth-form and college students can readily afford.

It is very much a hardware introduction. It starts with the concepts of mathematical analogues and from that foundation, develops the basic design and operation of analogue computers. This section relies heavily on simple differential calculus, so it may prove difficult to follow in detail if the reader lacks the necessary mathematical background.

Most of the book is, however, devoted to the digital computer; the mathematics used is restricted to arithmetic and Boolean algebra, and all the necessary explanations are provided.

Digital circuit design is introduced from first principles, by showing the effects of the basic logic elements in terms of relay logic. The equivalent circuits are then developed firstly in diode-register logic, then in diode transistor and transistor-transistor logic (TTL).

The authors show how those logic elements can be used to design adders, counters and shift registers; from that, the architecture of a small digital computer is developed and explained.

By this stage, the reader has sufficient background understanding to be able to follow an explanation of instruction sets, addressiing modes and interfacing. Programming is introduced as an exercise in numerical machine-coding, then the functions of an assembler are explained and the existence of higher-level languages is mentioned.

The book will undoubtedly prove useful to students taking A-level, City and Guilds or similar courses; it will also interest the lay reader with a strong interest in computer hardware design.

One word of warning, though: readers who buy this book hoping for a useful introduction to computing which will lead on to the purchase of a personal system, or readers who expect to acquire useful information on attaching special peripherals to their Apple, Pet or TRS-80 may be disappointed. The information here is more theoretical and more basic than such readers probably want.

Conclusions

- **An excellent addition to this good-value series, recommended strongly to students or anyone who wants to understand the principles of computing from the viewpoint of the electronic engineer.**
- **At this low price, readers may be tempted to buy, hoping for an introduction to personal computing or to the social impact of computers.**
- **That would be a mistake — the authors are aiming at another market and their book would be quite unsuitable for any such purpose.**

Integrating the computer with your business.

By Porter and Chapple, edited by R B Yearsley, HFL Publishers Ltd. £9.50 paperback. ISBN 0 372 30032 4.

THE subtitle is Accounting for Computer Charges and coupled with the main title, reveals the surprising subject matter of the book. The authors believe that many companies are suffering because their computing department — dp division, management services section or whatever — is not properly part of its parent company, treated equally with other departments and with its true costs and resource utilisation properly visible.

They further believe that the situation can be corrected by detailed cost-accounting combined, ideally, with internal charging of other departments for computing resources used.

Most of the book is devoted to a detailed explanation of how costs can be calculated and minimised and how appropriate charges can be assessed and levied. That may sound as though the book would interest only company directors but, in fact, its appeal is far wider than that.

In covering their intended subject, the authors have provided a comprehensive guide to running a dp department. The fact they have provided plentiful examples from real departments and real projects will provide fascinating reading and comparison for dp managers.

At the same time, businessmen who are considering introducing or expanding the use of computers in their businesses will find that the book provides a useful insight into many of the implications and possible pitfalls.

On the negative side, it could be argued that it is too superficial in approach, yet too detailed and dogmatic in application. That is a charge which can be levelled against most management books, since the techniques of good management can be seen, with hindsight in any particular instance, to be plain common-sense. There is always a wide range of ways in which any particular principle can be applied in practice.

Nevertheless, a book of this kind provides a valuable compendium of techniques and principles, and the detail of the examples illustrates the techniques and gives them greater credibility and meaning.

At £9.50 for 300 paper-bound pages, the book is expensive, although the majority of copies will probably be set against tax in some way. The general reader may find it interesting; any public library will be able to supply a copy.

Conclusions

- **Mainly for the managers of large businesses with separate computing departments, rather than the local newsagent contemplating buying a small microcomputer system.**
- **Recommended for the former class of readers; interesting reading for the latter.**

Programming microcomputers with sample programs.

By Stanley J Evans. Prentice/Hall International. £10.35 hardback, ISBN 0-8359-5683-0.

THERE are three elementary requirements for any introductory text: it must be correct in text and examples; the order in which information is presented must be logical and designed for beginners; it must not contain superfluous, confusing detail. This book fails on all three counts.

It is in two parts. Part 1 describes basic concepts of computers and programming, touches on Fortran and Cobol covers Basic and PL/M in some detail, and finishes with an overview of APL.

Part II contains reference tables for ASCII and binary-to-Hexadecimal-to-decimal-to-binary conversion, and the sample programs of the title: a number-base conversion program and a Dow-Jones Industrial Average Forecaster both in Basic and neither of much interest.

That sounds a reasonably attractive package, but closer reading reveals the flaws. The author appears to have an electronic engineering background, and his introduction to computer basics is very low-level in approach and hops erratically and confusingly from topic to topic.

It is as if Evans had jotted down a list of headings as they occurred to him and then expanded each one, with no attempt to establish relevance or a useful order. His examples are too often incorrect and they display an unfortunate and amateurish leaning towards obscure and ill-structured programming.

Consider, for example this extract from page 65

> The following is a useful way of using relational operators:
> 125 A = —(B>C)*B — (B< = C) *C
> This statement will set the variable A to MAX (B,C) = the larger of the two variables B and C.

As the author has omitted to mention that true and false have the numerical values —1 and 0 respectively, the unfortunate reader is left confused, at best. At worst, the reader might believe that this is good programming style, rather than an advanced trick used only if desperately short of memory or processor power.

One minor good point about the text is that on page 49 the author distinguishes clearly between programming a microcomputer — which is just programming — and microprogramming — which is the specialised task of building the instruction set of a microprogrammable computer by specifying the logical actions performed by each internal element of the processor in executing a single machine-code instruction. Unfortunately, part 1 of his book is called Microprogramming theory and examples — exactly the wrong use of which he complains.

The best section of the book is the chapter on PL/M which is a perfectly acceptable introduction to this useful language. Nevertheless, one good chapter — even one of 78 pages — cannot completely redeem an otherwise mediocre book.

Conclusions

- **Mediocre and occasionally misleading.**
- **The book is not recommended to any class of readers.**
- **There are many, far better, introductions to programming available.** *Martyn Thomas*

What happens during an interrupt

David Peckett looks at interrupts and their uses.

MANY COMPUTER systems have to respond immediately to unpredictable outside events. For instance, a computer running some form of chemical process may have to take emergency action if a reaction chamber overheats.

One could program the computer to poll external devices at regular intervals to see if they need attention; that approach could, however, introduce undesirable time delays and would represent a software penalty.

At other times, events may take place at regular intervals which are separated widely in terms of computer time. A 6502 might be programmed to accept an input from a paper tape reader, PTR, by a polling loop:

```
WAIT LDA STATUS;WAIT FOR MSB
     BPL WAIT   ;. . TO BE SET
     LDA DATA   ;READ DATA
     STA (FILE),Y;FILE IT
     INY        ;UPDATE POINTER
     JMP WAIT   ;BACK FOR NEXT
                 BYTE
```

The last four instructions handle the data and, together, take 15μ Sec to complete. The PTR is unlikely to read

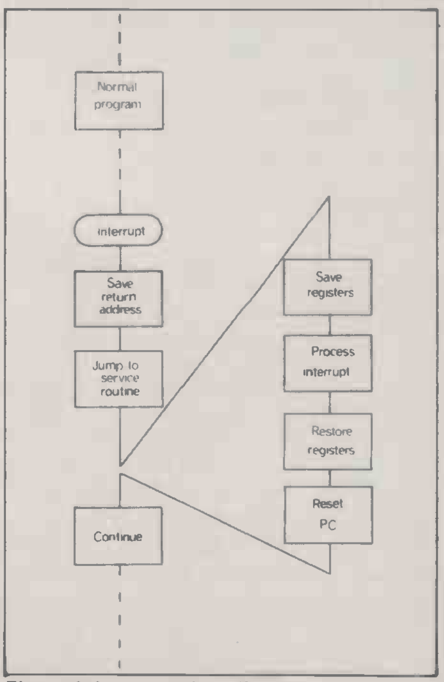


Figure 1. Interrupt handling.

more than 500 characters per second, i.e., one every 2,000 μ Sec. That means that the micro will spend 1,985 μ Sec in every 2,000 waiting for something to happen — 99.25 percent of its time. It would be much better if it could do something with that time, and only service the PTR when the latter demanded it.

Generally, interrupts are events which can happen at any time and which demand an instant response — well, not exactly instant. Because an interrupt is not normally in phase with the system clock, it can occur — probably will occur — in the middle of an instruction's execution. It would be too complicated for the micro to drop what it was doing immediately and so it will respond when it finishes its current instruction. That is near enough to instant for most people.

Handling interrupts. When the interrupt occurs, the micro will jump to a defined point in memory where it expects to find the interrupt-service routine which handles the interrupt. At the end of it, the micro will jump back to the point where it was interrupted.

In some ways, an interrupt is like an unpredictable subroutine calls. Like such a call, the micro must first save its program counter in the stack so that it can return at the end of the routine. The interrupt handler will also use some, if not all, of, the registers in the micro which will probably contain half-processed data. Those registers must not be corrupted — if they were, the return would be meaningless.

It is, therefore, normal for the micro to save all its internal registers in the stack during the interrupt, and restore them afterwards. Sometimes, as with the Motorola 6800, they are saved automatically, sometimes, e.g., the 6502 and Z-80, special code must be written. The register handling obviously adds a software overhead to the service routine. The basic form of an interrupt service routine is shown in figure 1.

Enabling interrupts. Sometimes, interrupts cannot be allowed to occur. For example, if the micro is busy taking in serial data when the interrupt occurs, it must not react. If it did, it would return from the interrupt to find that the data stream had moved on, and so the resumed program would process rubbish. At other times, an interrupt must be protected against disturbance.

It is, therefore, normal to give the programmer a way of controlling the response from the micro. It could be by setting a flag — e.g., the 6502s CLI and SEI instructions, or by controlling an internal flip-flop, e.g., the Z-80 EI and DI. If an interrupt occurs when the response is disabled, it will normally be serviced as soon as the block is removed.

In certain circumstances, the interrupt must be handled immediately — for instance, the micro may have to respond

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to a power failure before the V_{cc} rail drops too low — about 2mSec. Both our micros have to interrupt input pins; a non-maskable interrupt — NMI — which will always obtain a response, and an interrupt request — IRQ — which is the normal, maskable, input.

Identification of interrupts. Interrupts from a single device are easy to understand, but what happens if several devices, e.g., cassette recorder, PTR, keyboard, external instruments — are all connected to the same interrupt pin? — figure 2. How does the micro know which one needs service? It has two options; polling and vectoring.

The polling approach is more easily understood but more expensive, in terms of software, to implement. The micro has to look at the status of each device to see which one called it — it can then jump to an appropriate routine — figure 3.

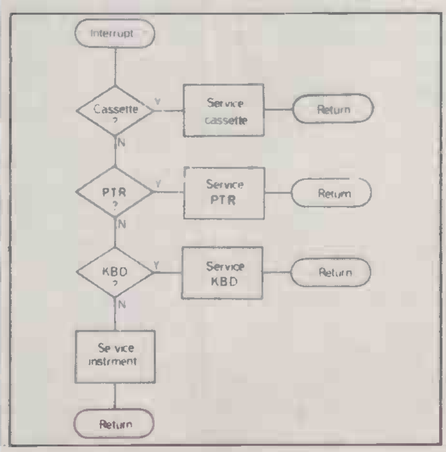
Vectoring is a more elegant and faster-responding approach. As well as setting the interrupt line, the peripheral also forces a byte on to the data bus. The micro reads that byte, and uses it to generate the address of either the start of that peripheral's service routine, or a pointer to the start.

There is obviously a danger that the word forced on to the bus could interfere with the instruction being processed when the interrupt occurs. To prevent that happening, the micro sets an output signal when it starts the service routine. That signal is used to gate the byte on to the data bus — figure 4.

Priority of interrupts. If a micro can be interrupted by several devices, Murphy's Law decrees that two or more will demand attention at the same time. The micro then has to decide which one to handle first. Even more complex, there may be a system of interrupt priorities by which vital interrupts can stop lesser service routines, but not the other way round.

Like so many other aspects of microcomputer design, two basic approaches are possible. The problem can be tackled by software, or it can be tackled by hardware. There is the usual trade-off between the two — software is cheap but slow, hardware is expensive but fast.

Figure 3. Interrupt polling.



A software-based priority system is very simple, and uses polling. The micro polls the peripherals in descending order of importance and services the first one it encounters. If that approach is used, the interrupts must be disabled all the way through the handler. That is because the interrupt line will remain active during the high-priority service, but should be responded to only at the end.

A weakness of the polling technique is that it cannot cope with high-priority interrupts of low-priority events. That is because the response from the micro is disabled during the service routine.

The simplest form of hardware-based priority scheme relies on a special priority interrupt control — PIC — chip, such as an Intel 8214. That can control, typically, eight peripherals, which are assigned fixed priorities by the PIC pins they are wired to — figure 5. Whenever an interrupt occurs, the PIC routes it to the micro, together with a data byte defining which peripheral has interrupted.

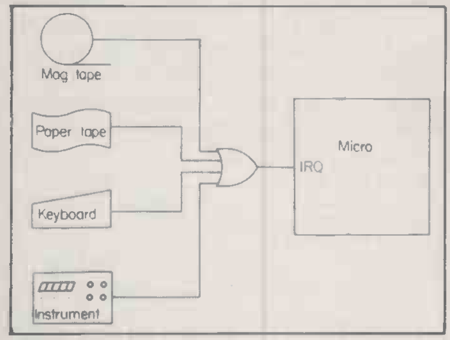


Figure 2. Multiple interrupts.

The micro can use that byte with vectored interrupts. The PIC also holds back low-priority interrupts until more important ones are finished, but will allow a high-priority one through on top of a low one. It thus gives all the basic interrupt control we might want.

An alternative to a PIC is a daisy-chain. That approach strings several individual device controllers, e.g.,PI/Os, together in series — figure 6. The controller nearest the CPU has the highest priority. If it does not need service, it will pass on requests from lower in the chain. However, if it has called for an interrupt, it will block lower requests while it is serviced.

The system can be used with vectored interrupts — the vector is passed up the chain just like the control signals. Obviously, it allows high-priority to interrupt low-priority and, in general, gives similar facilities to a PIC. It has the advantage, however, of using the standard peripheral chips, rather than extra hardware. It can also be extended to any number of devices, rather than being limited to the eight of a PIC.

The 6502 has provision for both non-maskable — NMI — and maskable — IRQ — interrupts. It has an almost identical response to both, and does nothing until it has finished its current

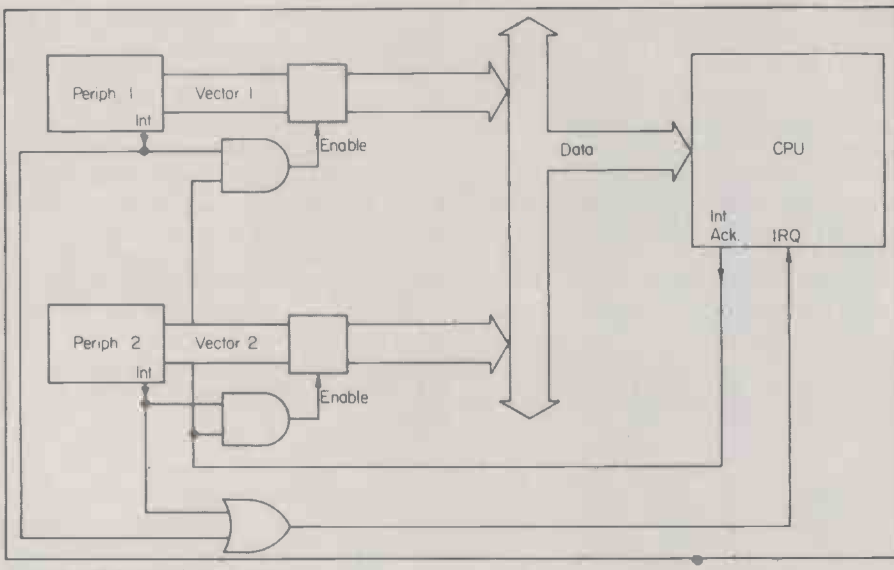


Figure 4. Vectored interrupts.

instruction. It then starts to service the interrupt.

Initially, the contents of the PC — which shows the instruction the micro was going to perform next — are saved on the stack to give a return address; the PSW is also pushed on to the stack. The PSW must be saved because virtually any operation would corrupt the flags.

The micro then sets the "I" flag in the PSW to "1". That stops responses to further IRQs until the programmer allows them. The 6502 cannot be interrupted while it is entering the service routine.

Finally, the micro loads the contents of addresses FFFE and $FFFF_{16}$ — for an IRQ — or addresses $FFFA_{16}$ and $FFFB_{16}$ — NMI — into the program counter. The data at those two locations act as vectors to the two service routines.

The routine does whatever is necessary and ends with the special instruction "RTI" — ReTurn from Interrupt — that pulls the saved PSW from the stack, incidentally setting I back to its original value, and then recovers the return address into the PC. The micro then returns automatically to where it left off.

The 6502 does not do anything with A, X or Y during interrupts. In practice, of course, the handler would almost certainly use A, and probably X and Y also. The start of the service routine should therefore save those registers, which can be recovered at the end:

```
;START OF INTERRUPT SERVICE
ROUTINE
     PHA        ;SAVE A
     TXA
     PHA        ;SAVE X
     TYA
     PHA        ;SAVE Y
      .
      .
      .
;SERVICE ROUTINE PROPER
      .
      .
      .
     PLA
     TAY        ;RESTORE Y
     PLA
     TAX        ;RESTORE X
     PLA        ;RESTORE A
     RTI        ;RETURN
```

That puts a five-instruction penalty at each end of the service routine, but it is unavoidable if the micro is to pick-up properly at the end. You will recall that the I flag was set at the entry to the interrupt handler. That is fine if you do not want to be interrupted. Often, though an interrupt can itself be interrupted. It is up to the programmer to allow for that via the "CLI" command. Equally, if the main program must not be interrupted for any reason, you should use "SEI".

As its name implies, the NMI response cannot be blocked by I, but will be actioned whenever it happens. For that reason, it is normally reserved for emergencies, such as power failures, which cannot tolerate any delay.

Because the 6502 uses the data in two addresses as vectors to the interrupt routines, the programmer must ensure

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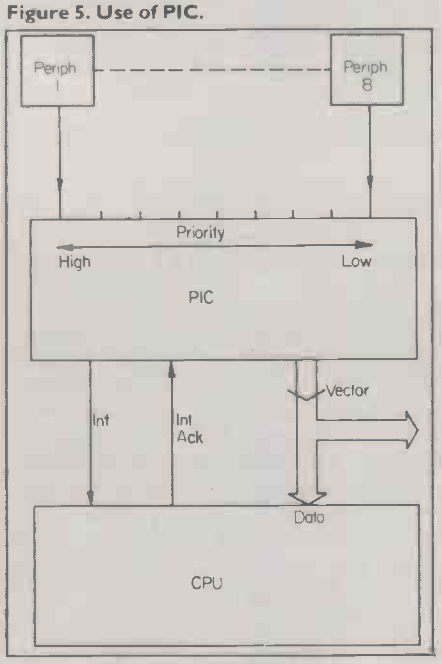
Figure 5. Use of PIC.



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that the proper start points are loaded into the top of memory. If that is not done, interrupts will not be handled. The 6502 technique means that any interrupt-using system must have RAM at the very bottom of memory — for page-0 and the stack — and RAM or ROM at the very top; something is also needed between.

Break. There is only one more 6502 instruction which we have not covered in

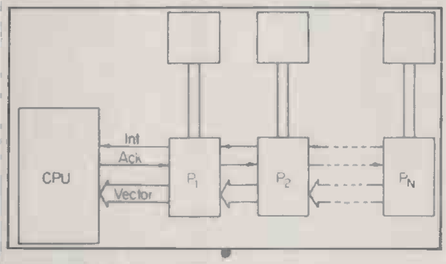

Figure 6. Daisy-chain.

the series — "BRK" BReaK. It acts as a software interrupt and, like an IRQ, saves the program counter and PSW, and then vectors to the address held in FFFE/F. BRK is normally used as a patch in software proving, and is intended to replace multi-byte instructions. You must be careful when you use it, because it saves (PC + 2) in the stack and not program counter. That may sometimes cause problems with the RTI.

When a monitor program inserts breakpoints in a program, it does so via BRKs. The interrupt routine then puts the registers, etc., somewhere where they can be examined, and gives the normal facilities to the poor soul who is trying to debug the software. How does the interrupt service routine tell the difference between an IRQ and a BRK? They use the same vector.

The PSW saved in the stack after a BRK has its "B" flag set to "1"; the PSW left in the micro is unchanged. You can then test the flag in the stack to see just what has happened:

```
;START OF INTERRUPT SERVICE
ROUTINE
  PHA              ;SAVE A
  TXA
  PHA              ;SAVE X
  TYA
  PHA              ;SAVE Y
  TSX              ;X=SP
  LDA $104,X       ;READ PSW FROM
                   STACK
  AND #%00010000 ;TEST B FLAG
  BNE BREAK        ;BREAK ROUTINE?
;ORDINARY INTERRUPT — CONTINUE
```

The interrupt service routine must, first, save the registers. The PSW is then read out of the stack via an indexed "LDA"; the base address recognises that the stack is on page-1, three more items have been added to it since the PSW was pushed on, and the SP points to the next empty space. That technique avoids disturbing the stack or the SP. Once the stacked PSW is in A, it is easy to check and respond to the B flag.

The Z-80 can respond to IRQs in any one of three ways, termed interrupt modes 0, 1 and 2. The three modes can be selected via the three instructions "IM0", "IM1" and "IM2" alternatively, when the micro is re-set, it goes automatically into mode 0.

Interrupt mode 0. Mode 0 is identical to the only 8080A maskable interrupt mode. When the interrupt occurs, the external device must set not only the IRQ line, but also has to force a single byte on to the data bus. The Z-80 finishes its task, takes the byte, and interprets it as an instruction. At that point, nothing has been pushed to the stack, but the response from the micro to further interrupts has been disabled.

In theory, any single-byte instruction could be forced on to the data bus, but, in practice, it will inevitably be one of the eight "RST p" commands. Those commands are effectively single-byte subroutine calls to eight possible page-0 addresses; the particular address is indicated by the "p". Like ordinary "CALL"s, they save the program counter in the stack, and load the start address of the routine into the program counter.

Each of the eight "RST"s will cause a jump to a block of memory only eight bytes long — figure 7. Obviously, no sensible service routine can be put in that space, and so each block will normally contain only a jump to another point in memory where the real service routine lies. Interrupt mode 0 thus effectively gives eight vectored interrupts, with the pointer

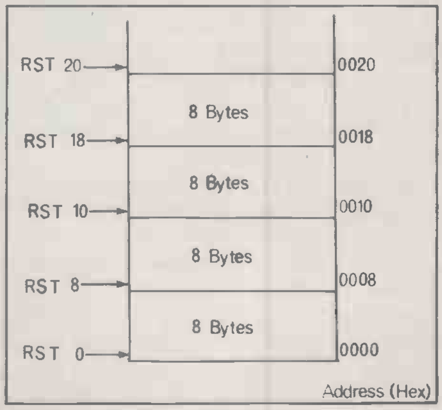

Figure 7. Mode 0 Interrupts.

supplied by the peripheral defining the location of a vector to the service routine.

Since nothing but the program counter goes into the stack automatically, the handler's first actions must be to save the environment by pushing all the Z-80 registers on to the stack. They can be recovered at the end of the routine. The last instruction in a mode 0 interrupt service routine must be "RETI". That acts as a normal subroutine "RET", but also sets internal flags to tell the micro that the interrupt is over. It does not re-enable interrupts, and so the programmer must do that explicitly with an "EI" at whatever point is appropriate.

The total software overhead of a mode 0 interrupt is shown in figure 8, which illustrates a "RST 30" operation. The

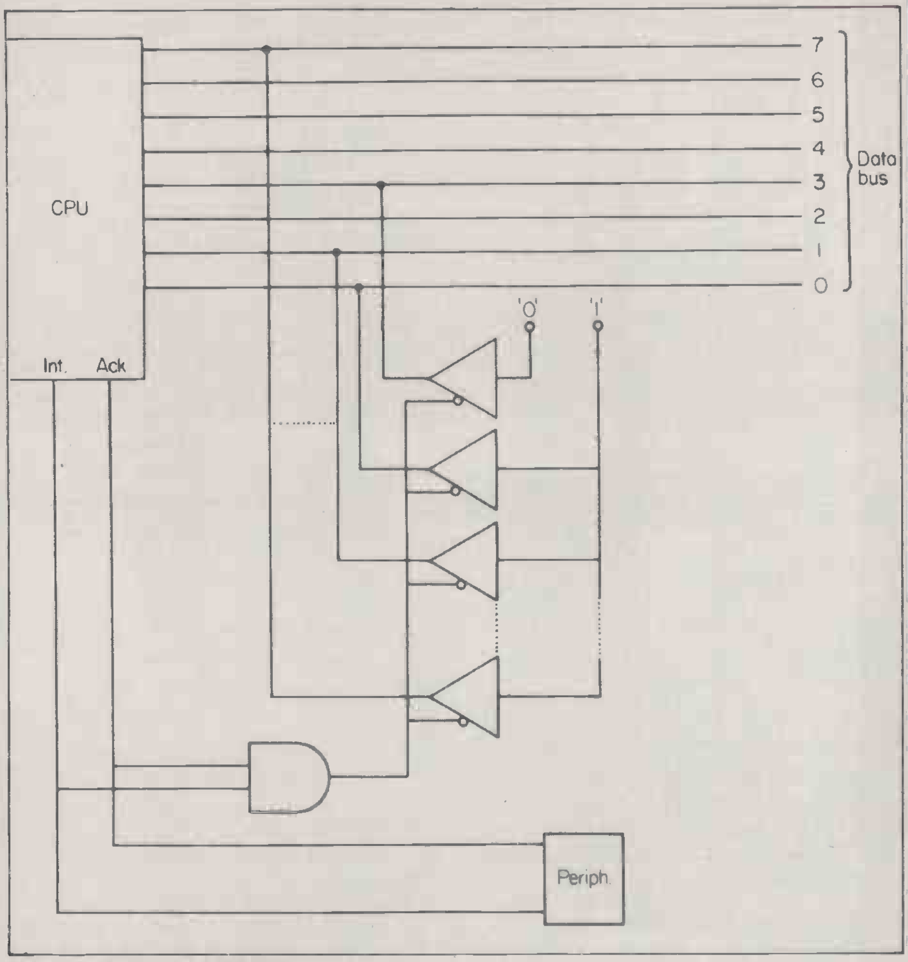

Figure 9. Hard-wired 'RST30'.

code for the RST p, e.g., RST 30 = 1111 0111, can derive from two main sources. Either it can be applied directly from the interrupting device, e.g., from a Z-80 PI/O vector address register, or it can be applied to the data bus by a suitable gating system — figure 9.

Although the RST instructions are primarily intended for use with interrupts, you can use them at other times. If your system does not use interrupts, or uses only a few, you could use them perfectly well as normal subroutine calls. In particular, if space is tight, the availability of single-byte calls could make all the difference.

Figure 8.

```
;Z80 INTERRUPT-HANDLING SOFTWARE OVERHEAD
;
;THE NEXT INSTRUCTION IS AT 0030H
;
        JP    INT30  ;GO TO INTERRUPT ROUTINE
         :
;THE NEXT INSTRUCTION IS WHEREVER IN
;MEMORY IS CONVENIENT
INT30   PUSH  AF
        PUSH  BC
        PUSH  DE     ;SAVE THE
        PUSH  HL     ;..REGISTERS
         :
;ACTUAL SERVICE ROUTINE
         :
        POP   HL
        POP   DE
        POP   BC     ;RESTORE THE
        POP   AF     ;..REGISTERS
        EI           ;ENABLE INTERRUPTS
        RETI         ;RETURN FROM INTERRUPT
;
;THE "RETI" PULLS OUT THE PC SAVED
;WHEN THE INTERRUPT OCCURRED
```

Interrupt mode 1. If the Z-80 has been set to mode 1 by the "IM1" command, its interrupt response is similar to that of the 6502. When the interrupt occurs, the system performs an automatic "RST 38".

From that point, the response is identical to a mode 0 response in which "RST 38" was jammed on to the data bus. The value of that mode is that it does not need external devices to force anything on to the data bus; the micro response is entirely self-contained. Indeed, it ignores anything which might be on the bus at the time.

On the other hand, there cannot be any vectoring direct to the routines for specific peripherals. If several devices could force a mode 1 interrupt, the Z-80 must poll them, just as the 6502 had to.

Mode 1 is normally used with very simple systems in which only one external device is likely send an interrupt.

Interrupt mode 2. This mode, selected by "IM2", is by far the most powerful of the three Z-80 maskable interrupt modes. It makes provision for no less than 128 different vectored interrupts, which should be more than adequate for the most complex system.

Whenever a mode 2 interrupt occurs, it is acknowledged in the usual way, further interrupts are disabled, and the interrupting device jams a single byte on to the data bus. The micro takes the byte, and uses it

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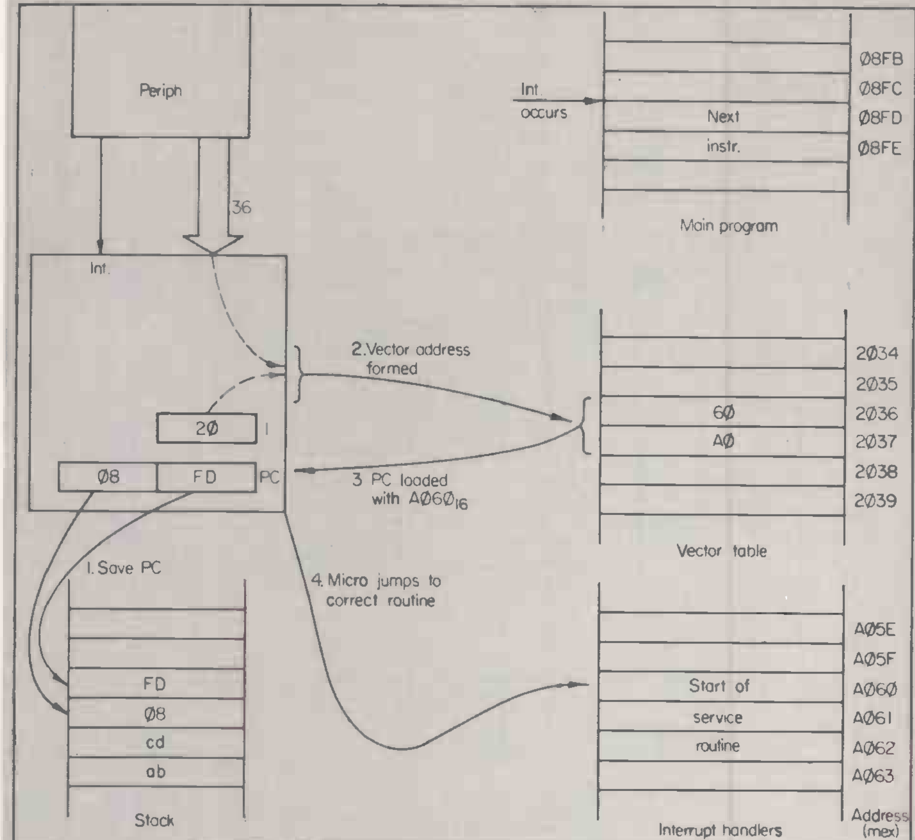

Figure 10. Mode 2 interrupt.

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as the lower byte of an address; the upper byte is defined by the contents of the Z-80 "I" register.

Together, the two bytes form a pointer to a location in a vector table somewhere in memory. The contents of the program counter are pushed on to the stack, and the 16-bit vector pointed to is loaded into the program counter. The micro jumps to a new address, which is the start of the interrupt service routine for whatever peripheral sent the interrupt in the first place. The whole process is shown in figure 10.

Once the correct service routine has started, then the system continues just as in the other two modes. The registers must be saved, the interrupt handled, the registers restored, and interrupts re-enabled. Finally, an "RETI" pulls the interrupted program counter off the stack to force the micro back to where it was interrupted.

The great value of that approach is that many peripherals can be handled, without wasting time identifying the source of an interrupt. The interrupt identifies itself and forces the micro to the right service routine.

The Z-80 peripheral chips such as the PI/O are designed to be used with this interrupt mode. We saw last month that, like the other Z-80 peripherals, the PI/O contains a vector address register — VAR — for each channel. If the device is to be used with mode 2 interrupts, the VAR is first loaded by writing to that channel's control port a vector control word. This has the format: xxxx xxx0 the peripheral chip's logic recognises the "0" in the LSB position, and routes the entire byte into the VAR.

Whenever the chip initiates an interrupt, the contents of the VAR are put on to the data bus to form the lower byte of the vector address. Because the LSB is always zero, a maximum of 128 bytes can be generated (00_{16} - FE_{16}). Stepping in twos allows each entry in the vector table the two bytes it needs to hold a 16-bit pointer.

Normally, each peripheral port will send a vector, thus identifying itself. The address can be anything, but it is normal to use a methodical system whereby port "n" has vector "2xn". That also ties in with the Zilog approach of giving each data port a separate control port; since the micro can address 256 I/O ports, we can have 128 control ports and 128 data ports.

For a system using five data ports — 0-4 — in conjunction with mode 2 interrupts, that could give the interrupt vector table of figure 11. The "I" register is assumed to contain 80_{16}. Using that allocation, the interrupt routine for port 0 starts at address $A000_{16}$, and both port 1 and port 3 are served by a routine starting at $A090_{16}$. Perhaps these two ports are both temperature sensors.

The vectored interrupt system is also well suited to a daisy-chain control system, particularly when using Zilog-type peripheral chips. The chain passes automatically through the correct vector for any given peripheral, and takes care of any priority problems.

When writing a program using vectored interrupt, what must you bear in mind? Obviously, the handlers have to be written, and you must establish the vector table at a suitable place. Because the table obtains the high byte of its address from I, it has to be on a single page. The page is set up with a "LD I,A" instruction:

```
LD  A,VCTPGE  ;DEFINE VECTOR
               PAGE
LD  I,A       ;SET I REGISTER
```

You can read the contents of I by "LD A,I". That action also sets the Z and S flags and — this may be useful — sets the P/V flag to show whether or not interrupts are enabled. A "0" in P/V means that interrupts have been disabled. If you are not using interrupts, "I" could become a spare register for temporary data storage. Finally, if you are using vectored interrupts, you must load the appropriate vectors into the peripheral chips VARs.

Non-maskable interrupt. Like the 6502, the Z-80 has an NMI facility. It behaves much like a mode 1 interrupt, except that the micro goes to 0066_{16} to find the vector to the NMI handler. Since non-maskable interrupts are normally high priority, the micro response also disables — DI — maskable interrupts automatically. The previous setting of the interrupt-enable bi-stable is saved.

The end of an NMI routine is marked by the "RETN" instruction which behaves just like the "RETI" of the maskable interrupt, except that it restores the interrupt enable flip-flop automatically to its original state.

The detail of the non-maskable interrupt handler is perfectly normal. Because it has a single start-point, it must identify the interrupting device by some form of polling, but only a few peripherals will generate an NMI anyway.

There is no such thing as a typical interrupt routine. Apart from the fact that interrupts are usually concerned with handling peripherals, there is nothing particularly remarkable about them from a software point of view. Many of the program segments which I gave in earlier parts of the series could, if topped and tailed to save the micro environment, become perfectly satisfactory interrupt handlers.

	Address (Mex)
	7FFF
ØØ	8ØØØ
AØ	8ØØ1
gØ	8ØØ2
AØ	8ØØ3
2Ø	8ØØ4
A1	8ØØ5
gØ	8ØØ6
AØ	8ØØ7
ØØ	8ØØ8
A2	8ØØ9
	8ØØA

Figure 11. Interrupt vector table.

The 6502 has a basic interrupt handling facility, and programmers have to rely heavily on software to decide what peripheral to service. It has a typical micro interrupt system.

The Z-80, on the other hand, has much more in common with a proper computer, except that it has only two levels of interrupt. Its interrupt mechanism is very hardware-orientated, and depends on setting up the system with a good deal of care. It allows it to respond very efficiently to multiple interrupts which explains part of its attraction to designers of micro-based control systems. The 6502 is perfectly adequate for the vast majority of microprocessor applications. Only when you approach minicomputer applications does it become unable to cope.

Table 1. This month's instructions.

Operation	6502 Mnemonic	6502 Flags	6502 Effect	Z-80 Mnemonic	Z-80 Flags	Z-80 Effect
Return from Int.	RTI	All	PSW and PC from stack	—		
Break	BRK	B (in stack)	PSW to stack (PC+2) to stack	—		
Set Int Mode 0	—			IMO	None	Mode 0 set
Set Int Mode 1	—			IM1	None	Mode 1 set
Set Int Mode 2	—			IM2	None	Mode 2 set
Subroutine call to Page-0	—			RSTp	None	"CALL 00p"
Return from IRQ	—			RETI	None	Return made
Return from NMI	—			RETN	None	Return made, Int enable f-f restored
Load I register	—			LD I,A	None	I = A
Read I register	—			LD A,I	S,Z,P/V	A = I. P/V = Int. f-f

Note: "p" can be 0, 8, 10, 18, 20, 28, 30 or 38, all Hex.

BUYERS' GUIDE

The Buyers' Guide is a summary of low-cost computers available in this country. It appears every third month; we add new computers and amend existing information, as required, to keep it up-to-date. Systems are listed by manufacturer.

Microcomputers

ACORN COMPUTERS

Systems 1,2,3,: 6502-based, 1-8K RAM, COS or DOS, Hex or full keyboard, TV interface, Acorn bus. Personal or scientific use. Reviewed September 1979. *From £65 for System 1 kit; £285 for System 2 kit; £670 for System 3 kit*

Atom: 6502, 2-12K RAM, up to 40K external memory, full keyboard, Basic in ROM, high-resolution graphics. cassette and TV interface, parallel port, I/O lines. Should eventually be able to link into a ring. Acorn Computers Ltd, 4a Market Hill, Cambridge CB2 3NJ (0223) 312772. Reviewed November 1980. *From £130*

ALAN PEARMAN LTD

Maple: Z-80A, 16-64K RAM, S-100 bus, CP/M, 8in. discs, RS232 serial and parallel. Sold mainly as Micro-APL system. Alan Pearman Ltd, Maple House, Mortlake Crescent, Chester CH3 5UR. (0244) 46024. *From £1,510*

ALPHA MICRO

AM-1010, AM-1051: WD-16, 64K-16MB RAM, S-100, four 8in. up to 90MB hard discs, RS232 up to 20 ports. Alpha Micro, 13 Brunswick Place, London N1 6ED. (01) 250 1616. *From £7,500*

APPLE COMPUTERS

Apple II Plus: 6502, 16-48K RAM, 8K ROM, colour graphics, 5¼in. discs, general use. Own bus. Reviewed October 1979. *From £695*

Apple III: 6502A with supporting chips, giving it a superset of 6502 instruction set. 96-128K RAM, colour graphics, integral 5¼in., RS232, four 50-pin expansion slots. Microsense, Finway House, Hemel Hempstead, Hertfordshire HP2 7PS. (0442) 48151. *P.O.A.*

ATTACHE

Attache: 8080, 64K RAM, S-100, parallel port, 8in. discs, business system. Friargrove Systems Ltd, 494 Great West Road, Hounslow, Middlesex (01) 572 3784.	*From £1,737 to £7,000*

BASF

System 7100: Z-80A, 64K RAM, RS232, 5¼in. discs, business systems. MPR, 293 Grays Inn Road, London WC2. (01) 837 6332.	*From £4,937*

BILLINGS

BMS: Z-80A, 64K RAM, 8in. 200MB hard discs, business system. Mitech Data Systems, 8 Guildford Road, Woking, Surrey. (04862) 23131.	*From £4,295*

B L MICROELECTRONICS

Biproc: Z-80 or TMS9980 kit, 1K RAM, 2K monitor, RS232, cassette, TV. BLM, 1 Willow Way, Loudwater, High Wycombe, Buckinghamshire HP11 1JR. (0494) 443073.	*From £150*

BLEASDALE COMPUTER SYSTEMS

UDS: 8080, Z-80, 6809, 32K-1MB, Multibus, CP/M, 5¼in., 8in., hard, RS232, four parallel ports, IEEE 488, development system. Bleasdale Computer Systems, Francis House, Francis Street, London SW1. (01) 828 6661.	*P.O.A.*

BRUTECH ELECTRONICS

BEM: Single-board processor with 6502 and no RAM. Data Precision Equipment, 81 Goldsworth Road, Woking, Surrey GU21 1LJ. (04862) 67420.	*From £133*

BYTRONIX MICROCOMPUTERS

Megamicro: 8080/Z-80, 64K RAM, 8in. discs, CP/M. Business and university use. Bytronix, 83 West Street, Farnham, Surrey GU9 7EN. (0252) 726814.	*From £6,080*

CANON BUSINESS MACHINES

Canon BX-1/BX-1d: 6800, 64K RAM, 5¼in. integral, RS232, V24 ports, business use. Canon Business Machines, Wadden House, Stafford Road, Croydon, Surrey. (01) 680 7700.	*From £3,250*

COMMODORE BUSINESS MACHINES

Pet: 6502, 8-32K RAM, IEEE ports, integral 9in. screen, personal and general use. Reviewed August 1979.	*From £460*
8000 Series — SuperPet: Upgrade of original Pet. 12in. screen, 5¼in. discs, business and general use. Reviewed October 1980.	*From £895*
Kim-1: 6502, LED six-digit display, 1K RAM, cassette and Teletype interface, evaluation board for 6502 chip. Commodore Business Machines, 818 Leigh Road, Slough Industrial Estate, Slough, Berkshire. (75) 74111. Reviewed November 1978.	*From £99.95*

SHOPWINDOW

COMPSHOP

UK101: 6502, 4-8K RAM, TV interface, RS232, full keyboard, single-board, personal use, similar to Ohio Superboard. Compshop, 14 Station Road, New Barnet, Hertfordshire EN5 1QW. (01) 441 2922. Reviewed May 1980. — *From £199 for kit*

COMPUCOLOUR

Compucolour II: Z-80, 8-32K RAM, 5¼in. integral discs, 13in. colour VDU, RS232. General use. Dyad Developments. The Priory, Great Milton, Oxfordshire OX9 7PB. (08446) 729. Reviewed June 1979. — *From £998*

COMPUCORP

655-675: Z-80, 60K RAM own OS but will run CP/M with modifications, RS232, IEEE and others optional. 1-4 5¼in. discs, 16by80 VDU. Business use. Barnet House, 120 High Street, Edgware, Middlesex. (01) 952 7860. — *From £2,595 to £4,750*

COMPUTER CENTRE

Minikit: Z-80, 16K RAM, serial and parallel, 5¼in., CP/M, S-100. — *From £800*

Maxikit: Z-80, 16K RAM, serial and parallel, 8in., CP/M S-100. Computer Centre, 9 De la Beche Street, Swansea SA1 3EX. — *From £911*

COMPUTERMART LTD

Computermart 2000 range: Z-80A, single/multiple, 16-256K, CP/M, S-100 bus, graphics, 8in. single-density double-sided, 180MB hard disc, general/business use. Computermart, 60 St. Faiths Lane, Norwich, Norfolk. Norwich 615089. — *From £6,000*

COMPUTHINK

Act System 800: 6502, 48K RAM, full keyboard, graphics, 5¼ or 8in. discs, 12in. VDU integral. Business system. Act, 66-68 Hagley Road, Edgbaston, Birmingham B16 8PF. (021) 455 8686. Reviewed February 1980. — *From £4,000*

CROMEMCO

Single Card Computer: Z-80, S-100, 1K RAM, 20mA/RS232. OEM and industrial use. — *From £273*

Z2: Z-80, 31A power supply, motherboard, 21 sockets, serious hobbyist and OEM use. Reviewed February 1979. — *From £573*

Z2-H: Z-80A, 64-512K RAM, S-100 bus, CDOS, 10MB formatted fixed disc, two 5¼in. discs, hard discs up to 70MB. — *From £5,373*

System 2: Z-80A, 64-512K RAM, S-100 21 slots, CP/M, VDU, two 5¼in. discs, hard discs up to 70MB. Multi-channel interface available. General/business use. — *From £2,095 to £6,408 for seven users*

System 3: Z-80A, 64-512K RAM, S-100, CP/M, two or four 8in. discs, hard discs up to 70MB, general/business use. Datron Microcentre, 2 Abbeydale Road, Sheffield S7 1FD. (0742) 585490. Microcentre, 30 Dundas Street, Edinburgh EH3 6JN (031) 556 7354. Comart, PO Box 2, St Neots, Huntingdon, Cambridgeshire PE19 4NY. (0480) 215005. — *From £3,568 to £8,304 for seven users*

DATA APPLICATIONS

DAI Personal Computer: 8080, 8-48K RAM, colour graphics, 20 Eurocard industrial interface modules, RS232, industrial use. Data Applications, 168 Dyer Street, Cirencester, Gloucestershire GL7 2PF. (0285) 2588. *From £998*

DIGITAL DATA ELECTRONICS

SPC/1: 8085, 32-48K RAM, own OS, COMAL, Assembler and Pascal, graphics, up to three 5¼in. drives, up to four 8in. drives, 10MB Winchester, up to four 20MB cartridge, many ports. DDE, Clark House, Pump Lane, Hayes, Middlesex. 01-573 8991. *From £1,995*

DIGITAL MICRO SYSTEMS

DSC-3: Z-80, 64K RAM, CP/M, 8in. discs, hard discs up to 28MB, RS232/V24, business and general use. *From £3,445*

DSC-4: Z-80, 128-512K RAM, CP/M, 8in. discs, hard discs up to 28MB, RS232, RS422, business and general use. *From £3,995*

Hex-29: AMD 2900 16-bit, 64K-1,024K RAM, Hex bus, 8in. discs, hard discs up to 28MB. Eight to 32 ports, RS232. Modata, 30 St Johns Road, Tunbridge Wells, Kent TN4 9NT. (0892) 41555. *From £6,445*

DURANGO

F85: 8085, 64K RAM, own bus and OS, graphics, four RS232 ports, integral 9in. VDU, 9 × 9 printer, keyboard and two 5¼in. disc drives. General use. Comp Ancillaries, 64 High Street, Egham, Surrey. (07843) 6455. *From £7,500*

DYLE HOUSE

System 2000: Z-80, 64K RAM, dual 8in. discs, own OS, business use. Dyle House, 36 Abbot Way, Wellingborough, Northamptonshire. (0933) 79135. *P.O.A.*

DYNABYTE

DB8/1,2,4,5,6,7: Z-80, 32-64K RAM, S-100, CP/M, MP/M RS232, 5¼ or 8in. discs, hard discs up to 96MB, expands to multi-task/user system. Business use. Bill Miller, Dynabyte, 25 Park Road, Falsgrave, Scarborough, Yorkshire. (0723) 65559/73338. *From £1,600 to £12,000*

EACA

Video Genie EG3003: Z-80, 16-48K RAM, S-100, CP/M, 5¼in. discs, RS232, personal and general use. Lowe Electronics, Bentley Bridge, Chesterfield Road, Matlock, Derbyshire DE4 5LE. (0629) 2430. Reviewed February 1980. *From £369*

ECS MICROSYSTEMS INC

Aristocrat: Z-80A, 32-180K RAM, 12K PROM, dual 5¼in. drives, 946K. Three RS232 and one parallel port, CP/M, wide range of protocols, business and general use. Telecomputing Systems Ltd, Seacourt Tower, Westway, Oxford. (0865) 723621. *From £3,950*

EQUINOX

200: Z-80, 64-512 RAM, S-100 bus, CP/M, Omnix, MicroCobol, MVT FAMOS, cartridge disc, six serial and one parallel port, business use. — *From £7,500*

300: WD-16, 64-256K RAM, S-100 bus, CP/M, Omnix, MicroCobol, MVT FAMOS, cartridge disc drive, six serial ports, business use. Equinox, 16 Anning Street, New Inn Yard, London EC2A 3HB. (01) 729 4460/(01) 739 2387. — *From £10,500*

EUROCALC

Euroc: 8080, 64K RAM, 8in. discs, 15in. VDU, CP/M, business use. Eurocalc, 55/56 High Holborn, London WC1. (01) 405 3113. — *From £8,000*

EXIDY

Sorcerer: Z-80, 16-48K RAM, S-100, RS232, CP/M, 5¼in. discs. Plug-in ROM pack programs. Liveport, The Ivory Works, St Ives, Cornwall TR26 2HF. (0736) 798157. Reviewed May 1979. — *From £749*

GNAT

System 10: Z-80, 65K RAM, own bus, CP/M, graphics, 5¼in. discs, RS232, RS449, 12in. VDU, full keyboard, optional IEEE. Business use. Millbank Computers, 98 Lower Richmond Road, London SW16. (01) 788 1083. Reviewed December 1980. — *From £2,995*

HAYWOOD

Systems 1000-8000: Z-80, 32-65K RAM, 6000 is S-100, 3000 single-board, CP/M, graphics, 5¼in. discs, three serial and parallel ports. Business, scientific and general use. Haywood Electronics Assoc., 11 Station Approach, Northwood, Middlesex. (01) 428 9831. — *From £2,359*

HEATH/ZENITH

H8: Single-board WH8 assembled, 8080, 16K-65K RAM. Heathbus nine slots, cassette interface, nine-digit LED. — *From £321*

Z89: Z-80, 16-48K RAM, CP/M, integral 5¼ in. drive, optional dual external, two RS232, full keyboard, 12in. VDU. — *From £1,570*

WH-11A: LSI-II, 16-bit, 16-32K RAM, own bus and OS, optional dual 8in. drives, serial and parallel ports. Heath Ltd, 11b Bristol Road, Gloucester GL2 6EE. (0452) 29451. (01) 636 7349. — *From £1,250*

HEWART

6800Mk II: 6800 single-board, 1K monitor, 1K user RAM, 1K VDU RAM, 128byte scratchpad, education and home user. S-50 bus. — *From £155*

6800S: 6800, 16K monitor, 8K Basic in ROM, graphics, 5¼in. drive. Hewart, 95 Blakelow Road, Macclesfield, Cheshire. (0625) 22030. — *From £229*

HEWLETT-PACKARD

85A: 16-32K RAM, 32K ROM, IEEE 488, RS232, graphics, 5¼in. drives, integral 32 × 16 VDU, integral thermal printer, QWERTY and numeric keypad. Scientific use. Hewlett-Packard, King Street Lane, Winnersh, Workingham, Berkshire. (0734) 784774. — *From £1,830*

IMAGE DATA PRODUCTS LTD

Image Data Eight: 6802, 4-40K RAM, 43-way bus, own OS, Basic assembler and editor, viewdata-style graphics, up to four 5¼in. discs, up to 12 RS232 ports. Image Data Products, 1-4 Portland Square, Bristol, BS2 8RR (0272) 40248. — *£500-£4,000*

INDUSTRIAL MICROSYSTEMS

Series 5000: Z-80, 16-56K RAM, CP/M, S-100, two or three 5¼in. discs, two serial and one parallel port, desk unit, business and general use. — *From £1,500*

Series 8000: Z-80, 64-256K RAM, S-100, CP/M, MicroCobol, MVT FAMOS, Omnix, two, three or four 8in. disc drives, two serial and one parallel port, desk unit, business and general use. Equinox, 16 Anning Street, New Inn Yard, London EC2A 3HB. (01) 739 2387/(01) 729 4460. — *From £2,500*

INSTAR

Omega: 16-bit, 48-256K RAM, dual floppies, hard discs, up to 12 simultaneous users, business use. — *From £7,500*

Asatayd: Z-80, 16-56K RAM, dual floppies, CP/M, S-100 bus, business use, Instar, 61 High Street, Croydon, Surrey CR0 1QD. (01) 680 5330. — *From £4,950*

INTERTEC

Superbrain: Z-80, 64K RAM, 256 static RAM, dual Shugart, optional hard disc, CP/M, S-100 bus, business and general use. Encotel, Succombs Hill, Upper Warlingham, Surrey. (820) 5701. Sun,138 Chalmers Way, North Feltham Trading Estate, North Feltham, Middlesex. (01) 751 6695. KGB, 88 High Street, Slough, Berkshire. (75) 38581. Icarus Computer Systems Ltd, 27 Greenwood Place, London NW5 1NN. 01-485 5574. Reviewed April 1980. — *From £1,495*

ITHACA INTERSYSTEMS

Pascal Micro DPS1: Z-80, 64K-1MB RAM, full IEEE S-100 bus, CP/M version 2.2, graphics 8in. and hard discs, RS232, four parallel and two serial ports per S-100 board. Ithaca Intersystems, 58 Crouch Hall Road, London N8 8HG. (01) 341 2447. — *From £4,258*

ITT

2020: Built under licence from Apple, expires at end of 1980. See entry under Apple II. ITT, Star House, Mutton Lane, Potters Bar. (77) 51177. — *From £827*

KEMITRON ELECTRONICS

UDS 3000: Z-80, 1-64K RAM, Kbus, own OS, CP/M, 8in. and hard discs, ports up to 256. Kemitron Electronics, (0244) 21817. — *From £640 to £4,000*

LOGABAX

LX-500: Z-80, 32K RAM, S-100, CP/M dual 5¼in. drives, business use. LogAbax Ltd., 1-7 Wesley Avenue, London NW10. (01) 965 0061. — *From £3,000*

LSI COMPUTERS

M-One: 8080, 8-16K RAM, own OS, dual Shugart 8in. drives, two serial and one parallel port, 12in. VDU and full keyboard. Business use.	*From £5,995 with software package*
M2: 8085, 64K RAM and 4K EPROM. To be launched in December 1980. LSI Computers, Copse Road, St Johns, Woking, Surrey GU21 1SX. (04862) 23411.	*P.O.A.*

LUXOR

ABC 80: Z-80, 16-40K RAM, 12in. VDU, IEEE 488, RS232, 5¼in. drives, loudspeaker, personal and education use. CCS Microsales, 7 The Arcade, Letchworth, Hertfordshire ST6 3ET. (04626) 73301.	*From £795*

MICRO V

Microstar: 8085, 64K RAM, three RS232, serial inputs, StarDOS, twin 8in. drives, general use. Microsense, Finway Road, Hemel Hempstead, Hertfordshire HP2 7PS. (0442) 41191.	*From £4,950*

MICROMATION

Z-Plus: Z-80, 64K RAM, S-100 bus, CP/M (3), MP/M two serial and six parallel ports, business use. Rostronics, 115-117 Wandsworth High Street, London SW18 4HY. (01) 874 1171. Reviewed May 1980.	*From £3,950 to £8,550*

MICRONEX

MX-100: Z-80A, 64K RAM, S-100 bus, RS232, CP/M, Pixel graphics display system, twin 8in. drives. Micronex, Harford Square, Bristol BS18 8RA. (027) 589 3042.	*From £3,485*

MIDWEST SCIENTIFIC INSTRUMENTS

MSI 6800: 6800, 16K-56K RAM, 5¼ or 8in. or hard discs up to 10MB. Systems 1,2,7 and 10. System 7 runs Flex, MSI, DOS and SDOS, RS232. System 10 is System 7 with hard disc. Business use. Strumech (SEED), Portland House, Coppice Side, Brownhills, Walsall, West Midlands. (279) 4321. Reviewed March 1980.	*From £1,100 to £12,000*

MODULAR BUSINESS SYSTEMS

Tutor: 8085, 32-64K RAM, Intel Multibus, CP/M, optional graphics, twin 5¼in. drives or four 8in., two RS232 serial ports.	*From £2,500*
Elite: 8085, 32-256K RAM, Intel Multibus, CP/M, 5¼in. to 24MB hard discs, RS232, 24-bit TTL programmable port. Modular Business Systems, 21 Chappel Lane, Yeadon, Leeds LS19 7NX.	*From £5,400 to £25,000*

NASCOM

Nascom 1: Z-80, 2-64K RAM, serial and up to 16 parallel ports , 8K Microsoft Basic, 1K monitor in EPROM. Personal use. Reviewed January 1979.	*From £125*
Nascom 2: Z-80, 1K RAM expandable to 256 with Nascom System 80 case. Nasbus, 8K Basic, 2K monitor and 2K character generator, low/high-resolution graphics and colour. 5¼in. single or twin floppy discs, RS232, parallel port, Kansas City cassette port. Nascom Microcomputers, 92 Broad Street, Chesham, Buckinghamshire. (02405) 75151. Reviewed April 1980.	*From £295*

NATIONAL MULTIPLEX

Pegasus: Z-80, 48K RAM, S-100 bus, 5¼in., 8in. drives, CP/M, 12in. VDU, business use. London Computer Store, 43 Grafton Way, London W1. (01) 388 5721. — *From £2,700*

NEWBURY LABORATORIES

7768: CPU board, 4K RAM, cassette and VDU interface, up to 64K RAM, kit only. — *From £45*

NewBrain: Z-80A, 2K static RAM plus 4K static or 16K dynamic, RS232 ports, 16-character, LED display, hand-held. Newbury Laboratories, King Street, Odiham, Hampshire. (025) 671 2910. — *From £155 for model without LED*

NEWTRONICS

Elf II: Single-board on 1802, 256bytes to 64K RAM, Hex keypad, RS232 I/O and VDU interface, option keyboard, machine code or Tiny Basic, educational. — *From £39 for kit*

Explorer 85: 8085, 4-64K RAM, S-100 bus, RS232, VDU interface, 8080 and Z-80 software, hobbyists and OEM use. Newtronics, 255 Archway Road, London N6. (01) 348 3325. — *From £299*

NORTH STAR

Horizon: Z-80A, 16-56K RAM, 5¼in. twin drives, S-100 bus, own OS, business, educational or scientific use. Comart, PO Box 2, St Neots, Huntingdon, Cambridgeshire PE19 4NY. (0480) 215005. Equinox, Kleeman House 16 Anning Street, New Inn Yard, London EC2A 3HB. (01) 729 4460. Reviewed April 1979. — *From £995 to £2,500*

OHIO SCIENTIFIC

Ohio Superboard and Challenger I: 6502, 8K Basic in ROM, 2K monitor, 4K RAM, full keyboard and VDU interface. Hobbyist use. Reviewed June 1979. — *From £160*

Challenger 2: 6502, 48K RAM, dual 8in. drives, serial port, low-cost business use. — *From £1,500*

Challenger 3: 6502, Z-80 and 6800, 48-56K RAM, OSI 48-pin bus, serial port for VDU, CP/M, expands to eight users, 10, 20 and 75MB hard disc, business use. — *From £2,300*

Challenger 4: Similar to Challenger I but 64 × 32 display, colour and sound option. U-Microcomputers, Winstanley Industrial Estate, Long Lane, Warrington, Cheshire WA2 8PR (0925) 54117/8. CTS (0706) 79332. Millbank, 98 Lower Richmond Road, London SW16. (01) 788 1083. Reviewed September 1979. Mutek, Quarry Hill, Bath, Wiltshire. (0225) 743289. — *From £450*

PANASONIC

Panasonic: 8085, 56K RAM, full keyboard, integral 24 × 80 VDU, integral twin 5¼ or 8in. floppy drives. Three RS232, business use. Panasonic Business Systems, 9 Connaught Street, London W2. (01) 261 3121. Reviewed June 1979. — *From £4,150*

PROCESSOR TECHNOLOGY

Sol: 8080, 16K RAM, S-100 bus, 5¼in. drives, VDU integral, business system. Comart, PO Box 2, St Neots, Huntingdon, Cambrideshire PE19 4NY. (0480) 215005. Reviewed July 1979. — *From £1,750*

RAIR

Black Box: 8085, 32-256K RAM, dual mini-floppy discs, eight programmable serial ports, RS232, CP/M, hard discs to 10MB, general and business use. Rair, 30-32 Neal Street, London WC2H 9PS. (01) 836 4663. Reviewed November 1979 and August 1980. — *From £2,300*

RCA

Cosmac: 1802 micro with Hex pad and TV interface. Machine-code programming with Tiny Basic option. HL Audio, 255 Archway Road, London N6 5BS. (01) 348 3325. — *From £79 for kit*

RESEARCH MACHINES

380-Z: Z-80, 4-56K RAM, RS232, CP/M, twin 5¼ or 8in. discs, high-resolution graphics. Sold principally to higher and secondary education. — *From £830 to £3,500*

280-Z: Board version of 380-Z. Research Machines, PO Box 75, Mill Street, Oxford. (0865) 49791. — *From £722 for 4K version*

ROCKWELL

Aim-65: 6502, 1-4K RAM, full keyboard, RS232, discs, hobby use, Portable Microsystems, Forby House, 18 Market Place, Brackley, Northamptonshire NN13 5SF. (0280) 702017. Reviewed July 1979. — *From £250*

SATTCO AB

Databoard 4680: Z-80, 16-64K RAM, own bus, full-colour graphics, 5¼in., 8in. and hard discs up to 10MB, 64 interface units. General use. Microsystems Technology, PO Box 5, Knutsford, Cheshire, WA16 9DU. (0565) 52911. — *P.O.A.*

SCIENCE OF CAMBRIDGE

MK-14: 8060, 256bytes user memory to which ¼K RAM can be added, Hex pad, cassette interface, seven-digit LED, single-board. Reviewed May 1979. — *From £39*

ZX-80: Z-80A, 1-16K RAM, 4K Basic in ROM, cassette and TV interface, touch-sensitive keyboard, educational use. 22 graphics. Science of Cambridge, 6 Kings Parade, Cambridge CB2 1SN. (0223) 311488/312919. Reviewed July 1980. — *From £79 for kit*

SD SYSTEMS INC

SBC-100: Z-80, 1-48K, S-100 bus, Basic in 8K ROM, four ROM sockets, optional 5¼in. drives, RS232 serial and parallel, single-board. — *From £155*

SD-100/200: Z-80, 64-256K RAM, 8K PROM, S-100 bus, RS232, CP/M, 12in. VDU, twin 8in. drives, business, industrial and general use. Airamco, Unit A2, 9 Longford Avenue, Kilwinning Industrial Estate, Kilwinning, Ayrshire KA13 6EX. (0294) 65533. Barcellos, Kimberley House, Vaughan Way, Leicester. (0533) 26584. — *From £3,750*

SEN ELECTRONICS

Organiser: Intel 8085, 64K RAM, multi-user Basic, 8in. drives or — *From £7,500*

20MB hard discs, three RS232, business use. SEN, 5 London Street, Chertsey, Surrey KT16 8AP. (09328) 66744.

SGS-ATES

Nanocomputer: Z-80, 6-64K RAM, Gamma bus, 2K NC-2 monitor in ROM, Basic as option, RS232, cassette interface, Hex keypad. Midwich, Hewitt House, Northgate Street, Bury St Edmonds, Suffolk, IP33 1HQ. Reviewed October 1979. — *From £350*

SHARP ELECTRONICS

MZ-80K: Z-80, 16-48K RAM, 10in. integral VDU, integral cassette, loudspeaker, 5¼in. disc optional, general use. — *From £480*

PC-1211: Pocket computer. Programmable in Basic with cassette interface. Sharp Electronics, Sharp House, Thorp Road, Newton Heath, Manchester M10 9BE. (061) 205 2333. Reviewed July 1980. — *From £85*

SINTROM ELECTRONICS

Periflex 630/48: Z-80A, 32-48K RAM, S-100, CP/M, twin Micropolis 5¼in. discs, two serial and three parallel ports. — *From £2,080 to £2,500*

Periflex 1024/64: Z-80, 64K, S-100, CP/M, dual 8in. discs, two serial and three parallel. Sintrom Electronics, Arkwright Road, Reading, Berkshire RG2 0LS (0734) 85464. — *From £3,100*

SIRTON COMPUTERS

Midas Range: Z-80, from 8K RAM, S-100 or IEEE bus, CP/M, MP/M, graphics, up to four 5¼in. or 8in. drives, hard disc, RS232, 8-bit parallel, IEEE 488. Sirton Computers, 76 Godstone Road, Kenley, Surrey CR2 5AA. 01-668 0761. — *£785-£2,150*

SMOKE SIGNAL

Chieftain 511-821: 6800/6809, 32-64K RAM, S-50 bus, Flex DOS68/68d/69 dual 5¼in., 8in., dual RS232, video board, wide range of options, general use. Windrush Micro Designs, Gaymers Way, North Walsham, Norfolk. (069) 245189. — *From £1,807*

SOLID STATE TECHNOLOGY

Athena: 8085, integral dual mini-floppies and mini-cassette, and matrix printer, can be expanded with 10 micros beyond CPU. Memory to 1.2GB. Claims performance similar to DEC PDP-11/34. Butel-Comco, 50 Oxford Street, Southampton, Hampshire SO1 1DL. (0703) 39890. — *From £3,000*

SORD COMPUTER SYSTEMS INC

M200 Range: Z-80A, 64K RAM, S-100 bus, Sord OS, graphics, 5¼ 8in. or hard discs, two RS232, integral 80 × 24 VDU. Business use. Midas Computer Services Ltd, 2 High Street, Steyning, Sussex (0903) 814523. — *From £1,850 to £6,950*

SHOPWINDOW

SOUTHWEST TECHNICAL PRODUCTS

C/09: 6800, 56K RAM, Flex OS, 5¼in, 8in. or 15MB hard discs, business, educational and scientific packages.

S/09: 6800, 128K RAM-380K RAM,. Uniflex OS, support up to 16 users in foreground and background mode. Southwest Technical Products, 38 Dover Street, London W1X 3RB. (01) 491 7507. *From £3,000 to £10,000*

SPENCER JOHNSTON LTD

SJL 8000: Z-80A, 64-208K RAM, integrated database system to user specifications, 8in. discs to 4MB Winchester to 80MB. Sun Computer Services, 60 Broad Lane, Hampton, Middlesex. (01) 979 9824. *From £8,000*

SYNERTEC

Sym-1: 6502, 4K-64K RAM, port-expansion kit, TV interface, Kim software, hobbyist use. Newbear, 40 Bartholomew Street, Newbury, Buckinghamshire. (0635) 30505. *From £160*

TANDBERG DATA

TDV Series: 8080A, 32-64K RAM, Intel bus, 4K Basic discs system in ROM, one plus three 8in. discs, or 2.5MB disc cartridge, eight ports, semi-graphics, CP/M version available, educational use. Tandberg Data, 81 Kirkstall Road, Leeds, LS3 1HR. (0532) 35111. *From £4,000*

TANDY CORPORATION

Model 1: Z-80, 4-48K RAM, RS232, Level I and Level II Basic in ROM, separate keyboard and 12in. VDU, small business and personal use. Reviewed November 1978. *From £349*

Model 2: Z-80, 64K RAM, integral 8in. disc, integral 12in. VDU, detachable keyboard, CP/M serial and parallel ports, Level III Basic, business use. Tandy, TRS-80 Division, Bilston Road, Wednesbury, West Midlands, WS10 7JN. (021) 556 6101. Reviewed March 1980. *From £1,995*

TANGERINE COMPUTER SYSTEMS

Microtan 65: 6502, 1-48K RAM, Tanbus, IEEE 488, Tanbug in ROM (1K), Pixel graphics, 5¼in. discs, 32 I/O lines and three serial ports, from single-board upwards. Tangerine Computer Systems, Forehill, Ely, Cambridgeshire. (0353) 3633. *From £69*

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Son of Hexadecimal Kid

A parable in eight virtual pages by Richard Forsyth

Johnny McNull, guided by a mysterious sign in the sky, has arrived at Sprocket's Hole in time to witness the birth of Cleo's child.

Cleo named her little boy Samson, after his father. The Hexadecimal Kid had been known to almost everyone simply as Hex, but she had always preferred his real name, Sam Synapse.

She asked McNull to be the baby's godfather. McNull, flattered by the request, agreed readily, and his visits to Sprocket's Hole became much more frequent. He took a keen interest in the boy's upbringing, and it was only with great difficulty that Cleo persuaded him to keep secret the boy's ancestry — for little Samson was a direct descendant of Abraham Synapse, now revered as a Nullard saint.

So the infant grew into a youngster at Sprocket's Hole, looked after by his mother and aunt, and visited frequently by Johnny McNull. There were also in attendance Piltdown 2 and the shadowy figure of Bill Bootstrap.

Every morning, Samson used to walk nearly six kilometres to the village school in what had been the Silicon Valley human reservation, since re-christened Happy Valley. His schoolmates teased him mercilessly about the diabolical black arts — such as assembly-language programming — rumoured to be practised by Bill Bootstrap when the moon was full. Living on the fringe of events as they did, that was one of the few signs they saw of the completeness with which the new orthodoxy of Nullardy had won over the hearts and minds of the people.

Its effect on Samson was to change his attitude towards Bootstrap from fear to curiosity. He was particularly puzzled by the way his mother tolerated Bootstrap's presence while clearly disapproving of him.

One day, when he was 10 years old, he arrived home from school to find Johnny McNull's donkey tethered outside the house. He stole in quietly and found McNull in the kitchen chatting with his mother about the old days before the System Crash.

That afternoon, some of the older children, who had been more fully indoctrinated about the evils of computers, had taunted him in a particularly vicious manner. One had even called him a bit-slice processor. He hardly knew what they were talking about; so, since McNull was reputed a wise teacher, he decided to try and discover.

"Hello Uncle", he said as he walked through the door, "what's a silicon chip"?

Both adults turned suddenly, taken aback by his unannounced entry. There was a moment of cold silence.

"Hush, son", his mother admonished him. "Don't talk about such things. Those days are over".

"But you were talking about those days. I know you were. I heard you".

McNull drew himself up to his full height, which was scarcely more than the boy's and attempted to tower over him.

"Be thankful", he declaimed, "that thou art not tainted with the stains of the past; for I tell thee that computers were the work of the devil. That which men called the System was a great wickedness, a destroyer of all mankind, and we must be for ever on our guard against any who seek its return. Ask, therefore, no more on these matters, that thy innocence be not corrupted".

Samson sat down rebuked. His mother started setting out his tea, and tried to turn the conversation to other topics. Yet as he ate in silence, he resolved to learn all he could about the forbidden secrets of computing. There was only one person left to ask — the formidable Bill Bootstrap.

His opportunity arose a few days later while his mother and aunt were busy in the vegetable garden and Piltdown 2 collecting firewood. He observed Bootstrap slinking off towards the hills which bordered their dwelling-place. He followed cautiously, well behind, and was struck immediatley by the change in Bootstrap's habitual demeanour. Instead of the ambling shuffle of the doddering dotard, his stride was quick and purposeful.

After 20 minutes or so, Bootstrap stopped by a large cedar tree and looked around. Samson darted into the undergrowth, grazing both knees as he dived. Peeping out, he saw that Bootstrap was digging under the branches. Reckoning that his quarry was sufficiently engrossed, he crept up for a closer look.

Abruptly Bootstrap turned on him. "What have you followed me here for"? he demanded.

"I want to know about silicon chips", blurted out the young lad.

"So you're interested in microprocessors, are you"? A rare smile creased the android's features. "Well, you've come to the right place. Just stay there and watch".

Bootstrap resumed his digging. Soon he unearthed a large wooden chest, bound with ropes. He untied them and flung open the lid.

"There you are," he declared. "Gaze your fill. You won't see much of that around these days."

It was a veritable treasure chest. Samson was staring down at possibly the finest collection of microelectronic hardware still in existence. There were ROMs, RAMs, EAROMs, PROMs, UARTs, LEDs, processors of various technologies — Schottky TTY, NMOS, PMOS, CMOS and I²L — circuit boards, motherboards, disc-controller cards, a colour TV with video-dazzler interface, heaps and heaps of floppy discs and — most valuable of all, though he did not know it at the time — 50 back copies of the CP/M User Group Newsletter.

Even the carpentry was impressive. There was a place for everything, and everything was carefully put away in its proper place. There were boxes within boxes, neat little sliding partitions and shelves for the software manuals. He was looking at a decade of dedicated work.

Bootstrap drew out a pinewood box with a touch-sensitive keypad engraved on its upper surface, connected it to the TV set and slotted an 8in. floppy into its side.

"Go ahead", he urged, "try it: type J 0000".

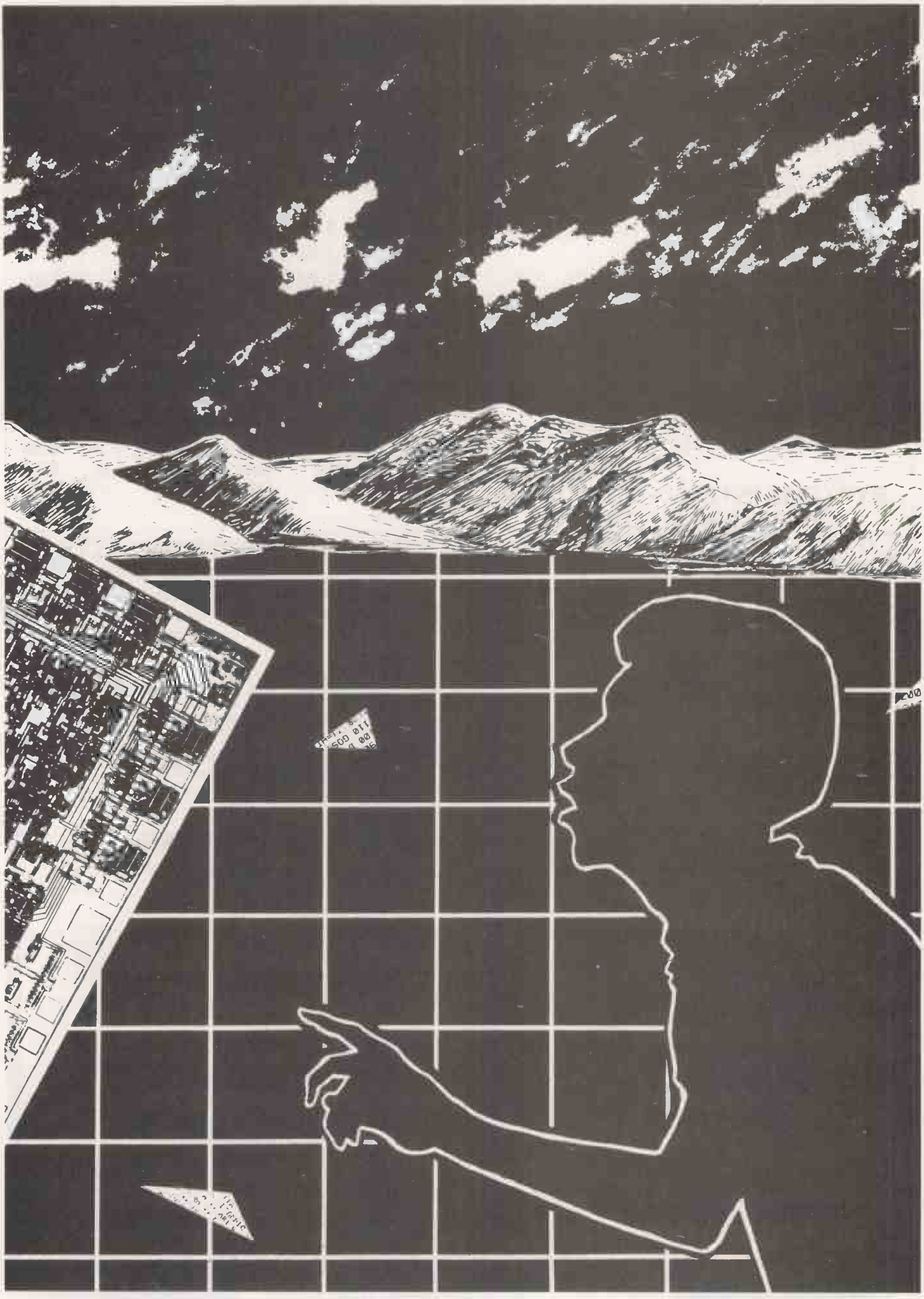
Gingerly, Samson obeyed. The screen flickered, then the message 'CP/M Version 23.04M, Copyright Mae West Software Shop' appeared, followed by the question 'Menu (Y/N)?'.

"Not bad, eh"? enquired Bootstrap. "Menu-driven CP/M. I modified it myself. What you are looking at there is the Moonshine Micro — a scientific business system on a chip. You want word processing? You want high-resolution colour graphics? They are right here. You want screen-based editing with full cursor control and programmable forward and reverse scrolling? Just press one key".

Samson was not sure he wanted editing with full cursor control, still less programmable forward and reverse scrolling, but he nodded appreciatively. He had tapped a rich seam of high-pressure sales patter in the normally taciturn Bootstrap, who had for so long been forced to hide his true colours. Now that he had found an audience — albeit a poorly-informed one — years of repressed jargon gushed out like a geyser. Samson just let the buzzwords flow over him. When at length the flood abated he asked "can it play Space Invaders"?

Bootstrap tapped his forehead with the inside of his palm. "We have indexed sequential file-handling; we have PL/I; we have multi-processing; we have stock control; we have payroll; we have nominal ledger, bought ledger, sales ledger and general ledger; we have compilers, interpreters, assemblers and more text editors than a cat has fleas; we even have a chess program better than Bobby Fischer — but does he want to see them? Oh no, he wants to play Space Invaders".

"So it doesn't have Space Invaders?" concluded the boy, disappointed. Well does it?



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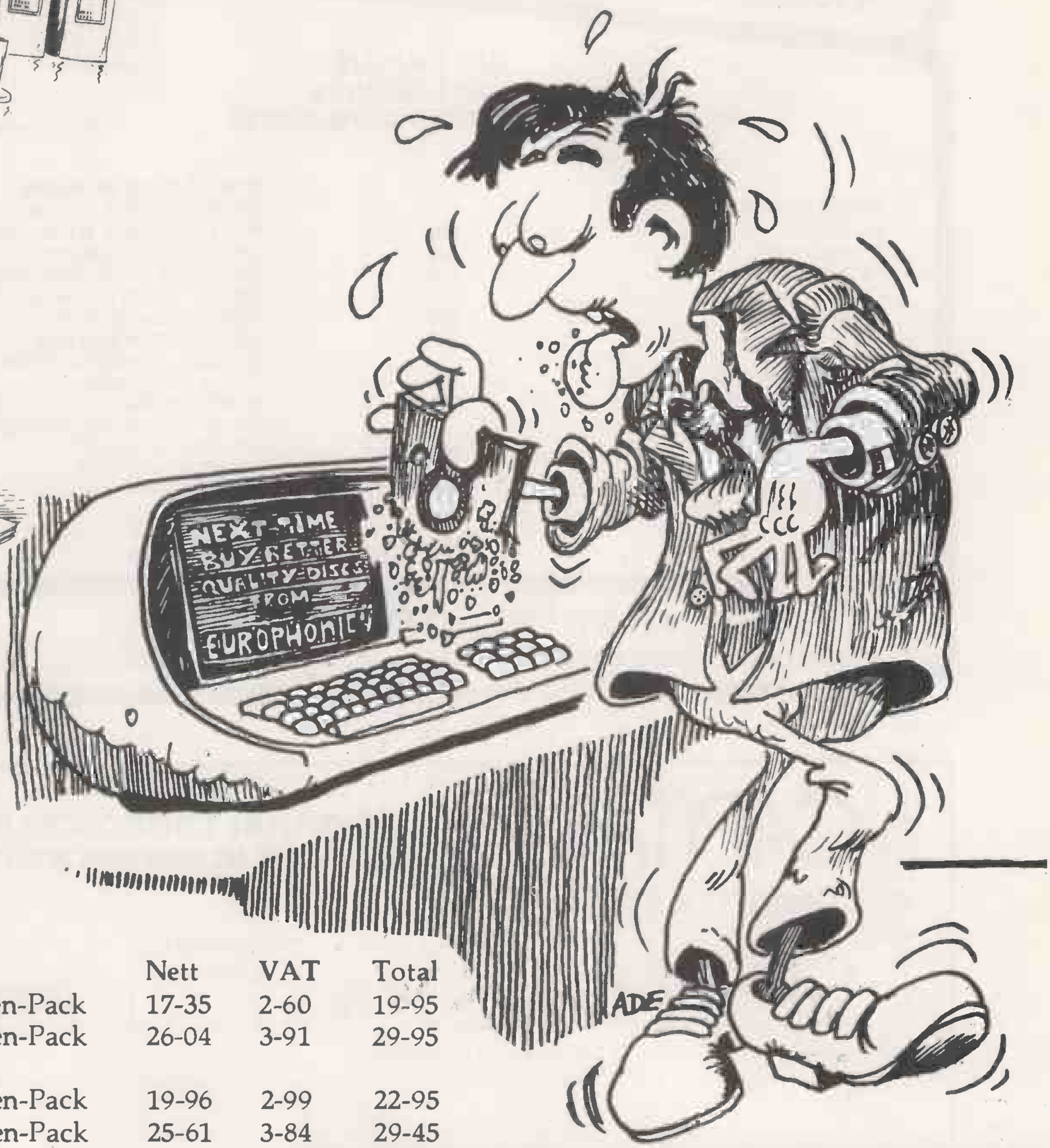

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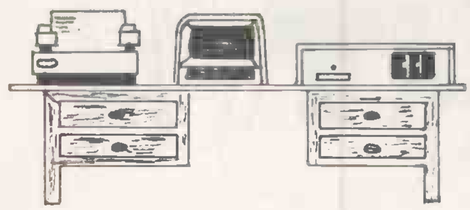

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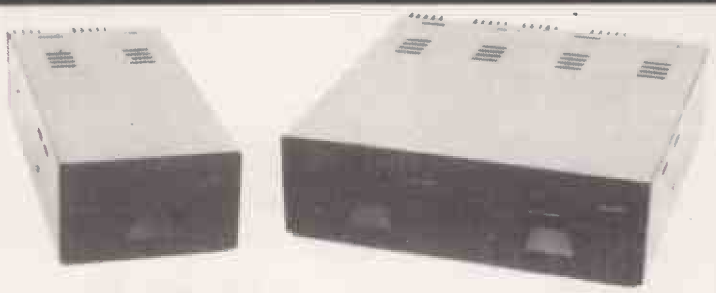

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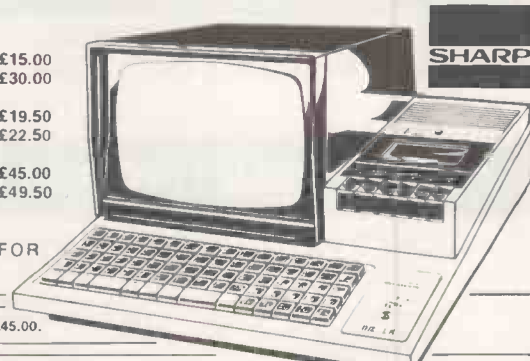

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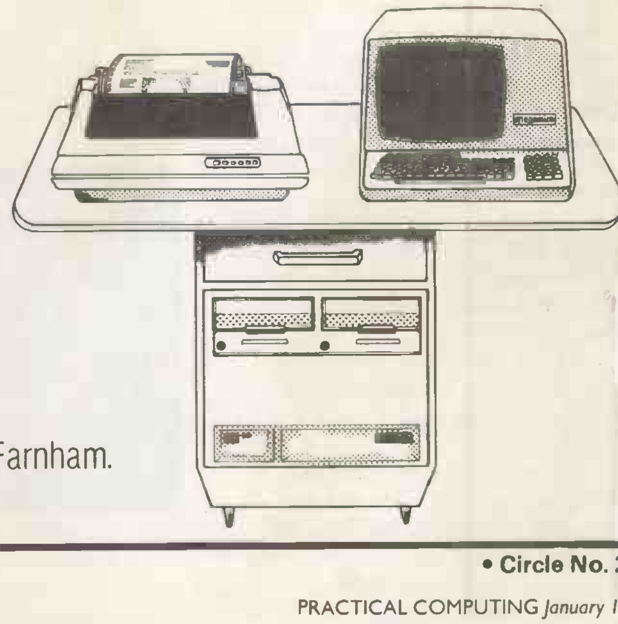

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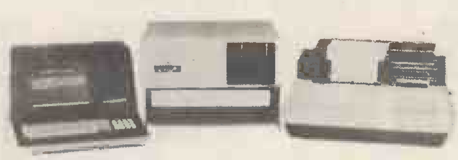

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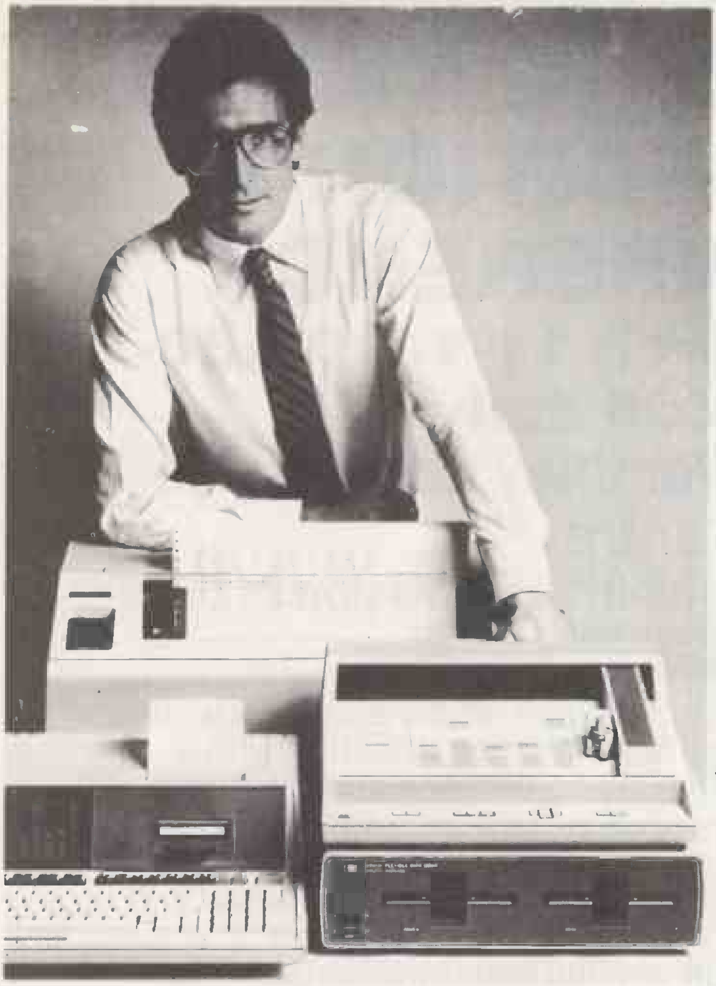

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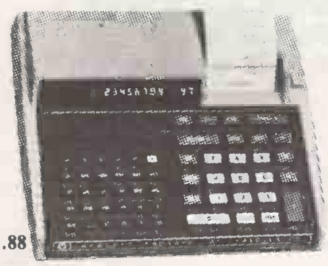

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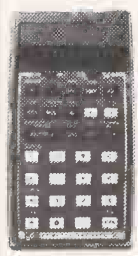

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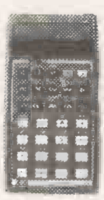

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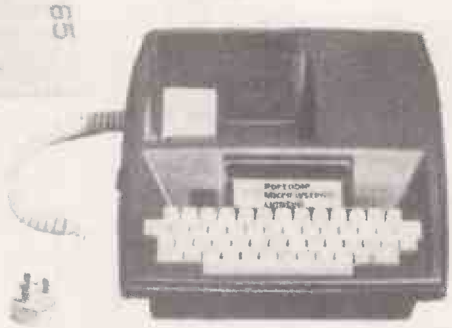

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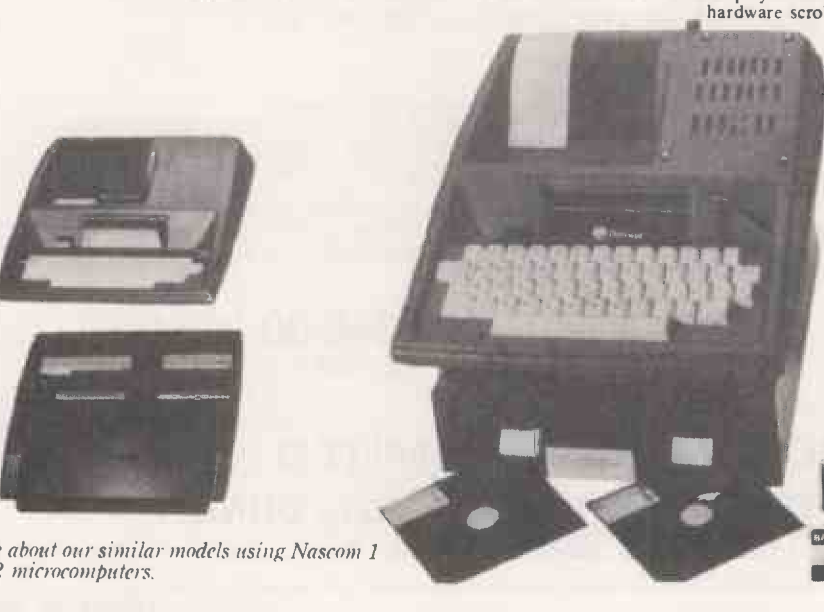

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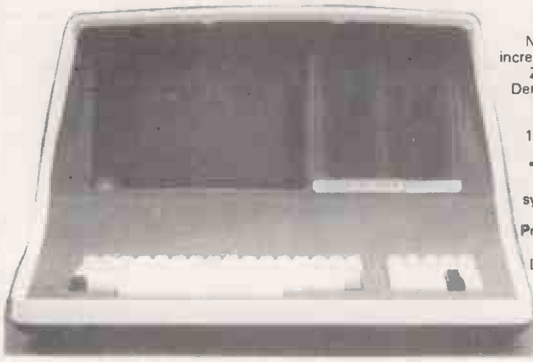

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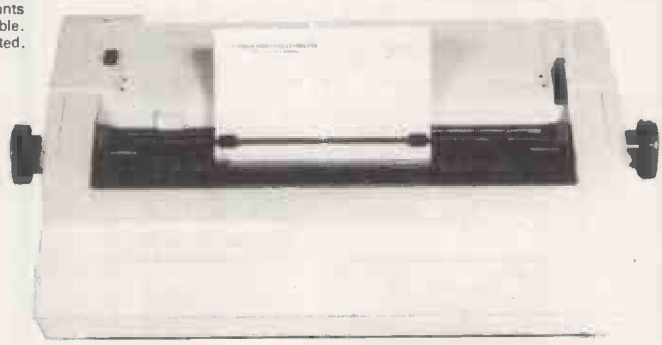

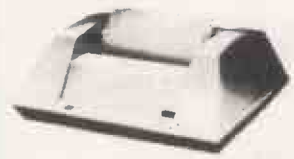

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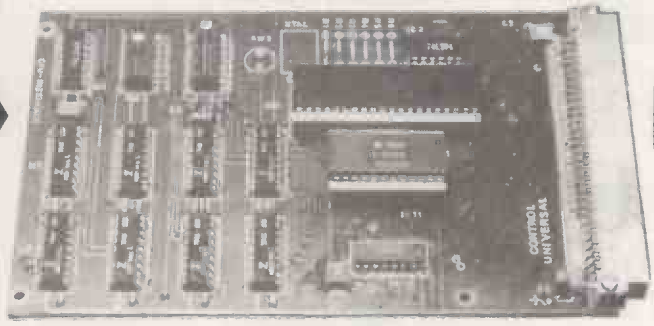

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Certain parts of the CP/M and D-DOS disc systems are available in kit form. Details available on request.

ENCLOSURE FOR N2+5

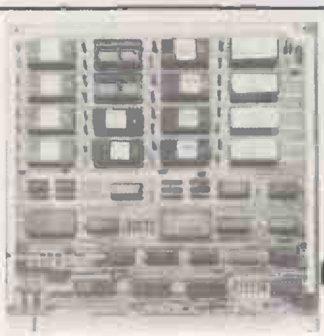
The Kenilworth case is a professional case designed specifically for the Nascom 2 and up to five additional 8" x 8" cards. It has hardwood side panels and a plastic coated steel base and cover. A fully cut back panel will accept a fan, UHF and video connectors and up to 8 D-type connectors. The basic case accepts the N2 board, PSU and keyboard. Optional support kits are available for 2 and 5 card expansion.

Kenilworth case £49.50 + Vat
2-card support kit £7.50+Vat • 5-card support kit £19.50+Vat

INTERFACE ENHANCING UNIT

The Castle Interface is a built and tested add-on unit which lifts the Nascom 2 into the class of the fully professional computer. It mutes spurious output from cassette recorder switching, adds motor control facilities, automatically switches output between cassette and printer, simplifies 2400 baud cassette operating, and provides true RS232 handshake.

Castle Interface Unit .. **£17.50** + Vat



EPROM EXPANSION

The Nasbus compatible EPROM board accepts up to 16,2708 or 2716 EPROMs. It has a separate socket for the MK36271 8K BASIC ROM for the benefit of Nascom-1 users. And for Nascom-2 users, a wait state for slower EPROMs. The board also supports the Nascom Page Mode Scheme.

EPROM Board (kit). . . . . £55+VAT
EPROM Board (built & tested) . . . . . . £70+Vat

A-D CONVERTER

For really interesting and useful interactions with the 'outside world' the Milham analogue to digital converter is a must. This 8-bit converter is multiplexed between four channels - all software selectable. Sampling rate is 4 KHz. Sensitivity is adjustable.

Typical applications include temperature measurement, voice analysis, joystick tracking and voltage measurement. It is supplied built and tested with extensive software and easy connection to the Nascom PIO.

Milham A-D Converter (built and tested) **£49.50** + Vat

NASCOM-2 Microcomputer Kit £225 + Vat
NASCOM-1 Microcomputer Kit £125 + Vat
Built & tested £140 + Vat
IMP Printer. Built & tested ..... £325 + Vat

All prices are correct at time of going to press.

PROGRAMMER'S AID.
For Nascom ROM BASIC running under Nas-Sys. Supplied in 2x2708 EPROMs. Features include: auto line numbering; Intelligent renumbering; program appending; line deletion; hexadecimal conversion; recompression of reserved words; auto repeat; and printer handshake routines. **Price £28+Vat.**

DUAL MONITOR BOARD. A piggy-back board that allows N1 users to switch rapidly between two separate operating systems. **Price (kit): £6.50+Vat.**

BASIC PROGRAMMER'S AID.
Supplied on tape for N1/2 running Nas-Sys and Nascom ROM BASIC. Features include auto line number, full cross-reference listing, delete lines, find, compacting command, plus a comprehensive line re-numbering facility. **Price: £13+Vat.**

PROM-PROG MKII.
2708 (multi-rail) and 2716 (single-rail) EPROM programmer kit controlled by N1/2 PIO. Supplied with comprehensive software for use with Nas-Sys. **Price: £25.95+Vat.**

All the products are available while stocks last from the Nascom dealers below.
(Mail order enquirers should telephone for delivery dates and post and packing costs.) Access & Barclaycard welcome.

BITS & PC'S
4 Westgate, Wetherby, W.Yorks.
Tel:(0937) 23744

BUSINESS & LEISURE MICROCOMPUTERS
16 The Squre, Kenilworth, Warks.
Tel:(0926) 512127.

ELECTROVALUE LTD.
680 Burnage Lane, Burnage, Manchester M19 1NA.
Tel:(061) 432 4945.

28 St Judes, Englefield Green, Egham, Surrey TW20 0HB.
Tel:(0784) 33603. Tlx:264475.

TARGET ELECTRONICS
16 Cherry Lane, Bristol BS1 3NG.
Tel:(0272) 421196

INTERFACE COMPONENTS LTD.
Oakfield Corner, Sycamore Road, Amersham, Bucks.
Tel: (02403) 22307. Tlx:837788.

HENRY'S RADIO
404 Edgware Road, London W2.
Tel:(01) 402 6822.
Tlx:262284 (quote ref:1400)

BARCLAYCARD

• Circle No. 288

TTLs by TEXAS

7400	11p
74S00	60p
7401	12p
7402	12p
7403	14p
7404	14p
740S	18p
7406	36p
7407	36p
7408	17p
7409	19p
7410	15p
7411	24p
7412	20p
7413	30p
7414	40p
74C14	90p
7416	27p
7417	27p
7420	17p
7421	40p
7422	22p
7423	34p
742S	30p
7426	40p
7427	34p
7428	36p
7430	17p
7432	30p
7433	40p
7437	35p
7438	35p
7440	17p
7441	70p
7442A	60p
7443	112p
7444	112p
7445	100p
7446A	93p
7447A	75p
7448	80p
74S0	17p
74S1	17p
7453	17p
7454	17p
7460	17p
7470	36p
7472	30p
7473	34p
7474	30p
747S	38p
7476	32p
7480	50p
7481	100p
7482	84p
7483a	90p
7484	100p
7485	110p
7486	34p
7489	210p
7490A	30p
7491	80p
7492A	46p
7493A	36p
7494	84p
7495A	70p
7496	65p
7497	180p
74100	130p
74107	34p
74109	55p
74116	200p
74118	130p
74119	210p
74120	110p
74121	34p
74122	48p
74123	60p
7412S	75p
74126	60p
74128	75p
74132	75p
74136	75p
74137	50p
74141	50p
74142	200p
74145	90p
74147	190p
74148	150p
74150	130p
74151A	70p
74153	70p
74154	120p
741S5	90p
741S6	90p
74157	70p
74159	190p
74160	100p
74161	100p
74162	100p
74163	100p
74164	120p
74165	130p
74166	120p
74167	200p
74170	240p
74172	450p
74173	120p
74174	90p
74175	85p
74176	90p
74177	90p
74178	160p
74180	93p
74181	160p
74182	90p
74184A	150p
74185	150p
74186	500p
74188	325p
74190	120p
74191	120p
74192	100p
74193	100p
74194	120p
74195	95p
74196	95p
74197	80p
74198	150p
74199	150p
74221	160p
742S1	140p
742S9	250p
74278	290p
74279	110p
74283	140p
74284	360p
7428S	360p
74290	150p
74293	150p
74298	200p
7436S	100p
74366	100p
75467	100p
74368	100p
74390	200p
74393	200p
74490	225p

74LS SERIES

74LS00	14p
74LS02	16p
74LS03	18p
74LS04	16p
74LS0S	25p
74LS08	22p
74LS09	21p
74LS10	20p
74LS12	30p
74LS11	40p
74LS13	40p
74LS14	50p
74LS20	20p
74LS21	40p
74LS22	27p
74LS26	30p
74LS27	38p
74LS30	20p
74LS32	27p
74LS33	27p
74LS37	30p
74LS38	38p
74LS40	25p
74LS42	70p
74LS47	75p
74LS51	24p
74LS55	30p
74LS73	50p
74LS74	27p
74LS75	36p
74LS76	45p
74LS83	70p
74LS85	80p
74LS86	40p
74LS90	40p
74LS92	70p
74LS93	60p
74LS95	75p
74LS96	110p
74LS107	45p
74LS109	80p
74LS112	40p
74LS113	90p
74LS114	45p
74LS122	80p
74LS123	60p
74LS124	180p
74LS125	50p
74LS126	50p
74LS132	60p
74LS133	30p
74LS136	55p
74LS138	65p
74LS139	75p
74LS145	120p
74LS147	220p
74LS148	175p
74LS151	80p
74LS153	60p
74LS154	200p
74LS155	60p
74LS156	90p
74LS157	60p
74LS158	60p
74LS160	90p
74LS161	75p
74LS162	140p
74LS163	100p
74LS164	90p
74LS165	140p
74LS166	180p
74LS173	110p
74LS174	100p
74LS175	100p
74LS181	320p
74LS190	100p
74LS191	100p
74LS192	100p
74LS193	100p
74LS194	100p
74LS195	140p
74LS196	120p
74LS197	90p
74LS221	120p
74LS240	175p
74LS241	175p
74LS242	170p
74LS243	170p
74LS244	150p
74LS245	250p
74LS247	140p
74LS251	140p
74LS253	90p
74LS257	90p
74LS258	160p
74LS259	160p
74LS266	100p
74LS273	170p
74LS279	90p
74LS283	90p
74LS298	160p
74LS299	375p
74LS323	400p
74LS324	200p
74LS348	200p
74LS365	48p
74LS367	70p
74LS368	100p
74LS373	150p
74LS374	150p
74LS375	120p
74LS377	160p
74LS378	140p
74LS390	120p
74LS393	120p
74LS399	200p
74LS445	140p
74LS640	450p
74LS641	450p
74LS642	450p
74LS643	450p
74LS644	450p
74LS668	100p
74LS670	250p

74S SERIES

74S00	60p
74S04	60p
74S05	75p
75S08	75p
74S10	60p
74S20	60p
74S30	60p
74S32	90p
74S37	90p
74S64	60p
74S74	90p
74S85	300p
74S86	180p
74S112	120p
74S114	120p
74S124	300p
74S132	160p
74S133	75p
74S138	225p
74S139	225p
74S157	250p
74S174	250p
74S175	320p
74S194	350p
74S241	450p
74S260	70p
74S373	500p
74S374	500p

93 SERIES

9301	160p
9302	175p
9308	316p
9310	275p
9311	275p
9312	160p
9314	165p
9316	225p
9321	225p
9322	150p
9334	360p
9368	250p
9370	300p
9374	200p

4000 SERIES

4000	15p
4001	22p
4002	20p
4006	95p
4007	20p
4008	80p
4009	40p
4010	50p
4011	20p
4012	25p
4013	50p
4014	84p
401S	84p
4016	45p
4017	70p
4018	89p
4019	45p
4020	100p
4021	110p
4022	100p
4023	27p
4024	50p
402S	20p
4026	130p
4027	50p
4028	84p
4029	100p
4030	55p
4031	200p
4034	200p
4035	110p
4036	295p
4039	295p
4040	100p
4041	80p
4042	80p
4043	90p
4044	90p
4046	110p
4047	100p
4048	55p
4049	45p
40S0	45p
4051	80p
4052	80p
4053	80p
4054	150p
405S	125p
4056	135p
4059	600p
4060	115p
4063	120p
4066	50p
4067	450p
4068	27p
4069	20p
4070	30p
4071	25p
4072	25p
4073	25p
4075	25p
4076	107p
4081	27p
4082	27p
4086	72p
4089	150p
4093	70p
4094	250p
4095	95p
4096	95p
4097	340p
4098	120p
4099	200p
40100	220p
40101	132p
40102	180p
40103	180p
40104	99p
40105	120p
40106	90p
40107	60p
40108	470p
40109	100p
40110	300p
40114	250p
4502	120p
4503	70p
4507	55p
4508	290p
4510	99p
4511	120p
4512	80p
4514	250p
4515	300p
4516	110p
4518	100p
4520	100p
4521	250p
4526	108p
4527	150p
4528	100p
4532	140p
4534	550p
4536	375p
4538	120p
4543	180p
4553	320p
4556	72p
4560	200p
4569	250p
4572	40p
4583	110p
4584	90p
4585	150p
4724	250p
40097	90p
14411	1100p
14412	1100p
14433	1100p
14500	700p
14599	290p

CPUs

1600	1200p
1802C	750p
2650A	1600p
6502	650p
6502A	950p
6800	650p
6802	950p
6809	2000p
INS8060	1000p
8080A	450p
8085A	1100p
9980	2000p
Z80	650p
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R03-2S13 U.C.	650p
R03-2S13 L.C.	700p
74S262	1000p

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MC6847	1500p
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6522	650p
6532	800p
6820	375p
6821	340p
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8205	320p
8212	200p
8216	200p
8224	275p
8226	400p
8228	525p
82S1	475p
8253	1000p
8255	450p
8257	900p
8259	950p
8279	950p
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IM6402	450p

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FD1791	£36
FD1771	£25

MINI DRIVE

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2102-2L	120p
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2112A	300p
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2114-3L	350p
2114-4L	250p
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4044-4	600p
4116-2	300p
4118-4	1200p
5101	400p
6810	300p
4016-4 (2K x 8 Static)	P.O.A.
4532-2 (4K x 8 Dynamic)	P.O.A.

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74S188	275p
74S189	275p
74S201	350p
74S287	350p
74S387	350p
74S470	650p
74S471	650p
74S472	900p
74S571	900p
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(Many more stocked)

EPROMS

1702A	700p
2708	400p
2716(+5v)	700p
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AD536A	1300p
AD558	775p
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DS8836	150p
DS8838	225p
MC1488	75p
MC1489	75p
MM58174	1200p
75107	160p
75110	250p
75154	175p
75182	230p
75324	375p
75361	300p
75363	400p
75365	200p
754S1/2	72p
75491/2	70p
8T26	160p
8T28	200p
8T9S	200p
8T97	160p
81LS95	120p
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9602	220p
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1.008MHz	350p
1.8432MHz	325p
2.00MHz	325p
2.45760MHz	325p
3.276MHz	300p
3.579MHz	175p
4.00MHz	290p
4.194MHz	300p
4.43MHz	125p
5.0MHz	325p
6.0MHz	300p
6.144MHz	300p
7.0MHz	300p
7.168MHz	300p
8.00MHz	300p
8.867MHz	300p
10.00MHz	310p
10.7MHz	300p
12.0MHz	350p
16.00MHz	350p
18.00MHz	300p
18.432	350p
19.968MHz	390p
26.690MHz	350p
27.145MHz	325p
38.6667MHz	350p
48.0MHz	300p
55.5MHz	400p
116.0MHz	350p

LOW PROFILE DIL SOCKETS BY TEXAS

8 pin	9p	18 pin	16p	24 pin	24p
14 pin	10p	20 pin	20p	28 pin	30p
16 pin	11p	22 pin	22p	40 pin	40p

WIRE WRAP SOCKETS BY TEXAS

8 pin	30p	18 pin	50p	24 pin	70p
14 pin	35p	20 pin	60p	28 pin	80p
16 pin	40p	22 pin	65p	40 pin	100p

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2 x 15	100p		
2 x 18	120p	2 x 22	135p
2 x 25	160p	2 x 25	160p

VOLTAGE REGULATORS

Fixed Plastic T0-220

1A	+ve		—ve	
5v	780S	60p	7905	65p
6v	7806	70p	7906	80p
8v	7808	70p	7908	80p
12v	7812	60p	7912	65p
15v	7815	60p	7915	70p
18v	7818	70p	7918	80p
24v	7824	70p	7924	80p

100mA +ve	TO-92			
5v	78L05	30p	79L05	70p
12v	78L12	30p	79L12	70p
15v	78L15	30p	75L15	70p

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LM309K	140p		
LM317T	200p	78MGT2C	140p
LM323K	500p	79GUIC	225p
LM723	37p	79HGKC	650p
78GUIC	200p	78P05	900p
78H05	550p	RC4195NB	150p
78HGKC	600p	TL497	300p

SOFTY: Ideal software development tool. Run, De-bug, verify your programmes using SOFTY to simulate ROM, then programme EPROM with SOFTY. KIT £100 + VAT

ACORN ATOM: Kit supplied with 8K ROM, 2K RAM. May be extended to 12K ROM + 12K RAM on board. Full size qwerty keyboard, 6502 Processor, UHF TV output. Free manual.
KIT £120 + VAT, BUILT £150 + VAT, PSU £10.20 + VAT.

BOOKS (NO VAT)

Understanding Microprocessors	£3.50
Micros — Interfacing Techniques	£9.95
Programming the 6502	£7.95
Programming the Z-80	£8.95
6502 Applications Books	£7.95
Interfacing the 8255	£6.95
Intro. to Micros (Osborne) Vol. 0 (Beginners Book)	£5.95
Vol. 1 (Basic Concepts)	£7.95
TTL Cookbook	£7.15
Z-80 Interfacing Vol. 1	£7.75
Z-80 Interfacing Vol. 2	£8.50
6502 Assembly Lang. Prog	£8.25
6502 Software Design	£7.95

(Please add P&P 75p per book)

EXPANSION PCB: will hold upto 8K RAM (16 x 2114) plus 4K, 8K, or 16K EPROM. Can be easily interfaced with most systems. Fully decoded and buffered lay-out on board. £17.00 + VAT

EPROM ERASER TYPE UV140: will erase upto 14 EPROMS in approx. 20 mins. Slide tray for safety. Mains and Erase indicators. £62 + VAT

SPECIAL OFFERS

2114 (450ns)	£2.00
2708	£4.00
2716 (+5V)	£5.00
4116—2L (200 ns)	£2.00

(offer subject to stocks)

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FD-50A 40 TRACKS 5¼"
£150 + £1.20 P&P + VAT

We carry large stocks of Memories, TTLs, CMOS; LINEARS, TRANSISTORS AND OTHER SEMI-CONDUCTORS and welcome inquiries for volume quantities.

VAT: Please add 15% to total order value
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ACCESS & BARCLAY accepted.

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NEW THE TUSCAN S100

A Z80 based S100 Computer System.

Available in Kit Form or Assembled. All components available separately.

Houses two 5¼" drives for a compact business system
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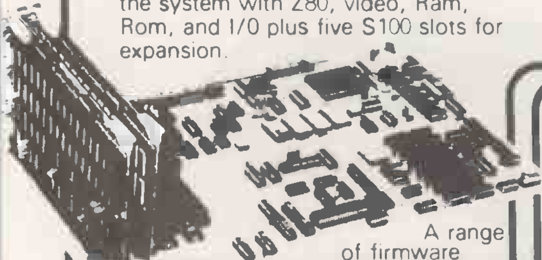
Two keyboard options
Hinged lid for easy access.
Stylish finish ideal for office or home.



TUSCAN main board. The heart of the system with Z80, video, Ram, Rom, and I/O plus five S100 slots for expansion.

A range of firmware options available.

On Demonstration NOW

KITS from £195 + VAT
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NASCOM PRODUCT LIST + VAT

I/O board kit less I/O chips	45.00
UART + BAUD rate generator + crystal for I/O board	16.00
Econographics kit for additional 128 characters (N1 only)	30.00
2708/2716 Programmer suitable for N1 and N2 under NAS-SYS	£20.95
Nascom 19" rack mounting card frame for N1 and N2	32.50
Nas-DA disassembler 3 EPROM for Nas-sys	37.50
MK36271 8K BASIC in 8K x 8 ROM	
Naspen VS in 2 EPROM	30.00
Nas-sys monitor in 2 EPROM	25.00
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Nasbug T4 2 x EPROM	25.00
Tiny Basic 2 x EPROM	25.00
Super Tiny Basic 3 x EPROM	37.50
Super Tiny Basic upgrade 1 x EPROM	12.50
Tape Software	
ZEAP 2 tape and documentation for Nas-sys	30.00
8K BASIC tape and documentation for N1	15.00

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Full after sales service

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Nas Pen text editor (2, 1Kx8 EPROMS) £30
Expansion boards (in kit form)
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16K RAM £140

EPROM CARD (NASCOM compatable) KIT. Suitable for 16 x 2708 or 16 x 2716 or mixed 1 x NASCOM 8k BASIC ROM £55.00. BASIC programmers aid. Self locating tape £14.96.

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THE HENELEC DISK SYSTEM

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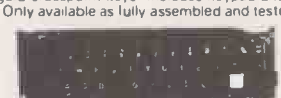

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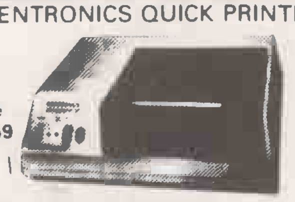

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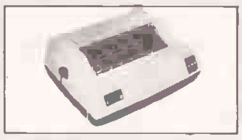

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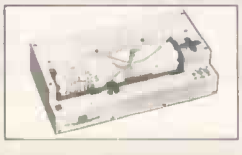

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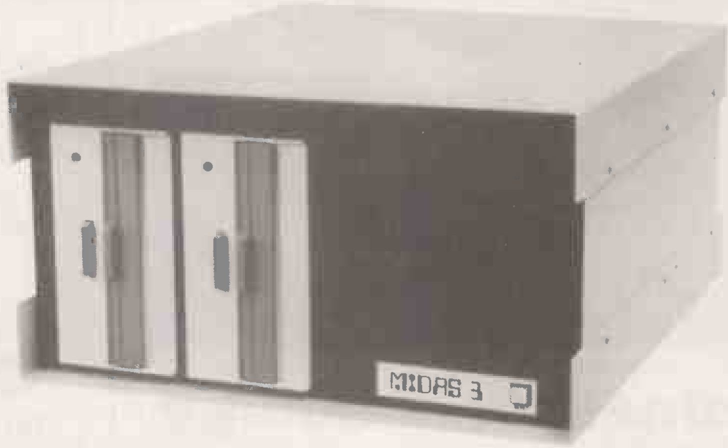

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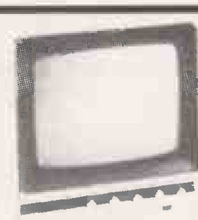

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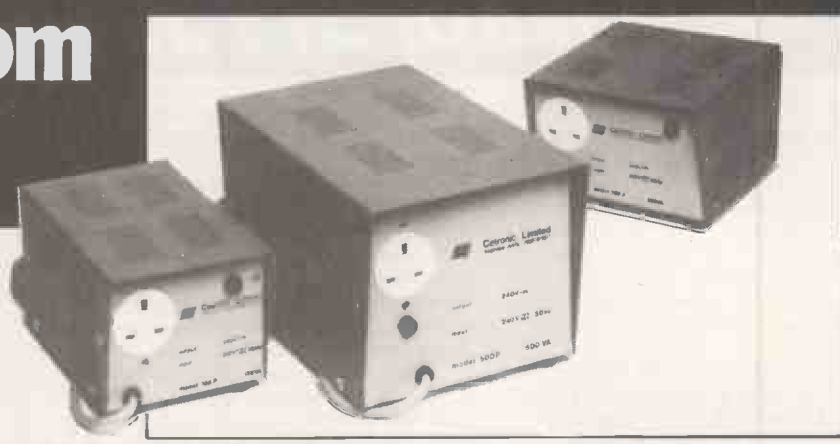

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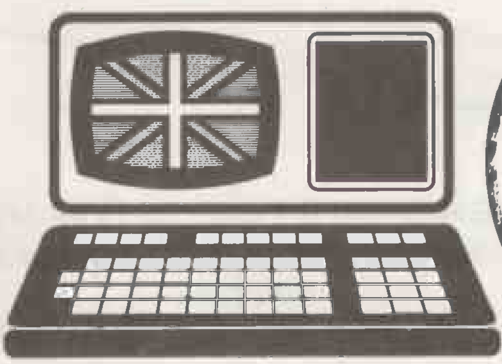

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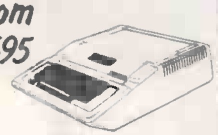

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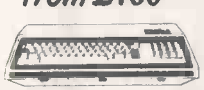

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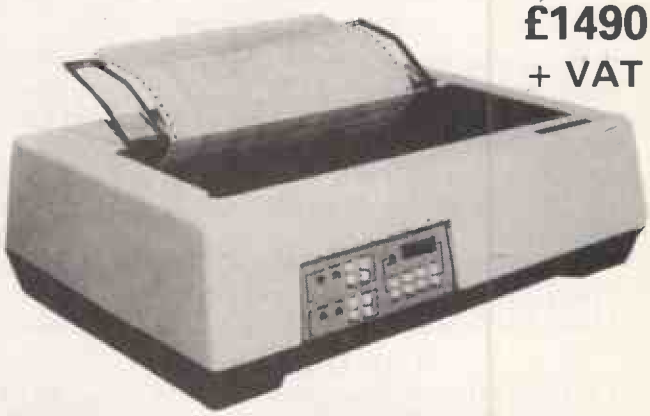

The Datasouth DS180 is a dot-matrix serial impact printer designed for high performance at an economical price. Application flexibility and a long list of standard features make the DS180 an ideal device for small business systems, distributed communications networks and intelligent terminals.

HIGH SPEED PRINTING
Utilizing 180 cps optimized bidirectional printing, the DS180 offers higher throughput than any printer in its class. Its 9-wire printhead produces highly legible 9x7 characters with decenders for lower case letters and true underlining. All 96 ASCII characters may be printed across a 132 column line at 10 characters per inch. Expanded characters (5 cpi) may be selected for highlighting portions of the text.

USER PROGRAMMABLE
The DS180 offers a large number of user programmable features, yet is easy to operate. A unique programming keypad with a non-volatile memory makes printer set-up quick and simple. Top of form, horizontal and vertical tabs, perforation skip-over and auto line feed are just a few of the features the user may select. Communications status may also be programmed and monitored using the indicator panel lights and LED display.

ATTRACTIVE DESIGN
Compact, desk-top packaging allows the DS180 to fit into almost any installation. Its noise dampening cover makes it suitable for use in a quiet office environment. The cartridge ribbon makes routine changes clean, fast and convenient.

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Through the use of state-of-the-art microprocessor electronics, reliability and maintainability have been greatly improved. The simple modular design of the DS180 provides easy access to all major components. A single printed circuit board contains both the power supply electronics and digital controller for the printer. A self-test feature and diagnostic display panel help the user verify proper operation of the unit and isolate problems should they occur.

COMMUNICATIONS
Interfaces on the DS180 include RS232 and 20mA current loop serial interfaces, and a Centronics compatible parallel interface. Baud rates from 110-9600 and parity selection may be keyed in by the user for his specific application.

FORMS HANDLING
Adjustable tractors accomodate forms from 3-15 inches wide. A head-to-platen gap adjustment ensures optimum print quality on up to 6-part forms. Fanfold paper may be fed from the front or bottom of the DS180. A paper out sensor may be programmed to send a stop transmission character and sound an audible alarm.

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Reliable performance is ensured by a stringent quality control program. Datasouth uses pretested, high reliability parts from leading manufacturers. Multiple tests are performed on subassemblies during each stage of production, with each completed unit undergoing a final 24 hour print test and burn-in. The DS180 carries a 90 day warranty on materials and workmanship.

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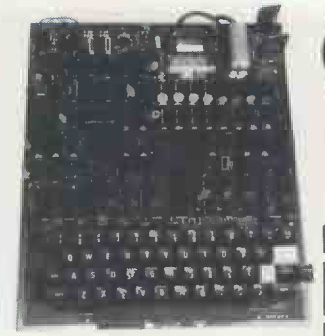

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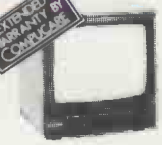

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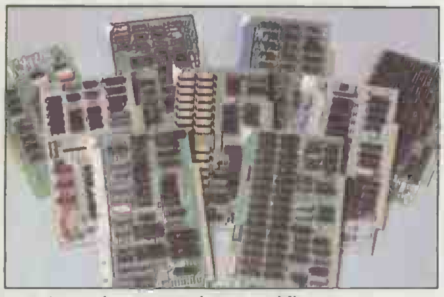

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