

Practical Computing

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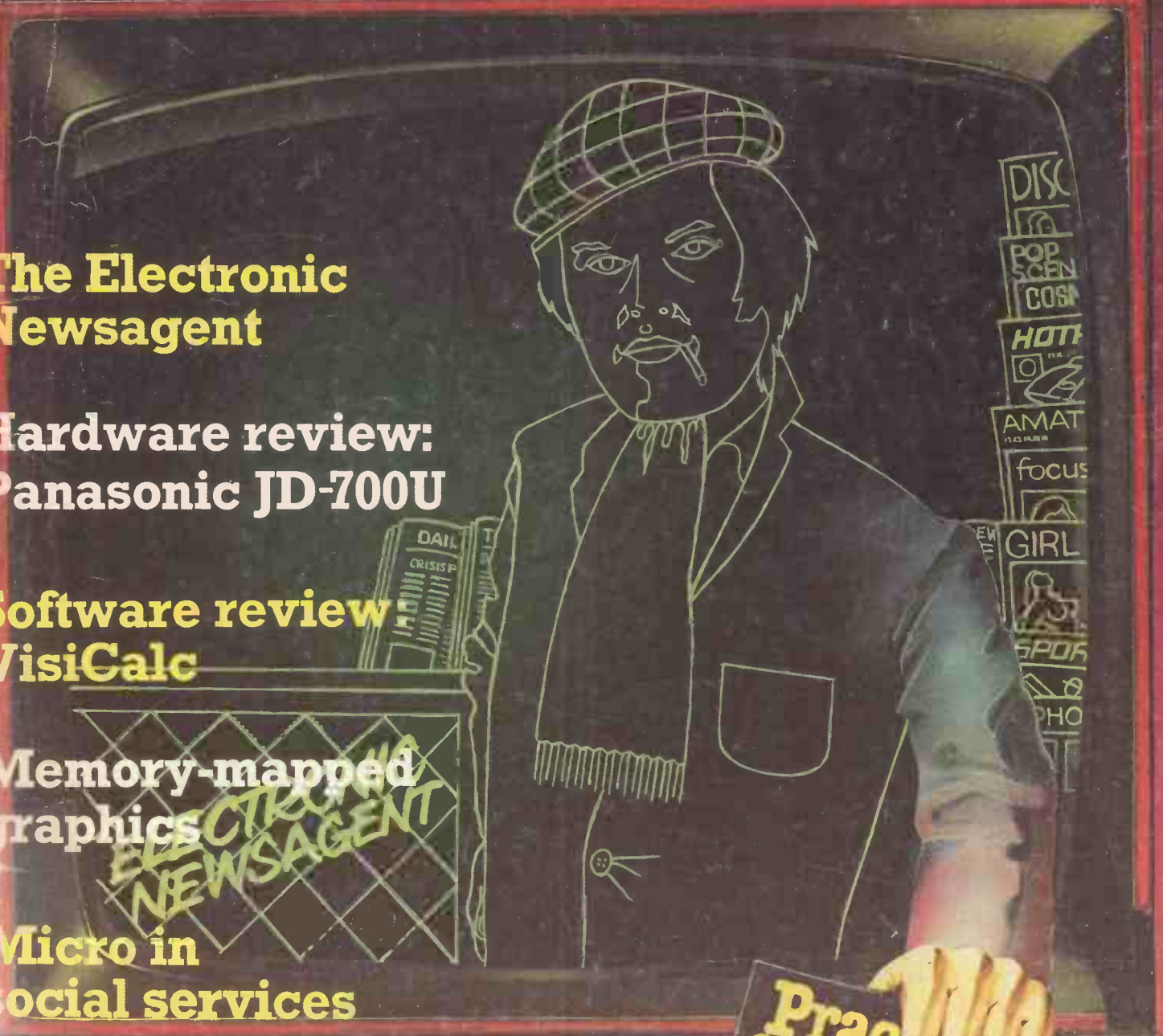
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Every effort is made to check articles and listings but PC cannot guarantee that programs will run and can accept no responsibility for any errors.

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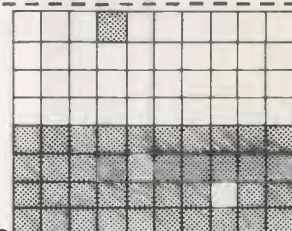
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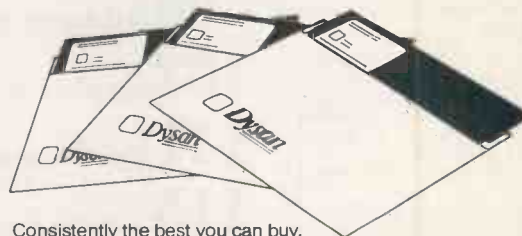
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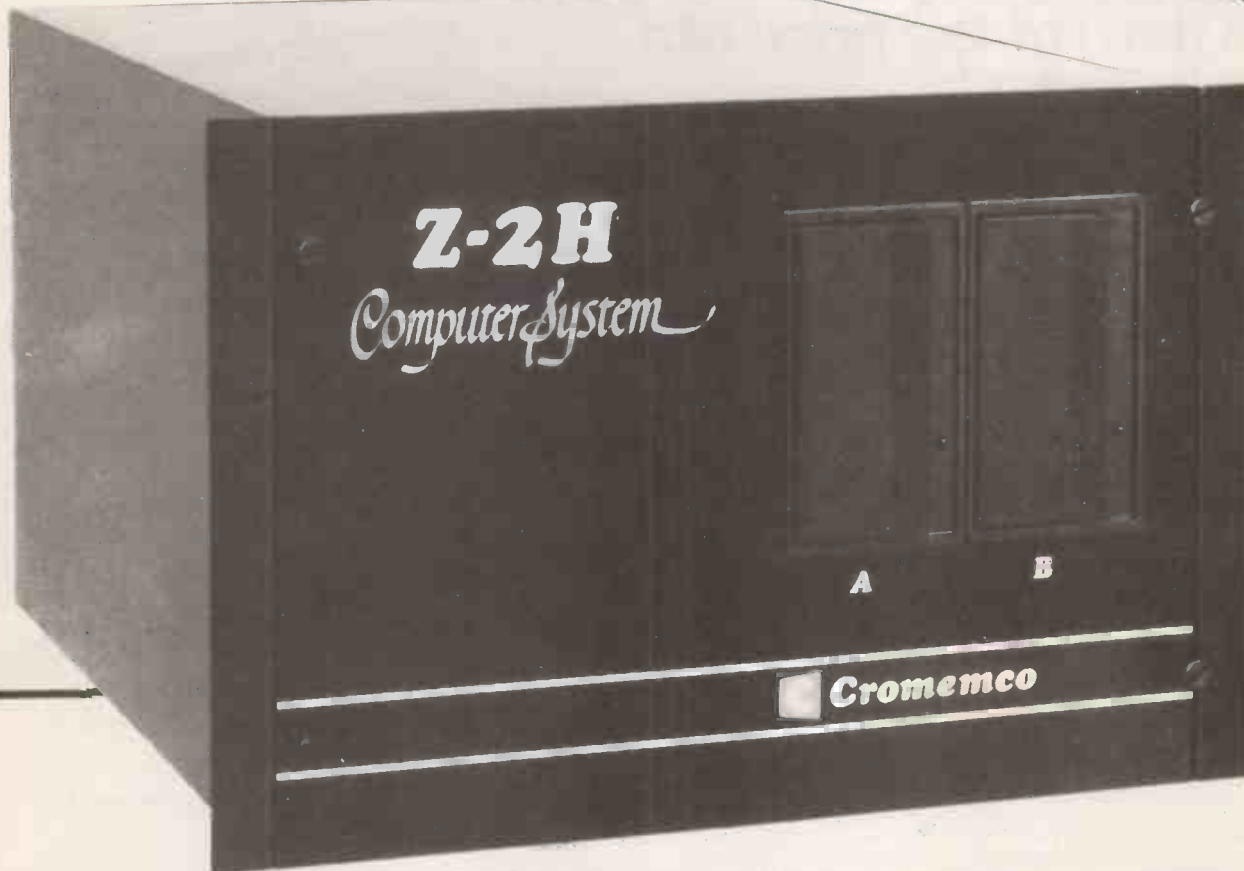
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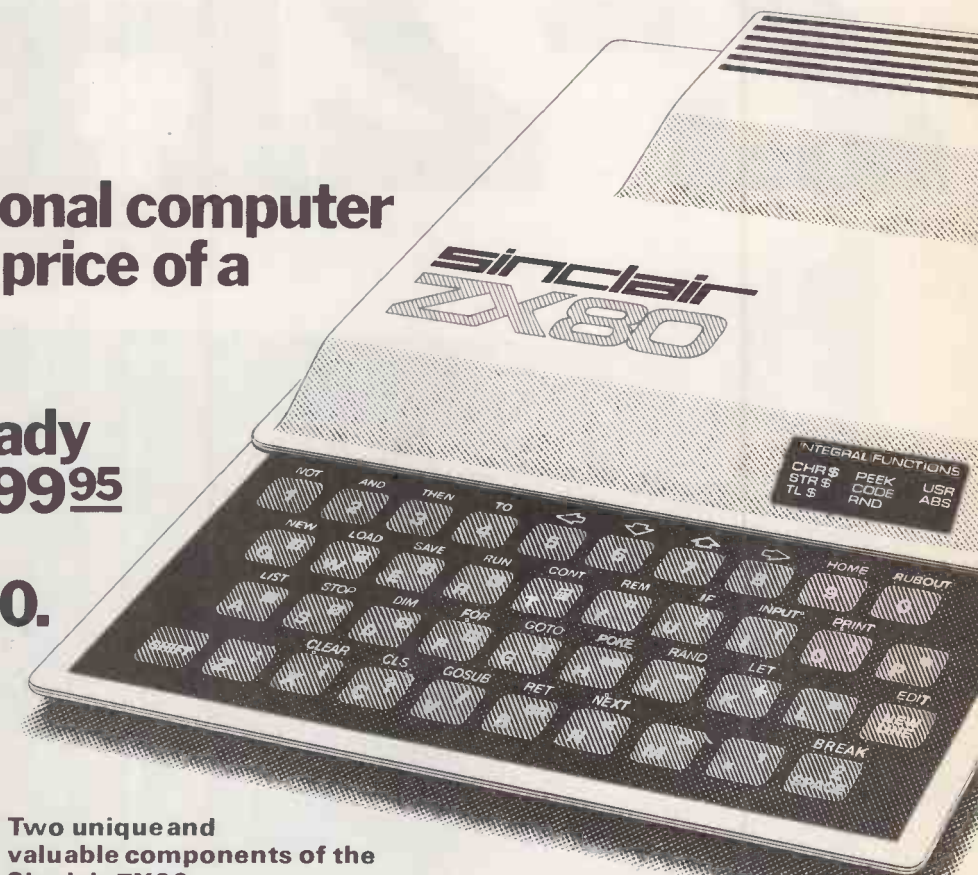
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* Use a 600 mA at 9 V DC nominal unregulated mains adaptor. Available from Sinclair if desired (see coupon).



Two unique and valuable components of the Sinclair ZX80.

The Sinclair ZX80 is not just another personal computer. Quite apart from its exceptionally low price, the ZX80 has two uniquely advanced components: the Sinclair BASIC interpreter; and the Sinclair teach-yourself BASIC manual.

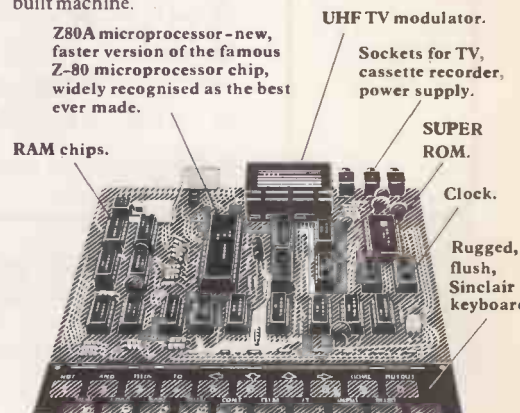
The unique Sinclair BASIC interpreter... offers remarkable programming advantages:

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- Unique syntax check. Only lines with correct syntax are accepted into programs. A cursor identifies errors immediately. This prevents entry of long and complicated programs with faults only discovered when you try to run them.
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- Variable names of any length.
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- Timer under program control.
- PEEK and POKE enable entry of machine code instructions, USR causes jump to a user's machine language sub-routine.

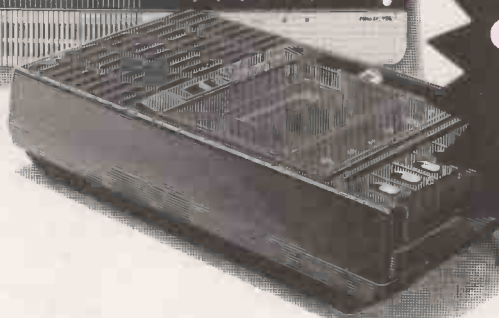
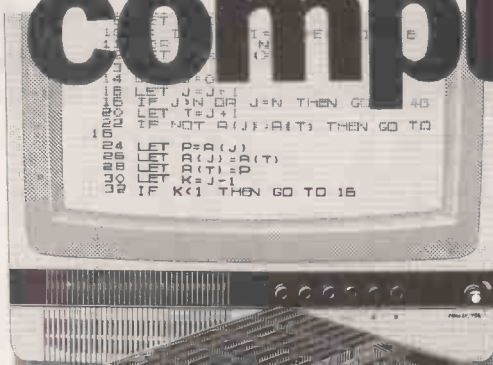
- High-resolution graphics with 22 standard graphic symbols.
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... and the Sinclair teach-yourself BASIC manual.

If the features of the Sinclair interpreter listed alongside mean little to you – don't worry. They're all explained in the specially-written 128-page book *free* with every kit! The book makes learning easy, exciting and enjoyable, and represents a complete course in BASIC programming – from first principles to complex programs. (Available separately – purchase price refunded if you buy a ZX80 later.) A hardware manual is also included with every kit or built machine.



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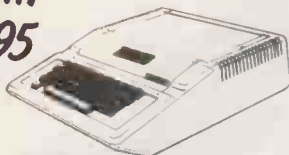


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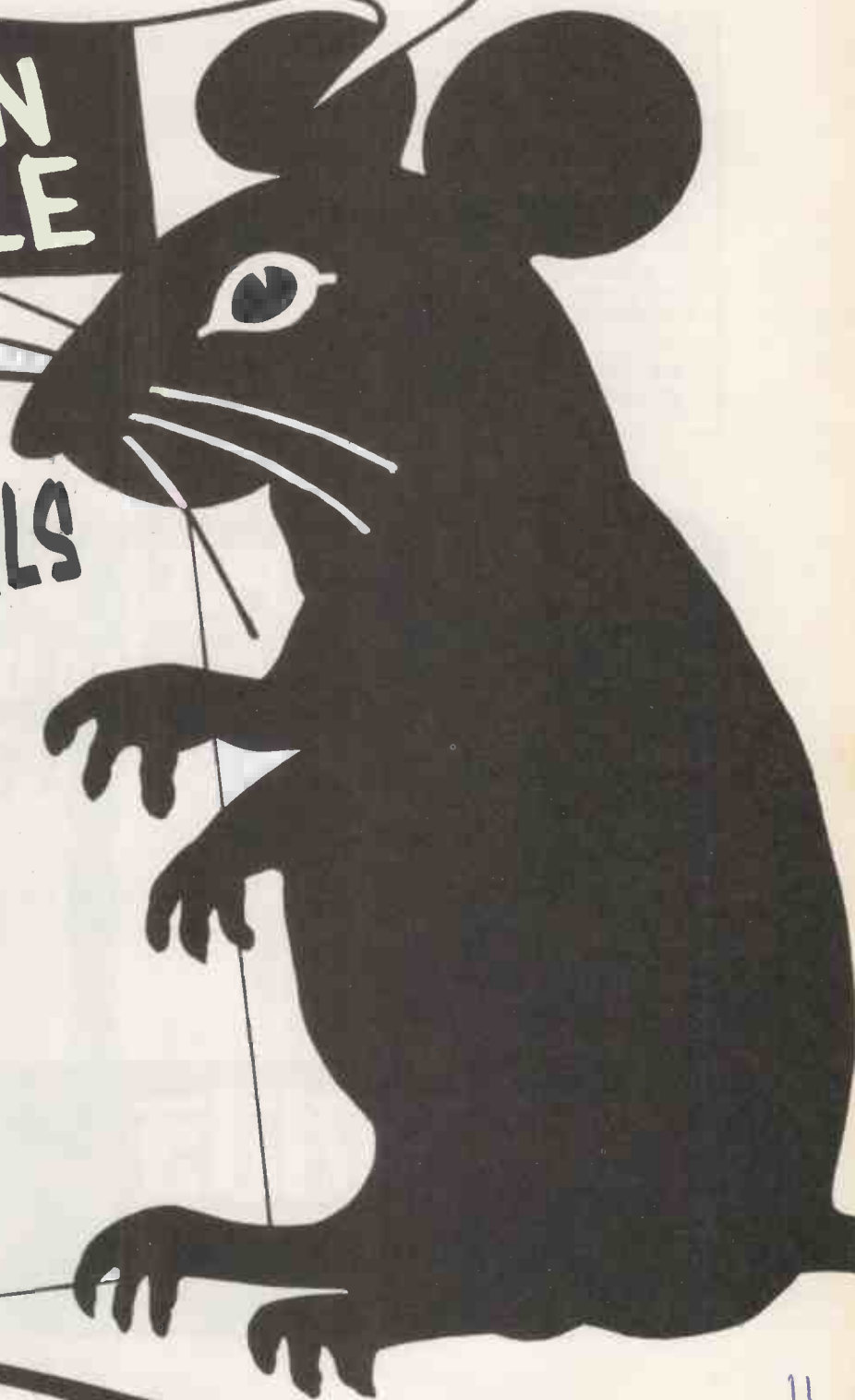
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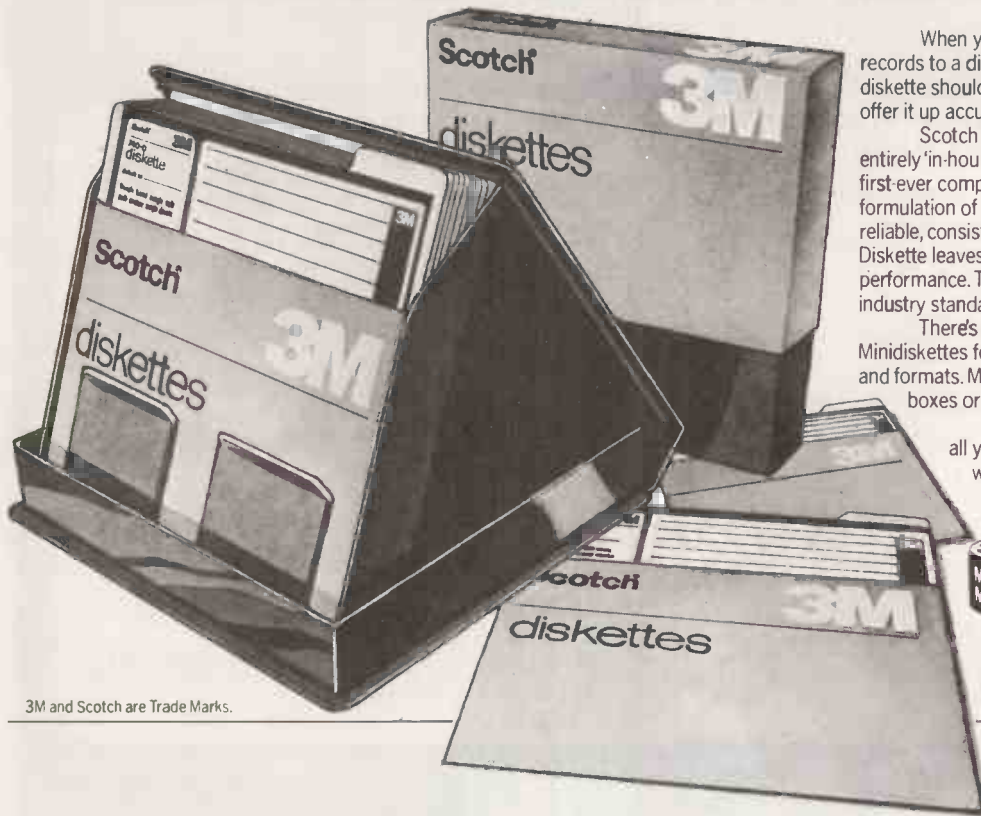
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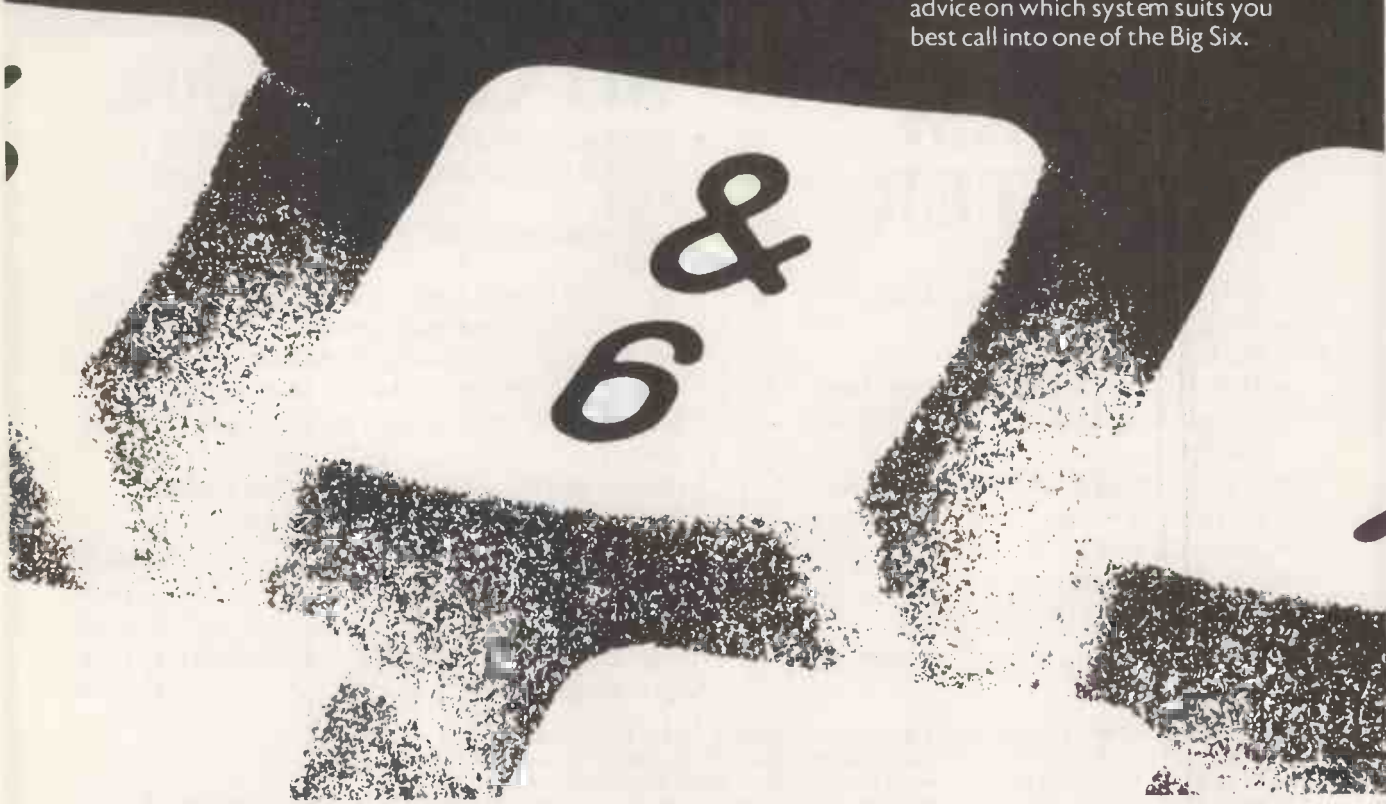
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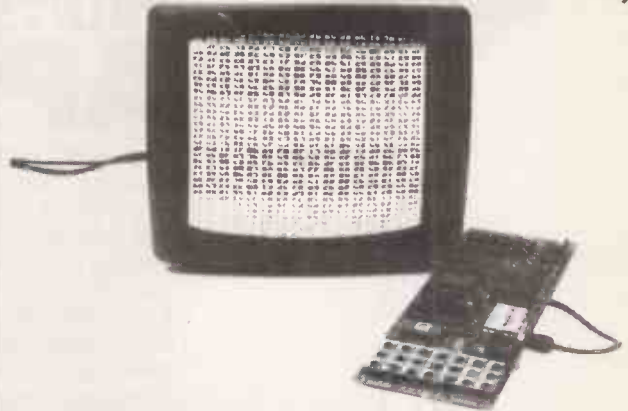
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In the end, when the program is complete and working, the DIL plug is removed and replaced by an EPROM device programmed by SOFTY. SOFTY is able to program the 2704/2708/2716 family which have 3 voltage rails — we supply with each SOFTY details of a simple modification which allows SOFTY to program the single rail 2716/2732 etc.

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To help in the process of program development SOFTY has various assembler key-functions, which include — block shift without overwriting, block store, cursor control, match byte and displacement calculations (for jumps etc). A high speed cassette interface is also provided for storing working programs and useful subroutines.

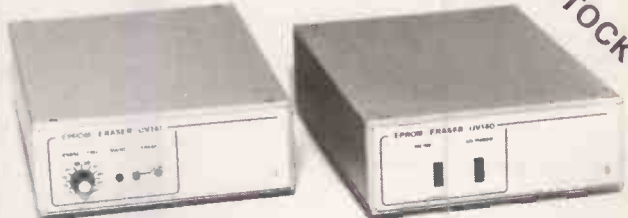
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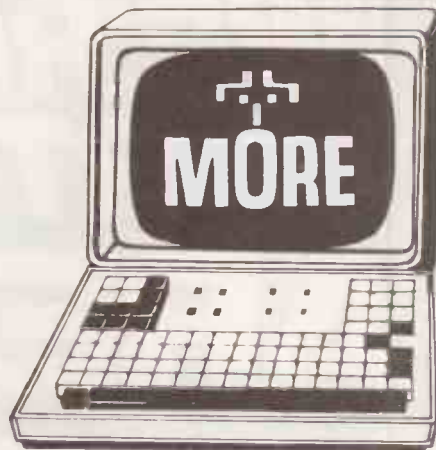
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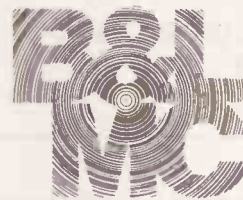
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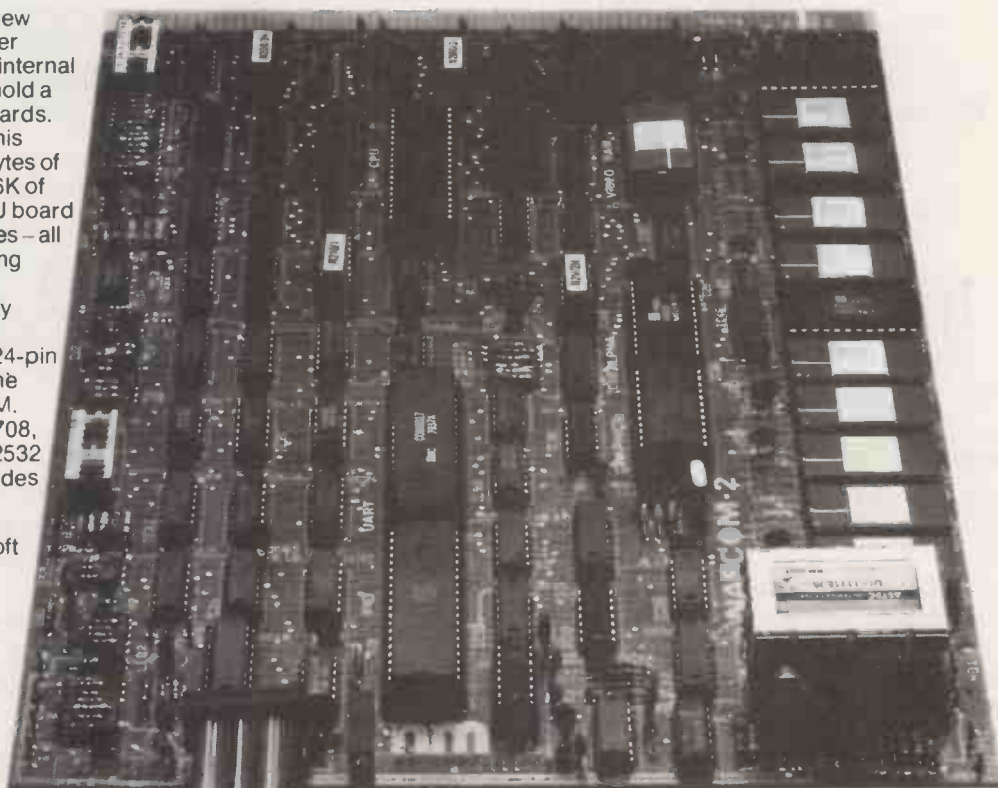
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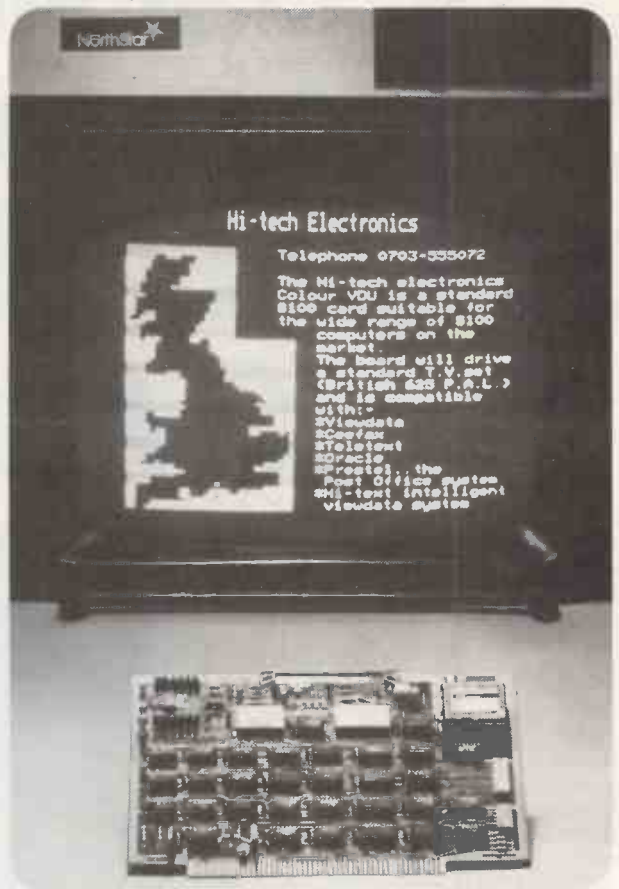
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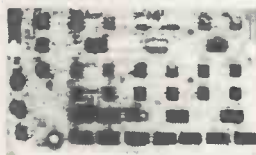
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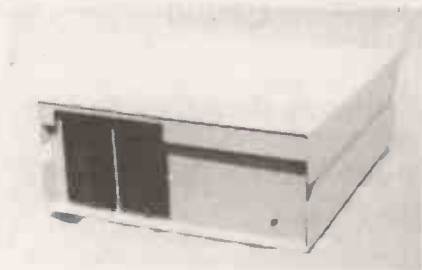
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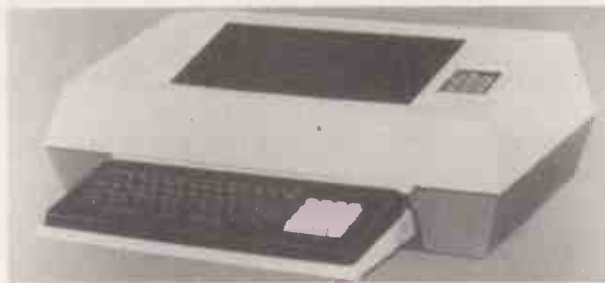
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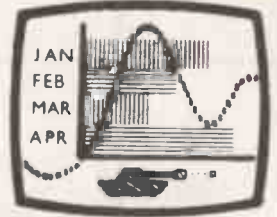
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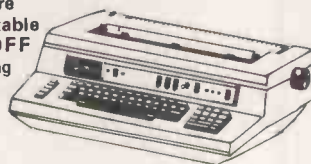
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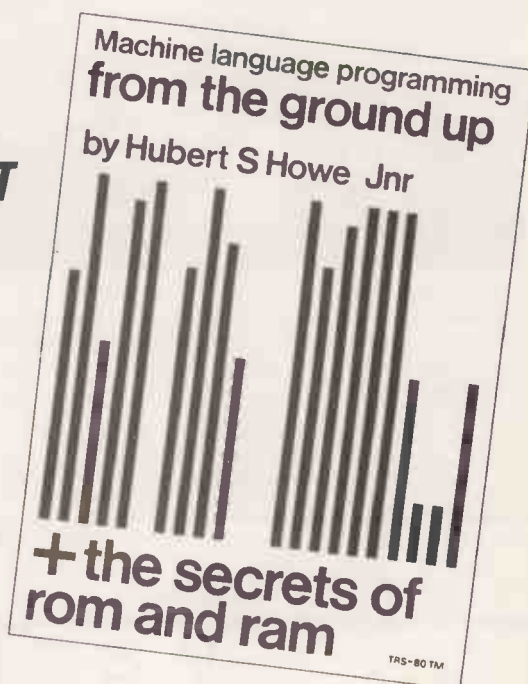
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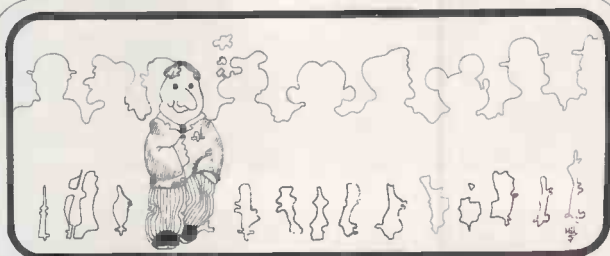
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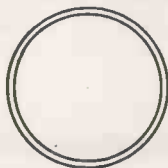
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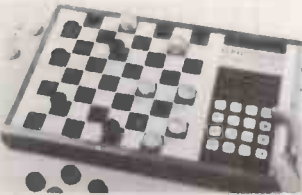
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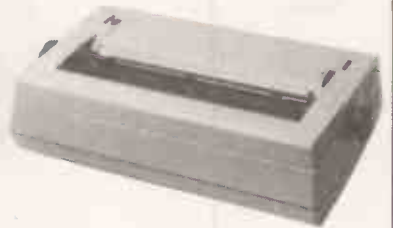
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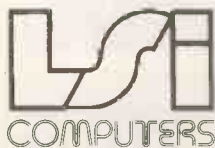
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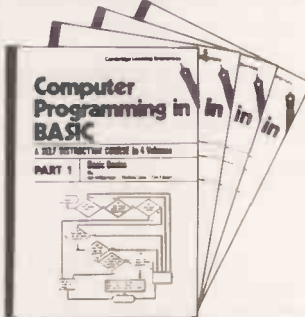
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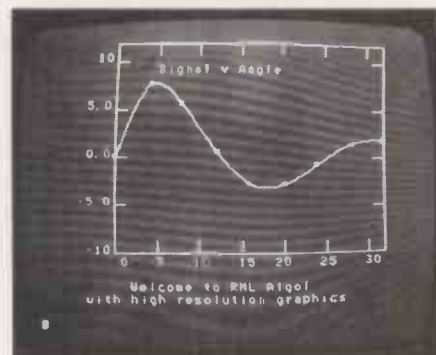
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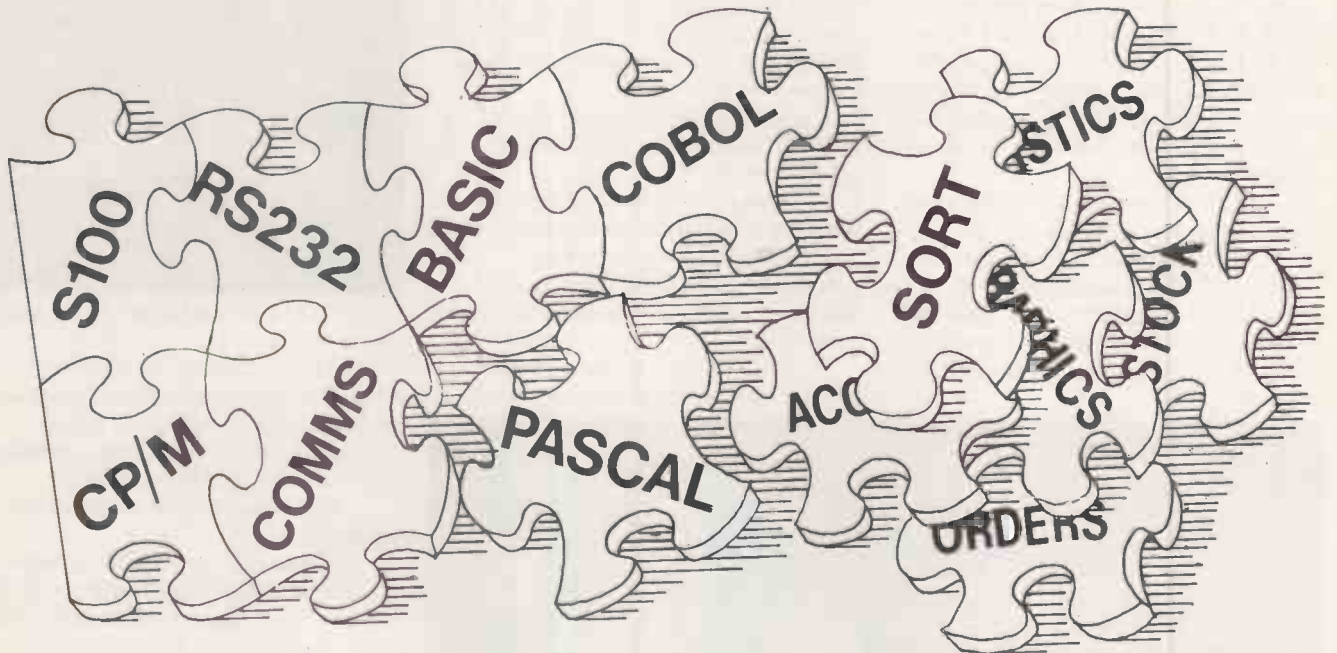
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ALL THOSE WHO WORK with personal computers owe a huge debt to the many thousands of people who went before and broke the ground. Things we take for granted — the organisation of a machine into processor and memory, the machine code instructions which the processor executes, assemblers, high-level languages, operating systems — those are all things which have absorbed millions of man-hours of work. Many mistakes have been made — and corrected — and we have the benefits of them.

However, with this inheritance of powerful techniques is an inheritance of points of view which is not so helpful. Because most of today's experts in computing owe their expertise to working with large machines, we tend to take for granted that their problems are our problems, and what is worse, that they know more about our solutions than we do.

The two points of view collide most visibly over the question of language. Which high-level language ought micro-computers to run? The accepted wisdom says that a language should be block-structured — that is, it does not define variables outside the bit of program in which they are used. It should be recursive — that is, one ought to be able to write procedures which call themselves.

It ought to support advanced data structures. It ought to be written so that its lay-out shows its function. Basic, the language which most micro users write, is dismissed on all these grounds. The debate rages about what language should replace it, and those who like Pascal will point to it as fulfilling all these conditions.

I am not at all sure that the correct questions are being asked. If you have to write a program 30,000 lines long, you do, indeed, tend to run out of variable names. You do not want a variable used in a subroutine at the front re-emerging disastrously in one at the back. It makes things much simpler if you can define the region in which variables exist.

Yet the longest program one could fit into a micro is about 5,000 lines, and the great majority of useful programs are far shorter than that. Block structuring solves a problem that does not really concern us.

Recursiveness is very pretty, but there are few mathematical problems it solves, and when it does, it's slow and greedy on memory. It is fortunate that most of the time it's a solution looking for a problem.

Again, if embarking on a huge program which will take several people several years to write, it may well save a good deal of time to be able to define individual data structures. Programs for micros are not like that. By the time you have become used to the special data structure for one program, you have finished and are about to start something totally different.

Finally, program-structure and lay-out. I find that for my simple needs, a program consisting of many Basic sub-routines is easy to understand and debug. Each subroutine is prefaced with a little note which explains the variables it uses and what it returns. Each has one entry point and one exit. It may not be elegant but it certainly works. Do we really need more?

A further hidden factor which confuses the discussion is that the mainframe industry tends to think in terms of teams of programmers. Many of their problems are caused by the

need to co-ordinate the activities of bored, rebellious and possibly rather uninformed people. As has been pointed out in these pages before, that is not at all the case in our business.

We have programmers who are highly motivated and who, presumably, hold everything they need in their heads. The contrast was highlighted for me by a young friend who wrote 5,000 lines of debugged machine code in two weeks. Contrast that with the industry standard of five lines a day, or 70 in two weeks.

If publishers had to employ teams of writers to produce books, one would expect them to become bogged-down in problems of co-ordination and compatibility. When it comes to the writing of dictionaries and encyclopedias they do and this kind of publishing is very specialised. It is unfortunate for us that computer traditions have grown-up round writing that kind of program when what we should be considering is much more like a novel.

That difference in aim has an effect on the language problem. We need something which enables easy movement — to try this idea and that. We do not need a language which enforces rigidity, which demands time spent in defining things which might soon be changed. We need a language which will interpret for development and compile for action. It needs, ideally, to be as flexible as human language.

I write with some feeling here, because I started recently to wrestle with Pascal, gave up after a week and went back to assembler. It was, in comparison, much easier. In contrast with Basic, Pascal was a penance.

It seems clear that the road forward is through improvements in Basic. I look forward to trying the Microsoft version 5 which will either interpret or compile, and will link to bits written in machine code, Fortran or Cobol. Basic would benefit from some more developments — named subroutine calls, pointers, dynamically-allocated variables and dynamically-defined arrays.

We can live without them. The proof is that plenty of people are writing big, useful programs in Basic and making adequate livings from them.

That micros have put computing back 15 years is a complaint one hears frequently. It is true, and there is little point pretending it has not happened. In comparison with today's mainframes or even minis, many of the things we can do are pathetically limited, but the quantity of useful work which can be done is vastly increased. Instead of computing power being localised in a few, highly-expensive spots, it has now spread over a wider area.

It needs to be primitive because it has to be used by newcomers. It will no doubt develop and the branch which has been spliced into the tree of computer development 15 years ago will grow in its own way. There is no reason why it should take the same course as the main stem. We have to make up our minds about our own future. If we want something which makes the mainframe industry laugh we shouldn't mind.

It is too easy to be intimidated by professionals who argue from the wrong premisses to wrong, but authoritative-sounding, conclusions. If the future of the micro is with a kind of super-Basic, they'll just have to tolerate it. □

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.

Answering criticism

THE CRITICISM of the Sinclair ZX-80 in April Printout seems to be unduly harsh. The correction of its price from £100 to £180 is misleading; the cost of the TV and cassette recorder constitute the bulk of the difference and are items which a great many people own already. Moreover, anyone who can afford £100 for a micro is even more likely to have the tape recorder and TV already.

The upper RAM limit of 16Kbytes is listed as a disadvantage — is it really? Sinclair claims that RAM is used $\times 4$ more efficiently which is equivalent to 64Kbytes — few people will need more than that and few micros can cope with more.

The lack of discs on the ZX-80 is more serious, but anyone prepared to spend several hundred pounds on a good disc system would normally be looking for a more expensive computer in the first place.

According to the article, the machine's lack of logs, sines and so on, means that "it cannot be regarded as an up-market calculator". Is it meant to be one? For anyone planning to buy a micro for use as a scientific calculator, the ZX-80 is not a good choice. On the other hand, if he wants to write programs, it has one or two useful features that many £15 calculators do not — like Basic.

Finally, would someone like to explain why, if the article is correct in saying that one cannot gain access to the processor to write machine code, the ZX-80 has a USR function "causing jump to a user's machine language subroutine"?

Brian Medley,
Leeds.

● One can enter machine code with POKE and call it by USR. However, it is an awkward way of working. If machine code writing is to be at all productive, one needs an assembler and a proper monitor for debugging. Since the ZX-80 is aimed ostensibly at the beginner, it seems odd to make things so difficult for him.

ZX-80 capabilities

I WAS interested to read your column on the Sinclair ZX-80 — *Practical Computing*, April — having studied in detail the ZX-80 manual, my conclusion also was that the machine would provide a simple introduction to programming and probably be capable of a variety of simple games.

I feel, however, a few points should be clarified. Firstly, the ZX-80 Basic is an all-

integer Basic, which means that any decimal calculation — not just logs or sines — requires remarkable programming and considerable skill.

I must pre-empt the possible reaction from Sinclair on this point by acknowledging that the manual does contain a routine to divide one integer by another and output a result to a few decimal places.

I am more concerned, however, with calculations involving two decimal numbers of any size. They must involve the user in programming his own floating-point software package — a very complex and store-consuming business.

Secondly, as I read it, the RAM is 1K, expandable to 4K, not 4K expandable to 16K as stated. The misunderstanding probably arises from the assertion that 1K RAM on the ZX-80 is worth 4K anywhere else.

G K Blackwell,
South Brent,
Devon.

Short record

IN THE Feedback pages of your excellent magazine, much space has been devoted to the subject of holo-alphabetic sentences — sentences which contain all 26 letters of the alphabet.

In the twentieth edition of the *Guinness Book of Records* is the following entry under Words, shortest holo-alphabetic sentence: The contrived headline describing the annoyance of an eccentric in finding inscriptions on the side of a fjord in a rounded valley as "Cwm fjord-bank glyphs vext quiz" represents the ultimate in containing all 26 letters in 26 letters.

Peter Ansell,
Cambridge.

QWERTY query

I AM surprised and delighted that QWERTY query in January, 1980, has produced so much correspondence, but I would like to point out my original letter does state short sentences. Anyone with enough vocabulary can write a sentence containing all the letters if they make it long enough.

The best English example I have been given is in 29 letters: quick blowing zephyrs vex daft Jim. Nobody has yet offered the solution to whether Sir Isaac Pitman or Lewis Carroll is the father of the 'quick brown fox'.

I would like to thank Jones and Frogg — Feedback, March, 1980 — for the only

foreign one I possess, but what is 'le bicles'? Nobody seems to know.

Finally, I might add to Roger Standing's letter in Feedback, April, 1980, that we are trying to form the one-word compound German noun, which contains all 26 letters.

Larry Mascall,
Berkely,
Gloucestershire.

East Anglian users

A FEW friends and I have recently started a computer user group to cater for both amateurs and professionals in East Anglia. Anyone interested should telephone Norwich 402311 or send a SAE to me.

Jan Rejzl,
128 Templemere,
Sprowston Road,
Norwich NR3 4EQ.

Ninth Basic

IN REFERENCE to my article, Eight Basics for Nascom, which appeared in the April 1980 issue of *Practical Computing*, I have since received a copy of the new XTAL Electronic XTAL Basic 2.2.

It is a much-enhanced version of their XTAL Basic 2.1 — the version described in the review — and is now the only Basic sold by XTAL. In addition to a number of new commands and a superlative piece of documentation, it includes the ability to define your own reserved words directly, driving machine code routines in such a way to allow you to create a totally individual Basic to your own specifications.

Nick Laurle,
Langport,
Somerset.

Library software

WE HAVE been commissioned recently by the British Library to compile a directory of microcomputer software suitable for library and information use. While we realise that there is little software written expressly with the library and information market in mind, our initial work shows that many commercially-available packages can be adapted for our purposes.

The problem is discovering the existence of such packages in the first place. We are reasonably confident about gaining information on the more obvious software, but the possibility exists that a less-

(continued on page 52)



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(continued from page 50)

well-known package might escape our net.

For that reason, would anyone, i.e., OEM, software house, user group etc., with a potentially-relevant applications package contact us?

The only incentive I can offer, is the possibility of some free publicity. It might be worth considering that the libraries and information units of this country do form a sizeable, and hitherto largely-untapped, market.

Microcomputers have penetrated this market, but only to a very small extent — one of the stumbling blocks is a lack of knowledge about available software.

Bob Winfield,
Aslib,
London WC1.

Inspiration

THE SIGHT of the 10-move win against the Microchess program on level 8 in your April, 1980, issue inspired us to do some work on the machine, and produced a seven-move defeat.

White	Pet (black)
1 E2-E4	E7-E5
2 D1-F3	D8-F6
3 F1-C4	F6-E7 ?
4 D2-D4 Pawn sacrifice	E5-D4 accepted
5 C1-G5 Bishop sacrifice	E7-G5 accepted
6 F3-F7 Pawn regained	E8-D8
7 F7-F8 Bishop regained	You win

At least it occupies less space.

A D Mitchell and Ashton Delauncy,
Sittingbourne,
Kent.

Chess problems

I HAD problems with Maurice Fozzard's chess game in *Practical Computing*, February, 1980. However many times I reset the chessboard, I could not make Pet respond with G8-F6 on the first move. Only after playing the first move would it proceed with the game as written.

Peter Jennings's Microchess 2.0 is receiving a good hiding now. Does anyone know of another Microchess program for Pet or in 6502 code? If so, let's hear about it. Thank you for a very fine magazine.

B N Bidgood,
Manor Park,
London E12.

Hi-fi interface

I RECALL reading somewhere, not in a specialist computing journal, that in the future we may see home computers linked closely with not only TV systems but also with stereo equipment, especially once digital recordings have become widespread.

Nowhere, however, have I seen mention of this in a computing journal, neither in an article or in advertisements placed by the manufacturers or retailers of small computers.

It would seem that some simple moves might be made now, especially as I feel many may share interests in both hi-fi and computing. Mention is often made of using home computers to store and retrieve recipes — perhaps to convince wives of the value of their husbands' hobby — but I suspect a greater potential might lie in cataloguing music collections, on disc or tape, especially the latter if many home recordings are made.

It is not a simple task, without a computer, to keep in touch with a large, and perhaps changing collection, and some real benefit could, therefore, arise from such a system. Later the concept might be extended to direct retrieval of a recording on receipt of the appropriate command. I would be interested in any comment on these ideas.

P F Fagan,
Brunssum,
The Netherlands.

In West Sussex

A MICROCOMPUTER club has recently been formed in Crawley, West Sussex. The club is open to anyone interested in personal computing, with or without their own computing facilities.

It is the intention that meetings be held weekly, with the publication of a monthly or bi-monthly newsletter containing system ideas and suggestions and relevant technical information. Those interested are welcome to contact me.

J Fieldhouse,
18 Seaford Road,
Broadfield,
Crawley,
West Sussex.

Game-playing

IN RESPONSE to George Blank's article in April on game-playing, may I add that many of those programs do not tackle their instruction sheet properly? For example, in *Zombie*, published by you a few months ago, you are forced to wait about 30 seconds for the instructions to appear, which, when they do, vanish before you have had time to glance at them.

A time loop could be added, of course, but would it not be simpler to have them printed-out before the computer started its preparations, so we could read while we wait?

Richard Devey,
Horsham,
Sussex.

Sharp reminder

I HAVE bought a Sharp MZ80-K with 22K user RAM, after close evaluation of its competitors on performance and price.

I intend to form a London and south-east Sharp MZ80-K user group to enable

all members to exchange ideas, software, etc. Anyone interested should telephone me in the evening on Hornchurch (STD 04024) 42905. Affiliation of the group to other user groups will be considered later depending on the response from members.

Joe Seet,
Hornchurch,
Essex.

Program Power

IT HAS been apparent for some time that there has been a lack of software for Nascom 1 and 2. We are certain that a substantial number of near-professional standard programs have been written, but knowledge of them probably remains with the author or his local Nascom club. Not least among the reasons will be the variety of monitors which have been available at one time or another.

To remedy the situation, Program Power has been established to act as a form of program exchange. We will undertake to make programs available nationally to owners of Nascoms, at a price which will enable us to pay reasonable royalties to the authors.

We hope this will generate the enthusiasm to finish those brilliant ideas which are almost saleable programs and perhaps create a few more original thoughts. We shall be concentrating on 8K Basic and machine code programs.

Any authors of Basic programs written for TRS-80, Pet or other micros who could provide listings for conversion to Nascom should also contact us.

R G Simpson,
Program Power,
5, Wensley Road,
Leeds LS7 2LX.

Open to cheating

CONGRATULATIONS on *Maze Runner* in *Practical Computing* April, 1980. However, I felt the author laid a challenge in saying that a routine to check that all Xs have been removed would slow the game too much. The game is wide open to cheating as written.

A line to achieve the result is:

```
275 Q1 = PEEK (15425) : Q2 = PEEK (15486) :
Q3 = PEEK (15841) : Q4 = PEEK (16318) :
IF Q1 AND Q2 AND Q3 AND Q4 <> 88 THEN 380
```

Line 340 becomes redundant so delete it. An alternative is to insert the routine at line say 345, change 340 to read after 'THEN' 345 instead of 380. Update your instructions to suit.

Bugs and typographical errors are:

```
Line
450 IF S(W) > S(I) THEN W = I
620 SET(X,0) : SET(X,47)
710 T = T + 1 : IF T = 40 THEN RETURN
```

Keep up the good work.

A K Waller,
Moseley,
Birmingham. □



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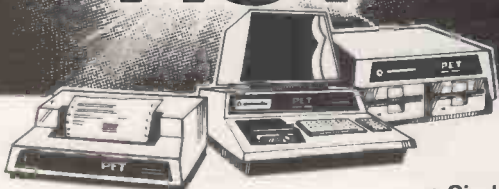
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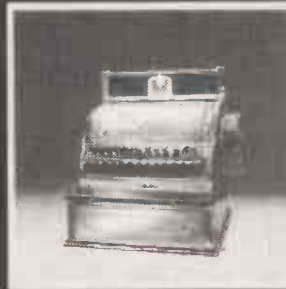
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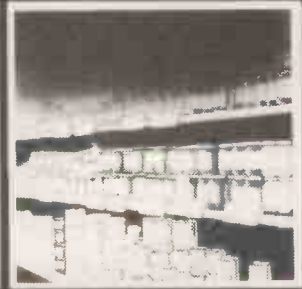
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• Circle No. 176

Schools given Apples worth £30,000

APPLE microcomputers worth £30,000 have been given to specially-selected schools by the U.K. Apple importer and distributor, Microsense Ltd. The schools were selected in co-operation with Mini and Microcomputers in Secondary Education (MUSE).

Seven schools which have already received the systems include those for the blind, handicapped and deaf as well as primary and secondary schools.

MUSE intends to ensure that the Apples are used to develop software which will help other schools starting their own micro projects. At the presentation

of the valuable equipment, Mike Brewer, the chairman of Microsense, said that the equipment was being donated in an effort to increase public awareness of Apple computers.

The gifts should also provide more opportunity for the development of educational software. Half of the money has been advanced by Microsense and the rest by Apple Inc, the U.S. manufacturers of the computers.

John Coll, MUSE chairman, explained that the schools had been selected on the basis of letting as many people as possible benefit from the gift.

He went on to reveal that

the £30,000 would pay for 12 systems, one of which would be kept for the MUSE librarian to develop a program library for Apples. Apart from the seven already allocated, four systems will be held by MUSE for short-term loans to schools for special projects and weekend courses. A full set of peripherals will also be kept by MUSE.

Microsense has followed its gift with a special offer of 25 percent off the basic price of an Apple system for any school.

A folder with details of the offer has been sent to 36,000 schools in the U.K.

Good home needed for PDP-15

BIRKBECK College, London, has a PDP-15 which it wants to donate in July or August. A good educational home could have it for nothing, but they would have to pay for moving and be prepared to spend about £5,000 a year on maintenance. It uses the DECTape operating system. Write to Mick Farmer, Department of Computer Science, Birkbeck College, 12 Gower Street, London W1.

Best-selling software

THE FORCE behind Petsoft, Applied Computer Techniques, is diversifying into software for the Apple II microcomputer. The new company, Appeware, has been launched with a catalogue of 75 established best sellers such as the Personal Software VisiCalc.

Appeware will charge £125 for this program; the popular Apple Data Base will retail at £23.50. The new company intends to develop some of its own business packages. The existing Petsoft network of distributors will be used, along with all the Apple dealers.

Disc covers

IF YOU have ever felt unhappy about the idea of sending your discs through the post, to *Practical Computing*, for example, a Coventry company, Swan Packaging, has produced a simple idea to protect them. It will supply Discpacs in two sizes, for 8in. and 5¼in. discs. The Discpac is supplied flat but folds easily and quickly to make a firm postal package which will protect up to six discs. The 8in. packs sell at £44 for 250 with discounts for cash on delivery and larger orders. The 5¼in. packs start at £28 for 250. Swan recommends that all discs are wrapped in metal foil before posting.

Home computer which talks

A HOME computer which talks is how Texas Instruments plans to market the TI-99/4, now available at more than 20 distributors in the U.K. Texas Instruments hopes to break into new sectors of the market with a sustained advertising campaign.

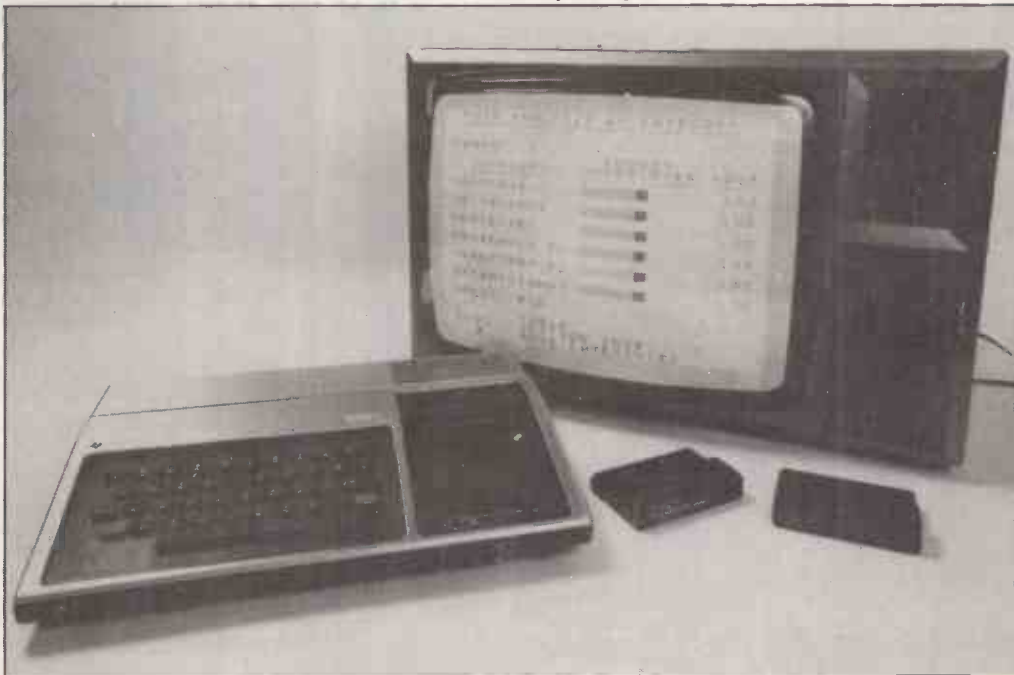
Built round the TI-16-bit 9900 chip, the computer consists of a console with 16K of RAM, a sound generator, full-colour graphics and an optional speech synthesiser. As yet the system is compatible only with the U.S. television standards so the price of nearly £1,000 includes a new 14in.-colour monitor. Texas Instruments consumer division general manager, Ian Davies, claims: "There is a certain utility in this. When people buy the system they will also be buying a second colour TV set".

The computer is supplied with a range of plug-in firmware modules, each with 30K of ROM, including programs for chess, grammar for children and a household finance package. A software module which will use the speech synthesiser to teach

children how to read is still in the prototype stage.

For the home programmer the TI-99/4 has Basic in 14K of ROM. An RS232 adaptor is available as an accessory and floppy disc drives should be on the market later this summer.

The Texas Instruments TI-99/4 for home computing.



Simple, but effective

A NEW product consisting of a sheet of card, a sheet of paper and a plastic folder is now available. Sounds simple and it is.

The paper is marked with a grid corresponding with the POKE numbers for the Pet memory display locations. The grid can be used for planning complicated graphics before any figures are entered into memory.

The pack is provided with a water-based, felt-tipped pen so that marks on the plastic can be wiped away. The grids are only available for the Pet but others are expected to follow soon. Details: Impex Enterprises, 12 Wallscourt Road, Filton, Bristol, BS12 7NS. □



THE LATEST offering from Centronics is the Model 737 matrix printer. It was designed for the microcomputer-based small business system market and offers high-quality print. It also has new features such as the ability to print subscripts and superscripts. Price £650 Centronics, Burgess Hill (04446) 45011.

Special prize for inventiveness

THE WINNERS of the British microprocessor competition — *Practical Computing*, December, 1979 — have been announced by Sir Keith Joseph, the Secretary of State for Industry. The competition was sponsored jointly by the National Research and Development Corporation (NRDC) and the National Computing Centre (NCC).

The competition attracted more than 200 entries, with 125 of those in the main category of working models. The first prize went to Sinar Agritec, of Egham, Surrey, for a small, portable meter to measure the moisture content of grain.

Although all of the prizes were awarded for applications involving microprocessors, only one centred on a micro-computer. An entry from Graeme Harker and Anthony McKay of the Royal Grammar

School, Newcastle-upon-Tyne, won a special prize of £500 for inventive flair.

Using a standard 32K Pet, they developed a system for controlling the stage lighting for their school's drama society. The software, written in machine code by Anthony McKay, allows all the lighting sequences for a performance to be programmed, enabling the operator to develop lighting routines which would previously have been physically impossible.

The lighting control system, which has already won the BBC Young Scientist of the Year Award, is now attracting the attention of several companies aware of its commercial potential.

In his speech, Sir Keith Joseph stressed that the Government supported the expenditure of tax payers'

money for educational programmes to educate the public about future technologies, but that industry should be left to develop by itself. He said that he would like to phase out Government support for the micro industry were it not for the discouragement of enterprise by the last Labour government. □

Programmer-time savings

SAVINGS of up to one-third of programmer-time are claimed by Phipps Associates for a new software product for the Panasonic JD range. The product is issued in permanent ROM-form for writing directly in the processor.

John Phipps, who founded his company recently, explains that the VDU monitor software handles all operator communications with the

Survey shows satisfaction

THE CONTROL Data Institute has conducted a survey of the 2,000 people from its computer-operating, programming and engineering courses.

From almost 500 replies, CDI learnt that 97 percent are still working in the computer industry and more than 90 percent are satisfied with their career progression.

The responses show that while 50 percent of the programmers have remained in the same position, 25 percent have advanced to programmer/analyst or senior-programmer level, while one had become a dp supervisor within a year of completing the course.

The survey also showed that a successful career in computing does not require any particular background — 33 percent of programmers are from clerical jobs and 19 percent had backgrounds in manual work. □

Wang system

THE RAPIDLY-GROWING U.S. mini-manufacturer Wang is to release a new bottom-of-the-line system with an integral Winchester disc for \$12,000. □

Free maintenance service

ONE OF the most common complaints *Practical Computing* receives is about the cost and quality of the maintenance service offered by microcomputer dealers, so it was with a certain amount of scepticism that we investigated a note which claimed that a group called Alpha Research has departments in computer software, electronic equipment, meteorology, botanical

surveys, library research and any others you care to name. The note continued: "Just in case you are worried about the cost, don't. There isn't any charge".

We discovered that members of Alpha Research work and study in each of the areas listed and, in a philanthropic gesture, decided to use their spare time applying their skills for free. One of the experts, Lee Cooke

summarises their computer experience as Pet, Basic and Machine Code; Z-80 mainframe computer, Crememco control Basic; Compukit UK101, Basic and machine code; and Apple II and Basic only.

Their offer is to help anyone who really needs it. Contact Lee Cooke, Alpha Research Group, Worthing, Sussex. Tel: (0903) 41633. □

machine and checks all data keyed by the operator before passing control to the applications program. In doing so, it provides a simulated protected field capability for the visual display unit.

The package is compatible with CP/M or the Basic operating system. Phipps Associates is based in Epsom, Surrey. Tel: (78) 212 15.

CAP Microproducts, the micro software arm of CAP-CPP, has signed Distributed Data Processing as its first vendor of MicroCobol for the Panasonic JD range.

This latest vendor agreement follows the recently-announced agency deal with Comart to market MicroCobol on the Cromemco System 3 and brings to 16 the total number of systems on which MicroCobol has been implemented. These include the PDP-11, the Sord 223 and the Triton 3. □

Software company based on years of study

THE MARKET for good software for the more popular microcomputers is now strongly established. Whereas a few months ago companies talked of making long-term investments in the market to mark their territories, big money is now being spent in the expectation of a tidy profit in months rather than years.

A company has been formed to produce microcomputer software with the backing of a massive Dutch insurance group and the experience and contacts of the well-known

Nascom word-processing package

A WORD-processing package, Naspen, has been introduced for the Nascom 1 and 2 microcomputers. It is available in two versions: VS.1 for Nas-Sys monitors and VT.2 for Nasbug T4 — it is not suitable for Nasbug T2 and B-Bug.

The package should be used with 16K of RAM but 8K can be used provided the pointer to the top of RAM is altered. All

IBM stand-alone

IBM HAS launched its 5120 stand-alone computer at £5,577, £2,773 less than its nearest counterpart, the IBM 5110. It includes a screen, keyboard and two diskette drives.

computer consultant, David Hebditch. The new company, Microtrend International, has more than 125 programs for the Pet, Apple, TRS-80 and CP/M-based micros and by the end of the year nearly twice that number should be available.

The Dutch insurance group, Centraal Beheer, has funded the operation through its larger computer bureau subsidiary, CSR. CSR studied the mini, and now the micro market, for seven years before making its move. The first decision for the

the commands are direct-acting and single-character. Nascom Microcomputers Ltd, 92 Broad Street, Chesham, Buckinghamshire.

company was to find and hire a competent external advisor and according to Harry Costa, the new company director of research, CSR spotted David Hebditch speaking at a conference. The company followed him through seminars and conferences for nearly three years before deciding that he could be approached.

The final decision to finance the software company was taken slightly more than 18 months ago. The launch has been delayed deliberately until a viable product line could be presented to the public.

All the software will be produced by Microtrend Ltd, in the U.K., while the worldwide distribution and marketing of the line will be handled by Microtrend International in Amsterdam.

U.K. factory for Puma robot

CONSPICUOUSLY missing from the electronics revolution so far are not devices and applications, but large numbers of good, old-fashioned entrepreneurs with the self-confidence and drive to get things done. Jo Engelberger, president of Unimation, the U.S. robot manufacturer, reminds one irresistibly of those dynamic American millionaires immortalised by

PG Wodehouse: "Men who think on their feet and do it now".

Unimation recently announced its intention to establish a U.K. factory for its Puma industrial robot, backed by £420,000 from the NRDC and £240,000 from the Department of Industry, and sited in Telford, Shropshire. The decision to build the factory should mean about

New graphics board

R-SQUARED LTD, specialists in systems based on the Vector Graphics microcomputer now has a new high-resolution graphics board available. Intended for use with the Vector Graphics high-speed 8K RAM memory board, it is S-100-bus-compatible and can be used in any S-100 bus microcomputer with room for expansion boards. The board operates in digital output or 16-level, grey-scale modes. R-Squared is based in Crowborough, Sussex. Tel: (08926) 61587.

Geest family

GEEST MICRO Systems has launched a family of microcomputers based on the TI 16-bit micros — the TI 9900 and the 990/5, with one set of accounting, stock-control and payroll packages and another for civil and structural engineers. Each system has 64K RAM and the top of the range can take up to 200MB of hard-disc storage.

The Unimation Puma robot going through its paces.



100 new jobs in Telford by 1983.

The new venture is only the second robot manufacturing unit in the U.K. The NRDC says that it is anxious to invest in U.K. companies wanting to manufacture robots and design and build associated systems.

Jo Engelberger lists 10 problems which need quick and economic solutions: rudimentary vision, tactile sensing for orientation, hand-to-hand co-ordination, computer-directed appendage trajectories, mobility, compactness, energy-conserving musculature, general-purpose hands, voice communications, and inherent safety.

The main resistance to the use of Robots in the U.K. has been, according to Engelberger, not from the unions but from managements who, he believes, have gone into negotiations with the unions whispering robots as a way of frightening them.

He believes that this pump-priming investment from the NRDC and the DoI will prove a considerable stimulus for developing software to control Unimation robots.

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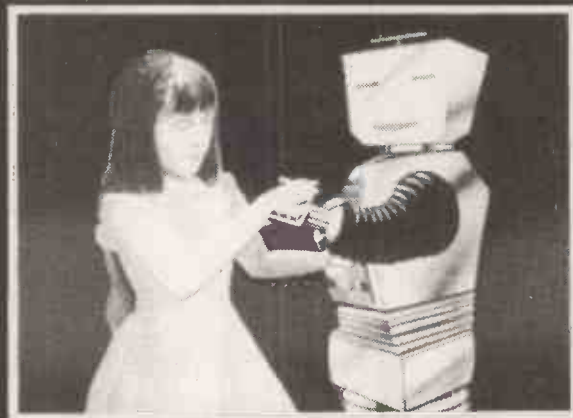
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Panasonic JD-700U heads Japanese challenge

THE JAPANESE challenge in the field of very large scale integration (VLSI) micro-electronics has been in the news a good deal recently. The Panasonic 700 is part of the first wave of newly-announced and exhibited Japanese microcomputers. Now that major Japanese companies have entered the microcomputer market, how does a machine like the Panasonic compare to the already-available U.S. and British machines? Japanese products have an enviable reputation of offering very good value for money with high reliability. Does this new challenger in the micro-computer market continue in the same tradition?

Attractive package

The Panasonic JD-700U computer is a desk-top-type computer with a 12in. screen, full alpha-numeric keyboard and two mini-floppy disc drives all built into an attractive package. It is, however, reasonably large, occupying an area of about 2ft. x 2ft. and is heavy at around 66lb.

The machine is based not on some new Japanese VLSI technology but on the U.S. Intel 8085A at 2MHz, with 64Kbytes of dynamic RAM on the version under

review. The keyboard includes the alpha- numerics in the QWERTY lay-out, separate numeric keys, cursor control keys and some 21 special-function keys. The computer has, unusually, three serial ports claimed to be standard RS232C types. There are no convenient parallel I/O ports.

Delivered with the machine were two mini diskettes labelled respectively CP/M

by Vincent Tseng

and Basic, along with a manual for each. There were at first sight, no instructions for setting-up, but it seemed simple enough; just plug-in the mains plug and switch-on at the power switch at the front of the machine. Being the cautious type, I ensured that there were no diskettes in the drives on powering-on.

Signs of life showed in the fan, and the LED indicating access on the disc drives lit on drive one, two and then one again, with the usual drive active sounds. Then a message which read "SET DISKETTE" appeared on the screen, the access light on drive 1 remained on but there were no more sounds than the fan.

Hitting keys on the keyboard at this

stage, including control-C, had absolutely no effect. The mini diskette, with the required operating system, CP/M, was inserted into drive 1, and within a few seconds the system was active with the usual CP/M prompt of "A " on the screen, but surprisingly the normal announcement message of CP/M and the version number was not there.

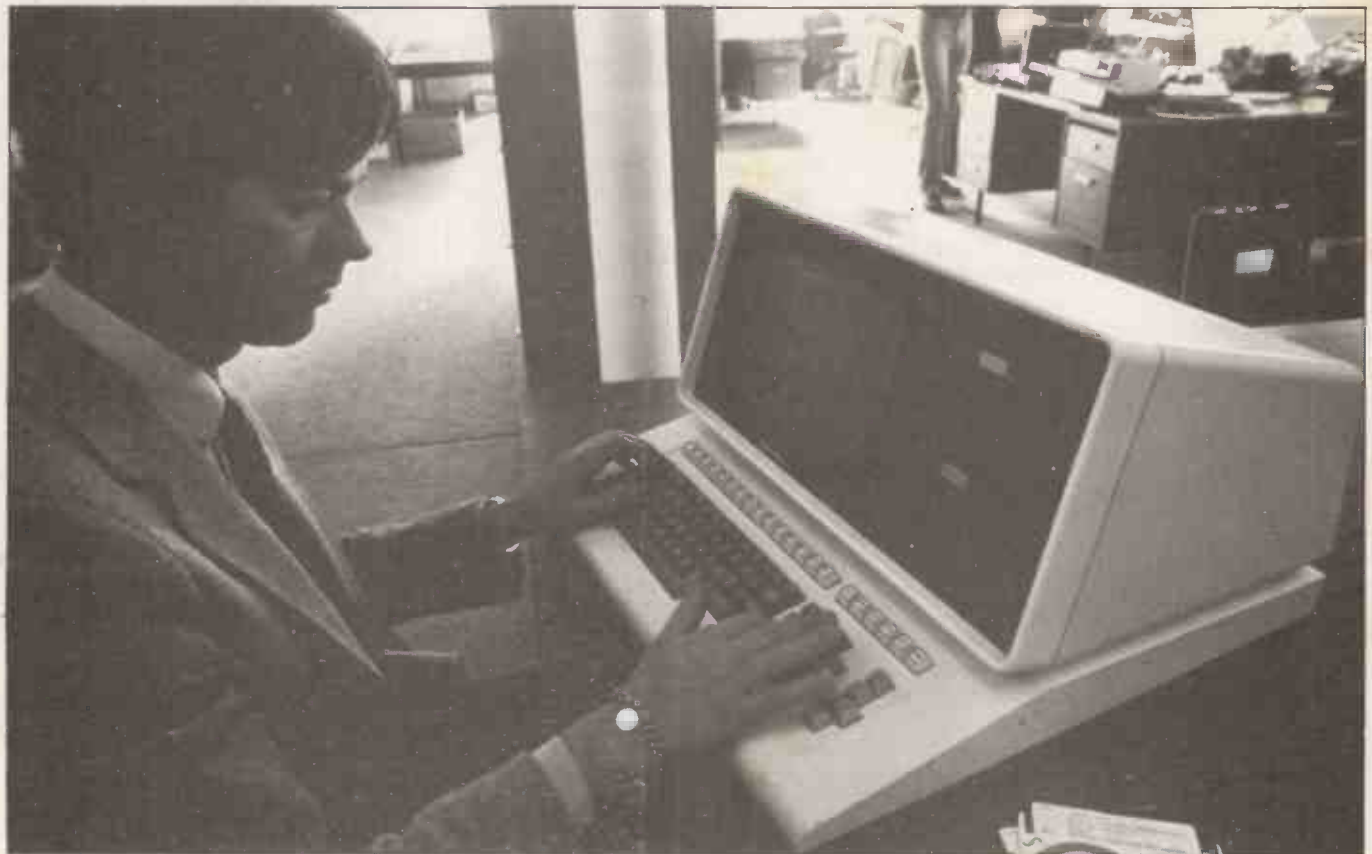
Mention of the version number, 1.4, was eventually found in the manual, toward the back, on some of the listings of routines, and in section 10 which showed the differences between versions 1.3 and 1.4. Using DDT and displaying sections of memory, DDT announced itself as "DDT VERS 1.4" and a copyright message for Digital Research was found in memory at 100H.

Basic disc

The Basic disc was inserted into drive two and a CP/M DIRectory executed for drive two, or B:, but showed nothing. Worried that a corrupted or blank Basic disc had been delivered, a STAT command was tried for drive two — this time there were three large files shown but the file names were jibberish.

In case the Basic did not work under
(continued on next page)

Ian Patterson of APT Computers Systems, London, demonstrating the Panasonic JD - 700U



(continued from previous page)

CP/M, the Basic disc was booted-up on the system by inserting the disc and powering-on and this time Basic Rev. 5.0 (Matsushita Version) by Microsoft announced itself on the screen.

The 12in. screen used green phosphor, and displayed both upper- and lower-case characters with very good clarity and definition right across the screen and into the corners where there was a slight deterioration.

There was a slight, but noticeable tremor in the image displayed. 80 characters x 24 lines in a claimed 12 x 7 dot-matrix format were capable of being displayed. The relatively large dot matrix in a 14 x 10 field accounts for the high legibility and definition of the characters as well as allowing true descenders in lower-case alphabets.

The phosphor of the screen had rather long persistence, particularly noticeable in low ambient light conditions. When scrolling the screen, for example, the previous lines take discernable time to fade away, making the screen unpleasant to view when characters are changing.

Lower-case

When switched on, the keyboard is initialised to lower-cased alphabets. To obtain the upper-case, one needs to use the shift key as on a normal typewriter, or the shift-lock key. The shift-lock key is of the non-latching type, so that the only indication that it has been activated is the response to keys hit displayed on the screen.

Unlike typical terminal or VDU keyboards, the shift-lock key works as a normal mechanical typewriter. When activated, all keys hit generate the characters shown on the upper symbols of the keys. On most terminals, the shift-lock is, in fact, a capitals lock key for alphabets only, so that when the top row of combined numerical and punctuation keys are used, they still generate numerics. To access the punctuations, one uses the shift key, which when released does not affect the capitals lock key.

The shift-lock key on the Panasonic 700 is de-activated when the shift-key is used — again, as on a mechanical typewriter. There may be contention that this is a sensible system as it is adapted more easily by an accomplished typist of the typewriter variety, but may confuse people more used to terminals and VDUs.

I certainly found it frustrating, even though I am used to both typewriters and VDUs. I think it must be the fact that there is no indication that the shift-lock key has been activated, and that the shift key can de-activate it with no indication, other than responses to keys hit.

One grows used to seeing lower-case commands when entered from the keyboard. Both CP/M and Basic will accept those as if they were indistinguishable from upper-case.

One annoying feature is that the often-

used DElete key is an upper symbol combined with an underline dash. That means that DElete has to be used with shift or when the shift-lock key is activated. Also control lower-case "c" is not recognised by this particular version of CP/M, and only an upper-case control-C will cause a re-boot.

CP/M is a well-known operating system for 8080-, 8085- and Z-80-based machines — see Rair Black Box review, *Practical Computing*, November, 1979. It was developed by the U.S. company, Digital Research. It worked reasonably well on the Panasonic and the only problem I encountered was that on one diskette, after formatting it and using the ERA B:*.* command to ensure all files were

Summary specifications

CPU —	8085A
Clock rate —	2 MHz
Memory —	32K or 64K (delivered) bytes of 4116 dynamic RAM. 2K of 2716 EPROM for boot- strap. 2K of 2114 static RAM for screen.
Mass storage —	2 x mini-floppy disc drives claimed Shugart-compatibility storage 60Kbytes under CP/M and 70Kbytes under Basic.
Screen —	12in. green P39 phosphor, dis- playing 80 characters x 24 lines of 7 x 12 matrix in 10 x 14 field.
Keyboard —	94 keys with alpha-numeric in QWERTY lay-out. Operation similar to mechanical type- writer. Separate numeric keys, cursor-control keys and 21 special-function keys PF1- 15, PE1-6.
I/O —	3 x serial I/O RS232C-type, no convenient parallel I/O.
Software —	2 separate operating systems CP/M 1.4 or Basic.

deleted from it, I was still unable to write or transfer any files to it.

CP/M indicated that the directory was full on that disc which resisted numerous attempts to write to it despite formatting, erasing and using SYSGEN — initialising as system disc.

That disc was later capable of being written to under Basic and, having been formatted and erased under Basic, was capable of being written by CP/M after the usual format and erase. The problem remains a mystery and may suggest an undiscovered bug in either the operating system or the machine.

It was not surprising to find that the version of Basic interpreter was by Microsoft. The Basic diskette, however, was not compatible with the operating system CP/M. It had, in fact, its own stand-alone operating system and was capable of booting-up on its own.

It has all the usual language features as found in the more usual Microsoft Basic (Rev. 5.0). Good string-handling functions, transcendental functions, as well as the TRON and TROFF commands to give debugging facilities.

There were extra commands for the

Basic operating system, such as MOUNTING and REMOVE discs, and an executable file of "UTY" — utility routines — which had functions for formatting, initialising and clearing discs. The MOUNT and REMOVE commands were to allow access to the discs and to remove the access when necessary.

It was essential to execute the REMOVE command before removing any disc, to avoid the risk of corrupting the allocation, or directory, information, and losing further access to data stored on that disc.

That was very inconvenient — it is all too easy to forget to use the REMOVE command before removing or changing the disc, with disastrous consequences to both the removed and the newly-inserted discs. The allocation information is stored and updated in memory and is, therefore, not correct for the newly-inserted disc and can cause total loss of information.

That was not a feature I liked, and it cannot be recommended for anything but non-serious use, as it is too prone to operating errors, with the accompanying loss of data.

Having also tested Microsoft Basic Revs. 4 and 5 before, I was surprised to find the timings for the benchmark programs to be very slow, in the region of twice as long as the timings for the Rair Black Box — also 8085A. It probably was due to the fact that this version of Basic also contained the operating system and the slower clock rate for the 8085A — the maximum clock rate for the 8085A is 3MHz.

Special function

A feature which I liked was the provision of special-function keys. There was a row of keys along the top of the keyboard arranged in two groups, labelled PF 1 to 15 and PE 1 to 6, making 21 in all. The PF keys worked under the Basic where they had the same effect as the execution of a Basic command-statement line, and any statement line was assignable to any key — they are user-programmable.

That was useful, as often-used commands can be assigned to a PF key and called-up by a single key-stroke. Those keys are initialised to certain useful functions on booting-up the Basic system and are listed in the Basic manual.

I did not find mention of the PE keys in the manual except for PE1 under the EDIT command where it was used as control-[to end an insertion. Attempts were made to find out the characters generated by the PE keys by writing a short routine in Basic using INPUT and PRINT, but to no avail.

The special function keys did not appear to operate under CP/M which was a pity. There were also cursor control keys on the keyboard and although they could move the cursor around under both Basic and CP/M, there was no screen editing as with Nascom 2 — *Practical Computing* April, 1980 — and, therefore, they were

of no operational value under the two systems.

The capacity of the inbuilt, twin, mini-floppy disc drive was very low as the recording format was single-density. That gives only about 60Kbytes storage per drive under CP/M. The specifications in the OEM manual claims 70Kbytes.

This limited storage tends to make business use difficult but not impossible. Serious consideration should be given by the manufacturer to upgrading the recording format to double-density, if not to double-sided — neither is offered as options at the moment.

Good access

Access into the computer was good, the logic was contained on one single, but large, circuit board, accessed from the bottom. All components were soldered directly to the board, including all the LSI 40-pin chips. That is not a good thing for easy servicing, unless total board exchange servicing was envisaged. Most of the components were from Intel, Texas Instruments and Motorola.

Almost all the RAMs were of Japanese manufacture, though. The 4116s, dynamic RAMs for the computer memory and the 2Kbytes of static 2114 for the screen memory, bore the Mitsubishi trademark and the three 8251 USARTs were by NEC, a second source for Intel.

Despite 64Kbytes of RAM, addresses above F800H were not accessible, tested

Background

The Matsushita Electric company was founded in 1918 and has since grown to be the largest corporation in Japan and one of the largest in the world. Turnover last year exceeded £4,400 million. There are more than 110,000 employees, producing 10,000 different products and manufacturing most of the components. Panasonic is part of the corporation.

Teletronics in the U.K. won the distributorship for Matsushita office products when there was a clear division between office and consumer electronics. Now, as the two markets have started to overlap, Matsushita has bought Teletronics and changed its name to Panasonic Business Equipment (U.K.) Ltd. The address and telephone number are 9 Connaught St, London W2, 01-262 3121.

Panasonic intends to concentrate its efforts on the smaller end of the business computer market and the JD-700U reflects this aim. Rather than announce and develop entirely new systems, the company hopes to improve progressively the Panasonic range. The next major announcement expected will be a new version in the JD range with an integral Winchester technology hard disc and a single floppy drive.

under CP/M DDT, and showed that there was a wrap-around of addresses every 100H bytes and the character generator ROM resided in that region.

The disc drives, claimed to be Shugart SA104-compatible, had the National symbol and the keyboard PCB looked as though it was of Japanese manufacture.

Two manuals were supplied with the machine, for CP/M and Basic. The Basic manual gives operating instructions for setting-up but it does not mention that

this was a version which included a self-standing operating system.

The manual was very much like the standard Microsoft Basic manuals — the information is there but you have to look for it and know what to look for.

The CP/M manual was the standard from Digital Research, brief and useful for reference.

Conclusions

- Particular shortcomings were in the long persistence of the phosphor of the screen, the non-terminal operation of the keyboard with no indication of the activation of the shift-lock key.
- Of more serious nature was the low capacity of the mini-floppy discs, common to all mini-floppies recording on single-density, and not peculiar to the Panasonic.
- The awkward operating procedures in Basic were too prone to dangerous errors.
- The question remains, why did they not use the usual CP/M-compatible Basic from Microsoft, instead of having two operating systems?
- My disappointment may have been caused by unduly-high expectations about the quality of the Japanese challenge in the microcomputer market.
- It has attractive packaging, programmable special functions keys and the Japanese reputation for high reliability.
- The machine reviewed costs in the region of £4,000.

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VisiCalc is a general-purpose modelling system written by Dan Bricklin and Bob Frankston of Software Arts Inc, Massachusetts, and designed to run on Apple II or ITT 2020 with a minimum configuration of 32K RAM, a floppy disc or tape and a printer.

DUBBED THE 'Electronic Sheet' by its authors, VisiCalc has gone on sale in the U.K. as a financial-modelling system. At £100 the system will, we expect, find many users in the fields of engineering and science, education and statistics as well as in finance and marketing. In fact, in any field where tabular reports of rows and columns of calculated numbers are used, VisiCalc will be a very powerful tool.

It has the added attraction that no knowledge of programming languages is required — though, a knowledge of Basic further extends its capabilities. To extend the machine to its full requires some study, but most should be able to use it with a few hours' practice and soon after will be able to produce working models.

Addressed array

Simply speaking, VisiCalc allows the user to build a set of calculations within a table — an addressed array — having a maximum width of 63 columns by a maximum length of 254 rows. At each address in the table — accessed by a row and column co-ordinate — the user may enter a value or a formula telling the system what relationship that value has to any other value in the array.

The screen acts as a window on the sheet or table and can be moved around easily to illustrate values and their formulae in any part of the table.

VisiCalc is geared to answer the 'what if' question so often asked of employees and usually requiring an answer five minutes ago. Once a basic model is established in memory, values may be plugged-in at any point and re-calculation occurs, or calculation rules can easily be altered with the

same instantaneous result. Once written, models may be stored on cassette tape or floppy disc and recalled at will.

When loaded, VisiCalc initialises an array for the user and displays the top left-hand side of the table through the 'window' or screen shown above. The highlighted top row shows the column

by Mike McDonald

labels A, B, C and so on. The first column indicates the row numbers 1, 2, 3, up to 20.

The balance of the table, although not displayed, is out to the right of that portion shown for a total of 63 positions. Labelling of the columns is alphabetic — A to Z, AA to AZ and then BA up to BK. The row numbers continue downwards to 254.

The user has four key motions of up, down, left and right to move the cursor, displayed above as a white bar at position A1, round the table to any co-ordinate. At the top of the display are three lines of information. The top line tells the user the current cursor address and the nature of the data in that field or any formulae which apply.

The next line down is used to display command options and sub-options, and the third line, blank as above, is the edit line where all keyed transactions are displayed and edited before being committed to the table. Anything typed in the edit line is assumed to apply to the field in which the cursor is positioned in the table, figure 5.

Each table position or address may be accessed either by physically moving the

cursor via key-strokes to that location, or by using one of the many commands consisting of a 'GOTO CO-ORD' by entering an address, i.e., B5 on the edit line.

The cursor then moves automatically to that location on the screen. If an address is outside the currently-displayed fields, the window scrolls to portray that region of the table in which the address resides.

Once the cursor is at the desired position, the user may enter information into that field. Our first working example is a very simple three-line model to calculate a gross margin from sales and costs figures entered.

With the cursor at A1 we simply type the word SALES. VisiCalc determines whether input is descriptive, numeric, calculative, or whether it is a command by examining the first character entered.

Alphabetic entry is taken as descriptive, numeric as a value. A '+' or '@' sign is calculative and '/' is a command request. The word SALES appears as typed on the edit line and RETURN places it in field A1 on our table.

Error correction

We then right-cursor to position B1 and enter the number 100. At the point of entry on the edit line, the user has the opportunity to back-space and correct any errors. On entering a RETURN or cursor movement, the value is accepted and transposed to the table. We cursor-down to positions A2 and B2 and enter the word COSTS and the value 60.

At A3, we enter GROSS and cursor-right to B3. Here we need a formula to subtract values B2 from B1. There are two ways to do this: either the formula

+B1—B2 may be keyed directly on the edit line or, after entering a '+', the cursor may be moved up to position B1.

As it is moved through B2, '+B2' appears on the edit line and is replaced by '+B1' when the cursor is moved-up again. A '-' keyed now fixes this value on the edit line and the cursor leaps back to position B3. The edit line now displays '+B1-'. An upward cursor movement brings it to rest on address B2 and 'B2' is tagged on to the end of the formula. The process is completed by hitting return; the cursor leaps back to B3, the value 40 appears under the cursor and the top line of the screen displays B3 (V) +B1—B2 — figure 1. That may sound long-winded but it illustrates that formulae may be built-up on a simple relational basis by using cursor movements instead of keyed values.

As each calculation is built-up, VisiCalc calculates the result automatically, although it may be suppressed if required. Once this simple model is set-up, the cursor may be moved to positions B1 or B2 and a new value entered. As each value is changed, the software notes the change on the top line and re-calculates the result at B3.

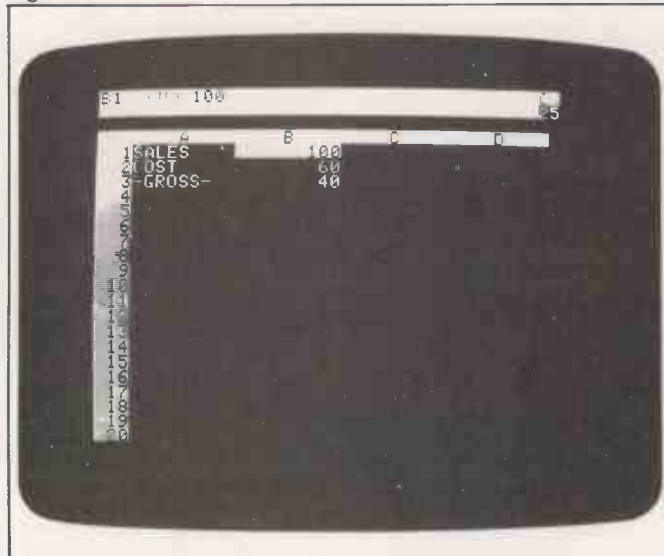
The cursor is moved through each field on the screen and its characteristics are displayed on the top line showing its location, nature — i.e., V for value or L for label — format if numeric, and value or applicable formula, figure 1.

Accounting rules

The accounting rules have now been established for the first column of our model. The next step is to duplicate it across the sheet to allow for, say, six months of data, i.e., six columns. To repeat previous transactions would have been tedious and time-consuming. VisiCalc solves this problem with a Replicate command.

Replicate is accessed by entering a '/R' and requests a source range of rows of columns and a target range. Once entered, it displays the value or formula to be

Figure 1.



Commands and their sub-options

Only the first character of each command is entered.

- /Blank — blanks the current cursor address.
- /Clear — clears all values, formulae, and labels from memory. Requires confirmation Y or N? before execution.
- /Delete — deletes either Row where cursor resides or Column where cursor resides.
- /Format — formats current field to:
 - Default — resets all formats to that set under /Global command of each individual field.
 - General — sets current field to free format.
 - Integer — sets current field to integer value.
 - \$ — sets current field to decimal 2 places.
 - Right — right justifies label string at current field.
 - Left — left justifies label string at current field.
 - * — causes graphical representation of value in *.
- /Global — options include:
 - Format — as stated but applied globally.
 - Column — column width setting, value entered.
 - Recalc — A or M? sets re-calculation to automatic or manual.
 - Reval — R or C? sets evaluation order by row or column.
- /Insert — R or C? inserts a row or column at current cursor position.
- /Move — From and To? moves row or column to any other position in the table.
- /Print — To? prints selected array from table

starting from current cursor position to entered address.

- /Replicate — Source : Target? Relative & No Change? duplicates formulae across rows and columns and alters source expression to become relative at each new address.
- /Storage — Load disc file, offers display of existing files
 - Save file to disc, entry of filename.
 - Delete disc file, entry of filename.
 - Initialise new disc
 - Write file to cassette
 - Read file from cassette
- /Titles — Horizontal, fixes horizontal title in place against scrolling at current cursor position. Vertical, fixes vertical title in place against scrolling at current cursor position. Both, as for both horizontal and vertical. None, cancels any existing title option.
- /Version — displays current version title of software package.
- /Window — Horizontal, splits screen into two sections with a horizontal divider showing column letters. Vertical, splits screen into two sections with a vertical divider showing line numbers. I, returns screen to single-window format. Simult, permits simultaneous scrolling of screen in both windows of split-screen formats. Unsynch, turns-off synchronised scrolling in split-screen mode.

transferred, offering the option of making the formula relative to each column / row.

It would be pointless duplicating the formula +B1—B2 in every position. By requesting relative option, VisiCalc then places a formula in each position, altering the column label, i.e., at C3 ÷ +C1—2, D3 ÷ +D1—D2 and so on. Our transaction takes the following keyed format:

```
/R
SOURCE RANGE?
B3...B3:
TARGET RANGE?
B4...F4
B1—B2 RELATIVE OR NO) CHANGE?
```

When we have done this, we are able to move the cursor to each position of sales and costs data and enter values. On each entry, VisiCalc produces the correct result on the third line. Equally we could use the /Replicate command to reproduce the values at B1 and B2 all the way down the

line to avoid unnecessary keying effort.

A simple formula at C1 of +B1*1.1 would cause the sales figure in column B to be increased by 10 percent and placed in column C1. That could also be replicated down the line causing a single entry at B1 to be increased by 10 percent for each period.

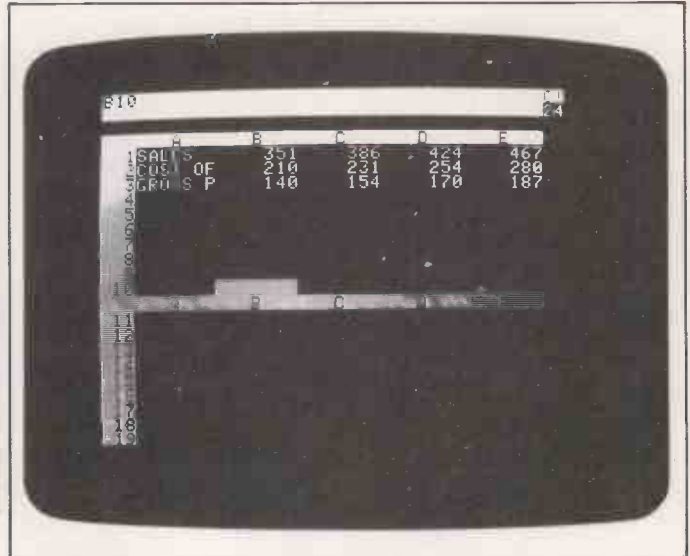
The /Replicate command is undoubtedly VisiCalc's most powerful command and saves considerable time when we start to work with more complex models.

Screen limitation

One limitation of the Apple system is the 40-character screen width. VisiCalc does scroll, but titles down the left-hand column A or in row 1 can disappear from the edge of the screen when scrolling occurs and often the user will need to examine one portion of his model and the bottom line or totals column simultan-

(continued on next page)

Figure 2.



(continued from previous page)

ously either in development or running phase.

The program caters for this in several ways — see figures 2 and 3. The default column width is set to nine characters on starting-up. That may be reduced Globally with a /Global command. Reducing the global column width to seven characters allows us to display columns A to E in the previous example.

The Global command applies to all fields in the table but merely reduces the information displayed without affecting the accuracy of the number.

The window may be split into two discrete windows either horizontally or vertically to duplicate row numbers or column letters. Cursor movement and scrolling in each side of the display are independent of the other half. The split will occur wherever the cursor is positioned on the screen, and is actioned with a /Window command with options of H for horizontal or V for vertical splitting.

Simultaneous

Thus if we were to calculate a total in column G, we could display columns A to D on the left side of the screen and G on the right side. All amendments to data on the left are rippled through to the right as re-calculation occurs.

For very large models, scrolling may be geared so that both sides move simultaneously, displaying columns or rows remote from each other — figure 4.

To avoid losing line names or column headings when scrolling, a /Title command allows the user to fix such fields on either a horizontal or vertical axis or both. Any scrolling will not affect these lines until the /Title option is cleared.

Each data field may have one of several formats. /Format may be used when keying data into addresses to set the display of numbers to integer, decimal fixed two places, or free format.

Free format is not justified and will use scientific notation on large numbers, i.e.,

1,000,000 ; 10E5. Text or label fields may be right- or left-justified individually. The format of the whole screen may be affected from the /Global command with the /Format as a sub-option.

Therefore, selecting integer format while developing an application combined with a narrow column width allowed us to display up to 12 columns at once. They were later expanded to the correct width and format.

Once a model has been set-up the user may save it away on a disc or tape. The functions accessible through the /Storage command are:

Save — saves all entries, titles and window settings currently in force to floppy diskette.

Write — as for 1, but to cassette.

Load — loads saved models from diskette and re-instates them as saved.

Read — as for 4, but from cassette.

Delete — deletes specified file from disc with a Y or N confirmation request.

Initialise — formats a blank diskette for use by VisiCalc.

VisiCalc saves models under user-nominated file names and stores them on disc or tape as text — ASCII — files. When loading back into the system, the software asks the user for the file name to be loaded and the user may cursor — through displayed entries on the disc to select one.

File names may be up to 30 characters in length. Models are loaded to memory exactly as they were last accessed, including cursor positions, permitting development work to continue with minimum fuss.

Calculation rules or formulae entered against each field are entered as normal algebraic expressions with the usual operator notation of $\frac{1}{2}$ — / * and either field addresses as the operands or numeric constants.

Two unusual features built into the formula entry procedure are: When a formula of, say, +A1/B2, has been entered, the user may key a '!'. VisiCalc will retrieve the numeric values at positions A1 and B2 automatically and

evaluate the expression, replacing the formula with its numeric result; using the same formula +A1/B2, an entry of '#’ will cause VisiCalc to replace the last address (B2) by the numeric value currently at address B2.

Those facilities offer the user a useful debug or substitution method when building complex expressions.

On entering a formula for a field or altering a value in a field, VisiCalc re-calculates the whole sheet automatically to reflect the changes. That may be suppressed by switching-off the option and entering a ‘!’ when re-calculation is required. The program also has a number of built-in routines that may be used in formulae:

@SUM(RANGE) — computes the sum of the values in the range.

@MIN(range) — computes the minimum value in the range.

@MAX(range) — computes the maximum in the range.

@COUNT(range) — returns the number of non-zero entries in the range.

@AVERAGE(range) — calculates the average of the non-blank entries in the range.

@NPV(dis, range) — calculates the Nett Present Value of the cash flows in the range, discounted at the rate specified by dis.

@LOOKUP(v, range) — compares value v to the values in the range and places cursor or calculation in the next logical position.

@NA — results in a ‘Not Available’ value which makes all expressions using the value NA.

@ERROR — results in an error value which makes all related values equal error.

@PI — results in 3.1415926536.

@ABS(v) — produces an absolute value of v.

@INT(v) — results in an integer value of v.

Maths functions

The following maths functions are also available and are self-explanatory;

@EXP(v) @SQRT(v) @LN(v)

@LOG10(v) @SIN(v) @COS(v)

@TAN(v) @ASIN(v) @ACOS(v)

@ATAN(v)

The range value may consist of row or column addresses entered as a range or individual values. The user may define the

Figure 3.

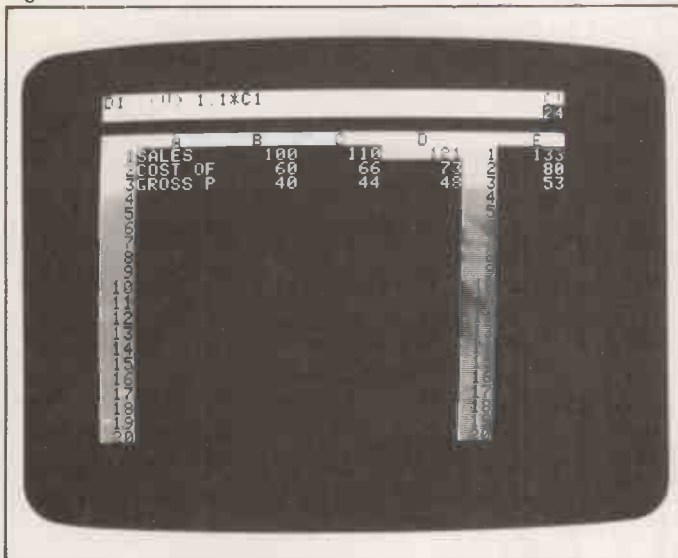


Figure 4.



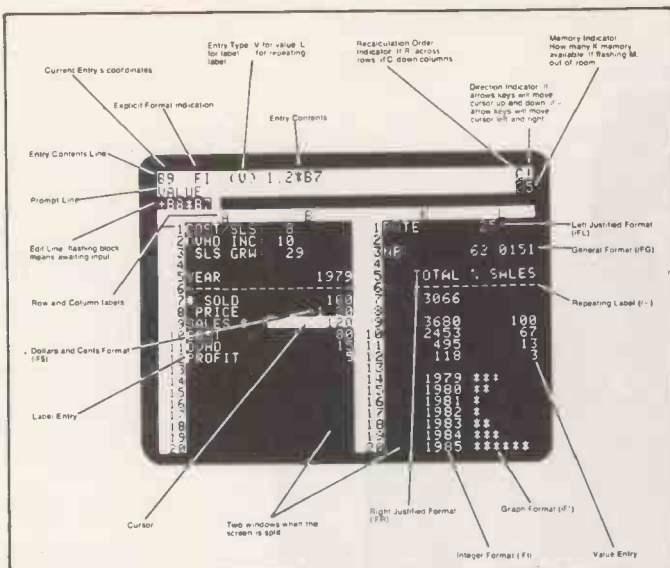


Figure 5.

order of calculation in terms of columns of rows, i.e., the default is calculated down each column, starting at column A. Calculations may be formed so that evaluation is by row across the screen.

Unlike other programming languages, VisiCalc evaluates formulae from left to right rather than in order of priority. Brackets may be used to nest calculations, but will not force the order of evaluation.

Three simple edit functions are provided to modify models or amend them at a later date to include new additions or deletions: /Delete — Row or Column must be specified; once this is done, a deletion occurs at the point where the cursor is resting. Any subsequent rows or columns are brought forward to replace deleted member. /Insert — as for Insert, a row or column is added and the balance re-shuffled to accommodate the change. /Move — requires the user to cursor from source to destination or simply to enter the appropriate addresses for either row or column adjustments.

The software package has a /Print feature designed to produce a hard-copy listing of the sheet. The print facility is simple to use and the only options are the nomination of the top-left-hand and bottom-right-hand corners of the array to be printed.

Flexibility

That allows a certain flexibility in producing reports. The image printed will duplicate exactly the data displayed on the screen. We felt it would be useful if the print routine allowed the user to print-out the related formulae for each screen address, as there appears to be no way to obtain it in hard-copy form.

Also lacking was the facility to add any additional headings or frills to the report. The fact that each model and its current logged values are stored as text information on the diskette does mean that Basic users can access the files from user-written programs to produce tailored reports. Otherwise VisiCalc is not specifically

geared to produce special reports. One sub-option within the /Print command, is the ability to create a print file on diskette.

One of the features of the format command is the ability to represent integer numbers by a row of asterisks corresponding to the size of the number. It means that with careful modelling we were able to produce reasonably good bar charts from column-oriented data, i.e.,

A	B	C
No	FUNCTION I	FUNCTION II
1	@	@@@@@@@@@@@
2	@@	@@@@@@@@@@@
3	@@@	@@@@@@@@@@@
4	@@@@	@@@@@@@@@@@
5	@@@@@	@@@@@@@
6	@@@@@@	@@@@@
7	@@@@@@@	@@@@
8	@@@@@@@@	@@@@

With expanded column format and the print option, we were able to obtain good plots on the printer of various functions, and formulae.

Documentation

The standard of documentation for VisiCalc is good. The user manual is bound in a neat A5 ring binder which includes the master software floppy diskette and a reference card with most options indicated.

The manual is more of a training aid than a reference text and certainly leads the user through the features of the package with ease. There are very good sections on obtaining the best results from the software and facilities.

There is also a user registration card for the purposes of software updates and news. Another section describes the VisiCalc dynamic memory allocation method. It simply means that as memory is used and released, the software expands the dimensions of the memory used automatically or contracts upon deletion of rows or columns.

Core is allocated according to the size

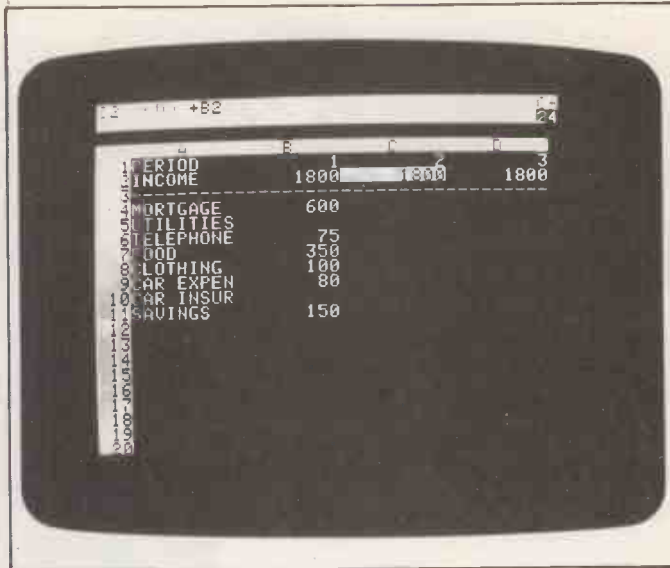


Figure 6.

of the current array. If a bottom right-hand co-ordinate is addressed, VisiCalc pre-allocates room for the values which may well occupy any intermediate positions.

On the top-right-hand side of the display are two indicators. The very top corner will contain a C or an R to indicate the order of calculation through the model and flashes when the CPU is in mid-calculation. Below that is a two-digit memory-free indicator which updates itself constantly as the model is developed or modified.

The indicator flashes if the memory capacity is approached. Another nicety of the system is the correction against the re-set being pressed. Unfortunately, the Apple II re-set button cannot be disabled from the software. VisiCalc cannot recover from this fatal action but enters automatically the /Storage mode in the event that re-set is hit.

The user is also advised against making cyclic errors in addressing and designing models and advised how best to avoid such problems.

Conclusions

- We found the VisiCalc to be a highly-professional software tool which caters for many possible users and errors.
- It is extremely versatile and very powerful for any application requiring tabular calculation.
- The documentation is very good and covers all aspects a user is likely to encounter.
- The program may be used on a very simple or very complex level to produce highly satisfactory results.
- It is unfortunate that the Apple display is limited, but every possible facility has been provided to help the user overcome this handicap.
- VisiCalc is loaded as a machine code routine and occupies 26K of RAM, including DOS.
- We were unable to find any bugs in the program or to crash the system. □

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Off-line

I GROANED. Pat had just made the most stupid move. "Mate in one", I said quietly and shut my thoughts so that he couldn't metaplex my opinion.

"What"?

"You're about to put yourself in check from my bishop", I explained and moved to take his rook. "And my rook. Check-mate".

"Oh damn".

I felt charitable. "Do you want to go back and restore the queens to their original places"?

"No", he grumbled, becoming petulant.

Outside the wind screamed. It was already up to three hundred kilometres an hour. I'd retracted all the antennae on the landers and lowered the floors as far as they would go but I still felt we'd both soon be torn off our feet. "Sounds like a demented banshee", I muttered.

My companion didn't answer. He had problems and I'd tried to protect him as much as I could. But it was the sand. In spite of all the protective shields and masks, it continued to blast through everything and coat the old respiratory valves.

"Mike, what's a banshee" he queried suddenly.

"I meant the wind". Why did he have to ask such idiotic questions? How was I to know? It was just a word I'd heard sometime in the past, used by the others when we'd first landed on this wretched planet. And that had been a long time ago.

Miserably I stared at the space between the VDUs on the two consoles in my cabin. There was nothing else to look at. Outside was a solid wall of sand and I knew the wind might go on for another month or more.

Or it might stop as suddenly as it had started.

Since the breakdown of the long-range detector, and because of Pat's worsening condition, we couldn't find out what was going on above the crater in which we'd taken shelter. At least, not as quickly as I'd have liked. Pat couldn't move about much now and there was little point in my going anywhere without him. For one thing, there wasn't anywhere to go. If it wasn't sand, it was rock, and if it wasn't rock, it was ice, with crevasses and canyons that yawned sometimes for more than a hundred kilometres, and we weren't stable enough to caterpillar-out of those any more.

A few times we scoured down a gully 20,000 kilometres long, right to the

equator. We had gone all round the northern hemisphere sampling soil and setting-up experiments of various kinds. But now we had to stay near the pole because my companion couldn't travel and we needed water if we were to survive and continue our job. I supposed the expedition was important, but I was heartily sick of it, and of continual chess games.

It was nearing nightfall when the wind dropped abruptly and I glimpsed a patch of mauve sky between the last flying sand particles. Fed up with playing chess, I shifted about to get more comfortable. Then something happened which froze me

by Caith Gill

to my seat. The hatch to the cabin had opened without my conscious control.

"Checkmate"! Pat shouted in elation at the same moment. Then he gave a gasp. "Mike, the hatch".

There was a flurry of sand and something heaved itself inside.

"What the hell have you let in"?

I was too amazed to do anything. "I don't know. I didn't let it in". I stared at the creature. It was tall, almost reaching the ceiling. On an impulse, I glanced at the calendar on the wall by the table. The oddly-shaped figure in the picture was faded, but I fancied there was a resemblance.

At fancy, however, the similarity stopped. The animal that had walked in front of me had a smooth white skin with a smear of red dust on its feet. It tilted itself from side to side and I guessed that the black slit at the top was a sensory organ — an eye probably.

"Then how did it get in" Pat snapped. "And are you just going to let it wander all over our experiments"?

Without thinking, I slammed the hatch shut.

"That was a stupid thing to do. Now it can't get out, you fool".

But the intruder showed no sign of alarm — merely of curiosity.

"Mike", Pat whispered with surprising calmness, "we're not supposed to pick up aliens. It's part of every basic instruction that we don't interfere. Contamination, remember".

That jolted me into a response. "You choose some bright times to throw basic instructions at me". I grated. Then I burst into an uncontrollable laugh. "What the hell do you think we've been doing all these years then, if not examining and

cataloguing alien life forms? This is the chance —".

"Yes but it's different from anything else we've found. It isn't exactly microscopic, is it? So what the devil are you going to do about it"?

"Report it to base"?

I wasn't happy. In the early days of the expedition I used to work by the book, reporting every detail. But I'd wised up since then. After all, we didn't know what they did with our reports and frequently the subsequent demands hadn't been to our advantage. Even less, since Pat's illness had developed. So now we just went on gathering data and I sent off a report intermittently, when I felt like it. This seemed to give them too much to think about and they hadn't bothered us for ages.

With growing apprehension I watched the creature walk over to the row of potted plants above Pat's VDU. "It seems able to detect the plants, but doesn't pay the slightest attention to us".

"Then do something, for God's sake".

Pat was almost squeaking with rage. He could become irritated over the tiniest thing, without having aliens prodding at his beloved plants and the other experiments he'd set up.

I made a hurried scan of the immediate vicinity outside but couldn't find anything else like the animal that had appeared so miraculously in my cabin. "Where has it come from, that's what I want to know? The planet's atmosphere shouldn't be able to support anything this size".

"Mike"! My companion was becoming exasperated. He moved, the lander's body lurching upwards out of the sand drift as he did so.

Even though the creature was in my cabin, the floor shifted and I watched in horror as it grabbed at the table for support. "Don't do that". I hissed. "You could harm it, even kill it".

(continued on next page)

"We're not supposed to pick up aliens. It's part of every basic instruction that we don't. Contamination, remember".

(continued from previous page)

"Maybe that's what we should do".

"Are you mad".

But there wasn't a wrinkle in the white skin of the animal and it seemed unperturbed after the initial shock.

"Do you think it can hear us"? said Pat, regaining his composure.

He was so damned unpredictable.

"Well it doesn't seem able to see us properly, so presumably it can't hear us either", I answered. Then an idea occurred to me.

Before I could go on, the alien suddenly lifted its hands and removed the ball it had on top. Underneath was another ball for all that I could see covered with cilia-like growths similar to the flagella on

Pat was becoming hysterical.

some of the protozoa we had examined from a dig under the glacier. I felt a rush of excitement.

"No wonder we've never come across this thing before". Its action had just confirmed my tentative idea. "It's wearing protective gear of some sort so it doesn't live on this planet. That means it must be intelligent, otherwise how could it have got here"?

"That makes matters even worse. You should never have allowed it to get near us, let alone into your cabin. You realise it could kill all my plants"?

"Your plants, what about —"?

"That's what I mean. It's a hazard to us, and to everything we're doing. You must get rid of it. Or I will".

The creature spun round. With a shock, I realised I was looking at a head and face. Pat was becoming hysterical.

"Wait", I cautioned.

It slipped out of its synthi-skin protective gear, which crumpled on the floor around its ankles. The pale flesh so revealed had a warm translucency and the curvature of the upright spine was highlighted by the same flagella as on the head, but minute and golden.

It was the same creature as depicted on the calendar — *Playboy* nineteen-something-or-other, it said.

I stared as it sat down comfortably in the moulded chair, its hands hesitant, then caressing the keys.

To my astonishment it logged on. A vague but pleasant memory stirred. It had been a long time since I'd had to answer visually. "THIS IS MARTIAN IN-DEPTH KIRLIAN ELUCIDATOR", I printed up on the screen, "MIKE FOR SHORT".

The corners of the protozoan mouth turned up slightly. We've found you at last". The creature tapped easily on the keys. "Well Mike, we can now return you two ancient mariners home to Earth, update you, and put you back on-line".



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Every day, millions of newspapers and magazines are distributed around the U.K. to more than 35,000 newsagents. Each has to judge his own market and keep close track of any change in demand. In these two reports, Duncan Scot looks at a wholesale newsagent in Peterborough, who supplies to more than 130 newsagents, and at a retail newsagent in Wisbech, Cambridgeshire. Both proved ideal applications for the microcomputer.

NEWSPAPERS HAVE always excited interest — the masses read them as avidly as MPs and governments and are ready to be swayed by arguments exploring new fringes of ignorance. The Sunday newspapers are perhaps the most potent. During the week there is never enough time to devote to the kind of news they provide, but on Sunday we receive a full-frontage blast of pre-packaged culture as the supplements eat-up the hours before lunch.

Authoritative

Their authority gives them a certain fascination, but there is as much drudgery in the newspaper business as any other and as the papers roll hot off the presses, the teams of packers and drivers work to send their editions on trains round the country where distributors are waiting to

continue the process through the night.

The first editions of the Sunday newspapers are printed by early Saturday evening. They then enter a complex distribution network which has to deliver copies as far afield as Mallaig and Padstow at the same time as the last editions are being dropped by van in London. Special British Rail trains, shared by all the papers, rush each edition to local distribution centres around the country. The system has hardly changed since the war.

As the *Times* and the *Daily Mirror* would testify, new technology has never been readily accepted into the world of newspapers except perhaps in the provinces, which is where we discovered a local distributor using a microcomputer to speed the news to our breakfast tables.

Desmond Westrope owns and runs a

Sunday newspaper wholesale business in Peterborough, Cambridgeshire, where, every Sunday morning, he and his team of drivers and packers, deliver to all the newsagents within a 20-mile radius. From the time the first-edition train pulls in at 1.30am, until well after the crack of dawn, more than 130 newsagents are supplied with their weekly orders.

Franchises

It takes time to establish oneself in this business. When Westrope inherited the business from his father there were three major competitors in the area, and he had the franchise for only a few of the national papers. Over the years, he has managed to pick-up all the franchises and gain the trust of the newsagents, which may prefer small independent wholesalers.

There is no question of having to work for only one day a week. The 15 van drivers are all subcontracted and spend the rest of the week working for WH Smith & Sons. In the meantime, Westrope, and his son David, catch up on the rest of the business.

"On Mondays and Tuesdays my son drives round all the newsagents and collects the returns — the unsold papers — and sorts all the stops — changes in orders — while I update the accounts", he explains. "Then on Wednesdays the Sunday magazines start to arrive".

The *Sunday Times* and the *Sunday Telegraph* prepare their magazines several weeks in advance, share the same printers and use the same transporters to deliver the magazines around the country, in time for sorting and delivery during the rest of the week.

The exception to this is the *Observer*, which is printed in Bristol. "They don't have enough print capacity", continues Westrope. "So they try and print the whole of their *Sunday Plus* section earlier in the week". But in practice things can go wrong and it can arrive anytime between Thursday and Saturday, leaving little time to sort and deliver before Sunday.

"The sooner we can send all the supplements to the newsagents, the more time they have to sort them for their customers before the Sunday rush, and the more time we have to catch up with our accounts and make sure that our packing lists are right".

Before the special train arrives early on Sunday morning each of the newsagents

Q/SC		Q/SC
0/8	SUNDAY MAIL	0/8
2/9	SUNDAY POST	2/9
6/0	NEWS OF THE WORLD	0/0
12/22	SUNDAY EXPRESS	0/22
13/16	SUNDAY MIRROR	1/16
13/9	SUNDAY PEOPLE	1/9
6/0	SUNDAY TELEGRAPH	0/0
4/10	SUNDAY OBSERVER	4/10
8/11	SUNDAY TIMES	2/11
0/22	WEEKEND	0/22

in the area has a packing list written out in his name. It sound like a simple, if not tedious, task but the printing industry uses some unusual ways of counting.

Newspapers are counted in units called quires packed into bundles; the number of quires in each bundle varies depending on the newspaper. To add to the confusion, each newspaper thinks that a quire is a different number of newspapers. For example, the *Sunday Times* has 20 newspapers to a quire; the *Sunday Telegraph* 26, and some of the others 25. So drawing-up a packing list can involve considerable calculation.

If one newsagent would like an order including 341 *Sunday Mirrors*, the order would be marked as 13/6 which means 13 quires and six additional single copies. There are 12 quires to each bundle for the *Sunday Mirror*, so the packer has to take one bundle, one quire and 16 single copies. With 10 newspapers to be sorted for more than 130 newsagents, and with different orders every week, the paperwork involved can be daunting.

The accounting is no easier, as Westrope explains: "Each of the newspapers offers a different discount to the wholesaler and to the retailer. Every week I have to go through every single newsagent and every single newspaper to calculate the amount of money taken and who will have what share. There is a good deal of work involved".

Paperwork

With the passing of his middle years and his business still continuing to grow, Westrope has begun to feel the strain of all his work. About two years ago, still unwilling to hire full-time staff, he decided he had had enough. "I really felt", he explains, "that I was becoming desk-bound with all the accounts, paperwork and invoicing and that I was not spending enough time out and seeing our customers, which is where our business is. You have to keep in contact."

"It was taking me nearly two days every week to look after the accounts and to make sure that they went out on time, and this was before I could even start thinking about the packing lists and everything else, like the VAT forms and paying the van-drivers".

Potential

Realising the potential for computers, but unsure of where to look, he turned to a bureaux service in Nottingham which offered him a reasonably efficient but costly service with a terminal in his office at the back of his home. "I was wary of them from the start", he explains. "I wanted to have everything under my own control here and, of course, it is quite expensive compared to buying your own system, but I didn't know that then. I was also unhappy about the lack of flexibility."

"It was a real nuisance to have any of the details altered week by week and we could work only during office hours. When you work for yourself you sometimes like to

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BOX NO. 15

17/02/80

PETERBOROUGH

	Q	SC	EXTRAS	RETAIL	TOTAL
SUNDAY MAIL		8		0.14	1.12
SUNDAY POST	2	9		0.12	7.08
NEWS OF THE WORLD	6			0.16	24.00
SUNDAY EXPRESS	12	22		0.18	57.96
SUNDAY MIRROR	13	16		0.16	54.56
SUNDAY PEOPLE	13	9		0.16	53.44
SUNDAY TELEGRAPH	6			0.18	28.08
SUNDAY OBSERVER	4	10		0.20	22.00
SUNDAY TIMES	8	11		0.22	37.62
WEEKEND		22		0.14	3.08

GROSS TOTAL	288.94
DISCOUNT	77.14
NET TOTAL	211.80
CREDITS	5.30
BAL. FWD.	404.72
TOTAL BAL O/S	611.22

work in the evening, especially when some of your work is in the middle of the night".

Convinced he could find a better system somewhere in Norfolk, he started looking at computers at stationery exhibitions: "I met a man in Birmingham who tried to sell me a Pet but he knew next to nothing about the system and we would have been in a real mess if anything had gone wrong. We would have had to pay for someone to come from miles away and they would have been busy charging us £16 per hour for the travelling time before they started to find out what was going wrong".

Towards the end of 1979 he attended a local office equipment exhibition and met the team of a local microcomputer systems house. "I explained the problem to them and they took away some samples of my work from the agency and said they would have a go at writing a program".

Within a few weeks Westrope tried a program, accepted it, with a few minor alterations, and transferred his business to it without the customary trial period, showing apparently more faith in the

system than the programmers themselves.

"The whole system was up and running within a few days. I got my son's fiancée to come in, as a touch-typist, and enter all the details of my business which then went straight into the system".

Matrix printer

The system is based on the Exidy Sorcerer with two mini-floppy drives built into the VDU and an Anadex matrix printer. According to Westrope it has been a real boon and for £4,500, well worth the investment. "I can now do all the work in a few hours each week. I just update all the information on Tuesday afternoon, once my son has all the returns sorted. So I am saving two days a week when I can deal with everything else, or just relax".

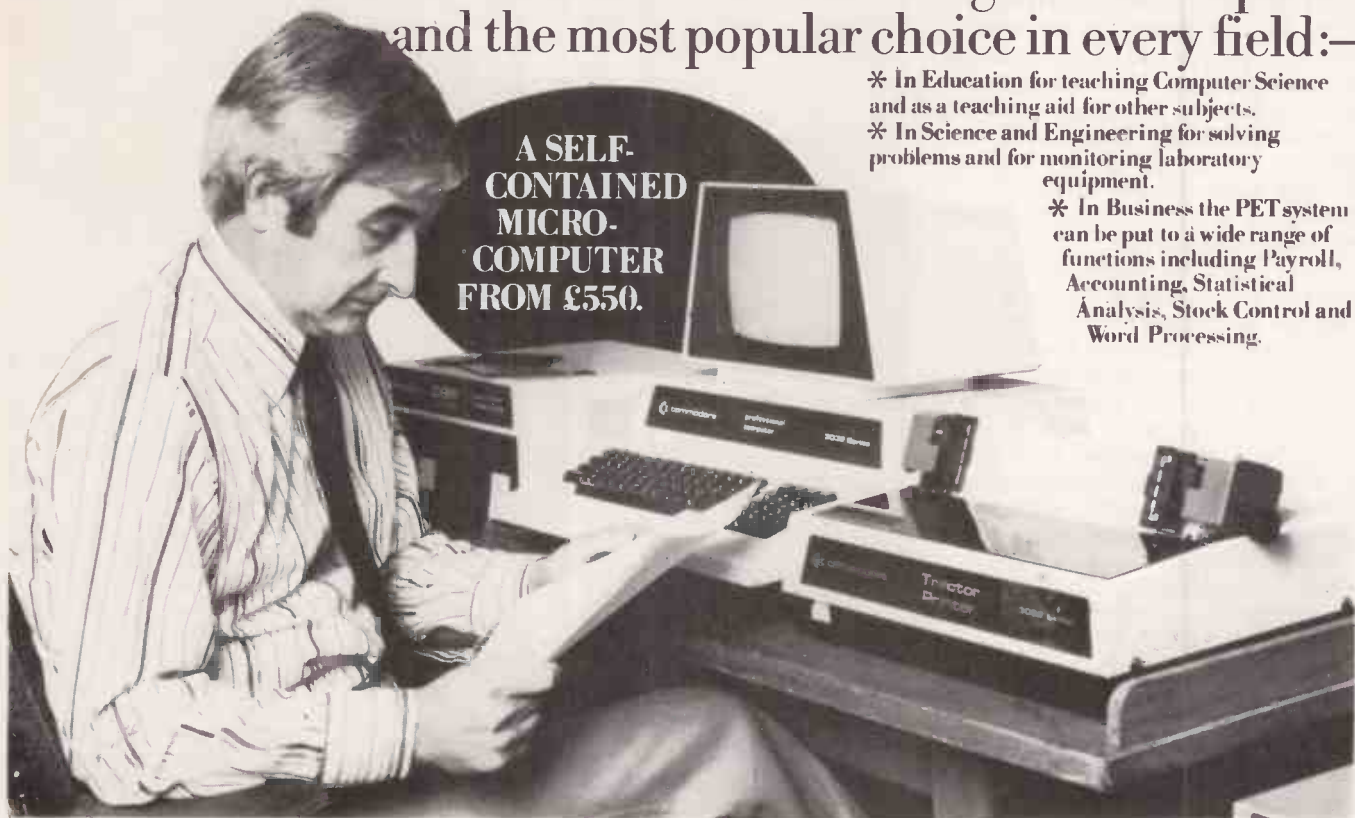
The operation of the system is simple and requires no specialist skills. When the program disc is loaded, the following choice of operations is displayed:

- 1 Add customer to file.
- 2 Display customer information.

(continued on page 75)

Your Commodore PET System

The Commodore PET is Britain's best selling microcomputer and the most popular choice in every field:-



* In Education for teaching Computer Science and as a teaching aid for other subjects.
* In Science and Engineering for solving problems and for monitoring laboratory equipment.

* In Business the PET system can be put to a wide range of functions including Payroll, Accounting, Statistical Analysis, Stock Control and Word Processing.

Not least of its attractions is the price of a PET - from £550 for a self contained unit, to under £2,500 for the complete system including Floppy Disk Unit and high-speed Printer. Ask your nearest Commodore dealer below for details about Commodore hardware, software and training courses.

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Bristol Computer Centre,
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Commodore

We made small computers big business.

Commodore Information Centre, 360 Euston Road, NW1 3BL. 01-388 5702

• Circle No. 185

(continued from page 73)

- 3 To amend customer details.
- 4 To delete a customer.
- 5 To update an order.
- 6 To produce packing lists.
- 7 To produce invoices.
- 8 To enter payments, credits and extras.
- 9 To access publications file.
- 10 To stop.

New details

The publications file has to be altered only rarely, when the list of Sunday newspapers changes or, for example, one of them goes on strike for a long period. On most Tuesday afternoons, Westrope chooses option number eight to feed in the details of any cheques he has received, and the value of the returns

from each customer from the previous Sunday.

The invoices will then be produced automatically when he accesses number seven. Later in the week he can update his order — five — and then at the last minute, print-out his packing lists using six.

He is still very cautious of the computer and is careful not to expect too much of it. He certainly has no plans to use his Sorcerer to teach himself Basic or to write some of his own programs although, in a curious way, he seems to resent some of the mystique which has grown around computing. Some of this resentment stems from the fact, from the time of his first flirtations with computing, that he could

never be sure that he had negotiated a good deal.

"It is worse than showing your books to your accountant", he says. "They say that have to know every intimate detail of your business and a good deal of it could be terribly useful to a competitor."

Real trust

"You have to find someone you can really trust, firstly because they get to know all about your business and secondly, if the system they sell you breaks down, you'll be putting your business at risk". Perhaps as the months roll by he will become more inquisitive about this box in his back room which magically saves him so much money.

Final link in distribution chain handled by micro

THE RETAIL NEWSAGENT is the final link in the distribution chain, although the sale of newspapers is seldom sufficient to keep a shop in business. At Poyser Printers, in the centre of Wisbech, Cambridgeshire, a small Fen town, daily newspapers play only a small role among nearly 1,000 other lines of stock. Poyser is unusual only in that it has recently transferred the business on to a microcomputer.

Stationer

The shop is really a small commercial stationer which has expanded over the years to include a printing works. The proprietor, Allen Snowden, bought the

company from the Poyser family shortly after the war.

As the business has grown, so has the amount of paperwork. The purchase ledgers, the sales ledgers, VAT and the payroll occupy almost the bulk of every working day, especially with so many lines of stock. "The buying of stock is a skillful operation", explains Snowden, "and you have to give yourself enough time to make sure that you are buying all the correct things. For example, we normally sell very few ring-pull binders and I keep very few in stock. With the steel strike, I thought that there would either be a shortage or that their prices would rise because the

major part of their cost lies in the steel. So I ordered a number of them. You have to think ahead in this business".

Accounts

The printing works developed more by chance. As three of his older workers retired, Snowden decided that it was time to invest in a small offset machine and some camera equipment. "To our surprise, the whole business took-off as we discovered that we could do virtually anything.

"While the printing works were just starting, we were very short of staff. I had

(continued on page 77)

Allen Snowden at the keyboard: "It would be much quicker if I could touch-type".



“If you want what’s best for your PET, choose Commodore software.”

Kit Spencer
General Manager,
of Commodore Systems
360 Euston Road
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The Commodore PET is Britain’s best selling micro-computer, with over 18,000 already installed in a wide range of fields, including Education, Business, Science and Industry.

This has led to a tremendous demand for high quality software.

And Commodore has met this demand by producing a first class range of programs, now available from the nationwide network of Commodore Dealers.

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Over 50 Petpacks of programs are available (mainly on cassette) from Commodore Dealers.

These cover such popular titles as Strathclyde Tutorial, Statistics pack 1, Assembler Development System, Stock Market Trends and the Treasure Trove Collection of game packs. Plus the new Arcade Supergame Series including “INVADERS” – quick to learn but difficult to master and already a No 1 favourite. Prices range from £5-£50.

TRAINING COURSES AND SEMINARS

PET systems are simple to use and any normal advice or assistance

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Commodore also produce a range of business software application packages on disk. They were created by leading experts specifically for the PET business system. Here is our current range:—

NEW COMACCOUNTS PROGRAM — £650 + VAT
This puts complete financial control at your fingertips, with immediate access to current and trial balances. It is an integrated accounting system with up to 650 Sales Accounts, 650 Purchase Accounts and 400 Nominal Accounts.

NEW computerised diary — COMPLANNER £50 + VAT
Business Information — **COMBIS £150 + VAT**
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you may need can be obtained from Commodore Dealers.

On the other hand, for rapid training on a basic or advanced level, you will certainly be interested in Commodore’s intensive 2- and 3-day residential courses. We also run one day general appreciation seminars.

PET USERS’ NEWSLETTER

This is Commodore’s official method of sharing new information and ideas between the many thousands of PET users. The newsletter is published regularly and for an annual subscription of £10 you can start receiving copies now.



Look out for this sign. It tells you that compatible products of other manufacturers have met with our standards of approval.



To: Commodore Information Centre, 360 Euston Road, London NW1 3BL. 01-388 5702



I am a PET owner Please put me in touch with my nearest dealer
Please send me details of: Commodore PET Software
Training Courses & Seminars I would like to receive the Users’ Newsletter and enclose £10 annual subscription

Name _____

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PC56

commodore
We made small computers big business.

• Circle No. 186

(continued from page 75)

one of the workers, Mike, doing all the accounts for me and in a moment of weakness, I offered to do them for a few weeks while they caught up with all their orders. I was also slightly worried about the number of discounts I was losing through settling our accounts late. If you time all your payments correctly you can save up to £100 every week".

He thought that it would be a matter of weeks before he could pass the accounts back to Mike, but as Mike became busier, so Snowden found himself spending more and more of his working time at his desk, getting further and further behind: "It is a time-consuming task. We work out our total sales from the till total every day, and then at the end of the week we calculate the amount which has to go on VAT. It is only maps and newspapers which are zero-rated. We have to place all our orders on Monday and Tuesday.

"I think it was last July, and I was becoming really fed-up and edgy, when my assistant, Mrs Robinson, told me about her son who was starting a micro-computer systems house in the area.

Systems house

"I knew nothing about computers. Some of our invoices were computerised but I didn't really think about it, and there is another company in Wisbech which went on to computers and, as a result, had to close for weeks. Its machine cost more than £30,000 so I put the whole idea out of my mind. Then I was told I could have a complete system for £3,000".

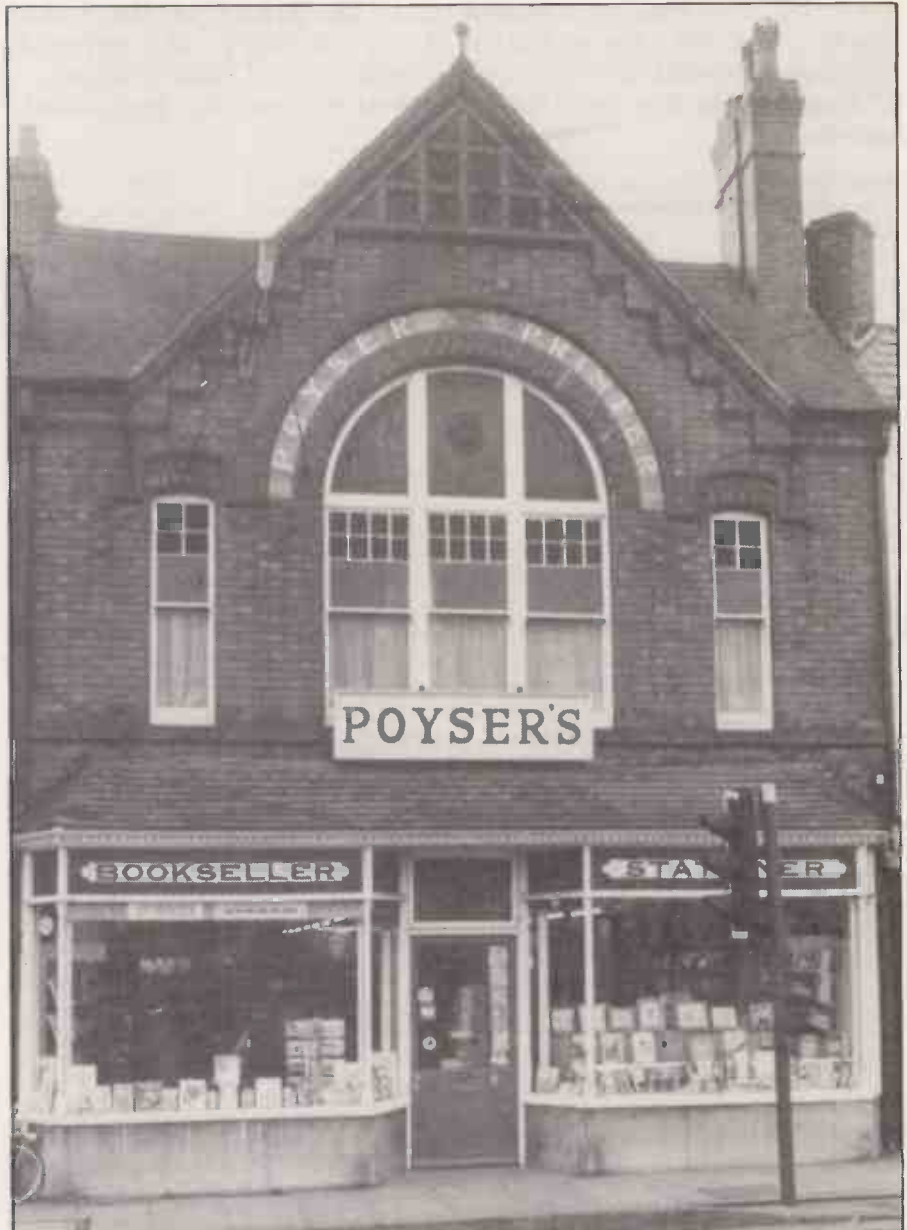
According to Snowden, there was a massive communication gap when he first started to talk to the systems house. Although he knew his own business, it was quite hard trying to describe it effectively enough for a good business program. Despite a few hiccups and alterations to the program the system was running before the Christmas-rush period. As yet, only half of the business — the purchase ledger — has been computerised but it is certainly saving him a good deal of time.

As with Desmond Westrope's system, there is a simple menu choice, allowing little chance for mistakes.

- 1 Add supplier to file.
- 2 To list suppliers.
- 3 To amend suppliers information.
- 4 To delete a supplier.
- 5 To enter invoice details.
- 6 To display invoice details.
- 7 To pay invoices.
- 8 For VAT information.
- 0 To stop.

The system runs on an Exidy Sorcerer with two Shugart mini-floppy disc drives and a small TV monitor.

"I'm only just beginning to be used to it", says Snowden. "It would be much quicker if I could touch-type. All the same, I managed to put all the January invoices in on one day. It is funny how, even when you are saving a lot of time,



even the smallest delay in the program can be really irritating, so I have asked for one or two improvements in the program.

"Otherwise it seems to be working very well. I am now up to date with all the discounts and I have to spend far less time on it. The first real test will be at the end of the financial year when we have to add-up all the total balances. I am looking forward to see how much time that will save".

Mrs Robinson, as the original enthusiast behind the system, is clearer and more ambitious about its future potential. She envisages a day when the computer will control all the stock, enabling her to be more effective with the sales representatives who always call.

Other businesses in the town have yet to be convinced by the idea. Some of them have wondered how Snowden can find the time to watch television during the day. "Most of the other shops round here", he explains, "belong to the old brigade and it would be impossible to persuade them to change their ways and buy a computer.

There is one chap who is so overworked that I am convinced he will not make it to the end of the year.

"It often amazes me. A businessman will happily go out and buy the latest Jaguar, which he doesn't really need, but tell him that the latest calculator will cost him £35 and he will run a mile".

Confidence

It does seem, however, that small businesses are, at last, beginning to realise some of the benefits which small computers can bring as confidence in this new-fangled technology grows. Both Westrope and Snowden still seem very wary of their computers, perhaps because so much of their business depends on the machines operating without the slightest hitch and also because their systems are so new. It is obviously not necessary for every businessman to be able to write his own programs but it could help them if they knew how their system worked and how to understand their programs. □

In the curious way in which Prestel has grown as the U.K. viewdata service, the speed of its development and general availability depend on the mutual confidence of three groups — the Post Office, the information providers, and the equipment manufacturers.

THE commitment-measuring probes were gathering data all over the exhibition halls and conference suites at Viewdata 80.

The following questions were at the back of everyone's mind:

- The Post Office — how effective was its simultaneous publicity campaign going to prove? Now that it had stated its plans up to March, 1981, what rate of expansion did it forecast after that? Could it answer foreign criticism

by Peter Sommer

that Prestel lacked sophistication compared to its rivals?

- The information providers — how long could they continue without the certain prospect of a market? What kind of mood were they in? Were some IPs re-defining their objectives towards the more immediately-lucrative business at the expense of residential users?
- The manufacturers — were the household names prepared to make a serious commitment towards mass production? What prices were they asking for viewdata receivers now — and what would they be asking in 18 months? Could the small, inventive companies offering specialised services afford to continue much longer in the expectation of a bright tomorrow, or were high interest charges going to finish some of them?
- Was the concept of publicly-accessible viewdata to be diverted into a series of private systems — add-ons

to the mainframes of large corporations and used chiefly as a semi-interactive device for disseminating internal company information?

The difficulties in measuring commitment were well-known to the multifaceted industry before Viewdata 80 started and as a result many people knew they had to rely on subjective judgments.

The hidden drama of the show was supplied by Ayr Viewdata whose stand sported a viewdata add-on which it claimed could be delivered at £90 in quantities of 1,000-off. In terms of a High Street price, it would cost £120-£130 or a rental of 50p-75p a week. The arrival of the device is 18 months to two years ahead of all forecasts.

The big manufacturers have tended to concentrate on complete sets, partly because they believed the Post Office might sponsor its own adapter — the Post Office announced in February that it would leave such a development to private enterprise — and partly because of difficulty in achieving adequate quality through an RF modulator.

Ayr seems to have solved the difficulties; in the conditions of the exhibition viewing, the image, even with difficult yellows and greens, seemed steady and solid. Laurence Cook of Technalogs, who designed the device, says that a high proportion of the component cost was in the heavily-filtered modulator.

The Post Office has already revealed the plans for opening computer centres until 1986. The plans are arranged so that firm commitments need be entered only six months ahead of demand — growth

Little doubt is well on

from now on will be demand-orientated.

The main technical announcement was the unveiling of Picture Prestel and dynamically-re-definable character sets (DRCS). Many of the newer viewdata systems — the Japanese Captain, the Canadian Telidon, the U.S. Knight-Ridder Viewtron, and the French Didon/Antiope all offer an apparently more-sophisticated set of images.

Historically, the Prestel image, the first of its kind, is limited by a number of considerations. Graphics resolution depends on the amount of memory in the receiver and ROMs and RAMs were not always as inexpensive as they are now. Compatibility with broadcast teletext standards was, and is, considered important. The Post Office had been saying constantly that the important feature of viewdata was not its ultimate sophistication — full-colour, high-resolution digitised maps are not the least achievement of VDU technology — but that standards become universally accepted, inexpensive and easy to use.

New solution

Picture Prestel is clearly a whole leap forward. As a result of comparison techniques, it lacks the final degree of detail of present-day broadcast TV standards, but it is more than acceptable as a catalogue-type illustration. In the current format, the picture uses about one-ninth of the screen area, saving considerably on loading-down times.

The picture appears line by line in a vertical scan, but a progressive build-up mode may be adopted in the future. The picture store requires 24K. DRCS is a means of extending the graphics capability to include foreign fonts, and totally new shapes so that such items as circuit diagrams and simple maps can be produced. The traditional way of increasing the graphics capability of a VDU is by increasing the size of the ROM character generator.

The Post Office solution is to use a RAM, which accepts a series of instructions to cover the required graphics set before the processor as a whole is loaded-up with the instructions for display. The RAM is held while the particular graphics set is needed and is then emptied until a fresh set is loaded in later. It is a solution to almost any display problem.

The last element in the Post Office offering was its publicity — which must be counted a bit success. Boase Massimi Pollitt created the five spots for the middle of *News at Ten* which worked

The Sony viewdata monitor with video graphic printer.



that Prestel its way

well. At Wembley, in addition to the Post Office stands, the Great Hall was used for a series of specialist shows, the biggest of which was Fanfare for Prestel, which featured Alex Reid, the now-departing director of Prestel, jumping on a giant keypad to activate the world's largest Prestel set — courtesy of a giant TV projector. Reid is very different from most managers of national utilities and obviously enjoys showbusiness. An unforgettable performance.

There has been little discussion of viewdata at Parliamentary level in the U.K. and, unlike the situation in France and Japan, there is no central backing. The biggest threat to British viewdata-type standards is from the decision of the French to make viewdata available to their population as part of the process which will computerise the French telephone directory and make it available at an alphanumeric terminal by every telephone.

Large range

There is a large range of viewdata receivers at the £900 mark and many well-known rental companies are offering deals, but if there's a hesitant member of the partnership it is BREMA, the manufacturer's trade association. Its representative at the press conference was Lord Thorneycroft.

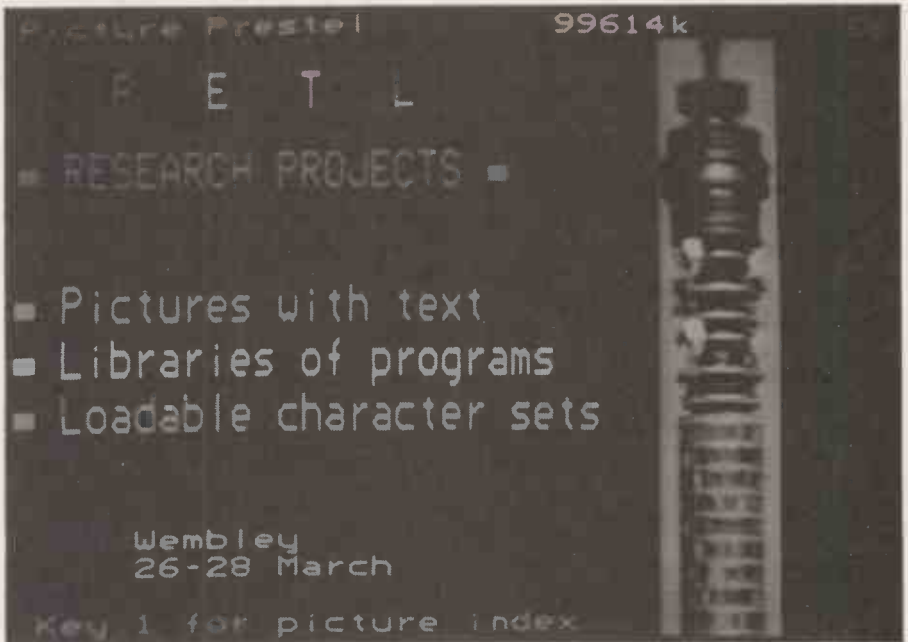
The Japanese are not yet allowed to sell their viewdata equipment in the U.K. but Sony, which had a tentative presence at the Professional Viewdata Show in September, 1979, has clearly invested in more models since then.

For those who believe that the path of mass acceptance will be via public access coin-op terminals, a rival to the Cherry/ISE pioneer from Bell Fruit was a pleasing sight.

It contains a video-recorder and when not being used as a viewdata terminal, it plays tapes of video advertisements.

Sharing a stand were the Owl Appletel, now with full Post Office approval, and the Prestel version of the Acorn. Both companies reported good business. In another part of the exhibition the Luxor ABC80 was also in viewdata mode. The experimental ITT 2020 arrangement was also on display but there are no immediate plans to develop it into a saleable commodity.

All of these units need appropriate software and the designers will have to decide whether they are going for an IP market — with one set of sophisticated requirements — or users — for whom auto-indexing is the main need, followed by word-search of specific pages.



There is now an Appletel users' club which exists via the *Practical Computing* database—*Practical Computing* *45631, Appletel users' club *456318.

The two micros built round viewdata, the TECS and ISE Sparrow, were also on display. Technalogs has recently received funding from the National Enterprise Board and has been developing its software. It has also been mounting a telesoftware experiment with Oracle, the IBA teletext service.

For would-be constructors, two new chips in particular should be noted. Firstly, Mullard, whose viewdata module has been looking increasingly cluttered compared to the General Instruments version, is to make available at the end of the year a brand new LSI, code-named Lucy. At the exhibition, it showed it behind closed doors, but a specification sheet (SAA5070) shows it has a very wide range of facilities on-board, and just as the teletext character generator has been seized on by home computer enthusiasts, so will this one be. GI had 264 command infra-red transmitter and receiver — in fact the receiver chip contains 32 channels of DC control for various TV functions. The chip is ideal for those who dislike ribbon connectors between keyboard and processor.

Many companies were offering intelligent IP terminals. They all had, more-or-less, the same functions borrowed from word-processing programs and none was clearly superior to the others, though if prizes are to be awarded, the Telemachus TM3 seemed to be the most complete and Hi-tech had hooked-up a digitiser pad which simplifies graphics. You are given a series of inkwells for colours and for contiguous or continuous mode. The main difficulty in use is that the coarseness of the teletext graphic set — which does not have diagonals — makes horizontal or vertical lines difficult

to implement unless they are precisely parallel to the VDU window's sides.

The BBC Ceefax and IBA Oracle services were present. Oracle has been able to extend its graphics set without losing compatibility with existing requirements. The technique used is similar, but not identical to, the Post Office solution to the same problem. It was also showing its telesoftware, which has not been seen a great deal because of the rareness of the processor involved — a Signetics 2560. John Hedger of London Weekend Television spoke enthusiastically of the possibilities of broadcast telesoftware but at the moment it is just an interesting experiment.

Agreement needed

CAP was demonstrating its viewdata version of telesoftware. What is needed now is agreement as to protocols and standards. There appears to be a certain resentment at the way CAP is attempting to link telesoftware to its own proprietary portable language MicroCobol.

Viewdata 80 gave a splendid opportunity to view a number of foreign systems. In addition to displays from Prestel close-relatives in Germany, the Netherlands and Switzerland, the first live demonstrations of the French systems attracted a great deal of interest. The French had pulled the plug on a British Prestel show in their country, and a day before Wembley, the British did the same to them.

The result was an agreement that no restrictions would be placed on either country to the others' demonstrations. The Japanese Captain system has very appealing graphics. In the conference rooms, there was a good deal of argument over relative standards.

Most participants felt extremely optimistic about the rapid acceptance of viewdata. □

Problems of poor resolution overcome with ingenuity

Gary Marshall outlines some ideas for producing displays on a memory-mapped screen and delves into methods which draw lines and create mobile displays.

COMPUTER GRAPHICS may be obtained with the use of straightforward programming techniques on personal computers such as the Pet and Apple. With these, and similar systems, the display screen is memory-mapped — a particular symbol appears at a given position on the screen when the appropriate number is stored in the appropriate memory location. Displays obtained in this way tend to lack resolution, but with the aid of some ingenuity, this shortcoming can be largely overcome.

Same principles

To illustrate and explain some of the techniques of computer graphics in a concrete way, let us consider how graphics are obtained when programming the Pet in Basic. The same principles apply when any similar system is used. The Pet screen provides 25 rows, each with 40 character positions, so that the screen is divided into $25 \times 40 = 1,000$ positions.

We can identify any screen position by giving its row and column, thus obtaining a pair of values we can call its co-ordinates. The co-ordinates of the screen position in row I and column J are written (I, J) and, in particular, the co-ordinates at the top left-hand corner of the screen, in the first row and the first column, are (1, 1) while those of the bottom right-

hand corner, in the last row and the last column, are (25, 40).

Each screen position corresponds to a location in the memory — the top-left screen position is mapped to the location with address 32768, the location with co-ordinates (1, 2) to location 32769 and so on to the bottom-right corner, which is mapped to 33767. In general, the screen

Codes used by the Pet

When given the instruction PRINT ASC("A"), the Pet prints the code for the character A, which is 65. Most confusingly, codes obtained in this way are not necessarily the ones used in POKE instructions. To obtain the code for a character as used with POKE, place the character in the top-left corner of the screen and give the instruction

```
PRINT PEEK(32768)
```

The number printed is the code for that character as used in the POKE instruction.

Table 1.

location with co-ordinates (I, J) is mapped to location $32768 + 40(I - 1) + (J - 1)$ which is illustrated by figure 1.

The memory locations are 8-bit words, and so can contain any of $2^8 = 256$ different 8-bit patterns.

When programming in Basic, a character can be displayed on the screen by using the POKE instruction. The instruction

```
POKE 32768,42
```

causes the binary representation of the number 42 — that is 00101010 — to be stored in location 32768. Now that location is mapped to the top left-hand corner of the screen, so that in this position the character *, whose code is 42, is displayed.

Thus the instruction POKE 32768,42 causes a star to appear in the top-left corner of the screen. A procedure for making the Pet give the code of any symbol is shown in the table 1.

To determine what is displayed at a particular screen position, we can use the PEEK instruction. The instruction

```
X = PEEK(32808)
```

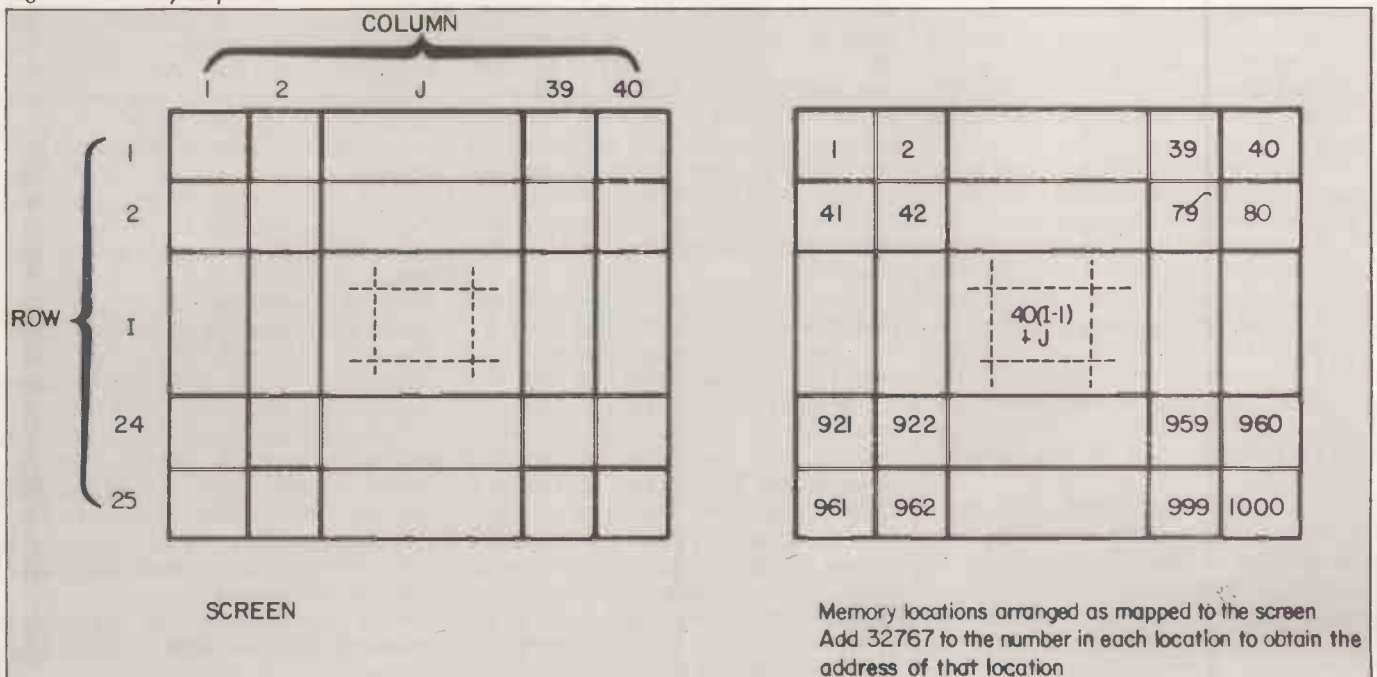
causes location 32808 to be examined (PEEKed) and the value of its contents be assigned to the variable X. Location 32808 is mapped to screen position (2, 1), so that when the instruction has been executed, X contains the value of the code for the symbol at the beginning of the second line.

Machine code

The PEEK and POKE instructions enable us to do things in a high-level language which are usually only possible in a low-level one. To illustrate this, the assembly code to perform these computations is now given.

To simplify the explanations, the

Figure 1. Memory map for Pet screen.



accumulator can be regarded as a special location for the use of low-level programs. The assembly equivalent to POKE 32768,42 is

```
LDA # 42, load the accumulator with the number 42
```

```
STA 32768, store the accumulator contents in 32768
```

The assembly code equivalent to X = PEEK (32768) is

```
LDA 32768, load the accumulator with the contents of 32768
```

```
STA X, store the accumulator contents in the location assigned to X
```

We can now move symbols round the screen, taking the first small step towards the production of animated graphics. For example, those instructions move a symbol from the top-left to the bottom-right of the screen:

```
10 X = PEEK (32768), find symbol at top-left
```

```
20 POKE 32768,32, blank it out
```

```
30 POKE 33767,X, put symbol at bottom-right
```

Generalisation

A straightforward generalisation of the program causes a symbol initially at the top-left of the screen to flit back and forth between top-left and bottom-right. The new program is

```
10 X = PEEK (32768)
```

```
20 POKE 32768,32
```

```
30 POKE 33767,X
```

```
40 POKE 33767,32
```

```
50 POKE 32768,X
```

```
60 GOTO 20
```

If this causes movement that is too fast to appreciate, the program can be slowed by introducing delays, thus

```
35 FOR I = 1 TO 100: NEXT I
```

```
55 FOR I = 1 TO 100: NEXT I
```

When writing programs to produce complex animated graphics, it is seldom necessary to slow the program. The more usual requirement is to increase its speed. Unfortunately, it isn't so easy to speed a reasonably efficient Basic program as it is to slow it down. The ultimate solution to the speed problem may well be to program in assembly code.

Simple figures

We can design a simple line-plotting program and use it to produce simple figures composed entirely of lines. For the sake of simplicity, our program will produce only straight lines which are horizontal, vertical or diagonal. That is particularly convenient because there are symbols available for constructing lines in those directions.

We shall design a Basic subroutine which draws a straight line on the screen automatically, given the screen co-ordinates of the beginning and end of the line, provided the line is in one of the specified directions. The initial flowchart for the line-drawing subroutine, which requires the start and end co-ordinates of the line to be provided is given in figure 3.

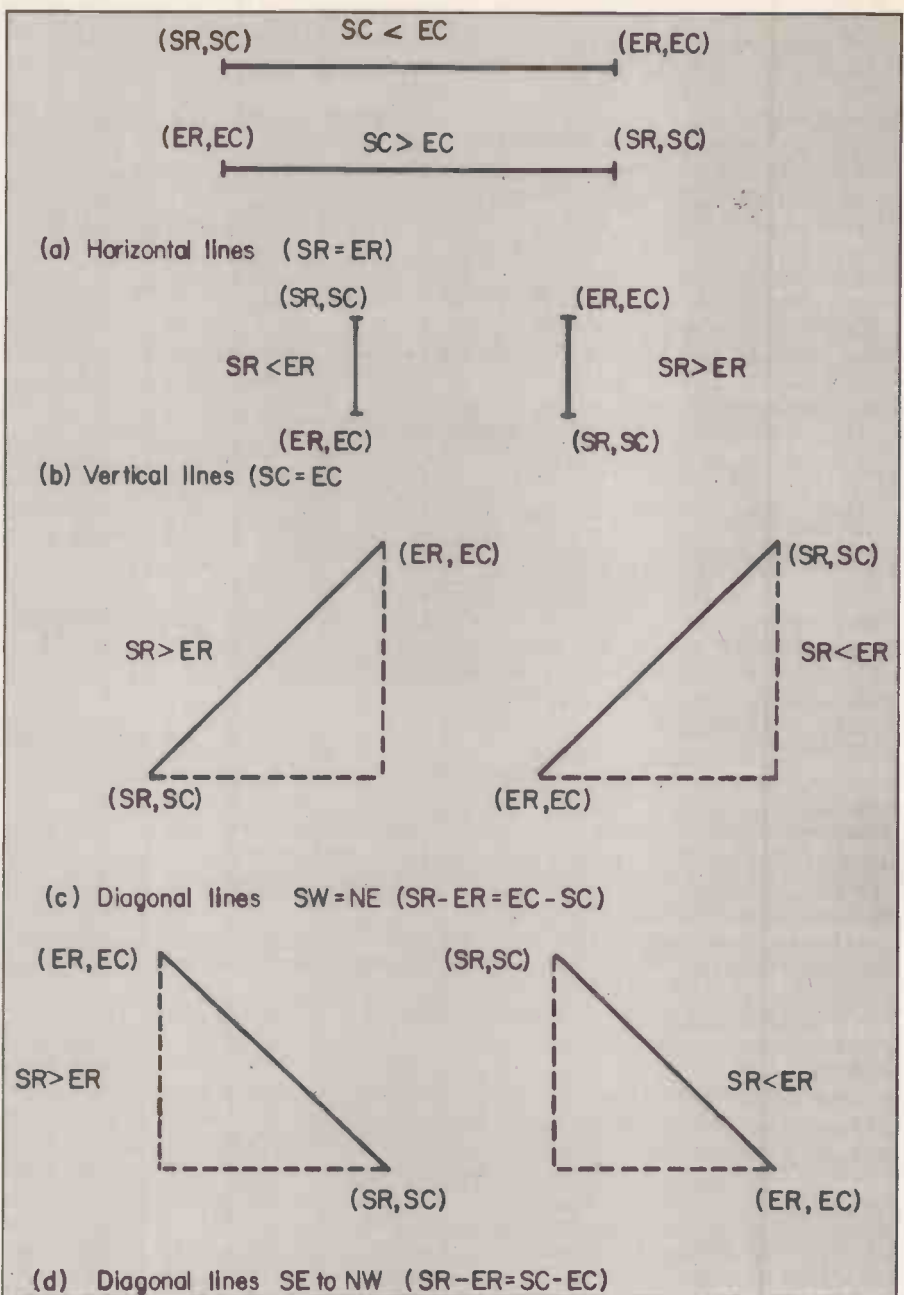


Figure 2. Special cases covered by line-plotting routine.

The subroutine, expecting the co-ordinates of the beginning of the line to be held in SR and SC as (SR, SC) and the co-ordinates of the end of the line to be held in ER and EC as (ER, EC), is

```
500 INC = 1: SL = 32767 + 40*(SR-1) + SC
```

```
510 IF SR = ER GOTO 600
```

```
520 IF SC = EC GOTO 700
```

```
530 IF SR-ER = EC-SC GOTO 800
```

```
540 IF SR-ER = SC-EC GOTO 900
```

```
550 PRINT "LINE NOT IN A REQUIRED DIRECTION"
```

```
560 RETURN
```

```
600 IF SC > EC THEN INC = -1
```

```
610 FOR I = 0 TO EC-SC STEP INC
```

```
620 POKE SL + I, 67
```

```
630 NEXT I
```

```
640 RETURN
```

```
700 IF SR > ER THEN INC = -1
```

```
710 FOR I = 0 TO ER-SR STEP INC
```

```
720 POKE SL + 40*I, 66
```

```
730 NEXT I
```

```
740 RETURN
```

```
800 IF SR > ER THEN INC = -1
```

```
810 FOR I = 0 TO ER-SR STEP INC
```

```
820 POKE SL + 39*I, 78
```

```
830 NEXT I
```

```
840 RETURN
```

```
900 IF SR > ER THEN INC = -1
```

```
910 FOR I = 0 TO ER-SR STEP INC
```

```
920 POKE SL + 41*I, 77
```

```
930 NEXT I
```

```
940 RETURN
```

Figure 2 shows all the cases to be considered by the plotting routine. The subroutine follows the flowchart more or less accurately. It can be compressed at the expense of some legibility to:

```
500 INC = 1: SL = 32767 + 40*(SR-1) + SC
```

```
510 J = 1: K = 1: R = ER-SR
```

```
520 IF SR = ER THEN R = EC-SC:
```

```
X = 67: J = 0: GOTO 570
```

```
530 IF SC = EC THEN X = 66: K = 0: GOTO 570
```

```
540 IF SR-ER = EC-SC THEN X = 78: K = -1: GOTO 570
```

```
550 IF SR-ER = SC-EC THEN X = 77: GOTO 570
```

```
560 PRINT "HLINE NOT IN A REQUIRED DIRECTION": RETURN
```

```
570 IF R > 0 THEN INC = -1
```

(continued on next page)

(continued from previous page)

```
580 FOR Z = 0 TO R STEP INC
590 POKE SL + (40*J + K)*Z, X
600 NEXTZ
610 RETURN
```

We can write a general program for drawing figures composed of straight lines. The program accepts the value of N, the number of lines in the figure, and then accepts the co-ordinates of the beginning and end of each line, storing them in the arrays called SX, SY, EX and EY. It then calls the subroutine to draw each line in turn. The input data required to draw the square illustrated in figure 4 is

```
N = 4 (Number of lines)
SX(1) = 10, SY(1) = 10 (Start of first line)
EX(1) = 10, EY(1) = 20 (End of first line)
SX(2) = 10, SY(2) = 20 (Start of second
line)
EX(2) = 20, EY(2) = 20 (End of second
line)
SX(3) = 20, SY(3) = 20 (Start of third line)
EX(3) = 20, EY(3) = 10 (End of third line)
SX(4) = 20, SY(4) = 10 (Start of fourth
line)
EX(4) = 10, EY(4) = 10 (End of fourth line)
```

Because the figure is continuous, the end of one line is the same as the beginning of the next one. The program is:

```
10 PRINT "ENTER NUMBER OF
LINES";: INPUT N
20 DIM SX(N), SY(N), EX(N), EY(N)
30 FOR I = 1 TO N
40 PRINT "ENTER START
CO-ORDINATES OF LINE"; I
50 INPUT SX(I), SY(I)
60 PRINT "ENTER END
COORDINATES OF LINE"; I
70 INPUT EX(I), EY(I)
80 NEXT I
90 FOR I = 1 TO N
100 SR = SX(I): SC = SY(I)
110 ER = EX(I): EC = EY(I)
120 GOSUB 500
130 NEXT I
```

Note that only lines in the required directions can be drawn, and that an attempt to draw one in another direction results in the line not being drawn and a message produced at the top of the screen. The plot of the square is, literally, a little rough at the corners, but this can be amended, if required, with a little ingenuity.

Having drawn a figure, it is useful to be able to transform it. It is particularly useful with representations of three-dimensional objects in giving different views of them. Useful transformations

Figure 4. Plot of a square.

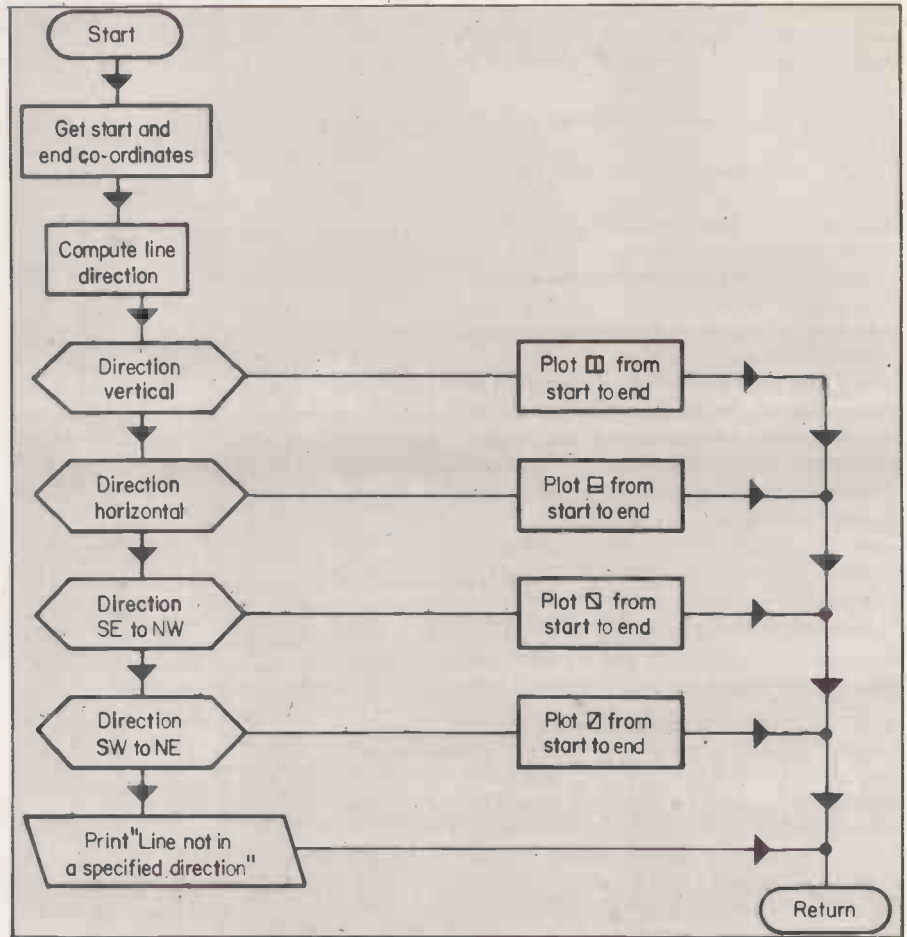
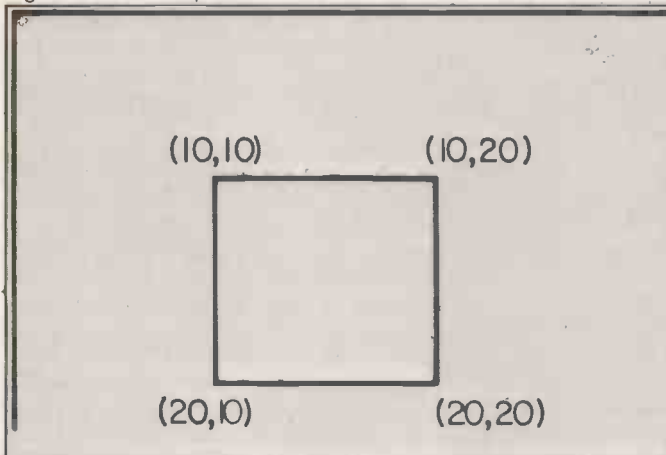
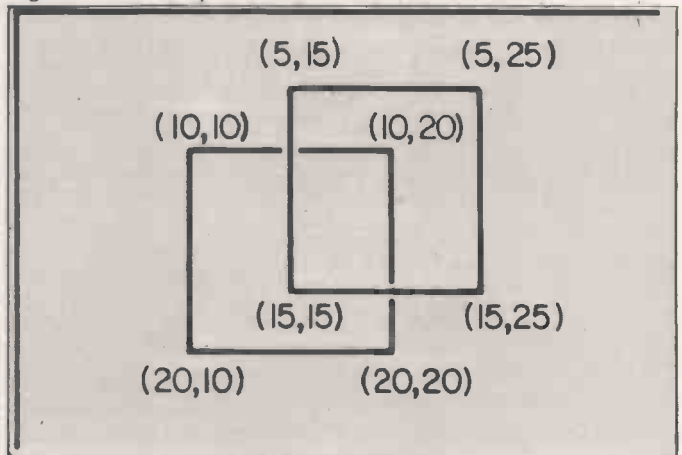


Figure 3. Flowchart for line-plotting subroutine.

include magnification, translation, rotation and combinations of these. Our primitive plotting system is not at all suitable for dealing with rotation, since, as an example, it can only display the square, whose plotting we described, after rotation through 45 degrees or multiples of 45 degrees. Translation of that square, by five columns to the right and five lines upwards, to produce a plot similar to that shown in figure 5, can be produced by adding those lines to the program for plotting the square itself.

```
140 FOR I = 1 TO N
150 SR = SX(I)-5: SC = SY(I)+5
160 ER = EX(I)-5: EC = EY(I)+5
170 GOSUB 500
180 NEXT I
```

Figure 5. Plot of a square and its translation.



Conclusions

- If a subroutine for plotting lines is available, it can be used for producing figures composed of lines and for displaying the results of transforming such figures.
- The introductory ideas can be extended, with the aid of more sophisticated programming techniques than those used here, to produce animated graphics, displays for video games, general plotting routines for straight and curved lines, drawings of objects consisting of any straight and curved lines, perspective views of three-dimensional objects and displays of transformed objects.

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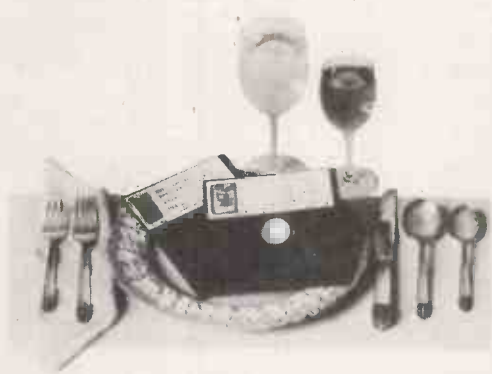
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EFFECTIVE MARCH 1980



Disabled and administration share the rewards

In an era of shrinking health-care budgets, the inexpensive micro has an important role to play in cost-effective administrative and educational work. Martin Hayman visited Jonathan Seagrave of the London Borough of Hillingdon to discover exactly what applications have been found for the versatile machine.

IT WAS NOT to combat the current cash squeeze on social services that research officer Jonathan Seagrave first decided to use a micro for administrative purposes at the London Borough of Hillingdon's vast modern civic centre.

One reason was, in fact, more practical — he and his wife Gillian won an Apple in the *Practical Computing* competition in February, 1979. After assiduous work with this machine, it soon became apparent that there was a strong case for a departmental micro — the computerisation of the social services' referral system this year was a major step forward.

Information

The purpose of the referral system is to provide senior management with details of what kinds of people visited the department for social work help, the kinds of problems they faced and, in broad terms, what kind of help they had been given. "Such information is essential for the rational allocation of resources and manpower and sheds light on changing social trends and the ways we should respond to them", says Seagrave.

When using a micro was proposed, there was the possibility of using a mainframe computer which Hillingdon shares with Hackney, Tower Hamlets and Haringey. After five years of discussion,

that system seems only now to be making worthwhile progress, and Seagrave admits he was relieved not to be compelled to use it. It would have cost his department £25,000 a year and would have been an albatross.

"Our viewpoint then was that a good, limited manual system which worked was better than a sophisticated computer system that didn't", he says. Indeed, his department's needs are relatively simple. Most of the client files which Seagrave's department handles are quite small, there are only a few in each category, and they may not need to be accessed more frequently than twice a year.

"If you can put all your details into one index card box, it is probably not even worth using a micro", he says. "But with more than 4,000, or if you need frequent access, it probably is worth it. It's a question of access time". That was the vital factor with the Borough's mainframe, which is dedicated to other tasks during the normal working day and would not have been available for social services use before 5pm.

As senior research officer, Seagrave's role was to see that summary sheets from the four area teams who dealt with clients — mostly disabled and handicapped people — were collated and produced as a quarterly quick summary sheet for

senior management. They were made subsequently into a detailed annual report providing cross-tabulations in detail.

Details were previously compiled on a multi-part form, coded and collated manually — hence the boxes, which appear on almost any form you may fill in, which read forbiddingly "For office use only".

Efficiency

Three years ago, Seagrave's colleague, Sheila Noble, revised this form and tightened the definitions. That, he says, made the system more efficient. The next stage was to computerise the data tabulated. "All those boxes were an obvious target", he says. "It was a management information system, but it was not time-critical. It was a good area for experiment".

Earlier experience with computers included a simulation program written by a disabled programmer, Christine Simpson, for the Open University Hewlett-Packard in its own brand of Basic. Although the Open University was very co-operative, telephone time for the project still amounted to £350.

Seagrave had looked round the micro market for a while, after this the department funded a week's hire of an Apple for evaluation: "It's clear that you can't

(continued on next page)

Christine Simpson is one of the handicapped programmers who works for and benefits from Hillingdon social service policy.



(continued from previous page)

really learn about these machines without spending a fair amount of time working with them", he says.

Though the primary intention was to explore a range of possible applications, it quickly emerged that the machine would prove itself best on the referral statistics.

At the same time, the department had been waiting for the Manpower Services Commission for a grant under the Special Temporary Employment Programme (STEP). Happily, it arrived at the same time as the micro, so with funds to employ five handicapped people, Seagrave was able to take on wheelchair-bound Christine Simpson as a programmer working from home.

It was Simpson who told him about the British Computer Society's specialist group for the disabled, and put him in touch with other disabled programmers who were eager for work.

It was this aspect of programming which led to further explorations of the micro for educational and training use for the disabled.

Since the arrival of the departmental machine in January, 1979, a second programmer under the STEP scheme, Sheila Butcher, has been taken on, and it was she who devised most of the material for mentally-handicapped teenagers in the Borough's adult training centre.

That work, which is still under development, derived, at least in part, from Mrs Seagrave's "flower-power" program, which uses the Apple colour display to draw a flower. The flower is a very pleasing display; could it not be used as a kind of visual reward when severely speech-handicapped children or young adults gave the correct response?

Giant step

One of the problems of training people with severe speech defects is to elicit a consistent response; if an inarticulate sound can be interpreted consistently as yes or no, it is already a giant step forward in the patient's relations with the external world.

The Apple speech board offers the possibility of recognising acceptable utterances and rewarding the patient by drawing a flower. The problem is one of editing — clearly the teacher has to decide what is, or is not, an acceptable utterance and so program the machine.

That would represent perhaps two days' work by someone who really knows the innards of the Apple. "What it needs is someone to write a utility program to edit the utterances, someone who can happily dig around in Hex which I don't do happily", says Jonathan Seagrave. "I'm not a very good programmer, I'm afraid".

There is a further problem; the familiar one of lack of funds. The Department of Health and Social Security has assigned practically no money to micro applic-

ations for the disabled, and does not seem interested in doing so. So far only hearing disability applications have been granted any funds.

So this aspect, at least, remains for further exploration as time and money permit. For the present, Seagrave's main drive is to computerise the administration of the local adult training centres. Briefly, the role of such centres is to employ disabled people in light industrial work for which they are paid a nominal sum — the maximum permitted before the wage starts to affect disability benefit is a meagre £4 a week.

The "employees" also pay dinner money throughout the week which also goes into the training centre accounts. So it may be seen that although the sums involved are small, the complexity of the system approaches that of a normal commercial payroll program.

Challenge

In introducing the micro, Seagrave is aware that he is challenging an existing clerical system which works well. To their credit, the staff involved were quick to see the point that the micro would free them from administrative work and permit their time to be used more effectively for the primary purpose of caring for the patients.

Doubtless, it also helped that they are involved in the discussions at all stages, and, in fact, helped choose the equipment. They eventually plumped for a thermal printer with its advantage of quietness.

Seagrave admits that this is now moving towards the sharper end of the business and says that he will be considering commercial software. This application is clearly more time-critical than the original research applications and he may well commission a program if no suitable tender turns up. He has been looking round the cottage software market.

He has done a great deal of his own legwork to popularise the micro — either his own or the department's — and, in general, has had a good response, both from handicapped people, children or adults, for the educational applications, and from his lords and masters for the administrative applications. "If you can be seen to use the machine effectively", he told me, "there's plenty of support".

The referral program certainly seems to be working well. After a few tests and amendments — mainly to facilitate a restart after a break in keying-in — it is in regular use and takes about half the time of the old manual compilation system. More important, the data is all on file for further analysis. He now intends to prepare a general-purpose analysis program for ready analysis of cross tables.

He does concede that, were he to start again, he might have considered modifying a commercial data management package, but these were not available at the start of the scheme. Yet

the home-made program has made it possible to include input and consistency checks which would in any case have required custom programming, even if they were patched on to a package.

They include range checks on data input and a sequence check on the serial numbers. Against this, he opted not to verify data input, since the application can tolerate occasional errors without disaster.

In the future, he is very keen to modify the referral program so that one of the department's most severely-handicapped clients, a teenager with no speech and limited movement, can do some of the key punching. From the programming angle this represents no problem. The program is working and there is already a set of switches wired up to the Apple game socket which the youth can use.

The difficulty lies in page-turning the forms. To overcome this, the forms may be changed to make them suitable for mechanical feed, and a page-turner may have to be wired-up from the Apple. The volume of work is quite modest but the youth probably will not be able to do all the keying-in. Other attenders of the day centres may contribute — keyboard work is very suitable for handicapped people, as Derek Nicholson's organisation, *Emphatic*, has shown.

New possibilities

What the micro does is to extend the possibilities further, to those who can't use a keyboard directly. The only other organisation making progress in this area, to Seagrave's knowledge, is the Spastic Society Professional Workshop under Peter Deakin, where there is also an emphasis on higher levels of skill and word-processing.

Seagrave contrasts his own department's modestly-funded work with the grandiose computer projects undertaken by local authorities only a few years ago.

Gateshead in Tear and Wear, for example, which won the British Computer Society Social Benefit Award recently, spent over seven man-years of programmers' time alone developing its system and now hopes, with ICL, to sell it to other local authorities. Yet before that, in 1973/4, East Sussex had produced a similarly elaborate terminal-based system — also presumably very costly, and also for an ICL machine.

At least he is making progress, even if it demands a high level of personal commitment and a great deal of work — and he does have the backing of his colleagues and the higher authorities. "It is a great pity", he says, "that central government, particularly the DHSS, takes so little interest in this kind of application for clients, even though it can enable the most severely handicapped to do productive work, and, more generally, increase administrative efficiency — achievements that one would have thought warranted energetic support".

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Planning techniques find optimal routes

Although robotics and artificial intelligence can be treated as two entirely separate disciplines, there is a good deal of interaction between them. Mark Witkowski looks at the impact of artificial intelligence techniques on robotics.

THERE ARE many possible reasons for applying artificial intelligence techniques to robotics. One is to gain a better understanding of the essential nature of intelligence — why some computations seem clever and worthy of further investigation and others do not, even though they appear more complicated.

Another is to discover new ways of manipulating data which are easier and more natural to write, which increase the efficiency or the applicability of an algorithm to a particular problem. Artificial intelligence has always been something of an assortment of ideas about perception, problem solving, abstraction, generalisation, skilled action, description, language, learning and memory and so on.

The tendency is to investigate those areas in isolation, even though the crudest definition of intelligence would indicate that it is not only the possession of these faculties but their interaction which is of significance.

At the moment, no robot possesses all those faculties but there are a handful which each demonstrate at least one or two to a significant extent.

Fortunately, it is not necessary for a robot to be very intelligent for it to tell us something useful about robot control. The ideas generated in research will slowly find their way to the shop floor and industrial robotics. It is, after all, easier to find a specific solution to a problem once a method of finding solutions in that area is understood.

Construction

Edinburgh University's Freddy system was programmed to construct small wooden toys from their component parts — Ambler et al. (1975) and Barrow and Crawford (1972). Were it not for the fact that this system could start from a situation in which the parts were tipped in a heap on the workbench before assembly commenced, the problem would have been relatively easy.

Furthermore, the algorithm was sufficiently robust to allow the initial pile to contain parts for more than one model of the same or different types, and totally extraneous parts which had to be identified and discarded.

Freddy was a five-degree-of-freedom manipulator in which the gripper could be lowered and raised on a gantry, rotated and closed. X and Y translation of the

objects was achieved by moving the workbench. A small vice was fitted to the bench into which objects could be clamped during assembly.

Sensing was provided in the form of proprioceptive co-ordinate feedback, two television cameras, one looking obliquely at the table, the other directly downwards. The gripper was fitted with tactile and force sensing.

The complete assembly process was not totally autonomous — the operator was

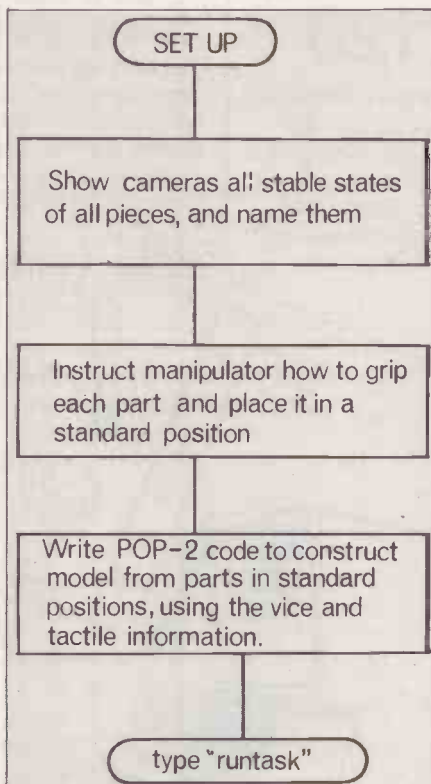


Figure 1. Operator actions.

required to do several things before the robot could be left to assemble models from piles of parts. The automatic part of the program proceeded in two stages.

In the first, parts were isolated from the piles, identified and laid-out in standard locations. This kit of parts would then be assembled using hand-coded routines.

The user had to do three separate programming or teaching operations before the robot was ready to go — figure 1. First, each part of each of the models had to be shown to the system in each of its stable states — the ways it would come to rest if dropped on the table.

That might be repeated several times so

that the program could build-up an internal description or representation of the part so that it could be recognised and identified later using only incoming visual sensory data.

Next, the user had to instruct the robot, using a keypad, how to pick-up, rotate and finally deposit in a standard position for assembly each of the parts used in the models. The user had to write some POP-2 code to take the parts from their standard positions and construct the model using the vice to clamp the pieces and tactile sensing to do any close insertion assembly.

POP-2 is the Edinburgh artificial intelligence programming language and not a specific assembly language like WAVE or AL — Burstall, Collins and Popplestone (1971).

Figure 2 shows the automatic part of Freddy's operation — a loop which can be cycled forever. Each time, the most useful operation which can be done in completing the model is executed first. So if everything is complete, the program finishes 1.

Standard

If all the parts required for the model are in their standard positions, the model is assembled, using the pre-defined code, 2. If this was not the case, the cameras are used to explore the table-top. A potential item is a bright region on the dark background — 3.

Once a bright region is located, it must be visually analysed. It will either be a useful item, a piece of the model still needed for the process to continue, in which case it is moved to its standard position — 4.

It could be part of the model but one which duplicates a part already in its standard position, and it must be put to one side — 5.

If there are no regions that can be identified as useful items, the robot sets about the smallest region as a heap — 6. The tactic used is to divide the heap into its individual pieces so they may be identified. The first strategy is to locate visually a protusion from the side of the heap and attempt to pick it up and place it in a clear area for identification.

If for some reason this fails for all the visible protusions, a second tactic is then employed to separate the heap.

The gripper is lowered on to the heap until it touches, thereby defining its height. Then an attempt is made to grab at

the heap, first halfway up and then, if that fails to isolate a single item, at the base.

In the case of a particularly entangled heap, a final attempt is made by ploughing the hand through its centre just above table level. That procedure is not entirely desirable as it causes significant disruption of the work-table lay-out. If the heap is still unrecognisable, it might as well be disposed of — 8.

That portion of Freddy's algorithm is characterised by a number of very useful ideas. First of all, extensive use is made of both visual and tactile feedback and there are many error recovery modes. Everything is checked periodically to make sure it has not moved and that the computer's internal description of the world matches the sensory data — 7.

Most of all, it is very persistent due to the structure of the main control loop — figure 2 — and will work away at objects and heaps until they succumb.

There are also checks to ensure that the proposed action is still applicable. For instance, just before smashing a heap, it checks that the heap is not really a recognisable object which slipped-through. The assembly routines are not as robust. It is the user's responsibility to include such checks as he or she feels appropriate, and if those tests are not made, the assembly may fail in an unexpected way.

Obviously the tactic actions of the lay-out algorithms are related closely to the types of item they manipulate. The vision routines depend on the objects being lighter in colour than the background, and the objects must be grippable by the hand.

Sensors monitor continually for the unexpected and error recovery was included at many levels. However, there was very little planning involved, actions being made in response to some immediate need. Problem solving and planning is an area where artificial intelligence can really help robotics.

Maze running

Of particular interest to anyone who may be entering the micromouse maze-running competition is the question posed by the exploration and learning of a maze.

The classic method of traversing a maze from some entrance to an exit is to keep touching either the left- or the right-hand wall until the exit is found. That would work for the maze shown in figure 3. You may note, however, that following the right-hand wall leads to the exit a good deal sooner than following the left.

It is, of course, entirely arbitrary as to which handedness is to be more efficient. Without knowing something further about the maze, there is no way of telling.

There is, in fact, a particularly nasty catch to the follow-the-wall algorithm — it works only if both start and finish are on an infinite face, that they are joined by a continuous wall.

There is no problem with figure 3 as they are both on the outside wall. Unfort-

unately, the micromouse competition rules clearly state that the finish will be in the centre of the maze, and so there can be no assumption that the algorithm will terminate.

It is also pointless to take turnings at random, since this would give very slow progress through the maze. It would be worse to change walls at arbitrary times. A systematic search of the maze is required. This will not help much for a single timed run but will be very valuable if the maze runner has a second chance.

Tarry's algorithm is useful — Berge (1962). It states that one should never go in the same direction twice along any one edge, nor take the edge from a junction by which one arrived unless no other choice is available. Figure 4 shows the maze in

figure 3, depicted in the form of a graph.

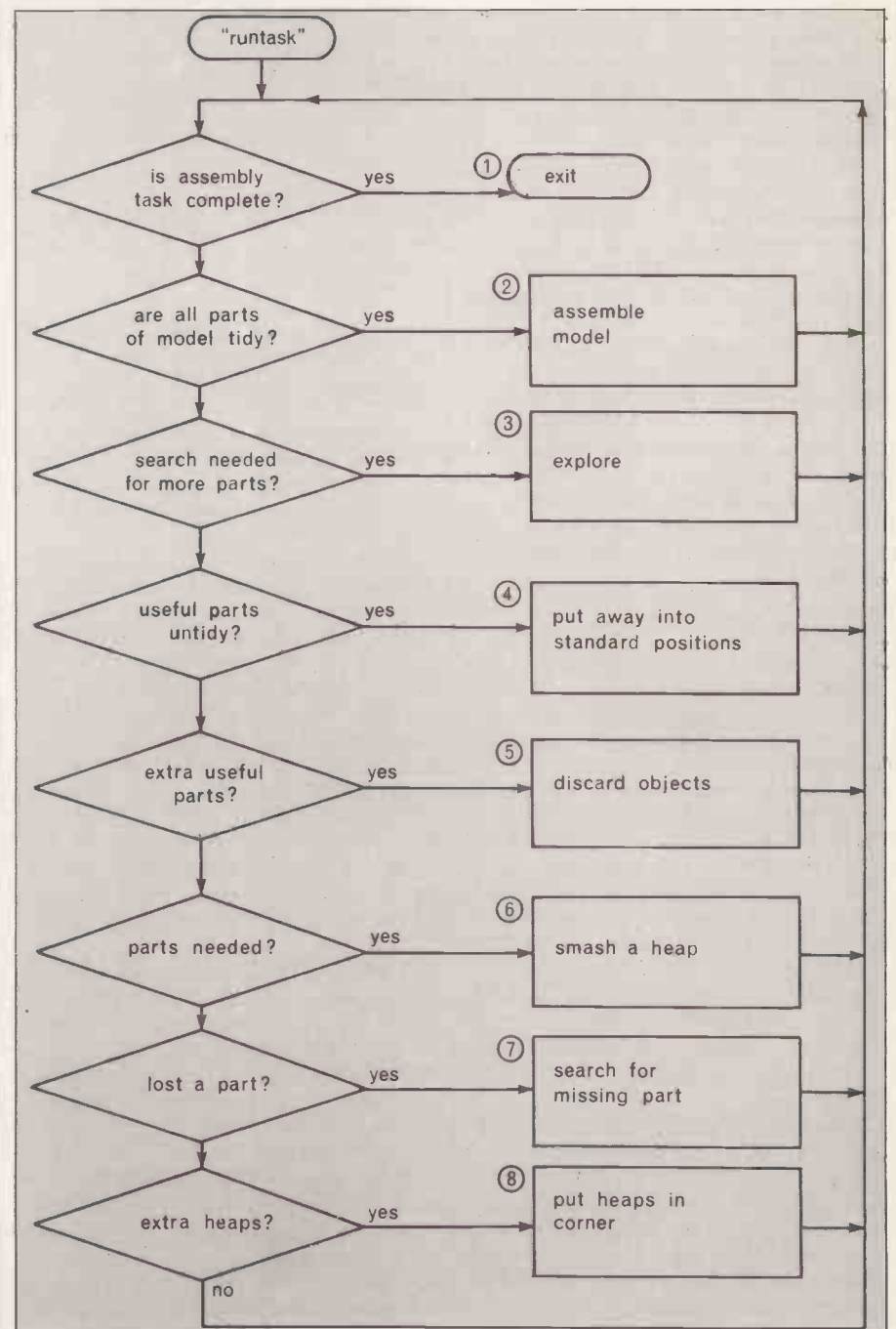
Each square in the maze at which a decision can be made is represented by one of the lettered notes, A to N, dead-ends are shown by 'X'. Arcs joining the nodes show the distance between junctions.

Clearly, with a graph like this, one could explore the maze and choose an optimum route without moving at all. By looking at either the ground plan or the graph, any particular route can be investigated. Following the right-hand wall leads to the exit via:

START(1), A(1), B(1), Xb(1) dead-end so back to B(5), D(3), H(3), M(2), N(2), back to N(5) and then EXIT, for a total of 26 moves.

Following the left-hand wall is altogether worse: *(continued on next page)*

Figure 2. Lay-out algorithm.



(continued from previous page)

START(1), A(3), C(4), F(3), Xf(3), F(1), I(1), J(1), K(2), Xkl(2), K(3), Xkr(3), K(1), J(3), L(3), Xl(3), L(3), E(2), G(3), H(3), M(2), Xm(2), M(2), N(5), EXIT, for a total of 64 moves with six dead-ends visited.

The best strategy is to travel through each tunnel and visit each junction in turn, but re-tracing one's steps as little as possible and remembering the internode distance. That must be methodical and some variant of Tarry's algorithm could well be used.

The mouse must first have some way of remembering each of the junctions, probably as an X-Y co-ordinate and then start exploring the maze. As an example, one might turn left unless that tunnel had already been mapped. So from the start there is no choice but to visit A, and the left-most exit goes to C, and thence to F.

F's left-most exit leads to the dead-end Xf, there is no choice but to turn back to F. The current left-most exit from F leads to I, which visits Xi and then J, which visits K, Xkl and Xkr, showing that the node K is itself a dead-end.

Back to J, L and Xl, to E, G, H, M, Xm and back to M, left to N and left again to the EXIT. As our purpose is to explore the maze, not leave it, the exit is treated as a dead-end and we turn back to N, Xn and M. H, D, B, Xb back to B and then A, which takes us back to the start.

With the graph safely in computer store, it is possible to plan a route to the exit in the least possible moves, START, A, B, D, H, M, N and EXIT, a total of 20. A complete exploration of the maze takes 132 moves, on the 14 x 14 ft. maze there is about 700 feet of track, and somewhat more than 600 possible nodes, each with a maximum of four exits, assuming no diagonals.

Exploration

To explore the maze in 10 minutes, the mouse's speed would have to be in excess of 14 in. per second. Open spaces should be traversed as they could represent a considerable shortcut.

The graph representation is particularly useful in this case as it is suited ideally to list processing languages, — Foster (1967) — such as Lisp, which is available on at least three microprocessors, the 6800 — Van der Wateren (1978) — the 6502 — Gardner (1979) and the Z-80 (Softwarehouse).

A further advantage is that artificial intelligence has given rise to a great many algorithms for searching graph structures of this form to find an optimal path through them.

They can be elegant, quick, efficient, exhaustive or heuristically-driven, according to taste — Nilsson (1971). Each algorithm is favoured in subtle ways by the exact design of the maze.

So with luck and a turbo-charged mouse — in the final analysis there is little substitute for well-directed brute force — a winner will actually reach the exit. Also

see Allen and Allen (1979) and Stanfield (1979).

Maze running is a special case of a more general navigational problem that is solved by planning techniques. A mobile robot must operate in the passages and spaces between obstacles without hitting them. Even if the vehicle has an accurate picture of its own position, either by dead-reckoning or some navigational aid, and that of the obstacles it has to avoid, it must still plan a route from its current position to its destination.

In a warehouse, algorithms akin to

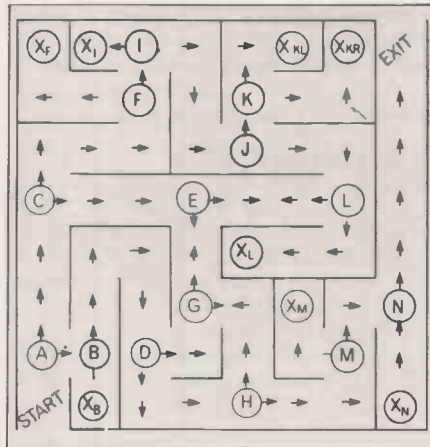


Figure 3. A maze.

those used for the maze may suffice with the vehicle running in the middle of the passageway. Any obstacle detected by its sensors would cause the vehicle to plan a new route round it. Presumably, when two such vehicles meet, being too stupid to go round one another, they would both turn, plan a new route and, doubtless, meet somewhere else.

Figure 5 shows an open-plan robot environment, bounded by walls but containing a few — five in this case, A to E — square obstacles. The problem is to plan a route from the start position, at the bottom, avoiding all the obstacles, but obeying some shortest path criterion.

Normally, that would be the shortest total distance but in a robot suffering navigational error while turning, the straightest path may be preferable. If computer time was at a premium the first path found, of the several possible, may be chosen or the best path found after a fixed number of seconds.

Assuming that the positions of the objects are known, there are a number of algorithms for planning a route through the robot's environment. Clearly, a good deal of geometry is going to be involved, and hence a good deal of computation.

Any technique which keeps this at a minimum will be welcome. The map could be stored as a topological, graphical representation, perhaps in a two-dimensional array. Each element in the array would correspond directly to a co-ordinate in real space.

For large areas, particularly if there are only a few objects, that will be very

cumbersome. Saving only the corner points of the objects would be far more efficient. In planning a minimal route it is desirable to pass by the objects as closely as possible to avoid travelling excess distance.

Computation can be further reduced by treating the robot as a point and by expanding each of the objects it must avoid by an amount equivalent to the radius of a circle which just surrounds the robot.

The result of this expansion is shown in figure 5. Clearly, if a point can navigate round those obstacles, the robot can move around the originals.

The next stage is to build a graph of all the points visible from the current position, and then all the points visible from those new places, and so on. A corner is visible from the current position if a line can be drawn to it without crossing any line which represents the face of an object, i.e., 1.3-1.4.

That could be rather time-consuming even though the routine to test if one line crosses another is minimal. Time could be saved by noting that a good deal of the robot world is invisible from any point as it is occluded by other obstacles. Figure 6 shows such a graph.

There is no need to join nodes at the same depth, 1.n or 2.n and so on, since it is pointless going somewhere in two stages when it is possible to arrive there by a straight line. Each of the arcs shows the length of the line between the two points in question. The underlined number beside each node is the distance which has been travelled to reach it.

Deeper nodes

Where two routes pass through the same point, only the shorter is used to compute distances to the deeper nodes. Eventually, the goal point is reached, or there are no more nodes to expand as the goal was unobtainable anyway.

The distance and route to be taken is now obtained easily from the graph. Searching the graph can proceed in a number of ways. First a breadth search, in which all the first-level nodes are expanded, 1.n, followed by all the second-level nodes, 2.n, then successively deeper nodes.

Searching in this way, the goal node to be found first is 1.6 — 2.4 — Goal, 179. The search would have to proceed to the fifth level to obtain the best route. When there are a large number of nodes, richly interconnected, the search space can become massive in a combination of explosion. However, the combinatorial explosion does not sound the death knell of artificial intelligence problem solvers.

The perfect search strategy is to know some heuristic measure which indicates the most advantageous arc of the many possible. Heuristics are often referred to as rules-of-thumb, extra knowledge or understanding about the problem domain.

A perfect heuristic would lead to a total depth first search, in which one particular successor to a node, rather than its neighbours, is expanded. That would lead directly to the goal.

In reality, a heuristic measure only indicates which of the nodes it might be best to explore. If the search leads to a terminal node, dead-end or one known not to be useful, the search must back-up to a previous node and follow another promising series of arcs.

Possible heuristic measures for searching figure 6 might include expanding the node which has the shortest route back to the start point, or expanding arcs that represent directions that most directly point to the goal position.

Using the co-ordinates of the points, the optimal path START — 1.3 — 2.2 — 3.2 — 4.1 — GOAL can be converted into a LOGO program, which could drive a turtle:

```

TO GOTOGOAL
10 RIGHT 39      (turn 39 degrees right)
20 FORWARD 41   (go 41 units forward)
30 LEFT 41
40 FORWARD 36
50 LEFT 70
60 FORWARD 27
70 RIGHT 24
80 FORWARD 36
90 LEFT 15
100 FORWARD 22
110 END
    
```

The more general case where the objects to be circumnavigated are not squares but arbitrarily-shaped is nothing like as straightforward. This simple edge expansion is not optimal. In fact, the robot could have squeezed between blocks A and B of figure 5 and if the block had been rounded at the corners to the robot's radius, the solution path would have been totally different. Further details of these algorithms may be found in Lozano-Pérez and Wesley (1979).

Planning and problem solving can be

used in generating higher-level, more descriptive plans than those purely for navigation or maze-running. The Shakey robot project at the Stanford Research Institute (SRI) used a problem solver (STRIPS — Stanford Research Institute Problem Solver) to tackle chain of action tasks — Fikes and Nilsson (1971).

Figure 7 shows a typical Shakey environment. A suite of rooms connected by doors to an adjoining corridor contains the robot and a selection of boxes.

The robot can make actions within this world by applying any one of a number of different operators, such as 'goto', 'pushto' or 'gothrudoor'. Whenever there is more than one possible operator, several difficulties arise during planning which were not noticeable with the maze and navigation examples.

Before, only the robot or micromouse changed position. There were no other effects and it was assumed that whenever the robot moved it is no longer where it was and has arrived at its destination.

Environment

During STRIPS planning, even though nothing in the real environment is moved, when it plans to move an object or the robot, the old information in the database about that thing must be removed and replaced with updated information about its new status.

So each time a new node is added to the problem graph by planning to apply an operator, a new version of all the axioms must be generated. That is the essence of the frame-problem: every time you plan an action, the next stage in your plan must assume the world has been changed as a consequence of previous actions.

STRIPS deals with that by having a delete and add list for each of the operators which can be used. The delete list specifies which of the current world model axioms will no longer be true of the world

if that operator were to be applied; the add list specifies the axioms which would have to be added after it was used.

A further complication is that operators may only be used if certain conditions are true of the world. The robot may not, for instance, push a box unless it is already next to it. Thus the operator:

goto(m)

in which the robot moves to place 'm' has the pre-condition:

(4x) [INROOM(ROBOT,x) ^
LOCINROOM(m,x)]

which states that the robot and the proposed new place for it must both be in the same room. The delete list:

ATROBOT(\$), NEXTTO(ROBOT,\$)

tells the system that wherever '\$' the robot was, and whatever it was next to, it will no longer be there after the operator goto(m) is used. The add list:

ATROBOT(m)

is the new information the model requires; the robot will be at 'm'. The operator goto2(m) moves the robot next to the item 'm', which could be, for example, a box or doorpost. Gothrudoor(k,l,m) causes the robot to go through door 'k' from room 'l' into room 'm' and it has the pre-conditions:

NEXTTO(ROBOT,k) ^ CONNECTS(k,l,m) ^
INROOM(ROBOT,l)

The robot must be beside the door 'k'; 'k' must connect room 'l' to room 'm' and the robot must be in room 'l'. The delete list is:

ATROBOT(\$), NEXTTO(ROBOT,\$),
INROOM(ROBOT,\$)

stating that the robot is neither where it was, next to what it was nor in the same room as before.

The add list simply states that the robot is in the new room:

INROOM(ROBOT,m)

A goal for the robot to achieve, a task or problem to be solved is also couched

(continued on next page)

Figure 4. Graphic representation of maze in figure 3.

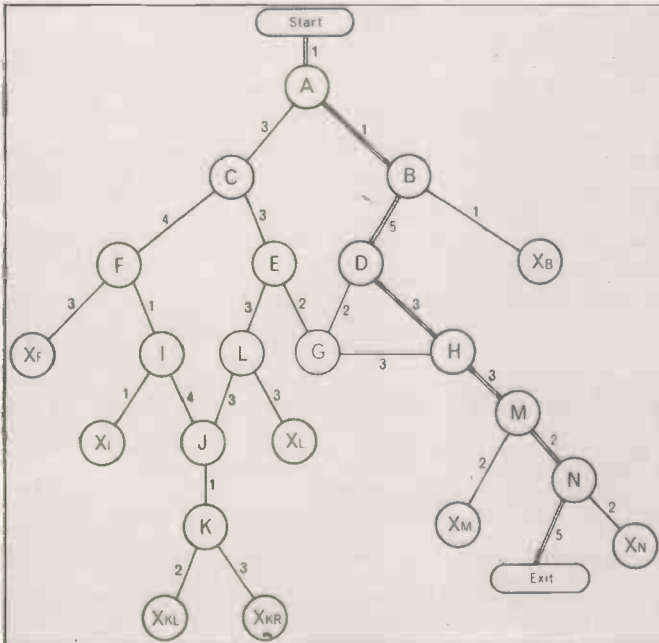
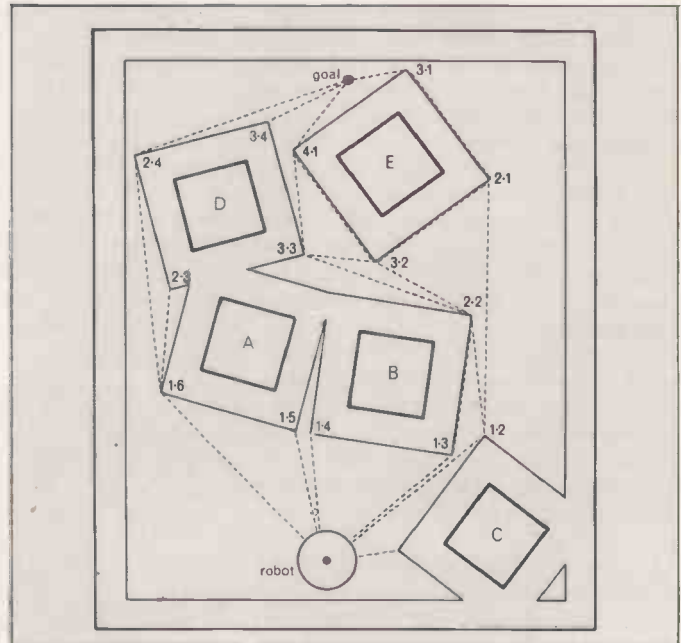


Figure 5. An open-plan robot environment.



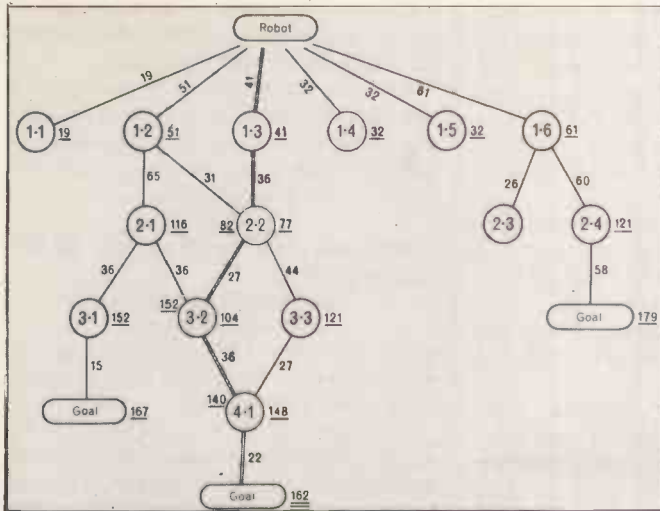


Figure 6. Graph of navigation problem posed in figure 5.

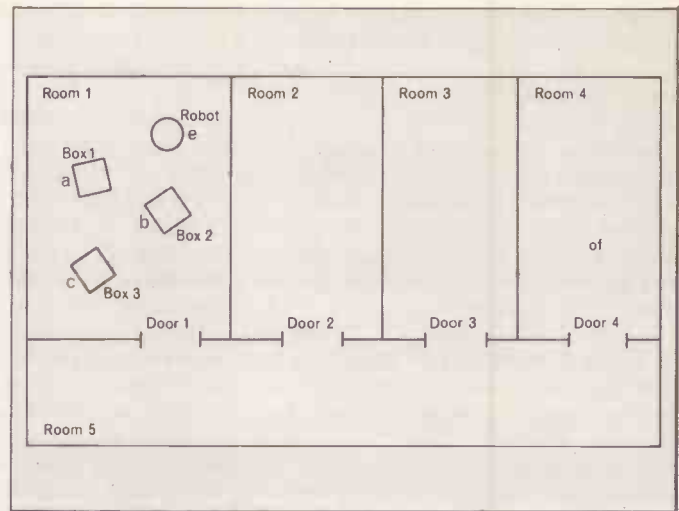


Figure 7. A STRIPS/Shakey world.

(continued from previous page)

in terms of a logic well-formed formula (wff):

$\text{NEXTTO}(\text{BOX1}, \text{BOX2}) \wedge \text{NEXTTO}(\text{BOX2}, \text{BOX3})$

place box 1 next to box 2 and box 2 next to box 3. Group all three boxes together. The problem solver proceeds by trying to show that the goal wff follows logically from the axioms describing the world and actions by the process of resolution. Strictly speaking, it does exactly the opposite of that — Nilsson (1971) and Kowalski (1979).

Almost as a by-product of that proof the operator list is generated:

$\text{goto2}(\text{BOX2}), \text{pusto}(\text{BOX2}, \text{BOX1}),$
 $\text{goto2}(\text{BOX2}), \text{pusto}(\text{BOX3}, \text{BOX2})$

or the goal wff:

$\text{ATROBOT}(f)$ gives:

$\text{goto2}(\text{DOOR1}), \text{gothrudoor}(\text{DOOR1},$
 $\text{ROOM1}, \text{ROOM5}),$

$\text{goto2}(\text{DOOR4}), \text{gothrudoor}(\text{DOOR4},$
 $\text{ROOM4}, \text{ROOM4}),$

$\text{gotol}(f)$

The system is clearly far more powerful than either of the previous 'planners'. Interesting environments can be described, many operators can be used to plan complex sequences of actions. Even though not English, the goals can be requested in a reasonably clear, and very unambiguous manner.

All is not wonderful, however, as a great deal of computation goes into generating a STRIPS plan. The wff format must be translated into its equivalent clause form, Nilsson (1971), updating the frame as a major task, as is the process of resolution itself.

A heuristic used to guide the problem search is that of goal difference. An operator is chosen which is likely to reduce the differences between the current state of the world and the required goal state. Fortunately, this information is provided almost directly in the form of each operator's add list.

In general, it takes considerably longer to generate even those short plans of actions than it takes for the robot to execute them. To overcome that to a cer-

tain extent, the designers added a facility to store portions of plans made to solve problems, so that they could be recalled and used *en bloc* — Fikes, Hart and Nilsson (1972a) — and also to generalise their stored plans so that they would be applicable as widely as possible.

Furthermore, they looked at the problems introduced by a second active unit in the environment, a second robot, which would change the world without updating the database axioms of the other — Fikes, Hart and Nilsson (1972b).

The lower levels of the Shakey system used a form of route planning similar to the one described earlier. Hardware checks, co-ordinate verification and error recovery, along with many other aspects are all integral in a project of this nature. Some idea of the scope of the Shakey project might be gained from Raphael (1976) or Raphael et al. (1971).

A number of other robot planning systems have been devised which do not involve robots, but simulate their actions on computer terminals. Among them are Doran's pleasure-seeking automaton, Doran (1968), Fahlman's BUILD system, Fahlman (1974), in which a simulated arm would build complex structures of blocks, requiring considerable planning ability.

It is interesting to note that in saving the effort of programming a robot arm, 80 percent of the programming effort in the system went on the simulation of the environment which included the effects of gravity and over-balancing. There was no attempt to model arm trajectories; blocks just disappeared and re-appeared where they were wanted.

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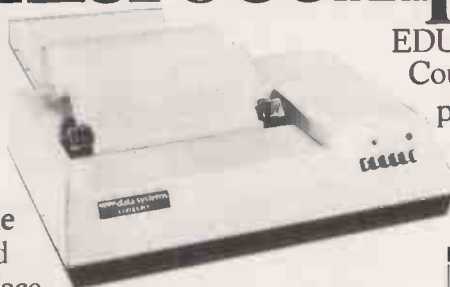
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Servos are inexpensive and easy to build

The design of a simple, low-cost robot arm poses many problems. Principal among them is the choice of motive power devices. Nick Hampshire reports on electric motors and their use as computer-controlled servo mechanisms.

THE RANGE of motive unit types — i.e., muscle — is extensive, ranging from hydraulic rams to stepper motors. The majority of these devices are neither inexpensive nor simple in construction, system-design or use.

Of all the options, electric motors, either stepper or DC, are best suited to low-cost simple construction. We have looked at stepper motors in some detail in previous articles *Practical Computing*, April and May, 1979. In this article we shall not concern ourselves with them — our topic is DC motor servo mechanisms and how to interface them to a computer.

Motor control systems fall into one of two categories — open-loop and closed-loop control. Open-loop control is used in most stepper-motor systems; the controlling device counts the number of steps to determine the position of the rotor.

In an open-loop system, there is no feedback from a position-sensing device to the controlling device. Open-loop

control is usually satisfactory with a stepper motor. However, if the motor misses a step because the torque is temporarily inadequate, the controlling device will not be aware that it has

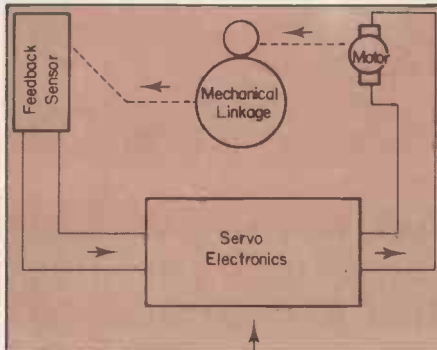


Figure 1. Simple block diagram of servo.

happened and cumulative errors will result.

In a closed-loop control system a sensory device is attached to the motor's

rotor. This sensory device is read by the controlling device every time there is an output to the motor, thereby checking that the position of the rotor is correct. By using feedback in a closed-loop control system, accurate positioning can be achieved without cumulative errors, even when using a device as difficult to control as a DC motor.

Sensory or feedback devices can take a wide variety of forms depending on the application and on whether the rotation of the rotor, either forwards or backwards — usually after being geared-down — is fixed or free.

The commonest form of servo motor — familiar to users of radio control models — is a servo mechanism with a fixed limit to its rotation, usually 180 degrees. The position-sensing device used for feedback in such devices is a potentiometer, see figure 1. The servo electronics usually uses a method known as digital proportional control.

With that method, the input from the computer or controlling device is a digital pulse of carefully-controlled width, see figure 2. An internal pulse is generated by the control electronics. Its width depends

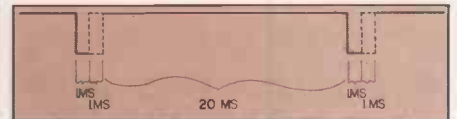


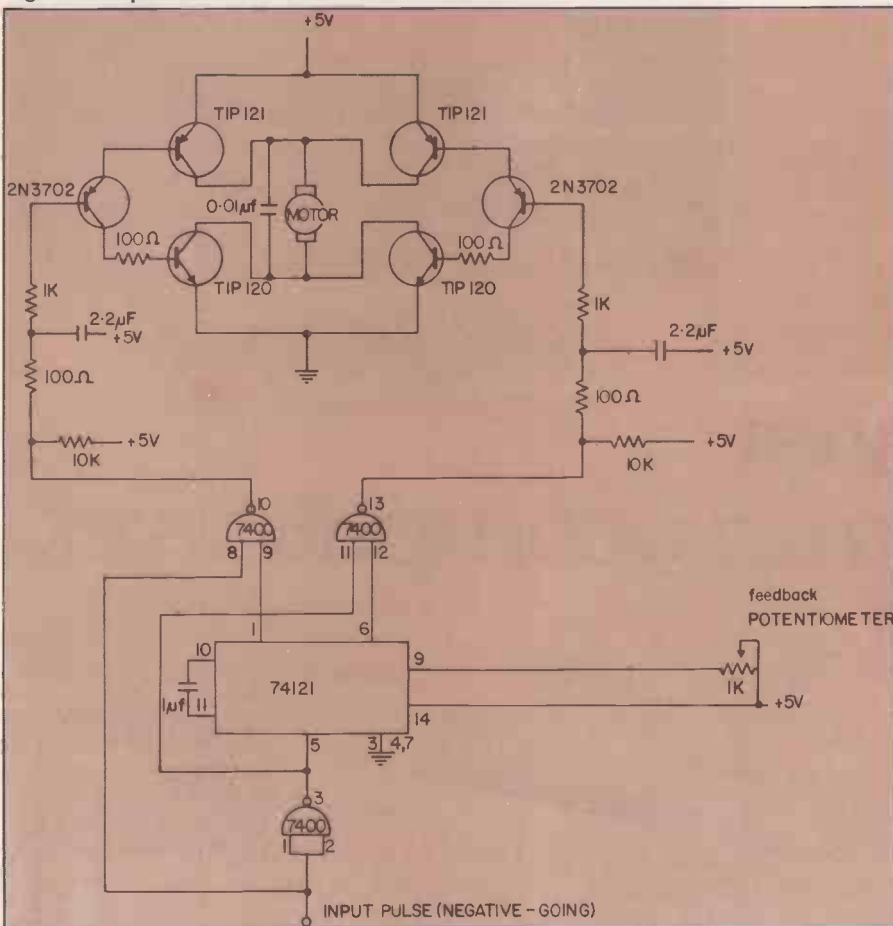
Figure 2. Waveform of input.

on the position of the feedback potentiometer. The width of the internal pulse is compared to the width of the input pulse. If they match, no current goes to the motor. If they do not match, current is fed to the motor, which rotates the potentiometer in the appropriate direction via the gear chain.

As the position of the feedback potentiometer changes, so does the width of the internal pulse. Eventually, the internal and input pulse widths will match and current will cease to be fed to the motor. If the motor overshoots the correct position, the control electronics will sense it and reverse the polarity of the motor to bring it back to the correct position.

Similarly, if an external force is applied to the motor shaft, rotating it away from the desired position, the electronics will sense it and restore the rotor to its correct position. By feeding a sequence of such pulses into the servo electronics, the motor can be made to track the varying

Figure 3. Proportional control servo circuit.



pulse width. The model aircraft servo is an ideal low-cost, about £12, device for anyone wishing to experiment with computer control of servo mechanisms. Those devices are very small — less than 35 c.c. — and weigh about 50gm. Despite their size, they deliver a healthy torque as a result of gearing — about 40 oz. in. — though unfortunately this is not sufficient for use in robot arm.

They can be used in a wide range of applications from the control of valves to the construction of a simple plotter. Just three wires lead from the servo, two are for the motor power supply (200mA at 5V) and the third is the pulse input line. These servos typically expect pulse widths of between 1 and 3 milliseconds.

The pulse can be either positive- or negative-going depending on the make of servo. The pulses should be repeated every 15 to 20 milliseconds, though the frequency of repetition is not critical.

Waveforms

The servo will take about one second to move from one extreme to another and interfacing one to a computer is thus simply a matter of using a timing-loop within a program of programmable timers within an I/O chip to generate a waveform like that in figure 2.

The variable section of the pulse width is about one millisecond; with a processor clock at 1MHz, the maximum positional accuracy using a programmable timer — 16 bit — and a 180-degree maximum servo rotation is .18 degrees, i.e., 1/1000 of the arc of rotation.

That is only a theoretical accuracy, though, since it assumes true linearity of the feedback potentiometer which in practice probably has a five percent variability plus the assumption that there is no backlash in the gear chain.

Proportional control servo electronics are quite simple. An example is shown in figure 3. The circuit consists of three parts, the servo amplifier, the servo drive and the servo unit. The servo amplifier consists of a 74121 monostable to generate

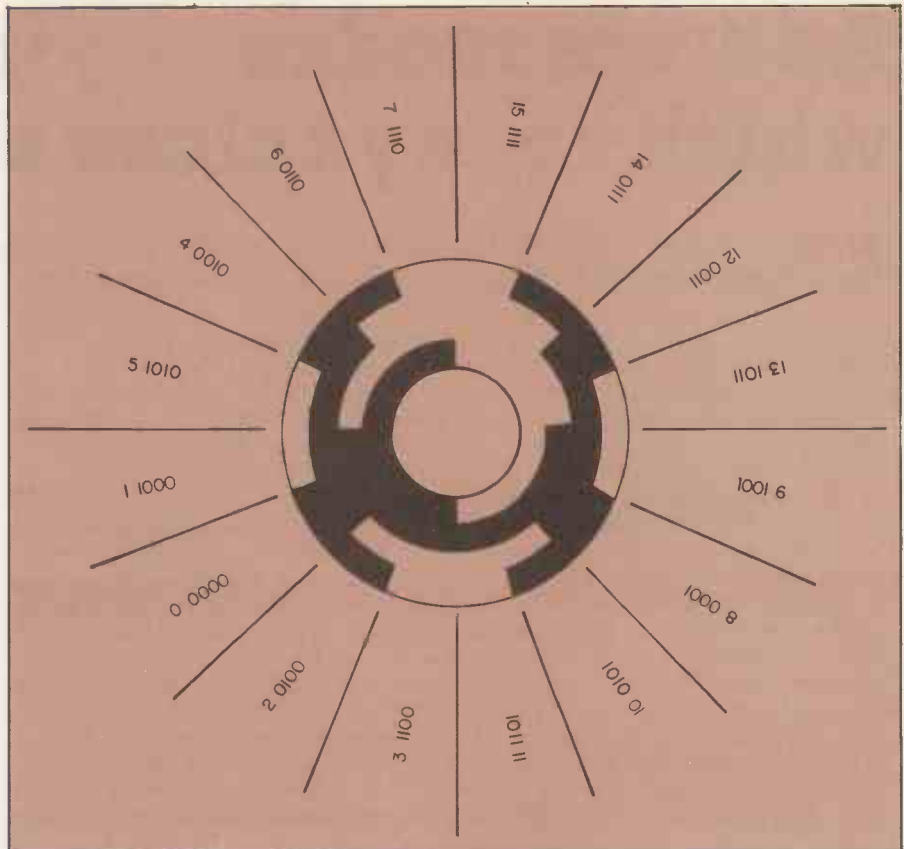


Figure 4. Excess three-gray code shaft encoder four-bit.

the internal pulse and a pulse-length comparator circuit.

The monostable is triggered by the leading edge of the input pulse. The width of the monostable output pulse is proportional to the resistance of the feedback potentiometer which is the resistance component of the RC timing circuit of the monostable. The comparator circuit consists of three Nand gates.

Two outputs

The circuit has two outputs; one drives the motor forwards via the servo drive circuit, the other drives it backwards. The choice depends on whether the input pulse is shorter than the internal pulse or longer.

The servo drive is a fairly standard bridge circuit for directional control of DC motors. The power transistors will drive the average small motor and have a power rating of several amps. The servo unit consists simply of the motor, the feedback potentiometer and the mechanical linkage between them.

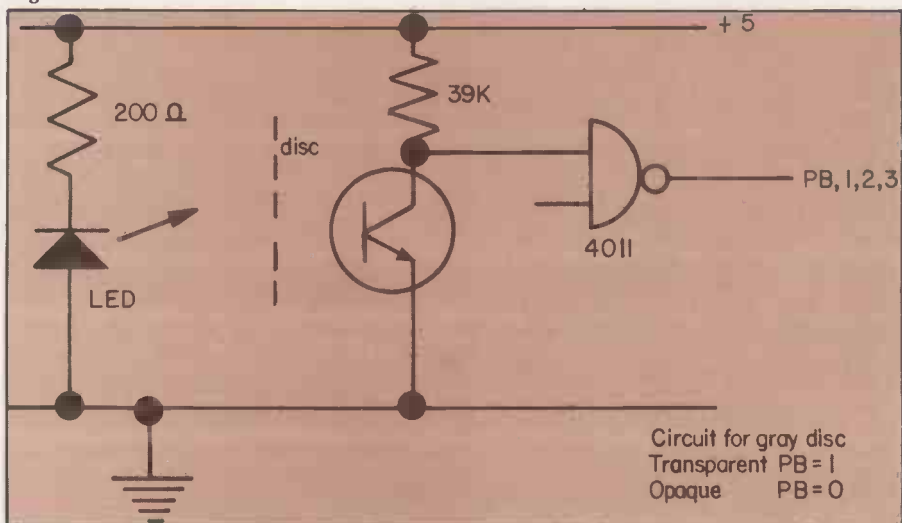
Servo mechanisms need not be confined to the use of motors or limited to rotations of 180 degrees. Depending on the gearing, the output of a rotary servo motor could be tens or even hundreds of turns between the two extremes of motion. A rack and pinion mechanism will convert the rotary motion of an electric motor into linear motion, with a linear potentiometer as the feedback device.

The only feedback device considered so far in this article is the potentiometer. In applications requiring high precision, such devices are not accurate enough. One of the commonest replacements for a potentiometer feedback is optical encoding. It involves attaching an optical encoding disc to the motor driveshaft, either before or after gearing. Figure 4 shows such a disc.

The encoding disc is read by an array of photodiodes to detect the transmission of light through the disc from an LED on the other side. As the disc rotates, the coded output from each of the photodiodes changes and can be read by the computer controlling the motor.

This system is more accurate and a further advantage over the potentiometer is that it permits free rotation.

Figure 5.



Address modes — vital topic which repays close study

Generally, the more ways that a computer can address data, the more flexible it is. This month, David Peckett describes different types of addressing and looks at what the 6502 and 8080A offer.

AN IMPORTANT aspect of any computer program is that instructions can exist in various forms, depending on how data is to be accessed and where it is to go. You will recall that a microcomputer instruction can be one, two or three bytes long. The first byte is always an opcode, defining what the micro is to do. There may also be a 1- or 2-byte operand, defining what or where the computer is to do it to.

Many instructions such as the one to load the accumulator, can exist in several forms, depending on their addressing mode. For example, in the 6502 we have already met:

LDA #data and LDA address

The first, an immediate load, has two bytes, with the second being the data to be loaded. The second version uses two bytes to define the address, and is thus a 3-byte operation. The two forms of the instruction have opcodes A9₁₆ and AD₁₆ respectively to define the two operations.

Implied addressing is the simplest form. It is used where the instruction defines all we need to know about the data, what is to be done to it and where it's going to be done. With micros, it is inevitably a single-byte instruction, and examples are:

6502: CLC; DEX; TAY

8080A: INX rp; DAA; MOV r₁,r₂

Immediate addressing. An instruction using immediate addressing provides the data it will manipulate as an operand. Any 6502 assembly language instruction using immediate addressing contains a "#", while the 8080A uses special mnemonics. Examples are:

6502: LDA #data; ADC #data; SBC #data

8080A: MVI r,data; SUI data; LXI H,data

The data field can be either data or a label defined as a given value. The instructions can be two or three bytes long, depending on how much data is involved. For instance, "LDA data" needs two bytes, as it loads a single byte into the accumulator. On the other hand, since "LXI H,data" loads 16 bits into (H,L), it is three bytes long.

Direct addressing. In direct addressing, the operand field of the instruction contains the address where the data is to go or is to be found. Since both these micros use 16-bit addressing, the instruction always has three bytes. Examples are:

6502: LDA ADDR1; STA \$ABCD;
ADC \$1000

8080A: LDA \$ABCD; STA ADDR1;
LHLD \$1000

The address field can be either the address itself, or a label representing the

address. The important point is that the address is defined explicitly.

A sub-form of direct addressing is called page-0 addressing. In this mode, the high byte of the address is always set to zero, and the instruction provides only the low byte. It, thus, accesses the 256 memory locations from 0000₁₆ to 00FF₁₆. The advantage is that only one byte is needed to form the address, giving 2-byte instructions which take up less space and run faster. It is best to try to use this form whenever you can. The 8080A does not have page-0 addressing, but the 6502 can apply it to almost any instruction which has a direct addressing form, e.g.,

STA \$20; ADC \$15

If the numerical address field is FF₁₆ or less, the assembler will use page-0 addressing automatically. Labels can be defined as being on page-0.

Indexed addressing. It often happens that

we have a long list of items, in continuous memory, which we must process identically. The obvious way is to use a loop, but how do we arrive at each item in turn? One solution is indexed addressing.

In this form, the instruction provides a base address (BA), which is modified by adding the contents of an index register (IR). The operation is then performed on the address defined by the sum of the base address and the index register (BA + IR).

If you are told someone lives in the third house after the one with the green door, that is indexed addressing. I hope it is clear how indexed addressing is used to go through a list of items.

A fixed base address is used in a loop; on each pass through the loop, the index register is either decremented or incremented. Either way, each item is handled in turn.

Our two micros have different

Table 1. 6502 addressing options

Mnem.	Implied	Page-0		Index,X		Indir,X		P-O,I'x,X		Indir
	Direct	Immed	Index,Y	Indir,Y	P-O,I'x,Y	R'tive				
ADC	*	*	*	*	*	*	*	*	*	
AND	*	*	*	*	*	*	*	*	*	
BCC										*
BCS										*
BEQ										*
BMI										*
BNE										*
BPL										*
BVC										*
BVS										*
CLC	*									
CLD	*									
CLI	*									
CLV	*									
CMP		*	*	*	*	*	*	*	*	
CPX		*	*	*	*	*	*	*	*	
CPY		*	*	*	*	*	*	*	*	
DEC		*	*	*	*	*	*	*	*	
DEX	*									
DEY	*									
INC		*	*	*	*	*	*	*	*	
INX	*									
INY	*									
JMP		*	*	*	*	*	*	*	*	*
LDA		*	*	*	*	*	*	*	*	
LDX		*	*	*	*	*	*	*	*	
LDY		*	*	*	*	*	*	*	*	
NOP	*									
SBC		*	*	*	*	*	*	*	*	
SEC	*									
SED	*									
SEI	*									
STA		*	*	*	*	*	*	*	*	
STX		*	*	*	*	*	*	*	*	
STY		*	*	*	*	*	*	*	*	
TAX	*									
TAY	*									
TXA	*									
TYA	*									

approaches to indexed addressing. The 6502 uses the pure technique I have described, modifying a base address by the contents of either X or Y. The data in the index register is treated as an unsigned binary number. Typical indexed instructions are:

```
LDA ADDR3,X; STA $1000,Y;
ADC $FF10,X
```

The 8080A does not have the full indexing capability of the 6502. As we have seen, the register pairs (RPs) (B,C) and (D,E) can be used as indices to load and store the accumulator. Furthermore, the RP (H,L) gives access to the memory location "M", which can be used in any appropriate instruction. Examples are:

```
MOV A,M; ADD M; STAX B
```

However, the 8080A does not have special instructions to calculate (BA + IR) swiftly like the 6502. In most cases, that is

not important, since indexing is used normally to step along a list from one end. It can, nevertheless, lead to complicated programming.

Indirect addressing. Absolute addressing forms such as direct addressing and variations such as indexed addressing are fine if the data is always placed in rigorously-defined areas of memory. It is not necessarily possible, however, as in many cases, the memory allocations must vary throughout a program, being defined by what the program has done.

Thus the program must calculate where the data is, and then pass that address to another program segment. It does this by indirect addressing, which uses reserved memory locations to show the position of other data.

The basic instruction has the form:



The data stored at the address is used, however, to form another address, which defines the data to be manipulated. In other words, an indirectly-addressed instruction defines an address where a pointer to the data can be found. Since addresses need two bytes, the address in the operand contains the low byte of the pointer and the next byte gives the pointer's high byte.

Figure 1 shows the process diagrammatically for an ideal micro — not the 6502 or 8080A. Initially, the instruction is "Load A (Ind) abcd". Address "abcd" contains "rs", and "abcd+1" contains "pq". The indirect address gives a pointer to "pqrs". Location "pqrs" contains 1016 which is the data loaded into A.

In principle, in-directions can be nested, but that can become complicated. In-direction is like saying: "If you ask at the house with the green door, they'll tell you where I live".

I used an idealised example because neither of the two micros provides true indirect addressing. The 6502 uses a very limited form, while the 8080A needs several lines of code to obtain the full effect. That is the price you pay to squeeze a CPU on to a single piece of silicon. **Relative addressing.** We met relative addressing last month, in the shape of the 6502 branch instructions. We can see that it is a variation of indexed addressing, with the displacement field being used to modify the base address represented by the PC. The 6502 uses this mode for conditional branches only, while the 8080A does not have relative addressing at all. **Further addressing modes.** We have now covered the common addressing modes which micros, or for that matter any computers, use. If we want, however, to do something far more complicated, we can have compound modes such as indirect indexed or indexed indirect. The 6502, in fact, gives such facilities, but the 8080A doesn't really try.

The 6502 has a remarkably wide range of addressing modes for a microprocessor. In the descriptions of the difference basic modes, I outlined some of its options. The micro also provides a number of sub-modes which we have not yet examined.

What, precisely, are the 6502 addressing modes? Obviously, some instructions use implied addressing which normally excludes them from any other mode — there are exceptions, but we have not encountered them yet. Also, many instructions have an immediate form; this mode has no variations. Relative addressing is used only for the branches, and the branches use only relative addressing. Again, there is no need to go further. Direct addressing is perfectly straightforward.

The indexed and indirect modes, however, are rather complex, and we'll look at these in more detail.

6502 indexed addressing. Remember, a

(continued on page 101)

Table 2. 6502 assembly language formats. The table uses a hypothetical mnemonic, since no real operation uses all the possible modes.

Addressing Mode	Format	Remarks
Implied	OPN	No operand field
Direct	OPN addr	16-bit address
Page-0	OPN addr	8-bit address
Immediate	OPN #data	
Indexed	OPN addr,X/Y	16-bit address, X or Y possible
Page-0, Indexed	OPN addr,X/Y	8-bit address, X or Y possible
Indexed Indirect	OPN (addr,X)	8-bit address
Indirect Indexed	OPN (addr),Y	8-bit address
Indirect	JMP (addr)	JMP only, 16-bit address
Relative	OPN displace 't	Branches only

Table 3. This month's instructions.

Operation	6502			8080A		
	Mnem.	Flags	Effect	Mnem.	Flags	Effect
16-bit addition of RP to (H,L)	—			DAD rp	C	H,L = H,L + RP
Compare to Accum	CMP o	N,Z,C	Set flags for: (A-d/(a))	CMP r	All	Set flags for: (A-r)
Compare to X	CPX o	N,Z,C	Set flags for: (X-d/(a))	—		
Compare to Y	CPY o	N,Z,C	Set flags for: (Y-d/(a))	—		
Compare Immed to Accum	—			CPI d	All	Set flags for: (A-d)

Notes:

- "a" = Address — defined by the program
- "d" = Data — defined by the program
- "o" = Operand — can be an address or data
- "r" = Any 8080A register, including M
- "rp" = Any 8080A register pair
- "d(a)" = Data, or the contents of the address defined by "a"

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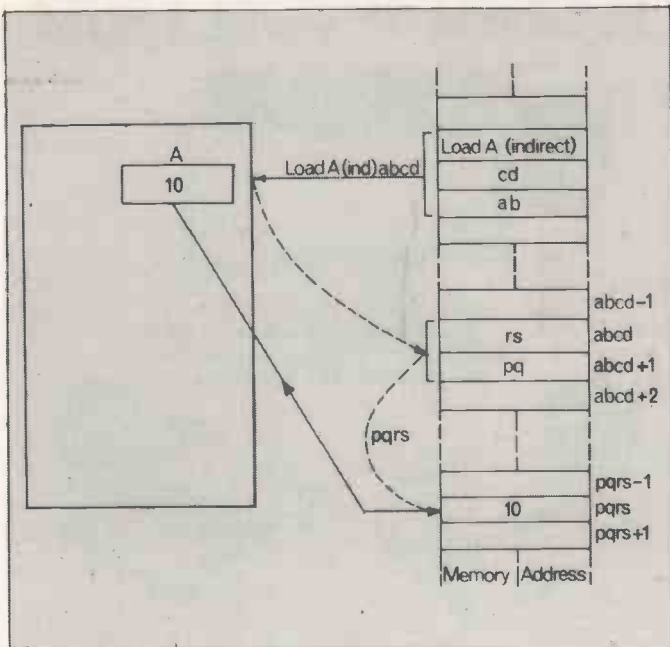


Figure 1.

(continued from page 99)

micro using indexed addressing goes to the address defined by the sum of the operand and the index register. The 6502 has two forms of indexed addressing — absolute and page-0. To make things more complicated, it doesn't use the two index registers, X and Y, in the same way.

Normally, if indexed addressing is possible, you can always use the "Absolute,X" mode. Also, if you can use "Absolute,X", you can also use "Page-0,X". However, some instructions, such as "STY", allow only the "Page-0,X" form.

The opportunities for using Y are more limited. About half the instructions which allow "Absolute,X" also allow "Absolute,Y". However, only two instructions have a "Page-0,Y" mode — these are "STX" and "LDX".

As an example of indexed addressing, look at figure 2. Suppose that X contains 30_{16} , "STA \$1000,X" will store the contents of the accumulator at address 1030_{16} .

Remember that the lack of a page-0 mode does not stop you indexing from this page. It only means that you must use two bytes to define the base address, rather than the single byte of a page-0 instruction. An assembler will take care of all that for you, anyway.

Generally you must be careful to use a valid form of indexed addressing. Your assembler will tell you if you make a mistake, but it is less frustrating to be right first time. Either way, since X and Y are only eight bits long, we can only index through a list of 256 items or less.

6502 indirect addressing. The 6502 has only one instruction using the pure indirect form which I described — that is "JMP". It is possible to write a program which computes a jump address dynamically, which it then uses via an indirect "JMP".

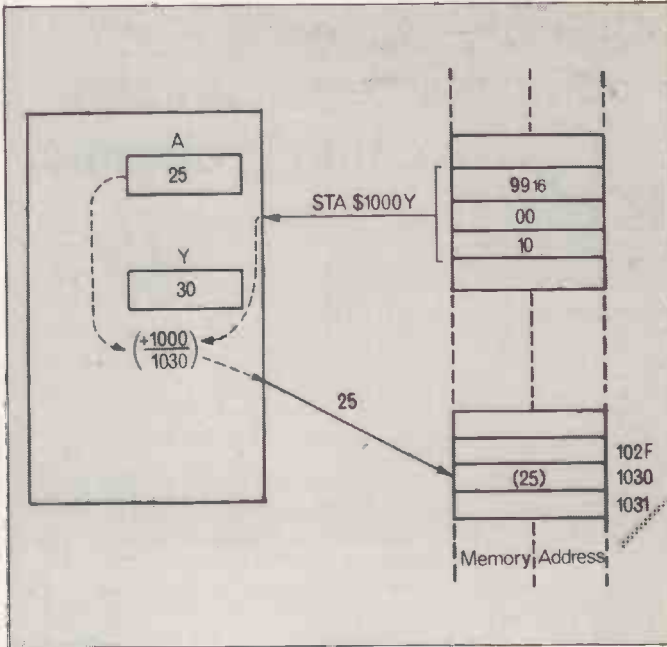


Figure 2.

I do not recommend that you use it. A "computed GOTO", which it amounts to, is totally alien to any concept of maintainable software. It makes it almost impossible to find program bugs, and any future modifications to the software are a challenge, to say the least.

The normal indirect modes of the 6502 are indexed indirect and indirect indexed. They use the X and Y registers respectively as indices, and can be combined only with page-0 addresses.

Indexed indirect. In this mode, the contents of X are added to the operand to form a new page-0 address. The contents of this address are then used as a pointer to the target address. Figure 3 shows the technique.

In the example, the instruction is "LDA (\$1A,X)", and the index register contains 10_{16} . Initially, the micro loads the base address and adds X to obtain the address of the pointer — $2A_{16}$. This address contains "rs" and the next byte ($2B_{16}$) contains "pq". These are taken together to make the target address "pqrs", and the data in it is loaded into A.

The technique sounds long-winded but it is a useful way of handling a list of pointers. The pointer number can be defined by X, and found by indexing from a base address. As an analogy: "Go to the third house after the one with the green door, and they'll tell you where I live".

Beware, this mode only works on page-0, and any carry from the addition of the base and X is ignored. Thus, "LDA (\$AB,X)", when X contains 71_{16} , moves the pointer from $001C_{16}$, and not $011C_{16}$. It is easy to corrupt data if you misuse this mode.

Indirect indexed. It is, roughly, the opposite of indexed indirect. Again, it uses addresses on page-0, but Y is used for the indexing. The address defined by the instruction gives a pointer. The value of this pointer is then indexed.

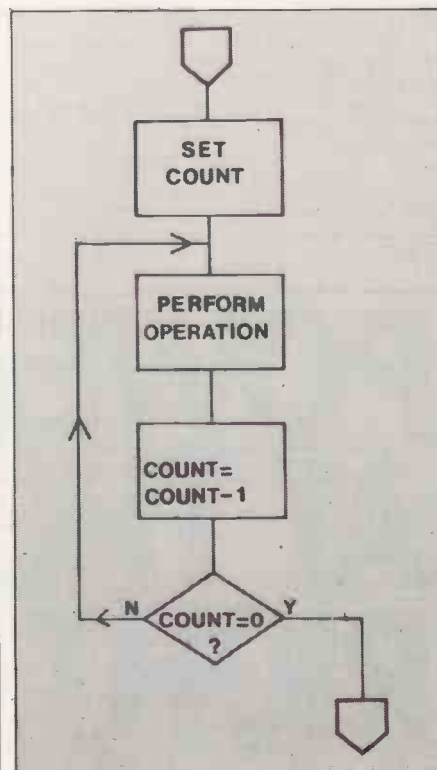


Figure 5a.

The process is shown in figure 4. The instruction is "LDA (\$10, Y)"; the micro goes to addresses 0010 to 0011, and extracts a pointer to address 1234_{16} . It is then indexed by Y, which contains 10_{16} , and the data at 1244_{16} is loaded.

"Go to the house with the green door — they'll tell you the street in which I live. My house is the third one along".

Like the indexed indirect mode, the base address can only be on page-0. Of the 2 compound forms, indirect indexed is probably the more useful. It allows the base address of a variable-length list of data to be placed in a fixed location; the micro can then index its way along the list.

(continued on page 103)

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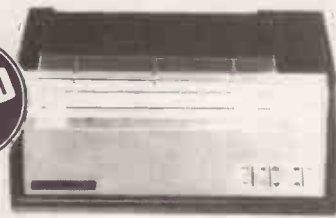
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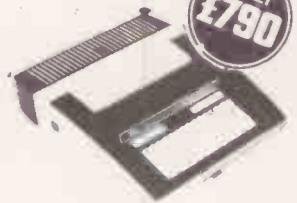
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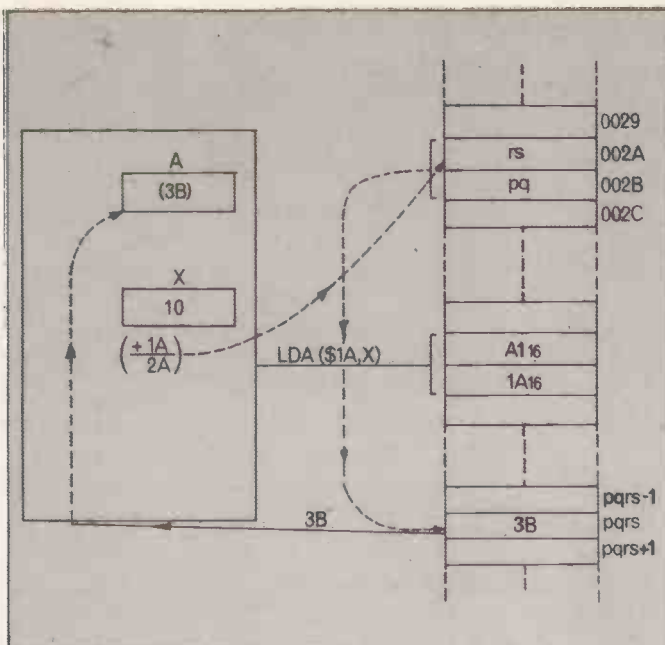


Figure 3.

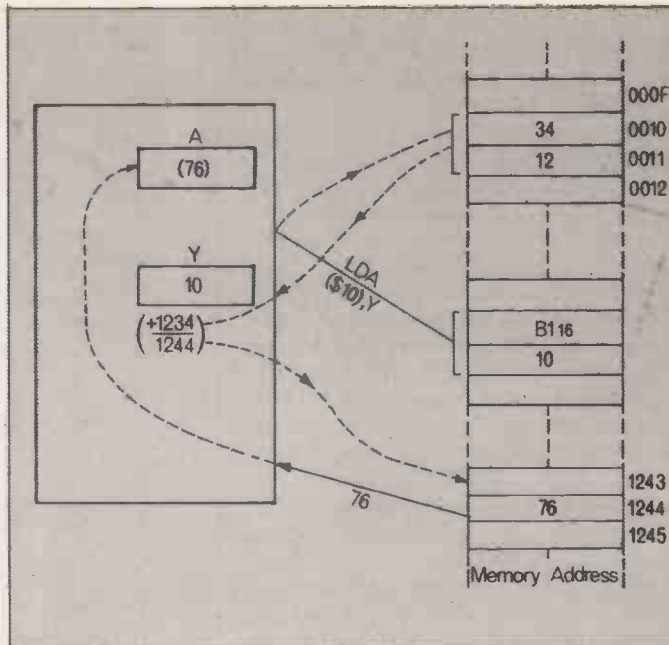


Figure 4.

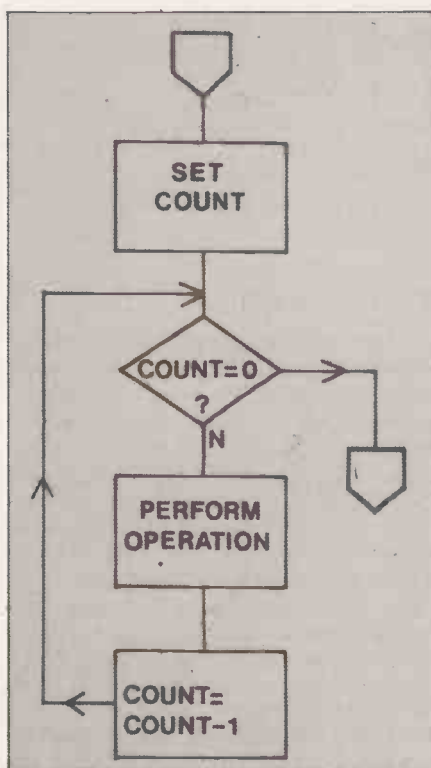


Figure 5b.

(continued from page 101)

The mode is thus very useful for passing lists of data from one program segment to another. Obviously, we can index directly only along a list of 256 or less items. If the list is longer, and it may very well be. We must increment the high byte of the pointer, thus adding 256 to it, every 256 iterations.

6502 addressing options. Table 1 lists all the 6502 instructions we have met so far, and shows which addressing modes each of them can use.

The 8080A has fewer addressing modes than the 6502. It is limited to direct and immediate modes, plus the indexed/implicit hybrids provided by the three RPs.

Another major difference between the two micros is in the construction of their assembly-language mnemonics. The 6502 uses a basic mnemonic, e.g., LDA, and uses the operand field to define the precise mode. The 8080A, on the other hand, uses different mnemonics for each mode. For example, "MVI A,data", "LDA address" and "MOV A,M" are, respectively, the immediate, direct and indexed accumulator load instructions.

Although the 8080A instructions allow only those three basic addressing modes, it is, however, possible to combine instructions to obtain the effect of more. Indirect addressing is reasonably easy. If the pointer is stored in locations "IND" and "IND + 1", "LHLD IND" will put it into (H,L). We thus generate an indirect pointer to M. For instance, to load A direct from "IND":

```
LHLD IND ;H,L CONTAINS POINTER
MOV A,M ;INDIRECT LOAD
```

Obviously, this needs two instructions.

For true indexed loading, we need to use a second RP, e.g., (D,E), as the index. We also need the instruction "DAD rp". That instruction performs a 16-bit addition of the data in the given RP and (H,L), and puts the result into (H,L). We can then use a program segment like:

```
LXI H,BASE ;SET BASE ADDRESS
DAD D ;CALCULATE OFFSET
MOV A,M ;INDEXED LOAD
```

It's also possible to generate the compound modes which the 6502 uses. We can achieve an indirectly-indexed, i.e., indexing after indirection, instruction easily. For instance, the equivalent to "LDA (IND),Y", where Y contains 10_{16} , is:

```
LHLD IND ;LOAD BASE POINTER
LXI D,810 ;SET UP INDEX
DAD D ;(H,L) CONTAINS (IND + 10)
MOV A,M ;INDIRECT INDEXED LOAD
```

Alternatively, for an indexed indirect, i.e., where the address of the pointer is in-

dexed, instruction, equivalent to "LDA (BASE,X)" when X contains $2A_{16}$:

```
LXI H,BASE ;SET UP BASE POINTER
LXI D,82A ;SET UP INDEX
DAD D ;INDEXED POINTER ADDRESS
MOV D,M ;D HOLDS POINTER LSB
INX H ;POINT TO POINTER MSB
MOV H,M ;H HOLDS MSB
MOV L,D ;(H,L) NOW HOLDS POINTER
MOV A,M ;INDEXED INDIRECT LOAD
```

It is clumsy, but it gives the desired effect.

Normally, however, we increment the index one step at a time from zero, and we do not need those complex constructions. In fact, what we are trying to do is to make the 8080A emulate a 6502. There are much better ways of achieving the proper effect with an 8080A, using all its registers. Occasionally, we might want to translate 6502 code into 8080A code, but it's best to understand first what the program is trying to do.

So, a single 6502 instruction can be in any one of up to eight different modes, all using the same basic mnemonic. Each mode, however, generates a different opcode — if it didn't, the micro would not know what to do. Yet how does the assembler produce the opcodes? The problem doesn't arise with an 8080A, because each mnemonic has only one meaning, but with the 6502 it is not so clear.

In fact, the assembler looks at the whole instruction, and not just the mnemonic. The operand field has a format for each mode which the assembler recognises and generates the appropriate opcode. We have already seen some of the formats, but, for reference, the full range of conventions is shown in table 2. Be warned — these are the normal 6502 conventions, and the ones I shall be

(continued on next page)

(continued from previous page)

using in this series, but I do not guarantee that your assembler will use them. Please check first.

We have covered a good deal of new material, so I don't intend to introduce many new instructions. I've described the 8080A "DAD rp" and there is no other instruction which will be useful at this stage.

Last month, we had to compare two numbers to find the larger — we subtracted one from the other to solve the problem. Since it is a very common requirement for a program to have to compare two numbers, both our micros provide special instructions to simplify the task.

The instructions are shown in table 3, and are effectively identical for the two machines. The micro subtracts the indicated data from the contents of the accumulator — or X or Y in the 6502 — and sets the flags accordingly. The result of the subtraction is not stored, however, and no registers are altered.

There are six possible relationships between the two numbers; if we are testing A against data of value "p", they are:

$A < p; A \leq p; A = p; A > p; A \geq p; A \neq p$

By suitable tests of the Carry and Zero flags, we can make conditional jumps based on any of these six relationships. For example, we could have:

	6502		8080A
$A < p$	BCC LESS	JC	LESS
$A = p$	BEQ EQUAL	JZ	EQUAL
$A > p$	BEQ NOTGT	JZ	NOTGT
	BCS MORE	JNC	MORE
NOTGT	NOTGT

Notice the different treatment of the carries because of the two ways in which the micros show a borrow. In the last example, we have to separate the equal case, because a simple no borrow would mean equal or greater.

The comparison instructions are particularly useful on two occasions: If we have to iterate through a loop until something happens, and don't know how long it will take; if a loop can occur for a pre-determined number of times which may include zero. The loop flowchart we used last month, figure 5a, gives one pass through the loop even if "COUNT" is initially zero. By re-arranging the test, we can avoid this happening, figure 5b. The second flowchart gives a completely universal loop; however, the first type will run slightly faster.

We shall now look at two short programs which employ some of the facilities I've outlined. The first inputs an undefined number of bytes until it reads a terminator. The second transfers a block of data from one area of memory to another.

Input routine. Very often, a program must read in a string of data and store it in a defined area. We do not know how long

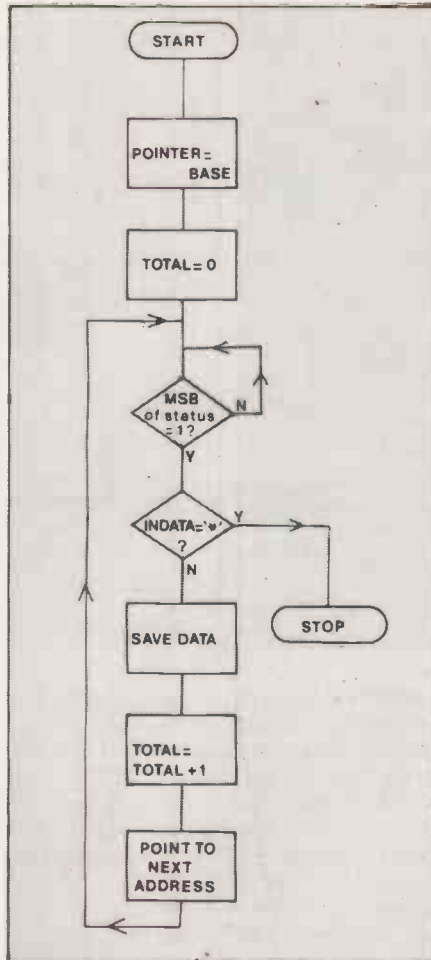


Figure 6.

the string will be, but its last character is pre-defined, e.g., a "***". Further, the bytes may arrive asynchronously, and the program has to monitor a status bit which shows when data is ready. This bit is the MSB of a status word, "STATUS".

Figure 6 is the flowchart for such a routine. It uses indirect addressing to point to where each byte is to go. The program also keeps track of how many bytes are received — there may be more than 255. The final "***" is not saved. The 6502 and 8080A programs are given in figures 7a and 7b respectively. **6502 program.** First of all, the program sets the storage pointer at address "POINT", and clears the two bytes needed for "TOTAL". In the main loop, we monitor "STATUS", looping round-and-round until the MSB equals "1". The input data is read, and the routine uses a "CMP" to test it.

We save the input byte, using indirect addressing. The program has to use indexed indirect, but, with X set to zero, it is equivalent to pure Indirect.

The pointer and total are then incremented, remembering to test for a carry from the low to the high byte, and the program goes back to wait for another byte.

8080A program. The 8080A program is similar, but shows the value of being able to manipulate 16 bits directly. It uses (D,E) and (H,L) to contain the pointer

```

;6502 INPUT ROUTINE
;SET UP POINTER AND COUNTER
LDA #BASELO ;LSBS OF BASE
STA POINT
LDA #BASEHI ;MSBS OF BASE
STA POINT+1
LDA #0
LDA TOTAL ;LSBS OF TOTAL
STA TOTAL+1 ;MSBS OF TOTAL
TAX
;MONITOR INPUT STATUS
INPUT LDA STATUS
BPL INPUT ;MSB=1?
;MSB SET - READ BYTE
LDA INDATA
CMP #'* ;* IS END OF SEQUENCE CODE
BNC END ;FINISHED?
;VALID DATA WAS INPUT - SAVE IT
STA (POINT,X) ;INDIRECT SAVE
INC TOTAL ;TOTAL=TOTAL+1
BNC NOCRRY ;INCREMENT "TOTAL" MSBS?
INC TOTAL+1 ;YES
NOCRRY INC POINT ;POINT TO NEXT STORAGE ADDRESS
BNC INPUT ;INCREMENT "POINT" MSBS?
INC POINT+1 ;YES
JMP INPUT ;GO BACK FOR NEXT BYTE
END NOP ;FINISH INPUT
  
```

6502 input routine.

```

;8080A INPUT ROUTINE
;SET UP POINTER AND COUNTER
LXI H,BASE ;(H,L) WILL BE POINTER
LXI D,0 ;(D,E) WILL SAVE TOTAL
LXI B,DATA ;THIS WILL SPEED UP THE PROGRAM
;MONITOR INPUT STATUS
INPUT LDA STATUS ;READ STATUS WORD
CPI 0 ;THIS SETS THE FLAGS
JP INPUT ;MSB=1?
;MSB SET - READ BYTE
LDAX B ;INPUT DATA
CPI '*' ;END OF SEQUENCE CODE
JZ END ;FINISHED?
;VALID DATA READY - SAVE IT
MOV M,A ;INDEXED SAVE
INX H ;INCREMENT POINTER
INX D ;INCREMENT COUNTER
JMP INPUT ;BACK FOR NEXT WORD
;SAVE TOTAL
END NOP ;END OF INPUT
MOV H,D ;COPY (D,E) IN (H,L)
MOV L,E ;(THERE IS A BETTER WAY)
SHLD TOTAL ;SAVE TOTAL
;END OF SEGMENT
  
```

8080A input routine.

and total respectively. (B,C) is set to the address of the data input port to speed reading input data.

Since an 8080A "LDA" does not affect the flags, we must set them deliberately before we can test the MSB of "STATUS". "CPI 0" is one way of doing this. Apart from the easier way of incrementing 16 bits, the main loop is almost identical to that of the 6502.

Finally, we save the total, having first moved it from (D,E) to (H,L). It would be advantageous if the 8080A allowed 16-bit direct movement between (B,C) and (D,E), and memory.

Block transfer routine. This is another common requirement. The number of bytes to be transferred can be anything from one to a little less than half of the available memory, and the total must therefore be defined by two bytes.

Because the 8080A makes it so much easier to handle 16-bit numbers than does the 6502, it is not really practical to have a common flowchart. Sometimes, flowcharts must reflect the target computer — more strictly, the target language.

The 6502 flowchart is figure 8a, and the 8080A is figure 8b. In both cases, the lowest address of the byte to be transferred is "FROM", and its destination starts at "TO". The number of bytes is given by "TOTAL".

6502 program. In the 6502 program, figure 9a, there are two data transfer

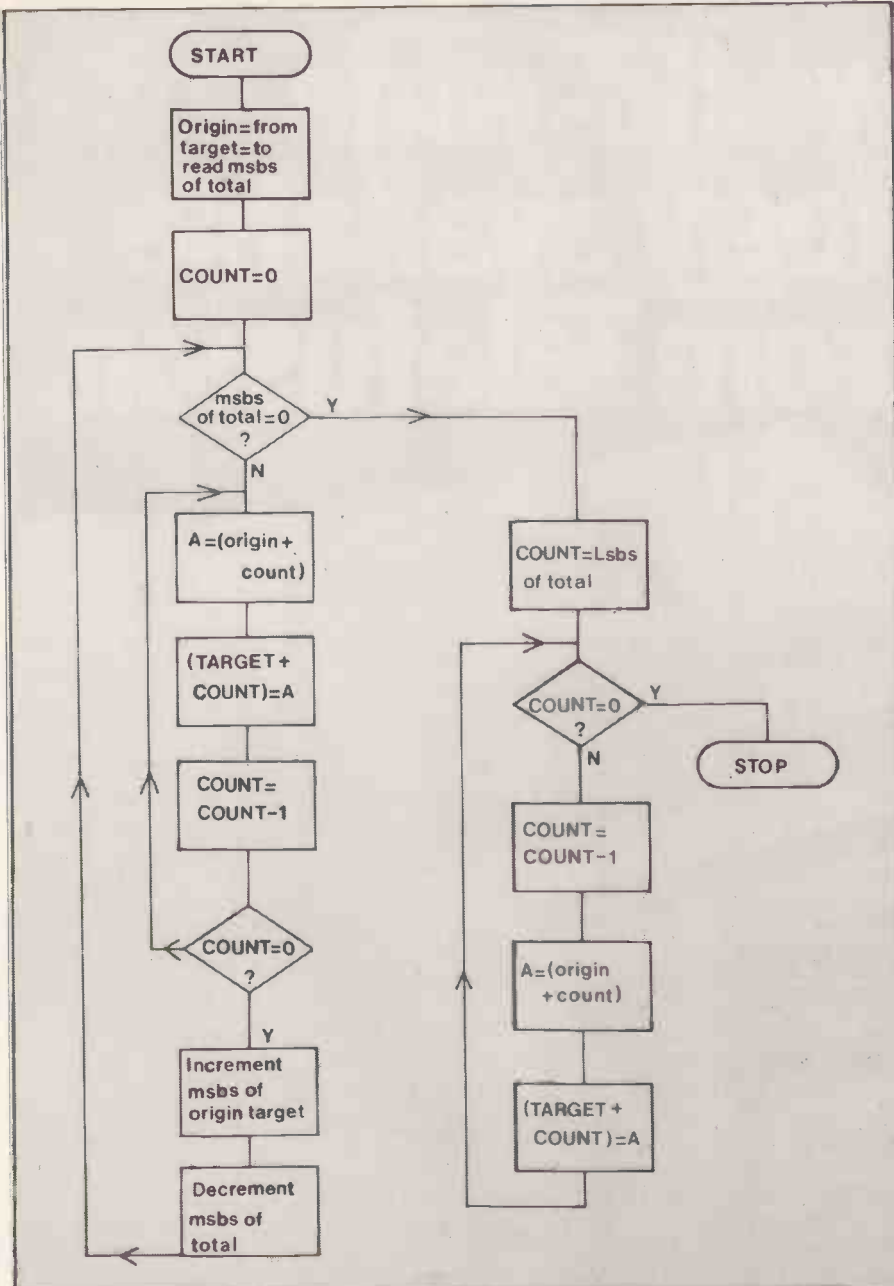


Figure 8a.

blocks. The first moves the number of 256-word blocks defined by the high byte of "TOTAL" which may be zero. At the end of each block, the high bytes of "FROM" and "TO" are incremented.

Note that we use indirect indexing to transfer each block without modifying the pointers within the loop. You may find the way of counting 256 iterations interesting — it is done by decrementing Y from O all the way back to O.

If you calculate, you'll find that this gives 256 passes through the loop before the test of Y finally sees zero. X is used to count the number of blocks.

Finally, the number of bytes defined by the low byte of "TOTAL" is moved. This time, we have to decrement Y before each data transfer. If we did not, there would be a one-byte gap between the last 256-byte block and the low-byte block. This technique lengthens the loop, as it demands a "TYA" to set the flags for

every test we are undertaking.

8080A program. This program, figure 9b, is much simpler than that of 6502. (B,C) and (D,E) are used as 16-bit indices for the data transfer, and (H,L) contains the count. The only complication arises because we must test H and L separately, since "DCX H" does not affect any flags.

By checking L before H, we have to test H only once every 256 bytes. Obviously, this speeds the program.

I have not deliberately manipulated things so that the 8080A appears in a rosy light. The two programs show the massive advantages of being able to handle 16 bits of data at once, rather than being forced to work one byte at a time.

Here are a few problems: How do we multiply a binary number by four without making any additions? How do we multiply by 10, with only one addition? How could we combine H and L to test (H,L) for zero with a single instruction?

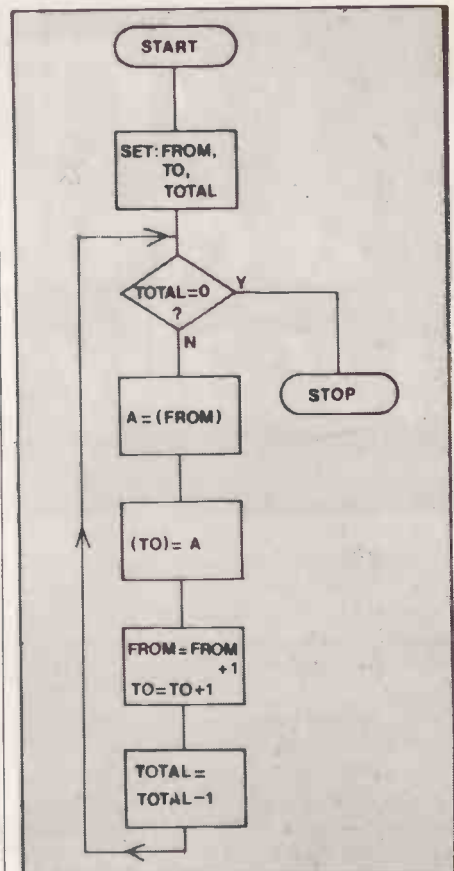


Figure 8b.

```

:6502 BLOCK TRANSFER ROUTINE
:SET UP POINTERS
LDA *FROMLO
STA ORIGIN
LDA *FROMHI
STA ORIGIN+1 ;"ORIGIN" HOLDS "FROM"
LDA *TOLOW
STA TARGET
LDA *TOHIGH
STA TARGET+1 ;"TARGET" HOLDS "TO"
LDY #0 ;USED AS POINTER
:SET UP NUMBER OF 256-BYTE WHOLE BLOCKS
LDX TOTALHI
BEQ ZERO ;WHOLE BLOCKS ZERO?
:NO. MOVE A 256-WORD BLOCK
NEXT1 LDA (ORIGIN),Y ;USES INDIRECT INDEXED
SEA (TARGET),Y ;ADDRESSING FOR TRANSFER
DEY
BNE NEXT1 ;ANOTHER WORD?
:END OF BLOCK. POINT TO NEXT
INC ORIGIN+1 ;INCREMENT THE MSBS
INC TARGET+1 ;OF BOTH POINTERS
:IS THERE ANOTHER WHOLE BLOCK?
DEX
BNE NEXT1 ;NO MORE BLOCKS
:MOVE THE REMAINING PART BLOCK
REST LDY TOTALO
BEQ END ;ANY BYTES IN PART BLOCK?
:YES - CONTINUE
DEY ;SEE TEXT
NEXT2 LDA (ORIGIN),Y ;INDIRECT INDEXED
STA (TARGET),Y ;ADDRESSING AGAIN
TYA ;SET FLAGS FOR Y
BNE NEXT2 ;ANOTHER WORD?
:END NOP ;END OF ROUTINE
    
```

6502 block transfer routine.

8080A block transfer routine.j

```

:8080A BLOCK TRANSFER ROUTINE
:SET UP POINTERS
LXI B, FROM
LXI D, TO
LXI H, TOTAL
:CHECK FOR TOTAL = 0
TEST MVI A, 0 ;SET UP FOR TEST
CMP L ;LSBS=0?
JNZ NOT0
CMP H ;MSBS=0?
JZ END
:(H,L) IS GREATER THAN ZERO
NOT0 LDAX B ;INDEXED MOVE
STAX D ;OF BYTE.
INX B ;INCREMENT
INX D ;POINTERS.
DCX H ;DECREMENT COUNTER.
JMP TEST ;SEE IF (H,L)=0
:END NOP ;END OF BLOCK TRANSFER
    
```

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Attack refuted

ROY WALDOCK, a programmer at Portsmouth Polytechnic, writes to complain about the attack on Apple users. The reason we have not contributed to your magazine, he writes, is that we don't have time to put pen to paper. I have torn myself away for a few minutes to offer Apple users a simple, but useful, program.

The program uses RWTS routine found in the new release of the operating system DOS 3.2. U.S. usage is well documented and so I will not explain its uses apart from saying it allows the user to read-from or write-to any track and sector on the disc.

Track 17 sector "O" contains a volume table of contents (VTOC). Within the sector there is a track-bit map which shows the status of all sectors on the disc. By loading this sector, it is possible to count the number of free sectors and, thus, the amount of free disc space.

When run, the program I have enclosed will give this information. The free-disc-space routine is written in assembler and is also included.

LIST

```

5  REM FREE SECTOR PROGRAM
10 GOSUB 1000: REM POKE FREE
    SECTOR ROUTINE
20 CALL 768
30 FS = 256 * PEEK (808) + PEEK (809)
40 V = PEEK (824)
50 TEXT:CALL - 936
60 UTAB 5: PRINT "DISK VOLUME ";V;"
    HAS ";FS;" FREE SECTORS"
70 PRINT : PRINT "THIS IS
    EQUIVALENT TO ";FS * 256/1024;"
    KILO-BYTES"
75 P = 100 - INT ((FS/455) * 100 + 0.5)
80 PRINT : PRINT "AND IS ";P;"%";"
    FULL"
90 END
1000 POKE 768,169: POKE 769,3: POKE
    770,160: POKE 771,42: POKE 772,32:
    POKE 773,217: POKE 774,3:
1010 POKE 775,169: POKE 776,0: POKE
    777,141: POKE 778,40: POKE 779,3:
    POKE 780,141: POKE 781,41:
1020 POKE 782,3: POKE 783,162: POKE
    784,187: POKE 785,189: POKE 786,68:
    POKE 787,32: POKE 788,160
1030 POKE 789,8: POKE 790,74: POKE
    791,144: POKE 792,8: POKE 793,238:
    POKE 794,41: POKE 795,3:
1040 POKE 796,208: POKE 797,3: POKE
    798,238: POKE 799,40: POKE 800,3:
    POKE 801,136: POKE 802,208:
1050 POKE 803,242: POKE 804,202: POKE
    805,208: POKE 806,234: POKE 807,96:
    POKE 808,0: POKE 809,0:
1060 POKE 810,1: POKE 811,96: POKE
    812,1: POKE 813,0: POKE 814,17:
    POKE 815,0: POKE 816,59:
1070 POKE 817,3: POKE 818,0: POKE
    819,32: POKE 820,0: POKE 821,0:
    POKE 822,1: POKE 823,0
1080 POKE 824,0: POKE 825,96: POKE
    826,1: POKE 827,0: POKE 828,1: POKE
    829,239: POKE 830,216
1090 RETURN
0010: FREE DISC SPACE ROUTINE
0020:
0030:
0040: 0300 ORG
    $0300
0050: 0300 RWTS *
    $03D9
0060: 0300 A9 03 LDAIM
    $03 POINT TO IOB
    
```

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.



```

0070: 0302 A0 2A LDYIM $2A
0080: 0304 20 D9 03 JSR
    RWTS READ VTOC
0090: 0307 A9 00 LDAIM
    $00
0100: 0309 8D 28 03 STA
    HIGH
0110: 030C 8D 29 03 STA
    LOW
0120: 030F A2 BB LDAIM
    $BB
0130: 0311 BD 44 20 LOOP LDAAX
    $2044
0140: 0314 A0 08 LDYIM $08
0150: 0316 4A AGAIN LSRA
0160: 0317 90 08 BCC
    NOTFRE INCREMENT COUNTER
    EVERY
    TIME WE GET A1 SINCE
    THIS INDICATES A
    FREE SECTOR
0170: 0319 EE 29 03 INC
    LOW
0180: 031C D0 03 BNE NOTFRE
0190: 031E EE 28 03 INC
    HIGH
0200: 0321 88 NOTFRE DAY
0210: 0322 D0 F2 BNE
    AGAIN
0220: 0324 CA DEX
0230: 0325 D0 EA BNE
    LOOP
0240: 0327 60 RTS
0250: 0328 00 HIGH =
    $00
0260: 0329 00 LOW =
    $00
0270:
0280:
0290: INPUT/OUTPUT BLOCK I.O.B.
0300:
0310:
0320: 032A 01 IOBST =
    $01 TYPE INDICATOR =
0330: 032B 60 SLOT NUMBER *16
    $60
0340: 032C 01 DRIVE NUMBER =
    $01
0350: 032D 00 EXPECTED VOLUME
    $00 NUMBER =
0360: 032E 11 TRACK NO. OF VTOC
    $11 =
0370: 032F 00 SECTOR NO. OF VTOC
    $00 =
0380: 0330 3B LOW ORDER BYTE OF
    $3B DCT =
0390: 0331 03 HIGH ORDER BYTE OF
    $03 DCT =
0440: 0332 00 LOW ORDER BYTE OF
    $00 BUFFER =
0410: 0333 20 HIGH ORDER BYTE OF
    $20 BUFFER =
    
```

```

0420: 0334 00 UNUSED =
    $00
0430: 0335 00 UNUSED =
    $00
0440: 0336 01 COMMAND CODE 01 =
    $01 READ =
0450: 0337 00 ERROR CODE =
    $00
0460: 0338 00 ACTUAL VOLUME
    $00 NUMBER =
0470: 0339 60 PREVIOUS SLOT
    $60 ACCESSED =
0480: 033A 01 PREVIOUS DRIVE
    $01 ACCESSED =
0490:
0500: DEVICE CHARACTERISTIC TABLE
    DCT
0510:
0520: 033B 00 DEVICE TYPE =
    $00
0530: 033C 01 NUMBER OF PHASES
    $01 PER TRACK =
0540: 033D EF TIME COUNT =
    $EF
0550: 033E D8 TIME COUNT =
    $D8
    
```

Refined method

TRY THIS on your Apple II; says Frank Atkinson of Gateshead, Tyne and Wear.

```

20 A = .99
30 B = .98
40 C = A-B
50 PRINT "C is "; C
    
```

When you RUN, you may be amazed to see 9.99999978E - 03. What has happened is that the simple statement was changed to binary, calculated and then re-translated from binary, with this horrible result.

'E', of course, is a mathematician's shorthand for $\times 10$ to the power of, but that does not help — especially if you are planning to transfer a short number on to a text file of specified record length.

A crude method for a similar problem was included in my Make day number, published in *Practical Computing*, March, 1980. There, I divided seven and instead of subsequently multiplying by seven, I multiplied by eight. More recently, I found it preferable to add .01 and multiply by seven.

To return to the example, you can add, say, .0001, multiply by 100 and finally divide the result by 100. Better still, turn this into a function. So add these lines:

```

10 DEF FNA(A) = INT((A + .0001)*
    100)/100
60 PRINT "C IS NWO "; FNA(C)
    
```

and try RUNning it again.

Finally, you might be surprised by the result of applying this function to the following number. Enter.

```

70 D = - 2.98023224 E - 08
80 PRINT "D IS"; FNA(D)
    
```

Varied Pursuit

MY VERSION of Pursuit; Pursuit II, offers
(continued on next page)

(continued from previous page)

a degree of portability, amendability and variety, writes A Kowalski from Langley Mill, Nottinghamshire. The program has been kept simple and should be understood easily when the meaning of the variable names has been explained.

Note, the robbers' movement is independent and partly random. The attempt to escape is an illusion caused by the police pursuing. Because of that independence, the robbers' position may be controlled by keys or paddle controls — analogue inputs — or any other means available.

Speed relates closely to plotting definition and should be adjusted accordingly but is best kept below about 10. Even with the police speed lower than that of the robbers, a catch can often be made.

If the police speed is faster, they may overshoot and have to back-track. Interesting patterns can be formed by replacing line "90" with "90 H PLOT XC, YC TO XR, YR".

```

10 HOME: CX=3: SL=250
20 PI=3.14159: P2=PI/2
25 Z=0: XL=Z/2: YL=150
30 VTAB 21
40 INPUT "ENTER COPS & ROBBERS SPEEDS "; SC, SR
50 HCR: HCOLOR=7: SX=Z
60 XC=7: YC=77
80 XR=197: YR=85
90 H PLOT XC, YC: H PLOT XR, YR
100 IF (ABS(XR-XC)+ABS(YR-YC)) < CX GOTO 510
110 IF CX > SL GOTO 270
120 VR=VR+RND(XR)-0.5
130 YR=XR+COS(VR)*SR
140 IF (YR < Z OR YR > XL) THEN VR=VR+P2: GOTO 130
150 YR=YR+SIN(VR)*SR
160 IF (YR < Z OR YR > XL) THEN VR=VR+P2: GOTO 130
170 YC=ATN((YR-YC)/(XR-XC))
180 IF XC < XR THEN VC=VC+PI
190 XC=XC+COS(VC)*SC
200 IF XC < Z THEN XC=Z
210 IF XC > XL THEN XC=XL
220 YC=YC+SIN(VC)*SC
230 IF YC < Z THEN YC=Z
240 IF YC > YL THEN YC=YL
250 SX=SX+1
260 GOTO 90
270 RS= " ESCAPES "
275 HOME: VTAB 22: PRINT "THE VILLAIN "; RS
280 PRINT "AT X="; INT(XR); " Y="; INT(YR); " STEPS="; SX
290 SX=Z
300 GOTO 30
310 RS=" IS CAUGHT "
320 GOTO 275
    
```

VARIABLES

COORDINATES—
 XL, X LIMIT YL, Y LIMIT
 MAY BE PRESET FOR ANY DESIRED WINDOW.
 XC, X FOR COPS YC, Y FOR COPS
 XR, X FOR ROBBERS YR, Y FOR ROBBERS

VECTORS—
 VC, ANGLE IN RADIANS FOR COPS
 VR, ANGLE IN RADIANS FOR ROBBERS
 OTHERS—
 CX, CATCH PROXIMITY preset to 3, may be raised or lowered for easier or harder catch, respectively. Relates exactly to plotting definition.
 SX, STEPS TAKEN COUNTER
 SL, STEP LIMIT FOR VILLAIN TO ESCAPE
 Reducing or increasing gives shorter or longer game respectively.
 RS, RESULT OF CHASE
 OBJECTIVE OF GAME
 To achieve the longest chase without letting the villain escape.

Fiendish plot

A PLOTTING program for Apple users from Q North, of Brighton, Sussex, plots a 3-D perspective view of a function, with hidden line removal. The function is typed in at line 1000, and always begins F = ... The function shown is a good demonstration, but better ones can be found easily.

```

10 X0 = 1: X1 = 0: Y0 = 0: Y1 = 1
20 F0 = -1: F1 = 1
100 HGR: POKE -16302, 0
110 FOR I = 0 TO 100 STEP 5: K = I
120 FOR J = 0 TO 160: GOSUB 500: NEXT J
125 IF I = 100 THEN 150
130 FOR K = I + 1 TO I + 4: FOR J = 0 TO 160 STEP 8
140 GOSUB 500: NEXT J: NEXT K
150 K = 0: J = 0: HCOLOR = 7: GOSUB 505
160 H PLOT 10, 91 TO 110, 191 TO 270, 0, 191
170 K = 100: GOSUB 505: J = 160: GOSUB 505
180 STOP
500 HCOLOR = 0
505 Y = Y0 + (Y1 - Y0) * K / 100: X = X0 + (X1 - X0) * J / 160
510 GOSUB 1000: F = (F - F0) / (F1 - F0) * 89
513 IF F < 0 THEN F = 0
516 IF F > 89 THEN F = 89
520 H PLOT 10 + K + J, 91 + K - F: HCOLOR = 7: H PLOT 10 + K + J, 91 + K - F
530 RETURN
1000 F = SIN (J * K / 200) / (K + .1): RETURN
    
```

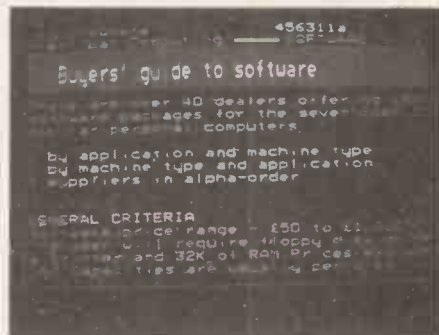
Information exchange

WITH THE Apple computer now linked to Prestel by the Appletel system, it seems

the logical step to start taking advantage of the exceptional facilities offered by Prestel for exchanging information between Apple users. *Practical Computing* has provided space on its Prestel pages for an Appletel users' club.

Even if you do not have an Appletel system or an Apple, the club pages will be of interest as they are aimed at all micro-computer users with access to Prestel, writes Mike Gardner, of Owl Computers, who developed Appletel and will edit the Appletel users' club pages.

The kind of item we want to include are

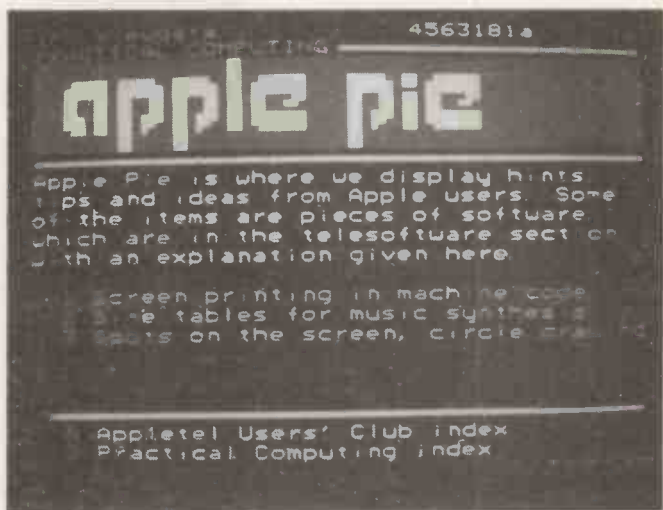
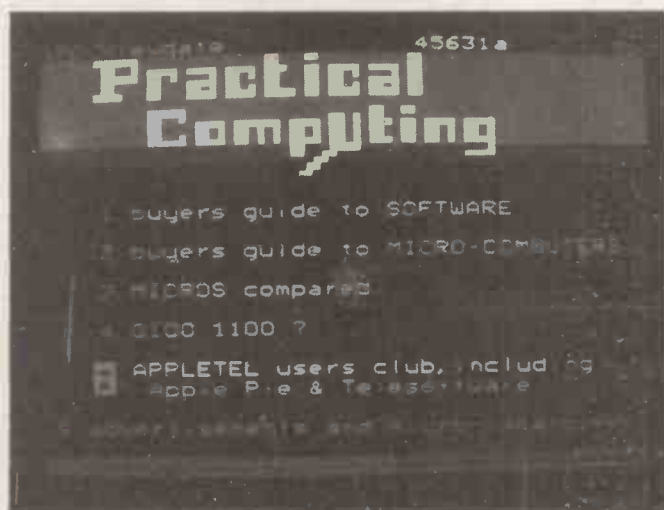


hints on the use of the Apple, software and hardware, news about applications for Apple, whether or not in conjunction with Prestel, and Apple programs and entertainment — Prestel games, quizzes.

Everything has to be contributed by you, so please write to me at *Practical Computing*.

The whole point of Prestel is to provide electronic communication, so there are exciting possible ways of using the Appletel users' club pages. Very soon it should be possible to input programs published on the pages into the Apple directly for execution — a real application of the telesoftware which everyone has been discussing.

What is more, we hope to be able to gather your contributions electronically — you type them on to a Prestel response frame and we edit them back on to Prestel. I'm sure there are more ingenious ways of using Prestel for an interactive users' club like this, so I shall wait for your suggestions.



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Idiosyncrasies

PETER ANTILL of Windsor, Berkshire, was most interested to read Tony Winter's explanation of the hardware idiosyncrasies of the Pet in Pet Corner, April, 1980. Faulty ends of files is a problem I have encountered and I am indebted to Winter for offering an answer, he writes.

His proposed solution, however, is suspect. I find the prospect of randomly-positioned blanks scattered throughout my data files alarming, to say the least.

A better solution is to test for the rogue carriage return when inputting the data. The following program demonstrates the method:

```
10 DIMA$(127):CR$=CHR$(13)
20 OPEN#10,8,10,"1:TEST,S,W"
30 FOR I=1 TO 127: A$(I)="AAA":PRINT#
  10,A$(I);CR$;NEXT:CLOSE#10
40 REM...INPUT AND TEST
50 OPEN#10,8,10,"1:TEST,S,R"
60 GET#10,A$:IFASC(A$)=13 THEN K=
  1:GOTO#10
70 INPUT#10,B$:K=ST:A$=A$+B$
80 IFK=0 GOTO#60
90 CLOSE#10
```

The only limitation with this method is that the incoming data must be at least two characters long — a small price to pay for peace of mind.

In fact, I use a slightly-modified version:

```
60 GET#10,A$:IFASC(A$)<32 THEN K=
  1:GOTO#10
```

I know the input data should be alphanumeric and the test ensures that no other rogues are involved.

High-resolution

JONATHAN DICK from Bristol has sent a program which enables you to plot high-resolution points on the Commodore 3022 printer. It divides one line into 480 discrete points which can be plotted individually.

The program consists of two sub-routines, the first sets-up variables for the second to use. The second subroutine does the plotting. To communicate with it, the variables 'P' and 'M' are used.

'P' contains the number of the point to plot. If the number is more than 479, the subroutine sets variable 'OU' to one and control is passed to the main program. Variable 'M' contains instructions to be executed by the printer after plotting your point, e.g., if 'M' is a positive number the printer moves-down 'M' lines — the lines are set one dot apart.

If 'M' is a negative number the printer moves-up 'M' lines, if it can, since the number of lines it can move is controlled by a factor which is explained in the section on how the program works.

If 'M' is zero, the printer stays on the same line after plotting the point. You can change the line without plotting a point, by making 'P' a negative number, setting 'M' to the number you want and calling the subroutine.

The program employs the user-definable character which is available on the printer and the ability to vary the line-



feed distance. The characters on the printer are made of a seven by six dot matrix. With the user-definable character you can make any pattern in that matrix.

The program defines a two-dimensional string array called A\$ which contains format information for all the possible single-dot patterns in the character — there are 42.

Using this array, it is possible to print any point in the dot matrix, e.g., if you wanted to plot the point 4,5 in the dot matrix, we send the string A\$(4,5) to the printer through a special file. The dot at 4,5 then becomes the user-definable character.

When the program starts, a pointer is set to the top row of the user-definable character, and then a point or points can be plotted across the page on that line. When you move down a line the pointer is moved to the next row of the character.

The process continues until the seventh row where a carriage return and line feed is executed and the pointer set to the top of the character again. The line-feed distance is set so that the lines butt-up against each other.

That is the reason for the restriction on the number of lines you can move-up on the page. You can only move-up the software pointer, you cannot move the paper.

So if you are on row four of the character, you can move-up only four lines and if you are on row six you can move six. If you try to move too many lines, the subroutine sets variable 'ER' to 1 and control passes to the main program.

Using the program is very easy. The lines 10-30 in the listing are needed and must be used before any plotting. Line 10 opens two files to the printer.

Special file

The first is the special file for the user-definable character, while the second is the file for normal printing. Line 20 calls the first subroutine which sets-up the variable A\$ with the format information in it.

This subroutine takes a few seconds to execute but it needs to be called only once before plotting. Line 30 sets the line-feed distance, although this could be incorporated into the set-up subroutine if desired.

Line 40 contains an example of the use

of the actual plotting subroutine, it plots a sine curve. This program is able to plot more than one point per line as the user-definable character can, contrary to popular belief, be changed while still remaining on the same line. That is done by executing a 'CHR\$(141)' which is the code for a carriage return with no line feed.

Righting wrongs

THE PET is very versatile and one of its great advantages lies in the fact that most commands can be abbreviated to two characters. One danger is that in a moment of forgetfulness you enter the abbreviated NEW for SAVE, write B P O'Hare and A S Goodenough, from Harrow, Middlesex.

However, all is not lost, as long as you are very careful, for NEW does not destroy a program — that could be done only by writing a "O" into every used memory location.

The pointers to the end of Basic are merely altered so that the Pet thinks it has nothing in memory, and all we have to do is restore the appropriate pointers.

Provided you have a Pet with the new ROM, and have read the machine language chapter of the user manual, you can do this by going into machine code and looking for three groups of zeros. The example should clarify the procedure.

Firstly, have a look at the machine language representation of the first few lines of Basic in the Pet immediately after powering-up. Use SYS1024 to enter the machine language monitor. The lines should be something like this:

```
SYS 1024
B*
PC IRQ SR AC XR YR SP
.; 0401 E62E 32 04 5E 00 F8
.M 0401,0430
.; 0401 00 00 AA AA AA AA AA AA
.; 0409 AA AA AA AA AA AA AA AA
.; 0411 AA AA AA AA AA AA AA AA
.; 0419 AA AA AA AA AA AA AA AA
.; 0421 AA AA AA AA AA AA AA AA
.; 0429 AA AA AA AA AA AA AA AA
.M 0028,0030
.; 0028 01 04 03 04 03 04 03 04
.; 0030 00 40 FF 00 00 40 FF FF
Now type X to return to basic and
enter the following program:
10 A=1
20 B=2
30 C=3
40 PRINT A,B,C
```

If you now repeat the above SYS commands, you should see:

```
SYS 1024
B*
PC IRQ SR AC XR YR SP
.; 0401 E62E 32 04 5E 00 F8
.M 0401,0430
.; 0401 09 04 0A 00 41 B2 31 00
.; 0409 11 04 14 00 42 B2 32 00
.; 0411 19 04 1E 00 43 B2 33 00
.; 0419 24 04 28 00 99 41 2C 42
.; 0421 2C 43 00 00 00 AA AA AA
.; 0429 AA AA AA AA AA AA AA AA
.M 0028,0030
.; 0028 01 04 26 04 26 04 26 04
.; 0030 00 40 FF 00 00 40 FF FF
```

(continued on next page)

(continued from previous page)

Type X to return to Basic. If you now type NEW, two important pointers will be changed. Zeros will be written into locations 0401 and 0402, and locations 002A and 002B will become 03 and 04.

A LIST command will indicate that there is no program in the computer and you will still have the usual number of bytes available as there are normally immediately after powering-up.

So, how do you restore the program? The Basic program starts at locations 0401 and 0402, which contain the address of the second line of Basic, in Hex. In the program, the second line starts at 0409, the intervening code representing the Basic line 10, and it must be re-entered in two halves in reverse order, in locations 0401 and 0402. You must also tell the Pet where the variable table starts, and since that always follows the end of Basic, look for the group of three zeros which denotes this — it can be difficult to find in a long program.

The address you want is that of the following number, which in this case is 04 and 26, and these must be entered in locations 002A and 002B in reverse order.

Syntax error

Type X to return to Basic. You should find that you've found your program again. A similar problem can occur when you exit your program unexpectedly — perhaps by a syntax error. It is easy to correct the program, but you will lose all allocated variables. However, there is a way round the problem which is easy to demonstrate and which needs no manual changing of machine code. All you need do is follow a few instructions.

Enter and run the four-line program. Insert a colon instead of the comma after 'A' and RUN. All you will obtain is a '1' on the screen, plus 'SYNTAX ERROR IN LINE 40', although a direct enquiry will show that the three variables are still allocated correctly.

Clear the screen, type SYS 1024 to enter machine code, and call-up memory locations 0028 to 0030 — the start of the variable table — and return to Basic by typing X (Return).

SYS 1024

```
B*
PC IRQ SR AC XR YR SP
.; 0401 E62E 32 04 5E 00 F8
.M 0028,0030
.; 0028 01 04 26 04 3B 04 3B 04
.; 0030 00 40 FF 00 00 40 28 FF
```

Now call up line 40, which will read 40 PRINT A:B,C, and correct it in the usual way. Type SYS 1024 again and you will be back in machine code. Take the cursor up the screen carefully until it is over line :0028 and hit return three times.

You will have re-set the pointers in the variable table and be back in Basic. However, be careful only to GOTO the corrected line to return to your program and do not use RUN as it clears all variables automatically.

The example is trivial, but it illustrates

an important principle. It should be noted that the technique is for emergencies only, and can be used only when the corrected program is no longer than the original. For that reason, if not for the sake of legibility, it is often wise not to economise too much on spaces. Try GOTO 40 now and you will find you have the three variables again.

Machine code enthusiast

PET USERS who, like myself, are interested by machine code programming may wish to run their program from Basic using a RUN command and not a SYS, writes Kevin Jones from Lytham St Annes, Lancashire. If one lists Microchess, one finds,

```
10 SYS(1039)
```

which, of course, sets the program pointer at location 040F Hex. The codes, beginning at location 0400 for 1 SYS1037 which is slightly shorter, is: 0400 00 0B 04 01 00 9E 31 30 33 37 00 00 00 040D Machine language program starts here.

Of course, since a Basic program normally occupies locations 0400 upwards, it is possible only to use it for a complete program written in machine code, not a subroutine to be kept in the memory at the same time as a Basic program. The only other difference is that the byte on which the program ends must be RTS (op-code 60) and not BRK (code 00).

New facilities

A NUMBER of changes have been made to the Pet since it was first introduced slightly more than two years ago, writes Julian Allason, of Petsoft. Improved cassette player, revised ROMs and typewriter keyboard are some of the more notable improvements.

Frequently, it has been the success of individual entrepreneurs in marketing useful add-ons which has spurred Commodore to make the necessary design alterations. The large keyboard arrived only after an ex-Commodore employee, Bob Skyles, demonstrated the demand by selling hundreds of them himself.

The arrival of the 16K and 32K Pets was similarly preceded by the success of add-on memory purveyors like Small Systems Engineering and latterly, Plessey.

Looking at the growing list of accessories and peripherals, it is interesting to speculate on what Commodore will be including next. The most successful recent product has been the Programmers' Toolkit, and it would be surprising if several of its facilities did not find their way into the next revision of Basic.

Kingston Computers has been offering a hardware repeat keyboard which allows any character to be repeated if the key is depressed for a few moments. That would certainly be a useful facility to have as standard.

Perhaps the single, most-welcome

addition to present capabilities of Pet is high-density graphics. At present, the highest resolution obtainable is 80x50 using the quarter character squares, although resolution of one-eighth character-width is possible in one direction only.

IJJ Design of Marlborough has been offering the spectacular MTU high-resolution graphics board for around £300. Now there is news of a British-developed high-density graphics board from HB Computers of Kettering which expect it to retail for less than £175.

Increased sales

It is said that when Personal Software introduced VisiCalc in the U.S., sales of Apples rose by 25 percent. Now a Pet version of VisiCalc has leapt the Atlantic. Dr Adam Osborne, not normally known for gushing praise, described VisiCalc as a work of art. Another U.S. reviewer called it the best piece of microcomputer software yet published.

The program acts almost as an extension of the computer's operating system, allowing the user to enter numbers, alphabets and formulae on the keyboard. It is then possible to carry-out extremely complex calculations and projections quickly and easily.

Once the first projection is complete, the re-calculation feature allows one to ask: "What if that oscillation were damped by another 10 percent? What if sales drop 15 percent in September?" All figures affected by September sales are amended instantly.


VisiCalc is available on Commodore disc from most Pet dealers, price £125.

Several interesting new programs just released include an air-traffic-control simulation from Landsler Software on cassette at £5, the Commodore incomplete record accountancy package, and a 6502 Assembler programming tutorial from Petsoft priced at £25 on cassette or disc.

Simulation

I spent several nerve-wracking evenings on Petplan, the business simulation. The program was developed to run on main-frames several years ago by a specialist software house called Understanding Ltd, which recently converted it for the Pet.

Petplan simulates a manufacturing company, making Petals. Up to four players act as directors, hiring, firing, marketing and investing. Balance sheets, production and sales reports showing the effect of decisions taken, are generated. I managed to lose £7 million in my first year. Petplan costs £60 including a 50-page manual and a voice-guide on cassette and is available from most Commodore dealers.

A real must is the Pet Show at London's Café Royal on June 13-14. More than 50 suppliers of Pet goodies will be there. There may also be a chance to try out the new super Pets. 



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Increasing capabilities

I HAVE spent a great deal of time, with the aid of the T-Bug monitor program, investigating how the TRS-80 computes, writes J F Hancock of Bristol.

Page E/1 of the Level II manual lists the Basic keywords used in writing Basic programs, but as you have probably discovered many of them can be used only if you have a floppy disc system — they are reserved for use with Level II disc Basic. I hope to show how to use those reserved disc Basic words — and give them new meaning.

When the TRS-80 is switched-on, or reset, it goes through its housekeeping routine. Part of that routine at 078D Hex, 1933 Dec, programs a section of reserved ram, 4152 to 41A5 Hex, 16722 to 16805 Decimal, with instructions for the words, reserved for disc Basic, giving them their meaning. When you do not have a disc system the instructions in Hex are for example

419A = C3 Jump to NN
419B = 2D LSB (Least significant byte of NN)
419C = 01 MSB (Most significant byte of NN)

That means jump to 012D Hex for your next instruction. The reserved word RSET goes to 419A Hex for its instruction. Type in RSET and enter — press enter — ? L3 ERROR is displayed. Now change those instructions by Poke statements,

419B = 19
419C = 1A

Now type Poke 16795,25: Poke 16796,26 and enter

419A = C3
419B = 19 Jump to 1A19 Hex
419C = 1A

Type RSET and enter and READY is now displayed. Not very useful — but you have given a new meaning to RSET.

For something more useful — a new meaning to the reserved words CLOSE and OPEN, it could be useful to CLOSE off a Basic program already in memory, to load in another program without losing the first one. There is one stipulation — the program to be loaded must have line numbers beginning with numbers greater than the last line number of the program already in memory.

To enable us to CLOSE or block-off an existing Basic program, it will help if we know how a Basic program is stored. The housekeeping routine of a Basic program

is 42E9 = LSB of start of next Basic line
42EA = MSB of start of next Basic line
42EB = OA: 10 LSB of Basic line number
42EC = 00: 0 MSB of Basic line number
42ED = 84: 132 CLS
42EE = 00: 0 last byte always zero
42EF LSB of start of next Basic line goes here
42F0 MSB of start of next Basic line goes here

The last byte of your Basic program line is always ZERO. Type in this program line, 10 CLS and enter. Now if you peek at, or use a monitor program, you will see that

ADDRESS: HEX: DEC
42E9 = EF: 239 LSB of start of next Basic line
42EA = 42: 66 MSB of start of next Basic line
42EB = OA: 10 LSB of Basic line number
42EC = 00: 0 MSB of Basic line number
42ED = 84: 132 CLS
42EE = 00: 0 last byte always zero
42EF LSB of start of next Basic line goes here
42F0 MSB of start of next Basic line goes here

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.



42F1 LSB of line number
42F2 MSB of line number

After switching-on, when your TRS-80 went through its "housekeeping" routine, it programmed

40A4 = E9 LSB of Basic program starting address
40A5 = 42 MSB of Basic program starting address
and
40F9 = EB LSB of address of first line number
40FA = 42 MSB of address of first line number

Now after entering the line: 10 CLS

40A4 = E9 LSB of address start of Basic program
40A5 = 42 MSB of address start of Basic program
but now
40F9 = F1 LSB of address for next line number
40FA = 42 MSB of address for next line number

I hope that you can now see why if you subtract two from the address contained in 40F9 and 40FA which is 42F1, —2 = 42EF and Poke it into 40A4 and 40A5 so that 40A4 = EF: 40A5 = 42, the TRS-80 will assume that your Basic program now starts at 42EE.

So do this, type in Poke 16548,239: Poke 16549,66 and enter. Now type LIST — nothing is listed. The line, 10 CLS, has to all intents and purposes, disappeared. 20 PRINT "THIS IS MY NEXT PROGRAM" and enter and LIST.

To open the Basic in memory so that line 10 CLS becomes available again, all that has to be done is to restore the original starting address in 40A4 and 40A5 Hex. So Poke 16548,233 Poke 16549,66 and enter and LIST.

10 CLS. 20 PRINT "THIS IS MY NEXT PROGRAM" and all is restored again.

A machine code routine to do this is

CLOSE
D9 — EXX — Save what Basic is doing
2A — LD HL,(NN) H = contents of address 40FA
F9 L = contents of address 40F9

40
2B — DEC HL Subtract 2 from HL
2B DEC HL
22 — LD (NN),HL Contents of L into 40A4
A4 Contents of H into 40A5
40

D9 EXX Back to what Basic was doing
C9 RETURN

OPEN
D9 — EXX
21 — LD HL, NN L = E9
E9 H = 42
42

22 — LD (NN),HL L into 40A4
A4 H into 40A5
40

D9 — EXX
C9 — RETURN
Change M/C to Decimal.
CLOSE = 217, 42, 249, 64, 43, 43, 34, 164, 64, 217, 201
OPEN = 217, 33, 233, 66, 34, 164, 64, 217, 201

Decide where to Poke it, so that CLOSE and OPEN can be instructed where to find their new meaning. Suppose you have 16K RAM and that your normally load KBFIX the key de-bounce routine.

CLOSE from 7FB5 to 7FBF Hex
from 32693 to 32703 Dec
OPEN from 7FC0 to 7FC8 Hex
from 32704 to 32712 Dec
WBFTX from 7FC9 to 7FFF Hex
from 32713 to 32767 Dec

CLOSE looks for instructions at 4185-4187 Hex
OPEN looks for instructions at 4179-417B Hex

Here is a Basic program:

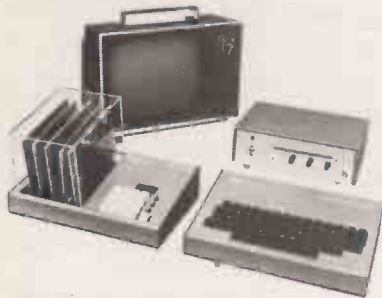
10 Poke 16774, 181: Poke 16775, 127: Rem Instruct CLOSE
20 Poke 16762, 192: Poke 16763, 127: Rem Instruct OPEN
30 FOR X = 32693 to 32712: READ A:Poke X, A: NEXT
40 DATA 217, 42, 249, 64, 43, 43, 34, 164, 64, 217, 201: REM CLOSE
50 DATA 217, 33, 233, 66, 34, 164, 64, 217, 201: REM OPEN

Once this program has been run, it can be deleted, but if you have to re-set the computer the Pokes in lines 10 and 20 will have to be done again. The machine code routines in high memory will stay unchanged.

Remember, whenever you use this program you must protect it in memory by answering MEMORY SIZE in the example with 32692.

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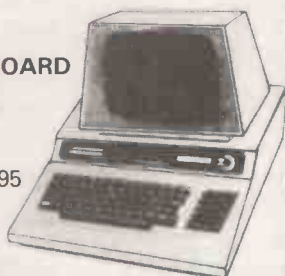
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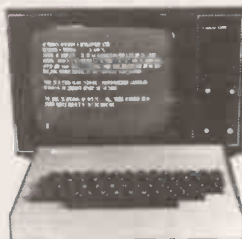
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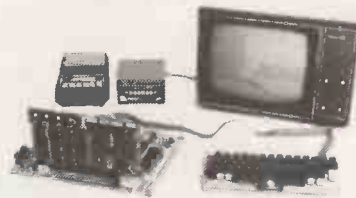


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Word on legibility

A NOTE for Superboard II users from Alan Linton in Belfast — the closely-packed output of the Superboard can be made more legible by the command POKE 15,0. It causes output of two line-feeds instead of one when listing programs or executing print statements. The command POKE15,72 returns to normal.

Latest additions

WALTER WALLENBORN of the 6502 Club writes with a few points about additions to 6502 system. The Plessey Inpet has dropped another 10 percent in price, he writes, making it £224.10 plus VAT for 32K of fully-built and burnt-in RAM.

If you do not have a Pet, you will need a 74154 to decode the select lines but if you want to build your own, order with some friends directly from Strutt at its 100-off prices.

If you can obtain S-100 static-RAM cards at a reasonable price, these points should help to put it on to your system: LOW on SOUT (pin 45), R/W on SMEMR (pin 47), (R/W and 02) on PDBIN (pin 78), NOT ((NOT (R/W)) AND 02) on PWR (pin 77) and, if you need it, NOT (PWR) on MWRITE (pin 68).

When you plan on using only one card, you can manage with tying data inputs to outputs to data bus, but if you want more than one card, data inputs to S-100 need buffering from the data lines.

An easy way to interface to a centronics parallel-interface printer from a 6522 (VIA) is to connect the lines as follows:

CA1 — paper empty
PA7 — BUSY
PA6 to PA0 — DATA7 to DATA1
CA2 — DSTA (data strobe) on PET use CB2

I use the subroutine on the AIM. It takes an ASCII character in the A register and sends it to the printer, while checking paper empty and busy.

```
PRINT      STA A001      ;Character to
                        PORT A
```

A new add-on memory for the AIM65, the AIMEM, includes 32Kbytes of memory in a self-contained unit with its own power supply. British-designed and built, the unit is available from Portable Microsystems Ltd for £335 + VAT. Tel: (0280) 702017. The memory can be connected to any system using the Motorola Exorcisor bus.



THE 6502 SPECIAL is dedicated exclusively to the exchange of information between 6502 users. It is up to you, the reader, to help establish this page with your ideas, problems and guidance for other 6502 users. Please mark your letters 6502 Special. We pay £5 for each contribution published.

```
LDA A00D      ;Check IFR
                for paper
                empty
BMI PAPEMP    ;If empty
                branch
BUSY          LDA A001      ;Check BUSY
                line
                ;Loop until not
                busy
STROBE       LDA ≙ $0D      ;CA2 LOW
                STA A00C
                LDA ≙ $0F
                STA A00C
                RTS          ;CA2 HIGH
                ;RETURN
PAPEMP       LDA ≙ $07      ;ASCII BELL
                CODE
                STA A001      ;Character to
                PORT A
                BNE STROBE   ;Branch
                always to
                STROBE
;INITIALIZE  Come here once before using
                PRINT
INIT         LDA ≙ $0F      ;The F is E to
                set CA2
                STA A00C
                ;to a HIGH
                and 1 to set
;CA1 sensitive to a LOW to HIGH transition
                LDA ≙ $7F
                STA A001
                ;Set all
                outputs to
                HIGH
                STA A00C
                ;Then make
                them outputs
;PA7 stays an input
```

Mesmeric doodle

I HAVE been surprised and gratified by the response to my request for help in recording variables from the UK101 writes Reg Newman, from Chesham, Buckinghamshire. Great expertise has been shown in the varied solutions.

I have had calls and visits from friendly and enthusiastic helpers, who have answered not only my query but also have given me help in entering assembler lang-

uage and have freely offered programs on which they must have spent much time and thought.

One in particular, an ingenious Basic editor, may inspire the production of a new ROM for UK101. Anyway, one's faith is restored, not only in human nature, but in the brain power available to help us out of the present slough — if only someone can harness it.

Could I venture another question; if one has a program, already resident, e.g., an editor, is there any possibility of loading from tape a further program without disturbing what is there already?

As an aid to thought, I find it helpful, and slightly mesmeric, to watch an ever-changing doodle-program. In the hope of starting a fashion, I offer a doodle which produces the effect of a mad town-planner. No doubt those with more experience can better this easily.

Mad Village Doodle. UK101 Microsoft Basic

```
1  A = 3: B = 14
4  FOR W = 53248 TO 54271
6  POKE W,189
8  NEXT W
10 N = INT(1024*RND(1))
20 M = 53248 + N
25 P = B + INT(A*RND(1))
30 IF RND(1) > .5 THEN POKE M,P
35 POKEM + 27,236
36 FOR K = M + 1 TO M + 10
37 POKE K,32
38 NEXT K
40 FOR D = 53248 TO 54248 STEP 63
45 POKE D + 32,189: POKE D + 33,32:
    LPOKE D + 34,32
47 POKE D + 35,32: POKE D + 36,32:
    POKE D + 37,189
50 K = INT(4*RND(1))
52 IF RND(1) < .3 THEN POKE
    (D + 33 + K),46
55 NEXT D
57 FOR R = 1 TO 400: NEXT R
60 IF RND(1) < .03 THEN 80
65 IF RND(1) .2 THEN POKE M + 7,231
70 GOTO 10
80 POKE M + 3,227
90 POKE M + 4,187
100 POKE M + 5,187
110 POKE M + 6,228
120 POKE M + 17,14: POKE M + 18,15:
    POKE M + 19,15: POKE M + 20,14
140 GOTO 10
```

I/O port

AS THE Compukit lacks any parallel I/O facilities, Nigel Hepworth of 7 Greycourt Close, Idle, Bradford, Yorkshire, has written with news of a I/O port for the system.

The board allows 24 lines of I/O, programmable in groups of four. An on-board relay is fitted to allow the switching of up to 5W load. A 40-pin, on-board socket is also provided to allow further expansion. Prices, including VAT and P&P are kit £35 and built £40. □

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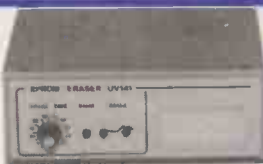
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Tabular display

IT IS EASY to form a table by eye, so that the numbers in each row fit snugly under the column headings, with the decimal points aligned vertically, writes Ralph Turvey of Geneva in Switzerland. Programming a computer to do that neatly is more complicated. I offer a solution — one which uses the POS function, or a substitute.

Both the Pet and the Exidy Sorcerer have the POS function, and with its graphic capabilities, upper- and lower-case and 30×64 character screen, the Sorcerer can produce very professional-looking tabular displays. The coding is written for the Sorcerer, i.e., for 8K Microsoft Basic.

It is not necessary to set-out the date part of the program. This part should enable the user to input the number of rows in the table, R, and the number of columns, C. With the zero row and zero column left for subsequent use, the data, row-name and column-name arrays must then be dimensioned, sufficient string space having first been provided:

```
DIM D(R,C), RN$(R), CN$(C)
```

It will also be necessary to dimension two further arrays:

```
DIM PS(C), DS(C)
```

The program should now provide for user input of the data into the D array, either by row or by column, first obtaining user input of the row — side — headings, RN\$(), and of the column — top — headings, CN\$(). Note that "I" is used as row counter and "J" as column counter.

The final preliminary is the generation of two characters for drawing lines, using the method explained on page 88, *Practical Computing*, December, 1979. A centred single dot for horizontal lines and a double dot for vertical lines make lines which guide the eye without being too obtrusive and which intersect neatly. The necessary coding is:

```
FOR J = -512 TO -497
```

```
POKE J,0
```

```
NEXT J
```

```
POKE -512,16 : POKE -508,16 : POKE
```

```
-502,16
```

To provide a vertical line on the left margin of the table at TAB(LM), separating the row names from the numbers in the body of the table, it is necessary to calculate LM as the length of the longest row name plus one. That will enable the longest row name to be printed in columns 0 to LM-1, with a blank before the vertical line.

```
1000 LM=0
```

```
1010 FOR I = 1 TO R
```

```
1020 IF LEN(RN$(I)) > LM THEN LM =
```

```
LEN(RN$(I))
```

```
1030 NEXT I
```

```
1040 LM = LM + 1
```

The next step is to calculate the minimal necessary width of each column, J=1 TO C. This, denoted W, will equal whichever is greater — the length of the column name or the number of horizontal spaces required to accommodate the column of

IN DECEMBER 1979, we ran a special feature on the Exidy Sorcerer. We wrote that Exidy Sorcerer users seem to be neglected, partly because we seldom receive manuscripts. That no longer holds true. Rather than produce another special feature for the Sorcerer, we present a Sorcerer page — the Sorcerer's apprentice — and will pay our usual £5 for each item published.



figures when the decimal points in it are aligned vertically.

That number of spaces, which can be up to 14, equals (P). The largest number of digits before the decimal point, plus one for the initial blank or minus sign; plus (Q): one space for the decimal point, plus the largest number of digits after the decimal point. The necessary code is:

```
1050 SW = 0
```

```
1060 FOR J = 1 TO C
```

```
1070 P = 0 : Q = 0
```

```
1080 FOR I = 1 TO R
```

```
1090 U = D(I,J)
```

```
1100 V = LEN(STR$(INT(U))) + (ABS(U) <
```

```
J)
```

```
1110 IF V > P THEN P = V
```

```
1120 V = LEN(STR$(U)) - V
```

```
1130 IF V > Q THEN Q = V
```

```
1140 NEXT I
```

```
1150 W = P + Q : V = LEN(CN$(J))
```

```
1160 IF W < V THEN DS(J) = P + (V-W)/2
```

```
: W = V : GOTO 1200
```

```
1170 IF W > LEN(CN$(J)) THEN CN$(J) =
```

```
"" + CN$(J)
```

```
1180 IF W > LEN(CN$(J)) THEN CN$(J) =
```

```
CN$(J) + "" : GOTO 1170
```

```
1190 DS(J) = P
```

```
1200 SW = SW + W
```

```
1210 NEXT J
```

Line 1160 makes column width equal the length of the column name if this exceeds P+Q. If, on the other hand, the length of the column name falls short of P+Q, lines 1170-80 augment the column name with blanks to make it as long as P+Q.

Line 1160 or line 1190 store in the array DS() the distance inside the column J at which the decimal point should be placed so that the numbers in that column will have their decimal point centred under the

middle of the column name and/or so that the numbers will fit inside the column.

Out of all the spaces in a line from 0 to 63, LM has now been allocated to row names and the vertical line separating them from the body of the table. SW has been reserved for the C columns of data. Consequently, the remaining space per column is (63-LM-SW)/C.

If this is less than one, there can be no spaces between the columns, while if it is at least 3, three spaces can separate the columns with the vertical separating line in the central space.

Hence, after a Clear Screen command, the column headings can be printed as follows, using character 192 to provide the vertical line:

```
1220 PRINT CHR$(12)
```

```
1230 SP = (63-LM-SW)/C
```

```
1240 IF SP < 1 THEN PRINT, "Insufficient
```

```
space" : STOP
```

```
1250 PRINT TAB(LM); CHR$(192);
```

```
1260 FOR J = 1 TO C
```

```
1270 DS(J) = DS(J) + POS(X)
```

```
1280 IF SP > = 3 THEN PRINT " ";
```

```
1290 PRINT CN$(J);
```

```
1300 IF SP > = 3 THEN PRINT " ";
```

```
1310 PS(J) = POS(X)
```

```
1320 PRINT CHR$(192);
```

```
1330 NEXT J
```

```
1340 PRINT
```

Line 1270 puts the appropriate location for the decimal point in column J into DS(J), while line 1310 records in PS(J) the location of the vertical dividing line following column J. To do this in a Basic without the POS function, it would be necessary to calculate these locations. For example, PS(1) would be LM + LEN(CN\$(1)) + 1 with SP < 3, and would be two greater than this with SP > = 3.

A horizontal line now needs to be drawn and the rest of the table printed. Thus the line-drawing subroutine could be:

```
2000 FOR J = 0 TO PS(C)
```

```
2010 PRINT CHR$(193);
```

```
2020 NEXT J
```

```
2030 PRINT : RETURN
```

Using this subroutine, the rest of the coding is then:

```
1350 GOSUB 2000
```

```
1360 FOR I = 1 TO R
```

```
1370 PRINT RN$(I);
```

```
1380 PRINT TAB(LM); CHR$(192);
```

```
1390 FOR J = 1 TO C : U = D(I,J)
```

```
1400 PRINT TAB(DS(J)-LEN(STR$(INT
```

```
(U)))-ABS(U) < 1);U;
```

```
1410 IF POS(X) < = PS(J) THEN PRINT
```

```
TAB(PS(J)); CHR$(192);
```

```
1420 NEXT J
```

```
1430 PRINT
```

```
1440 IF R < 14 THEN GOSUB 2000
```

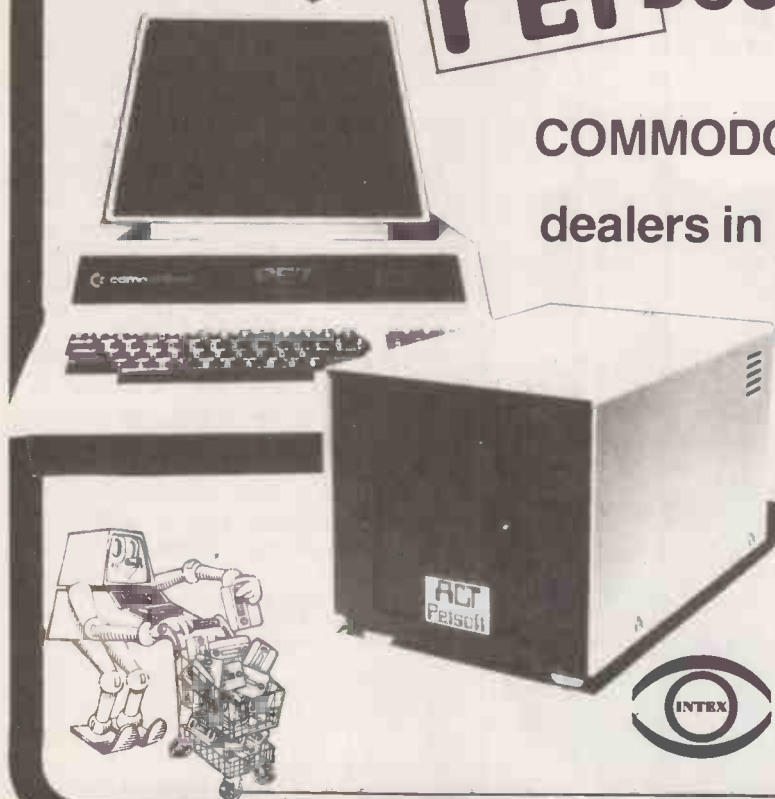
```
1450 NEXT I
```

```
1460 PRINT CHR$(17) : INPUT X$
```

The last line tucks the cursor away in the top left-hand corner and stops the program until you want to continue. ▢

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Apple COS and the output bug

In the second part of his series on creating a cassette operating system for the Apple II, Hugh Dobbs discusses the output bug and how to deal with the problems it causes.

AT THIS stage, we must consider all the possible kinds of output which COS may be expected to handle, if it is to be able to emulate DOS approximately. Output may be:

- Keyboard, or other input, echo in command mode in any language.
- Keyboard echo in a Basic INPUT or equivalent.
- Keyboard echo in a new mode which will allow one to MAKE files manually.
- Program output addressed to COS, i.e., following 'retn CTRL-D'.
- General program output, including output from ASSEMBLER and from monitor routines.

The necessary actions are display, unless suppressed by some new mode of NOMON and/or EXEC, filed already in input buffer, on 'retn', and check for COS commands. Display unless (READ and NOMON I); do not file. Display; file; check for terminator, e.g., CTRL-. . Display unless NOMON C; file in input buffer; on 'retn', check for COS commands. Display unless (WRITE and NOMON O); file if WRITE.

Command mode

We need flags to control all this. First, we use one byte of storage to show which mode of operation is involved: MAKE, normal command mode, CTRL-D output, WRITE, READ, normal input, normal output which account for seven of the eight bits.

Next, we need one byte to show which NOMON conditions apply, if any. Note that NOMON C affects only CTRL-D output, I affects READ and O affects WRITE. All we have to do is align the appropriate bits in the two locations, do a logical AND, and the result will decide whether or not anything will appear on the screen. We can even add the facility, offered by Superboard, of suppressing all printout without any further effort.

Set all eight bits in the NOMON flag, supposing that we always have at least one bit set in OMODE. We need one more bit of storage — a flag to show whether the previous character output was 'retn'. We also need a few bytes of RAM for temporary storage and for file pointers, and also for the input/output vectors if COS is to be ROMable. They will all fit in the margins of page 2 of video RAM.

I am assigning the following storage locations, for the present:

878: INPUT FLAG will be used by the input

'bug'; bit 7 shows READ mode and bit 6 shows EXEC mode.

879: Operating MODE Bits: M, W, R, C-D, command, —, —, —.

87A: NOMON Bits: —, 0, I, C, —, —, —, —.
87B: CRLAST flag Low bit is 1 if 'retn' last, otherwise 0 for all.

979: File Pointer Low address byte.
97A: File Pointer High address byte.

97F: File Pointer (high) MAXimum value allowed without error.

9F9: X value IN (restore on exit).

9FB: Y value IN (restore on exit).

Entry points

The COS entry points are stored at 87C to 87F, and the exit vectors, initially to the monitor, are stored at 8FC to 8FF. Since all these are in the margins of text page 2, that page should be prepared. If you had the forethought to save the prepared page along with the beginnings of COS itself, using

*800.EFFW Write text page 2 and COS-so far to tape, with HELP you can now Read it in again thus:

*800.EFFR

Otherwise, you can either repeat the preparations now, or continue and sort out the rest later. The I/O vectors can be inserted from monitor:

*87C:F0 0C 1B 0C

*8FB:4C F0 FD 1B FD note that 4C is JMP absolute.

Then switch to ASSEMBLER:

*F666G ASM

!978:STY FFFF; FPL/FPH Write to FILE subroutine.

! JMP D85; CONTD No room to finish in this margin.

!9F8:LDX#FF; XIN Exit, restoring X and Y.

! LDY#FF; YIN

! RTS

Note that if there is a semicolon following an assembler statement, any further text on that line is ignored — unless over-written by the assembler output. In practice, it allows about six characters of comment at the end of a line, like ...LDA (35),Y or ...JMP (8FE) — but don't try to use the last position on a line, if you want readable results.

Locations 979/97A/9F9/9FB, which are set to FF at present, will change to more usual values when COS is running; do not be tempted to use

!978:STY 0000

because the intelligent miniassembler will assume that you want zero-page addressing and so you will obtain the wrong opcode.

What we have so far is two non-

ROMable subroutines. Now we need some revisions in the initiation stage and the input 'bug', for which I will give a full listing here rather than patch the old version. We can then move on to the main work of this section, the output 'bug'.

```
!C00:LDX #4; INIT version 2
! LDA 35,X; LOOP pick up I/O vector
! CMP 87B,X is it COS address?
! BEQ C11; TO SKIP if so don't switch
! STA 8FB,X store as COS exit
! LDA 87B,X pick up COS entry address
! STA 35,X and store as I/O vector
! DEX; SKIP next location
! BNE C02; TOLOOP
!S14:EA EA EA EA EA EA use fake monitor
to put in six NOPs
!CIA:RTS; END INIT
! PHA; INBUG
! LDA #20
! BIT 878; INFLAG note changed address
! BMI C27; TOREAD stub
! BVS C27; TOEXEC sub
! BNE C27; TO???? spare stub
! PLA
! JMP (8FE); TOKEYIN note changed
address
```

The revised version of INIT avoids the problem, found in the previous version, of disabling all I/O — and everything else — if called twice. Yet it will not re-attach itself to the monitor if it is used, for instance, with a printer. There is an easy but messy solution to it, but I hope to produce something more artistic and, in the meantime, this version works. Now for the output 'bug'.

```
!CF0:STY9FB; YIN OUTBUG 8 Jan. '80
! STX 9F9; XIN
! TAY save character in Y register
! LDA 879; OMODE what are we doing?
! BMI D34; TODISP skip tests if it is
make
! TAX save OMODE in X register
! LSR 87B; CRLAST clear CRLAST into
carry flag
! BCC D2D; TOCRTES
```

If the last character was not a 'retn', perhaps this one is. If it was, we have to check for a CTRL-D, program output addressed to COS, or for a prompt — keyboard command mode — or for another 'retn'. At this point, the line above the ASM prompt (!) should read

```
0D00—90 2B BCC S0D2D TOCRTES now
type on:
! CPY #84; CTRLD?
! BNE D25; TOPRTES if not, prompt ?
! LDY #A0; SPACE replace char. by
space
! LDA #2; INBUF file in input buffer:
page 2
! STA 97A; FPH set file pointer
! STA 97F; FPMAX no overflow
allowed
! LDA #0
! STA 979; FPL start of page 2
! LDX #10; ISCD flag CTRL-D output
! STX 879; SOMD set Operating
MODE;
```

note that as before this is also saved in X.

```
! LDA #40
! AND 878; INFLAG
! STA 878; INFLAG
```

Both CTRL-D output and a return to command mode will cancel a file READ

and WRITE, but will not cancel EXEC if that is operating. That is compatible with DOS.

```
! TXA return OMODE to A
! BNE D34; TOPRINT? forced (X is not
zero)
! CPY 33; PRTES
! Location 33H holds the current prompt,
so this will work with any language.
! BNE D2D; TO CRTES if not, 'retn'?
! LDX #8; ISPR flag keyboard
command
! BNE D17; TOSOMD
! Set OMODE, INFLAG, and branch to
PRINT? as for CTRL-D. Forced.
! CPY #8D; CRTES
! BNE D34; TOPRINT?
! INC 87B; CRLAST set flag to show
'retn'.
```

The line above the prompt should now read

```
0D31—EE 7B 08 INC S087B CRLAST
! A contains OMODE as does X, while Y
holds the output character. If we BIT A
with the NOMON flag, a zero result is obtained — the Z flag is set. If no bit in OMODE matches the corresponding bit in NOMON — that is, Z is not set if there is a '1' in the same position in each word. If that is the case, printout is to be suppressed.
```

```
! BIT 87A; PRINT? 87A being NOMON
! BNE D3E; TO FILE? suppress printout
! TYA character to A
! JSR 8FB; PRINTOUT see (*8FB....)
```

Note that the 6502 does not have JSR(8FC), though it does allow JMP(8FC) :::: JuMP to — the contents of 8FC and 8FD. That is a minor inconvenience.

```
! TXA OMODE to A
! AND #D0; FILE?
! If it is MAKE, WRITE, or CTRL-D
output, it is filed, otherwise not.
! BEQ D45; TOCOS?
! JSR 978; TOWFILE file it.
! TXA OMODE to A
! AND #18; COS?
```

If not keyboard command and not CTRL-D output, exit restoring A, X, Y.

```
! BNE D4E; TO CMD otherwise check
for 'retn'
```

```
! TYA; EXIT character to A
! JMP 9F8; EXIT2 see above, !9F8
! LDA 87B; CMD CRLAST to A
! BEQ D4A; TOEXIT EXIT should be
D4A!
```

We arrive at the command decoder which is reached only when a 'retn' is reached in keyboard command mode or in CTRL-D output. Thus a COS command issued while a program is running must be preceded by 'retn' CTRL-D and followed by 'retn'. That again is compatible with DOS 3.2.

```
! LDY #FF -1; becomes 0 in a moment
! LDX #0; XZERO point to start of
input buffer
! JSR D7C; READON take non-space
character from buffer
! INY point to next char. in command
table
! CMP DA6,Y; TABLE do they match ?
! BNE D6D; TOWRONG if not,
! LDA DA7,Y pick up next char. in
```

(continued on next page)



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(continued from previous page)

command table

```
! BMI D57 ; TOREADON unless
! command is finished
```

All keyboard input, and all program output, will be in the form of ASCII code plus 80 H — that is, with the high bit set. The command table consists of commands in the same form, separated by single bytes with the high bit not set, and terminated by one 0 byte.

The byte following any command is a vector to the routine for handling that command, except that it must be shifted left, doubled, so that we can cover a whole page. With the high bit not set, it can point only to an address in the range 1 to 80 — actually in the range E01 to E80 — while doubling allows it to point to any odd location from E01 to EFF.

BMI branches if the N flag is set, that is, if the high bit of the byte loaded into A is set. Otherwise we have found a COS command — or possibly one shared with Basic, such as RUN — and all we have to do is jump to the appropriate routine. The line above the prompt should now read

```
0D63— 30 F2 BMI 80D57 TOREADON ....
! TAY ; FOUNDIT! save vector/2 in Y
! LDA #E high byte of routine address
! PHA push it
! TYA restore vector/2
! ASL convert to vector
! PHA push low byte of r.a. minus 1
! RTS jump to it via RTS
```

Since the program counter is incremented after an RTS, it is going to jump to 0EXX, where XX is one greater than the vector we calculated. That deals with the COS command, once we find one.

If there is a mismatch, the decoder must step over any remaining characters of the incorrect command in the table, and be ready to select the first character of the next possible command. If it has reached the end of the table, it must restore A, X, and Y, clear the OMODE flag to cancel either command mode — in case the mode changes — and return to the calling routine, transparently. Thus:

```
! INY ; WRONG point to next char. in
! cmd table
! LDA DA6,Y ; pick it up
! BMI D6D ; TO WRONG loop if not
! finished command
! BNE D55 ; TOXZERO test for next
! cmd if any
! STA 879 ; OMODE clear command
! mode if not. (A is 0).
! LDA #8D restore A ('retn')
! BNE D4B ; TOEXIT2 and X and Y,
! and exit to calling routine. Unconditional
! branch.
```

The last line should now read
0D7A— D0 CF BNE 80D4B TOEXIT2

Now we need a subroutine to read a non-space character from the input buffer. It is in fact identical to a subroutine used by ASM — but not, unfortunately, part of the monitor, so that it would only be available if on-board ROM is selected and, therefore, we have to include it here.

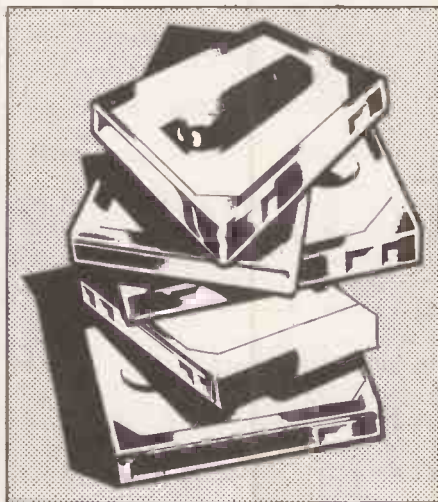
```
! LDA 200,X ; GETNSP take char. from
```

in. buf.

```
! INX point to next char.
! CMP #A0 ; SPC? was it a space?
! BEQ D7C ; TOGETNSP loop if so
! RTS
```

There is another piece of unfinished business from the Write-to-FILE routine, which does not fit into the margins of text page 2 but is ROMable — which I am continuing here, temporarily:

```
! INC 979 ; FPL WriteFileCONTd
! BNE DA5 ; TORETURN same page,
! no overflow
! INC 97A ; FPH next page if allowed
! LDA 97F ; FPMAX what is limit of file
! space?
! CMP 97A ; FPH have we passed the
! limit?
! BCC DA5 ; TORETURN if not, carry
```



on to next page

```
! LDA #1
! STA 879 ; OMODE
```

Clear MAKE, C-D, WRITE and indeed everything else; system mush crash 'safe' and give message of some kind to the operator.

```
! JSR FF2D ; TOPRERR monitor
! subroutine: 'ERR' and bell.
! LDA C000 ; GETKEY wait for
! operator to respond
! BPL D9D ; TOGETKEY loop until
! someone does
! STA C010 clear keyboard strobe
! RTS that should be DA5
```

That should cause the remaining output from an offending file-WRITEing program, for instance, to be dumped on to the screen rather than have it overwrite program space, variable space, or COS itself.

There is still one way in which this version of COS can be crashed — simply by holding down the space bar and the repeat key in command mode. That will fill the input buffer, 200 to 2FF H, with spaces, ring the bell in between the last eight or so, print a backslash, and then a return.

COS will then scan the input buffer for possible commands, but since there is nothing there but spaces, it will go into an infinite loop — D7C to D83. Hit re-set and re-start COS, for now. This will be connected later.



Now we need a command table with at least one command in it; the obvious one, of course, is 'HELP', since we have already written the routine for that, i.e., to display text page 2. It is the first routine in page E, so HELP must be the last entry in the command table and must be preceded by a byte of 7F H or less, so that it will be read as a command, and followed by a 00 byte — end of table, and vector to HELP routine at 0E01.

The rest of the table should, for the moment, be filled with bytes of 80 H or more. Re-set to return to monitor, and:

DA6:AA First character in command table: ASCII '' with high bit set.

DA7<DA6.DF9M Copy ''s up as far as DFA inclusive.

*DFB:08 C8 C5 CC D0 00 Vector for other 'command', HELP, end of table.

In case you missed the first part of this article, *Practical Computing*, May, I should explain that we had written a short routine, starting at E00 with a series of NOPs temporarily, which would display the second page of video RAM where we intend to put a list of COS commands with a short explanation of each, and return to the first page when you hit a key.

We have now overwritten the first byte of this with 00 (BRK), so the routine starts at E01 — where COS will jump to when we connect it and type 'HELP' (from any language). If you do not have the routine, you can add it from monitor by typing:

*E01: EA EA EA EA EA AD 51 C0

*:AD 55 C0 AD 00 C0 10 FB

*:AD 10 C0 AD 54 C0 4C 67 FD

Even if you have nothing very HELPFUL stored on page 2, you can still use it to test COS. Note the use of a colon with no address in front of it here. It allows one to continue inserting data where the previous line left off, so that 'AD 55 C0 ...' goes into D09 and following locations.

Transparent

We tested the HELP routine from monitor by *E00G and from Basic by CALL 3584; since E00 is now a BRK instruction, you can try *E01G or CALL 3585, as appropriate. Then connect COS by *C00 or CALL 3072, and check that it is transparent to normal monitor commands, Basic statements and program output, and to the ASSEMBLER.

If you are in the habit of using re-set to switch between languages, break it now. It will kill COS and will soon be unnecessary. CALL —151 from Basic, and use *C090 CTRL-B to reach Applesoft, rather than using the hardware switch, and instead of using re-set to escape from ASM, try !\$FF69G.

Now, from monitor, try

*878.87B display INFLAG, OMODE, NOMON, CRLAST.

They were all 00 originally, and three should still be 00 — or maybe four. If you hit re-set and try again, OMODE should have changed to 08 to show that you were in command mode when COS

was killed. Re-connect COS, switch to INTeger Basic, try

>I0PRINT print a 'retn'

>20GOTO10

>RUN

and then re-set again, kill COS, and again do *878.87B. This time, OMODE should be 00 and CRLAST should be 01. If so, everything is working so far. Now the fateful moment, re-connect COS and type HELP — it doesn't matter which language you are in. Page 2 of text should appear, as before — but this is now due to COS and not to the use of a monitor Go or a Basic CALL.

Now hit any key — not re-set. The mystery bug strikes; page 1 appears for an instant, then page 2 returns and you can repeat this as often as you like. The only way out is re-set. Why does this happen, when *E01G works perfectly?

The answer is, there is one more thing we should do when COS finds a command. Here is a clue:

*E18:6A change JMP GETLNZ to JMP GETLN

Exploration

Re-connect COS and try HELP again which works. Switch to INT and check that HELP works there and that when page 1 returns you are really in command mode, for instance:

>HELP

>IS THIS BASIC?

***SYNTAX ERR

>I0 PRINT "HELP"

>20 END

>RUN it does not work

HELP

>SPRINT"" put in a CTRL-D there

>RUN still does not work

HELP

>SPRINT""; CTRL-D in there again

>I5PRINT "NO !" wait and see

>RUN it works

HELP

>IS THIS BASIC ? try it and see.

NO!

A little further exploration will show that a 'retn' is needed before the CTRL-D. One further problem — COS recognises two command modes: keyboard command, with a sequence of 'retn', prompt, HELP 'retn'; and CTRL-D output, with a sequence of 'retn' CTRL-D HELP 'retn'. Apparently, CTRL-D and prompt should be interchangeable, yet if you replace the CTRL-D by prompt thus:

>SPRINT"";

and then RUN it, it does not work. Why not?

A few final things: return to monitor and try

*978.97F 8C FPL FPH 4C 85 0D 00 FPMAX


Three bytes should have changed.

*9F8.9FF A2 XIN A0 YIN 60 00 00 00

two changes.

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BUYERS' GUIDE Software

The Software Buyers' Guide is bigger and more comprehensive this month. The successful presentation used in the last guide has been retained but for easy reference, suppliers, applications and machine types are listed in alphabetical order. Application packages are listed by machine type, giving machine, company name, price and capacity.

The usual criteria have been applied. The minimum configuration is 32K of RAM, a disc and a printer; the price of the package must lie between £50 and £1,000; the companies listed are the source of the software or the main dealers in the U.K., and the capacity quoted is per disc or drive.

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Machine type	Supplier Name	Price	Capacity
Commodore 3032	G W Computers Ltd	£275 - £575	1,000
Z-80/8080	Great Northern C S Ltd	£995	varies
Ohio Scientific	Microcomputer B M	£656	
Tandy TRS-80	Microcomputer Applications	£90 each	
Tandy TRS-80	T & V Johnson Ltd	£110	750 trans/disc
Commodore 3032	Bristol Software Factory	£300	1,000 A/Cs 6,000 trans
Apple II	Vlasak Electronics Ltd	£855	
CP/M North Star	Benchmark CS Ltd	£950	200 A/Cs 500 trans 300 ITM
Commodore 3032	Stage One Computers		
Commodore 3032	Commodore B M (U.K.) Ltd	£650	650 A/C/ledger
CP/M	Computastore Ltd	£1,000	
Tandy TRS-80	Mode Microcomputer Applications	£350	

General Ledger

Machine Type	Supplier Name	Price	Capacity
Z-80/8080	Great Northern C S Ltd	£275	varies
Tandy TRS-80	Tridata Micros Ltd	P.O.A.	to be linked to S/L P/L



Apple II	Computech Systems	£295	500 A/Cs 1,600 trans
Commodore 3032	HB Computers Ltd	£200	linked to S/L & P/L
Apple II	Vlasak Electronics Ltd	£225	200 A/Cs 1,000 trans
CP/M	Computastore Ltd	£500	999 A/Cs 99 centres 9 companies
CP/M	Comput-A-Crop	£400	
CP/M North Star	Benchmark CS Ltd	£250	500 A/Cs 5,700 trans
Apple II	Microdigital Ltd	£295	

Incomplete Records

Machine type	Supplier Name	Price	Capacity
CP/M	Profcomp Ltd	P.O.A.	2,000 entries
Commodore 3032	Micro Computation	£555	120 A/Cs 5,000 trans
Apple II/ITT 2	Padmede Computer Services	£450	900 A/Cs 2,000 trans/disc
Exidy Sorcerer	Basic Computing	£350	incl. Vasee also Micropute
Apple II	Personal Computers Ltd	£250	1,000 trans 2,600 A/Cs
Commodore 3032	Stage One Computers		

Job Costing/Billing

Machine type	Supplier Name	Price	Capacity
CP/M	Graffcom Systems Ltd		100 activity codes
Z-80/8080	Great Northern C S Ltd	£330	varies
Apple II/ITT 2	Padmede Computer Services	£300	1,000 A/Cs 99 centres
Apple II/ITT 2	Padmede Computer Services	£300	150 A/Cs
Commodore 3032	Stage One Computers		

Mailing Systems

Machine type	Supplier Name	Price	Capacity
CP/M	Structured Systems Group	£50	varies
Apple II	Keen Computers Ltd	£300	500 addresses
Tandy TRS-80	T & V Johnson Ltd	P.O.A.	3,000 names/addresses
Z-80/8080	Micro Focus	£90	varies
CP/M	Graffcom Systems Ltd	£250	varies
Apple II/ITT 2	The Software House	£57	
Commodore 3032	Stage One Computers		
Apple/ITT 2020	Systematics Intl Ltd	£300	500 addresses

Payroll

Machine type	Supplier Name	Price	Capacity
Apple	Algobel Computers Ltd	£295	500 employees
Commodore 3032	Computastore Ltd	£200	275 employees
		£350	500 employees
CP/M	Graffcom Systems Ltd	£500	250 employees
Tandy TRS-80	Tridata Micros Ltd	£218	400 employees
Apple II/ITT 2	Computech Systems	£379	
Apple II/ITT 2	T W Computers Ltd	£145	
Commodore	Petsoft Ltd	£50	200 employees
Commodore 3032	Landsler Software	£95	250 employees
Commodore 3032	L & J Computers	£220	
Tandy TRS-80	3-Line Computing	£140	
Apple II/ITT 2	Hewport Ltd	£400	100 month 50 weekly
		£500	
Apple II/ITT 2	Vlasak Electronics Ltd	£360	
CP/M	Comput-A-Crop	£450	
Apple II	Microdigital Ltd	£375	
Commodore 3032	Commodore B M (U.K.) Ltd	£150	200 employees
Apple/ITT 2020	Systematics International Ltd	£295	350 employees

Property Management

Machine type	Supplier Name	Price	Capacity
Z-80/8080	Graham Dorian Software	£325	varies
Apple II/ITT 2	Algobel Computers Ltd	£650	400 buildings 250 own 2,000 trans
CP/M	Algobel Computers Ltd	£650	2,000 trans

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Purchase Ledger

Machine type	Supplier Name	Price	Capacity
CP/M	Structured Systems Group	£460	varies
Commodore 3032	Microact Ltd	£350	2,000 A/Cs 7,000 trans
Z-80/8080	Great Northern C S Ltd	£275	varies
Tandy TRS-80	Tridata Micros Ltd	£225	175 A/Cs 1,350 trans
Apple II	Vlasak Electronics Ltd	£315	200 A/Cs 1,000 trans
Apple II	Computech Systems	£295	500 A/Cs 1,600 trans
Commodore 3032	HB Computers Ltd	£350	800 A/Cs 4,000 trans
CP/M	Computastore Ltd	£400	500 A/Cs 3,100 trans
Apple II/ITT 2	Padmede Computer services	£300	900 A/Cs 4,500 trans/disc
Exidy Sorcerer	Basic Computing	£125	incl. Vasee also Micropute
CP/M	Comput-A-Crop	£400	500 A/Cs
CP/M North Star	Benchmark CS Ltd	£250	500 A/Cs 2,000 trans
Apple II	Microdigital Ltd	£295	
Commodore 3032	Act (Petsoft) Ltd	£120	200 A/Cs 700 trans

Records Management (DBMS)

Machine type	Supplier Name	Price	Capacity
Commodore 3032	Commodore B M (U.K.) Ltd	£150	650
Commodore Pet	Stage One Computers	£120 & £180	165K
Apple II/ITT 2	T & V Johnson Ltd	£95	112K per drive
Ohio Scientific	Microcomputer B M	£175	
Commodore 3032	Amplicon M S Ltd	£140	1,500 records
Tandy TRS-80	T & V Johnson Ltd	£200	
Z-80/8080	Structures Systems Group	£135	varies
Commodore 3032	Compsoft Ltd	£95 ea	170,600-5,000 records
Apple/ITT	The Software House	£140	
Commodore 3032	Microact Ltd		400K - 800K
Apple/ITT 2020	Systematics International Ltd	£72 & £175	
Apple/ITT 2020	Systematics International Ltd	£125	1,000 references

Sales Ledger

Machine type	Supplier Name	Price	Capacity
Commodore 3032	Microact Ltd	£350	2,000 A/Cs 7,000 trans
Z-80/8080	Great Northern C S Ltd	£275	varies
Tandy TRS-80	Tridata Micros Ltd	£225	175 A/Cs 1,350 trans
Apple II	Vlasak Electronics Ltd	£315	200 A/Cs 1,000 trans
Apple II	Computech Systems	£295	500 A/Cs 1,600 trans
Commodore 3032	HB Computers Ltd	£350	800 A/Cs 4,000 trans
CP/M	Computastore Ltd	£400	500 A/Cs 3,500 trans
Apple II/ITT 2	Padmede Computer Services	£300	900 A/Cs 4,500 trans/disc
Exidy Sorcerer	Basic Computing	£125	incl. Vasee also Micropute
CP/M North Star	Benchmark CS Ltd	£250	500 A/Cs 2,000 trans
Apple II	Microdigital Ltd	£295	
Commodore 3032	Act (Petsoft) Ltd	£120	200 A/Cs 700 trans

Stock Systems

Machine type	Supplier Name	Price	Capacity
Apple II/ITT 2	Microdigital Ltd	£225	625 items
CP/M	Graffcom Systems Ltd	£350	520 - 6,000 items
Z-80/8080	Great Northern C S Ltd	£275	varies
Tandy TRS-80	Tridata Micros Ltd	£200	630 items/disc
Commodore 3032	Commodore B M (U.K.) Ltd	£150	650
Commodore 3032	Bristol Software Factory	£300 - £360	2,300
Z-80/8080	Graham Dorian Software	£325	varies
Apple II/ITT 2	Vlasak Electronics Ltd	£285	
Commodore 3032	Petsoft Ltd	£50	2,000
Commodore 3032	L & J Computers	£120	3,400 items
Commodore 3032	Microact Ltd	£350	2,500 items 1,000 A/Cs
Tandy TRS-80	T & V Johnson Ltd	£115	1,000 items
Tandy TRS-80	T & V Johnson Ltd	£145	1,000 items/invoices
Commodore 3032	Aplicon M S Ltd	£750	500-600 items 255 A/Cs
Exidy Sorcerer	Basic Computing	£125	incl. Vasee also Micropute
Apple/ITT	The Software House	£80	
CP/M North Star	Benchmark CS Ltd	£450	1,000 items 750 trans
Commodore 3032	Stage One Computers		

Commodore 3032	Act (Petsoft) Ltd	£75	
Apple/ITT 2020	Systematics International Ltd	£500	200-2,500 items
Z-80/8080	Rogis Systems Ltd	£500	900 - 3,500 items

Word Processing

Machine type	Supplier Name	Price	Capacity
Commodore 3032	Commodore B M (U.K.) Ltd	£75 & £150	170 pages
Tandy TRS-80	T & V Johnson Ltd	£109	10,000 words
Ohio Scientific	Microcomputer B M	£116	
Apple II/ITT 2	Algobel Computers Ltd	£75	800 lines
Commodore 3032	Dataview Ltd	£159	
Commodore 3032	HB Computers Ltd	£70	39 A4 pages
Apple II/ITT 2	Vlasak Electronics Ltd	£120	
Z-80/8080	Structured Systems Group	£120	varies
Apple II	Personal Computers Ltd	£150	17 A4 pages
Commodore 3032	Stage One Computers		
Commodore 3032	Act (Petsoft) Ltd	£325	
CP/M	Computastore Ltd	£400	
Apple/ITT 2020	Systematics International Ltd	£75	

Applications by machine

Apple II/ITT 2020

Application	Supplier Name	Price	Capacity
Cash-flow/bank	Vlasak Electronics Ltd	£80	
Credit control	Microdigital Ltd	£130	
DBMS	The Software House	£140	
DBMS	T&V Johnson Ltd	£95	112K per drive
DBMS I & II	Systematics International Ltd	£75 & £175	
DBMS text files	Systematics International Ltd	£125	1,000 references
Estate agents' register	Vlasak Electronics Ltd	£120	
Estate agents' system	Systematics International Ltd	£850	
Financial planning	Systematics International Ltd	£295	
Incomplete records	Personal Computers Ltd	£250	1,000 trans 2,600 A/Cs
Incomplete records/nominal ledger	Padmede Computer Services	£450	900 A/Cs 2,000 trans/D
Job costing	Padmede Computer Services	£300	1,000 A/Cs 99 centres
Job-T&M cost recording	Padmede Computer Services	£300	APCs
Ledger general	Computech Systems	£295	500 A/Cs 1,600 trans
Ledger general	Microdigital Ltd	£295	
Ledger general	Vlasak Electronics Ltd	£225	200 A/Cs 1,000 trans
Ledgers/general sales purchase	Vlasak Electronics Ltd	£855	
Ledger purchase	Computech Systems	£295	500 A/Cs 1,600 trans
Ledger purchase	Microdigital Ltd	£295	
Ledger purchase	Padmede Computer Services	£300	900 A/Cs 4,500 trans
Ledger purchase	Vlasak Electronics Ltd	£315	200 A/Cs 1,000 trans
Ledger sales	Computech Systems	£295	500 A/Cs 1,600 trans
Ledger sales	Microdigital Ltd	£295	
Ledger sales	Padmede Computer Services	£300	900 A/Cs 4,500 trans
Ledger sales	Vlasak Electronics Ltd	£315	200 A/Cs 1,000 trans
Letter writer	Vlasak Electronics Ltd	£80	
Mail system	The Software House	£57	
Mailing and letter writer	Keen Computers Ltd	£300	500 addresses
Mailing system	Systematics International Ltd	£300	500 addresses
Modelling (VisiCalc)	Microsense Computers Ltd	£95	
Payroll	Algobel Computers Ltd	£295	500 employees
Payroll	Computech Systems	£379	
Payroll	Hewport Ltd	£400 - £500	100 months 50 weekly
Payroll	Microdigital Ltd	£375	
Payroll	Systematics International Ltd	£295	350 employees
Payroll	TW Computers Ltd	£145	
Payroll	Vlasak Electronics Ltd	£360	
Property management	Algobel Computers Ltd	£650	400 buildings 250 own 20



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Stock control	Microdigital Ltd	£225	625 items
Stock control	Systematics International Ltd	£500	200-2,500 items
Stock control	The Software House	£80	
Stock/purchase/order invoicing	Vlasak Electronics Ltd	£285	
Structural engineering design	James C Steadman	£200	
Word processing	Vlasak Electronics Ltd	£120	
Word processing	Algobel Computers Ltd	£75	800 lines
Word processing	Personal Computers Ltd	£150	17 A4 pages
Word processing	Systematics International Ltd	£75	

Commodore 3032

Application	Supplier Name	Price	Capacity
Appointments planner	Commodore B M (U.K.) Ltd	£50	200 entries
Building conversion	Micro Computation	£300 - £400	320 clauses
DBMS	Amplicon M S Ltd	£140	1500 records
DBMS	Commodore B M (U.K.) Ltd	£150	650
DBMS	Microact Ltd		400K-800K
DBMS MK I & II	Compsoft Ltd	£95 ea	17,600-5,000 records
DBMS sequential & random	Stage One Computers	£120 & £180	165K 165K
Hotel room system (INTG)	Landsler Software	£275	8X99 rooms for 400
Hotel system (+ billing)	Landsler Software	£450	130 rooms
Incomplete records A/C	Micro Computation	£555	120 A/Cs 5,000 trans
Incomplete records	Stage One Computers		
Insurance brokers' system	Stage One Computers		
Insurance renewals	Stage One Computers		650 policies
Job/apartments planner	Stage One Computers		
Ledger general	HB Computers Ltd	£200	Linked to S/L & P/L
Ledger/general & purchase	Bristol Software Factory	£300	1,000 A/Cs 6,000 trans
Ledger purchase	ACT (Petsoft) Ltd	£120	200 A/Cs 700 trans
Ledger purchase	HB Computers Ltd	£350	800 A/Cs 4,000 trans
Ledger purchase	Microact Ltd	£350	2,000 A/Cs 7,000 trans
Ledger sales	ACT (Petsoft) Ltd	£120	200 A/Cs 700 trans
Ledger sales	HB Computers Ltd	£350	800 A/Cs 4,000 trans
Ledger sales	Microact Ltd	£350	2,000 A/Cs 7,000 trans
Ledger/sales, purchase & general	Commodore BM (U.K.) Ltd	£650	650 A/C ledgers
Ledgers/sales, purchase & general	Stage One Computers		
Ledgers/stock/invoicing	GW Computers Ltd	£275 & £575	1,000
Mailing system	Stage One Computers		
Ordercontrol	MMS Computer Systems	£250	3,600 orders
Payroll	Commodore BM (U.K.) Ltd	£150	200 employees
Payroll I & II	Computastore Ltd	£200 & £350	275 & 500 employees
Payroll	Landsler Software	£95	250 employees
Payroll	Petsoft Ltd	£50	200 employees
Payroll/invoicing	L&J Computers	£220	
Printers quote system	Microland	£175	
Stock control	Act (Petsoft) Ltd	£75	
Stock control	Amplicon MS Ltd	£750	500-600 items 255 A/Cs
Stock control	Commodore BM (U.K.) Ltd	£150	650 items
Stock control	Microact Ltd	£350	2,500 items 1,000 A/Cs
Stock control	Petsoft Ltd	£50	2,000 items
Stock control	Stage One Computers		
Stock control	Bristol Software Factory	£300 & £360	2,300 items
Stock control	L&J Computers	£120	3,400 items
Window replacement	CSM Ltd	£500	

Word processing	Act (Petsoft) Ltd	£325	
Word processing	Dataview Ltd	£159	
Word processing	Stage One Computers		
Word processing	Commodore BM (U.K.) Ltd	£75	170 pages
		£150	
Word processing	HB Computers	£70	70
Work measurement	The Alphabet Company	£150	

CP/M

Application	Supplier Name	Price	Capacity
Hire purchase system	Graffcom Systems Ltd.		varies
Incomplete records	Profcomp Ltd	P.O.A.	2,000 entries
Job-time recording	Graffcom Systems Ltd		100 activity codes
Ledger general	Benchmark CS Ltd	£250	500 A/Cs 5,700 trans
Ledger general	Comput-A-Crop	£400	
Ledger general	Computastore Ltd	£500	999 A/Cs 99 centres
Ledger purchase	Benchmark CS Ltd	£250	500 A/Cs 2,000 trans
Ledger purchase	Comput-A-Crop	£400	500 A/Cs
Ledger purchase	Computastore Ltd	£400	500 A/Cs 3,100 trans
Ledger purchase	Structured Systems Group	£460	varies
Ledger sales	Benchmark CS Ltd	£250	500 A/Cs 2,000 trans
Ledger sales	Computastore Ltd	£400	500 A/Cs 3,500 trans
Ledger/sales, & general	Computastore Ltd	£1,000	
Ledger/stock/invoicing	Benchmark CS Ltd	£950	200 A/Cs 500 trans
Mail list system	Graffcom Systems Ltd	£250	varies
Mailing system	Structured Systems Group	£50	varies
Order entry & invoicing	Benchmark CS Ltd		
Order entry & invoicing	Graffcom Systems Ltd	£350	500-5,000 orders
Payroll	Comput-A-Crop	£450	
Payroll	Graffcom Systems Ltd	£500	250 employees
Property management	Algobel Computers Ltd	£650	2,000 trans
Purchasing system	Graffcom Systems Ltd	£450	540-7,000 invoices
Stock control	Graffcom Systems Ltd	£350	520-6,000 items
Stock/inventory control	Benchmark CS Ltd	£450	1,000 items 750 trans
Word processing	Computastore	£400	

Exidy Sorcerer

Application	Supplier Name	Price
Incomplete records	Basic Computing	£350
Ledger purchase	Basic Computing	£125
Ledger sales	Basic Computing	£125
Stock recording	Basic Computing	£125

Ohio Scientific

Application	Supplier Name	Price
DBMS	Microcomputer BM	£175
Ledgers/stock/invoicing	Microcomputer BM	£656
Word processing	Microcomputer BM	£116

Tandy TRS-80

Application	Supplier Name	Price	Capacity
DBMS	T&V Johnson Ltd	£200	
Invoicing	Tridata Micros Ltd	£75	Linked to stock SA
Ledger general	Tridata Micros Ltd	P.O.A.	Linked to S/L P/L
Ledgers/payroll various	Microcomputer Applications	£90	each
Ledger purchase	Tridata Micros Ltd	£225	175 A/Cs 1,350 trans
Ledger sales	Tridata Micros Ltd	£225	175 A/Cs 1,350 trans
Ledgers/sales, purchase, general & invoice	Microcomputer Applications	£350	



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Alphabetical list of suppliers

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Benchmark CS Ltd 0726-61000	Tremena Manor, Tremena Road, St Austell, Cornwall PL25 5QG.	S Willmott
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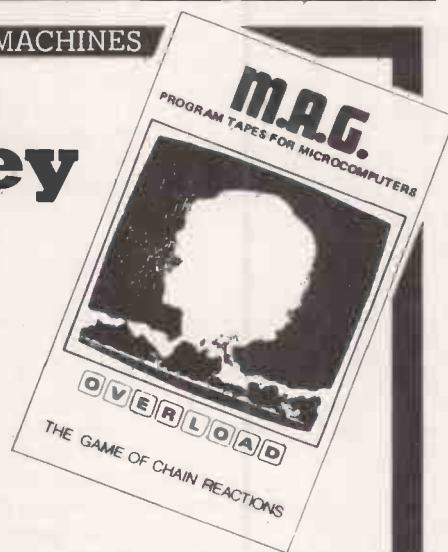
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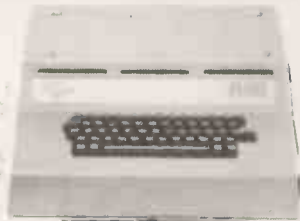
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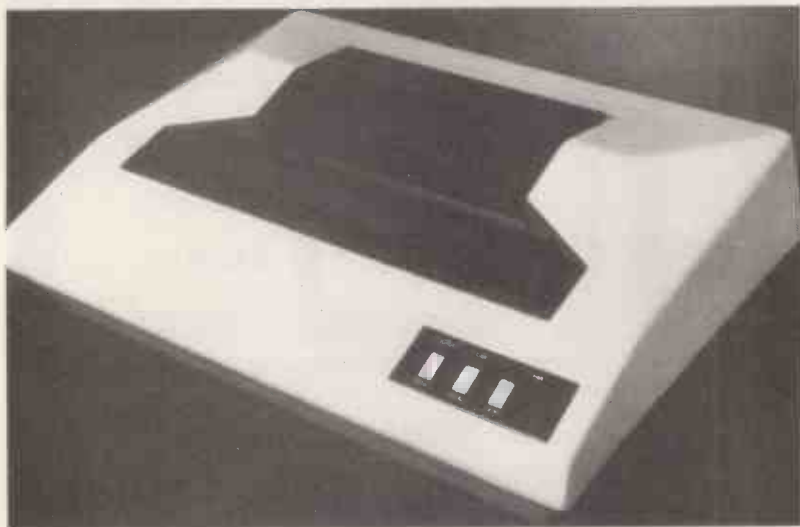
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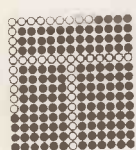


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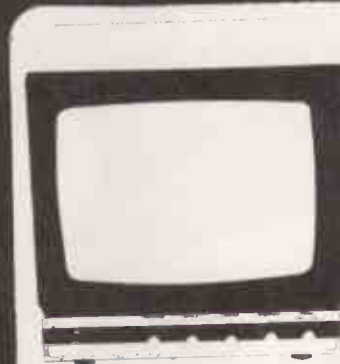
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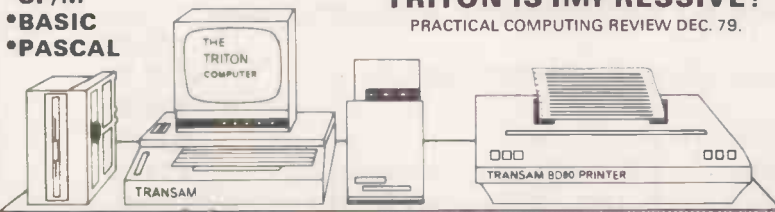
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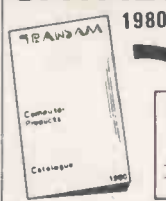
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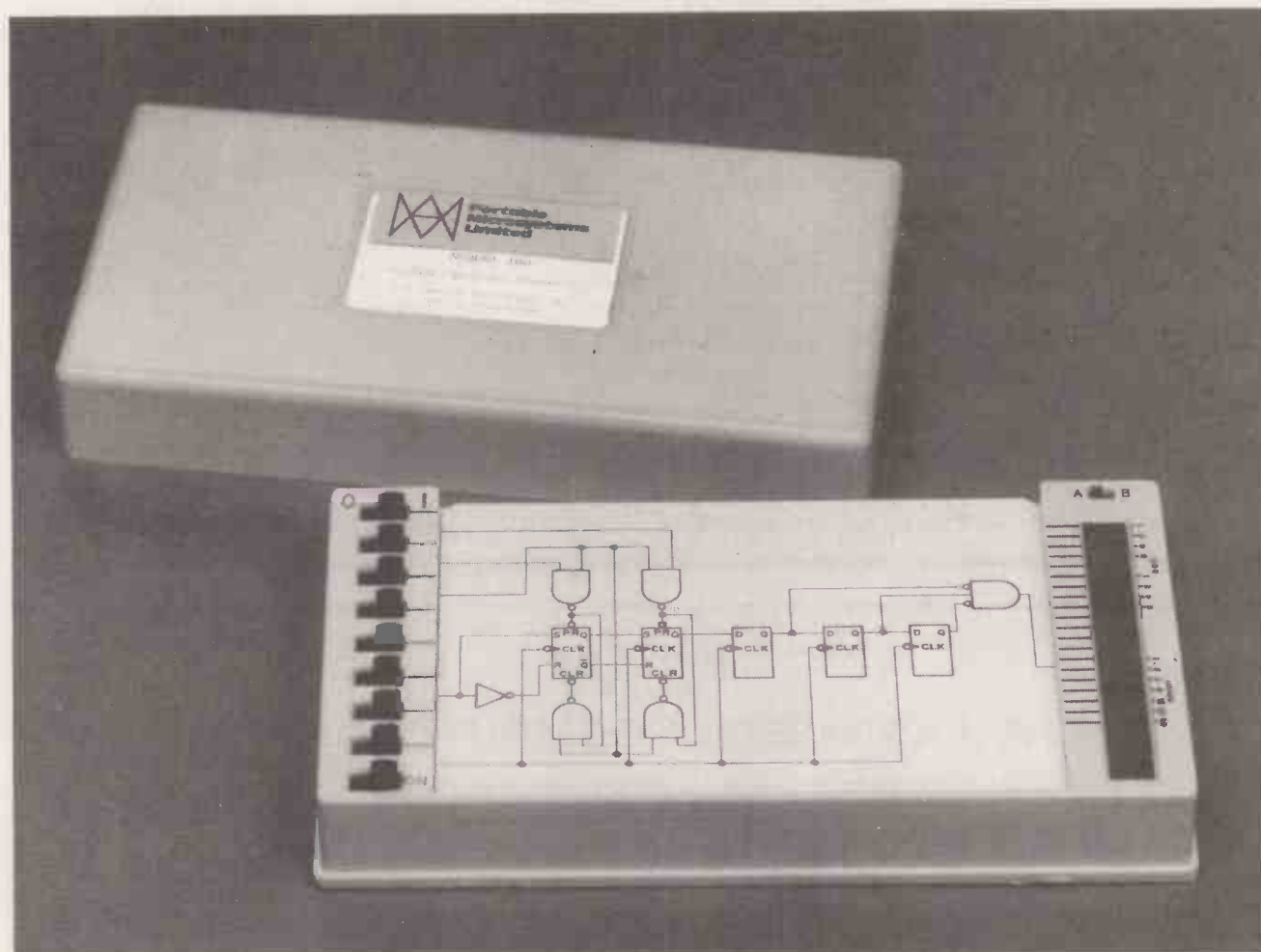
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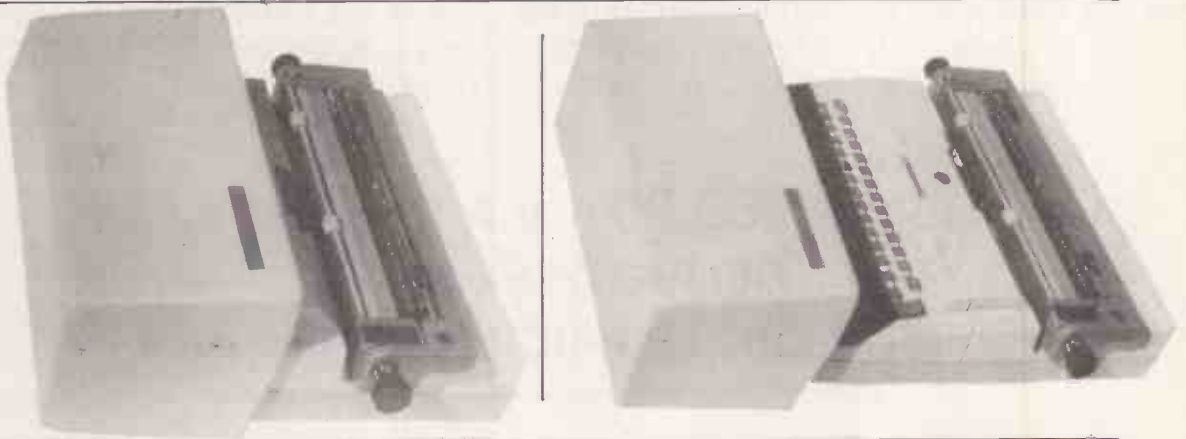
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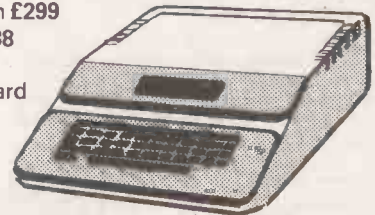
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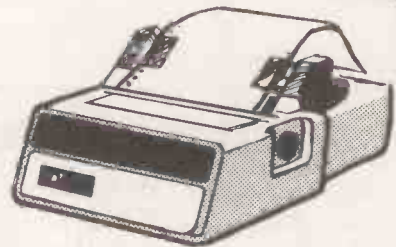


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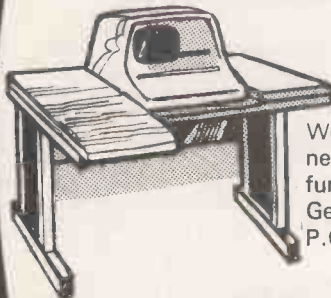
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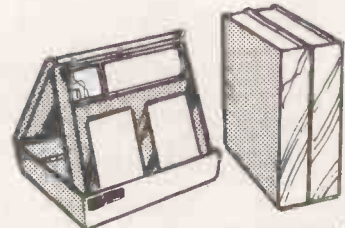
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Speed

The following benchmark test speaks for itself!

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BM1	1.7	1.3	1.4	0.7
BM2	9.9	8.5	7.8	3.9
BM3	18.4	16.0	15.0	7.5
BM4	20.4	17.8	16.5	8.3
BM5	21.7	19.1	17.8	8.9
BM6	32.5	28.6	27.0	13.5
BM7	50.9	44.8	39.5	19.8
BM8	12.3	10.7	7.5	3.8

Standard PCW benchmark tests, as published in *Personal Computer World's* review of the Challenger 2 (April '80 issue). Reproduced (with thanks) by courtesy of the staff of PCW.

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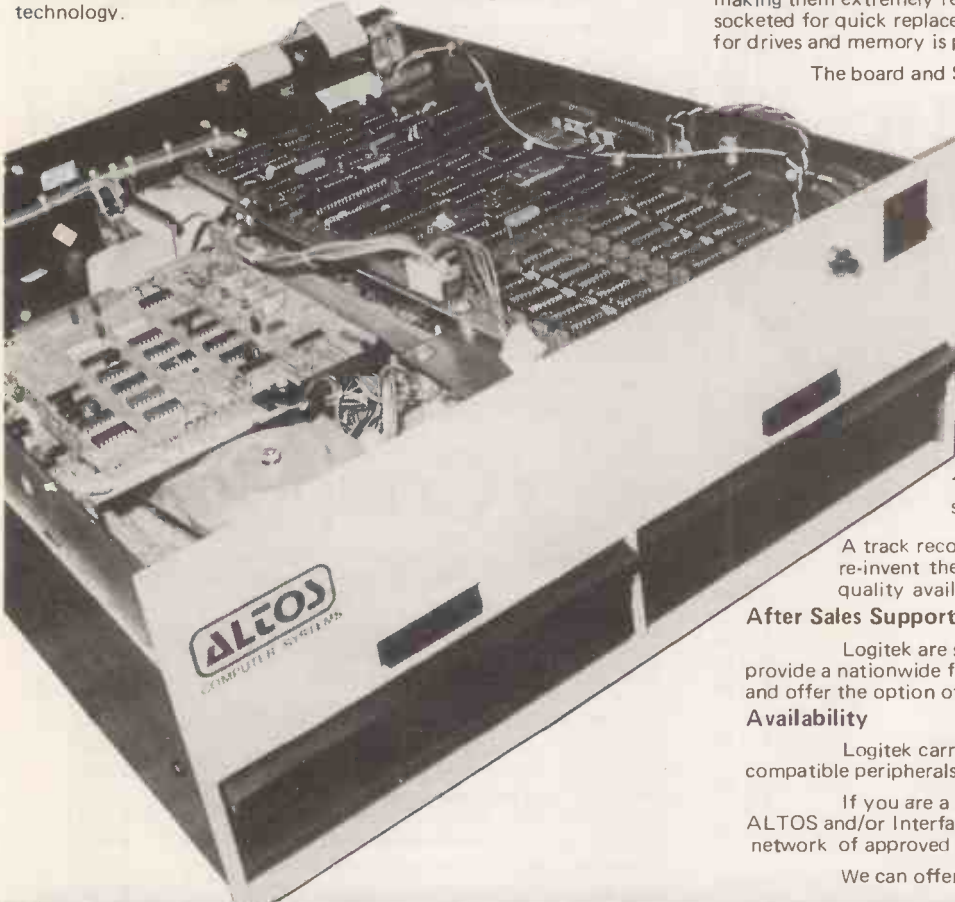
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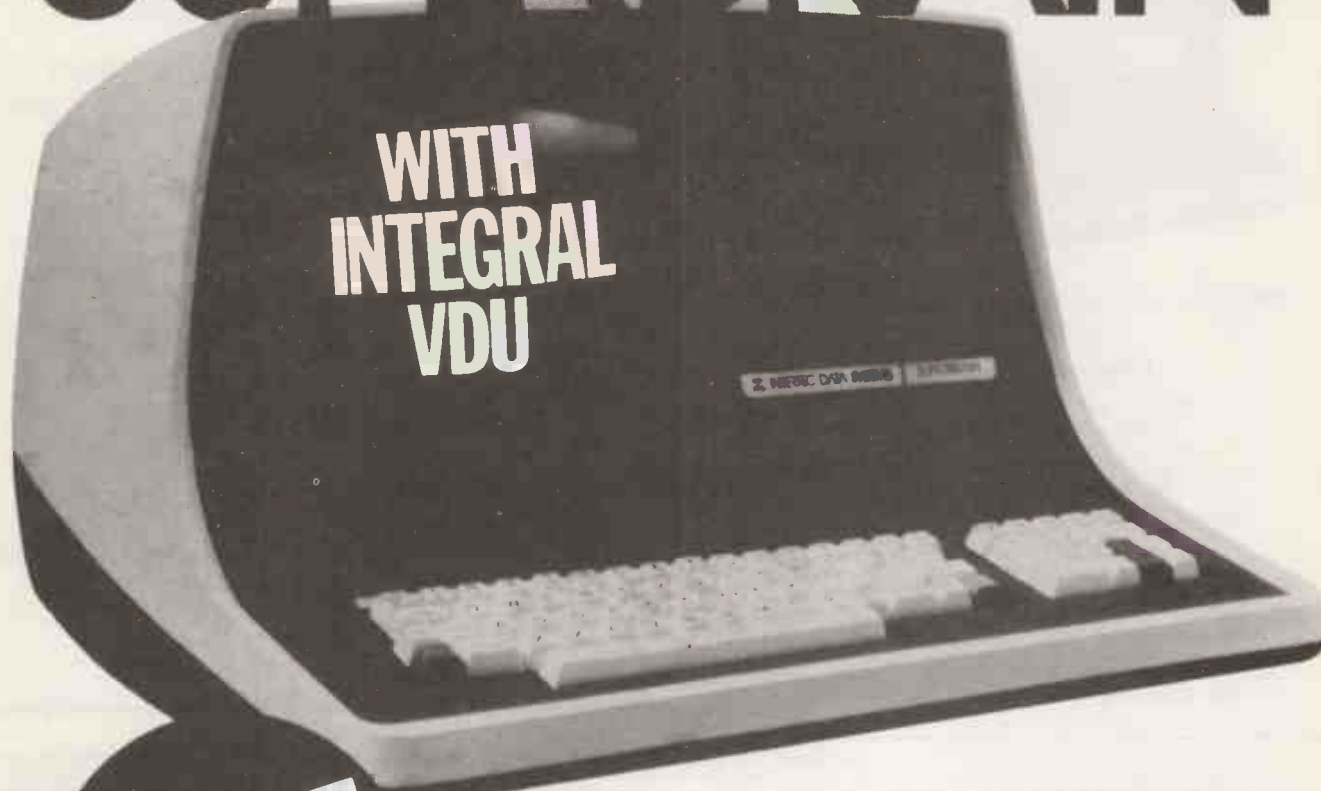
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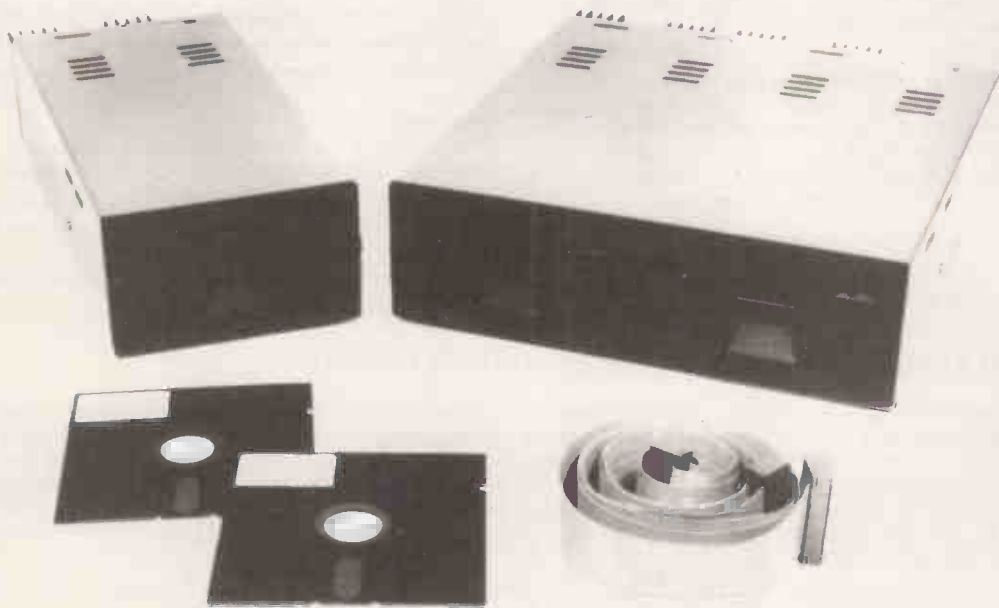


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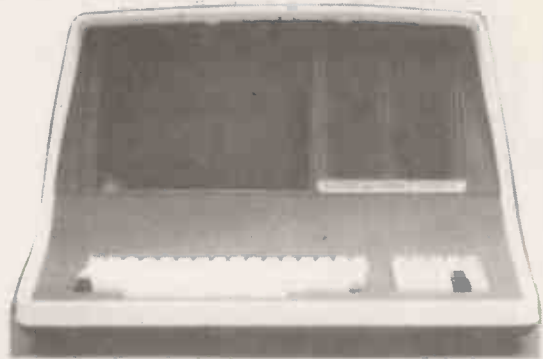
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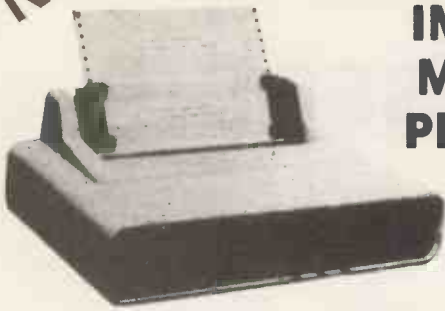
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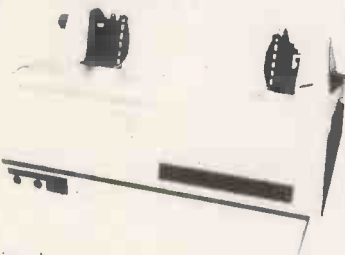
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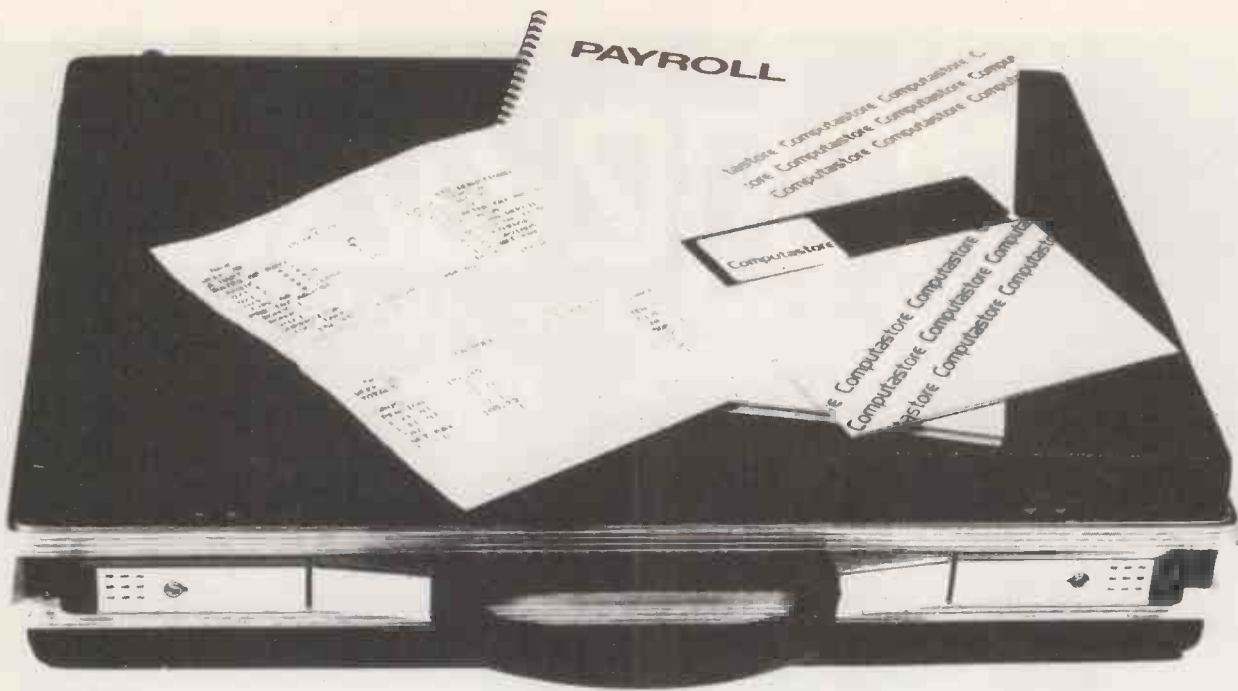
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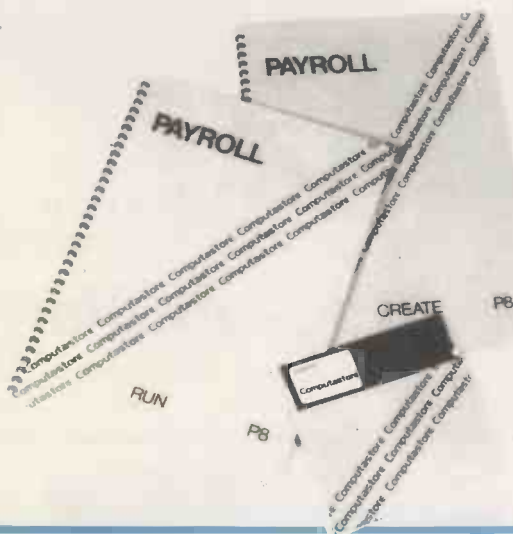
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- **20 Advanced APL.** Venue: Mollington Banastre Hotel, Chester. Fee: £75. Contact: Course registrar, Alan Pearman Ltd, Freepost, Chester CH3 5YZ. Tel: (0244) 46024.
- **23-25 World computing services industry congress II.** Venue: San Francisco, U.S.A. Contact: Thomas M Driscoll, 4400 Connecticut Avenue, N W Washgton DC 20008.
- **23-27 Financial modelling in APL.** Venue: Mollington Banastre Hotel, Chester. Fee: £245. Contact: Course secretary, Alan Pearman Ltd, Freepost, Chester CH3 5YZ. Tel: (0244) 46024.
- **24-27 Pascal — hands-on workshop.** Venue: London. Provides a systematic introduction to Pascal. Designed for engineers, scientists, programmers, analysts and managers who plan to use Pascal for the development of systems and applications software. Fee: £540 + VAT. Contact: ICSP U.K., Pebblecoombe, Tadworth, Surrey, KT20 7PA. Tel: (03723) 79211.
- **24-27 Computer communication networks.** Venue: London. Provides comprehensive, state-of-the-art foundation in computer communication network concepts, technology and implementation. Emphasis is on the practical aspects of network design, interfacing, protocols and packet switching. Fee: £470 + VAT. Contact: ICSP U.K., Pebblecoombe, Tadworth, Surrey KT20 7PA. Tel: (03723) 79211.
- **25-27 Pascal language programming.** Venue: Bedford. For system designers, project engineers and programmers who need to learn Pascal. Fee: £250 + VAT. Contact: Mike Hughes, Microprocessor Training Centre, Texas Instruments Ltd, Manton Lane, Bedford MK1 7PA. Tel: (0234) 67466. Extn. 3718.
- **26-27 Inspection method for software insurance.** Venue: London. This course explains the IBM-developed inspection method for software insurance. On completion, the participant should understand how to apply the techniques of the inspection method to software and related aspects of system development, and achieve greater cost-effectiveness in the activities of dp and dp-orientated departments. Fee: £310 + VAT. Contact: The Registrar, Infotech, Nicholson House, Maidenhead, Berkshire SL6 1LD. Tel: (0628) 39101.
- **28-29 Programming in Basic.** Venue: Hallam Tower Hotel, Sheffield. Designed for those who possess or are considering using a microcomputer or minicomputer in their business and wish to learn how to write programs using the Basic programming language. Fee: £125. Contact: Dean Consultancy Ltd, 45 Canterbury Avenue, Sheffield S10 3RU. Tel: (0742) 303054. □

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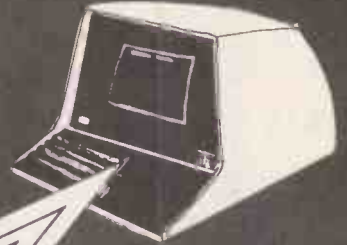
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A PRACTICAL GLOSSARY

Continuing the terminological gamut with T

Teletype

Used loosely for any keyboard/printer terminal. In fact, it's a registered trademark for an AT&T subsidiary, Teletype Corp, whose terminals dominated computing in the 1960s and early 1970s.

Their operating characteristics were widely copied, and their specification became a *de facto* standard for low-cost input-output devices — even when VDUs started becoming inexpensive and common in the second half of the 1970s. The simplest and most inexpensive VDU terminals still feature Teletype-compatibility.

Meanwhile, Teletype is still among the big boys in the business, notably through its good Teletype 43 — a 30 cps printer terminal.

Teletypewriter

See teleprinter.

Telex

A world-wide subscriber network for teleprinters. It is often a feasible alternative to data links using telephone lines — you can send and receive messages on both kinds of service, but the Telex is cheaper and simpler, though slower.

Terminal

Specifically, it is the end of a communications link, defined more helpfully by one dictionary as the point at which a user communicates directly with a computer. So, in theory, the keyboard and screen on a TRS-80 or a Pet are terminals.

In practice, you would be better off thinking of a basic unit comprising keyboard, screen, and/or printer connected to a computer by a cable and/or telephone line. That is the simplest terminal.

More clever are the so-called intelligent terminals. They incorporate a microprocessor and may give you local programming facilities — which means the terminal user can develop and run programs without communicating at all with the central computer. In that case, your terminal will probably have a cassette or floppy disc attached.

There are purpose-built industry-specific terminals which are really very complex. Banks

and supermarkets, for instance, typically have whole terminal systems with the terminal involving several different types of device — special printers, cash registers, those hole-in-the-wall cash dispensers, various kinds of automatic credit-card checkers, and so on. All can be linked to a small mini or microcomputer which, in turn, passes the data collected to the central computer.

Text editor

A special program which allows input of alpha-numeric text and modification without necessarily your having to be aware of how and when it will be printed. The output side may be looked after by a second program called a print formatter. Together, the two programs constitute a word processor. On its own, a text editor is a dramatically useful tool for program entry and correction — it can greatly simplify the time-consuming chores.

Throughput

It is usually defined in some all-embracing fashion like the total useful information processed or communicated during a specified period by a machine, system or procedure, measured in some terms meaningful to the process under consideration.

For example, a payroll system may deal with 50 employee records per minute; you might deal with 5,000 inquiries from an information retrieval system.

Time-sharing

The method by which one computer can service several users more or less all at the same time. In fact, the computer services each user in sequence; its high speed makes it appear that the users are all handled simultaneously — whereas in reality each receives a few milliseconds of the computer's attention in turn.

Tiny Basic

A subset of Basic devised by designer of minicomputers, Tom Pitman. It allows only integer arithmetic and limited string operations, but the more useful Basic facilities are there. Tiny Basic fits into only 4Kbytes which makes it great for sub-£250 microcomputer kits like the Elf II.

TP

Teleprocessing — though sometimes it is known as transaction processing.

Track

The channel on a disc along which data is stored — also called a cylinder. The term is also used with mag tape to refer to the longitudinal paths on which bits can be placed, so nine-track tape can have up to nine bits in a character.

A character is read by picking up a particular combination of bits horizontally across the tape from whatever is in the nine channels at that position.

Transaction

This term is bandied about a good deal in business computing. A transaction is any event — like receiving a bill or despatching an order — which requires a record to be generated in the system.

You may encounter the impressive but ill-defined term transaction processing. Usually it means that each transaction is processed as it happens which makes transaction processing the opposite to batch processing in the commercial environment.

Transfer rate

The speed at which a footballer changes clubs. Also the rate at which data is transferred from a peripheral device to main memory. You will usually meet it in reference to cassette or floppy disc units.

The transfer rate quoted so blithely is the theoretical maximum. In practice, the performance will generally be constrained by many other factors. Transfer rate is usually given as characters, bits or bytes per second.

Transistor

You don't really need to know anything about them, but this electronic device is absolutely critical to the development and design of today's computers.

Transmit

To send information from one place to another via a data transmission circuit which usually means a telephone line.

Trap

A method of detecting program

errors when illegal instructions are executed or illegal memory locations are accessed. Usually what happens is that the program branches briefly to a special subroutine when some unusual condition occurs during the running of a program.

The operating system may assume control automatically and correct the condition or note the cause of failure. Trapping is also a feature of certain diagnostic routines.

TRS-80

The world's second most popular personal computer is Tandy's little baby. It adopted a very different approach to the Commodore Pet, even though both use the same elements — keyboard, screen, cassette, graphics and Basic.

Tandy went for the Z-80 rather than the 6502 — Intel derivative versus Motorola parentage — opted for a real keyboard rather than the calculator-style keys on the Pet, and decided to sell three cable-connected boxes rather than one integrated unit.

As a result it's difficult to weigh these two similarly-priced computers against each other. Both manufacturers are now going for business versions of their computers — floppy disc systems at the £2,000-plus mark.

Truth table

You may find the term applied to a table describing a logic function by listing all possible combinations of input values and indicating all the logically true output values.

That is all associated with the heavy esoterica of Boolean arithmetic, so most of us can safely forget it.

TTL

Stands for transistor-transistor logic; it's one of the standard design approaches to semiconductor integrated circuits. Standard TTL provides the lowest component cost of conventional logic.

It is relatively fast and is unsurpassed for a variety of functions but it has at least four disadvantages; high power dissipation, limited noise immunity, inadequate speed for some applications, and limited complexity. □

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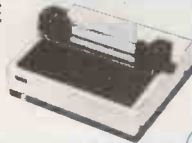
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