# Practical Computing

60p

February 1981

Volume 4 Issue 2

Satellite communications

Reviews:

Ozz business planner

MuPet

DAI

CP/Net and Unix

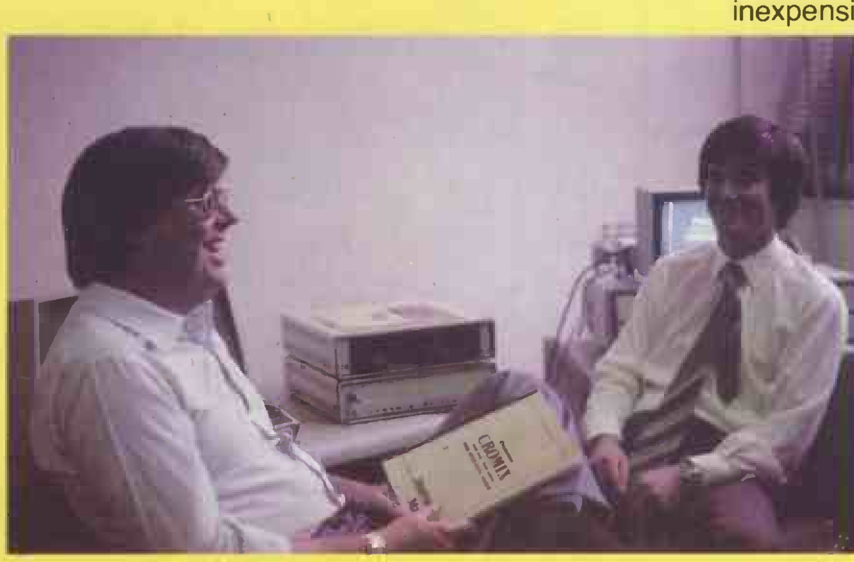
Stonemason and playwright use micros

# MicroCentre introduce . . . . . . System Zero


New System Zero Computer with quad-capacity DDF disk drive. The system includes built-in diagnostics for a quick system test of memory, controller and disk drives

**Basic System Zero £587**
**System Zero/D with DDF £2355**

The System Zero is a small computer especially designed for dedicated applications. It is particularly useful in process control situations.
In the basic model you get Cromemco's famous Z-80A single card computer, 1k of RAM, 4k of ROM, Control Basic, and an attractive cabinet. The motherboard provides 3 extra card slots on the S-100 bus, for tailoring the system to particular applications.
The basic model is designed for ROM-based programs, but it can be expanded by the addition of memory and I/O cards. It is fully compatible with all Cromemco peripherals, including floppy disks and hard disk systems. Suitably configured the System Zero can run any Cromemco operating system or software package.



At the recent UK launch of the System Zero Computer, Cromemco's Technical Director Roger Melen presented a System Zero/D with 128k memory running Cromix. Here he is seen discussing the system with MicroCentre Director Andrew Smith (right).

## System Zero/D

This special version of the System Zero has 64k of fast RAM, and a model DDF dual disk drive. It includes two double-sided double-density 5 inch disk drives giving a total of 780k bytes storage; and RDOS-2, a new resident disk operating system with terminal and printer drivers, and self-test diagnostics.
The System Zero/D is an exceedingly inexpensive development computer ideal for setting up dedicated applications to run in the basic model. It will support Cobol, Fortran IV, Ratfor, Structured Basic, Lisp, RPG II, Word Processing, DBMS, and the full range of Cromemco's business applications software.

## Operating system

The System Zero/D will run any Cromemco operating system provided sufficient memory is available. The mimimun configuration of 4k ROM runs control Basic; with 64k RAM the system will run RDOS-2 or CDOS (compatible with CP/M); and with 128k the Zero/D will run the Cromix system (based on Unix).

## For C Cromemco... call the experts

MicroCentre
Tel: 031-556 7354

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Edinburgh EH3 6JN

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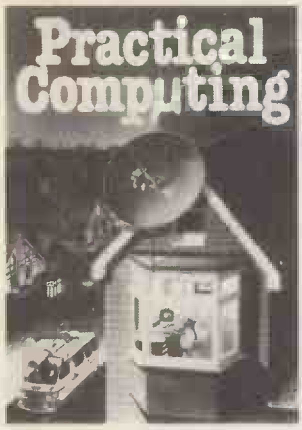


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**Prestel page number 45631**

# In the microcomputer jungl[e]
# The Sharp MZ-80 system now wit[h]

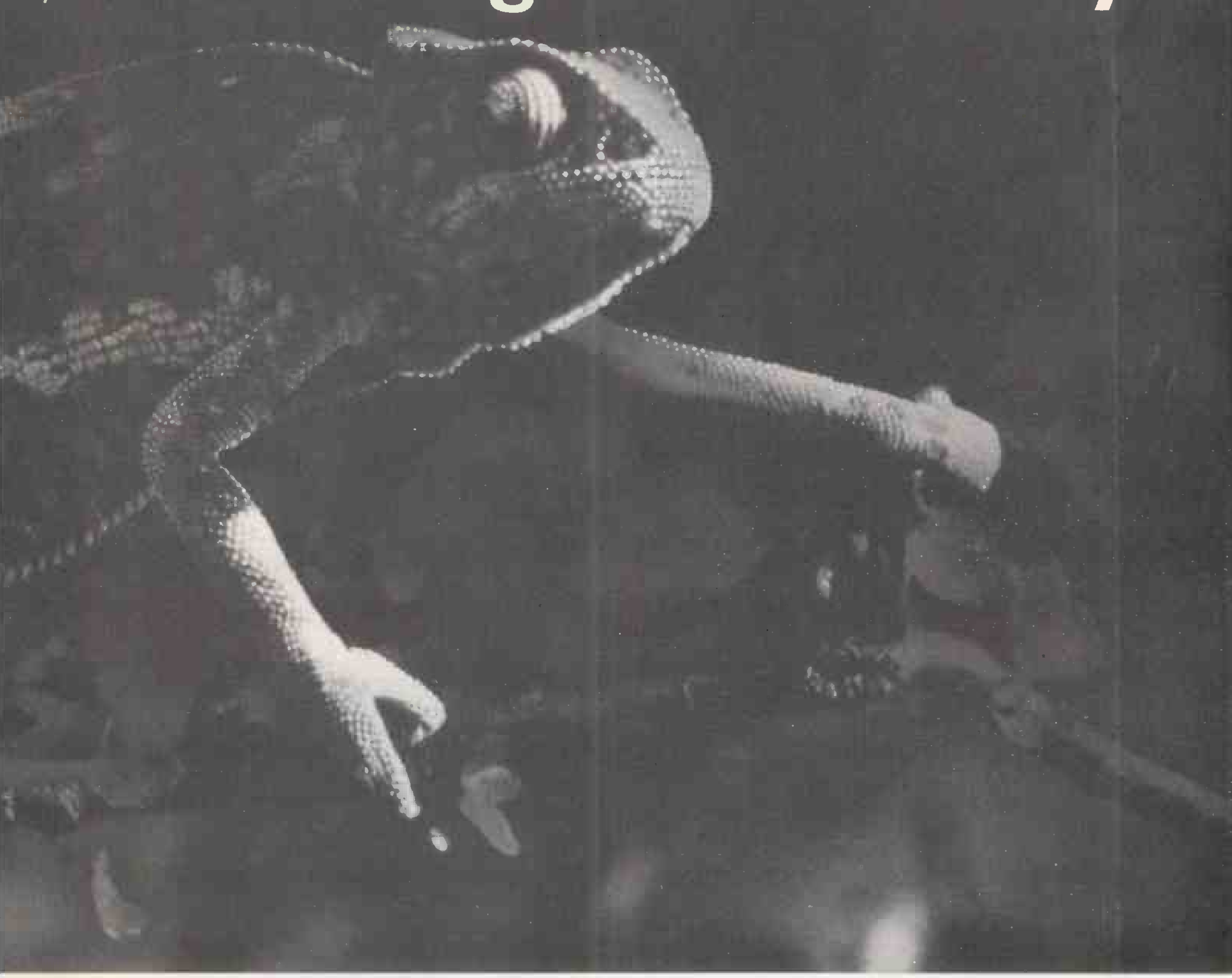
Since its introduction, the Sharp MZ-80 system has proved to be one of the most versatile systems in the micro jungle, for commerce, industry and enthusiasts alike.

Now the MZ-80 Computer system has even more versatility thanks to CP/M,™ giving greater adaptability to face the future. After all look what happened to the Dinosaur.


The MZ-80 system
is made up of the MZ-80K
computer with the powerful Z-80 microprocessor.
MZ-80FD Floppy Disc storage unit, now with
CP/M™ for even greater versatility.
MZ-80P3 dot printer producing ultra Sharp print out copy.

CP/M™ is a Trade Mark of Digital Research Ltd and was developed by Crystal Electronics, Torquay.

# survival depends on adaptability. P/M(TM) has even greater versatility.



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2) Delivery in U.K. is free of charge
3) All goods & software are stocked on immediate delivery
4) 6 month main unit, 12 month memory guarantee
5) 24/48 hour mailing of any spare module free within warranty
6) Same service as 5) outside warranty for ad hoc charge
7) 10 free diskettes (28.50)
8) 10% of hardware value in free software (1795.00)
9) Positive before ** and ** after sales service
If the transaction includes a printer and the business programs then the following are also added:
10) All cabling between printer and SuperBrain free (25.00)
11) Ribbon and Thimble free (eg. Spinwriter 4.75 + 9.75)
12) Extra 10 diskettes free (28.50)
13) Additional free software based on 10% of printer value
14) Free training session plus all necessary follow up
15) Box printer paper (28.50)
A typical deal could look like this:

| | |
|---|---|
| SuperBrain | 1795.00 |
| NEC Spinwriter | 1695.00 |
| | 3490.00 |

Bus program 775.00 plus MBasic 150.00 (less 349.00) = 576.00 Total purchase price 4066.00 Plus V.A.T.
The total value of free items on this deal was in excess of 500 pounds in virtue of incidental items as well as extended warranty and software.
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### EIDOS SYSTEMS

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### SOFTWARE SYSTEMS

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### MICRO FOCUS

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☐ (Z) **APL/V80** – Concise and powerful language for application software development. Complex programming problems are reduced to simple expresions in APL. Features include up to 27K active workspace, shared variables, arrays of up to 8 dimensions, disk workspace and copy object library. The system also supports auxiliary processors for interfacing I/O ports. Requires 48K CP/M and serial APL printing terminal or CRT .......... £270/£20

NEW

☐ **PASCAL/M** – Compiler generates P code from extended language implementation of standard PASCAL. Supports overlay structure through additional procedure calls and the SEGMENT procedure type. Provides convenient string handling capability with the added variable type STRING. Untyped files allow memory image I/O. Requires 56K CP/M .......... £195/£20

☐ **PASCAL/Z** – Z80 native code PASCAL compiler. Produces optimised portable reentrant code. All interfacing to CP/M is through the support library. The package includes compiler companion macro assembler and source for the library. Requires 56K and Z80 CPU. Version 3 includes all of Jensen/Wirth .......... £205/£15

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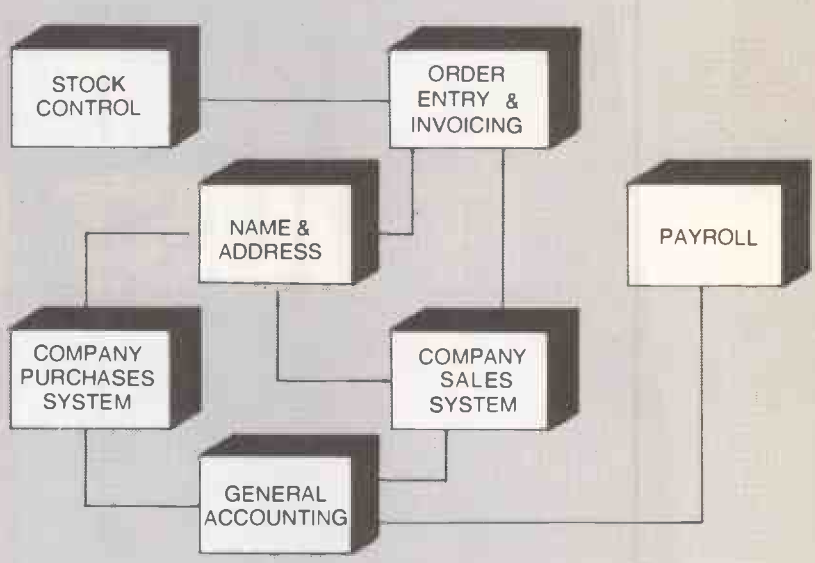


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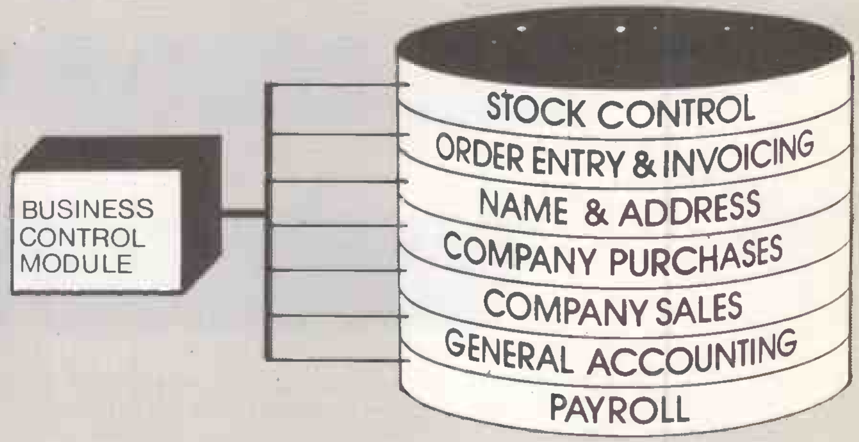


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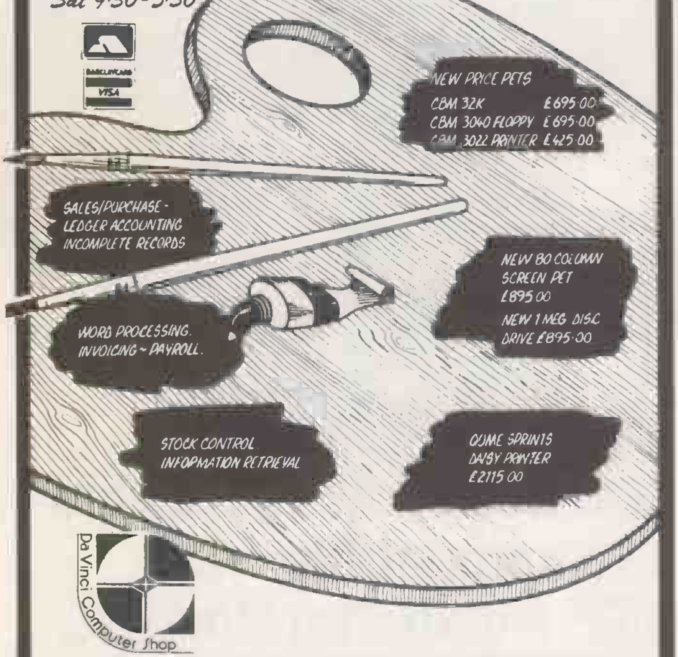


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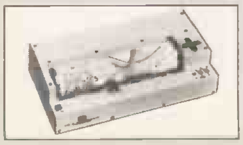

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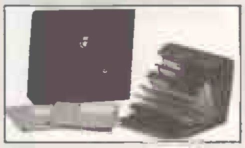

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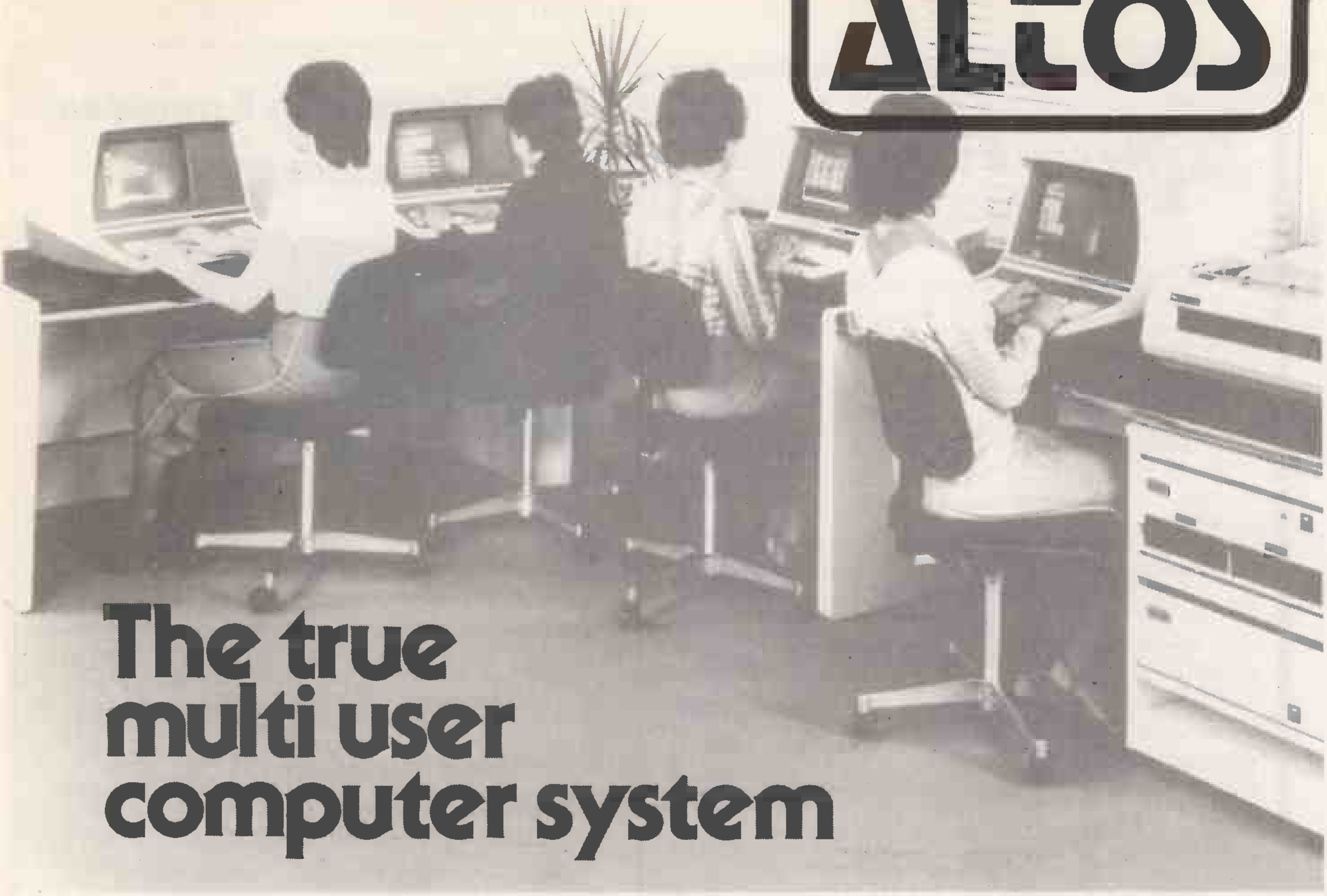

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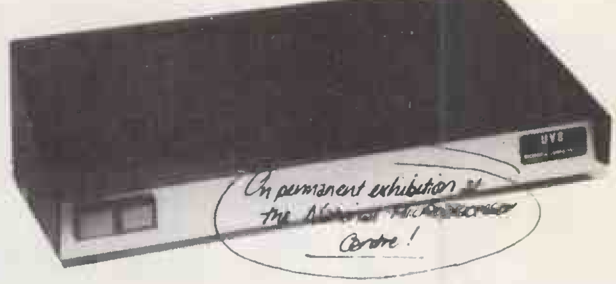


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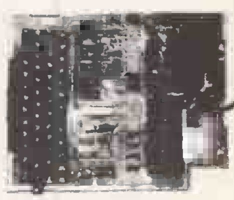

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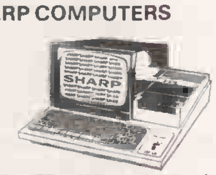


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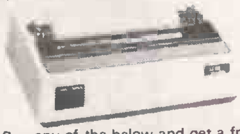

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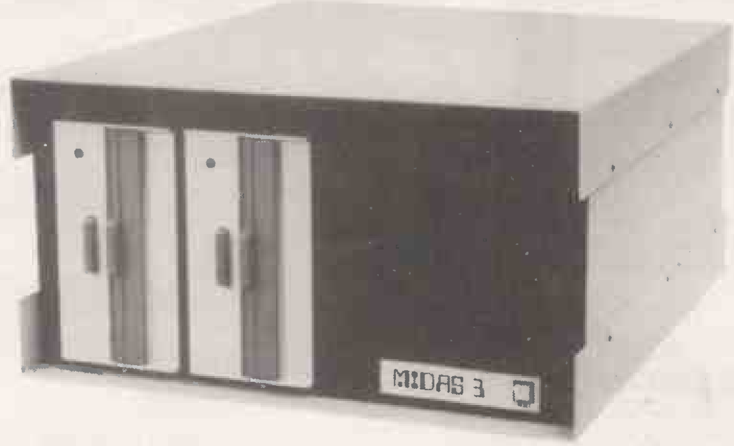


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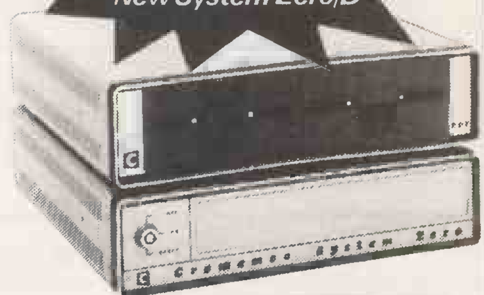

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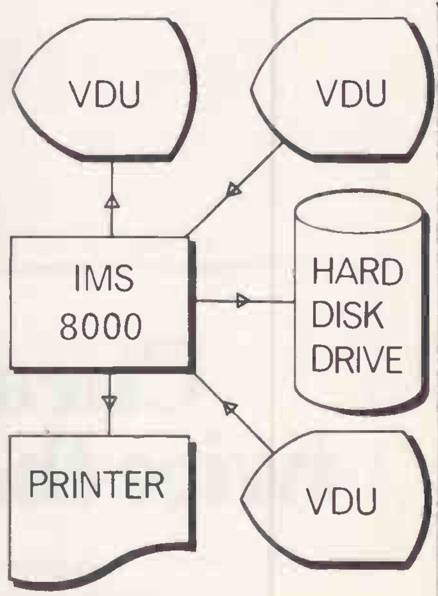


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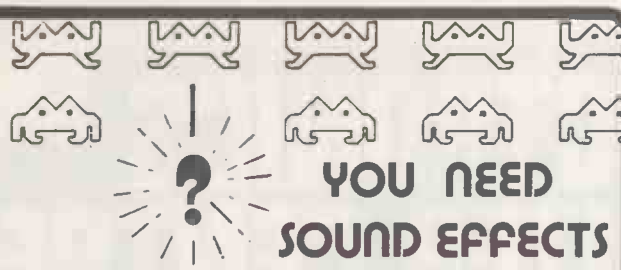

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# Ready next week

NO SADDER WORDS — as the poet Longfellow tells us — of tongue or pen are there than these: ready next week. In the micro business, all but about 10 percent of hardware and software, on first enquiry, is going to be "ready next week" — even though there have been announcements saying that the delight in question is in stock, totally finished, mature.

It is generally understood that materials advertised for sale already exist and are ready to be despatched to eager customers. Yet how often is the customer told: ready next week?

It would not be so bad if the week in question lasted the usual seven days — would that it did. More often it lasts seven times seven days, or even seven months. No doubt some items will eventually appear next week — a week in which each day counts as 365 ordinary, mortal, waiting-for-the-postman-to-knock days.

## Household names

It does not seem to matter whether one is dealing with huge firms — household names — or one man in a back bedroom in a big-city suburb. What they have to sell they may not yet have to hand. Last October, IBM announced for immediate release, a word processor which checks spelling mistakes. When asked to supply one, IBM said: "Certainly". When asked when? IBM said: "Ready next year" — perhaps demonstrating an honesty only large firms can afford.

We are in the throes of installing a micro in the *Practical Computing* office. It is intended to do useful things like word processing and mailing lists and checking payments to contributors.

When first arranged, we were to have the machine in early summer. The inevitable, statutory week extended itself to the Yuletide season with no prospect of imminent delivery.

On the one hand, one cannot imagine that companies advertise from charity. Advertising must produce customers — and a good few of them one would think. Also, one cannot imagine that those customers consistently put down the money and walk away, content with the assurance that their wants will be satisfied next week.

On the other hand, one would imagine that we, as an influential organ of public opinion would receive the very best of service. It is hard to believe that in the light of our own experience.

One would expect Galactic Wondercomp Ltd, operating from its granny's front room in Penge, to despatch itself when we telephone. Not so. When young hopeful has been brought to the telephone by cracked cries of: "Jimmeee — it's the gentleman from *Practical Complaining*" — the answer remains the same.

## Ordinary customers

If we have to wait three months for immediate delivery, what about the ordinary customers? From the anonymous depths of English literature, appears a fragment describing a sad group of people who 'earned a precarious living by taking in one another's washing'. I wonder if the micro community might not be just those, earning a precarious living by taking in one another's computing for delivery next week.

When they arrive, three-quarters of the devices may not work. That is explained partly by the micromarket's interest in new products whose orginators tend inevitably to forget the manager's golden rule: "Every project is always more than 85 percent and always less than 95 percent complete". That first five percent — which is everything — can and usually does take forever.

Sometimes, however, a product arrives on the agreed day and works. When such an unlooked-for event occurs — and it does occasionally — one tends to overlook it in disbelief. So rooted is our certainty that each box delivered, each floppy disc unwrapped contains not some technological delight but a very severe pain in the lower lumbar region, that there is hardly any pleasure in receiving these offerings.

## Office of the future

Sometimes, we feel that the office of the future should have nothing in it but nice, reliable paper and pens, with perhaps one manual typewriter in the corner, never to be used.

Imagine if the Sumerians had taken the Winchester disc route instead of fooling with clay tablets. By now, there would be a whole bunch of propagandists running about with the crazy proposition about data storage on platens of boiled tree using an optical technique. "Look, you just take a burnt stick out of the fire and write. It's so simple".

The problems seem to grow monthly more urgent. It was all very well in the dark days of two years ago, when we were all feeling our way into this new idea of real computing power in the user's hands, that life should be rather difficult. Those days ought to be past. I am afraid we are all guilty of overestimating the enthusiasm and patience of our customers. We are guilty of underestimating the steepness of the curve that separates the people who are prepared to wrestle for even five minutes with equipment which does not work from those who will go on for even 10.

Why are Pet and Apple such a success? Not because they are technically brilliant, because they are marketed in such a way that the buyer feels that success is assured. That kind of marketing is difficult and expensive. When we laugh at the larger companies and knowingly point out all the extra zeros on their prices and say to astonished lay bystanders that a micro can do just the same job at one-tenth of the price, we forget one small thing. IBM customers are promised a device which works. The extra zeros may be insignificant, all things considered. As they say: If it only costs money, it's cheap.

## Under-capitalisation

Those parts of Whitehall which are aware of the microcomputing industry like it because it embodies the virtues of self-reliance and low start-up cost. By the same token, we are grotesquely under-capitalised. Industries only skimp along, taking in each other's washing because they do not have the capital to accumulate stocks of goods and expertise.

That is really our problem — few can afford to start work until they receive an order, and, therefore, nothing can possibly be ready until next week. Considering that the micro business is one of the few which shows any sign of staying alive, it would surely be worth investing .01 percent of the money in it that is annually sunk into the bottomless bog of the businesses which mangle steel into shapes the customers quite clearly do not want.

**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.**

## Recursive argument

BORIS Allan, in his article on recursion — Programming Techniques, *Practical Computing,* December 1980 — says that my remark in the *Liverpool Software Gazette,* third edition — "A Basic program (to solve the Towers of Hanoi problem) not using recursion is rather difficult to write and rather difficult to follow", together with another quote this time from *Practical Computing:* "Seem to be not only incorrect but to be repetitions of vaguely-understood folklore".

He then devotes most of the rest of his article to producing such a program and in the process, proves my original point conclusively. Thank you Boris Allan.

**John Stout,**
**Formby,**
**Liverpool.**

## Value of recursion

IT IS difficult to resist such a tempting challenge as that issued by Boris Allan in his article on recursion — December 1980. Most of my work is in language and compiler design — areas which would be a good deal more tedious if recursion were not available.

Consider the arithmetic expression, as in Basic or whatever, and try to define it without using recursion. Any sub-expression in brackets will form a nested arithmetic expression, so arithmetic expressions have a naturally-recursive structure.

That idea is extended throughout languages such as Pascal so that, for example, the THEN clause of an IF statement is allowed to be any statement, including another IF, and so the definition of the language is recursive at many points. The value of that to the programmer is, at the very least, a less-restricted language.

Compiling such recursively-defined syntax leads naturally to recursive routines in the compiler. So, for example, when a routine processing an If statement finds that the THEN clause is another IF, it can call itself recursively to deal with it. It is possible to avoid the recursion, as in the Tower of Hanoi problem, by using a table-driven approach, but that demands unusual programming techniques, and may require that code generation be done in a second pass — which makes for a larger and slower compiling system.

It must, therefore, be conceded that recursion is of very great value in the construction of economical compilers, and of course Pascal compilers in particular are usually written in Pascal — a major justification for Pascal supporting recursion.

Most of the other comments Allan makes about Pascal are incorrect. The problem of declaring mutually-recursive procedures has little to do with either Pascal or one-pass compilers — the same awkwardness occurs in Algol68, because it arises from the scope rules used in all algorithmic languages.

Finally the Pascal factorial function Allan offered contains a remarkable number of errors for such a short piece of code. The following is rather more representative of the language.

```
FUNCTION factorial (number: INTEGER);
BEGIN IF number<0
        THEN factorial: = 0`
        ELSE IF number = 0
                THEN factorial: = 1
                ELSE factorial: = factorial
                (number—1)*number
```

**Paul Farrell,**
**Cambridge.**

## Computing in Cornwall

THE Cornish Radio Amateur Club recently held an inaugural meeting where a Computing Club for Cornwall was formed — the first in the county.

The Club, meets at 7.30 pm on the third Monday in the month at the Social Club, SWEB Pool, midway between Redruth and Camborne on the A30. It will cater for all, amateur to professional, and hardware, software and all areas for beginners to experts.

Any enquiries should be addressed to The elected secretary, Richard M Frost, Trecarne, Alexandra Road, Illogan, Redruth TR16 4BA.

**AH Hammett,**
**Truro,**
**Cornwall.**

## Chess survey

J F WHITE'S Chess Machine Survey, *Practical Computing,* October 1980, is an admirable attempt to summarise a complex subject which becomes more so with each new generation of chess computers. However, while erudite, the article contains a number of significant errors.

The first machine on the U.K. market was Chess Challenger, introduced in July, 1977. Our Company pioneered the 'domestic' chess computer — and coincidentally heralded the start of the current boom in electronic and computer-based toys and games.

Indeed, by the time the Boris machine was introduced around a year later, the first one-level Chess Challenger was already being superseded by three-level and 10-level models.

White describes several competitive games in considerable detail yet manages to completely avoid — let alone describe in any detail — any mention of the two latest versions of Chess Challenger, namely Voice Sensory and Sensory 8 which went on sale to the consumer market in June this year.

For example he states that Chess Challenger is "pre-programmed with several book opening moves". That is damning with faint praise. Voice Sensory Chess Challenger has a repertoire of no less than 64 classic book opening variations, each averaging 15 moves into the game. It also contains a library of 64 of the world's greatest chess games by players such as Morphy, Capablanca, Spassky and Fischer.

Voice Sensory and Sensory 8 Chess Challengers feature a touch-sensitive playing surface which completely eliminates any need for move programming via a keyboard as in the past. In addition, the Voice Sensory version also has a built-in chess clock which tells the time remaining for each player, computer or human, tells elapsed time of the game, and displays the number of moves at any given stage of a game. The Sensory 8 board can be operated by battery or from mains via a small transformer supplied.

A useful optional extra for the serious chess buff on the Voice Sensory board is a print unit which connects via a multi-pin socket and which provides an automatic hard-copy printout for every move made. We also hope to introduce a re-chargeable battery pack for the board in the near future.

It has never been our policy to compare the strengths of our games to those of our competitors, but rather concentrate on the game play and additional features of interest to the consumer. Except in competitions such as the recent World Microprocessor Chess Championship, the possibility of two computer chessboards playing against each other is neither of interest or relevant to the average chess player and indeed might tend to confuse the lay public.

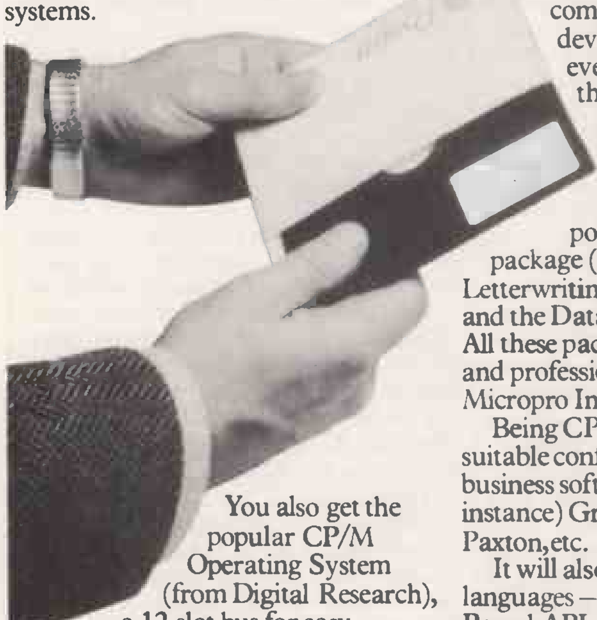
Voice Sensory Chess Challenger uses 224K bits of ROM and a development version of the model recently won the first ever World Microprocessor Chess Championship in London this year. The same development version also won the North American Microcomputer Chess

*(continued on page 44)*

# A Word Processor, Report Writer, Mailing System, Data Base Manager, and a Computer all for £1995*


Yes, we are offering all this with our SERIES 5000 5″ floppy-disc system for the incredibly low price of £1995.*

Not only do you get a powerful Z-80A system on the S-100 bus built to high quality standards by Industrial Microsystems, one of the longest-and best-established companies in the microcomputer industry, and supported by Equinox, specialists in microcomputers and multi-user systems.



You also get the popular CP/M Operating System (from Digital Research), a 12-slot bus for easy expansion, a Z-80A CPU for powerful performance, 2 serial and one parallel interfaces, 64KB of dynamic RAM with in-built error detection capability, and dual 5″ double-density drives with the option of a third drive (or quad capacity drives in place of double-density) in the same cabinet. Additionally, there is the Turbocharger option providing both enhanced disc capacity, disc performance and diagnostics. And if even greater storage is required we can supply 8″ floppy drives and cartridge disc drives.

A powerful system for the computer-user and system developer – and one with eventual access to OS/2000, the Industrial Microsystems networking system.

And for the office or business user we are including as standard a powerful Word-Processing package (Wordstar), a Mailing and Letterwriting package (Mail-Merge) and the Datastar Data Base Manager. All these packages are widely accepted and professionally written by Micropro International.

Being CP/M based, the system with suitable configuration will also run the business software developed by (for instance) Graffcom, Peachtree, Paxton, etc.

It will also run a wide range of languages – Basic, Cobol, Fortran, Pascal, APL, Algol, C.Lisp, and Forth and will support a wide range of add-on S-100 devices, such as floating point processors, Prestel interfaces, speech synthesisers, digitisers and plotters, etc.

And just to make certain that you get full use out of your system, nationwide field service support is available at a modest extra cost.

*add VAT and the terminal and printer of your choice at the costs shown.

| | |
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| **Series 5000 with 64KB Dynamic RAM, dual 5″ double density drives, CP/M Operating System, Wordstar, Mail-Merge and Datastar** | **£1995** |
| **The same system with quad drives in place of the double density drives** | **£2230** |
| **Add-on double density drive** | **£290** |
| **Add-on quad drive** | **£405** |
| **Peripherals:** | |
| **Televideo 912C VDU** | **£595** |
| **Elbit 1920X VDU with Wordstar keyboard** | **£895** |
| **OKI Microline 80 printer** | **£595** |
| **Texas 810 150cps printer** | **£1450** |
| **NEC Spinwriter RO Word processing printer** | **£1850** |

All prices exclude VAT, carriage, training and installation and are subject to our standard terms and conditions.

**OEM dealer and educational enquiries welcome.**

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**• Circle No. 157**

*(continued from page 42)*
Championship in San Jose, U.S.A., at the same time.

Those results prove the ability of the manufacturer, Fidelity Electronics Inc of Miami, Florida, to continue developing better, stronger programs for Chess Challenger.

**Paul Balcombe,**
**Computer Games Ltd,**
**London E18.**

## Pet new ROMs

I HAVE a Commodore Pet 8K with integral cassette and old ROMs. I like the integral concept; it suits the domestic environment better than a jumble of trailing wires linking separate monitor, cassette, processor, etc. Unfortunately, there is an increasing trend for software and hardware goodies to be produced for new ROM machines only.

I decided, therefore, to update my machine by buying a set of new ROMs from Commodore. I was shocked to discover that the price of the new-ROM set has increased from £30 to £108 — a 360 percent increase. I have also written to Commodore to express my disgust.

**JA Banks,**
**Loughton,**
**Essex.**

## Engineering software

I WAS interested to read the letter from RJ Campbell in Feedback December 1980. I very much agreed with many of his comments regarding the trivial uses to which the mighty micro is usually put.

There can be no doubt that the lack of engineering software in any quantity has hindered the appearance of the micro in the one place where it has a significant role to play, namely the engineer's desk.

However there are signs that help is now on the way. Skisoft was formed specifically to provide a limited quantity of this type of high-quality software, and our current product, the Pipezloss suite of programs, is available for pipeline sizing, pressure loss and flow calculations.

Future plans include programs for compressible flow and storage-tank optimisation costing and design. The programs are marketed by Aerco Gemsoft and run on the Apple II.

I have also noted various other programs with an engineering bias beginning to appear in catalogues of software from Microsense and others. It would, therefore, seem that if the trend continues, eventually engineers and scientists will realise that the micro has something to offer them.

I would not necessarily agree that Fortran is an absolute requirement, and as regards software portability, it is a nice point that the Fortran dialect used by some of the micros is a later and perhaps better one than that in use on some of the mainframes.

I suspect that standardisation in a particular language under an operating system such as CP/M gives the greatest chances of software portability. We are considering offering a CP/M version of all our software and would be interested to hear other people's views on this subject.

**MJ Skipp,**
**Skisoft Computer Services,**
**Weybridge,**
**Surrey.**

## Micro defence

IN REPLY to Martin Hawkins' haughty letter in the December issue, I should like to raise the following points.

Firstly, I am certain that *Practical Computing* is aimed at the micro user.

Secondly, everything must have a beginning, I dispute his off-hand condemnation of micros — they provide an excellent springboard for technicians and programmers of the future — if there is to be one.

If it is necessary to induce the younger generation into the field via the "fun market", so be it. Why should a magazine which succeeds in bringing computing closer to them try to extend itself to help those who have already enough money and experience in the computing world? The magazine provides a very useful introduction, and should not be criticised for staying within reasonable limits.

**Joshua Landy,**
**Cambridge.**

## Wood for trees

THERE IS much of interest to be found in *Practical Computing,* but one feature of editorial and contributor comment which stands out a mile, particularly on a retrospective survey, is how frequently both parties seem to miss seeing the wood for the trees.

Take, for example, the comments about the lack of creativity in the microcomputing field which appeared in the September editorial. Relevant comment appears in the December editorial yet there appears to be no inclination to link the two. The so-called passion for computing provided the impetus to get the micro business off the ground a year or so ago. What else but a desire to be creative would spark such passion? What could be more rewarding than a form of creativity which, while being satisfying in itself, offers so many additional advantages?

It is nevertheless understandable that the software market at present lacks variety. Software houses, if they possess any commercial acumen at all, will expend greatest effort in areas offering the greatest return. The small-business field is relatively large and can offer lucrative returns once the idea of a micro in the back-room really cathes on. Hence, the plethora of business packages available.

I can scarcely believe that there is much of a market for a multi-vessel heating/cooling system simulator as described by your correspondent Colin Grace — December, 1980, Feedback.

Similarly, RJ Campbell, Feedback December 1980, talks about software for engineering applications. It would appear to me, as an engineer, that the greatest usefulness of the computer lies in the earlier stages of product development when mathematical models can influence design and where statistical analysis can evaluate prototype performance. It is at those stages that the greatest returns can be expected in terms of saved time, effort and money.

In general, I cannot, therefore, subscribe to the view that creativity is lacking; indeed, in this neck of the woods, it is booming. It seems to me that what is needed is a more positive approach by journals, such as *Practical Computing,* to the compilation of a directory of specialist software obtained not from the software houses but from the end-user.

I envisage it as an entirely non-commercial activity in which end-users could contact one another through the medium of *Practical Computing* to exchange or otherwise negotiate the use of their software. At very least, such an activity would demonstrate to critics that something is being done to redress the imbalance in the market.

On the subject of criticism may I comment on the letter by Martin Hawkins in Feedback, December 1980. I must agree with some of his comments dealing with the type and quality of programs featured in *Practical Computing.* It is one thing to present the public with the idea that computing is childishly simple — comments in the September editorial — and another to publish programs which are chosen presumably to aid the aquisition of this simple skill and yet which fail to work either due to errors or omissions or, worse still, because the program algorithms are incorrect. The vision of many would-be programmers struggling to understand the illogic is less than edifying.

It is certainly not a time for pessimism. On the contrary, I see the next few years as being a very exciting time in which the micro, used wisely, will create far more jobs than it destroys, will eliminate much of the drudgery of repetitive work and thereby improve the quality of the work not to mention the lot of the employee. The role of journals such as *Practical Computing* should not be underestimated in all this.

There may be criticisms of material but its overriding role, as I see it, is to dispel much of the mystique which surrounds the computer. This it is doing very well — long may it continue. The possibility of further improvement will ensure my continued support, at least until such time as I feel that I can learn nothing new.

**C D Shaw,**
**Cambridge.**

# The New Paper Tiger 560 from T.E.

## Performance at a price you won't believe.

The latest addition to the Paper Tiger family, the 560, is comparable in cost to many other matrix printers. But that's where the comparability ends.

Features like a unique nine-wire staggered head which gives a high quality image by literally filling in the gaps between the dots with one pass of the head and 132 column printing on full size paper, put it well ahead of it's rivals.

Other standard features include: a full upper and lower case 96 character set, six software selectable character sizes, parallel and RS 232 interfaces and XON/XOFF line protocol plus a host of print optimisation characteristics. Features which are often not even available as options on other printers.

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• Circle No. 159

# Prestel price to fall with new add-on sets

PRESTEL may receive a much-needed fillip in the shape of cheap add-on terminals promised by two U.K. firms for this year. One of the great consistent criticisms of Prestel is that the sets are so expensive as to exclude all but the most affluent domestic users.

Both firms, Tangerine Computers and Radofin, aim to sell their add-on sets for less than £100 and are scrambling over each other to be the first with its product approved and on the market. Tangerine, which is building 50,000 sets, claims that it will be able to bring the price down to less than £100 within 15 months.

Both the Tangerine Tantel and the Radofin add-ons use a new chip from Mullard called Lucy which has been described as "almost a modem on a chip".

During this next year, Tangerine says, it will produce a development of its adaptor device which will be suitable for linking home terminal with other "private" databases, in the same way as currently being tried in Germany.

One pronounced difference between the two add-ons is their respective size. Tantel measures 9 × 6in.: Radofin's is about half as large again. Both are said to provide display quality which approaches that of a dedicated terminal. Only time and the availability of components — and of course, British Telecom approval — will tell whether quality and production will be up to those claimed.

# 'No software limitation' claim for multi-user UniFlex

A NEW operating system for microcomputers based on the Motorola 6809 chip has been released by the U.K. subsidiary of the U.S. corporation South West Technical Products. UniFlex is claimed to combine the structures and large-system features of Unix, developed by Bell Laboratories, with the flexibility of the SWTP package, Flex.

UniFlex is a multi-user, multi-tasking operating system with applications ranging from systems development to text-processing and general computing. By itself, it costs £250 but SWTP hope to sell it with their microcomputers which cost around £20,000 and which can support a 12-terminal system with 384Kbytes of memory and 17MB of disc storage.

Written in 6809 assembler language, SWTP claims that UniFlex is more efficient than Unix as it uses a lower code, increasing the speed of disc transfer by between 10 and 15 times. SWTP also claims that UniFlex has no practical limitation built into the software; any restrictions are hardware imposed. It supports a hierarchical file system allowing file sizes up to one billion bytes and disc capacities of more than eight billion bytes. More details are available from SWTP on 01-491 7507.

# Big Ears for speech input

A SPEECH-input device for most popular microcomputers has been announced by William Stuart Systems Ltd. Marketed under the name of Big Ears, the system consists of a microphone, pre-amplifier, analogue frequency filters and digital interface complete with software.

Words are stored as voice patterns which the system learns from repetition by the user.

Analysis is then by correlation over a statistical frequency plane which plots combinations or formats through the speech waveform. The units has been designed to connect directly to the UK101/Superboard family of computers or to any other via a spare user input port. The analysis programs are supplied in Basic with small real-time input routines written in 6502 or Z-80 machine code.

Big Ears is supplied fully assembled and costs £45 + VAT including post and packing, from William Stuart Systems, Dover House, Herongate, Brentwood, Essex CM13 3SD. 0277 810244.

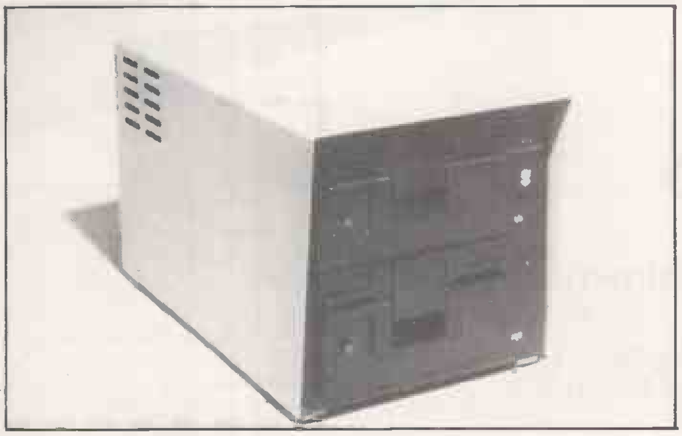
# Ohio base in England

OHIO Scientific, the third largest U.S. manufacturer of microcomputers, has established a U.K. marketing and sales centre in Langley in Buckinghamshire. Until now, the nine independent dealers had to buy their systems directly from the States. The Langley base will house a full administrative staff and facilities to support a U.K. network of 30 dealers. Fourteen dealers, including the original nine, have been contracted already. A list of dealers should be available from Ohio on Slough (0753) 77514.

# Gemini's twin floppy-disc system is for Nascoms 1 and 2

GEMINI Microcomputers, the new microcomputer manufacturer founded recently by John Marshall, who helped start Nascom, has introduced a CP/M floppy-disc system for the Nascom 1 and 2 microcomputers.

The CP/M system is supplied with one or two double-sided single-density 5¼in. drives giving a total of 160K of formatted memory per drive. The floppy disc controller can support up to three drives. Using the controller card, CP/M version 1.4 can be used. Internally, the Gemini system contains a power supply, a controller card and separate interconnects from the card to the Nascom 1 or 2 and the drives.



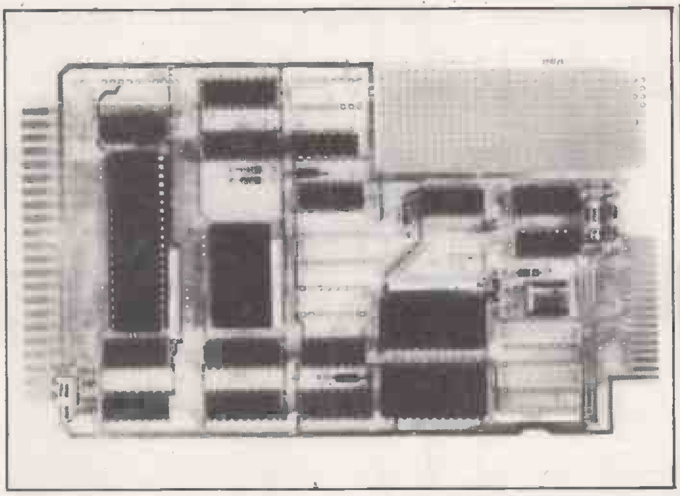
The disc system is available without CP/M to run the existing Nas-Sys software. Called the D-DOS system, it has simple read/write routines in EPROM and plugs straight into the Nascom PI/O. CP/M with a single drive will cost about £450; a spare drive will cost £205 and a single drive for the D-DOS £395. Details from Gemini on (02403) 22307.

Another product for the Nascom range, also from a company run by John Marshall, Interface Components, is in the form of a machine-code programming book for the two Nascom computers. The book, written by Graham Wilson, is aimed at the novice programmer and takes him or her through most of the Z-80 instruction set.

## System for garages

A NEW sales-analysis system for garages has just been released by the Computer Room, of Tunbridge Wells in Kent. Chargehand works from external and internal invoices to produce a full audit trail, daily and monthly reports of revenue centres, cost centres and VAT. The system also allows for multi-branch or multi-franchise operations.

The system is based on the Pet computer and will be sold for £430. Once a full system has been installed, garages could then use the microcomputer for other applications such as payroll and accounts. Details from Computer Room on (0892) 41645.



**The latest addition to the RCA Solid State range of single-board computers costs only £138 and is on a 4.5 × 7.5in. card. The device contains a C-MOS microprocessor 2MHz crystal-controlled clock, 512bytes of RAM, parallel I/O ports, power-on re-set, an interface expansion area, and a socket for 1 or 2Kbytes of user-selected ROM. More details from RCA on Sunbury-on-Thames 85511.**

## New answer to old problem

THE perennial problem of connecting new equipment to computers and word processors may be eased by a new interface unit which has been announced recently by the Birmingham-based company Micro-Zeno Ltd.

The Intelligent Interface Adaptor 1081 is a high-speed, bi-directional interface unit with an EPROM which is pre-programmed by the manufacturer according to the customer's requirements. Micro-Zeno claims that "the 1081 receives code from the terminal in question, removes parity bits, adds extra bits and restructures completely the code, if necessary, and provides the information in ASCII or EBCD".

There are three models in the range. The 1081 appears in a modular board form, including a 300 baud cuts tape interface, minus PSU, case and switch bank. The 1081/1 is a completely assembled unit, including the 300baud cuts tape interface in a self-contained PSU and case; the 1081/2 is similar but is fitted with a mini-cassette deck and associated control logic for integral high-speed data recording/recall.

Unit transfer rate on magnetic tape is 1,100-1,750 baud. The 1081 and the 1081/1 cost £195 and £345 respectively while the price of the 1081/2 depends on requirements. The software for a particular job should cost between £25 and £75. Information from Micro-Xeno on 021-356 3989.

# VIC-20 with 32Kbytes will be Commodore's answer to ZX-80

PLANS for a new computer aimed at the personal and hobby end of the market have been announced by Commodore Business Machines U.K. Ltd. Commodore hopes that the new computer, the VIC-20, will help it tap the demand discovered by the Science of Cambridge ZX-80 which has sold nearly 25,000 units since its launch in February 1980. The VIC-20 will be sold from the middle of 1981 for around £200, nearly £100 more than the ZX-80, although it will have considerably more computing power.

Kit Spencer, Commodore U.K. general manager, claimed recently that of the 30,000 Pet computers in the U.K., less than five percent have been bought for personal use.

The VIC-20, which has already been launched in Japan by a Commodore subsidiary for some trial marketing, has been built into a keyboard-sized unit and will connect to an ordinary television set or monitor. When it arrives in the U.K., its features will include full colour, sound programmable function keys and 5Kbytes of user memory with optional memory expansion to 32Kbytes.

It will run a limited Pet Basic on a full-sized keyboard and its 22 character by 23 line display will have high-resolution graphics with a graphics character set. The system will include external expansion ports; optional add-ons already being designed are joystick/paddles, lightpens, and an external plug-in memory and program cartridge.

According to Kit Spencer, Commodore hopes to attract the first-time users from the top end of the video-game market with the plug-in program cartridge and then lead them on to more serious computing with other peripherals such as tape cassette units, a single floppy-disc drive, printers and a range of accessories like application programs as plug-in ROM chips.

In common with other Commodore computers, the VIC-20 is based on the 6502 chip manufactured by the Commodore subsidiary MOS Technology. It also uses a new MOS technology semiconductor called the video interface VIC, which incorporates RAM, ROM and some video-control circuitry all on the same device. A development of the VIC-20 is expected as the VIC-40, which will generate a full 40-character display.

The VIC-20 will be sold through the existing Pet dealer network but Kit Spencer is also considering trying to sell the system to a more general public through some of the high-street electrical chains such as Currys and Dixons.

Other major developments from Commodore this year will include a new cash register based on the Pet computer.

Commodore International Ltd, the Commodore U.S. parent company, announcing its result for the fiscal year 1979/80, has shown that its sales figures for the year rose 77 percent to $125.6 million while its nett income has risen 170 percent to $16.2 million.

## Secret settlement in Apple and ITT copyright case

APPLE Computers and ITT had seemed to be set for legal action over the copyright of several products Apple was supposed to have licensed to ITT — but they have reached an agreement without disclosing its terms.

Apple had alleged that ITT infringed its copyright for the Apple Disc II system, DOS 3.1 software and "circuit diagrams and circuit lay-out diagrams relating to the Apple Disc II system".

Observers had expected a protracted legal battle when the High Court in London resumed its sittings in October last, but in the event both parties agreed to settle and to keep the terms of that settlement confidential.

In a statement read to the High Court, ITT said it was "happy to undertake that, except as provided in the agreement, it will not manufacture or sell any article infringing the copyright of Apple".

# BBC TV series aims to remove mystery from microcomputing

BBC Television is to take a giant step into microcomputing this year, with a 10-part TV series, a book by well-known computing specialists, an associated course in Basic programming which will be run the National Extension College — and a BBC microcomputer which is expected to sell for less than £200.

First news of the BBC initiative was from the Industry Secretary, Sir Keith Joseph, when he awarded prizes to the winners of the Department of Industry schools microcomputer competition. The six winning schools each received a Research Machines 380Z micro with Thorn colour VDU and Walters Dolphin line printer.

Another 111 schools received the handsome consolation prize of a 380Z without peripherals. Altogether there were 651 entries for the competition, and the remaining 534 schools will eventually receive as an "initiative prize" a microcomputer of the type planned for the BBC series.

The specification of the BBC micro is still a secret, though informed sources say that it is likely to be based on an existing machine, stripped of some of its more advanced features and "badge-engineered" for BBC Enterprises Ltd. Speculation centres around the Newbrain.

The machine will be used in the series to show programs in a standard language so eliminating worries about software portability. The BBC is said to feel that lending its authority to microcomputing will help to broaden the base of public computer literacy. Producer Paul Kriwaczek says: "We want to demystify computers and show the many opportunities that the new microelectronic technology can offer people in their homes".

The six winning schools were Collingwood County Secondary School, Camberley, Surrey; Glyn School, Ewell, Surrey; Thomas Alleyne's High School, Utoxeter, Staffordshire; Tonyrefail School, Glamorgan — individual winner Philip Rees — St Stephen's High School, Bardrainney, Port Glasgow, Renfrewshire; and Christian Brothers' School, Greenpark County Armagh, Northern Ireland.

## Longer disc life

A NEW aid for microcomputer users is claimed to triple the useful life of floppy discs by reinforcing the hub of the disc with a white mylar ring which is bonded on the disc.

Inmac, which manufacturers the Fortifier, claims that the hub greatly extends disc life and that the risk of data loss due to malfunctions in the disc head is significantly reduced. The rings cost 20p each. Details from Inmac on Runcorn (09285) 67551.

**Digitronix, of Milton Keynes, has launched a new mini-printer. It is a compact 32-column printer which it claims to be "the lowest-priced universal printer" at £195. The Mini Printer accepts conventional ASCII serial inputs at RS232, TTL and 20mA current loop levels, at seven baud rates from 110 to 4,800, and can be interfaced with most microcomputer systems. It can also accept data on a parallel port. The printing unit is electro-sensitive and prints the 64-character ASCII font on to aluminised paper rolls 50mm. wide. Other features include double-width characters and back-spacing. The unit is housed in a steel case measuring 277 by 138 by 70mm. Mains power is used but there is provision for low voltage DC input. Digitronix is on (0908) 566888.**

# Dot-matrix printer has double ingenuity

AN INGENIOUS dot-matrix printer, from Sanders in the U.S., performs ordinary printing with one pass of the head and works at dot-matrix speed or, if you wish, does typewriter quality printing with up to four passes of the head to fill in gaps between dots. Details of the Vario Printer from Carbonum Ltd, in Farnborough, Hampshire on 0252 517588.

Another letter-quality dot matrix printer is the new 737 from Centronics.

# Wide range of applications open to Apple bar-code reader

A BAR-code reader can be interfaced to the Apple computer and has been designed to read all the common bar-code formats. The Apple can be used to read special software so that the information from the bar code can be used for inventory labels or product codes.

Applications range from point-of-sale inventory control to use in libraries, for keeping a check of books which have been signed in or out. The reader could, if Applesoft programs are printed in paper-byte code, be used as an inexpensive means of reproducing and distributing software, loading

the software programs directly into the Apple.

The bar-code reader has been manufactured by Hewlett-Packard. When a bar code has been read successfully, a scan tone sounds indicating that the data has been read correctly. The bar-code reader will be available through all the Apple dealers for about £150 with some limited software.

Some U.S. computer magazines have tried to replace some of the program listings they publish with bar-coded versions. Although that eliminates many of the errors which creep into listings which have to be reprodcued and checked many times, it has proved difficult to persuade enough readers to buy bar-code readers for this purpose. Bar codes of programs have proved more popular in some microcomputing clubs and schools where libraries of useful subroutines can be kept in that form.

## Software and resources

A SMALL Liverpool-based software consultancy is trying to co-ordinate the activities of small software houses around the country to pool advertising resources and share local work.

The company, Startech, also claims that should a local member of the network not be able to meet a particular client's specifications, it will undertake the work themselves. Software houses wishing to join the service should contact Startech 051-722 4419.

# Experimental U.S. viewdata service is based on British system

A NEW viewdata system closely modelled on British Telecom Prestel has started an experimental test in the States. The system, Viewtron, is run by the Knight-Ridder newspaper chain from Miami, Florida and has been installed in a selected sample of 200 homes in the Miami suburb of Coral Gables. Pages are being put up by 29 information providers and advertisers, including the *Miami Herald*, the *New York Times*, Associated Press, Dow Jones and Co, the Consumers' Union and Macmillan Publishing.

System providers will be Associated Telegraphs and Telephones and overall director of the new enterprise is former broadcasting executive Albert Gillen. ATT will build, install and maintain terminals, modems and decoders, while Knight-Ridder will supervise the database. The experiment will cost more than $4million.

Describing the scheme, Al Gillen comments: "We want to know if people will see Viewtron as a helpful medium to diminish the minutiae of life. We do not go along with the body of thought in England that business is the key. Britain hasn't had any success in either area.

"After five years of trying, they're still at the stage we are at today: their own people looking at their own terminals".

The West German public videotex system, *Bildshirmtext*, also based on Prestel, has been expanded by linking with nine private databases, including several run by banks, mail-order houses and travel operators. Customers of the experimental system will now be able to display their own bank statements and effect credit transfers from home. Such transactions are password-protected. Networking software is supplied by Systems Designers as subcontractors to Aregon International.

Meanwhile in the U.K., GEC has launched a new bureau viewdata service aimed at private business users. Capacity of the system, which is to be known as the 4000, is 100,000 frames which can be edited from any of the terminals. A typical system of around 30,000 frames would cost about £50,000.

# Better odds for bookies

BOOKMAKERS are fighting back against punters using their micros to calculate some winning combinations on racing days. The Texas Instruments Ecstasy Settler, based on the TI-59 programmable calculator and the PC-100C print cradle and an Ecstasy Settler chip have been designed to help bookmakers calculate the odds and combinations on various bets and so stay one bet ahead of the gambling public. Interested bookmakers can telephone Texas Instruments on Bedford (0234) 67466.

# Triton 4 offers full integration in business-micro role

THE Trivector Triton 4 microcomputer is an all-British attempt at a fully-integrated business system which includes a 22MB Winchester disc, a 12MB security tape and 64K of RAM. If a separate 80-character-per-second, 132-column printer is included, the configuration will retail for a little under £9,000.

The system will run either CP/M or CAP MicroCobol and can be expanded up to 128MB of memory with up to four VDUs and two printers. More details from Trivector on Sandy (0767) 82222.


# Law has powerful armoury for combatting software piracy

CASSETTE piracy has moved into the big league of offences. In a recent case which has clear implications for the microcomputer industry, a wholesaler who refused to name his source for thousands of pirated cassettes of Beatles albums was fined £10,000 for contempt of court.

The wholesaler, Ian Wallace, was sued by EMI Records Ltd and the British Phonographic Industries in an attempt to discover who was manufacturing the pirated cassettes after BPI investigators had traced them to Wallace's wholesale outlet.

The action was settled when Wallace agreed to pay £2,500 towards the cost of the action and promised to give details of the suppliers of the pirated tapes. When Ian Wallace told the court he had bought 3,600 tapes for £10,000 cash from a man called "John", the judge disbelieved him.

He gave Wallace 28 days to pay the fine and ordered him to pay EMI's costs, estimated at around £17,500. If the fine was not paid, said the judge, he would consider sending Wallace to jail.

The case has a clear bearing on similar cases of pirated cassette software since the same provisions could be used by the court to compel a wholesaler or retail outlet of alleged-pirated software to name his source. That, along with the Anton Pillar order, *Practical Computing* January 1981, provides an extremely powerful armoury.

The Green Paper on copyright, originally promised for May, has been put back again from "before Christmas" to "early in the New Year". The document which is a draft proposal of new laws, is expected to draw widely on the 1977 Whitford Committee report on Copyright and Design. A Department of Trade spokesman told us that the reason for the delay was that the Green Paper was taking longer than usual to clear because of its "wide-ranging impact". However, few pople in the microcomputer industry have been consulted.

# Cassette cost to rise

DEARER cassettes are a near-certainty this year. The Mechanical Copyright Protection Society, MCPS, has declined to renew amateur recording licences and is actively urging a levy on blank tapes.

MCPS argues that there is widespread public infringement of the copyright laws and suggests that the record industry may lose as much as £200million in 1980 because of home taping, set against a revenue of only £15,000 from recording licences — most of which is swallowed in administrative costs.

The MCPS would be the likeliest collector of any such levy and would be charged with apportioning the revenue to its various claimants.

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# New Bill will spark vigorous debate before becoming law

FEW REACTIONS to the British Telecommunications Bill, which was published last November, have been enthusiastic. The declared intention of the Bill, which separates the telecommunications side of the former Post Office from the postal side, is "to introduce competition in telecommunications and to encourage better performance in postal services (to) pave the way for radical changes to meet the impending revolution in information technology".

Yet private industry feels that the changes have not been radical enough, while British Telecom is reportedly worried that there is too little scope for it to make stable long-term plans, since much of the power to license new products which may be attached to the British Telecom network will pass into the hands of the Minister and the Department of Industry.

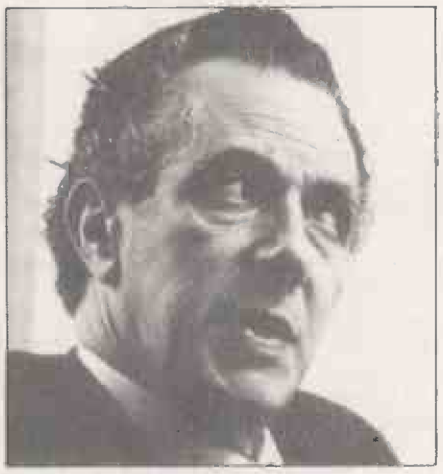
The Bill confers on private firms a "wider freedom to supply and install telecommunications equipment in competition with British Telecom which is good news for the smaller outfits who specialise for example in intelligent videotex terminals. Industry Secretary Sir Keith Joseph will have the power to license other persons to run such systems, without the need for further recourse to Parliament.

That is the area about which British Telecom is unhappy. The concentration of power within the Department means that a reverse in political strategy — if for, example, there were a change of government in 1984 — could mean that the whole £1.8 billion investment strategy could be thrown out of kilter.

## Power retained

It is not yet clear what arrangements Sir Keith will make to approve non-British Telecom systems which will be attached to the British Telecom network. The Bill provides that such approval will be granted either by the Minister, or by any "person or body appointed for the purpose" by the Minister. Such approval will be made after consultation with British Telecom, but the Minister retains the power to overrule British Telecom if it appears to him that it is "showing undue preference to, or is exercising undue discrimination against, any person".

Clearly, there is more expertise in British Telecom than elsewhere to assess what will or will not work in conjunction with the telephone network, and any independent, Ministry-approved body will have its work cut out if it proposes to argue against British Telecom. That body will be crucial to the whole operation since it will effectively referee the competition between British Telecom and private suppliers, and will be decisive in shaping the tactical development of the newly "diluted" monopoly; it could, for example, be used to regulate imported competition, as in France.



Industry Secretary Sir Keith Joseph.

Further important powers taken by the Minister include the ability to make general directives to British Telecom when he feels that the national interest is at stake. That includes matters which affect security and Britain's co-operation with other countries. It is an interesting aside since, in theory at least, it transfers some of the responsibility for securing data held in British Telecom-networked computers to the Industry Secretary.

Sir Keith would not be drawn on the subject of data protection when *Practical Computing* questioned him and inferred that the subject, on which Britain is about to commit itself by signing the European convention — see *Practical Computing* December Printout — will continue to be handled by the Home Office in consultation with the Industry Department.

In fact, a recent Home Office report, which suggests a compromise on proposed data protection laws is reportedly circulating in Whitehall. It is thought to contain exceptions for police and Home Office files from the citizen's right of inspection which most of Britain's European partners have already put into law. The Department of Industry Minister for Information Technology, Adam Butler, is thought to be applying pressure on the Home Office to change its mind about the exceptions, which may explain why Sir Keith, when asked about this point, alluded to "the subterranean workings of inter-departmental consultation".

The Industry Secretary's new powers could also conceivably be invoked on the thorny subject of telephone tapping. The new network switching System X is far less difficult for skilful operatives to tap into than the electro-mechanical one it replaces, and, as pointed out by the Post Office Engineering Union in a report last summer, there is an "institutional" relationship between police and the postal authorities which is set out in a confidential Home Office circular.

Both "official" and unofficial tapping may increase as a direct result of the loosening of the financial straitjacket and expansion of digital transmission proposed by the new bill.

Data theft is not a subject which interests many of the suppliers of equipment who had been hoping that the Post Office right to install the telephone line in the first place, and to maintain any equipment connected, would be demonopolised. That right remains firmly vested in the British Telecom, which probably represents a victory of sorts for the traditional suppliers of telecommunications equipment — GEC, Plessey, STC, Pye and BICC — which wanted some liberalisation of licensing procedures but equally were keen to ensure that there would not be a spate of cheap foreign competition.

## Punitive measures

Effectively the old Post Office monopoly on installation is transferred to British Telecom. The relevant punitive measures against infringement are also retained. Excepted are wireless transmission — covered by the Wireless Telegraphy Act 1949 — and light transmission systems, with the interesting caveat that "the things thereby conveyed are capable of being received or perceived by the eye and without more". Evidently, British Telecom is playing its cards close to the chest with respect to light transmission systems.

Yet if British Telecom is nervous about the degree of control which will be held by the Minister, there are many groups within the industry which are disappointed that British Telecom will still retain effective control of the telephone network. Opposition to the Bill is being marshalled under the umbrella of the Telecommunications Council. Prime movers are Ken Smith of IBM and Conservative MP John Gorst, who claimed that British Telecom would still be the master rather than the servant of the public.

# Ozz is powerful business tool

WE RAN Ozz on a 32K-based 8032 computer; a new 1MB 8050 disc drive; and a 3022 matrix printer. The software is capable of supporting two disc units providing each records file is set-up with the two drives attached. The Bristol Software Factory is the author of Ozz and the package will be available only through Commodore-appointed dealers. Bristol Software Factory also produces the Trade/Item/Monitor accounting packages which have been available for the 3000 series for the last year and have gained a good reputation. Ozz costs £300.

The package is supplied as an 81-page A4 manual with two floppy discs and no security ROMs or chips of any kind. Commodore has utilised a technique of

**by Mike McDonald**

corrupting the program discs which will prevent the inbuilt disc-copy and back-up routines from being used for making illicit copies.

The two discs supplied are both program discs and are clearly-marked as master and security versions. The manual recommends the security copy be placed separately in a safe place against accidental corruption of the master disc. Should a user destroy the master disc, extra security copies will be available through Commodore dealers at a nominal price.

Ozz is loaded from the diskette with the simple action of pressing the run key on the keyboard. The program, once loaded, remains native or resident and the program master disc can be returned to the safety of its jacket. On entry to the system, the user is given the opportunity of either setting-up new discs or accessing existing files and either two or four diskettes are mounted at this stage, depending on whether one or two drive units are attached.

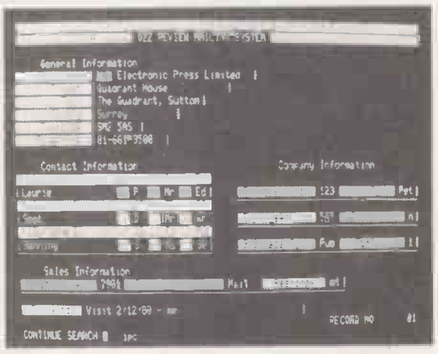
Scratch discs are newed automatically and initialised by the system or existing discs checked securely for the volume and name indicators expected by the software. Failure to mount the correct discs causes an error message and the user must repeat the operation until he loads successfully. Once complete, the user must declare the type of printer used as either an ASCII or Pet — IEEE488-type. The system is then entered and all functions of the Ozz package are available for use.

Ozz is primarily a records management system with a number of added features which include a text editor for production of standard reports and letters; a calculator with a multi-element memory for number-crunching functions on retrieved records; and a string-search facility for full record analysis and retrieval.

The user may design completely his or her screen formats according to taste. Up to 10 formats with 10 associated data files may be formed on the same pair of discs. Each screen set-up defines the record description for a file which will be associated with that format and the maximum record length is 254 bytes or characters.

Each file may hold up to 64,000 records and may not exceed 364 bytes on a two-disc system or 728Kbytes on a four-disc system. Against a total capacity of approximately 970K on a single dual drive unit, those capacities would also limit the ability to hold 10 formats and associated data files. A page of details on limits and sizing is given at the back of the manual and would-be users should read it before setting up a final system on Ozz.

Ozz uses the bottom line of the screen as a command input and message display. Ozz commands are mainly two words and




can be entered either in full or in an abbreviated form of two letters. If an abbreviation is used, Ozz expands the input into its full textual form and a return must be entered to confirm the correct interpretation of your input before it is actioned. A menu of options is not normally displayed unless requested specifically by entering help or 'H' < RETURN >. That causes the display of two pages of Ozz commands shown in figure 1.

Each row indicates the short form for a command followed by its full form and then a page-reference number in the manual for those seeking more information. The first function entered was format file or 'FF' to set the first record description. Ozz then provides the user with a blank screen on to which a format is entered.

All that is required is the entry of a field name which must not exceed 16 characters in length followed by a start-field and finish-field character. The field name or description must lie very close to the field and may be in normal or reverse format. The field length is left to the user and is defined by the number of spaces between the start- and end-field characters.

There are two types of start-field characters which define the field as either alpha-numeric or numeric only. Numeric fields may have a decimal point placed anywhere within them. The user may cursor round the screen to any position and set fields to obtain the optimum screen design for both data entry and subsequent retrieval and display. The example we set was for a mailing system and we used reversed field names to highlight the information content — figure 2.

Most of the standard QWERTY or ASCII keyboard characters may be used for separating or outlining fields and a special underscore character is provided through the ↑ key on the keyboard. On the screen format, we held details of:

- Company name
- Address
- Telephone number
- Contact surname
- Initials
- Tital and position for up to three people
- Turnover in millions
- Hardware type
- Number of employees
- Business type
- Customer flag
- Last-mailed data
- Product and application area
- Response and comments

That occupied the full 254bytes available and filled the screen. As each field is entered and completed, Ozz updates the command line at the bottom of the screen, informing the user of how many characters have been used in the design so far.

## Altering formats

A check may be made by entering ESC 'C' and Ozz warns of any fields open, if the maximum 254 characters is exceeded, and places the cursor on the offending field. The format may be altered and lines and spaces inserted or deleted at will until the desired result is achieved.

Having created the first format, we had to re-create and modify the first version to rectify missing labels. That occurs where Ozz cannot reconcile a field name with a field box on the screen. The manual recommends that two spaces are left between field names and the start of field character which follows. We found that to be sound advice.

Field names may also be placed above fields and they should also be well separated for safety's sake. Unfortunately, we could not find an easy way of discovering whether field names had been accepted at the time the formats are generated. The only way we could establish that was by committing the finished format to disc and then using either the calculator or document editor to select each field by name.

Names which could not be traced to a

field would be flagged according to which mode is being used. We found the calculator to be the quickest way to test the format but it meant converting all field types to numeric and creating a second temporary database to test the format.

Labels could then be corrected on a third format for final commitment to disc. Unfortunately, the formats created previously had been committed to disc and once there, cannot be removed or deleted and will use some of the available disc storage. Although that is a minor inconvenience, it underlines the suggestion made in the manual to experiment first with the system before moving into a production application.

With experience, we soon discovered what we could and could not do with the screen format editor. Our suggestion is to have always a spare pair of discs for experimenting with new screen formats which, once proven, can be re-keyed on to a new set of discs for running. That avoids occupying your discs with unwanted and space-consuming formats and associated files.

Once a format is completed, the user is prompted for a file name and an entry made in the file directory on the disc. The file is referred to by number in the directory which also indicates the record length and how many entries have been made on to that file.

The next step was to begin entering data into the file and manipulating it. The commands for that include:

Insert record
Amend record
Get record
Search file
Delete record
Update record

We started with the insert record option. On entering Ozz, a file format must be selected which is done through the select file option. If only one file exists in the file directory, this is chosen automatically. Otherwise the file directory is displayed and the desired file selected from the maximum of 10 which may be entered.

Once selected, the screen format is displayed and IR or input record moves the cursor into the first field ready for entry. Each field may be keyed into, edited, skipped and record-entry aborted or abbreviated at any stage of entry. Numeric fields are validated and a '—' sign is permitted. Text may be entered in upper- or lower-case and will be saved exactly as keyed.

The first alpha field entered is used as the key field on which a directory is built for very fast searching of records. It is impotant, therefore, to organise the data format to ensure that the first field is significant. Ozz will not permit entry of a record if data in the key field has been duplicated in a previous record.

Only the first 10 characters of the key field are used for the key-field directory. Once we had put a number of records in the file, the data entry routine was familiar and reasonably fast.

A minor irritation is that Ozz reverts to command mode at the end of each record input and the user must select the option IR, input record, between each entry.

We next tried the GR or get-record command. It is a fast search facility which requires a search string entered into the key-field box on the screen format. That entry may be either a full or truncated alpha entry or a record number reference indicated with a '#' prefix. Truncation is implied on entry of a substring followed by <RETURN>.

The first matching record is displayed in full on the blank format. Truncation should normally be indicated with a asterisk but we found a return worked equally well. If a record number is nominated, that record is produced on the format. Each time a record is accessed, Ozz displays the record number in the bottom right-hand corner of the screen for reference purposes. Once a record has been accessed successfully by either method, the rest of the file may be stepped through with either the NR, next record, facility or PR, prior record, option. Once selected, the next record is displayed. If the first record was accessed by record number, the nudge facility will continue to display records in record number order.

## Alpha search

If based on an alpha search of the key field, the records will be displayed in ascending or descending alpha order respectively. As each is displayed, a "Continue?" option is offered and accepted by a null entry. Null entry is used throughout the package as a confirmation of acceptance.

If SF or search file is selected, the user is prompted for a string entry at the bottom of the screen and on input, each record is searched in full for any occurrence of that string in any field. Any subsequent match in a record causes the record to be displayed in full and the matching element to be highlighted in flashing reverse field indicating where the match occurred. A "Continue" option is offered at the bottom of the screen and acceptance causes Ozz to continue the search through the file displaying each match in turn until terminated.

Records may be amended or deleted with an AR or DR option while displayed on the screen. The amend option allows the user to step through each field in the

*(continued on page 59)*


**Figure 1.**

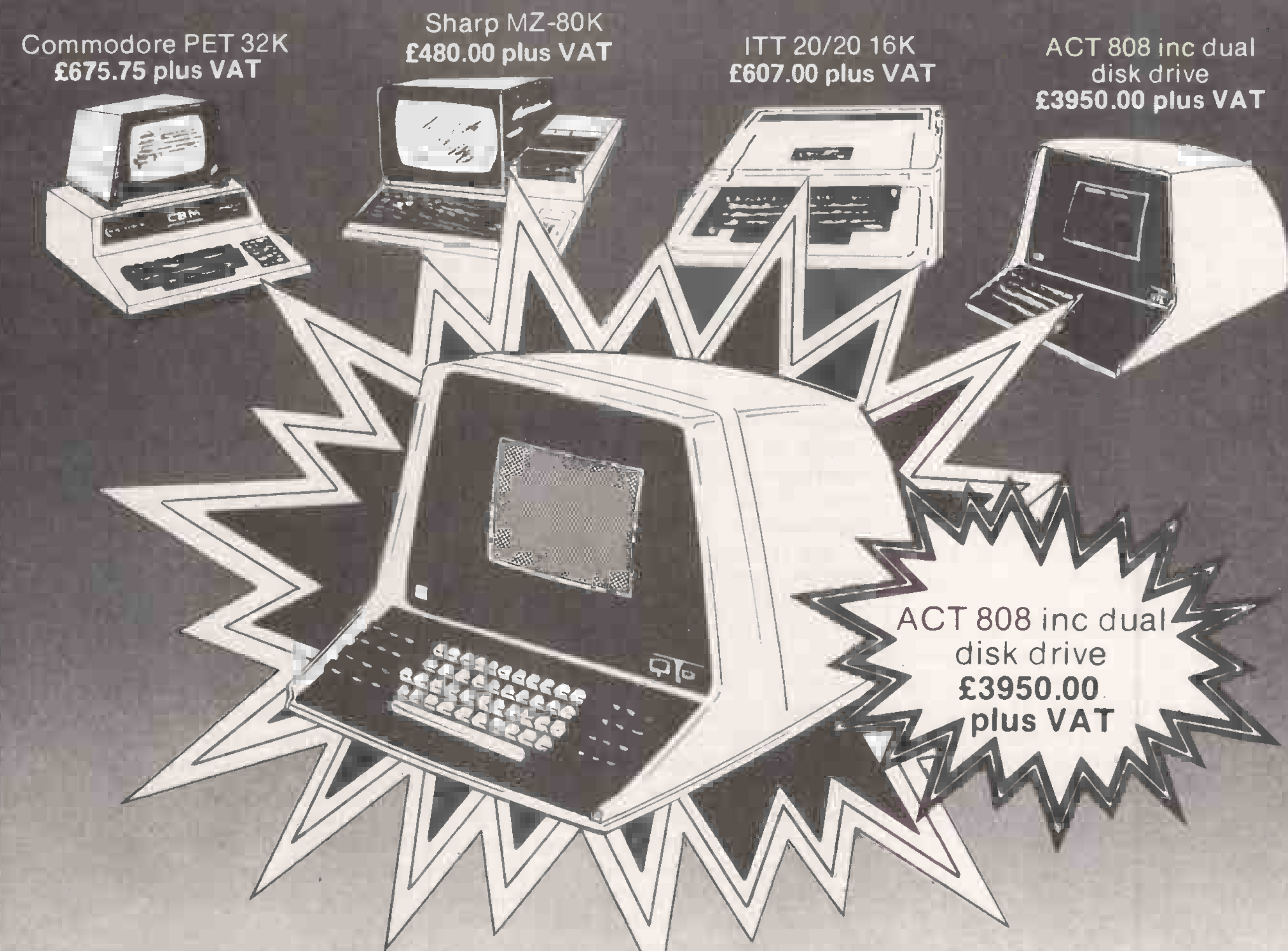
OZZ PROGRAM OPTIONS

| SHORT FORM | FUNCTION | PAGE |
|---|---|---|
| AR | AMEND RECORD | 76 |
| C | CALCULATE | 33 |
| CS | COPY SCREEN | 77 |
| DR | DELETE RECORD | 76 |
| DM | DISPLAY MEMORY | 46 |
| EA | EXECUTE AUTO | 67 |
| EO | EXIT OZZ | 79 |
| FS | FILE STATUS | 77 |
| FI | FINISH PRINTOUT | 67 |
| FF | FORMAT NEW FILE | 12 |
| FP | FORMAT PRINTOUT | 48 |
| GC | GET CALC PROGRAM | 45 |
| GP | GET PRINT FORMAT | 58 |
| GR | GET RECORD | 26 |
| H | HELP | 08 |

OZZ PROGRAM OPTIONS

| SHORT FORM | FUNCTION | PAGE |
|---|---|---|
| IR | INSERT RECORD | 23 |
| LF | LIST FILE | 61 |
| NR | NEXT RECORD | 29 |
| P | PRINTOUT | 63 |
| PR | PRIOR RECORD | 29 |
| RC | RUN CALC PROGRAM | 45 |
| SR | SEARCH FILE | 30 |
| SF | SELECT FILE | 22 |
| SA | SET ANALYSIS | 70 |
| SC | SET CALC PROGRAM | 42 |
| UR | UPDATE RECORD | 76 |
| VD | VERIFY DATABASE | 78 |
| ZM | ZERO MEMORY | 46 |

# Buying Computers?

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*(continued from page 57)*
record and add, alter or delete any of the information held. Delete record requires additional confirmation from the user before it is executed.

The calculator facility in Ozz allows the user to access numeric fields by name and perform calculations between fields, constants or temporary variables and other fields either on a direct basis via entry of formulae on the bottom line of the screen, or indirectly through a stored calculator program holding up to 16 steps of instruction.

A direct calculation is executed by selecting the C option or calculate. A format appears at the bottom of the screen. The result and variable fields are entered as field names and the standard arithmetic operations of * / — + may be input. A numeric constant may also be entered instead of a field name.

If the result is input as a field name that exists on the displayed screen format, that field is updated on the screen once the calculation is executed. If any of the field names input do appear on the screen format, the calculator either creates an entry or retrieves a value against an existing entry in the calculator memory.

## Memory area

That memory is a temporary memory area which can hold up to 16 variables not declared on the screen format. An example of its use would be, say, for carrying forward the total value of stock holding in a stock file where each record contains a quantity and value field. A calculator program may be set by selecting SC, set-up calculator, and entering each step in a calculation. Each calculator program may be stored in a calculator program file and up to 10 calculator programs may be stored on disc.

Stored programs may be altered and re-saved later. Running a calculator program has the same effect as entering a series of single calculation instructions at the bottom of the screen and will apply only to the record displayed on the record format. Although the record shown is altered according to any calculated results, that does not affect the information stored on disc.

That may be achieved only by issuing an update record command, UR, after the calculator has finished. UR does not allow the user to enter any of the displayed fields as in amend record but notes the changes made and alters the stored record.

The calculator memory will hold its variable names and their related values until cleared with a ZM, zero-memory command. That means values may be stored here and held while moving from one record format — or file — to another providing a simple linkage for numeric information between the files.

When setting the calculator memory, the user may toggle between the calculator step screen and the screen format being referred to with the use of the cursor key.

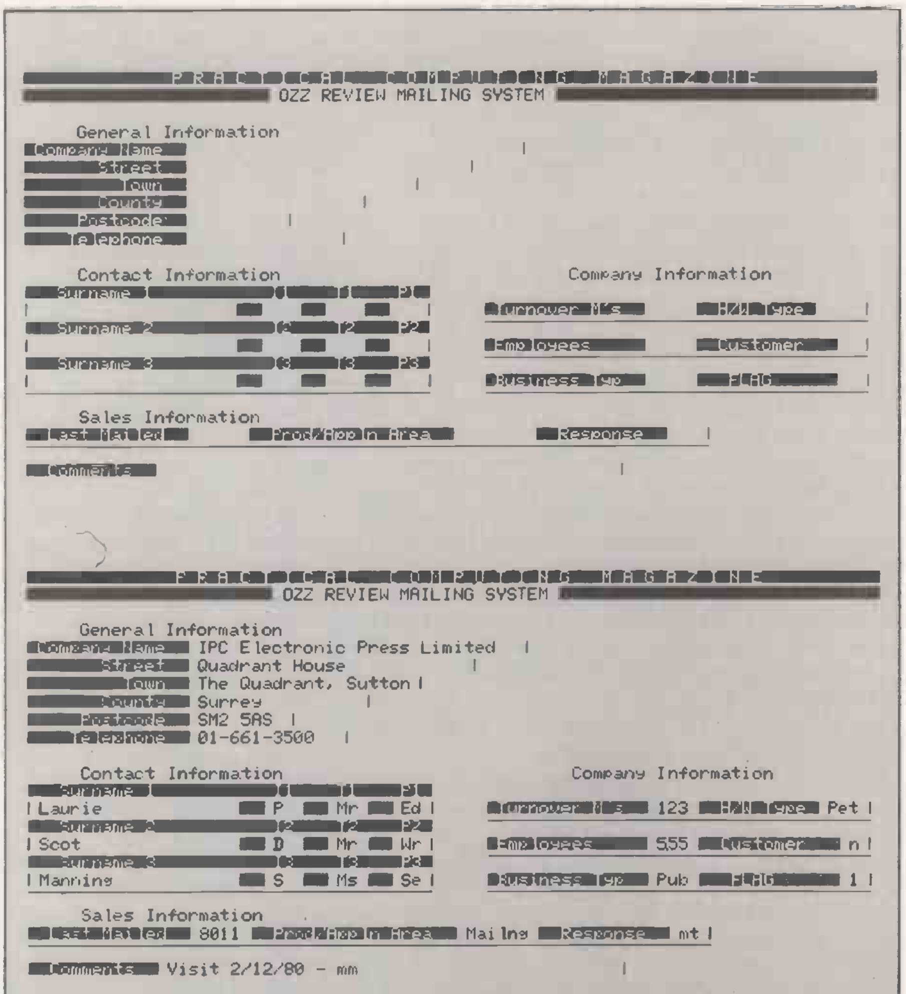

Figure 2.

The calculator memory may be examined at any point with the DM, display-memory command. Calculator programs are retrieved from disc with the GC, get-calculator command — they are accessed by name. Any calculator program loaded can be run by entering RC, run calculator. Any changes made to the displayed data appear instantaneously.

Certainly the most important facility of the system is the document feature and editor. It is a 76-line storage area into which the user may enter document formats which access and incorporate any field in the displayed format. On selecting FP, format printout, a blank screen with a display on the bottom line shows the cursor row and column position numerically.

Text may be entered anywhere on the screen and can be interspersed with the same field-start and finish characters as used in the screen format set-up stage. Once a field start character is entered the cursor returns to the bottom line and the user is prompted for the field name to be associated with that area. The field name entered may be one used either in the record format or declared in a calculator program and hence held in the calculator memory.

Each field entered on the document format is given an alpha-identification character in the first blank position. When cursored-to, it reveals the associated field name which is to be applied to that field. They are called labels. We formed a standard sales letter into which we wanted to enter details.

## Field boxes

Field boxes may be mixed freely with text and a ESC E indicates the end of the document page. A carriage return anywhere in the document tells Ozz to access the next record on file. At the bottom of our standard letter format we had a carriage return and document end placed to cause a full page to be printed for each record retrieved.

Once a document is formatted, it may be saved and stored on disc as for the calculator programs and up to 10 document formats may be saved and amended and re-saved on one set of discs. Each is given a name by the user and is accessed with the GP, get-print-format command. A directory is displayed of currently stored documents.

There are four elements to Ozz:

- Creating a record and accessing it
- Setting-up a calculator program to alter and add information on the record

*(continued on next page)*

*(continued from previous page)*

- Creating a document format against which we can list the data
- Forming an analysis mask for selection criteria;

It is now necessary to explain the modus operandi of Ozz. Effectively, Ozz requires the user to load each of the four elements listed into memory and then combine them to produce the required result, i.e., a selective listing or an update to the file records. If any of those functions are not selected from disc and loaded when executing a run, that option will not be offered for inclusion at run time.

Furthermore, each function may be executed manually, on a single-step basis or automatically, against the whole file. The reasons for that are to allow users to set Ozz to handle either transaction processing such as invoicing, order entry, or statement production or batch processing of bulk data for unattended output to the printer. That results in a very powerful business tool for a variety of applications and becomes more than just a records management system.

## Command set

The instructions available within the command set of Ozz are either of single-stroke or continuous nature. The overall execution command is LF or list file. A file must be selected and the record format on display before the command is issued. Once issued, the command line prompts the user to input the point of entry to the data records. That may be either a numeric reference to nth record, i.e., #1 or a string value, i.e., A or TK and Company Ltd.

If a numeric reference is used, the file will be listed from that point onwards in numeric order of entry on to the data file — sequentially. If an alpha search was entered, the file will be listed in alpha order from that point. Once the record is retrieved and displayed, the program tests to see if an analysis mask has been set. If so, the user is shown the record format with the analysis criteria on it and offered the question "Analise".

Next, the user is shown the calculator program in memory and offered "Calculate?". The program then takes the document format held in memory and proceeds to pass the file, extracting any record which matches the selection mask or all records if the masking is not enabled. It lists them in accordance to document definition.

The next run option is a single-step printout command P. Ozz will print the information required by the document format from the displayed record until it hits a breakpoint — <RETURN> on the document indicating a new record should be accessed. That allows a printed list to be compiled from single-line entries. Intermediate manual steps may be executed by the operator between each record retrieval such as manual or programmed calculators. Even the introduction of several calculator programs for running against the same data record is possible. That may sound baffling but it allows applications to be set-up to deal with:

Quotation compilation
Invoice generation
Payslip calculation

You can search for items from a stock file individually, calculated and posted line by line on to a pro-forma quote letter with optional manual calculations for discounts, uplifts, etc. The FI, finish printout, complements the printout command by forcing Ozz to stop waiting for further record information and to move to the text at the foot of the document format which typically containing totals and other text.

Another powerful single function is the EA, execute-auto command. It embodies three of the single-step functions and executes automatically in the order —

- Run the calculator program
- Perform a single-step printout
- Update the current data-file record

That amounts to keying RC, P, UR and is aimed at the transaction-processing requirement.

Ozz may be used, therefore, for the more traditional records-management applications or for specialist transaction-orientated processes. Since there are so many options within the command set of Ozz allowing the user total flexibility, we found the package somewhat confusing initially.

One very helpful utility provided in the Ozz instruction set is the VD or verify-database command. It may be used should the user ever encounter an abnormal end of program — such as the power dropping while in the middle of an Ozz run.

The manuals describes VD as a last line of defence against corrupted data discs. The command invokes a pass over the data files in an attempt to "re-establish the integrity" of the data files.

A distinction is made in Ozz between the amend-record function and update-record function. With amend record, the user can enter the data fields of the screen format for direct modification of the information displayed. Update record changes the data held on file to that shown on the displayed record format. That function is necessary bearing in mind that if the calculate or run-calculator function is used to modify fields in the displayed record, it is the screen-based version which is modified and any changes are not reflected back on to the disc file. It is, therefore, a manual facility for updating the data file between record retrievals.

The CS or copy-screen command does exactly that. It produces a high-speed dump of the screen contents on to the printer.

Finally, is the exit Ozz function which provides the user with a clean exit from the system. Any open data files are closed and records updated. It is an interesting point that Ozz seems to close its data files automatically after a period of inactivity of about a minute, probably as a security precaution. That should not make any difference to the user and is transparent to the operation of the program.

Ozz is written completely in machine code and ranks well in our league of good-quality, secure packages. Should either disc drives or printer become detatched from the system during use, Ozz senses it and aborts the run with a flashing "hardware failure — unable to continue" message.

It seems unfortunage that Ozz would not allow range searching on numeric fields, i.e., greater than 1,000 and less than 5,000 — and that output could be channelled only to the printer. Nor is there a sort facility apart from the key field. If a data file could be output from a search to disc, a second pass could be made to overcome the lack of range searching.

Ozz would probably be even more powerful if records could be updated automatically within the list file function. The provision of an execution file into which a series of Ozz commands could be stored and run with a single command would achieve the same result. A loop facility in such a file would allow a enormous number of tasks to be carried out on a batch run and the rest of the software world could almost give up and go home. Another improvement would be to allow the user to transfer a screen format to a new set of discs from a working set while in the experimentation stage.

Ozz is certainly the nearest offering to a true database facility giving file linkage through the calculator memory. It will be of interest not only to the business user but also to dealers and software houses. The flexibility of the system should allow systems sellers to meet most special or unusual needs.

## Conclusions

- **Ozz is an extremely flexible records management system which may be used in a traditional batch listing mode or a transaction mode.**
- **A document editor allows for the production of word-processing-quality standard letters with inserted information.**
- **The calculator facility permits sophisticated analysis of records with transfer to other file formats, i.e., control files or consolidations.**
- **The package is a very secure piece of software and we would look forward to seeing enhanced and new releases in the near future.**
- **The greatest asset of Ozz must be the ease with which screen formats may be set to users' tastes without worrying about bits and bytes and other complications.**
- **The documentation could be improved to cover the concepts of the mode of operation but the standard is much improved compared to previous Commodore manuals.**

# Apple Price List

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APPLE COMPUTER SYSTEMS APPLE COMPUTER SYSTEMS

# Easy-to-use DAI micro majors in colour and sound generation

DATA Applications International was established seven years ago and has its headquarters in Brussels. It has subsidiaries in the U.K. at Cirencester, and Munich in West Germany, with representatives in most other European countries.

DAI specialises in microcomputers and devices for the industrial, scientific and educational markets, and its systems cover applications in production control, process control, communications, automatic testing and data logging. More than 25 modules have been designed to use the standard Eurocard of 100mm. by 160mm., including a series of real-world interface cards such as analogue-to-digital cards, IEEE bus interface card and communications modules. The cards all use a standard bus called the DCEbus — digital control element.

It has recently announced a new computer for the personal market — the DAI personal computer. Housing an integral keyboard, it is a single module and features high-resolution colour graphics, stereographical sound generation, a range of interfaces including two games paddle sockets, dual cassette input, an RS232C interface and a DCEbus interface.

The machine is based on the Intel 8080A microprocessor and may be supplied with 12K, 32K or 48Kbytes of RAM. In addition to that, the machine has 24Kbytes of bank-switched ROM containing the resident software, the Basic interpreter, utility monitor and general-housekeeping modules.

## Floating-point option

The 8080 is a slow device by latest microprocessor standards but DAI has compensated for that by providing an optional floating-point processor, and a semi-compiling Basic. I could find no fault with the speed of the machine; a simple loop counting one to 100,000 took 30 seconds to execute, and 10,000 SIN functions, slightly more than 50 seconds.

The prototype computer was designed two years ago in a co-operative project with Texas Instruments as an attempt to produce a European microcomputer. When the prototype was completed, Texas Instruments decided against further involvement and DAI produced a production model alone. It has been available in Europe for some months and has apparently aroused a great deal of interest.

Three cables for power, television and for cassette recorder connection and two manuals are supplied with the system. The first manual is a 70-page introductory manual which I thought excellent although some people might consider it too condescending. It is written in a simple and chatty style and explains in a step-by-step manner how to connect the computer, switch-on, and how to write a simple program in Basic demonstrating some of the features of the system.

The other manual was a general-use guide called the personal computer handbook. I found its style and content good and comprehensive; it covers every feature of the system, but there were many typographical mistakes and omissions. Apparently, it was a preliminary copy, and DAI is producing corrected manuals.

**by David Watt**

As one of the main features of the computer is its colour graphics, it is obviously better to use it with a colour television although it will work equally well with a black-and-white set, giving shades of grey. A modern television with frequency lock is better.

I tested the system with an old reconditioned television and so found it very difficult to tune it properly. I succeeded several times and the colours were excellent.

There was a slight hum from the television when tuned to the closest frequency — also present when I tried the system with another set. I soon learned to ignore it and I believe DAI is working to remove this fault.

The computer is housed in an attractive, cream-coloured plastic case, light and yet robust. Behind the keyboard, which has a black metal surround, is a useful well — excellent for holding cassette tapes, pens or pencils. The back-plane is also black metal, matching the keyboard. The top casing may be removed by popping four plastic plugs.

Inside, everything appears neatly laid-out. The RAM and ROM chips are socketed as is the optional floating-point mathematics chip, the AMD 9511. On the left is a small Eurocard containing the components for the colour-graphics generator and PAL UHF television modulator. On the right is a robust-looking power supply enclosed in metal shielding.

It is not a machine for do-it-yourself maintenance; DAI with its background in industrial engineering applications has a reputation for reliability, and all its equipment is fully factory-tested before being supplied to the customer.

The backplane holds all the I/O ports plus the power switch and power socket. The power switch is a red plastic switch which lights when the power is on. A small green bulb on the right of the keyboard also lights and is a thoughtful touch since it is not always possible to see the power switch.

Below the power switch is the male 34-pin DCEbus connector. Besides the real-world cards, DAI is to provide a floppy-disc system and a printer which also will be interfaced through the bus. DAI has a floppy-disc system, but it is rather expensive since it was designed for the industrial market. A less expensive model is being designed for the personal computer. To the right of the DCEbus is the power socket which may be switched to either 220 or 110V AC.

On the right of that is an RS232C serial interface connector for a printer or terminal, followed by live DIN sockets. They are used for connecting two cassette recorders, two games paddles and a stereo output. The television aerial socket is on the right of the backplane.

An impressive feature of the computer is the colour-graphics module. There are 16 colours available including black and white and six basic modes of operation allow combinations of low- middle- and high-resolution, and a four- or 16-colour operation.

## High resolution

Obviously, the high-resolution, 16-colour mode offers the ability to produce the most complex displays, but it is also the slowest mode and occupies the most space in memory. DAI has adopted an ingenious method to reduce the memory requirement for screen displays to half that required normally.

As in most colour graphic systems, the screen is divided up into small areas called pixels which may each have a particular colour. If 16 colours are available, four bits are required to define the colour of a pixel, and a byte of memory is required to store two pixels.

The DAI personal computer has two modes of colour operation; four-colour mode and 16-colour mode. In four-colour mode, a set of four colour registers may be set to any of the 16 colours, so the colour of a pixel may be only one of the four colours in the register. A pixel will be represented by two bits of data. In 16-colour mode, the colour registers are not used. Instead, two bytes are used to hold the colour information for a group of eight pixels. Any two of the 16 colours may be used for any group of eight pixels.

The low byte is used to store the colours for the group, called the foreground and background colours, while each bit of the high byte is set to zero or one to indicate the foreground or background colour for a particular pixel.


The system is made more flexible by allowing the background colour of one group to be continued in the next group until a new foreground colour is selected. It is possible to have three colours in one group of eight pixels.

As mentioned, the system has three degrees of resolution after giving vertical and horizontal definitions of 65 by 72, 130 by 160, and 256 by 336 pixels. Another mode is used primarily for displaying text, but it may be used for very high-resolution graphics although that feature is not supported by the resident Basic.

In addition to the graphics modes, the computer may be put into all-character mode which displays 24 lines of text, 60 characters per line, or the graphics modes may be modified to display four lines of text at the bottom of the screen. If, when a program is running in an all-graphics mode and an error occurs, break is pressed or the end program statement is executed, the display is moved up four lines to display the appropriate message at the bottom of the screen.

The computer uses the standard ASCII character set and the quality of the character display is excellent. One character, the ASCII form-feed character, value 12, is used to clear the screen and move the cursor to the top left-hand corner of the screen. If you type more than 60 characters on a line, the system continues automatically on the next line displaying a 'C' at the start to indicate a continuation. Input can be continued for slightly more than four lines in that way before an error is produced.

The keyboard has 57 keys in the standard QWERTY pattern. On the left are four cursor-control keys, for moving the cursor left, right, up and down and the CNTL key. On the right are the TAB, BREAK, RETURN, CHAR DEL and REPEAT keys.

## Cursor control

The cursor control and the TAB keys are not recognised by the normal INPUT command, however there is a function in Basic called GETC which will obtain a single character from the keyboard and that function may be used to program the special keys. In normal text input, the CHAR DEL key moves the cursor back one character and prints a space. Unfortunately, it is possible to delete the prompt as well as any input you have typed with that key.

When typing in programs, that can have undesirable effects as Basic expects the first character on a line to be the prompt symbol. If you enter a line having erased the prompt symbol and type the line number starting in the first character position, the first character will be ignored which may cause a previous line to be overwritten. The problem is mentioned in the manual and it can be avoided by typing a space in the first position — but it can be annoying.

The CNTL key does not act in the same way as most systems, causing characters typed while the CNTK key is held down to generate a different ASCII character code. Instead, the CNTL acts as a toggle to change the mode of the alpha characters on the keyboard.

When the computer is switched-on, the alpha keys will generate upper-case letters unless shift is pressed which generates lower-case letters. If CNTL is pressed, the action of the keys is reversed which makes the keyboard more like a standard typewriter. I found it rather too easy to hit that key by mistake — awkward since Basic does not recognise lower-case letters in command and so it will generally cause a syntax error.

The re-set key is a tiny inset microswitch on the left of the keyboard which has to be pushed with the point of a pencil or some other sharp instrument — it is impossible to re-set accidentally. The keyboard is scanned by software. Debouncing and three-key roll-over are handled by the general housekeeping routines. Three-key roll-over means that the system will recognise up to three keys pressed simultaneously or in rapid succession, so key strokes are not lost even with very fast touch typists. A character may be repeated at a fixed rate by typing and

*(continued on next page)*

*(continued from previous page)*
also pressing-down the repeat key.

Although the keyboard is well laid-out, I found the keys were rather too close and had a slack feel to them. I wonder how well they will stand heavy use.

The computer has some extremely versatile sound-generation abilities. There are three programmable frequency generators and a white noise generator with programmable volume. That may be used to play sounds through the television or the stereo interface to your music system. Some very interesting effects may be obtained with them, particularly when using stereo.

## Resident software

The resident software provided with the system comprises Basic interpreter, machine-language utility, and a set of general housekeeping modules. The modules may be used by machine-code routines or the PEEK and POKE commands of the Basic. The Basic interpreter produces semi-compiled code which makes it faster and more economical in execution.

It is an extremely versatile version of Basic designed to resemble Microsoft Basic as much as possible, with additional commands to cover the colour and sound facilities of the system.

Variable names may be of any length although only the first 14 characters are significant. Integers may be in the range $2^{32}$ to $-2^{32}$ which gives numbers up to 1,000,000,000. Floating-point numbers may be in the range $10^{+18}$ to $10^{-18}$, printed to six digits of accuracy.

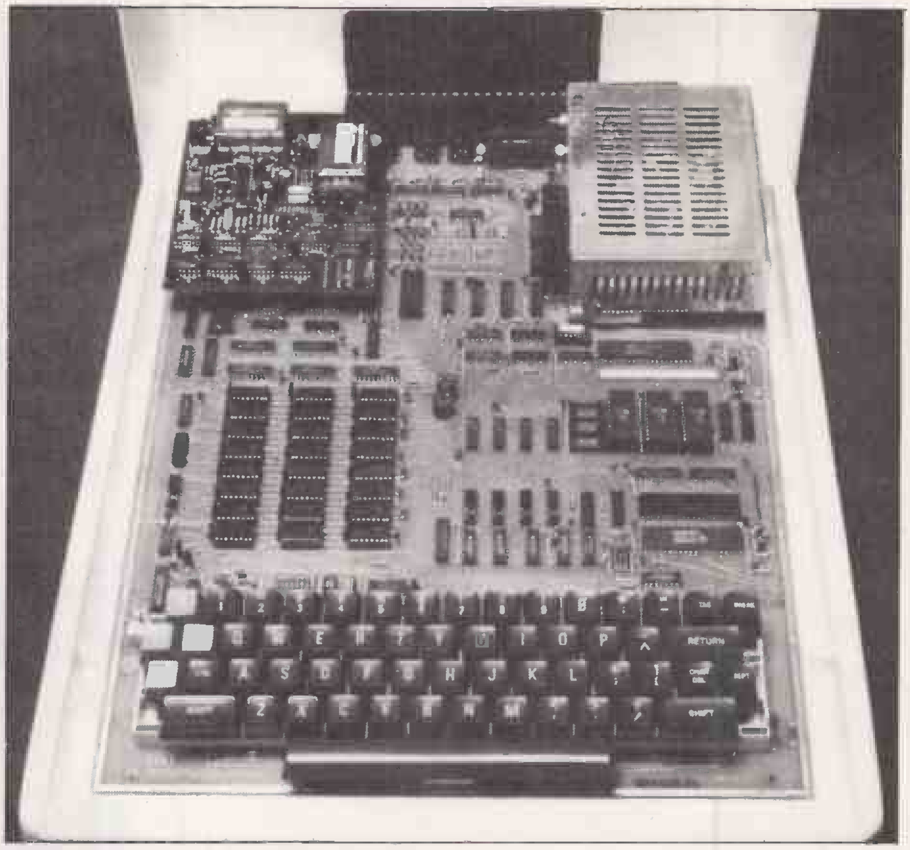
Strings may be up to 255 bytes long, arrays dimensioned to any number of levels, and dimensions having up to 256 elements. Before you use strings or arrays you must reserve sufficient space using the CLEAR statement. Finally, line numbers may be in the range one to 65536.

In keeping with the powerful colour-graphics facility, nine special commands and functions have been included in the Basic to the screen, these are:

MODE
COLORT
DOT
FILL
DRAW
SCRN
XMAX
YMAX

Mode is used to set the graphics resolution for four or 16 colours, graphics-only or mixed text and graphics. The text-only mode may also be selected. COLORT sets the four-colour register when in the four-colour mode.

DOT, DRAW and FILL are used to display dots, lines or rectangles of colour on the screen. The function SCRN returns the value of the colour displayed at a particular point on the screen. XMAX and YMAX give the maximum value for X and Y co-ordinates according to the current resolution. Thus in Modes 1 and 2, which are low-resolution, XMAX is 71 and YMAX is 64, while XMAX is 335 and YMAX is 255 in high resolution.



Those commands proved very easy to use particularly as the relationship of XMAX to YMAX is close to the three-to-four relationship in television screen sizes so that circles appear round when drawn on the screen. That contrasts with some systems where a special mapping algorithm must be used to produce correctly-proportioned shapes.

Three commands are available for programming the frequency and noise generators, ENVELOPE, SOUND and NOISE. ENVELOPE forms a series of pairs of volumes and time periods which may be used to modify the amplitude of sound being generated. The envelope may end in a constant volume or be made to repeat its sequence, until another is requested or the sound turned-off.

SOUND is the command which causes a note to be generated. A channel, envelope, volume, frequency, and whether tremolo or glissando effects are required, must be specified and a function, FREQ, is used to set the frequency.

NOISE is used to generate white noise using a specified envelope and volume. There is also a command, TALK, which may be used to generate some very interesting sound effects. DAI says it called that command, TALK, for want of a better name.

Programs and data may be saved or loaded from a cassette or floppy disc. The commands to do that in Basic are LOAD, LOADA, SAVE and SAVEA. Files may be of three types, 0 indicating a Basic program, 1 a data file array, and 2 a machine-code file.

Data may be stored only in the form of an array. INPUT and PRINT to a tape are not supported by the Basic. LOAD and SAVE are used for storing and loading Basic programs, file-type zero. A file name may be specified as part of the command.

If a file name is specified in a LOAD command, the computer searches for the required file, listing other Basic programs as it passes, and the file name is found. Otherwise, LOAD loads the first program it encounters.

LOADA and SAVEA are similar except that they operate on data array files only; LOADA does not display the names of files it passes over. CHECK may be used to display the names and file-types of files on a cassette, and also performs check-sum validation of the file names.

## File-load errors

Four types of file-load errors can be detected by the system of which error two, like check-sum error, and error three, data drop-off are the most likely to occur. They are caused generally by turning the volume on the recorder too high or too low. The CHECK command is the only way of discovering what is on a tape because the LOAD command displays only Basic file names, while LOADA and the utility monitor-read command do not display any names at all.

I would have preferred to see all those commands display the name of the file loaded as a visual check, especially if no particular file is requested, since the system will then load the first file of the correct type automatically.

The system will stop automatically and

start the tape recorder if it has a remote-control socket when loading saving or checking files.

The Basic has a useful edit command which allows text to be moved to an edit buffer for display and amendment. Any number of lines from a single line to a whole program may be edited at one time. The edit buffer displays the lines as typed-in except the carriage return character is indicated by a special symbol " ⏎ ".

The cursor control keys on the left of the keyboard may then be used to move the cursor round the lines on the screen. The screen acts as a window to the edit buffer. If you wish to edit some text now shown on the screen, moving the cursor in the required direction causes the text to be scrolled over.

The CHAR DEL key deletes the current character and moves-up all text on the line to the right. Typing a normal key inserts the character in the text before the current character. The edit command is very easy to use although it does not have facilities such as searching for a character string or changing characters. To change a character, you must insert the new character and delete the old.

David Collier at DAI explains that it is possible to write a much more powerful editor around the edit routine because all the routines are accessible using machine-code calls. One possible application of this is for a word-processing system.

The Basic has good program debugging facilities permitting a trace of program lines to be displayed on the screen while a program is running. Programs may also be stepped through, a line at a time, by using the STEP command and pressing the space bar for each step.

Hexadecimal numbers may be included in a program by prefixing the number with the '#' symbol. Numbers may be printed in Hexadecimal format by using the HEX$ function. PEEK, POKE, INP, OUT, WAIT, INPUT and PRINT are all available and are similar to the same instructions in Microsoft Basic. '?' may be typed instead of PRINT.

When you type data in response to an INPUT command, pressing RETURN does not move the cursor to the next line as on some systems. Instead, the cursor is left following the last character typed, giving more control over screen formats. It means you must execute a PRINT or CURSOR command to go to a new line.

The utility monitor may be entered from Basic by typing UT. The monitor has all the standard facilities to examine and store data or machine code in memory. Blocks of memory may be read or written to tape in the same manner as the LOAD and SAVE commands.

## Conclusions

- **A very enjoyable machine to use and considerable thought seems to have gone into every aspect of its design; it is difficult to find anything to criticise.**
- **The error-handling facilities of the system seem very good and is very difficult to do anything wrong in Basic without obtaining a suitable error message; it is possible to crash the system if you are using machine code.**
- **The system is designed for the personal and educational market and not for small business — it could probably be used as such with a suitable degree of effort.**
- **The editing facilities in Basic would form a sound basis for producing a word-processing system for this machine.**
- **The prices are £595 plus VAT for a 12K system, £725 for 32K and £795 for 48K which make it competitive with the Apple, TI-99/4 and many other colour-graphic systems: the optional hardware mathematics module is £149 and is a sound investment if you intend doing a good deal of mathematical calculation.**
- **The colour-graphics and sound-generating facilities are very good and the system is designed to interface with many types of peripheral.**
- **One area in which the system could be used very easily is home security, or as a control system for central heating and the home environment.**
- **The single area in which the Basic seemed slow was in building pictures using high resolution.**
- **To some extent, that is understandable considering the number of pixels in a high-resolution display and obviously it runs faster in machine code.**

# MuPet can provide low-cost facility with high-speed access

**Nick Hampshire reviews two Pet add-ons — MuPet and the MTU high-resolution graphics board.**

THERE are approximately 30,000 Pet computers in use in the U.K. alone, so it is hardly surprising that now a large number of independent manufacturers on both sides of the Atlantic have started to produce Pet-compatible products. The range and scope of those products on offer is great. I shall consider two of them; the MuPet multi-user Pet system and the MTU high-resolution graphics board.

MuPet is the acronym for multi-user Pet disc system. As the name implies, this piece of hardware allows a single 3040 or 8050 disc drive to be accessed by more than one computer — in fact, up to eight Pets may share a common disc drive and printer.

The MuPet consists of a control box which is connected to the IEEE port on the disc drive. The controller is interfaced to each Pet computer in the system using a daisy-chain of linking cables, each connected to a Pet IEEE port by an interface unit.

## Hardware based

The whole system is thus completely hardware-based and the individual machine user will not be aware that he is sharing a disc drive or printer with other users — except when a conflict arises for use of the same device at the same time.

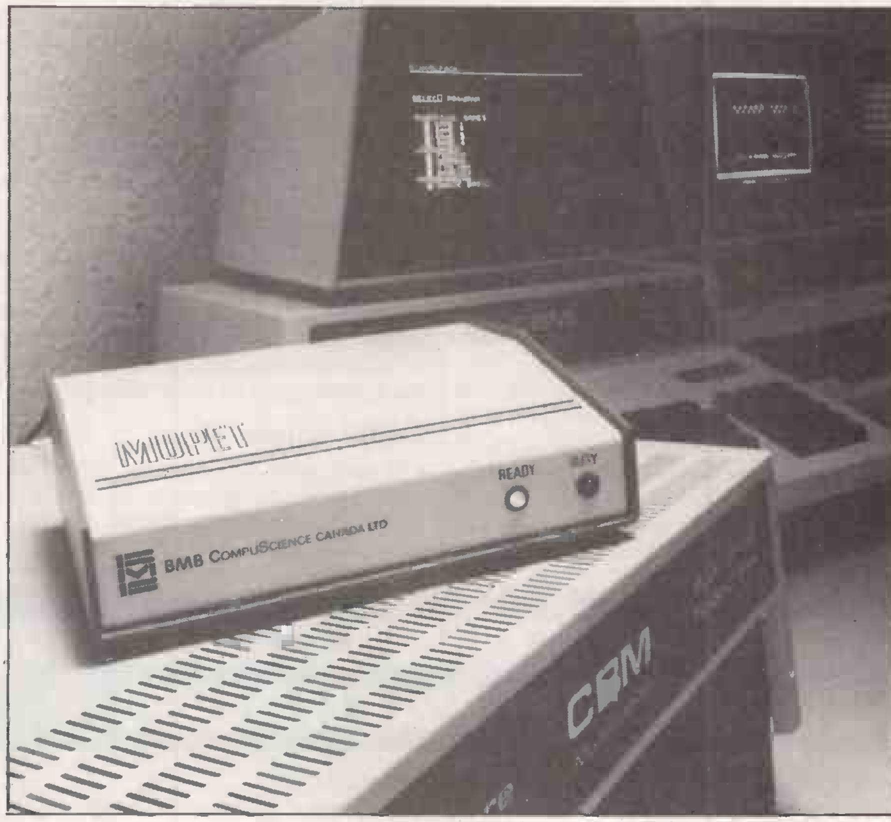
The principal application for MuPet is where multiple workstations all access a common database and/or where the cost of having a separate disc drive for each user is a major consideration. Word processing is a natural application for MuPet; several Pets each acting as a keying station would be required in an office.

Since the amount of disc access required in word processing is minimal compared to the time required to key a piece of text, there is little advantage in having a disc drive for each machine. Also by having a common disc drive, each user can access the text files entered by other users. The boss can have his own machine and access, check and correct letters and documents directly from the disc, at his own convenience.

The low cost of a MuPet will appeal particularly to the education market — an inexpensive computer facility for a class of students with the advantage of high-speed disc access for program storage and data.

The basis of the MuPet system is the controller, which contains the control electronics, a power supply and an IEEE-48 interface. The disc unit and printer are connected to the controller in the same manner as they would normally be connected to the Pet.

The controller, as its name implies, takes control of the IEEE bus from the Pet — essential if more than one computer is to be attached to the bus. A ribbon cable from the rear of the controller box is connected to a MuPet module which plugs directly on to the IEEE port of the first Pet in the system. Each subsequent Pet wishing to share the disc and printer has a similar module which is connected to the output connector on the previous module and to the IEEE port of the Pet added to the system.




The ribbon cables between each Pet in the system are supplied 6ft. long but can be obtained at the maximum length of 18 ft. All the Pets in the system are thus connected together in a daisy-chain manner, the last module in the chain has a special terminator on its output connector.

Having set-up the system, power can be applied in the normal way. If the disc drive uses DOS 1.00, it can be initialised by any one of the Pets in the system. Any of the Pets can now access the disc drive or the printer using the normal command syntax.

LEDs on the controller show the current status of the system; power on is indicated by a flashing green LED, and when any Pet in the system is accessing the IEEE bus, a continuous red LED is displayed. If more than one Pet tries to access the bus at the same time, the Pet closest to the controller is given priority, and the other Pet will be delayed until the first has finished its data transfer. The second Pet will then be connected automatically to the bus without any further operator commands.

One point should be noted: removing any of the connectors in the system when it is powered-up will usually result in the destruction of components on the controller board, making it inoperable — the system must be switched-off before disconnecting.

## Sequential files

The only special software requirements when using a MuPet-based system concern the use of sequential data files. It is common practice, when using sequential files, to leave a file open after accessing the required records, pending adding new records to the end of the file, or reading more records from the file.

That cannot be done in a system using

MuPet. If another Pet accesses the disc while the file is still open after the first record is read, but before the second is accessed, the head will be moved on the disc.

The head will thus no longer be located at the position in the file just prior to the second record. Files should, not, therefore, be left open after a sequential accessing. Either random-access or indexed-sequential files should be used in preference to sequential files.

Although a CBM or other compatible printer can be incorporated into the MuPet system in exactly the same way as in a single-user system, but access can be the source of considerable conflict. Disc access is reasonably fast and in the worst case, a computer will not require the bus for more than a few seconds to access the disc drive.

The printer, however, is very slow — the 3022 takes a minute to print a single page. If a large amount of printing is being done, other users of the system could experience very considerable delays. Those delays are particularly serious since, when the bus is being used to output to the printer, they also prevent the disc being accessed.

## Spooler system

To overcome that problem, a special spooler system is available which consists of a special module attached to the IEEE and user port of one of the Pets in the system, in place of the normal module. The special spooler module incorporates not only the normal daisy-chain ribbon cable connectors but also an IEEE connector to which the printer is attached.

The spooler module is used in conjunction with special printer spooling software which is loaded into the Pet to which the spooler module is attached. The Pet can then be dedicated to the control of the attached printer.

To do that, the spooling program looks at the disc to find data files which are flagged for output to the printer. Those data files are then accessed and output, since the bus is used only for disc access, the long delays caused by printer output no longer occur.

If you want to have more than one disc-based Pet system in a single location and wish to either reduce the system cost or use a common database with several operators, the MuPet is the obvious solution. The more users added to the system, the greater the savings in additional hardware.

On a three-user system, the cost of two disc drives and two printers can be saved. After allowing for the cost of the MuPet, that will give a reduction in total system cost of £1,735 — a very attractive prospect for cash-starved educational users.

My only complaint concerns the almost non-existent documentation provided with the device, though I understand that being rectified. Documentation for a device like MuPet is particularly important in fault-finding both for the user and for the dealer who has to provide maintenance support.

The lack of documentation is made worse because the manufacturer, in common with many other small add-on device makers, indulges in the deplorable habit of removing all device numbers from the components in its equipment. It is done under the misapprehension that it will prevent other people copying its product: it will not prevent a determined person, it just frustrates the end-user when he tries to have a fault repaired.

Without documentation, including circuit diagrams and fault-finding procedures, faulty units have to be returned to the manufacturer. The delays and inconvenience caused can destroy the reputation of what is otherwise an excellent product.

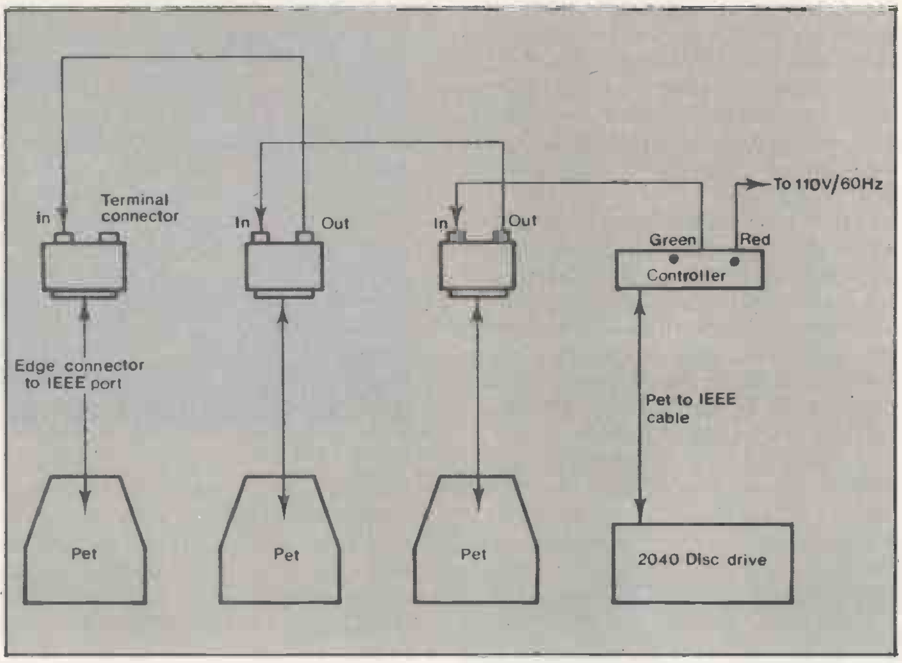



**Figure 1. Pet/MuPet three-channel connection.**

### MuPet conclusions

- **The MuPet is well made and very easy to use.**
- **I would recommend it to any user whose application justifies it.**
- **The MuPet is available from selected Pet dealers or direct from Kobra Microsystems, 14 Broadway, West Ealing, London.**
- **A standard three-user system costs £595.**
- **Additional Pets can be added at an extra cost of £125 for the extra module and cable required to connect each one to the system.**

# MTU high-resolution graphics board

ALTHOUGH the Pet can give a graphics display, it has to be created using the 64 special graphics characters in the ASCII character set. That gives an acceptable display for simple pictures. However, for the display of graphs and other more complex pictures, it is completely inadequate. That is because the maximum resolution, the smallest plottable point, is one of the quarter square characters, a resolution of 80 by 50 on a 3032.

The display on the Pet screen consists of a matrix of 320 by 200 picture elements — pixels. Normally, the video circuitry divides the display into blocks of eight-by-eight pixels, each block displaying a pattern, i.e., character, generated by a device called the character generator.

The best resolution obtainable using the existing circuitry with its character generator is a small square of four-by-four pixels — the quarter square. With the MTU visable memory board, one can address each individual pixel on the screen, which gives a resolution of 320 by 200, one of the best obtainable on a low-cost microcomputer — Apple high-resolution is 280 by 193.

The MTU graphics board consists of 8K 8Kbytes of dynamic RAM which is used to store the data for the 6,4000 pixels which constitute the screen display. The screen is organised as 200 rows of 40 bytes where each byte stores the on/off data for eight pixels. That 8Kbytes of memory is located in a 3032 from address Hexadecimal 9000 to AFFF.

Since the memory used to store the data displayed on the screen is part of processor memory space, it can be addressed using POKE commands. Also, when the graphics board is not in use, it can double as an extra 8K of expansion

*(continued on next page)*

*(continued from previous page)*

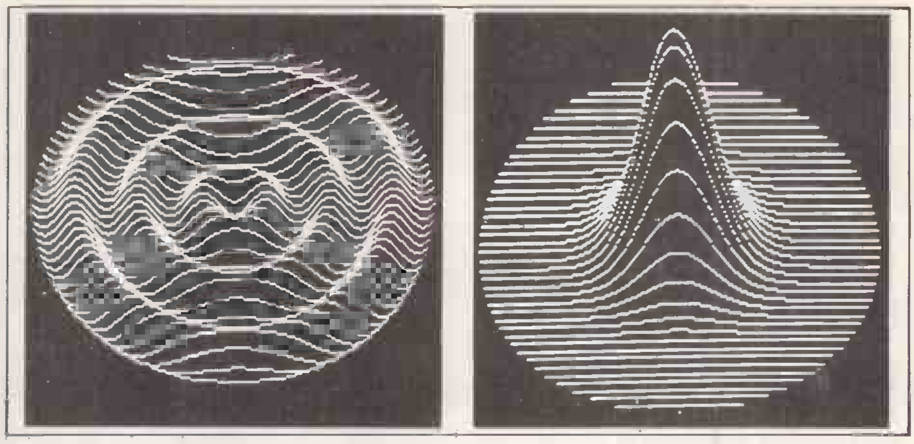
memory. Besides the memory, the circuitry on the MTU board generates the video signals required by the display circuitry in the Pet. Also provided is circuitry for adding a light pen to the Pet — an option which will be available in the near future.

The board is supplied assembled and tested and the documentation required for installation is quite adequate. Installation takes about 30 minutes and requires some soldering to connect the power leads from the graphics board to the Pet power supply and, if the board is installed in a 3032, to re-configure some of the jumpers on the main Pet logic board.

The main board is connected via a ribbon cable to a small connector board which is plugged into the memory expansion port. The main board is mounted under the top cover attached to a special mounting bracket.

```
10 GRAPHICS
20 CLEAR
60 DEFFNA(Z)=90*EXP(-Z*Z/600)
110 K=5
120 FORX=-100TO100STEP1
130 L=0
140 P=1
160 Y1=K*INT(SQR(10000-X*X)/K)
170 FORY=Y1TO-Y1STEP-K
190 Z=INT(100+FNA(SQR(X*X+Y*Y))-.707106*Y)
200 GOSUB340
220 IFZ<LGOTO300
230 L=Z
250 IFP=0THENGOSUB340:IFZ=Z1THENGOSUB340
260 SET(X+150,Z)
280 IFP=0THENZ1=Z
290 P=0
300 NEXTY
320 NEXTX
330 GOTO390
340 X$=A$
350 A$=B$
360 B$=X$
360 RETURN
390 END
```

Although one can generate graphics displays with POKE commands from Basic, it is far from being the easiest way, especially when there is a very good graphics program supplied with the board. The program, written in machine code, adds 19 extra commands to Basic, which, while easy to use, give very sophisticated control of the graphics display.



Pictures 1 and 2.

## Decaying cosine

A summary of those commands is shown in table 1, and the example in listing 1 shows how they can be used, in this case, to generate a pseudo three-dimensional graph of a decaying cosine. The resulting display is shown in picture 1.

The documentation provided with both the hardware and software is adequate though it lacks sufficient examples. The excellent series of demonstration programs compensates for that. They are supplied on the disc containing the graphics control program. There is also a tutorial program which takes the user through all the extra commands added to Basic with demonstrations of the function of each. Complete circuit diagrams are provided so fault diagnosis should be reasonably easy for any competent electronics engineer.

**Table 1. Summary of commands**

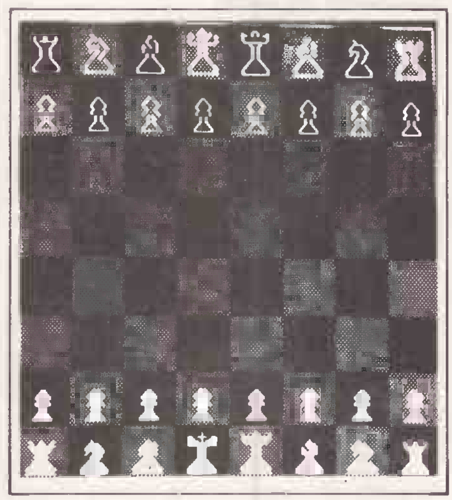
| Full name | Abbreviation | Format | Meaning |
|---|---|---|---|
| SET | SET | SET (x,y)<br>SET | Set point x,y<br>Set current point |
| RESET | RESET | RESET (x,y) or RESET | Re-set point |
| FLIP | FLIP | FLIP (x,y) or FLIP | Flip (invert) point |
| TEST | TEST | TEST (x,y) or TEST | Test point |
| SETLINE | SETL | SETL (x1,y1,x2,y2) or<br>SETL (x2,y2) | Set line to x2,y2 |
| RESETLINE | RESETL | RESETL (x1,y1,x2,y2) or<br>RESETL (x2,y2) | Re-set line to x2,y2 |
| FLIPLINE | FLIPL | FLIPL (x1,y1,x2,y2) or<br>FLIPL (x2,y2) | Flip line to x2,y2 |
| DOTLINE | DOTL | DOTL (x1,y1,x2,y2) or<br>DOTL (x2,y2) | Set dotted line to x2,y2 |
| TEXT | TEXT | TEXT (x,y,"text") or<br>TEXT (x,y,Z$) | Display text from x,y |
| DECLARE | DECL | DECL (r,x,y,w,h) | Declares an object at x,y |
| UNDECLARE | UND | UND | Clears all object data |
| MOVE | MOVE | MOVE (r,x,y) | Move object to x,y |
| CLEAR | CLEAR | CLEAR | Clear graphics screen |
| GRAPHICS | GRAPH | GRAPH | Pet screen to graphics |
| BASIC | BASIC | BASIC | Pet screen back to Basic |
| JOYSTICK | JOY | JOY (x,y) or JOY | Drawing facilities |
| INVERT | INV | INV | Flips the entire screen |
| BOTH | BOTH | BOTH (only later boards) | Pet screen mixed graph/Basic |
| BLANK | BLANK | BLANK (only later boards) | Pet screen blank |

All Petgraph commands can be used in any normal Basic context except for the following:

- Petgraph commands should not be used in Basic functions.
- If used after a 'THEN', Petgraph commands should be preceded by a colon, thus: IF ST THEN: RESET (X,Y)

## MTU conclusions

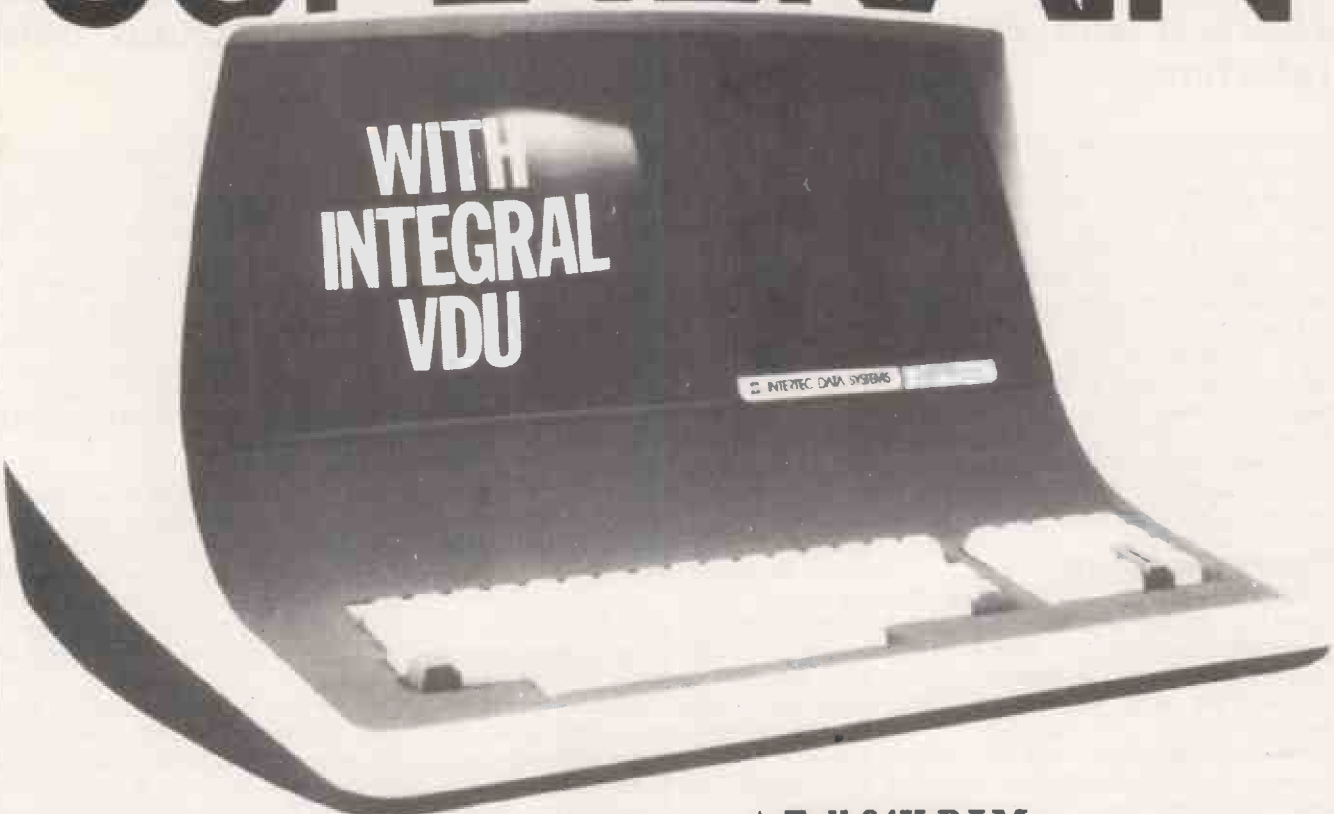
- **The MTU graphics board gives the Pet user a very good-quality graphics display and if your application needs such a display, the product should definitely be on your shopping list.**



Picture 3.

- **The quality of the hardware is good, though the design is conservative. The board, only recently available in the U.K., has been available in the U.S. for almost two years; to the British, that is an advantage since the board has been well tried.**
- **The support software provides the user with all the basic graphics-handling commands and is both well written, easy to use and robust.**
- **Further support software, e.g., three-dimensional graphics allowing rotation and display of hidden faces, would be useful but will doubtless arrive with more users of the board.**
- **The boards are available in the U.K. from IJJ Design Ltd, 37 London Road, Marlborough, and cost £320 each.**

# SUPERBRAIN

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# Satellite Communications

**The delights and problems of linking micros together are creeping up on us. Peter Laurie looks at what may be, surprisingly, the cheapest and easiest solution of all — if the politicians don't interfere.**

THE MICRO industry has now reached the point where it can clearly automate many individual office jobs which used to be done on paper. Payroll, accounts, stock control, word processing — all can work more cheaply, faster and more reliably on machine than with quill and parchment.

There is still, however, a great deal of paper in such offices. That is because data still is communicated as marks on wood pulp rather than in the raw material of computing — as data bits. Many are, therefore, beginning to experiment seriously with the hardware and software to eliminate those paper links.

## Powerful software

Six manufacturers are working on hardware for high-density communication within the office — that is over ranges of up to a 1,000 yd. between people who will be using highly-compatible systems.

When sufficiently powerful software is available, those local networks will dispense with a great deal of internal paper. In a small factory, say, an order will arrive in the post, and will be keyed into the database by the sales department. That information then appears automatically as a delivery note at the warehouse, an invoice in the accounts department, an alteration in the stock list and as a statistic in the managing director's cash-flow report.

Even now, the information that goods are wanted must arrive by post, and information that they have been despatched and what they cost has to leave by the same means. How can we rid ourselves of those last pieces of paper?

Obviously, by connecting the micros in each office together so that the computer of the firm which wants the goods sends an electronic order to the supplier and receives an electronic invoice in return. That could be done by mailing floppy discs — assuming that the formats were compatible.

No, the answer must be to link the computers together in some ways so that they can exchange data directly. Further, there is little point in linking just two firms' computers — unless they do a vast amount of business together. A system is needed which will link any two computers together.

Should that system be national or international? To decide we must look at what kinds of business the networked office will do. Most firms deal in physical goods and services which tend, by necessity, to be sold over relatively small geographical areas. Consider for instance, a wholesaler in foods whose lorries collect from ports and deliver to retailers over the north-east of England. He would need good national connections. What about an actors' agent whose clients appear in films made in Rome, Madrid, Los Angeles and London? He needs good international links.

What hardware can be contrived for linking computers together? Before we can think seriously about the possibilities, we have to look at a fundamental characteristic of information systems — bandwidth.

Bandwidth is to information flow much what resistance is to electrical flow. The band whose width is under consideration is a band or range of frequencies. The easiest place to start is with a voice. The human voice contains frequencies from 50Hz — one Hertz is one cycle a second — up to about 15,000Hz. To identify a speaker and understand what he is saying, we must be able at the least to hear sounds with frequencies between 300 and 2,700Hz.

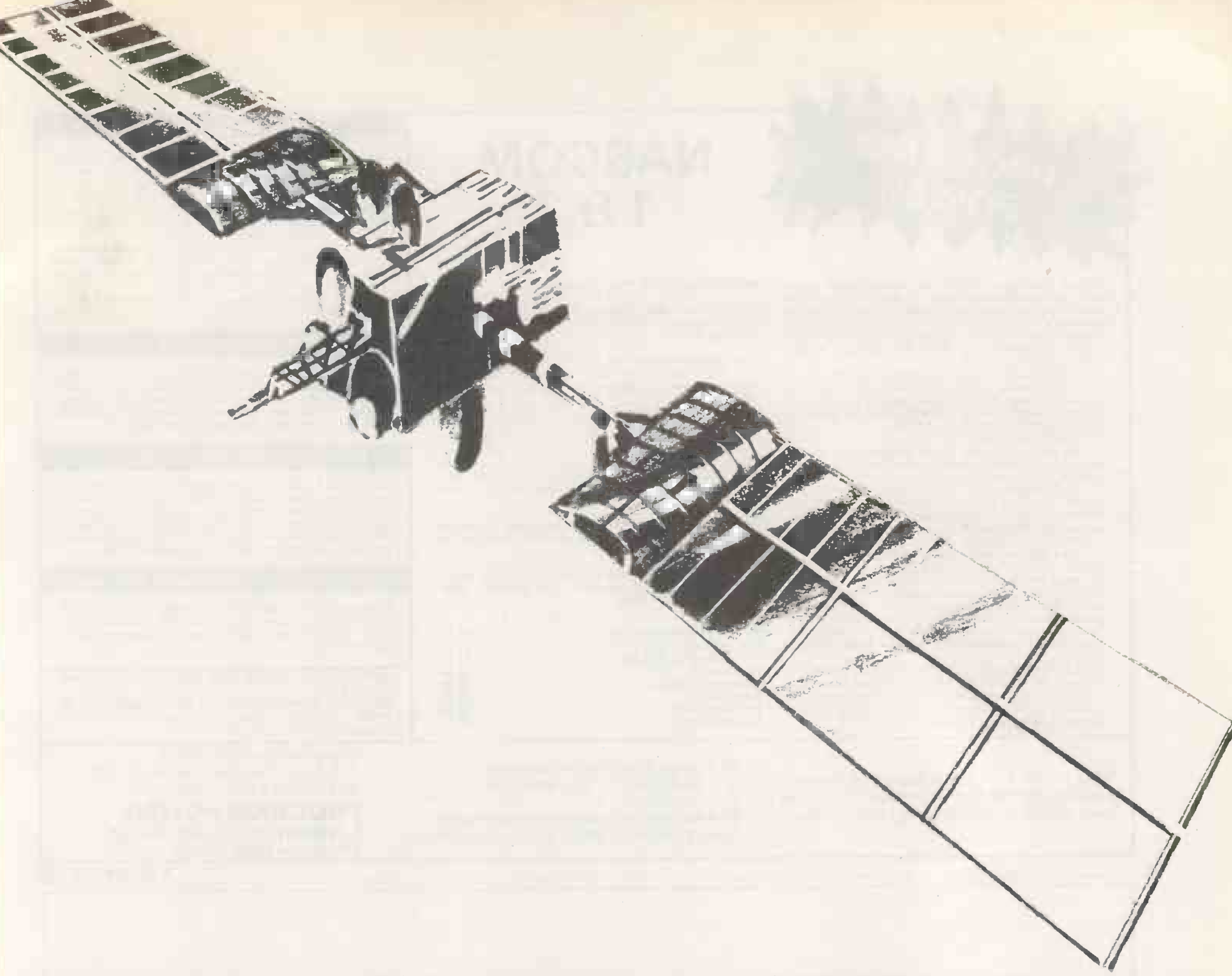
## Added detail

Frequencies higher and lower than that add detail but no essential information. The essential elements of the voice occupy, therefore, a bandwidth of 2,700-300 = 2,400Hz and that is roughly what world post and telecommunications services provide in their telephone networks.

If, however, we are listening to a singer — or, indeed, an orchestra — we must be able to hear frequencies between 50Hz and at least 8,000Hz — a bandwidth of 7,950Hz. That is the bandwidth broadcast by the BBC, and if the concert is in a hall in the provinces the Post Office must provide two telephone lines to give the necessary bandwidth — one line carries the low frequencies and the other the high. Stereo music reproduction, theoretically, gives bandwidth up to 15,000Hz — the limit of human hearing.

To complicate matters, we very seldom deal with a voice or an orchestra on its own. If the sound is to be broadcast, it must be put on to a carrier wave. So, in a medium-wave broadcast, the voice of a





singer, whose frequencies vary between 50 and 8,000Hz is imposed on a carrier at about a million Hz — 1MHz. The frequency from the transmitter's aerial ranges, therefore, between 1,000,050Hz and 1,008,000. It is also subtracted from the carrier because of the rather antique amplitude-modulated broadcasting technology we have inherited, so there is a second signal ranging from 999,950 to 992,000Hz. Altogether, then, a music programme on a carrier takes up a total bandwidth of 16,000Hz on either side of 1MHz.

Obviously no other broadcast can overlap that space in the radio spectrum. If they do, both signals will appear in the customer's receiver and he will hear garbage instead of *La Traviata* or The Police.

Although medium-wave broadcasts need 16,000Hz bandwidth, they are allowed 25,000 so there will be some space between each and its neighbour. That is so that receivers can be made at minimised costs and still give good results.

Let us consider something more complicated — a TV signal. That consists of up-and-down voltages not unlike music as the scanning spot runs across a line of the picture, recording light and dark and colour.

*(continued on page 73)*



**PROGRAM POWER**

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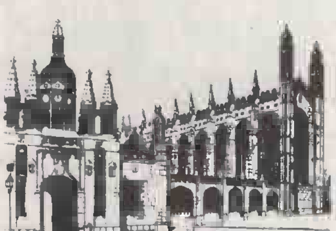

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*(continued from page 71)*

It also has some very sharp steps at the inter-line and inter-frame periods. What kind of bandwidth does a sharp voltage step need? To put it another way, what frequencies are contained in a step?

Those who read the article on Fast Fourier Transforms in the December 1980 issue will know that the only wave that has a pure, single frequency is a sine wave. All other shapes can be made from a combination of sine waves of different amplitudes and frequencies, and conversely, any shaped wave can be broken down into a number of sine waves. If it is to be properly reproduced, it must be sent down a channel which has enough bandwidth to pass all its important constituent waves.

The mathematics is complicated, but we can obtain an intuitive idea of what happens by considering pulses 500 microseconds long generated by TTL with a switching time of 5nanoseconds — figure 1. Each 5 nanosecond edge looks roughly like a quarter of a 50MHz wave — figure 2. The 500microsecond pulses look like a 1kHz wave — figure 3.

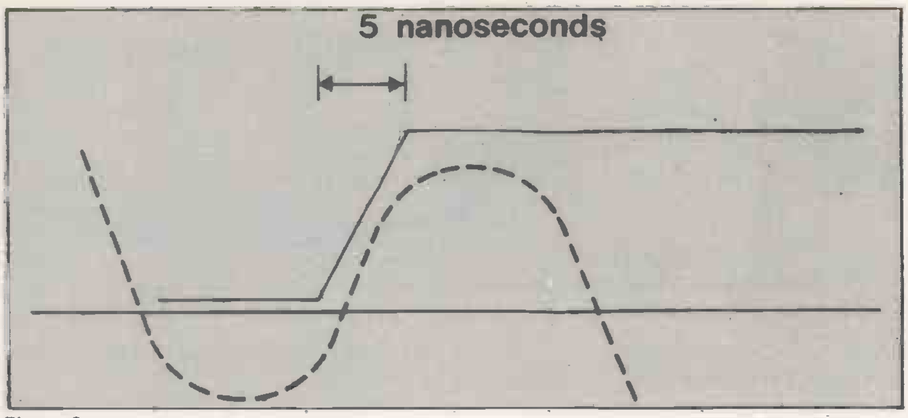



Figure 2.

## Flattened transitions

If we try to transmit the pulses down a telephone line which has a 4kHz bandwidth, all that will issue at the other end will be the 1kHz wave. The sharp, 5nanosecond transitions will become completley flattened.

If we want the pulse train exactly as it was originally generated, we must have a channel with at least 100MHz of bandwidth. Of course, the smooth wave can be put through a switching circuit which will put the transitions back — but they may well be in the wrong places. If the information content of the original pulse train lay in the precise timing of the transitions, or if the transitions occurred much more frequently than 1,000 times a second, as is very likely in passing computer data, the information content will be lost in passing through a low-bandwidth channel.

It turns out that to pass all the information contained in a colour TV signal, you need a channel with 6MHz bandwidth. That same channel will pass roughly 1,500 telephone calls — and that ratio in itself explains why video telephones never caught on. A vision link is vastly more expensive than a sound link.

What is the relationship between bandwidth and carrier frequency? Supposing TV signals were transmitted directly using frequencies between 50Hz and 6MHz. It would be impossible to design circuits to cope with a ratio of frequencies of about 100,000 between the highest and the lowest.

Instead, the vision signal is put on to a carrier, just like a medium-wave broadcast, and it became apparent that it is best if a carrier handles a signal with a bandwidth one-tenth or less than its own frequency. Therefore, a TV signal that occupies 6MHz of bandwidth needs a carrier of at least 60MHz.

Very roughly, the data rate in bits per second, i.e., pulses per second, is roughly the same as the bandwidth. So a TV channel, which has become the standard high unit of bandwidth will carry about 8Mbits or a million bytes per second. A telephone channel, with a certain amount of juggling, will pass 9.6Kbytes.

The implication of that argument is that the higher the carrier frequency we use, the bigger the bandwidth signal we can carry on it and the more information we can pass per second.

The first and most obvious solution for linking computers together, is through the telephone network. There are, after all, telephones everywhere — a hugh system of exchanges and trunk lines. The disadvantage is the narrow bandwidth and hence low data-rate that a telephone line gives.

Furthermore, data bits or pulses have to be encoded as musical tones to pass down the network and decoded back into pulses on arrival. The telephone system is full of bumps and clicks which listeners can cope with thanks to the high redundancy of speech, but which can play havoc with data.

A data rate of 9,600 bits per second is 1,200bytes or alphabetic characters per second, and it is usually necessary to use a complicated error-checking code — see Hamming Code in *Practical Computing*, December 1980.

When copper telephone cables are replaced by fibre-optics, bandwidth will be no problem. The frequency of light, thinking of it as a radio wave, is roughly $5.\ 10^{14}$Hz, and it can carry one-tenth of that as useful bandwidth, $5.\ 10^{13}$Hz. In practice, the usable bandwidth is limited by the switching speed of available logic devices to about 20MHz, or 2.5 million characters a second.

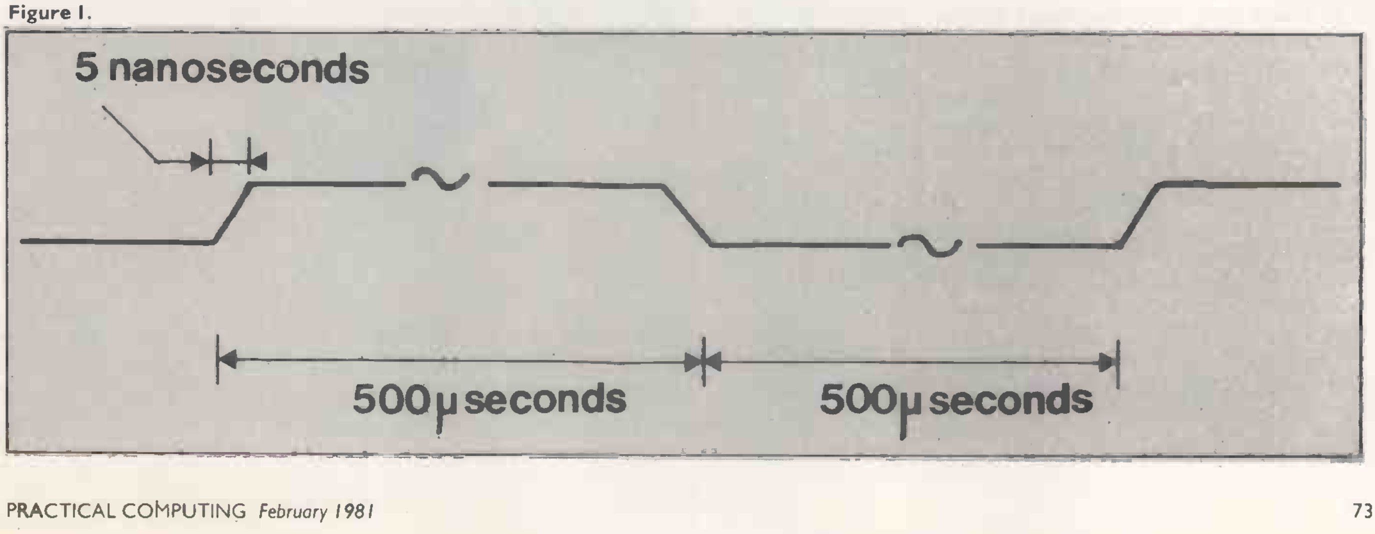
## Fibre optics

That is all very fine, but the Post Office has not made fibre optics widely available yet and probably will not for another 20 years.

The third practical alternative is to use satellites. At first sight that seems far too expensive, but technology is taking a large bite from satellite economics as it is from

*(continued on next page)*

Figure 1.



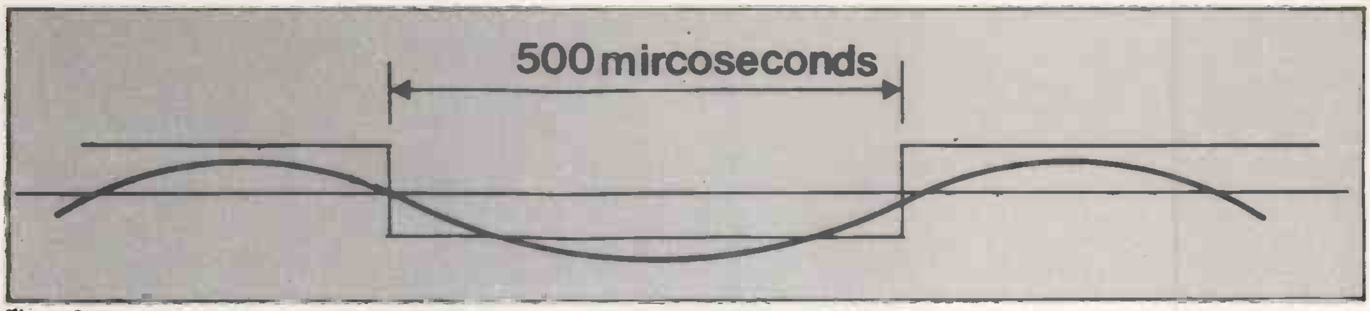


Figure 3.

(continued from previous page)
computing economics and the picture is changing.

The key to the whole problem is the increasingly-high carrier frequencies which satellites can handle. A high carrier frequency is good news for several reasons: it means smaller aerials, smaller wave-guides, smaller receivers and smaller transmitters — and consequently, cheaper systems.

## TV transmitters

The European Space Agency is considering installing TV transmitters working on the 12GHz — 12,000 million Hz — band in its L-SAT. A single satellite can transmit 40 TV channels, directing them to cover either single countries or most of a continent. Let us assume we have just one TV channel dedicated to data transmission. What could we do with it?

The receivers for television signals will use dish aerials about 1m. across which can be mounted anywhere which has a clear view to the south-west more than 20° above the horizon. A recent study for the Australian Broadcasting Corporation found that a complete dish, receiver and TV set for the Outback could be built for about £1,000 in quantity — U.S. amateurs build satellite receivers for £500.

If we equate that with the VDU for a micro, we have only to add a transmitter for send data to the satellite, and we have a system. Again, a sensible guess would be another £1,000. Therefore, a complete satellite interconnection peripheral would be about £2,000 or the price of a good printer.

## Short bursts

It would have a bandwidth of 6MHz, corresponding to a data rate of about 1MB a second, i.e., rather faster than you can read from a hard disc. It is most unlikely that people will want to transmit huge quantities of data, so we will make use of that high data rate by letting many people squirt short bursts of data. The satellite receives the burst, checks the address code to make sure it is a legitimate number and that its owner has paid his bill, and then re-transmits it on a second frequency.

The sender has finished transmitting and listens to make sure that his burst is correctly re-transmitted. If it is not, he sends it again, and continues to send it until it is correctly echoed. Then he sends the next burst.

Each receiver checks each transmitted burst for its own code number. If it is there, the receiver stores the burst — which may be garbled. If the serial number stays the same, the receiver overwrites the last message; if it increments, it adds the new burst to what it already has.

Each burst is, say 1,000 bytes long and is headed by the code of the person to whom it is addressed. 1,000 bytes at 1MB takes a millisecond so the satellite can receive a maximum of 1,000 bursts in a second. That, of course, assumes that the bursts are all sent neatly one after the other, which will not happen in practice since we assume that each installation sends a burst when it feels like it. Inevitably, some will overlap others.

To cope with that, each terminal is programmed to listen for the complete retransmission of its own signal. Until that happens, it repeats its original burst at random intervals.

## Aloha system

That method of working is known as the Aloha system and functions surprisingly well with a large number of users who use the system intensively for short periods. Overlaps and repeats reduce the maximum message handling rate from 1,000 to 200 bursts a second.

That is the number of transmitters which can work simultaneously: how big a population can one channel serve? James Martin, in his book, *The Wired Society,* estimates that the ordinary business user who is sending short messages, interrogating databases, etc., needs a service through the day at an average of 300 bits per second or 37.5 bytes per second. That means, in turn, that one channel can serve 5,333 users.

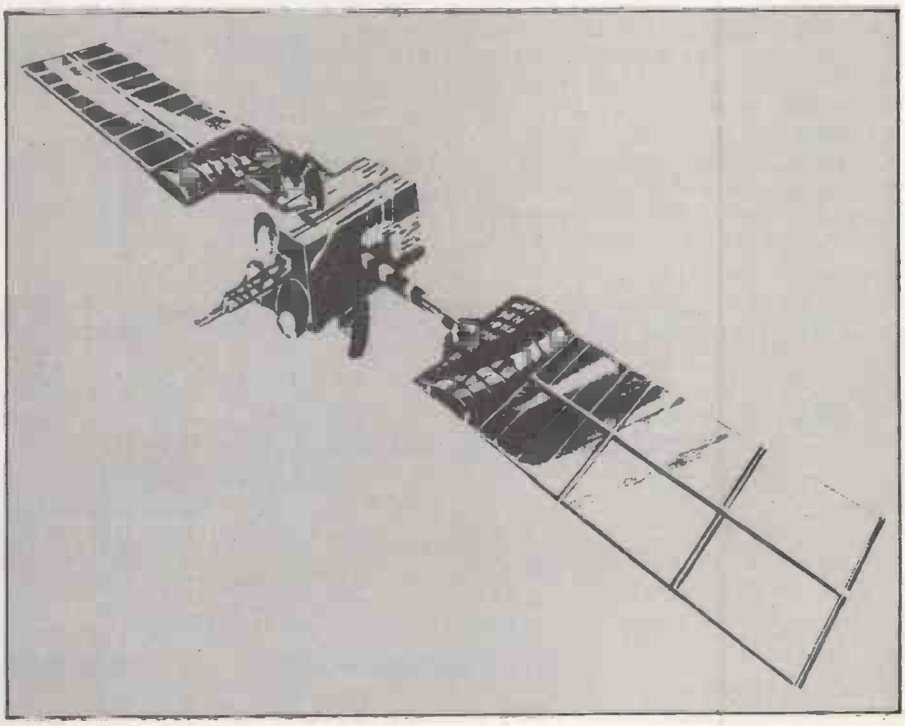
## Derisory cost

Since a satellite can operate 40 channels, a dedicated small-business satellite could handle communications for nearly 250,000.

How much would it cost? A satellite, flying, costs about £10 million and lasts five years.

Even allowing approximately 100 per cent profit for the owners of the satellite, that puts each user's share of the bird's cost at a derisory £80 — which compares rather well with an average quarterly telephone bill.

If we set about such a satellite now, it would be in business in three years'time — just when it is predicted there will be 250,000 micros in the U.K.



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# CP/Net acts as bridge in shared information network

THE PURPOSE of CP/Net, a network operating system, is to enable microcomputers to access common resources via a network. CP/Net allows microcomputers to share and transfer disc files, to share printers and consoles, and to share programs and databases. CP/Net consists of masters running MP/M and slaves running CP/M. The masters are hosts which manage the shared resources which can be accessed by the network slaves.

Because of their portability, CP/M and MP/M have gained widespread industry acceptance. That was accomplished by


Figure 1.

separating the logical operating system from the hardware environment by placing all hardware-independent code in a separate I/O module. That same design approach has been applied to CP/Net.

CP/Net is network-independent: all network-dependent code for the slave has been placed in the Slave Network I/O System, SNI/OS, module. All network-dependent code for the master has been placed in the network interface process, NetWRKIF module. Logical messages are passed to and from the SNI/OS or NetWRKIF are transmitted over an arbitrary network between masters and slaves using an appropriate protocol.

CP/Net is the first of a family of network operating system products from Digital Research. As shown in figure 1, CP/Net is a bridge between one or several microcomputers running MP/M and one or several microcomputers running CP/M. The MP/M master manages resources which are considered public to the network.

On the other hand, the CP/Net slaves executing CP/M have access to both the public resources of the master and their own local private resources which cannot be accessed from the network. That choice of architecture guarantees the security of the resources of the slave while still permitting resources of the master to be shared among the slaves.

The distinction between masters and slaves is also based on the ability of the MP/M masters to respond to the network asynchronously in real-time, while the CP/M slaves perform sequential I/O and are not capable of monitoring a network interface in real-time. The figure 1 illustrates the relationship between CP/M, MP/M and CP/Net.

by Thomas Rolander

The second network operating system product is named CP/Nos. This product is intended for applications in which the slave microcomputer has no disc resources and is, therefore, unable to run CP/M. CP/Nos consists of a bootstrap loader which can be placed into ROM or PROM, a skeletal CP/M which contains only the console and printer functions, and the logical and physical portions of the CP/Net slave.

At the user level, CP/Nos provides a virtual CP/M 2.X system to the slave microcomputer. A slave microcomputer could consist of a processor, memory, and an interface to the network. Thus, a CRT with sufficient RAM could execute CP/M programs, performing its computing

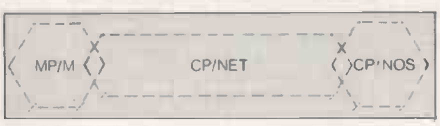



Figure 2.

locally while depending on the network to provide all disc, printer, and other I/O facilities. Figure 2 illustrates the relationship between CP/Nos, MP/M and CP/Net.

A third network operating system product, called MP/Net, provides the capability for MP/M systems to share each others resources on the network. With MP/Net there is no distinction between a master and a slave because all the nodes on an MP/Net can manage shared resources as well as to initiate network messages.

Thus, MP/Net provides a symmetrical network where all the nodes have equal capability. Figure 3 illustrates the relationship between MP/M and MP/Net.

CP/Net is designed to operate in multiple-processor environments which are tightly- or loosely-coupled processors. Tightly coupled processors may be defined as processors sharing all or a portion of common memory. Communication of inter-processor messages is at memory speed. Loosely-coupled processors are those which do not have access to memory which is common or accessible by both processors. Communication between loosely-coupled processors may be implemented with a serial data link or possibly a high-speed parallel bus.

In addition to the standard CP/M facil-


Figure 3.

ities, CP/Net provides the following capabilities:

- The network can be accessed for system I/O facilities.
- An electronic mail system is supported in which slaves and masters may send each other mail.

Figures 4 and 5 illustrate possible CP/Net configurations. Note that the inter-processor message format permits multiple CP/Net masters so that if the hardware capability exists, more than one master can be present in a network.

The slave portion of CP/Net is divided logically into two modules. The modules are the slave network I/O system, SNI/OS, and the network disc operating system, NDOS. The SNI/OS is a hardware-dependent module which defines the exact low-level interface to the NDOS which is necessary for network I/O. Although a standard SNI/OS is supplied by Digital Research, explicit instructions are provided for field reconfiguration of the SNI/OS to match nearly any hardware network environment.

The purpose of the NDOS is to intercept all CP/M BDOS function calls and to determine if the operation is to be performed locally or on the network. If the operation is local, control is transferred to the BDOS. If the operation is to be done on the network, the NDOS forms the

Figure 4.

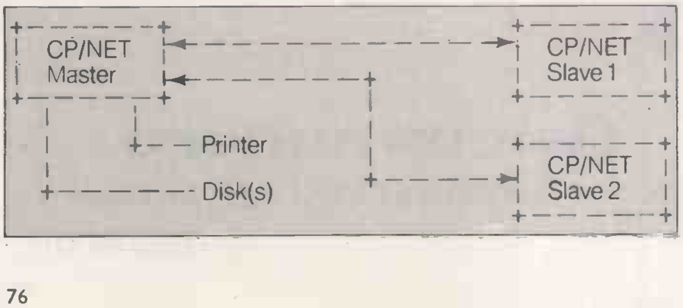
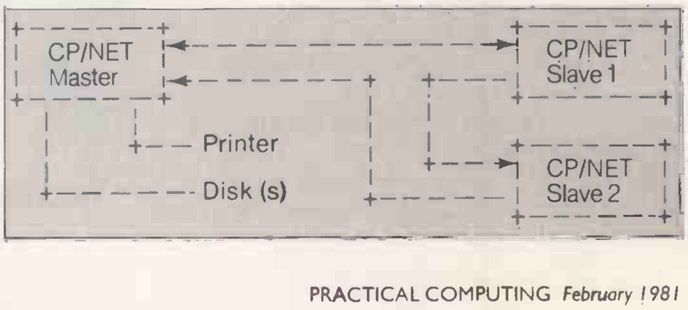



Figure 5.



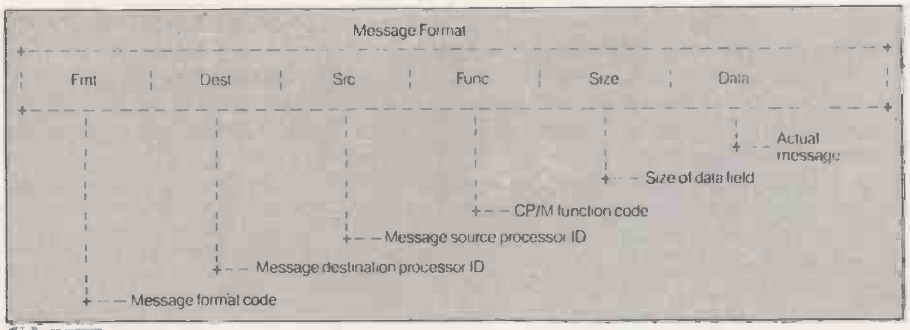



Figure 6.

appropriate logical message and sends it to the master via the SNI/OS to perform the specified function.

The simple message format used by CP/Net for processor communication includes some packaging overhead and the message itself. The packaging overhead consists of a message-format code, a CP/Net destination address, a CP/Net source address, a CP/M function code and a message size.

The message format does not contain a cyclic-redundancy code, CRC, or any other error checking as a part of the packaging overhead. The reason is because the user-written NI/OS can add the error checking when it places the message on to the network and then can test it when it receives a message from the network.

That function is intentionally left to the user, avoiding redundant error checking where standard interface protocols, both in software and hardware, may already provide error checking — figure 6.

The configuration table which resides in the CP/Net slaves' NI/OS is used to allow re-assignment of physical and logical devices. The configuration table creates a mapping of logical to physical devices which can be altered during CP/Net processing. In particular, the configuration table is used to specify the system I/O which is to be accessed through the network.

The slave configuration table is defined as: 000-000 Slave status byte

001-001 CP/Net slave processor ID

002-033 Disc devices, 16 two-byte pairs; first byte, high-order bit on equals drive on network with the master physical drive code in the least significant four bits; the second byte contains the master processor ID

034-035 Console device, first byte high-order bit on equals console I/O on network with the master console number in the least significant four bits; the second byte contains the master processor ID

036-037 List device, first byte high-order bit on equals list to network with the master list device number in the least significant four bits; the second byte contains the master processor ID

The network interface processes are part of the user-written NetWRKIF module. They perform the physical I/O for the CP/Net master. There is typically one network interface process per slave supported by the master.

Queues are used to pass messages between the interface processes and the slave support processes. The slave support processes are provided for the CP/Net master in the form of a resident system process.

Figure 7 illustrates the interaction between the slave support processes and the network interface processes which handle the direct physical I/O between the master and the slaves.

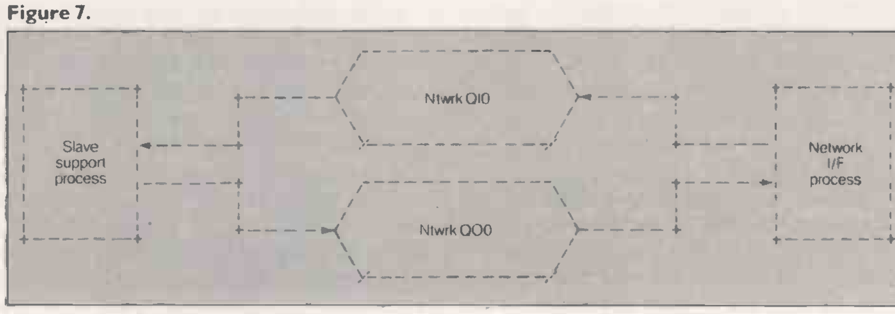
The CP/Net operating system from Digital Research brings CP/M-based networking to the microcomputer world. In conjunction with MP/M, the multi-programming monitor control program, a variety of CP/Net configurations allow valuable resources to be shared among a number of masters running MP/M and slaves running CP/M:

- Share and transfer disc files
- Share printers and consoles
- Share programs and databases

As with CP/M and MP/M from Digital Research, CP/Net is compatible with a variety of computer hardware, allowing a network to be constructed with any combination of shared memory, parallel I/O or serial links with any protocol.

Further information about CP/Net is contained in the CP/Net users' guide available from Digital Research, PO Box 579, Pacific Grove, California, 93950.

Figure 7.




# With Unix, you can compute without programming

**People are beginning to talk about the Unix operating system, developed by Bell Laboratories, as a possible rival to CP/M on 16-bit machines. Cornelia Boldyreff outlines the system.**

THE EARLIEST version of Unix, 1969-70, developed at Bell Laboratories ran on Digital PDP-7 and PDP-9 computers. It was modelled on the Multics system and the operating system resulted from a joint-development project undertaken in the mid-sixties by Bell Laboratories, MIT and General Electric — now Honeywell — which at the time it was conceived, was one of the first operating systems to be largely written in a high-level language.

The PDP-11 version of Unix became operational in 1971. Dennis Richie and Ken Thompson, joint developers of Unix, cite its most important achievement as the demonstration showing that powerful operating system for interactive use need not be expensive in either hardware or software development.

They claim the main system software was developed in less than two man years. That was not done at the expense of operating facilities as the users of Unix will testify; the system is characterised by its simplicity, elegance and ease of use.

Underlying the Unix operating system is the philosophy that programming is easier with software tools. In their most general form, they are programs which help in the development of other programs: editors, compilers, interpreters, debuggers, filers.

Some of the software tools underlying

*(continued on next page)*

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Unix have been described in a book, Software Tools, by B W Kernighan and P J Plauger. The book has become something of a bible among software engineers. It contains the source programs for many useful tools written in Ratfor — Rational Fortran. As Ratfor is available for the Z-80, those tools, which include a text formatter and editor, are within the grasp of personal computer users.

Conventional programming is well supported under Unix by the availability of several high-level languages and some low-level languages, but Unix enables users computing without programming.

Among the programming languages available on Unix are the following: Algol-60, APL, Basic, BCPL, C, Fortran, Lisp, Modula, Pascal, POP-11, Prolog, and Snobol. Implementation of languages is facilitated by the provision of a Unix program Yacc — Yet Another Compiler Compiler. The most prevasive of these languages is C. This is the language in which Unix is written and to which everything in Unix is tuned. Kernighan describes the virtues of C:

> C lets you write programs clearly and simply — it has decent control-flow facilities so your code can be read down the page, without labels or Gotos; it lets you write code which is compact without being too cryptic; it encourages modularity and good program organisation, it provides good data-structuring facilities.

C has been implemented on a wide range of computer systems, including some microprocessors. The availability of C on other systems has meant that the work of transporting the Unix system has been somewhat simplified.

## Main virtue

While C is a comfortable language for programming, one of the greatest virtues of Unix is that so much useful computing can be done without the user ever needing to write a program. That is because, using the Unix command interpreter or shell, you can string together in a single command-line calls to several of the software tools already provided by Unix. Within the command line, those calls to programs may be connected by pipes — a Unix facility whereby the output of one program may be used directly as the input of another.

The shell command lines shown illustrate the course of program development and file manipulation under Unix: This example is adapted from the Unix Programming Environment. The user wishes to prepare a multi-column list of file names on the on-line printer.

ls > filelist The ls program produces a list of file names which are directed to the file, file list.

pr -4 < filelist > temp The pr program takes its input from the file, filelist, and prints it re-formatted in multi-columns which are directed to the file, temp. In Unix terminology, the pr program acts as a filter.

lpr < temp The line printer spooler, lpr, takes as input the reformatted list in temp and spools it to the printer.

These commands may be strung together with semicolons into the single command line:

```
ls > filelist;pr -4 < filelist > temp;lpr<temp
```

The use of temporary files is unnecessary in most cases and by using the Unix pipe facility:

```
ls : pr -4 : lpr
```

a pipeline is created between the programs called in the command line. It performs the same tasks as before with the added advantage that programs connected by a pipe run concurrently. If the user wished to execute this command line repeatedly it could be stored in a file whose name would be passed to the shell for execution as required.

## Byte streams

Notice that Unix is not too exacting where input and output are concerned; it may be from a file, via a pipe, or from a terminal.

All input and output consists of streams of bytes. That uniform treatment of files, terminals, other devices, and inter-program pipelines gives the programmer a remarkable amount of flexibility when developing software. No alteration is necessary before a program developed for interactive use may be used used with input from files.

In the mid-seventies, with the advent of the Digital Equipment LSI-11 which is a micro-processor with an instruction set compatible with the PDP-11, an interest developed in producing a version of Unix to run on this low-cost hardware.

A stand-alone version of Unix, LSX, was the outcome. The LSX system was used for a number of research projects within Bell Laboratories ranging from the development of intelligent terminals to the controlling of dedicated hardware for speech synthesis. Unfortunately, LSX is not commercially available.

## Modified system

A version of Unix known as Mini-Unix is released by Bell for PDP-11s without memory management and the system has been modified to run on LSI-11 systems by various universities. Unix and Mini-Unix are available only under licence. For educational and academic use by non-profit-making educational institutions, a licence is supplied without fee from Bell Laboratories.

Commercial or administrative users may obtain the software for a fee from Western Electric Company. It recently lowered the price for a commercial licence and as a result, many systems companies have begun to offer customised Unix systems. Other companies have gone their own way producing look-alike Unix systems.

Whitesmiths, of New York were the first to market a look-alike Unix for the LSI-11 which users could run without obtaining a licence from Bell. Its Idris system was described in the spring 1980 issue of the Whitesmith Software Catalogue:

> The LSI-11 Idris operating system is a multi-process resident operating system for the LSI-11 microcomputer. It supports file systems compatible with the Unix/V6 operating system — Bell Laboratories 1975 — and accepts Unix system calls except ptrace.
> The System includes an assembler, loader, text editor, command interpreter shell, librarian, and sufficient additional utilities to permit the development and maintenance of new programs that operate under the system.
> On an LSI-11 with 60Kbytes of memory and sufficient secondary storage, the system enables the PDP-11 compiler from Whitesmiths to replicate itself and the operating system, which is predominantly written in C.

Yourdon Software Products Group, also of New York, was offering a Unix-like operating system for Z-80 microcomputer systems in 1980. Unfortunately, the product, Omnix, was withdrawn. Cromemco is offering a version of Unix specifically for its Z-80 systems — Cromex. It is available through Cromemco dealers.

## Recent version

Already a version of Unix is offered for the Motorola 6809 and 68000 known as UniFlex; it is marketed in the U.K. by Research Resources. After Western Electric lowered its prices for Unix, two groups rushed to put Unix on micro systems: the Zilog spin-off, Onyx, for Z-8000, and Thinker Toys of Berkeley for the 8080. The Onyx literature claims that the Onyx operating system is an adaptation of Unix, Version 7 — the most recent version which includes the portable C compiler and has itself been tailored to be portable.

Almost every week there seems to be news of further implementations. Microsoft is working on a version for 16-bit micros to be known as Xenix — heralded as the standard operating system of the 1980s.

The Chicago company, Mark Williams, has recently completed its own implementation of Unix using Version 7 as a starting point; the system, Coherent, works on machines based on the Intel 8086, Zilog Z-8000 and Motorola 68000. Most recently, there was a report that Amdahl will be offering the first version of Unix to run on a large mainframe.

As an increasing amount of people have had a chance to try the Unix system, its popularity has grown. As its developer has had the hindsight to foresee the desirability of portability, it is becoming available widely. A promising sign is that already there is an interest in marrying the UOSD system with Unix, a union which would allow both systems to develop in a complementary fashion. Imagining the progeny of such a union is left as an exercise for the reader.

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# TV playwright who upstages drudgery with word processor

**Martin Hayman talks to playwright Bill Hawkins and is introduced to his labour-saving word-processing system, Playshape.**

BRILLIANT ideas in microcomputing may often be the simplest, and they may not even be conceived by people who understand the micro. Before anyone protests, I do not advocate computer illiteracy. Knowing how to use the micro will doubtless be the indispensable skill of the literate in future decades, but it is as well to keep things in proportion.

I need no information on the construction of a spade to dig a trench, though I might need to know about forging and sintering if I were to re-design the shovel to create a new concept in trenching.

A new concept of trenching is, of course, unlikely, but new concepts in writing are a frequent occurrence. Such is claimed for the plain old word processor but despite being canvassed regularly for so-called creative writing, it tends to remain the preserve of the deadly-sounding "office of the future". Add to your word processor some new and, above all, specific routines to achieve a particular job and you have a new concept.

The essence of such strokes, which really fall under the heading of development rather than innovation, is that they are conceived to achieve a particular end. Take play-writing. Jim Hawkins, a professional writer, has been for years. He finds it expensive to have his final draft re-typed in exactly the format acceptable to radio and TV producers, and laborious to instruct even a skilful typist.

## Producer's requirements

The criteria are these: a shooting script must always have the speech attached to the character heading. This may include lyrics and one-liners. For example:

*Ghost* (beneath). Swear.

or

*Ophelia* (sings).
By Gis and by Saint Charity,
Alack and fie for shame!
. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
Quoth she, "Before you tumbled me,
You promised me to wed".

Each stanza of a lyric must be intact on the page; each one-liner must have its own place. Even when the final draft is made, the nature of TV plays is such that a great many changes may have to made to take into account producer's requirements, actors' casting and a whole host of other variables, all of which may complicate the format of a finished draft, requiring extensive re-formatting. That is where the Apple enters.

**Bill Hawkins, the TV playwright.**

The standard Pascal text-editing package created by the University College of San Diego is well thought of, but it was not exactly what Jim Hawkins needed for his purpose. What he wanted was something which would always default to his own specific instructions on play formatting: he tackled that himself.

Now Jim Hawkins is by no means a computer buff. He admits to an intelligent interest in computers from an early age, derived more from 1950s science fiction scenarios of cybernetic empires than from the contemporary keyboard/VDU machine. It was in 1955 that he read Norbert Viner on artificial intelligence.

His interest was fuelled by the speculative fiction of science fiction magazines and contemporary documents of the so-called communications explosion of the mid-sixties such as *New Worlds* magazine, and in time he wrote a screenplay in which the computer featured as a major character. Yet is was not until last year that he took the plunge and bought one — an Apple.

This screenplay, written in the first place for a BBC schools program, was collectively entitled, the Scientists, and illustrates some of the more theoretical considerations which led Jim Hawkins to the computer as a tool. The brief for the three 25-minute slots was that they should be a study of genetic engineering suitable for sixth-form study. Hawkins opted to turn it into a "sci-fi thriller" based on a debate between several of the leading figures in the debate about evolution: Galileo, Pope Urban VIII, Darwin, Huxley, Bishop Wilberforce. The setting was an orbiting space laboratory where genetic experiments were being carried-out in maximum isolation.

Into that setting enters a Greenpeace-type biologist who questions the experimental staff on the ethical need for the kind of experiments they are conducting. The computer, programmed like Kubrick's Hal to safeguard its own existence and versed in a kind of programmed ethics, misinterprets the conversations it overhears about risks and, as it were, bolts the door.

## Technological skill

It then summons from its memory holographic representations of the historical characters mentioned. Acting as referee, it compels the scientists to see through their debate to the end rather than leave it as an inconclusive conversation piece.

The important nexus between the computer and real life was, if you like, the interfacing of the security program with the ethics program. In that Jim Hawkins' concerns were similar to some of Arthur Koestler's, whose rather gloomy proposition is that mankind's technological skill has advanced by an uncountable factor while his moral skill is effectively little more advanced than when stone-age man used to clobber his enemy with a cudgel instead of an Armalite rifle or neutron bomb.

The computer held an ideal gene map, and the propositions which led to the drawing of that map of an idealised human being. Yet what, it wanted to know, was to be regarded as an acceptable deviation or deformity? That was the moral question to which the security section of the computer urgently needed an answer, holding that moral questions were equally amenable to solution given sufficient data on which to work.

That threw into the ring the hoary old chestnut of whether technology enriches human life, or whether it is simply developed as an end in itself. Or, to cut a long story short, why can science tell us everything, but not why an old song makes us laugh or cry?

The Scientists was re-broadcast on BBC2 to good reviews and Hawkins is pleased that he had been able to give vent to "an increasingly-important aspect of our lives which should be reflected". He is sceptical about the idea that we give a little of ourselves away to the machine when programming an expert system. Some authorities think such systems may be able to synthesise human knowledge derived from several brains so effectively that its thoughts become opaque to its users, who must then require it to explain its reasoning: "The computer is a slavish waste of time unless we dump on it. If we give it sufficient data it can help us to recognise patterns in modern-day life input".

### User group

It was not of course for those reasons that Jim bought his Apple. As well as just being interested, he needed it for his TV scripts and, like so many others, to handle his accounts and VAT.

"One of the good things about the micro is that you are in constant contact with what a computer can and cannot do. I would like to write a play about a user group. I think it would be very funny — but there is not one in my area. Computer games themselves are boring — but for the type who attends a user group, the computer itself becomes the game, what you can make it do".

If there are two categories of micro users, as Hawkins claims, he falls into the second of the two definitions. The first is the type who plays with the computer itself, and the second, those who need a quantity of spade-work done. That is how Playshape was born — as an extension of the UCSD Pascal text editor.

In play-writing, there is a good deal of typing of names. That was the first consideration. So the Ghost of Hamlet's father in the early example becomes /gh (return); Ophelia /op (return). Playshape seeks the mnemonic in its memory, writes the name in full and returns the cursor to the start of the next line. "That speeds things enormously and is economical with memory — which means you can get more of the play on to one diskette".

It also speeds the mental process of composition, which is a more important consideration, by ensuring that the author's concentration stays on what he is writing rather than worrying whether the words the Ghost or Ophelia might be about to say are going to spill over on to the next page.

Another ultra-useful command is scene-skip, which increments the scene and act, number which head a new page, //s. There is //, mnemonic, which searches for the character in question and prompts the user to put it on to the file at the end of the run if it is a new one. That might not seem very useful when considering Hamlet, but if you are working on a serial with 120 characters, as Hawkins is, it is worth its weight in gold.

A further asset to the writer is the character-invention facility. A standing joke among creative writers is the constant need to have at hand a set of telephone directories to invent plausible names. Jim Hawkins has mechanised that process by creating a whole sub-set of telephone directing names, which can be called randomly when needed.

Needless to say, it also checks whether you have used the name before since even the best human memory will tend to favour one name above another — the computer has no such partiality. It will then discover any cross-reference to an existing name. Say, we want to use a character called Bill Morris as a shop steward; he turns up under Bill, under Morris, under shop stewards and under convenors.

That names program has a further and potentially $1,000,000 spinning extension. It permits the producer to predict which character is in which set, and which set features which character. Hence, it is possible to draw a critical path analysis of production shooting. For example, it will tell you who is in the works canteen, which must be a help to those entrusted with the logistics of film-making.

### Serious storage

Hawkins says that a 55-minute play occupies about 60K of memory, so anyone who wants to re-write Hamlet had better be equipped with some serious storage. "The object of the exercise is to eliminate work", says Hawkins, "so I set the default system so the program normally runs in its most efficient mode. It's too much like work if you have to type 600 commands at the outset.

"I don't suppose it's very sophisticated but it's efficient for a certain job. Too much energy is expended trying to make micros do things they probably will never be able to do. If it won't do what you want it to do, you might as well just accept it.

"Doubtless with a mainframe you might be able to write thriller plots, but the micro has something of the Sorcerer's apprentice myth about it: all that can be read, written and done is there. That's why people find it so exciting, and hence the fascination with games of trolls and demons and so on. They think of it as a philosopher's stone: you rapidly forget what it's doing for you, and want it to do some more.

"Micros may be science, but anybody with imagination can use them. I would like to see more people in the arts using them, and not being frightened away by floating-point numbers".

# Mason restores buildings while office micro restores sanity

by Cathy Lane

THE TEMPLE Stone Restoration Company started almost by accident — which is also more or less how it acquired its own microcomputer. About 14 years ago, when selective employment tax legislation was first introduced, George Baulch and his brother started to work on a freelance basis mainly on subcontracts from their previous employers. As the jobs increased, they took on more staff and the company developed from there.

Today, the brothers are based in south-east London's Blackheath Vale, a quiet little road a mere stone's throw from the tasteful middle-class charm of Blackheath Village and a fitting setting for a company which specialises in restoring beauty in urban areas.

Most of Temple Stone's work involves cleaning facades and repairing the fabric of buildings, ranging from churches, public and industrial properties to a few private houses. Much of it is on a long-term basis. A church, for example, might start a fund-raising project on the basis of an estimate from Temple Stone. The first stage of restoration might not, however, begin for a year or so, and the entire job could take four or five years to complete.

*(continued on next page)*

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In recent years, Temple Stone has been restoring the tomb of Sir Richard Burton, intrepid explorer and discoverer of the source of the Nile, and has worked on St Annes Church in Tottenham, north London and the John Lewis department store in London's Oxford Street. In a good year, the company will turn over about £200,000 — but because of the cuts in public-sector spending and the instability of the building trade generally, George Baulch expects only around £130,000 this year.

That turnover is not at all bad for a company which has only three office staff — George Baulch, his daughter Pam and her husband Paul. There are also 11 full-time stone restorers as well as six self-employed men who work mainly for Temple Stone.

The company bought a Exidy Sorcerer in December 1979 — the result of a series of coincidences. Baulch had never seen a computer in his life before he bought the microcomputer: "I was always interested in electrics and electronics, though I never knew the first thing about them. I've always liked the idea of new technology, and watched plenty of programmes on TV about it. Then one day, quite out of the blue, a card arrived at the office, saying that I could have a computer for about £2,000. I had always thought they started somewhere around £10,000. So I telephoned the company immediately". The card was from EMG of Croydon, a local Sorcerer dealer. A representative from EMG arrived to demonstrate the system a few days later and Baulch was impressed.

## Impressive demonstration

Yet he was still wary: "What the man from EMG was doing was magic — things I hadn't thought possible. I half-suspected that it might have been some sort of gimmick". Baulch had been led by TV science fiction into thinking that computers fill whole rooms "with whirling wheels shooting backwards and forwards all the time. In fact, I was sceptical that this little machine really was a computer", he says.

On the other hand, the demonstration was undeniably impressive and so raised some doubts: "I was afraid that to buy it would be to buy a white elephant; it seemed far too sophisticated for us".

Baulch was being impressed particularly by the word-processing package on the Sorcerer. Like many smaller companies, Temple Stone had always had general problems with typing — first trying to decide whether the workload justified the presence of a sophisticated typewriter and skilled typist, and then finding and keeping the staff to do the job.

Temple Stone had specific requirements where word processing looked a real boon; many of the quotations given for restoration work run to 10 or 12 pages.

"It was always a real headache for us to supply a quotation. The first draft would have a few mistakes in it so I would rectify them and send it back to be re-typed. It would then return with those mistakes corrected but with many new ones. In the end, as the deadline approached we would just post it and hope for the best. I was always conscious that, in effect, the estimate is our presentation to the customer. If we could not even produce reasonable typing, what kind of mess would they think we were going to make of their masonry"? says Baulch.

The practical benefits the computer promised outweighed all other considerations, including Baulch's scepticism. Temple Stone soon found itself the owner of a Sorcerer with screen, cassette unit and a golf-ball printer for word-processing work.

Baulch looked at a Tandy TRS-80 that weekend before deciding which system to buy, but the Sorcerer's business-like looks swayed him in its favour.

"The training session the sales representative gave us was adequate — if you happen to have a brilliant mind. We didn't question anything we were told, because we didn't want to appear stupid, but then the moment arrived when we were left alone with it and our minds went blank", confesses Baulch.

Fortunately, some concerted group effort produced the desired result and they found that they all remembered separate pieces of information. In two weeks, they were all familiar with the machine — the first computer-produced estimate went out just a few days after delivery.

Having read a few books and magazines about microcomputers, Baulch soon realised that the computer could do more for his firm that simply act as a typewriter with a screen. His word processing is sophisticated now, and he is making good use of the features of the highly-regarded Sorcerer word-processing program.

"What is really a big help to us now is that each job can use a different mixture of standard clauses — some run to three or four pages. They are stored on tape, and we can call-up and print the clauses we need in the proper order at the end of any estimate which saves considerable typing time", claims Baulch.

Since the arrival of the Sorcerer, George Baulch finds it difficult to imagine how they ever managed without it. Temple Stone send out 30 or 40 letters a week and so the computer is in use about three hours every day.

Most of the initial problems they encountered were minor ones. The first and most pressing was that the golf-ball printer could not print a pound sign, only dollars — one of the more obvious penalties of importing equipment designed primarily for the U.S. market.

That was hardly insurmountable, and while EMG was changing the golf-ball, Temple Stone was loaned a daisywheel printer. Of course, that was faster and the print impression on the paper was nearly as good as with the IBM mechanism. With quotations running to several pages, it made sense to go for the more satisfactory unit despite the difference in price — nearly twice as much. Baulch has subsequently bought a Ricoh daisy-wheel printer.

Most of the other teething troubles occurred within the first month of purchase and were due largely to the operators: "Sometimes we would press the wrong button, and the program would lock so that that we could not enter edit mode. We would telephone EMG where we would be asked what we had done, and, of course, we didn't have a clue. By then, we had pressed almost everything. The people at EMG were very patient with us though, always sending someone along as soon as possible".

The Sorcerer has now been working, and working well, since January 1980. George Baulch particularly likes the fact that if the printer breaks down, the computer can still be used, with letters being created and stored to be printed later.

## No point of comparison

He still has no point of comparison, and he certainly has not been in close contact with many other micros: "I don't know anyone with one. The only computers I've seen have been when I'm working in the City, up on the site scaffolding and looking in through office windows". It gives him a certain degree of quiet satisfaction to observe that all those computers are bigger, more expensive, and probably no better than his.

Temple Stone has few ambitions for its computer. Baulch is thinking about computerising payroll, but only if EMG can provide a program which is straightforward. Some new hardware may be called for: the greater speed and capability permitted by floppy disc storage, for instance, may well outweigh the extra cost.

At present, it appears to be impossible to add charges automatically to the computer-produced estimates. It would be a neat extra, but all jobs are opinion-priced on the time required to work with each type of stone. At least the present system allows Baulch to be looking at a job while Pam is doing a rough draft of the estimate on the screen; prices can then be added in immediately on his return.

"It would be useful if we could do the payroll and the invoices on the computer", says George Baulch. "We have achieved the primary object — the main thing is that we can now send out professional-looking estimates and letters, that was why we bought it after all. Do you know we have had compliments on our new typist since then?

"I know that the computer has greater possibilities, but we're a small company, we know what we bought it for, and it is really doing all that we demand".


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# The Socrates Irony

BELL ROLLED over and looked at his watch. "Let's get dressed, Elaine. I'll have to take back the B-class file before we go".

In the Intelligence Collation Department, the borrowing of such high-level material from the library was timed; if it was not returned within the period — three hours in the case of B-classified cassettes — alarms would be flashing in Control.

Miles Bell worked with all categories of guarded information and he had a full clearance pass to every library within the ICD. His loyalty to his country was total; not to his wife.

Elaine was his project overtime and the B file was tonight's recorded reason for the extra toil. All ICD

**by Brian Williams**

personnel had to log their field of interest while inside the building, and lately it was the Caribbean Assessments that had merited Bell's labours for two or three evenings a week.

The Department worked many legitimate late hours expecially during international flare-ups, and it was designed accordingly. Senior officers had private rest rooms, showers and kitchenettes at their disposal, and Elaine was assumed by all to be just another service secretary. People here were trained not to answer too many questions so few were asked; for Bell it was using the system to fool the system.

He had long ago discovered how to trick the silent sentry into allowing two people in and out of the building on only one pass; it involved flicking the card with your finger just as the details were being read. The machine had to re-read the card and the personnel scanner suffered a distortion in its internal image memory.

It seemed to give the benefit of the doubt to the holder of such a high-ranking pass, or, as Bell joked, it turned a sympathetic blind eye. Dexterity and good timing were needed on Elaine's part in order to miss the beam interpreter, but she was lithe and fit. The staff entrances were discreet and disguised, so no-one witnessed their antics; Bell enjoyed the risk.

The circumstances of their meetings had become an acceptable part of their affair. Elaine never displayed the slightest interest in the Department's workings and in any case the only method of removing information was by old-fashioned writing or memorising it.

Bell suspected that she hardly had a glimmer of exactly what type of place this was, and she was certainly not in the pay of a foreign power or the dreaded Internal Security Unit. She was simply Elaine Parker who had fallen for a more mature married man — no security risk at all.

They showered, dressed and locked the office suite. Upstairs, Bell inserted his and the file's card into the sentry at the door of the B library which unlocked to allow them both to enter. Interior lock circuits made no attempt to count the number of people passing them; they were more interested in the whereabouts of the highly-secret cassettes.

Elaine waited just inside the door and Bell disappeared within the ceiling-high racks to re-insert the file and clock it off-loan. The security camera, evil eye, was rarely live at this time of day, and only an attempted withdrawal of another cassette would have been announced at Control.

"You, stay where you are", barked a loud, commanding voice, making them both start. From behind racks at the opposite end of the room a guard had suddenly appeared and was purposefully approaching Elaine with gun, although not aimed, nevertheless in hand.

"You have no authorisation for this sector. I am going to take you to Control", he snapped. Recovering quickly, Elaine, sometimes surprisingly naive, played him very wrongly:

"Don't you touch me", she spat, followed by a shout of "Miles". Bell hurried over, but to the security guard, an unauthorised young girl in a top-security area was as good enough reason for man-handling as he needed, and he took it.

Bell lost his natural composure for a moment and from behind gave the guard the oddest of high-speed tugs under the neck that Elaine had ever seen, either on TV or Holo. The two men seemed to grapple momentarily, then the guard slowly dropped to the floor, as one would imagine a wax figure to melt on the bonfire. His gun fell and clattered on the tiles, then only the panting of Bell's breath could be heard in the room.

"What's the matter with him"? asked the girl.

"He's dead", Bell murmured.

"But how? I mean, he, he —".

"Look, I had to take a course in some commando tricks when I worked under cover during the UN occupation of Afghanistan, early in the eighties. I had completely forgotten how effective it all can be. I didn't mean this to happen. His neck has snapped — the stockier they are —".

His words were true, although it was not the first time in his colourful career

**His gun fell and clattered on the tiles. Then only the panting of Bell's breath could be heard in the room.**

that Bell had had a body to dispose of. Even as he spoke, his brain was racing through the possible channels of action. Some of his colleagues said that when it came to situation analysis, they preferred his mind to the Department's mainframe — it was faster.

At least the guard had shown the good grace of not pressing the button on his waist-mounted panic pack; that would have brought men running from all directions, but might have been considered cowardly by a member of the tough NI organisation.

Elaine was pale and trembling.

"What are you going to do? I mean—".

"Quiet. Hold this door open for me". His voice was firm.

Taking the special card from the dead man's pocket, he picked up the gun and then the body. A very heavy-duty door led from the library to a small grassed section outside the building. Only a guard's card could activate the door, automatically alerting Control in the process, and if it closed there was no re-opening from outside. As with all the ICD, it was unintentionally easier to leave than to re-enter.

The green area outside was higher in relation to the surrounding woodland, and was separated from it by a deep ditch, a high security fence, then another ditch. Anti-helicopter masts rose up, and the whole complex was permanently illuminated at night. The supposed purpose of these small external window boxes, as they were nicknamed, was to house temporarily the racks and their precious contents under massive security in the unlikely event of an uncontrolled internal fire. Presumably, in the same circumstances, they would also take people.

Their unofficial role was to supply the guards with a breath of fresh air, and Control had become insensitive to the brief evening openings of external emergency doors. Security was not severely at risk because both the internal and external alarms immediately sounded if the perimeter fence was touched or the door remained open for more than five minutes, just as they did if anyone used a card other than a guard's in the sentry.

Of course, the evil eyes were subject to random activation during every hour of every day, and this was one of Bell's gambles; the other risk he had to take was that the dead man had reported to Control within the last 15 minutes. Each guard had to key his own personal and frequently-changed identity code on strategically-positioned wall-mounted panels every quarter of an hour. If he was being ordered to do so at gunpoint, he could enter a warning combination without alarming his kidnappers.

Bell carried the body to the first ditch and put the man's card back in his pocket. He then placed the gun in the unfeeling hand as best he could and gave the guard a push. The ditch was deeper than Bell remembered and it had more tree roots and rocks jutting out of the sides. It was almost a ravine really. The body fell clumsily and rolled until it slid into water unseen through undergrowth. Bell then kicked at the very edge of the turf until a chunk of rain-soaked earth broke away and fell down into the ditch somewhere in the region of the guard's body.

Quickly he returned to the girl and shut the door, glancing at the still-motionless evil eyes.

"Take my card and go back into the office. Hide until I arrive. It may be some time. I'll knock in code. Go now", hissed Bell, and saw her through the library's inner door. He then casually walked over to the new-incoming-files index and sat down. This time he was aware of camera movement — the guard was being missed. Half an hour passed before another guard and a senior officer entered the library.

"Seen a security guard in here recently"? asked the unsmiling captain.

*(continued on next page)*

*(continued from previous page)*

"No. No-one at all", replied Bell, not even looking away from the screen.

Eventually, a little before midnight, the body was found. Within minutes the library swarmed with uniformed men, and Bell was asked for a statement. He told them that he had been working at the index since about 9.30 pm and had seen only one other member of staff returning some cassettes around 11 o'clock, besides the captain. That was verified and Bell left the library with some guards, one of whom held the door open for him.

The next day passed with some obvious official activity but the ICD was not an informative territory and tongues did not wag.

"What's happening"? asked Elaine in a lunch-time café. She was still upset and Bell had agreed to meet her much against his better judgment.

"They've brought in Socrates", he replied.

"Who"?

"Some experimental gear. It stands for Scene Of Crime Relevancy Assessor and Theory Evaluations System. Meant to be a kind of silicon-chip Sherlock Holmes. Luckily, no court in the land accepts its findings as evidence yet".

She nearly spilt her coffee.

Some days elapsed before the section head — amusingly named Leake — announced to the morning assembly of senior staff that a guard had been found dead due to a fall in the ditch, apparently while checking a movement beyond the perimeter.

"Death was caused either by a broken neck or by a sharp branch and embedded in the cerebellum — take your pick", offered Leake.

Most of his announcement passed by without a flicker of interest. After all, it was a silly thing to do, to fall in the ditch, and surely the guards accepted some risk in their employment.

"Can I have a minute, Miles"? called Leake as everyone was leaving the small hall. Bell felt fully relieved. Now Leake would want to ramble on about the overdue Haiti Solution; well, that was hardly a problem after the rest of the week's events.

In his office, the head of section motioned Bell to take a seat.

"Odd about the guard", commenced Bell.

"Not really, Miles", replied Leake as he tried to coax some life out of a battered old pipe.

"You see, we know how he died well enough. But we also know why, don't we"? Leake peered over is glasses at Bell, who suddenly felt that rare sensation when only a few seconds separate elation from doom.

"This Department has been losing some top-grade material to the other side. One of our field people over there was surprised to see almost word-perfect reports that only exist — should exist — in this building and nowhere else. We discovered that this week and immediately placed a permanent guard in each library. You met one within an hour of this instruction. The next day we were going to launch a thorough staff surveillance combing — but you saved us all that.

"No need to waste time with denials or cock-and-bull stories and the like, Miles, it doesn't matter now. These two gentlemen will take over".

Bell had been totally unaware of the two men standing silently, hands crossed, behind the office door. They were from the Internal Security Unit and that meant the end of Miles Bell in these nervous near-war days.

> **"They've brought in Socrates", he replied. "Who"? "Some experimental gear".**

Behind the aroma of pipe tobacco Leake went on to explain: "Socrates found you out. Extensive plates of the body were taken *in situ,* and together with probes into the ditch walls, he proved by analysis that a man of the guard's build could not have ended up in his final position by an accidental fall. Impossible. The neck was broken before the fall — from the rear by a man of your stature.

"We went on to give the grass a surface scan. Many footprints and lawnmower tracks, but only one size-10 shoe imprint changed from a 26-stone load to a 12-stone load — yours. Then there was the soil breakaway. To shear in that manner, it must have been kicked — weight alone would have resulted in a completely different pattern.

"Finally we scanned the library floor. Socrates discovered that a fresh tile chip could only have been produced by something made of gun metal dropped from a height of four feet — nothing else would have split the molecular bonds of the tile in quite the same way. The rest is reasoned to a high-probability value".

"But it's not me", argued Bell, mouth like sand-paper. "I haven't been passing dope —".

Leake leaned over the desk, pipe in hand, and spoke only a few inches from Bell's face.

"It doesn't really matter to me whether you have or you haven't, Miles; even if it was someone else in the Department, they will be mighty thankful for a scapegoat. Only an outright fool would risk continuing now that the thing's blown up. What's gone has gone. The main thing for the moment is that we, as an agency, are unlikely to lose any more dope, as you call it".

Sitting down again he puffed at the pipe and spoke once more:

"In any event, I don't believe you for a minute, Miles. You can't tell me you ponder over top-grade files all those evenings for months on end and can only progress this much".

The section head held up Bell's rate-of-progress schedule.

"What else could you have been doing except writing down or committing to memory some of the nation's most secret assessments? If it had been preoccupation with one of the girls we'd have picked up coincidental on-premises times, eh? I've checked that out. Negative. Besides, you wouldn't have made a secret of that, would you, especially since ICD girls are chosen for their commonsense in matters of this nature; in short, they don't't".

Bell knew that if he told Leake about Elaine, he would not be believed. Even if he were, he would be simply throwing the girl to the ISU. He could not be tried for murder or even manslaughter, so his best chance was to try to convince Security that he was not passing secrets, even if it took months in the ISU prison.

The pipe required another few prods.

"By the way, I bet you don't know that Socrates will be accepted as evidence in the ISU trial — 1984 Protection of the Most Valuable Information Act, you see. By-passes normal courts so that the Government isn't embarrassed by spy scandals. You killed the guard, that we can prove beyond any shadow of a doubt. For the next 10 or 12 years that is all we need to prove. Gives us plenty of time to get the rest right, eh"?

"Take him away".

Shortly afterwards, another member of the Intelligence Collation Department, a hitherto librarian and now a trainee field operator, smiled to himself over late afternoon coffee. How quickly impending doom can change to relief, he mused. It meant no more dope for a while, his contact had told him, just carry on a routine for a few months until the guard business is history. Next day, he won promotion.

Finishing his drink he almost broke into a laugh. His first assignment was to "cultivate friendship and discreetly investigate" a certain female. He looked forward to another pleasant evening with Mrs Louisa Bell.

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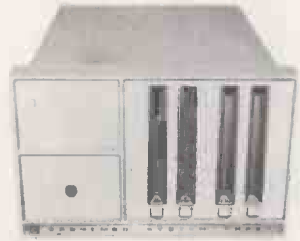

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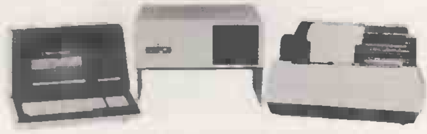

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# MONSTERS

RANDOM ROOM contents generator is a program which is designed to make life easier for the dungeonmaster and players of the game Dungeons and Dragons and other fantasy role playing games. The program generates random room contents, specifically for dungeons. Any number of rooms can be generated between any two room numbers you input. You can create monsters of one or more race in random quantities.

If the monsters are in their lairs, random treasure is generated: copper pieces, silver pieces, gems, etc. The program is designed to fill the gaps in dungeon complexes — instead of having an empty room, a random one can be created, giving more fun to the players. If a printer is available, the rooms can be output to it, giving a permanent record which can be entered into your dungeon files.

The monster generating program can be used for fun, or for the more serious purpose generating monsters to use in fantasy role-playing games such as Dungeons and Dragons, Chivalry and Sorcery, and others. The monsters produced randomly by the program

**by Chris Histed**

integrate in all respects with the accepted format. The only missing aspect is a picture.

There is a description of attributes, level treasure type, intelligence, etc. There is also a description of habitat, and bodily appearance, together with a name, chosen at random from a list of about 50 syllables. The monster's weapons are chosen, with the possibility of magical powers; and even a monster mark is included.

The monstermark is a means of judging the monster's strength and power — the higher the mark the more powerful the monster. The armour class is decided and is an indication of the armour of the monster, the lowest monster on which to inflict damage is AC 9; and the best and hardest to damage is AC0.

The hit dice of the monster is the amount of damage inflicted on it before it dies. That is determined for each individual monster by rolling the indicated number of eight-sided dice, and the level it has is determined by this and other characteristics. The percent in lair number is the percentage chance of the monster being in its lair where its treasure-type shown will be found. The alignment is an indication as to whether it will be friendly towards parties of adventurers.

```
1 DIM B$(100)
2 C$="S":D$=" IS "
3 DIM K(100)
4 LINE=0
5 FOR X=1TO30:PRINT:NEXTX
10 INPUT "ROOM £ WHAT TO ROOM £ WHAT",A2,A3
15 IF A3<A2 THEN 10
16 LET A2=INT(A2):LETA(3)=INT(A3)
20 FOR R=A2TOA3
100 LET A1=INT(RND*9)+1
110 ON A1 GOTO 120,130,140,150,160,170,180,190,200,210
120 LET A$="CHALK":GOTO220
130 LET A$="GRANITE":GOTO220
140 LET A$="MARBLE":GOTO220
150 LET A$="MARBLE":GOTO220
160 LET A$="GREY FLAGSTONES":GOTO220
170 LET A$="GREY ROCK":GOTO220
180 LET A$="BLACK ROCK ":GOTO220
190 LET A$="SLIMY GREY ROCK ":GOTO220
200 LET A$="SLIMY BLACK ROCK":GOTO220
210 LET A$="WET BASALTIC COLUMNS"
220 PRINT : PRINT "££££££££££££££££££££££££££££££ ROOM £ ";R;
225 PRINT "£££££££££££££££££££££££££££££"
230 PRINT :PRINT:PRINT
235 LET B1=INT(RND*20)+10
240 PRINT"THE ROOM IS";B1;"FEET HIGH";
250 PRINT "THE WALLS ARE COMPOSED OF ";A$;"WHICH LOOKS";
260 LET B2=INT(RND*4)+1
270 ON B2 GOTO 280,290,300,310,320
280 PRINT"OMINOUS";
285 GOTO 330
290 PRINT"PLEASANT":GOTO330
300 PRINT"NICE":GOTO330
310 PRINT"AWE-INSPIRING":GOTO330
320 PRINT"FEARSOME"
330 PRINT"IN THE ROOM YOU CAN SEE";
340 LET B2=INT(RND*16)+1
342 IF B2>10 THEN ON(B2-10) GOTO345,355,365,375,385,395
345 REM
350 ON B2 GOTO 360,370,380,390,400,410,420,430,450,460
355 PRINT"A CUP OF WATER WHICH GIVES OFF A PUNGENT ODOUR":GOTO470
360 PRINT"A BIG HOLE IN THE CEILING":GOTO470
365 PRINT"A NASTY MESS IN ONE CORNER":GOTO470
370 PRINT"A SMALL HOLE IN THE CEILING":GOTO470
375 PRINT"A VERY SMELLY SOCK ON A POLE OVER A FIRE":GOTO470
380 PRINT"A BIG HOLE IN THE FLOOR":GOTO470
385 PRINT"A BIG PILE OF WORN OUT SHOES IN THE CENTRE":GOTO470
390 PRINT"A SMALL HOLE IN THE FLOOR":GOTO470
395 PRINT"A SIGN SAYING 'Quiet Please' IN LARGE UNFRIENDLY";
397 PRINT"LETTERS OVER THE DOOR":GOTO470
400 PRINT"A SMALL POOL ON THE FLOOR":GOTO470
410 PRINT"A BIG POOL ON THE FLOOR":GOTO470
420 PRINT"A RAISED STONE DAIS":GOTO470
430 PRINT"A PIT IN THE FLOOR":GOTO470
440 PRINT INT(RND*5)+1;"ALCOVES IN THE":
442 LET B5=INT(RND*4)
443 IF B5=0 THEN PRINT"WEST WALL";
444 IF B5=1 THEN PRINT"EAST WALL";
445 IF B5=2 THEN PRINT"NORTH WALL";
446 IF B5=3 THEN PRINT"SOUTH WALL";
448 GOTO470
450 PRINT"A STONE STATUE OF";
452 LET B6=INT(RND*4)
454 IF B6=0 THEN PRINT"APOLLO"
455 IF B6=1 THEN PRINT"ODIN"
456 IF B6=2 THEN PRINT"MARS"
457 IF B6=3 THEN PRINT"THOR"
460 PRINT"MANY PITS IN THE CEILING":GOTO470
470 PRINT:PRINT"ALSO IN THE ROOM ARE:"
480 LET C1=INT(RND*15)
485 LET C5=C5+1
490 IF C1=0 THEN PRINT"A10'LONG DAISY CHAIN"
495 IF C1=1 THEN PRINT"A+";INT(RND*3)+1;"SWORD"
500 IF C1=2 THEN PRI (T"A RING OF REGENERATION"
510 IF C1=3 THEN PRINT"A SONG BOOK"
515 IF C1=4 THEN PRINT INT(RND*5)+1;"STONE BALLS"
520 IF C1=5 THEN PRINT"A COFFIN"
525 IF C1=6 THEN PRINT"TABLES AND";INT(RND*30)+1;"CHAIRS"
530 IF C1=7 THEN PRINT INT(RND*5)+1;"BOTTLES"
536 IF C1=8 THEN PRINT INT(RND*3)+1;
540 IF C1=8 THENPRINT"CUPS OF VALUE";INT(RND*100+2);"GP'S EACH"
550 IF C1=9 THEN PRINT"A STONE HAMMER"
555 IF C1=10 THEN PRINT"A STONE DAGGER"
560 IF C1=11 THEN PRINT"ANATOMICAL PICTURES"
565 IF C1=12 THEN PRINT"A STEEL BALL:";INT(RND*20)+3;"''IN DIAMETER"
570 IF C1=13 THEN PRINT"TWO DEAD RATS"
575 IF C1=14 THEN PRINT INT(RND*5)+14;"MARBLES"
576 IF C5>3 THEN 590
580 LET C2=INT(RND*10)
585 IF C2>3 THEN 480
587 REM WIB
590 LET D1=INT(RND*100)+1
610 LET D2=INT(RND*10)+2
620 REM £ IN ROOM
625 RESTORE
627 Y=1
630 FOR Y=1TO100
640 READ B$(Y)
645 READ K(Y)
650 NEXTY
652 R=0
655 LETR=INT(RND*10)+1
656 IFR>6THENFORR2=1TOINT(RND*2)+1
660 DATA ORC,10,ORC,10,ORC,10,ORC,10,ORC,10,LICH,1,RUST MONSTER,1
665 DATA BUGBEAR,6,DRAGON,3,DRAGRON,3,LIZARD MEN.9,HOBBITT,4,MAN,5
670 DATA ELF.5,GIANT-RAT,8,GIANT-CRAB,5,BALOR,1,GIANT MICE,3,SKELETON,5
675 DATA SHRIEKER,1,SPECTRE,1,GIANT-CENTIPEDE,10,GIANT-ANT,15,FLEA,100
680 DATA WERE-RAT,6,WERE-DOG,3,WERE-WOLF,2,BLINK-DOG,10,ENT,2
685 DATA DISPLACER BEAST,5,TITAN,1,GIANT,1,SALAMANDER,1,WIGHT,10
690 DATA FEAR MONSTER,1,WRAITH,4,WITCH,1,DEMON-TYPE 6,1,DEMI-GORGON,1
695 DATA URCHIN(RED),3,URCHIN(SILVER),1,URCHIN(BLACK),5,URCHIN(GREEN),5
700 DATA LAMASU,1,MANTICHORE,3,BONE-DEVIL,3,ASH-BEAK,4,GIANT-SLUG,1
705 DATA MAMOUTH,1,VELEDORE,1,STAIR-STALKER,1,BRAINFUNGUS,1
710 DATA FLYING FISH,2,GREEN SLIME,1,OCHRE-JELLY,1,BLACKPUDDING,1
715 DATA SMOKE-SPIRIT,1,WYVERN,3,TRAPPER,1,STONE-BELLY,1,SHEET-PHANTOM,1
720 DATA LITTLE OLD MAN,1,FREMEN,10,NEO-OTYUGH,1,OTYUGH,1,CAT-PERSON,10
725 DATA DEVIL-DOG,10,DEATH-DOG,10,SPIRIT,1,GARGOYLE,3,HARPIE,3
726 DATA WYVEN,4,PURPLEWORM,2,MINOTAUR,3,CENTAUR,6,UNICORN,2
727 DATA NIXIE,3,DRAYAD,6,GNOME,3,PEGASUS,1,HYPOGRIFF,1,ROC,1
728 DATA GRIFFON,1,INVISIBLE STALKER,1,DJINNI,1,EFREET,1,YELLOW MOULD
729 DATA 1,DIRE DOG,3,BORING-BEETLE,6
730 DATA LION,1 ,MONG,10,TROLL,3,EAR-SEEKER,50,STURGE,20,GIANT-LEECH,4
732 DATA DRUID,1,TRITON,30,OGRE-MAGI,6,SHADOW,1,DOPPELGANGER,12
734 DATA LYCANTHROPE,32,BEHOLDER,1,UMBER-HULK,4,HELL-HOUND,8
735 DATA PHASE SPIDER,6,STIRGE,30,GIANT TICK,12,OWL BEAR,5
736 DATA CARRION CRAWLER,6,GELATINOUS CUBE,1,HOMUNCULI,3,IRON GOLEM,1
737 DATA FLESH GOLEM,1,CLAY GOLEM,1,KOBOLD,20,HOBGOBLIN,5,TROLL,3
738 DATA SKELETON,6,ZOMBIE,3,GHOUL,5,MUMMY,3,SPECTRE,2,VAMPIRE,1
739 DATA COCKATRICE,5,BASALISK,4,MADUSA,2,GORGON,1,HYDRA,1,CHIMERA,1
740 LET T5=INT(RND*98)+2
741 LET T4=INT(RND*K(T5))+1
742 IF T4=1 THEN LET C$=""
743 IF T4<=1 THEN LET D$="IS"
745 LET T4=INT(T4)
746 IF T4>1 THEN LET D$="ARE"
747 IF T4=1 THEN LET D$="IS"
748 IF T4=0 THEN 741
750 IF T4>1 THEN LET C$="S"
755 PRINT:PRINT"        MONSTER";C$;":":PRINT
760 PRINT"THERE";
770 PRINTD$;"  ";
772 PRINTT4;"     ";B$(T5);C$
780 REM LET C+D$=""
785 REM N1=£APPEARING
790 LET N1=50+INT(RND*40)
800 IF N1>INT(RND*60)+40 THEN 950
805 LET M1=INT(RND*3000)
806 LET M2=INT(RND*1000)
809 LET M3=INT(RND*1000)
812 LET M4=INT(RND*10)-3
820 PRINT"THE MONSTER";C$;D$;"IN";
821 IF C$="S"THEN PRINT "THEIR";
822 IF C$=""THEN PRINT "IT'S";
824 PRINT "LAIR"
830 PRINT "THERE ARE";M1;"COPPER PIECES"
835 PRINT "THERE ARE";M2;"SILVER PIECES"
840 PRINT"THERE ARE";M3;"GOLD PIECES"
845 IF M4>0 THEN PRINT"THERE ARE";M4;"GEMS OF VALUE";
848 IF M4<1 THEN 860
850 FORT=11TOM4
852 PRINTINT(RND*150)+10;"";
854 NEXTT
857 PRINT"GOLD PIECES EACH"
860 REM
950 IF R>6THEN NEXT R2
3000 NEXT R
```

```
1 REM MONSTER GENERATOR:INPUT"PORT=",Y
2 PORT=Y
3 D1=0
4 FORX=1TO10
5 A(X)=0
6 NEXTX
7 PORT=Y
8 A$=" "
9 GOSUB 1000
10 GOSUB 1500
11 FORX=1TO30:PRINT:NEXTX
12 LINE=0
13 REM THIS PROGRAM WAS WRITTEN BY
14 REM
15 REM C.S.HISTED
16 REM
18 REM FOR A SWTPC 6800
19 REM COMPUTER
20 LET A=INT(RND*20)
21 GOSUB 2000
22 GOSUB 2100
23 GOSUB 2200
24 LET D1=Y
25 GOSUB 8000
30 LET A1=INT(RND*5)
40 LET A2=INT(RND*5)
50 LETA3=INT(RND*190)
55 LETK1=INT(RND*5)
60 LETA4=INT(RND*200)
61 LETA6=INT(RND*5)
62 LETA7=INT(RND*10)+6
63 LETA5=INT(RND*10)
64 LETA8=INT(RND*10)
65 LETA9=INT(RND*19)+1
66 IFA7=0THEN62
67 IFA9=0THEN65
68 IFK1=0THEN55
69 IFA8=0THEN 64
100 PRINTA$;"            "
110 PRINT:PRINT"DESCRIPTION:"
120 PRINT"HEIGHT=";A4;"CENTIMETERS"
130 PRINT"WEIGHT=";A3;"KILOGRAMS"
140 PRINT"NUMBER OF ARMS =";A2
150 PRINT"NUMBER OF LEGS=";A1
160 PRINT"NUMBER OF EYES=";A6
170 PRINT"NUMBER APPEARING=";K1;"-";A7
175 IF D1=1 THENPRINT"CLASS=";M$
180 PRINT"ARMOUR CLASS = ";A8
190 PRINT"HIT DICE(D8)=";A9
191 LET S=INT(RND*(A9/A8)+2.9)
192 IF S=0 THEN 191
193 PRINT"LEVEL =";S
195 LET P5=INT(RND*96)+5
196 PRINT"% IN LAIR= ";P5;"%"
200 PRINT"TREASURE TYPE=";H$
201 PRINT"ALIGNMENT=";L$;J$
202 PRINT"INTELLIGENCE=";K$
205 GOSUB1200
210 PRINT"WEAPONS USED=";C$;" ";D$;" ";E$;" ";F$;" ";G$
800 IF G$="MAGICAL"THEN GOSUB 3000
805 GOTO 3160
999 END
```

*(continued on next page)*

*(continued from previous page)*

```
1000 DIMB$(57)
1010 FOR X=1TO50
1020 READ B$(X)
1030 NEXTX
1035 FOR V=1TOINT(RND*4)+1
1040 LET A5=INT(RND*57)
1050 LET A$=A$+B$(A5)
1060 NEXTV
1070 RETURN
1100 DATAKOB,OLD,WIR,EN,A,AS,AD,ELI,ELR,OR,BAL,ORC,SAU,RON,AUD
1110 DATARAN,BE,BAL,LIN,SON,DEC,HE,CAL,CARRION,CRAWLER,CLA,CLE
1120 DATAGLI,IT,IT,OR,OR,OR,LI,LI,ICH,ICH,IBO,IBO,IXE,BOD,NIYU
1130 DATAWILL,IDI,AMI,IN,ANDI,ULO,IVERNI,SAGE,RETI,NUE,ERT,HASS,DER
1200 LET B1=INT(RND*4)
1210 IFB1=1THENC$="SWORD"
1214 Z1=1
1215 IF B1=1THENZ1=4.5
1216 IFB1=0THENZ1=1
1220 IFB1=2THENC$="SPEAR"
1225 IFB1=2THENZ1=3.5
1230 IF B1=3THENC$="DAGGER"
1235 IFB1=3 THEN Z1=2.5
1245 LET B2=INT(RND*4)
1250 IFB2=1THEN D$="ACID FLASK"
1252 IFB2=1THEN Z1=Z1+4.5
1260 IFB2=2THEND$="OIL FLASK"
1265 IFB2=2THENZ1=Z1+4.5
1270 IFB2=3THEND$="ROPES"
1275 IFB2=3THENZ1=Z1+2
1280 LETB3=INT(RND*4)
1290 IFB3=1THENE$="CROSSBOW"
1292 IFB3=1THENZ1=Z1+4.5
1295 IFB3=2THENE$="SHORT BOW"
1297 IFB3=2THENZ1=Z1+3.5
1299 IFB3=3THENE$=" "
1300 LETB4=INT(RND*4)
1310 IFB4=1THENF$="1*D4 BITES"
1315 IFB4=1THENZ1=Z1+2.5
1320 IFB4=2 THENF$="1 STING"
1325 IFB4=2THENZ1=Z1+3.5
1330 IFB4=3THENF$="1*D4 CLAWS"
1335 IFB4=3THENZ1=Z1+2.5
1340 LETB5=INT(RND*101)
1350 IFB5<50THEN RETURN
1360 LETG$="MAGICAL"
1370 RETURN
1500 LET B6=INT(RND*6)
1510 IFB6=1THEN H$="A"
1520 IFB6=2THENH$="B"
1530 IFB6=3THEN H$="C"
1540 IFB6=4THENH$="D"
1545 IFB6=0THEN1500
1550 IFB6=5THENH$="E"
1560 RETURN
2000 LETC1=INT(RND*4)
2010 IFC1=1THENLETJ$="GOOD"
2020 IFC1=2THENLETJ$="NEUTRAL"
2030 IFC1=3THENLETJ$="EVIL"
2035 IFC1=0THEN2000
2040 LETC2=INT(RND*4)
2050 IFC2=1THENLETL$="CHAOTIC"
2060 IFC2=2THENLETL$="NEUTRAL"
2070 IFC2=3THENLETL$="NEUTRAL"
2075 IFL$="NEUTRAL"THENIFJ$="NEUTRAL"THEN LET J$=" "
2076 IF C2=0 THEN2040
2080 RETURN
2100 LETC3=INT(RND*5)
2110 IFC3=1THENLETK$="SEMI"
2120 IFC3=2THENLETK$="ANIMAL"
2130 IFC3=3THENLETK$="NONE"
2140 IFC3=4THENLETK$="AVERAGE"
2145 IFC3=0THEN2100
2150 RETURN
2200 LETD1=INT(RND*6)
2210 IFD1=0THEN2200
2220 IFD1>1THENRETURN
2230 LETM$="UNDEAD"
2240 RETURN
2999 END
3000 PRINT"MAGICAL POWERS:"
3010 LETD2=INT(RND*18)
3020 IFD2=0THENPRINT"SPEAK WITH INANIMATE OBJECTS"
3030 IFD2=1THENPRINT"TELEPORTATION"
3040 IFD2=2THENPRINT"CONJURE ANIMALS"
3050 IFD2=3THENPRINT"SPEAK WITH THE DEAD"
3060 IF D2=4THENPRINT"CAN USE FIREBALLS ONCE PER HOUR"
3070 IFD2=5THENPRINT"CAN SIMULATE DEATH FOR";INT(RND*10);"TURNS"
3080 IFD2=6THENPRINT"WILL ALWAYS SAVE VERSUS POISON"
3090 IFD2=7THENPRINT"IS NOT SUBECT TO TELEPOTATION"
3100 IF D2=8 THENPRINT"IS IMMUNE TO DISEASES"
3110 IFD2=9THEN PRINT"CAN ONLY BE DAMAGED BY BLUNT WEAPONS OR SPELLS"
3120 IF D2=10THENPRINT"CAN ONLY BE DAMAGED BY SPELLS"
3130 IFD2=11THEN PRINT"CAN ONLY BE DAMAGED BY SHARP WEAPONS"
3131 IFD2=12THENPRINT"CAN USE ANY TYPE OF POISON"
3132 IFD2=13THENPRINT"MAY USE ANY MAGICAL WEAPON"
3133 IFD2=14THENPRINT"MAY USE ALL M.U. SPELLS UP TO ";
3134 IFD2=14THENPRINTINT(RND*3)+1;"LEVEL"
3135 IFD2=15 THENPRINT"CAN USE A WISH SPELL ONCE PER DAY"
3136 IFD2=16 THEN PRINT"CAN ROB";INT(RND*6)+1;"STR POINTS PER";
3137 IF D2=16 THEN PRINT"MELEE ROUND"
3138 IF D2=17 THEN PRINT "CAN ROB";INT(RND*6)+1;"DEX POINTS PER";
3139 IF D2=17 THEN PRINT "MELEE ROUND"
3140 IF M$="UNDEAD"THEN PRINT "ITS TOUCH DRAINS ONE ENERGY LEVEL"
3150 PRINT : PRINT
3151 RETURN
3152 IF Y=1 THEN FORX=1 TO 100
3153 IF Y=1 THEN NEXTX
3160 PRINT "HABITAT :"
3165 LET E1=0
3170 LET E1=INT(RND*7)
3180 IF E1=0 THEN PRINT"IN SLIMY SWAMPS"
3190 IF E1=1 THEN PRINT "IN SUBTERRANEAN PASSAGES"
3200 IF E1=2 THEN PRINT "IN THE WILDERNESS"
3210 IF E1=3 THEN PRINT "HANGING FROM A WEB ON THE CEILINGS OF ROOMS"
3220 IF E1=4 THEN PRINT "IN POOLS OF BOILING MUD"
3230 IF E1=5 THEN PRINT "AT THE BOTTOM OF DARK PITS"
3240 IF E1=6 THEN PRINT"AMIDST FILTH AND GRIME"
3248 GOSUB 4800
3250 PRINT :PRINT"MONSTERMARK = ";M
4000 LET N1=INT(RND*10)
4008 LET N$="ANIMAL"
4009 IF A1>=0 THEN IF A2>2 THEN LET N$="CREEPING ANIMAL ":GOTO4200
4010 IF A1=0 THEN IF A2=0 THEN LET N$="FLOATING BODY"
4012 IF A1>0 THEN IF A2>0 THEN LET N$= "ANIMAL":GOTO 4200
4013 IF A1>=0 THEN IF A2=0 THEN LET N$="CRAWLING ANIMAL":GOTO 4200
4020 IF A1=2 THEN IF A2<4 THEN N$="HUMANOID":GOTO 4200
4030 IF A1=0 THEN IF A2>2 THEN LET N$="CREEPING ANIMAL ":GOTO 4200
4040 IF M$<>"UNDEAD" THEN 4070
4050 IF A1<4 THEN IF A2<4 THEN LET N$="COWLED HUMANOID"
4060 GOTO 4200
4070 REM
4200 LET N2=INT(RND*5)
4210 IF N2=1 THEN LET O$="YELLOW"
4220 IF N2=2 THEN LET O$="GREEN"
4230 IF N2=3 THEN LET O$="RED"
4240 IF N2=4 THEN LET O$="BLUE"
4250 IF N2=0 THEN LET O$="BLACK"
4260 LET N3=INT(RND*5)
4270 IF N3=0 THEN LET P$="FUR"
4280 IF N3=1 THEN LET P$="BARE SKIN"
4290 IF N3=2 THEN LET P$="SCALES"
4300 IF N3=3 THEN LET P$="BONE"
4310 IF N3=4 THEN LET P$="FUR"
4320 LET N4=INT(RND*4).
4330 IF N4=0 THEN LET Q$="GREY"
4340 IF N4=1 THEN LET Q$="GREEN"
4350 IF N4=2 THEN LET Q$="PINK"
4360 IF N4=3 THEN LET Q$="BROWN"
4400 PRINT"THE";A$;"HAS THE OVERALL APPEARANCE OF A";
4410 PRINT N$;".THE SKIN OF THE";A$;"IS";P$:4420 PRINT "OF A";Q$;"COLOUR"
4425 IF A6=0 THEN GOTO7000
4440 PRINT "THE EYES OF THE";A$;"ARE OF A";
4445 IF M$<>"UNDEAD" THEN 4460
4450 PRINT "FIERY RED";
4460 IF M$="UNDEAD" THEN 4470
4465 PRINT O$;
4470 PRINT "COLOUR";
4475 GOSUB 7120
4480 FOR X=1TO30:NEXTX
4490 FOR X=1 TO 5:PRINT:NEXTX
4500 PORT=1
4600 END
4800 LET T3=A9
4810 LET R=1
4820 IF T3<(7/8) THEN R=2
4825 IF T3=(7/8) THEN R=3
4830 IF T3<=1 THEN IF T3>(7/8) THEN R=4
4845 IF T3>1 THEN IF T3<=(9/8) THEN R=5
4850 IF T3<=(9/8) THEN IF T3>1 THEN R=7
4855 IF T3>(9/8) THEN IF T3<=3 THEN R=6
4860 IF T3>3 THEN IF T3<=5 THEN R=8
4865 IF T3>5 THEN IF T3<=7 THEN R=10
4870 IF T3>7 THEN IF T3 <=9 THEN R=11
4875 IF T3>9 THEN IF T3 <=11 THEN R=13
4880 IF T3>11 THEN IF T3 <=13 THEN R=14
4885 IF T3>13 THEN IF T3 <=15 THEN R=15
4890 IF T3>15 THEN R=16
4999 REM
5000 LET A=0:LET D=0:LET M=0:LETX=0:LET Y=0
5005 D=((4.5*A9)*40)/9*(1+A8)
5010 LET A=D*Z1*(R/20)
5011 LET X=1
5012 IF D2=1 THEN LET X=1.2
5013 IF D2=4 THEN LET X=1.7
5014 IF D2=5 THEN LET X=1.3
5015 IF D2=9 THEN LET X=2
5016 IF D2=10 THEN LET X=2
5017 IF D2=11 THEN LET X=2.1
5018 IF M$="UNDEAD"THEN LET X=X+2
5020 IF D2=14 THEN LET X=5
5022 IF D2=15 THEN LET X=2.8
5024 IF D2=16 THE LET X=2.7
5025 IF D2=17 THEN LET X=2.5
5030 LET Y=(A*X)
5040 LET M=INT(Y/((A8+1)*2))
5050 RETURN
6999 END
7000 PRINT "THE";A$;"HAS NO EYES."
7010 LET L9=INT(RND*10)
7020 PRINT "THE";A$;"'SEES' BY THE USE OF ITS";
7030 IF L9=0 THEN PRINT"AUDIO SENSORS"
7040 IF L9=1 THEN PRINT"RADIO VISION"
7050 IF L9=2 THEN PRINT" ULTRA VIOLET SENSORS"
7060 IF L9=3 THEN PRINT"INFRA-RED SENSORS"
7070 IF L9=4 THEN PRINT"X-RAY VISION"
7080 IF L9=5 THEN PRINT"TELEPATHIC ABILITIES"
7090 IF L9=6 THEN PRINT"PSIONIC LISTENING ABILITY"
7100 IF L9=7 THEN PRINT"TOUCH"
7110 IF L9=8 THEN PRINT"ATMOSPHERE PRESSURE SENSORS"
7120 PRINT"THE";A$;"COMMUNICATES BY THE USE OF ITS";
7130 LET L8=INT(RND*5)
7140 IF L8=0 THEN PRINT"EARS";
7150 IF L8=1 THEN PRINT"BRAIN";
7160 IF L8=2 THEN PRINT"HAIR";
7170 IF L8=3 THEN PRINT "BOTTOM";
7180 IF L8=4 THEN PRINT "NOSE";
7190 PRINT "WHICH";
7200 IF L8=0 THEN PRINT "ARE";
7210 IF L8<>0 THEN PRINT"IS";
7220 PRINT"SITUATED ON THE";A$;"'S";
7230 LET L7=INT(RND*5)
7240 IF L7=0 THEN PRINT"HEAD";
7250 IF L7=1 THEN PRINT"RIGHT SIDE";
7260 IF L7=2 THEN PRINT"LEFT SIDE";
7270 IF L7=3 THEN PRINT"LEFT UNERSIDE";
7280 IF L7=4 THEN PRINT "RIGHT UNDERSIDE";
7300 RETURN
8000 LET A=0:LETV=0:LETC=0:LETA6=0:LETO1=0
8010 LET A$="":LETK$="":LETB$=""
8020 LET C1=0:LETC2=0:LETC3=0:LETC4=0
9000 RETURN
```

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# Randomisation Test is answer to significance question

**Probably the most frequently-asked question in statistics is: Given two sets of data with differing averages, is the difference significant? Owen Bishop provides the answer in the form of a test.**

THE QUESTION of significance arises in business, in the laboratory, in the classroom, in politics and in sport. Traditionally, it is answered by performing the students' "t" test or one of its variants which assume that the data conforms to a given distribution pattern, which it may not. They do not always give a clear result if the amount of data is small.

The Randomisation Test, which is a distribution-free test, has several advantages for the comparison of two sets of data. It also illlustrates, perhaps better than any other test, the main features of distribution-free tests and their suitability to the microcomputer. As an example, here are two sets of hypothetical though realistic data. Five packets of raisins, nominal weight 500gm. each, were bought from two supermarkets. At home, each packet was weighed to find its individual weight:

- From Supermarket A: 495, 490, 497, 493, 500: mean = 495gm.
- From Supermarket B: 499, 500, 502, 496, 503: mean = 500gm.

If the 10 packets were on sale at the same price, is it better value to shop at Supermarket B? You would be most unlikely to buy two small batches of packets and find that both had exactly the same mean. A difference of means is almost inevitable, but do the figures genuinely indicate that Supermarket B is more generous than A in weighing its raisins? Is Supermarket B the better buy?

It could be that the differences are purely random ones, due to variations in the operation of packing machines and random changes occurring during storage. It might even be that both supermarkets buy their raisins from the same supplier and the only non-random difference is the brand name on the packet. Next time, we might find we do better at A than at B.

If the difference between supermarkets is simply a random one, it should conform to the laws of probability and we should be able to test for randomness by using those laws. We might then find a significant difference between A and B emerging above the background of randomness.

Let us start again, taking 10 packets of raisins and weighing them without looking at their labels. They could be the same 10 as we had before so their weights are: 502, 495, 497, 500, 503, 490, 496, 500*, 493, 499.

There are two packets weighing 500gm. so to distinguish one from the other, we have called one of them 500*. Now we select five packets from the 10 and find their mean weight. We do that for all possible combinations of five packets and write down the weights of any selection that has a mean equal to or greater than the mean of the packets bought from Supermarket B. There are only seven such selections:

| | |
|---|---|
| 503, 502, 500, 500*, 499 | Mean = 500.8 |
| 503, 502, 500, 500*, 497 | Mean = 500.4 |
| 503, 502, 500, 500*, 496 | Mean = 500.2 |
| 503, 502, 500, 499, 497 | Mean = 500.2 |
| 503, 502, 500*, 499, 497 | Mean = 500.2 |
| 503, 502, 500, 499, 496 | Mean = 500.0 |
| 503, 502, 500*, 499, 496 | Mean = 500.0 |

One of the last two selections consists of the original five packets from B. All other selections than those listed have means less than 500gm. The rules for calculating combinations tell us that the total number of selections we can make from 10 packets, taking five at a time, is equal to $\frac{10!}{5!\ 5!}$ which is 252 selections.

Of all the 252 possible selections, only seven are as good or better than the selection we bought at B. The selection from B is included in that seven. This information can be examined in one of two ways:

- There is really no weight difference between the packets from Supermarket A and those from B; any differences we find are purely random ones; by chance the seven packets we selected from B was one of the five best selections out of 252 possible selections; we made the lucky one in 36 choice.
- Supermarket B puts on average a little more fruit in its packets.

If you assume the second statement to be true and always buy your raisins from B in future, there is only a one in 36 chance that this is the wrong thing to do. Most people would be content to accept that risk or, indeed, a risk greater than that if need be. Most people would accept a one in 20 risk of being wrong, unless life or limb were at stake.

Table 1.

| Positions of the 3 numbers array SA (0 to 5) | The numbers | Their total |
|---|---|---|
| 0, 1, 2 | 497, 500, 496 | 1493 |
| 0, 1, 3 | 497, 500, 499 | 1496* |
| 0, 1, 4 | 497, 500, 500 | 1497* |
| 0, 2, 3 | 497, 496, 499 | 1492 |
| 0, 2, 4 | 497, 496, 500 | 1493 |
| 0, 3, 4 | 497, 499, 500 | 1496* |
| 1, 2, 3 | 500, 496, 499 | 1495* |
| 1, 2, 4 | 500, 496, 500 | 1496* |
| 1, 3, 4 | 500, 499, 500 | 1499* |
| 2, 3, 5 | 496, 499, 500 | 1495* |

Given two groups of data, the Randomisation Test consists in merging the groups and then selecting all possible groups having the same number of items as the better group — the one with the larger mean. We count how many such selections equal or exceed the original better mean. We then calculate how many selections, larger, smaller or equal are possible in total. We can then define the probability that differences between the two original groups are random.

Like most distribution-free tests, the Randomisation Test is easy to understand, the mathematics elementary, but the operations involved are extremely boring. In our example, it did not take long to pick out the seven selections, for the figures were few and chosen to make a clear example. With other sets of data, with large numbers of items and much overlapping between the sets, the listing of selections could fill many pages. As numbers of items increase, the number of combinations increases alarmingly.

For example, given two sets of 20 packets each, there are $\frac{40!}{20!\ 20!}$ or $1.38 \times 10^{11}$ selections of 10 items. If difference was marginally significant — in 20 — we may need to find, list and average as many as 7,000 million best selections. That is where the methodical micro comes to the rescue.

The program for TRS-80 Level II 16K can compare two groups of 60 items each, if the items are expressed to three significant figures. The items are entered as a string which can hold up to 255 characters, and are each separated by a stroke or solidus, /. If the items have only one or two significant figures, more than 60 can be entered. If they have four or more significant figures or contain a decimal point or a minus sign, fewer than 60 can be entered. The allowable entry is large enough for most purposes.

The data is entered as two strings, A, B, to make keying fast, and to allow the whole set to be seen, checked and corrected before pressing enter. As listed, the program handles only integers, since that reduces execution time. For most users, the data will already be in the integer form or can be converted mentally to integers as it is entered.

If it is preferred, the program can be made to deal with six-figure floating-decimal numbers by altering the DEFINT statement on line 10 to DEFINT J-N,R,X,Z. The remainder of the program falls into eight distinct stages:

- Conversion of data strings to data array, lines 80-240: the strings, in turn, are read character by character to find the first solidus which indicates the end of the first number. When it is found, the value of the figures immediately before it is read as the first value in the data array VA, line 130, or VB, line 220. The process then continues to the next "/" and so on until "E" is reached. We then have two arrays VA and VB containing the data, and the numbers of items in each have been counted, KA and KB.
- Bubble-sort of data arrays, lines 250-380: this follows the standard procedure, arranging the data in each array in ascending order.
- Totalling the data arrays, lines 390-420: this gives TA and TB.
- Computation of overlap arrays, lines 430-600: if the data of our example are sorted as above, there is a region of overlap:

| | | |
|---|---|---|
| A 490 493 495 | 497 500 | |
| B | 496 499 500 | 502 503 |
| smaller than overlap | overlap | larger than overlap |

If we want to make the larger one, B, even larger, it is a waste of time to consider swapping any member of B for the smaller members of A, 490-495. Similarly, we would not consider swapping the bigger members of B, 502, 503, for any in A. The only figures which are concerned with the selection process are those of the overlap group. In lines 440-520 we operate on arrays VA and VB — TB > TA — creating new arrays SA and SB which contain only those members of A and B in the overlap group. They are also counted, giving NA and NB. Lines 530-600 perform the same operation if TA > TB. We now have two overlap arrays, SA, 497, 500, and SB, 496, 499, 500.

- Merging of overlap arrays, lines 610 to 640: SA is extended to include members of SB, so that SA now holds the complete overlap group, ready for the selection procedure. At line 640, SA is tested to see if by chance it has no members, no overlap, in which there is no selection to be done. The number (Z) of selections producing an equal or greater difference is obviously one and we jump to the seventh stage of the program.
- **Selection lines 650 to 730**: this procedure is one of general interest and has applications in other connections, so it is described in some detail.

We have in our example five items of data and need to pick from the two items to put in A and three to put in B. That can be done in seven ways, giving the seven selections listed previously. With so few figures, we can do that by inspection, but the computer must be more systematic. In general, given a list of, say, five numbers — 497, 500, 496, 499, 500 — the computer must run through all possible selections of three numbers as in table 1.

There are 10 possible selections from the overlap group, of which the seven marked "*", if selected for B, make B equal to or greater than before. By removing all the non-overlap data, the number of selections under consideration has been reduced from 252 to 10 — a great saving in computer time.

To perform the systematic selection, an array Q is set-up to hold the positions listed in table 1.Q is manipulated by three subroutines:

- 1000: enters a series of consecutive numbers beginning with X and starting at element K (Q (K) = X). At the beginning, X = K = 0, so the first array is 012 — see table 2.
- 2000: increments the last element in Q until it reaches maximum value — M-1, where M is the number of elements.

*(continued on next page)*

```
10 CLS:CLEAR600:DEFINT F-N,Q-Z:DEFSTR A-B
12 DIMVA(120):DIMVB(120):DIMSA(240):DIMSB(120)
13 DIMQ(240):DIMSN(240):DIMSR(240)
15 DIMSA(240):DIMSB(120):DIMQ(240):DIMSN(240):DIMSR(240)
20 PRINTTAB(18)"RANDOMISATION TEST":PRINT
30 PRINT"ENTER FIRST SET OF DATA(A) AS"
31 PRINT"POSITIVE OR NEGATIVE INTEGERS, EACH"
32 PRINT"SEPARATED BY A SOLIDUS(/)."
35 PRINT"EACH SEPARATED BY A SOLIDUS(/)."
40 PRINT:PRINT"AFTER FINAL ITEM TYPE E"
42 PRINT"THEN PRESS 'ENTER' KEY.":PRINT
50 INPUT A
60 PRINT:PRINT"NOW ENTER THE SECOND SET OF"
61 PRINT"DATA(B) IN THE SAME MANNER.":PRINT
70 INPUT B
80 FOR J=J1+1TO LEN(A)
90 IF MID$(A,J,1)="E"THEN 160
100 IF MID$(A,J,1)="/"THEN 130
110 R=R+1
120 NEXT
130 VA(KA)=VAL(MID$(A,J-R,R))
140 KA=KA+1
150 J1=J1+R+1:R=0:GOTO120
160 R=0:J1=0
170 FOR J=J1+1TO LEN(B)
180 IF MID$(B,J,1)="E"THEN 250
190 IF MID$(B,J,1)="/"THEN 220
200 R=R+1
210 NEXT
220 VB(KB)=VAL(MID$(B,J-R,R))
230 KB=KB+1
240 J1=J1+R+1:R=0:GOTO210
250 FOR J=0TOKA-2
260 K=0
270 FORL=0TOKA-2
280 IF VA(L) <=VA(L+1) THEN 300
290 VT=VA(L):VA(L)=VA(L+1):VA(L+1)=VT:K=K+1
300 NEXTL
310 IF K=0THEN330
320 NEXTJ
330 FOR J=0 TO KB-2
340 FOR L=0TO KB-2:IF VB(L)<=VB(L+1)THEN 360
350 VT =VB(L):VB(L)=VB(L+1):VB(L+1)=VT:K=K+1
360 NEXTL
370 IF K=0 THEN 390
380 NEXTJ
390 FOR J=0TOKA-1
400 TA=TA+VA(J):NEXT
410 FOR J=0TOKB-1
420 TB=TB+VB(J):NEXT
430 IF TA=>TBTHEN 530
440 FOR J=KB-1 TO 0 STEP -1
450 IF VB(J)>VA(KA-1)THEN 470
460 SB (NB)=VB(J):NB=NB+1:UB=UB+VB(J)
470 NEXT J
480 FOR J=0TOKA-1
490 IF VA(J)<VB(0)THEN 510
500 SA(NA)=VA(J):NA=NA+1:UA=UA+VA(J)
510 NEXTJ
520 GOTO 610
530 FOR J=0TOKB-1
540 IF VB(J)<VA(0)THEN 560
550 SB(MB)=VB(J):NB=NB+1:UB=UB+VB(J)
560 NEXT J
570 FOR J=KA-1TO0 STEP -1
580 IF VA (JA)>VB(KB-1THEN 600
590 SA (NA)=VA(J):NA=NA+1:UA=UA+VA(J)
600 NEXTJ
```

*(continued on next page)*

*(continued from previous page)*

- 3000: when subroutine 2000 has gone as far as it can, subroutine looks at the element before the last one and decides if it can be incremented, i.e., differs by more than one form the last element. New values of X and K are calculated. Then the program returns to subroutine 1000, to set a new series of consecutive numbers.

First time back, it begins at element 1 so Q(0) is unchanged and the consecutive series starts with '2' at Q(1), giving 023. If the two last elements differ by only one, subroutine 3000 looks one step back along the elements until it finds two which differ by more than one, and sets K and X accordingly.

Finally, when Q(0) = N - M, the last array has been generated and the program goes to the next stage. Each time that subroutines 1000 and 2000 have produced a new Q, the program has gone to subroutine 4000. Here, depending on the values in Q, the data have been selected from array SA, totalled and compared to those from the original overlap group belonging to B. If selection gives an equal or greater total, it is counted — line 4040. On leaving this section of the program, Z, the total of equal or greater, selections has been arrived at.

- Total possible selections, lines 740 to 850: this calculates the value of $\frac{N!}{KA!\ KB!}$.

As a combination-calculating subroutine, it is of use in many other applications. The difficulty with factorials is that they become so large that the values involved exceed the capacity of the machine. Perhaps that is one way in which microcomputers are not suited to distribution-free tests. Since these tests nearly always rely on combinational calculations of some kind, that can raise problems.

The difficulty can be avoided by incorporating previously-calculated tables of critical values in the program, or by comparing calculated values to published statistical tables. Here, we help the computer to overcome its number-crunching problems by teaching it some of the tricks we learned at school.

**Table 2. Sequence of Q for N = 5 M = 3.**

| Subroutine | K | X | Q(0) | Q(1) | Q(2) |
|---|---|---|---|---|---|
| Start (line 650) | 0 | 0 | 0 | 0 | 0 |
| 1000 | | | 0 | 1 | 2 |
| 2000 | | | 0 | 1 | 3 |
| 2000 | | | 0 | 1 | 4 |
| 3000 | 1 | 2 | | | |
| 1000 | | | 0 | 2 | 3 |
| 2000 | | | 0 | 2 | 4 |
| 3000 | 1 | 3 | | | |
| 1000 | | | 0 | 3 | 4 |
| 2000 | | | | no change | |
| 3000 | 0 | 1 | | | |
| 1000 | | | 1 | 2 | 3 |
| 2000 | | | 1 | 2 | 4 |
| 3000 | 1 | 3 | | | |
| 1000 | | | 1 | 3 | 4 |
| 2000 | | | | no change | |
| 3000 | 0 | 2 | | | |
| 1000 | | | 2 | 3 | 4 |
| 2000 | | | | no change | |
| Q (0) = N-M so GOTO 740 | | | | | |

If, in the long-departed days of calculations with pencil and paper, you had to calculate $\frac{n!}{r!\ (n-r)!}$

for n = 10, r = 6 you would write:

$$\frac{1 \times 2 \times 3 \times 4 \times 5 \times 6 \times 7 \times 8 \times 9 \times 10}{(1 \times 2 \times 3 \times 4 \times 5 \times 6)\quad(1 \times 2 \times 3 \times 4)}$$

The first obvious simplification is to cancel the 4 × 3 × 2 × 1 on both lines leaving:

$$\frac{5 \times 6 \times 7 \times 8 \times 9 \times 10}{1 \times 2 \times 3 \times 4 \times 5 \times 6}$$

More labour can be saved by further cancelling; in fact, the whole bottom line cancels out, leaving

$$\frac{1 \times 1 \times 7 \times 3 \times 10}{1 \times 1 \times 1 \times 1 \times 1 \times 1} = 210$$

which is easy enough to multiply by mental arithmetic. The program lets the computer calculate in a similar manner, so avoiding large numbers. It takes longer, but arrives eventually, which it might not do if asked to handle numbers such as 40! A straightforward factorial routine on TRS-80 cannot evaluate the expression when n is greater than 33 or r is 17, so is no use for large amounts of data.

To calculate the number of selections we set-up two arrays SN and SR. SN corresponds to the figures above the line after the first cancelling — 5 × 6 × to × 10. SR corresponds to the uncancelled figures below the line — 1 × 2 × to × 6. Then, lines 770-810, we take a series of multiplying factors, L = 1, 2, 3 etc., and look for numbers in SN that are equal to multiples of numbers in SN. The numbers in SN are then divided by the number in SR — cancelling — and the number in SR is made equal to one — cancelled-out. After that, the values in SN and SR are multiplied together, lines 820-850 to obtain F and G.

- Display of results lines 860-930: we now have all the information required to calculate and display the final results.

The program runs quickly when the amount of data is small and it is in such circumstances that distribution-free tests have the advantage over the parametric tests. It is also most likely that the user will have only small amounts of data to analyse.

With larger amounts of data the program may take considerably longer to run — the majority of the time is taken in selecting from the overlap group. As mentioned, the number of selections can run into billions if there is much overlap. Even so, the computer will do it more quickly than you can.

*(continued from previous page)*

```
610 FOR J =NATONA+NB-1
620 SA(J)=SB(J-NA)
630 NEXTJ
640 IF NA =OZ=1:GOTO740
650 K=0:X=0:N=NA+NB
660 IF TA>TBU=UA:M=NA:GOTO680
670 U=UB:M=NB
680 GOSUB1000
690 GOSUB4000
700 GOSUB 2000
710 IFQ(0)=N-MTHEN 740
720 GOSUB3000
730 GOTO680
740 FORJ=1TOKA:SN(J)=J+KB:NEXT
750 FORK=1TOKA:SR(K)=K:NEXT
760 FOR L=1TOKA
770 FORK=2TOKA
780 FORJ=1TOKA
790 IF SN(J)<>L*SR(K)THEN810
800 SN(J)=SN(J)/SR(K):SR(K)=1
810 NEXTJ,K,L,
820 F=SN(1)
830 FORJ=2TOKA:F=F*SN(J):NEXT
840 G=SR(1)
850 FORJ=2TOKA:G=G*SR(J):NEXT
860 CLS:PRINTTAB(20)"RESULTS OF ANALYSIS"
870 PRINT:PRINT"MEAN OF DATA A=";TA/KA
880 PRINT:PRINT"MEAN OF DATA B=";TB/KB
890 PRINT:PRINT"TOTAL NUMBER OF DATA"
895 PRINT"SELECTIONS IS";F/G;"."
900 PRINT:PRINT"NUMBER OF SELECTIONS GIVING"
905 PRINT:PRINT"EQUAL OR GREATER DIFFERENCE"
906 PRINT:PRINT"BETWEEN A AND B IS";Z;"."
910 PRINT:PRINT"PROBABILITY OF DIFFERENCE"
911 PRINT:PRINT"BETWEEN SETS OF DATA BEING SOLELY"
912 PRINT:PRINT"DUE TO RANDOM SELECTION IS:"
915 PRINT:PRINT"DUE TO RANDOM SELECTION IS:"
920 PRINTTAB(24)Z*G/F
930 GOTO930
1000 Q(K)=X
1010 FOR J =KTOM-1
1020 Q(J+1)=Q(J)+1
1030 NEXT
1040 RETURN
2000 IF Q(M-1) <M-1 THEN Q(M-1)=Q(M-1)+1ELSE2030
2010 GOSUB4000
2020 GOTO2000
2030 RETURN
3000 FOR J=M-1TO1STEP-1
3010 IF Q(J)=Q(J-1)+1THEN 3030
3020 GOTO3040
3030 NEXT
3040 X=Q(J-1)+1
3050 K=J-1
3060 RETURN
4000 UT=0
4010 FOR R=0 TO M-1
4020 UT=UT+SA(Q(R))
4030 NEXTR
4040 IF UT>=UTHEN Z=Z+1
4050 RETURN
```

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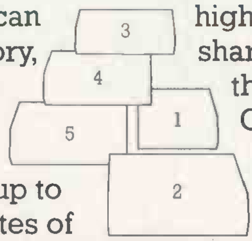


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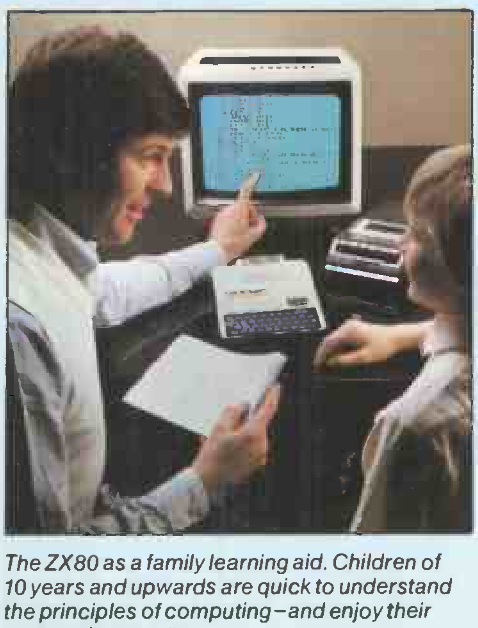

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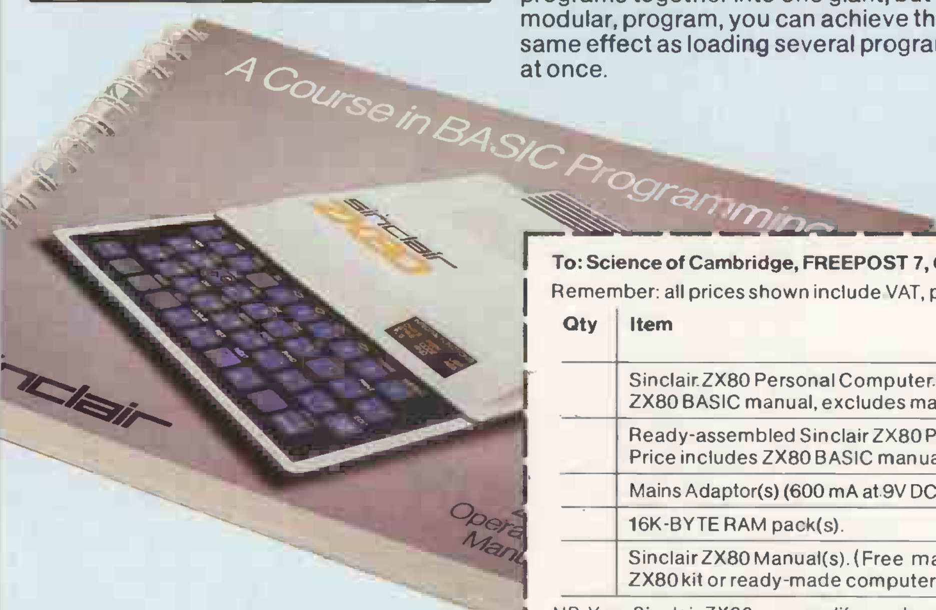


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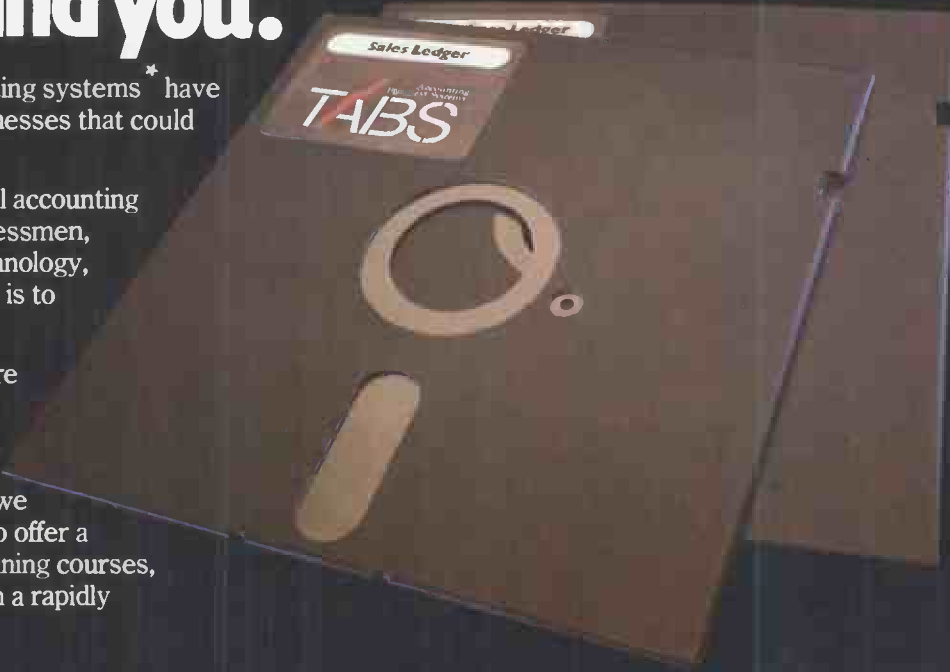


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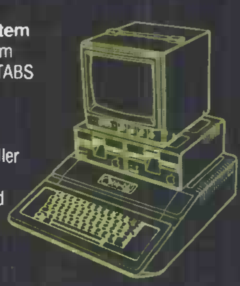

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# Using the Nascom Imp with the Commodore Pet

MOST PET users have restricted budgets and until recently, acquiring a good printer would have left little change from £600. Cheaper printers are now making an appearance and the Nascom Imp — Impact Matrix Printer — looks particularly attractive at £325 plus VAT.

The equipment is advertised as an 80-column bi-directional printer with 96-character ASCII set including lower-case, adjustable tractor or friction feed and baud rates from 110 to 9,600.

| ASCII code decimal | Prints | Also available as keyboard symbol |
|---|---|---|
| 8 | backspace | |
| 10 | line feed | |
| 13 | return | |
| 32 | space | |
| 34 | " | shifted " |
| 35 | £ | # |
| 95 | — | ← |
| 96 | / | shifted @ |
| 123 | } | shifted [ |
| 124 | : | shifted \ |
| 125 | } | shifted ] |
| 126 | — | |
| 127 | ░ | shifted ↑ |

Table 1.

The printer is compact, 15½in. by 9in., and has a blue plastic cover housing the four control switches, three of which contain LED indicators. Tractor feed requires the paper to be fed through a slot in the base while friction feed is from a paper roll supported behind the chassis.

The RS232 serial interface is brought out to a female DB25 socket on the rear panel. Connection to the Pet requires an IEEE-488-to-RS232 interface and I used a CMC ADA 1200. Printer and interface were both set to 300 bauds initially. The standard setting of the Imp for parity is disabled, stop bits is set at two, word length, eight, and automatic line feed at off and none required further adjustment.

The Busy signal which indicates that the print buffer is nearly full or that the printer is off-line was connected to the DTR, data terminal ready, line of the ADA 1200 interface. It was necessary to bridge R8, 10K, in the ADA 1200 with a 1.8K resistor to ensure that the Busy signal activated NRFD, not ready for data, on the IEEE-488 handshake line.

Some early problems in which the Imp mains and print-head fuses blew repeatedly were traced to a badly fastened 5V regulator which was overheating.

Attempts were made to speed printing by increasing the data transmission rate of printer and interface to 9,600 bauds. That produced only a small increase in printing speed and sometimes resulted in the buffer overflowing. The Imp can print at 60 lines per minute so is capable theoretically of 80 characters per second.

However, if there are more characters than spaces in the 80-character line, the bi-directional printing is stopped to

**by Malcolm Pritchard**

protect the print head. Since that halves the effective printing speed, there is little point in increasing the baud rate above 300 unless there is a great deal of processing or user input taking place between blocks of printed output.

Several shortcomings of the system soon became apparent. The ADA 1200 interface is not addressable and responds to any device number above three. A better interface would be required if other devices are also present on the IEEE-488 bus. The Pet, even though fitted with new ROMs, still has some oddities when printing to an external device.

Use of the TAB function always generates a number of spaces equal to the argument of TAB( ). That can cause problems if there are any characters preceding 'TAB' on a printed line. One solution is to include a return character, CHR$(13), before each new TAB, effectively setting the print head back at the left-hand margin

Use of several returns on one line slows the output and it may be preferred to insert the correct number of spaces between columns using the SPC function. Those techniques are demonstrated in the accompanying program which also includes the problem of printing in zones.

The Imp cannot reproduce the Pet graphic characters most of which are printed as the appropriate unshifted or lower-case character. Certain cursor control characters are printed as numbers:

| | |
|---|---|
| Cursor up | 1 |
| Reverse field off | 2 |
| Clear screen | 3 |
| Insert | 4 |
| Cursor left | = |

Some of the ASCII characters are not marked on the Pet keyboard. Table 1 will be useful if those characters have to be printed. Note that backspace eliminates the previous character and that shifted quotes can be included within a string.

The instructions in the Imp handbook are clear and the documentation includes circuit diagrams and software listings. Although the internal mechanics of the Imp suggest that it would not really be suitable for continuous commercial printing, it seems good value for money for hobby computing or intermittent business use.

Program 1 demonstrates the problems associated with tab and zone printing from the Pet. The listing was produced on the Nascom Imp which substitutes a pound sign, £, in place of hash, # . Friction feed was used with a standard A4 sheet of paper.

Some useful ASCII codes are shown in table 1. Several characters can also be printed from Pet keyboard via the ADA 1200 interface. That interface ors the sixth and eighth bits of each Pet character to produce the new sixth bit. The circuitry of the interface is very similar to that shown in the second edition of, The Pet Revealed, page 157.

```
10 REM DEMONSTRATION OF TAB AND PRINT ZONES WITH EXTERNAL PRINTER
100 PRINT CHR$(147);TAB(10);"PRINT DEMONSTRATION";PRINT:PRINT
110 INPUT"IS THIS A PRINT RUN (Y/N)";Q$:Q$=LEFT$(Q$,1)
120 IF Q$="Y" THEN PR=4:RT$=CHR$(13):RZ$=RT$:GOTO 160: REM PRINTER IS DEVICE 4
130 IF Q$="N" THEN PR=3:RT$="":RZ$=CHR$(13)+CHR$(145):GOTO 160: REM SCREEN IS 3
140 REM CHR$(13) IS RETURN, CHR$(145) IS CURSOR UP
150 GOTO 110
160 OPEN1,PR: REM OPEN FILE TO EITHER SCREEN OR PRINTER
170 PRINT£1
180 C$="CORRECTLY":T$="TABBED":O$="OUTPUT"
190 W$="WRONGLY":S$="SPACED":Z$="ZONED"
200 PRINT£1,W$;TAB(10);T$;TAB(20);O$
210 PRINT£1
220 PRINT£1,C$;RT$;TAB(10);T$;RT$;TAB(20);O$
230 PRINT£1
240 PRINT£1,C$;SPC(10-LEN(C$));S$;SPC(10-LEN(S$));O$
250 PRINT£1
300 IF Q$="Y" THEN CMD1
310 REM CMD1 SENDS ANY 'PRINT' OR 'LIST' TO FILE 1 UNTIL UNLISTENED BY PRINT£1
320 PRINT W$,Z$,O$
330 PRINT
340 PRINT C$;RZ$,Z$;RZ$,,O$
350 PRINT£1: REM PRINT£ UNLISTENS BUS
400 PRINT:PRINT CHR$(18);"PET ALWAYS PRINTS CORRECTLY TO SCREEN"
900 PRINT£1
910 CLOSE1
999 END
READY.
 WRONGLY             TABBED                               OUTPUT
 CORRECTLY TABBED       OUTPUT
 CORRECTLY SPACED       OUTPUT
 WRONGLY            ZONED                 OUTPUT
 CORRECTLY ZONED        OUTPUT
```

# Routines which will strengthen programmer's resources

by M G Walker

SORTING is needed frequently in analysis and many algorithms have been designed to achieve it. Algorithms are sequences of operations which obtain a desired result on a set of data. The result of sorting is to organise a list of randomly-ordered data into a desired order, Thus, sorting:

10 2 91 4 —2 0 0 3 5 8

into increasing order results in:

—2 0 0 2 3 4 5 8 10 91

or into decreasing order results in:

91 10 8 5 4 3 2 0 0 —2

There are two forms of sorting; by replacement and by insertion. In both cases, I assume that the list of quantities is numeric, to be sorted into increasing order and stored in an array A. The routines will work with character data, e.g., FRED, MG17A, JOE, and file records.

Sorting by replacement involves exchanging pairs of elements of A until all are ordered correctly. That re-arranges A which may not be helpful, and can take longer. Sorting by insertion takes elements one-by-one from A and places them in the correct order in another array B. It requires more storage space but can be faster and leaves A unaffected. Here are the various methods used in sorting by replacement.

- **Bubblesort:** The simplest sort method of this type. The method works by comparing the first element of the list with the second and if the second is smaller than the first, exchange them. Next compare the second and third elements and if the third is smaller than the second, exchange them. That is continued for the third and fourth and fourth and fifth — and the $(n-1)^{th}$ and $n^{th}$ elements. The whole process is repeated until all n elements are in the correct order. Each time we go through the array, we place the largest element at the end of the list, then the next largest, etc. Hence, for n elements, we examine the array n—1 times as the last element positions itself.

| | |
|---|---|
| Consider A to contain the list | 9 7 8 6 |
| which after one comparison becomes | 7 9 8 6 |
| and then | 7 8 9 6 |
| and then | 7 8 6 9 |
| after examining the array again and so on. | 7 6 8 9 |
| After the next examination and the array is sorted. | 6 7 8 9 |

The n—1 examinations form an I loop and since n—1 comparisons are made each time, an inner J loop is required. Thus the routine becomes

```
100 FOR I = 1 TO N—1
110 FOR J = 1 TO N—1
120 IF A(J) < = A(J + 1) THEN 160
130 S = A(J)
140 A(J) = A(J + 1)
150 A(J + 1) = S
160 NEXT J
170 NEXT I
```

This routine is not very efficient. Each time round the I loop, one element is fixed in the array so it is unnecessary to examine it again; we modify the J loop.

```
110 FOR J = 1 TO N—I
```

That is a great improvement. In a trial, a sort of 1,000 numbers took 57 seconds with this version against 79 seconds for the previous one. However, with the routine as it stands, if the array is sorted fully after, say, four executions of the I loop, all n—1 loops will still be executed. We, incorporate, therefore, a test so if, in the previous execution of the J loop, no exchanges were made, the routine halts. A test variable T is set from 0 to 1 when an exchange is made and the routine halts if T is still 0. This is the final bubble-sort, and took 54 seconds to sort the 1,000 numbers. Bubble-sort:

```
100 FOR I = 1 TO N—1
110 T = 0
120 FOR J = 1 TO N—I
130 IF A(J)< = A(J + 1) THEN 180
140 S = A(J)
```

**Figure 1.**

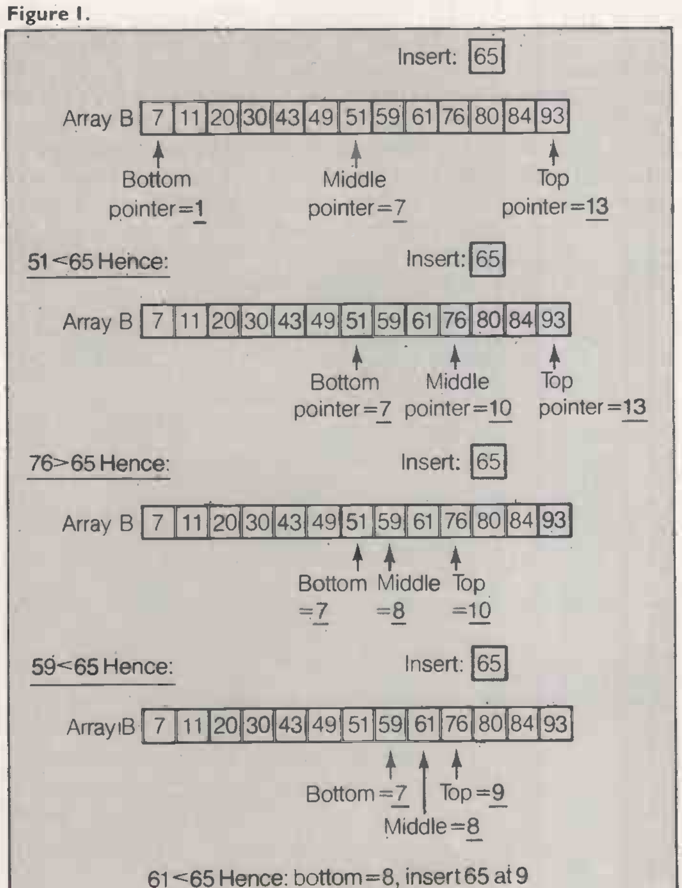
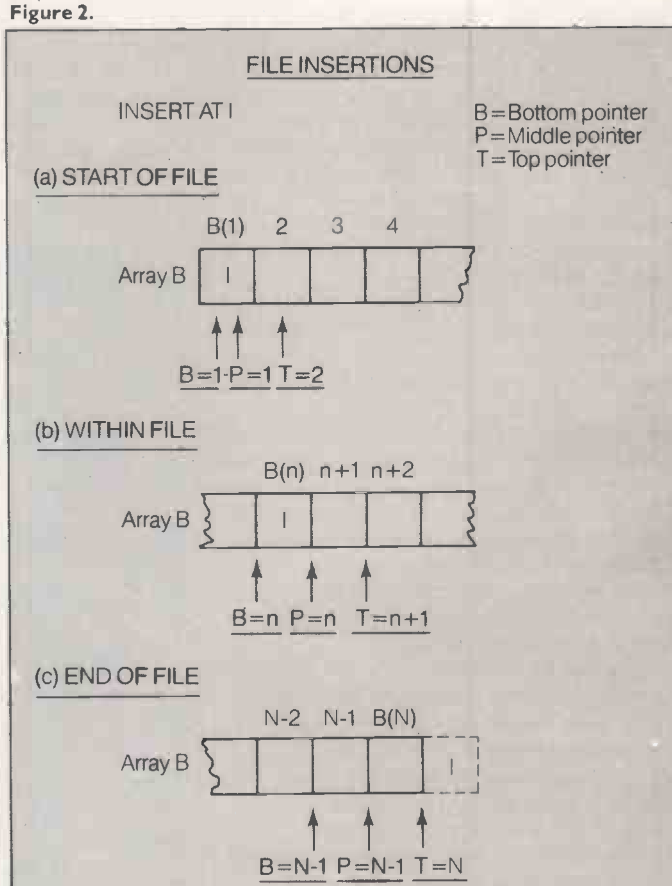



**Figure 2.**



```
150 A(J) = A(J+1)
160 A(J+1) = S
170 T = 1
180 NEXT J
190 IF T = 0 THEN 210
200 NEXT I
210 STOP
```

There is a version of bubble-sort known as shaker-sort which is slightly faster. Like bubble-sort, the routine moves up through the array exchanging elements, then moves back down the array also exchanging elements. It is faster as it fixes elements at both ends of the array.

● **Shell-sort:** Bubble-sort and Shaker-sort both examine pairs of adjacent elements in the array, that is, elements separated by one place; they are thus termed one-sorts. Shell-sort is faster than both and is really a succession of sorts, in the example we consider a shell-sort comprising a four-sort, a two-sort and a one-sort.

The routine executes a four-sort until no more elements are out of order. Note that the array need not be sorted after a 4-sort, consider

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 90 | 2 | 5 | 70 | 1 | 50 | 4 | 3 | 19 |
| first becomes | 1 | 2 | 5 | 70 | 90 | 50 | 4 | 3 | 19 |
| and after the four-sort | 1 | 2 | 4 | 3 | 19 | 50 | 5 | 70 | 90 |

The list is fully sorted to a four-sort but not to a one-sort, or even a two-sort — 19 and five being the first to be exchanged in the latter. In general, it is uncertain how many times a four-sort or two-sort will execute, so each is continued until a test for any exchanges fails. Hence, only the J loop of the routine is used. L is the separation between array elements to be compared. L = 4 for a four-sort, L = 2 for a two-sort and L = 1 for a one-sort. That needs a loop executed three times with L starting at eight and being successively divided by two. Shell-sort:

```
100 L = 8
110 FOR I = 1 TO 3
120 L = L/2
130 T = 0
140 FOR J = 1 TO N—L
150 IF A(J)< = A(J+L) THEN 200
160 S = A(J)
170 A(J) = A(J+L)
180 A(J+L) = S
190 T = 1
200 NEXT J
210 IF T< >0 THEN 130
220 NEXT I
```

The routine is much faster than bubble-sort — it takes 20 seconds to sort the 1,000 numbers; 100 take it two seconds. If line 100 is replaced by 100 L = 64 and line 110 by 110 FOR I = TO 6, the shell-sort comprises a 32-, 16-, eight-, four-, two- and one-sort and takes 4½ seconds to sort the 1,000 numbers. The user must ensure that his array is at least 1 + L/2 in size where L is the value in line 100.

Sorting by insertion is best illustrated by an example. Consider the list

10 2 91 4 —2 0 0 3 5 8

stored in array A, and consider a second array B the same size as A. The contents of A is called the source list and the contents of B, the destination list. The first element of A becomes the first element of B, the routine places elements of A into B by comparing to each element of B in turn and inserting at the appropriate point. The insertion requires moving all elements of B from the last to the one at the insertion point up one place.

| A | B |
|---|---|
| 10 2 91 4 —2 0 0 3 5 8 | 10 |
| 10 2 91 4 —2 0 0 3 5 8 | 2 10 |
| 10 2 91 4 —2 0 0 3 5 8 | 2 10 91 |
| 10 2 91 4 —2 0 0 3 5 8 | 2 4 10 91 |

That last insertion caused 10 and 91 to be moved up one place. Finally A is unaffected and B is

—2 0 0 2 3 4 5 8 10 91

Notice that if no element of B is found to be larger than the element of A currently being considered, it is added to the end of the list. Insertion sort:

```
100 B(1) = A(1)
110 FOR I = 2 TO N
120 FOR J = 1 TO I — 1
130 IF A(1) > = B(J) THEN 190
135 REM MOVE ELEMENTS OF B UP ONE
    PLACE
140 FOR K = I — 1 TO J STEP —1
150 B(K+1) = B(K)
160 NEXT K
170 B(J) = A(I)
180 GOTO 210
190 NEXT J
195 REM NO ELEMENT OF B LARGER,
197 REM ADD ELEMENT OF A ONTO
    END OF B
200 B(J+1) = A(I)
210 NEXT I
```

The routine took 23 seconds to sort the 1,000 numbers and can be improved. It is unnecessary to examine every element of B each time, and we introduce a faster method of searching an array — or file — called the binary search or binary chop.

The essence of the method are three pointers in the array — or file — which are initially set to the top, bottom and middle of the array. If the element referenced by the middle pointer is less than the value being inserted we have to insert somewhere in the upper portion of the array — see figure 1. The middle pointer becomes the bottom and a new middle pointer calculated.

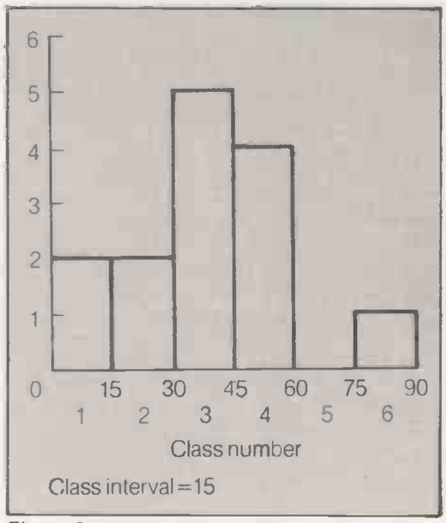



**Figure 3.**

If the element references by the middle pointer is greater than the value being inserted, we must insert somewhere in the lower part of the array, and the middle pointer becomes the top pointer and a new middle pointer calculated. When the top and bottom pointers are adjacent — figure 1 — we insert the A element in the B array. The method is called binary since we continually reject half of the part of the array being considered.

Insertion occurs when bottom and top pointers are separated by one. There are three situations — see figure 2. Inserting at the end of the file is handled by a test in the routine, and insertion at the start of the file is also identified by a test. This is

IF T = 2 AND A(I) < B(1) THEN T = T—1

which ensures that all B is moved up one place. In the listing, B, P, T are the array pointers. Binary sort:

```
100 B(1) = A(1)
110 FOR I = 2 TO N
120 IF B(I—1) > A(I) THEN 150
125 REM INSERT AT END OF ARRAY
130 B(I) = A(I)
140 GOTO 260
150 T = I—1
160 B = 1
170 P = INT ((B+T)12)
180 IF A(I) > B(P) THEN B = P
190 IF A(I)< = B(P) THEN T = P
200 IF ABS(T—B) >1 THEN 170
210 IF T = 2 AND A(I)<B(1) THEN T=T—1
220 FOR K = I—1 TO T STEP —1
230 B(K+1) = B(K)
240 NEXT K
245 REM INSERT AT START OR MIDDLE
    OF ARRAY
250 B(T) = A(I)
260 NEXT I
```

The routine is a substantial improvement on the previous version, sorting the 1,000 numbers took 11 seconds. Large savings resulting from inserting the 990th number formerly took 989 comparisons and now take eight.

Now, we shall consider forms of output more meaningful to the user than tables of figures. In all examples, the output data is in arrays A, D etc., each with N elements and sorted into ascending order where indicated.

A histogram is a form of graph in which data is grouped into a series of classes which are plotted against the number of data elements they contain. The width of the classes is the class interval and is constant for the histogram. Consider the data:

7 83 4 26 37 36 31 49 43 50 41 55 46 19

divided into classes 0—15, 15—30, 30—45, 45—60, 60—75, 75—90 which produces the histogram in figure 3. Note that the class limits coincide. Sometimes they would be 0—15, 16—30, 31—45 — which leaves 30.5, 15.7 and so on undefined. We specify that 15 goes in class 0—15 and not class 15—30.

Bars may be plotted horizontally or vertically as in figure 3. In either case, we first consider the size of the classes. The routines initially divide the data into 20 classes — 25 for vertical plotting — and adjust the class interval to an integer multiple of a power of 10, for example, 20, 0.04, 7 and adjusts the number of classes accordingly.

The variable E contains this exponent; C is the class interval and N1 the number of classes. In each routine, the values in A

*(continued on next page)*

*(continued from previous page)*

are put into classes in array B, J denoting the class number of each value. A is assumed sorted.

- **Horizontal plotting:** Line 100 calculates the initial interval R; lines 110 to 140 adjust that and determine the number of classes. Each element of A is examined in an I loop and the class to which it belongs, J, found and its contents incremented. The routine produces a horizontal scale for the maximum value in array B found in lines 190 to 220 and prints both the limits of each class in an I loop and an asterisk for each element in an inner J loop. Note the use of semicolons at the end of print lines 290 and 310 to suppress the carriage return, and line 330 to supply it.

The LEFT$ function in lines 250 and 260 is to print the left-most M characters of the string; this function varies between machines. The TAB function specifies horizontal position on the screen. If it is not available, use 17 additional spaces for TAB(17). Ensure array B is dimensioned for at least 30 elements.

```
100 R = (A(N) — A (1))/20
110 E = LOG (ABS(R))/LOG (10)
120 E = INT(E) + INT ((SGN(E)—1)/2)
130 C = INT(R/10 E + 0.5) * 10↑E
140 N1 = INT(R * 20/C + 0.5) + 1
150 FOR I = 1 TO N
160 J = INT((A(I) — A(1))/C + 1
165 REM ADD ELEMENT A(I) TO CLASS J
170 B(J) = B(J) + 1
```

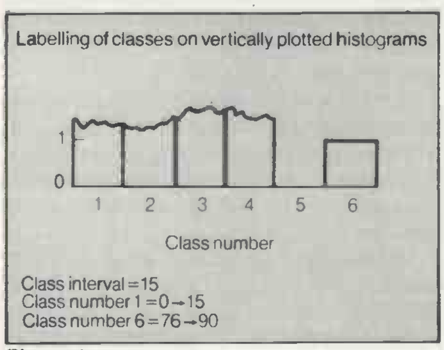



**Figure 4.**

```
180 NEXT I
190 M = B(1)
200 FOR I = 2 TO N1
210 IF B(I) > M THEN M = B(I)
220 NEXT I
230 PRINT 'NUMBER OF VALUES IN
    HISTOGRAM IS'; N
240 PRINT
250 PRINT TAB (17); LEFT$
    ('             111111111122222',M)
260 PRINT TAB (17); LEFT$
    ('1234567890123456789012345678901234', M)
270 PRINT TAB (17); LEFT$
    ('-------------------------', M)
280 FOR I = 1 TO N1
290 PRINT A(1) + (I—1) * C; ' — '; A(1)
    + I * C;
300 FOR J = 1 TO B(I)
305 REM PRINT * FOR EACH ELEMENT
    IN CLASS B(I)
310 PRINT '*';
320 NEXT J
330 PRINT
340 NEXT I
350 PRINT
360 PRINT 'CLASS INTERVAL IS '; C
```

The advantage of plotting horizontally is that class limits can be given for each class: the disadvantage is a loss in readability. The user may need to add print specifications to line 290. As they are indeterminate, I have omitted them. The routine will handle positive and negative data of any size. Machines with graphics can plot better characters than *, use reverse space on the Pet.

- **Vertical plotting:** The problem is to fit the class limits on the bottom of the plot. Thus, 25 classes on a 40-column screen give 1.6 characters for each limit. Those limits could be staggered on separate lines but that would require four lines and would be unreadable. The system adopted is to number the classes, state the class interval, and define fully the end-most classes of the histogram. See figure 4 which refers to the data in figure 3.

The routine is the same as far as line 240. An I loop is used to step through all values from M — the maximum number of values in any class — to one, and an inner J loop examines all of the B array for each I. An asterisk is plotted if the contents of a class are greater than or equal to the current I value.

Scales are produced together with supplementary information, the result is a plot of class number against frequency. Comments regarding LEFT$, TAB, and data are as before.

```
100 R = (A(N) — A(1))/25
110 E = LOG(ABS(R))/LOG(10)
120 E = INT(E) + INT((SGN(E)—1)/2)
130 C = INT(R/10↑E + 0.5) * 10↑E
140 N1 = INT(R * 25/C + 0.5) + 1
150 FOR I = 1 TO N
160 J = INT((A(I) — A(1))/C) + 1
170 B(J) = B(J) + 1
180 NEXT I
190 M = B(1)
200 FOR I = 2 TO N1
210 IF B(I) > M THEN M = B(I)
220 NEXT I
230 PRINT 'NUMBER OF VALUES IN
    HISTOGRAM IS'; N
240 PRINT
250 FOR I = M TO 1 STEP —1
260 PRINT I; 'I';
270 FOR J = 1 TO N1
280 IF B(J) > = I THEN 310
290 PRINT'  ';
300 GO TO 320
310 PRINT '*';
320 NEXT J
330 PRINT
340 NEXT I
350 FOR I = 1 TO N1
360 PRINT ' — ';
370 NEXT I
380 PRINT TAB(9); LEFT$
    ('          1111111111222222222223', N1)
390 PRINT TAB(9); LEFT$
    ('1234567890123456789012345678 90, N1)
400 PRINT TAB(27) 'CLASS NUMBER'
410 PRINT 'CLASS INTERVAL = '; C
420 PRINT 'CLASS NUMBER 1 RANGE';
    A(1); '—>'; A(1) + C
430 PRINT 'CLASS NUMBER'; N1;
    'RANGE'; A(1) + (N1 — 1) * C; '—>';
    A(1) + N1*C
```

A barchart of the data is shown in figure 5. Two sets of data may be another. Instead of plotting points, however, bars are plotted which extend to the horizontal axis. The horizontal values are non-negative.

Consider a barchart of a company's profits from 1970 to 1979:

Profit
1 2.5 1 0.5 —1 —2 0.5 1.0 1.5 1
70 71 72 73 74 75 76 77 78 79
Year

A barchart of the data is shown in figure 5. Two sets of data may be compared by superimposing their individual barcharts and plotting the bars of each with different characters. Whichever of the two data sets has a lower absolute value for the horizontal axis value considered — years in example — has all its bar plotted; the bar of the other data set is added to it.

The horizontal axis values are finite and limited to 30 in the routine to fit on a 40-column screen. The vertical axis values are scaled if they would otherwise not fit on a 25-line screen. Those limits may be altered to suit different screen sizes and printer widths. The arrays are not sorted.

- **Single data set:** The routine needs the maximum and minimum values in the array. They are both assigned the values of the first element of the array and are then compared with the rest. That is shown in lines 100 to 150 of the next listing where M is the maximum and X the minimum values.

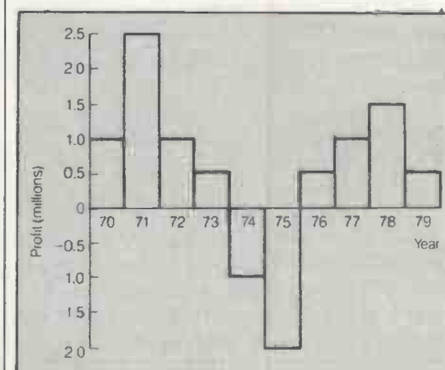



**Figure 5.**

The scaling factor, S, is calculated to bring the barchart within 25 lines, if that would be the case anyway, S = 1. The maximum value is set to zero if less than zero, as is the minimum value if it is greater than zero after line 150. That ensures a horizontal axis appears on the barchart.

The technique used to produce the barchart is the same as for the vertical histogram. An I loop steps through the vertical axis values and a J loop steps through the array plotting asterisks where necessary. The decrements in the I loop are in steps of S.

Both axes are labelled; the vertical axis with a scale and the horizontal with a universal scale set to the maximum screen width. Line 210 ensures that vertical scale values have at most two decimal places.

```
100 M = A(1)
110 X = M
120 FOR I = 2 TO N
130 IF A(I) > M THEN M = A(I)
140 IF A(I) < X THEN X = A(I)
150 NEXT I
160 IF M < 0 THEN M = 0
170 IF X > 0 THEN X = 0
180 S = 1
190 IF M — X > 24 THEN S = (M — X)/24
200 FOR I = M TO X STEP —S
210 I = INT (I * 100)/100
```

```
220 PRINT I; TAB(7) '1';
230 FOR J = 1 TO N
240 IF I = 0 THEN 290
250 IF A(J) > = I AND I > 0 THEN 310
260 IF A(J) < I AND I < 0 THEN 310
270 PRINT '  ';
280 GO TO 320
290 PRINT '—';
300 GO TO 320
310 PRINT '*';
320 NEXT J
330 PRINT
340 NEXT I
350 PRINT TAB(8); LEFT$
    ('          11111111112222222223',N)
360 PRINT TAB(8); LEFT$
    ('123456789012345678901234567890',N)
370 PRINT
```

• **Two data sets:** The procedure is as for the single data set; the maximum and minimum values M and X now apply to both arrays A and D. The only problems concern which character should be plotted in each bar. Consider the profits of two companies A and B. A barchart of the data is shown in figure 6.

Company A
1 2.5 1 0.5 —1 —2 0.5 1 1.5 1
Company B
1.5 2 0.5 1 —0.5 —1 —0.5 0 1 2
Year
70 71 72 73 74 75 76 77 78 79

The first set of data is plotted by '*'; the second by 'X' as specified in lines 220 and 230 of the routine. There are four combinations of the values of the data A(J) and D(J), and the loop pointer I used to step through the barchart from the maximum to the minimum values M and X — figure 7. M and X are adjusted with zero as in the previous routine.

There is one combination of A(J) and D(J) not shown in figure 7 which occurs when they are on opposite sides of the horizontal axis. Their signs will be different at that point — 1 if positive, 0 if zero, —1 if negative — and is identified by the test in line 380. Lines 320 to 350 resolve when no bar is plotted, line 360, and line 300 plots the axis. A vertical scale is produced, the routine scales A(J) and D(J) automatically to fit within a 25 line screen. A horizontal scale is printed below the barchart which is a plot of array element — years in the example — against magnitude — profit.

```
100 M = A(1)
110 X = M
120 FOR I = 1 TO N
130 IF A(I) > M THEN M = A(I)
140 IF A(I) < X THEN X = A(I)
150 IF D(I) > M THEN M = D(I)
160 IF D(I) < X THEN X = D(I)
170 NEXT I
180 IF M < 0 THEN M = 0
190 IF X > 0 THEN X = 0
195 REM SCALE VERTICAL AXIS
200 S = 1
210 IF M—X > 24 THEN S = (M—X)/24
220 PRINT 'FIRST INPUT DATA SET IS
    PLOTTED *'
230 PRINT 'SECOND INPUT DATA SET IS
    PLOTTED X'
240 PRINT
250 FOR I = M TO X STEP —S
260 I = INT (I * 100)/100
270 PRINT I; TAB(7) '1';
280 FOR J = 1 TO N
290 IF I < > 0 THEN 320
300 PRINT '—';
310 GO TO 490
320 IF A(J) > = I AND I > 0 THEN 380
```

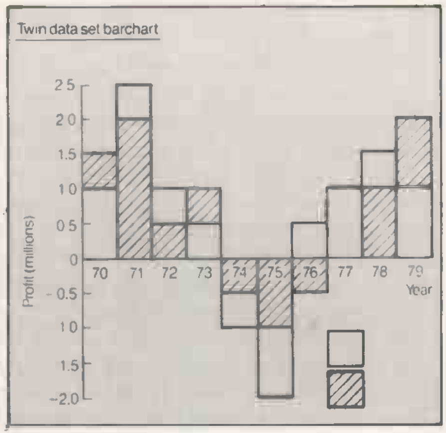



**Figure 6.**

```
330 IF A(J) < = I AND I < 0 THEN 380
340 IF D(J) > = I AND I > 0 THEN 380
350 IF D(J) < = I AND I < 0 THEN 380
360 PRINT '  ';
370 GO TO 490
380 IF SGN (A(J)) + SGN (D(J)) = 0 THEN
    470
390 IF ABS (A(J)) > ABS (D(J)) THEN 420
400 IF ABS (A(J)) > = ABS(I) THEN 430
410 GO TO 450
420 IF ABS (D(J)) > = ABS(I) THEN 450
430 PRINT '*';
440 GO TO 490
450 PRINT 'X';
460 GO TO 490
470 IF SGN(I) = SGN (A(J)) THEN 430
480 PRINT 'X';
490 NEXT J
500 PRINT
510 NEXT I
520 PRINT TAB(12); LEFT$
    ('          11111111112222222223',N)
530 PRINT TAB(12); LEFT$
    ('123456789012345678901234567890',N)
```

The J loop from lines 280 to 490 plots either a blank, a '—', a '*' or an 'X' for each element in arrays A and D. The code is somewhat complex but reflects the situations in figure 6. The ABS function — sometimes called MOD — gives the absolute value of its argument, thus ABS(5) = ABS(—5) = 5.

Next we consider the plotting of multiple low-resolution graphs on a VDU, screen or printer. The graphs are produced with the x-axis horizontal and sealed to fit within 40 characters, sealing factor S, and within 25 lines, sealing factor S1. A maximum of six sets of data can be plotted with any number of data items in each set provided this number is the same for each set. The x co-ordinates of all points are in an array X, the y co-ordinates are in a two-dimensional array Y(I,J) where I is the plot number and J the data elements. For example, to plot two graphs of points:

(3,4) (2,1) (0,0) (—7,2) (—8,—2) (—5, —1.5)
and (3,7) (2,8) (0,10) (—7,—2) (—8,—3) (—5,0)

the X array would be:

X(1) = 3 X(2) = 2 X(3) = 0 X(4) = —7 X(5) = —8 X(6) = —5

and the Y array would contain:

Y(1,1) = 4 Y(1,2) = 1 Y(1,3) = 0 Y(1,4) = 2 Y(1,5) = —2 Y(1,6) = —1.5
Y(2,1) = 7 Y(2,2) = 8 Y(2,3) = 10 Y(2,4) = —2 Y(2,5) = —3 Y(2,6) = 0

Six special characters are used to plot the graphs, one for each, an asterisk is used to show where two or more graphs coincide.

The routine attemps to fill the VDU screen as full as possible and may omit axes. Full details of the plot, maximum and minimum values of each axis, scale of each axis and the character used for each plot are given, and the routine pauses to allow that to be read before the screen is cleared or allowed to scroll up for the plot. As 40 by 25 gives poor curves, printing of graphs is recommended. The suggested plot values are 65 lines of 78 characters for a Pet printer, of 62 lines of 123 characters for a Teletype or IBM terminal. Alter values in lines 100 and 110.

The routine prints-out a character array to generate each line of the plot P$. That should be dimensioned for 40 characters and is filled initially with blanks. Axis characters are added where necessary and a pair of nexted J and K loops, lines 510 to 630 and 520 to 620 examine each plot and all values in the array for each plot, and place appropriate plot characters at position M in P$.

If an axis character is at position M, it is overwritten. If a plot character is at position M, it is replaced with '*'. W and W1 are the maximum and minimum values for the x-axis; Z and Z1 are the maximum and minimum values for the y-axis. They are found using the normal technique. The arrays are not sorted, and the data may be in any order provided x and y co-ordinates are in corresponding positions in the arrays. F holds the number of graphs being drawn. Note STR(A$,X,Y) takes Y characters from A$ starting with the Xth.

```
100 N1 = 39
110 N2 = 24
120 W = X(1)
130 W1 = W
140 Z = Y(1,1)
150 Z1 = Z
160 FOR I = 2 TO N
170 IF X(I) > W THEN W = X(I)
180 IF X(I) < W1 THEN W1 = X(I)
190 NEXT I
200 FOR I = 1 TO F
210 FOR J = 1 TO N
220 IF Y(I,J) > Z THEN Z = Y(I,J)
230 IF Y(I,J) < Z1 THEN Z1 = Y(I,J)
240 NEXT J
250 NEXT I
260 D$ = '+:X=;0'
270 S = (W—W1)/N1
280 S1 = (Z—Z1)/N2 + 0.01
290 PRINT 'X-AXIS HORIZONTAL,
    SCALED'; S; ':1'
300 PRINT 'Y-AXIS VERTICAL, SCALED';
    S1; ':1'
310 PRINT
320 PRINT 'X-AXIS VALUES FROM ';W1;
    'TO';W
330 PRINT 'Y-AXIS VALUES FROM ';Z1;
    'TO';Z
340 PRINT
350 FOR I = 1 TO F
360 PRINT 'PLOT'; I; 'IS DENOTED BY';
    STR(D$,I,1)
370 NEXT I
380 PRINT '* INDICATES TWO OR MORE
    CO-INCIDENT POINTS'
390 PRINT
400 A2 = 1
405 REM SET LOCATION OF VERTICAL
    AXIS
```

*(continued on next page)*

*(continued from previous page)*

```
410 IF W1 < 1 AND W > 0 THEN A2 =
    INT(ABS(W1)/S + 1)
420 A1 = 0
425 REM SET LOCATION OF
    HORIZONTAL AXIS
430 IF Z1 < 1 AND Z > 0 THEN A1 = 1
440 FOR I = 1 TO N2 + 1
450 C$ = '.'
460 IF A1 = 1 AND I = INT(Z/S1 + 0.5)
    + 1 THEN C$ = '—'
470 FOR J = 1 TO N1
480 P$(J) = C$
490 NEXT J
500 IF A2 > 0 THEN P$(A2) = 'I'
510 FOR J = 1 TO F
520 FOR K = 1 TO N
530 IF INT((Z — Y(J,K))/S1 + 0.5) + 1 <>
    I THEN 620
540 M = INT(X(K)/S) + 1
545 REM IF GRAPH ALL NEGATIVE
    CALCULATE NEW M
550 IF W < 0 THEN M = N1 —
    INT(X(K)/S)
555 REM IF GRAPH POSITIVE
    CALCULATE NEW M
560 IF A2>0 THEN M = A2 + INT(X(K)/S)
570 IF P$(M) = '.' OR P$(M) = STR(D$,J,1)
    THEN 610
580 IF P$(M) = '—' OR P$(M) = '1' THEN
    610
590 P$(M) = '*'
600 GO TO 620
610 P$(M) = STR(D$,J,1)
620 NEXT K
630 NEXT J
640 FOR J = 1 TO N1
650 PRINT P$(J);
660 NEXT J
670 PRINT
680 NEXT I
```

• **High-density plotting:** The form of high-density plotting described quadruples the resolution of a VDU screen or printer but requires the graphics characters shown in figure 8. Those characters could be incorporated in the graph routine but we consider the use of PEEK and POKE instructions in a memory-mapped screen.

Memory-mapped means that the screen locations are part of memory, so writing a value into one of those memory locations using POKE causes the character having that value to appear on the screen. Similarly, to read a character on the screen we merely read, using PEEK, the appropriate memory location. On the Pet, the screen memory is locations 32768 to 33768.
memory-mapped location. Generally, if

We derive a Basic routine to plot a graph of x co-ordinates in array X against corresponding y co-ordinates in array Y — neither array is sorted. A machine-code routine's speed is unnecessary here; there is one listed in an article by A Clark in the July 1979 edition of *Practical Computing*,

The routine first finds the maximum and minimum values of each axis — XM and XN, YM and YN — in lines 110 to 200 and reads in the values of the characters in figure 8, 32 being the value of a blank. Lines 240 and 250 calculate the scales for the x and y axes respectively. Lines 260 to 340 display the information relevant to the plot including the axis scales and axis ranges.

If the x values of the curve to be plotted lie round the origin, a vertical axis is produced — lines 360 to 380. If its y values lie round the origin, a horizontal axis is produced — lines 400 to 420 — and an origin — line 430. An I loop from 450 to 570 plots all N co-ordinate pairs (X(I), Y(I)).

For each pair the screen row, SR, and screen column, SC, are found and that position insepcted to yield a character value, E, in line 470. The number of this character in figure 8 is either found and set in variable J or J is set to zero — lines 480 to 510. SC and SR are examined to see which quadrant the point is to be plotted and the corresponding position in array T of the character set in variable E1 in line 540. The current contents of point — SC,SR — on the screen — variable J, J = 0 is a blank square — and the character to be plotted are ORed in line 550 and plotted in line 560.

Finally, lines 580 and 590 contain the data for the T array: 32 is a blank square; 108 is character 1 in figure 8 and goes into variable T(1); 124 is character 2 in figure 8 and goes into variable T(2), and so on. Line 340 clears the screen.

Those who do have a Pet but who have a screen of the same size, should alter the

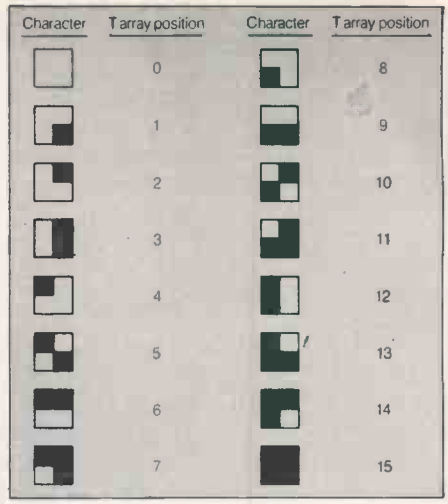
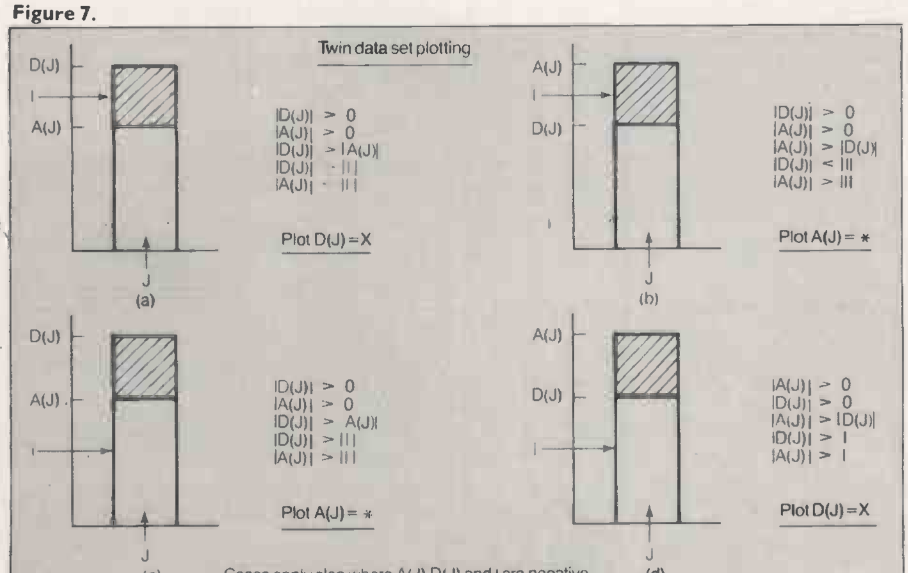



**Figure 8.**

value in line 100 to one less than the first your screen is L lines of C characters, replace 39 in line 240 by C—1, 24 in line 250 by L—1, 24 in line 360 by L—1 and 39 in line 400 by C—1. Ensure T is dimensioned for 16 elements, including the zero element T(0).

```
100 B = 32767
110 XM = X(1)
120 XN = XM
130 YM = Y(1)
140 YN = YM
150 FOR I = 2 TO N
160 IF XM < X(I) THEN XM = X(I)
170 IF YM < Y(I) THEN YM = Y(I)
180 IF XN > X(I) THEN XN = X(I)
190 IF YN > Y(I) THEN YN = Y(I)
200 NEXT I
210 FOR I = 0 TO 15
220 READ T(I)
230 NEXT I
240 RX = (XM — XN)/39
250 RY = (YM — YN)/24
260 PRINT 'PLOT STATISTICS'
270 PRINT 'NUMBER OF POINTS IN
    PLOT: ';N
280 PRINT 'X-AXIS FROM ';XN; 'TO'; XM
290 PRINT 'Y-AXIS FROM '; YN; 'TO'; YM
300 PRINT 'X-AXIS HORIZONTAL,
    SCALED'; RX; ':1'
310 PRINT 'Y-AXIS VERTICAL, SCALED';
    RY; ':1'
320 PRINT 'TO CONTINUE ENTER 1';
330 INPUT E1
340 PRINT '□'
350 IF XN > 0 OR XM < 0 THEN 390
360 FOR I = 0 TO 24
370 POKE B + I * 40 + 1 + ABS(XN)/RX,93
380 NEXT I
390 IF YN > 0 OR YM < 0 THEN 430
400 FOR I = 0 TO 39
410 POKE B + 40 * INT(YM/RY) + 1 + I,64
420 NEXT I
430 POKE B + 40 * INT(YM/RY) + 1 +
    ABS(XN)/RX,91
440 FOR I = 1 TO N
450 SR = (YM — Y(I))/RY
460 SC = (ABS(XN) + X(I))/RX
470 E = PEEK(B + 1 + INT(SC) + INT(SR)*
    40)
480 FOR J = 0 TO 15
490 IF E = T(J) THEN 520
500 NEXT J
510 J = 0
520 E1 = INT(SC—INT(SC) + 0.5)
530 E2 = INT(SR—INT(SR) + 0.5)
540 E1 = (1—E1) * (4 + 4*E2) + E1*(2—E2)
550 E2 = E1 OR J
560 POKE B + INT (SC) + INT (SR) *
    40 + 1, T(E2)
570 NEXT I
580 DATA 32, 108, 124, 225, 126, 127, 226, 251
590 DATA 123, 98, 255, 254, 97, 252, 236, 160
```

**Figure 7.**



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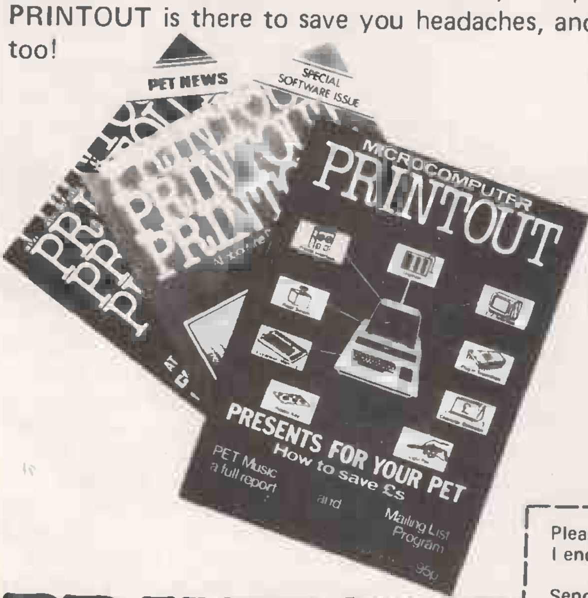


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# Co-ordinate-drilling simulation

IT IS OFTEN said that there is nothing new under the sun and that which appears new has, in fact, been done before. Some time ago, I found towards the back of Nick Hampshire's book, The Pet Revealed, an ingenious program which allows the Pet to plot in quarter-scale graphics. Some time later, I saw in the May 1979 issue of *Practical Computing,* an article on co-ordinate drawing for Kim.

At that time, I was looking for an idea for an application program which would demonstrate that even with the limited eight-bit user port on the Pet, one could achieve as much as industrial micros in, say, machine control.

Locations 5000 to 5036 will contain variables placed there during program run.

| | | | |
|---|---|---|---|
| S60 | 5037 | A0 00 | LDY #0 |
| | 5039 | A2 00 | LDX # 0 |
| S60A | 503B | B1 00 | LDA (start 1) Y |
| | 503D | 9D 00 50 | STA X1 |
| | 5040 | C8 | INC Y |
| | 5041 | E8 | INC X |
| | 5042 | E0 08 | CPX # 8 |
| | 5044 | D0 F5 | BNE S60A |
| | 5046 | A5 00 | LDA Start 1 |
| | 5048 | 18 | CLC |
| | 5049 | 69 04 | ADC 4 |
| | 504B | 85 00 | STA Start 1 |
| | 504D | A5 01 | LDA Start 1 + 1 |
| | 504F | 69 00 | ADC 0 |
| | 5051 | 85 01 | STA Start 1 + 1 |
| | 5053 | 4C 58 50 | JMP 580 |

**Table 1.**

This program is a good example of not re-inventing the wheel. By modifying parts of various programs one can create a new program. The program consists of a number of basic elements:

- A machine code co-ordinate-positioning routine to drive stepper motors in the X and Y axis.
- A control section to drive a DC motor in the Z, vertical, axis and also drive the drill motor. A stepper motor would really be ideal, but for cost and demonstration purposes a DC motor is adequate.
- A tone generator to output on the CB2 line to warn of imminent motor action.
- A screen-plotting routine to display the drill path.
- A screen-plotting routine to display the hole co-ordinates as they are drilled.
- A routine to output the co-ordinate plots from the screen to the printer. Indication of both quantity drilled, total run-time and the job number and operator prompts.

## by J A Forbes

Stepper motors were selected for the X and Y axes for two reasons. They are extremely accurate since while they may rotate typically 7°30' per step, any error in each step is not cumulative. The accuracy of resolution over a given distance is merely the function of the gear ratio used and the number of steps. The higher the number of steps the greater the resolution.

Secondly, they are very easy to use since there is no feedback positioning circuit. In a normal servo, one requires a positioning demand signal and a means of receiving an indication of shaft angle. That entails mechanical coupling and some degree of linearisation control and also rate damping.

In any case, stepper motors are generally used on most co-ordinate machine-control applications. In short, the aim is to simulate, as far as possible, a typical co-ordinate drilling program with as many of the operator-prompting and control characteristics as one might expect to see in a real industrial application.

The first main problem was to examine closely the existing May 1979 *Practical Computing* program for the Kim. The first obvious difference was that the program relied on the zero-page facility of the 6502 microprocessor. That is a feature which allows, in effect, two-byte addressing where other micros would use three bytes. Also, the zero page allows indexed addressing of a very flexible type.

Unfortunately, the Pet uses most of its own zero page for the Pet operating system. That could perhaps have been overcome by a trick outlined in the Pet Revealed. That is to write a subroutine which shifts all the zero-page data to a secure location at the top of memory, first having disabled the Pet operating system with a software interrupt.

One could then use the zero page and, when finished, use another subroutine to replace the original contents. However, one loses the jiffy clock in the process and so I decided to simply re-write the Kim program using absolute addressing, i.e., three bytes.

The program has two main features; the first is that it operates in double-precision arithmetic. That means that instead of using one byte to represent the co-ordinate value in X or Y, two are used. Obviously if one byte was used, the resolution would be poor since the maximum decimal value which could be used for, say, the X co-ordinate, would be 255.

The second feature is that there is a table of entered co-ordinates which, to be accessed repeatedly, requires the use of a zero-page address. Fortunately, there are a few bytes available on zero page in the Pet. They are the USR function bytes at memory locations 001 and 002.

The remaining variable values which in the Kim program were also stored in zero page, stored in a higher memory location. Having realised that it was possible, all that remained was to decide where to store the program.

User port bit allocation. Reference page 79 Pet manual.

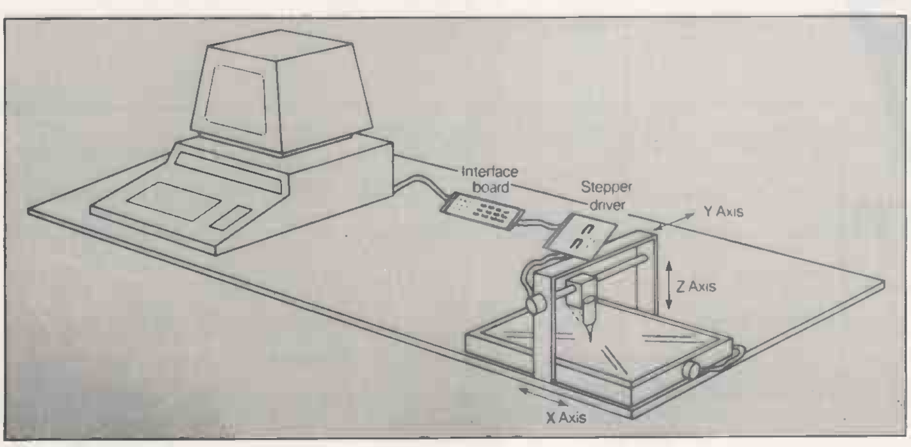
| Pin ident | Signal | label |
|---|---|---|
| C | PA0 | Unused |
| D | PA1 | X axis signal T, motor step, HI to Lo for step |
| E | PA2 | X axis signal R, motor direction, hI clockwise |
| F | PA3 | Y axis signal T, motor step, HI to Lo for step |
| H | PA4 | Y axis signal R, motor direction, HI clockwise |
| J | PA5 | Z axis, 1 = Drive down = 0 Drive up |
| K | PA6 | 0 1 |
| L | PA7 | Drill motor, 0 = off, 1 = turning |
| M | CB2 | Audio tone output |
| N | GND | Digital ground |

**Table 2.**

It would have been possible to re-adjust the top of memory to provide a secure section, but at the time, that did not occur to me and I simply chose an arbitrary location in the middle of memory. A good point to those writing such assembly code programs is to consider all factors prior to writing because without the use of a proper assembler facility, it is not an easy matter to alter all the locations manually for a second time.

The co-ordinate-drive program starts at Hexadecimal location 5000 with the previous zero-page variables contained from 5000 to 5036. The program proper starts a 5037 with the co-ordinate table starting at 5300 and the stepper-motor drive routine at 5400.

A full program listing is not given since



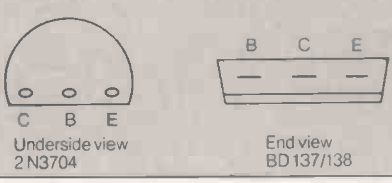
**Construction**

Use .1in. pitch Vero board.
Suggest .1in. printed circuit edge connectors for connections to Vero board.

**Components**

| | | |
|---|---|---|
| Interface board: | Resistors | 8 off 10K ¼ watt |
| | | 8 off 6.8K ¼ watt |
| | | 7 off 1K ¼ watt |
| | | 1 off 100 ¼ watt |
| | Transistors | 16 off 2N3704 |
| | | 6 off BD137 |
| | | 7 off BD138 |
| | Diodes | 12 off IN4002 |
| | Loudspeaker | 15 to 35ohm 3in. |
| Stepper board: | Resistors | 2 off 100ohm ½ watt |
| | | 2 off — depends on motor |
| | Capacitors | 2 off 0.1µF 25V wkg |
| | Integrated circuits | 2 off SAA1027 see text |
| | Sockets | 2 off 16 pin DIL |
| Miscellaneous | Pet user port connector from Intex Datalog Ltd | |

Transistor connection




the May 1979 article is adequate in most respects. However, because of the change from zero-page, the first part is given from 5037 to 5053 in table 1 to show the alterations. The remaining changes are to achieve absolute addressing only, but due to the type of stepper motor chosen, the motor drive routine is slightly different and is described.

In the original Kim program, the program took care of the four-phase switching sequence necessary to make the motors step. However, it is now possible to obtain good stepper motors where the logic of the phase switching is taken dealt with by an integrated circuit. Figure 1 shows the overall circuit diagram of the SAA1027 IC and motor windings. They are available with data sheet from McLennan Servo Supplies Ltd, the integrated circuits are £4.85 each, and the motors vary from £11 to £32, depending on performance.

The IC greatly simplifies the software requirements since only two signals are required. Logic high on the trigger input T enables phase switching while logic low, i.e., one low-high-low transition gives one motor step. Logic high on the R input gives anticlockwise rotation and logic low provides clockwise rotation.

Table 1a gives the motor drive routine, note that where it is necessary to alter the logic level of the R input to the IC such that R is at logic high, an extra instruction is required to set R high prior to stepping the motor. It is not possible to both step the motor and also set R high in the one move. Therefore, an instruction to set R high occurs at both X minus and Y minus stages.

The assembly program is provided in Basic and poked into memory during program set-up which takes about one minute. Once it is in memory, however, together with the high-density plot program which is stored in cassette two buffer, it is possible to use a machine code SAVE and have the co-ordinate and plot programs stored as normal Basic type files.

They can then be called using normal direct commands prior to loading the main program and avoid the delay in poking. Note, however, that the machine code or binary SAVE command given on page 115 of the Pet manual will not work for Pet disc. For those using a disc, the correct SAVE format, for example, for the co-ordinate program is as follows:

- Having poked the machine-code program into memory with the main program, key SYS64785 to call the Tim machine-language monitor and key.
  .S "0: COORD DRIVE", 08, 5000, 5469
  After returning to Basic, examine the director and you will find the program, coord drive, stored as normal. One can now load using normal commands, in a matter of seconds.

Now refer to table 2 which gives the information about how the Pet user port is allocated. Before finishing with the part of the program concerned with the co-ordinate drive, there are one or two final points to note. The torque of stepper motors falls rapidly as the speed is increased and referring to table 2 locations 545A and 545C set the time delay between each motor step.

Users will have to vary the values to suit the application, but if you intend to use the lower-priced motors, whatever you intend driving must have a low inertia and a very low friction movement. The other point concerns the interface between the Pet and the SAA1027-driven IC.

When working with microcomputers, it is a good idea to provide some form of isolation between the computer and the application so as to reduce greatly the element of damage due to accidental short-circuit. Details are of a suitable interface circuit which can be made on Veroboard using discrete components are

```
Stepper motor drive subroutine
located at Hex 5400
          5400  AD 17 50  LDA Z1
          5403  F0 0B     BEQ DoY
          5405  10 06     BPL Forw Y
          5407  20 2F 54  JSR X minus
          540A  4C 10 54  JMP DoY
Forw X    540D  20 24 54  JSR X plus
DoY       5410  AD 16 50  LDA Z0
          5413  F0 0B     BEQ Del
          5415  10 06     BPL Forw Y
          5417  20 4A 54  JSR Y minus
          541A  4C 20 54  JMP Del
Forw Y    541D  20 3F 54  JSR Y plus
Del       5420  20 5A 54  JSR Delay
          5423  60        RTS
X plus    5424  A9 1C     LDA #00011100
          5426  8D 4F E8  STA $E84F
          5429  A9 1E     LDA #00011110
          542B  8D 4F E8  STA $E84F
          542E  60        RTS
X minus   542F  A9 1A     LDA #00011010
          5431  8D 4F E8  STA $E84F
          5434  A9 18     LDA #00011000
          5436  8D 4F E8  STA $E84F
          5439  A9 1E     LDA #00011110
          543B  8D 4F E8  STA $E84F
          543E  60        RTS
Y plus    543F  A9 16     LDA #00010110
          5441  8D 4F E8  STA $E84F
          5444  A9 1E     LDA #00011110
          5446  8D 4F E8  STA $E84F
          5449  60        RTS
Y minus   544A  A9 0E     LDA #00001110
          544C  8D 4F E8  STA $E84F
          544F  A9 06     LDA #00000110
          5451  8D 4F E8  STA $E84F
          5454  A9 1E     LDA #00011110
          5456  8D 4F E8  STA $E84F
          5459  60        RTS
Delay     545A  A2 10     LDX $10
Do        545C  A0 30     LDY $30
D1        545E  88        DEY
          545F  C0 00     CPY, 0
          5461  D0 FB     BNE, D1
          5463  CA        DEX
          5464  E0 00     CPX, 0
          5466  D0 F4     BNE D0
          5468  60        RTS
```

Table 1a.

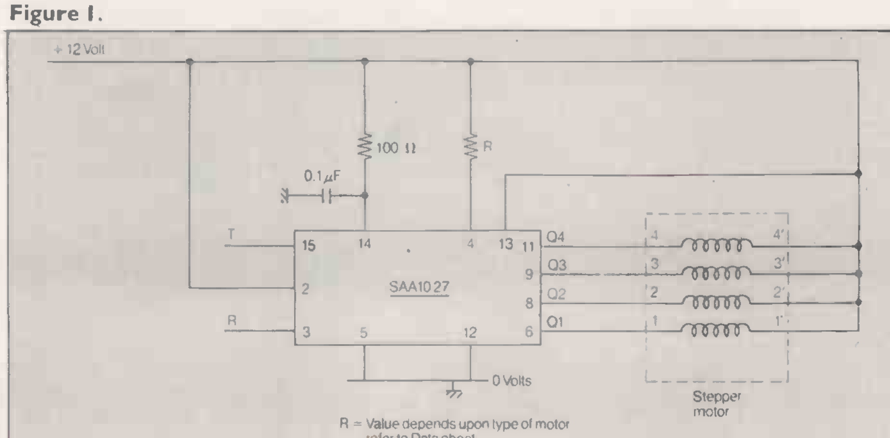
shown in figure 2, or if required the Darlington-configured transistors T1, T2 etc., can be purchased in integrated-circuit form.

However, many people do not have experience of ICs and the circuit given lends itself to home manufacture. The points on the diagram marked R and T go to R and T respectively on the stepper motor driver IC.

The reason for the driver transistors T5

*(continued on next page)*

**Figure 1.**



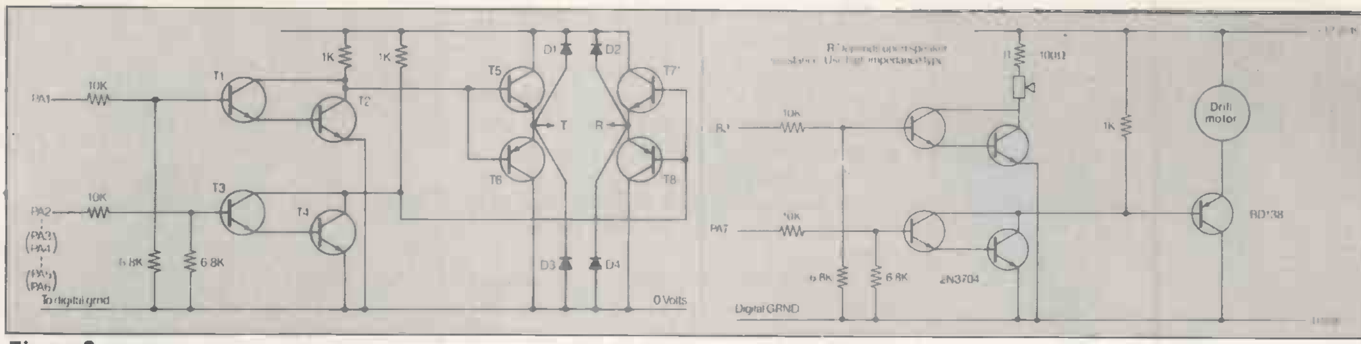



**Figure 2.**

*(continued from previous page)*
to T8 is so that having built the interface, one can use it for other general-purpose duties. For example, a model makers' DC motor can be inserted across points R and T and will rotate in one direction for inputs of 01 and in the opposite direction for inputs of 10. In this application, the points R and T are used independently. In my own interface, I include light-emitting diodes, LEDs, in series with the 1K collector resistors, thus giving a visible indication of the logic level of the output ports.

A power supply — figure 3 — providing +12V is required. The reason 12V is used for the supply to T5-T8 is that it allows for higher voltage DC motors when used and also meets the SAA1027 IC requirements for logic-switching levels.

The stepper motors run rather hot and the currents given in the supplier's data sheets are intended for specific voltages and should not be exceeded. The motors

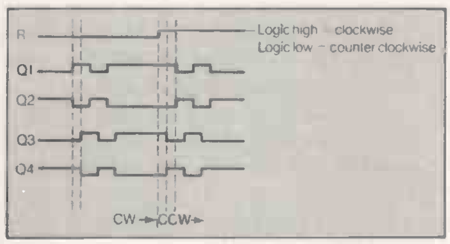



**Figure 1a.**

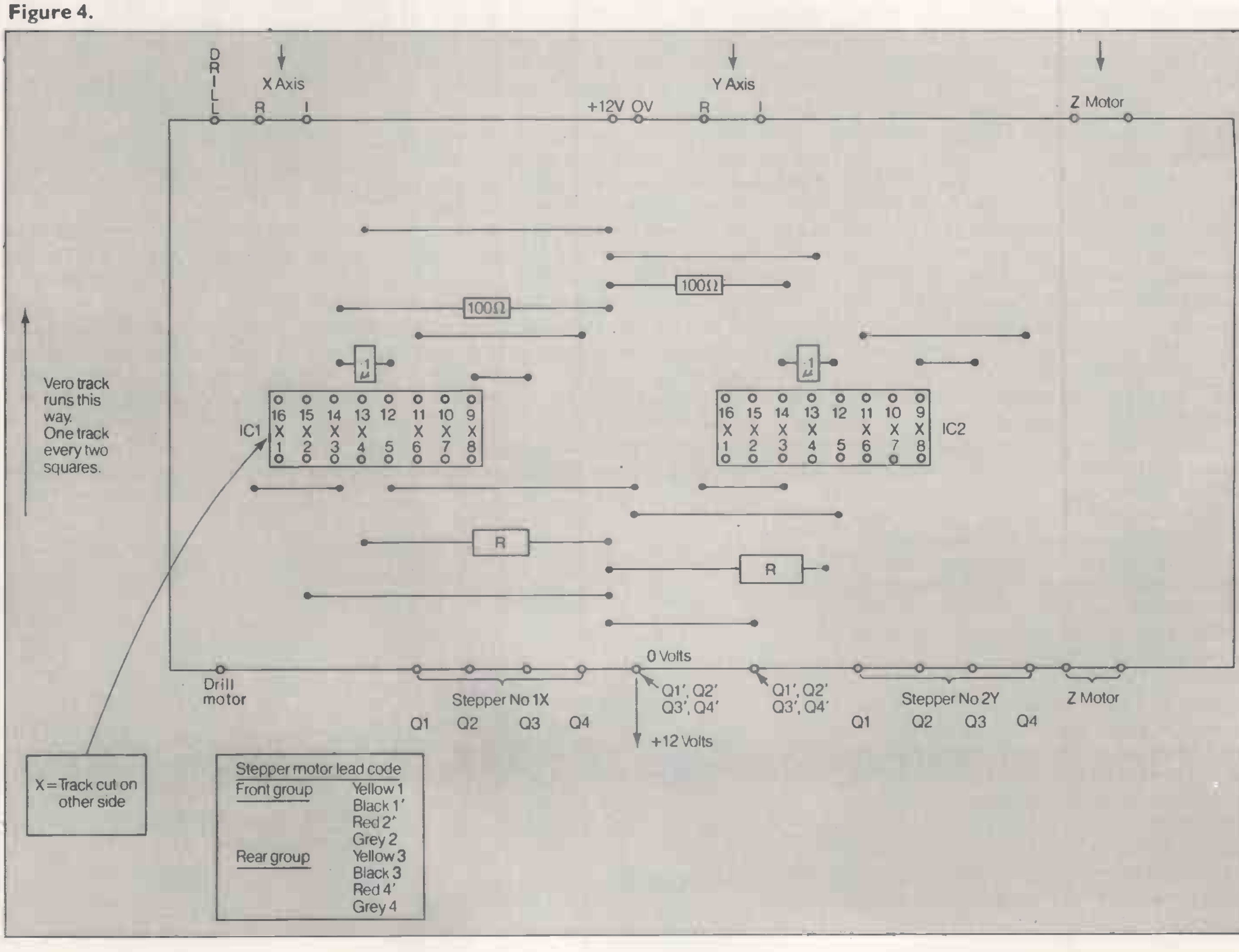
used in the application were type ID31 part number 112-31001, for 12V supply.

The original plotting program is given in the Pet Revealed. There is a high degree of similarity between it and the Basic version of the co-ordinate program given in the May 1979 issue of *Practical Computing.*

In the main program, the plotting program is intended for use in two ways. Firstly, it is used to make the assembly program alone plot each co-ordinate as it is drilled. Also before that, and after the user has entered his co-ordinates, to plot the path which the drill will describe and offer the option to re-enter the co-ordinates if, say, for example the drill appeared to take a path which would strike an object or perhaps show an uneconomical path between various co-ordinates.

Therefore, both the assembly version

**Figure 4.**



and the Basic version are used. The assembly version is poked into memory by the main program and is stored in the cassette two buffer. It may be saved separately in the co-ordinate drive pro-

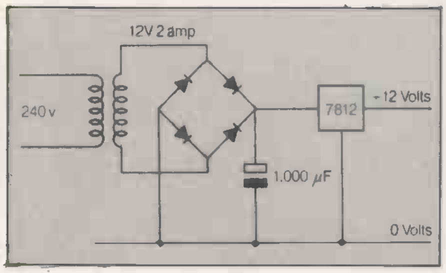



**Figure 3.**

gram to avoid the time delay in poking it into memory.

There is a difference, however, in the continuous path-plotting program from the original. In the original, the sequence of co-ordinates is entered by use of an INPUT command. In this application, the co-ordinates must be derived from the co-ordinate drive co-ordinates entered by the user.

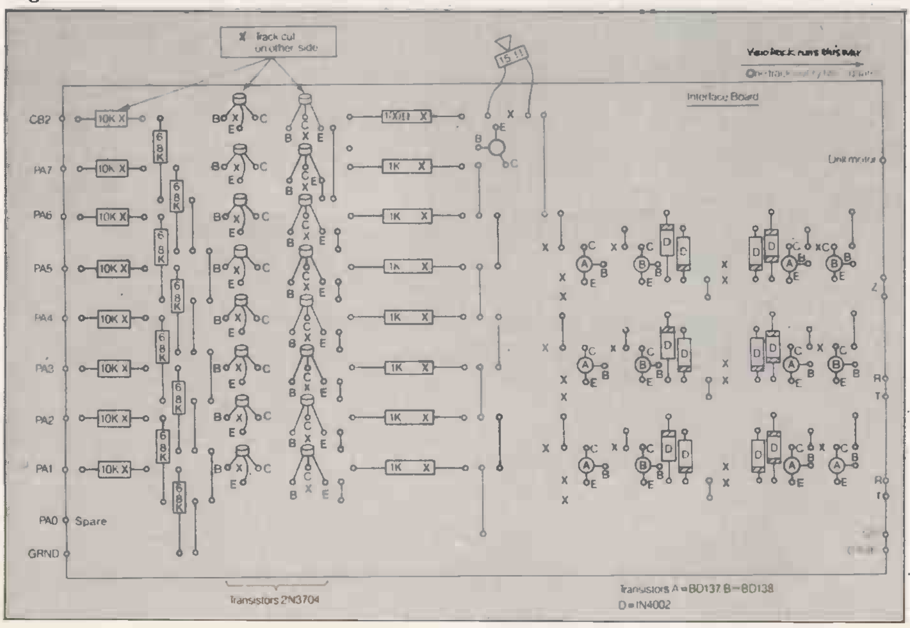
However, the plotting program has a maximum X value of 79 and a maximum Y value of 49. In the co-ordinate drive program, X and Y co-ordinates will typically have a maximum of, say, 1300 to take advantage of the resolution offered by the double-precision arithmetic.

Therefore, we use line 360 to divide the current X and Y input values by a factor, in this case 28, to ensure the plotting values are within limits. The new X, Y values are poked into successive locations of a plotting table which are used in line 890 to provide the substitute for the original INPUT statement.

It now remains to run through the main program and outline the activities in sections. Numbers refer to line numbers.

- 40, 50 and 60 cause the poke routines to place the assembly programs into memory using the routine from line 730 to 870.
- 70 sets the output registers to an initialised state.
- 80 makes the first co-ordinates equal to zero so that the motors always start and finish at zero.
- 100 sets the initial values of the plot table to zero.
- 110, 120 accepts job number and co-ordinates as inputs.
- 130 to 370 accepts the input co-ordinates and converts the decimal values between 0 and 1300 to a four-bit Hexadecimal value and then splits it into two bytes and stores the two bytes in successive locations in the co-ordinate table. That is necessary to provide for double-precision arithmetic working.
- 400 to 430 — if this is the last co-ordinate, the co-ordinate count variable CC is incemented and final values of zero are provided for the co-ordinate table and values of one for the plot routine — it cannot return to a zero value.
- 430 and 2070 to 2110 draws a plotting area on the screen.
- 450 to 500 and 880 to 1270 plots the expected drill path and offers the option to continue or re-enter the co-ordinates if the drill path is not acceptable.
- 1720 to 1740 requires confirmation that the operator has placed the workpiece in the drilling area, and if confirmed re-draws the screen plotting area.
- 1760 and 2120 to 2140 outputs an audible tone on the CB2 line to warn of imminent motor action.
- 1790 calls the co-ordinate drive routine and drives the stepper motors to the co-ordinate.
- 1795 finds the co-ordinates of the next plotted co-ordinates.
- 1800 calls the plot routine and plots the co-ordinates.
- 1820 to 1840 drives the DC motors for the Z axis for a predetermined time while operating the drill motor. Electrical end-stops by microswitches limit the travel and the value of 2000 is adjusted to suit the speed of the Z axis. In a real drilling machine, one would use a stepper motor and have a fixed drive count value for the required Z travel.
- 1860 and 2120 to 2140 output an audio tone to indicate drilling complete.
- 1870, 1890 offers another complete cycle.
- 1910 to 1960 and 2150 to 2240 prints on the screen the run time, batch quantity — number of cycles — and the job number and offers either that data or a printout of the co-ordinates as shown on the screen.

**Figure 5.**



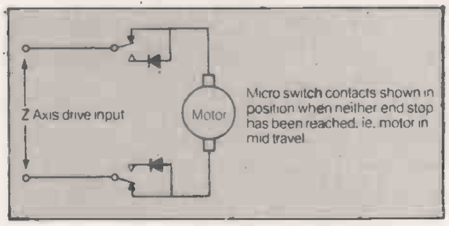




**Figure 6.**

The last routine is written for the Epson printer which is nearly identical to the printers marketed by Commodore. However, some of the control codes and character set are different, and the routine will not work on a standard Commodore printer. For a screen-print routine for the Commodore printer, refer to page 137 of the library of Pet subroutines by Nick Hampshire.

Figures 4 and 5 give a Veroboard layout. When soldering on Veroboard, take care not to make solder whiskers between tracks which is very easily done. It can cause instant destruction of integrated circuits. Connection between Veroboards is accomplished by using 0.1in. pitch PCB edge connectors.

Since two motors will have two phases energised at any one time, allowance should be made for that in the power supply. For the 12V motors used, a 2amp supply was catered for.

While the program and its details given were intended as a demonstration of capabilities, it is quite possible to use the program as the basis for an industrial drilling controller. The program will run without the hardware and it is suggested that you run it as a program only, to see the features. If you do so, there are delays which will take place as the program steps the motors to each co-ordinate.

One can adjust those delays at line 1660 — 545A and 545C in table 1a. The two assembly statements A230 and A030 are two loops; A230 is the outer loop and A030 the inner. Similarly, the delay while the Z axis, the drill, operates can be reduced by reducing the loop count of 2000 in lines 1820, 1830.

The use of a loop delay in lines 1820, 1830 does not give an exact travel distance for the vertical movement of the Z axis since there will be an element of creep due to different starting torques, etc. Figure 6 shows a method of stopping the Z axis by

*(continued on next page)*

*(continued from previous page)*

using small microswitches actuated by mechanical end stops. When one is engaged, it brings a diode into the circuit which will stop the motor. The diode will pass only a drive voltage in the proper polarity sense to drive the motor in a reverse direction from that which energised that particular switch.

```
10 PRINT"CS 8CD  DO YOU WISH PROGRAM DESCRIPTION,'Y'OR'N'"
20 GETZ$:IFZ$=""GOTO20
30 IFZ$="Y"THEN2250
40 PRINT"2CD 10CR R WAIT-SETTING UP":GOSUB540
50 GOSUB1280
60 GOSUB1600
70 POKE59459,255:POKE59471,30
80 FORI=21248TO21251:POKEI,0:NEXT
90 BC=0:CC=0:CO=21252:DC=20000:TIME$="000000"
100 POKEDC,0:POKE(DC+1),0:DC=DC+2
110 INPUT"CS 10CD 6CR       ENTER JOB NO ";J$
120 INPUT"CS 10CD 7CR        ENTER CO-ORD'S X AND Y";X$,Y$
130 N$=X$:E=0
140 REM90TO310,HEX CONVERSION
150 S=0:A$="":D=0
160 N=VAL(N$)
170 FORI=1TO4
180 Q=INT(N/16):R=N-16*Q+48
190 IFR>57THENR=R+7
200 A$=CHR$(R)+A$:N=Q:NEXT
210 Z$="00"
220 E$=Z$+RIGHT$(A$,2)
230 B$=Z$+LEFT$(A$,2)
240 N$=E$
250 FORI=0TO3
260 X=ASC(MID$(N$,4-I,1))-48
270 IFX>9THENX=X-7
280 S=S+X*16^I:NEXT
290 D=D+1:E=E+1
300 IFD=2GOTO330
310 POKECO,S:S=0
320 N$=B$:GOTO250
330 POKE(CO+1),S
340 IFE<>4 THEN   N$=Y$:CO=CO+2:GOTO150
350 X=VAL(X$):Y=VAL(Y$)
360 CO=CO+2:X=X/28:POKEDC,X:DC=DC+1:Y=Y/28:POKEDC,Y:DC=DC+1
370 PRINT"CS 8CD 4CR   RIS THIS THE LAST CO-ORD ?'Y'OR'N'."
380 GETZ$:IFZ$=""GOTO380
390 IFZ$="N"THENPRINT"CS":CC=CC+1:GOTO120
400 CC=CC+1
410 POKECO,0:POKE(CO+1),0:POKE(CO+2),0:POKE(CO+3),0:CO=CO+3
420 POKEDC,1 :POKE(DC+1),1 :DC=DC+2
430 GOSUB2070
440 DC=20000:FF=CC
450 FORI=CCTO0STEP-1
460 GOSUB880
470 NEXTI
480 CC=FF
490 PRINT"CH THIS IS A PLOT OF THE DRILL PATH"
500 PRINT"CHCDTO CONTINUE KEY 1.....TO RESTART KEY 2  "
510 GETZ:IFZ=1THEN1710
520 IFZ=2THENRUN70
530 GOTO510
540 DATA826
550 DATAA9,00,8D,E6,03,85,34
560 DATAA5,31,C9,32,90,03,EE,E6,03
570 DATAA5,30,C9,50,90,03,EE,E6,03
580 DATA2C,E6,03,F0,01,60
590 DATAA9,31,38,E5,31,85,31
600 DATA46,30,26,34
610 DATA46,31,26,34
620 DATA06,31,06,31,06,31,A5,31,06,31,26,32,06,31,26,32,10,65
630 DATA31,85,31,A5,32,69,80,85,32
640 DATAA6,34,A9,01,85,34,E0,00,F0,05,06,34,CA,90,F7
650 DATAA4,30,B1,31,A2,00,DD,CE,03,F0,0D,E8,E0,10,90,F6
660 DATAA9,04,8D,E6,03,60
670 DATAA5,33,D0,07,8A,05,34,18,AA,90,0A
680 DATAA5,34,49,FF,85,34,8A,25,34,AA
690 DATAAD,40,E8,49,20,29,20,F0,F7
700 DATABD,CE,03,A4,30,91,31,60
710 DATA20,7E,7E,61,7C,E2,FF,EC,6C,7F,62,FC,E1,FB,FE,A0
720 DATA*
730 READL
740 READA$
750 C=LEN(A$)
760 IFA$="*"THEN860
770 IFC<1ORC>2THEN850
780 A=ASC(A$)-48
790 B=ASC(RIGHT$(A$,1))-48
800 N=B+7*(B>9)-(C=2)*(16*(A+7*(A>9)))
810 IFN<0ORN>255THEN850
820 POKEL,N
830 L=L+1
840 GOTO740
850 PRINT"BYTE"L"= "A$" ???"
860 PRINT" ";
870 RETURN
880 X1=PEEK(DC):Y1=PEEK(DC+1):X2=PEEK(DC+2):Y2=PEEK(DC+3)
890 DC=DC+2
900 GOSUB920
910 RETURN
920 REM SUBROUTINE TO DRAW LINE
930 REM BETWEEN TWO POINTS ON SCREEN
940 REM CHECK CO ORDS IN BOUNDS
950 IF(X1>=0ANDX1<=79)AND(X2>=0ANDX2<=79)THEN980
960 ER$="X OUT OF RANGE"
970 RETURN
980 IF(Y1>=0ANDY1<=49)AND(Y2>=0ANDY2<=49)THEN1010
990 ER$="Y OUT OF RANGE"
1000 RETURN
1010 ER$=""
1020 XD=X2-X1
1030 YD=Y2-Y1
1040 REM NEAREST DIAGONAL
1050 A0=1:A1=1
1060 IFYD<0THENA0=-1
1070 IFXD<0THENA1=-1
1080 REM NEAREST HORIZ VERT
1090 XE=ABS(XD):YE=ABS(YD):D1=XE-YE
1100 IFD1>=0THEN1140
1110 S0=-1:S1=0:LG=YE:SH=XE
1120 IFYD>=0THENS0=1
1130 GOTO1160
1140 S0=0:S1=-1:LG=XE:SH=YE
1150 IFXD>=0THENS1=1
1160 REM SET UP
1170 TT=LG:TS=SH:UD=LG-SH:CT=SH-LG/2
1180 D=0
1190 REM WHILE MORE POINTS DO
1200 POKE48,X1:POKE49,Y1:POKE50,0:POKE51,D:SYS(826)
1210 IFCT>=0THEN1240
1220 CT=CT+TS:X1=X1+S1:Y1=Y1+S0
1230 GOTO1250
1240 CT=CT-UD:X1=X1+A1:Y1=Y1+A0
1250 TT=TT-1
1260 IFTT<0THEN RETURN
1270 GOTO1200
1280 DATA20535
1290 DATAA0,00,A2,00,B1,00,9D,00,50,C8,E8,E0,08,D0,F5,A5,00,18
1300 DATA69,04,85,00,A5,01,69,00,85,01,4C,58,50,EA,EA,AD,04,50
1310 DATA38,ED,00,50,8D,08,50,AD,05,50,ED,01,50,8D,09,50,AD,06,50
1320 DATA38,ED,02,50,8D,0A,50,AD,07,50,ED,03,50,8D,0B,50
1330 DATAA9,01,8D,14,50,8D,15,50,AD,08,50,10,05,A9,FF,8D,14,50
1340 DATAAD,09,50,10,05,A9,FF,8D,15,50
1350 DATAAD,09,50,10,18,AD,08,50,49,FF,18,69,01,8D,0C,50
1360 DATAAD,09,50,49,FF,69,00,8D,0D,50,4C,C3,50,AD,08,50,8D,0C,50
1370 DATAAD,09,50,8D,0D,50,AD,0B,50,10,18,AD,0A,50,49,FF,18,69,01
1380 DATA8D,0E,50,AD,0B,50,49,FF,69,00,8D,0F,50,4C,EC,50,AD,0A,50
1390 DATA8D,0E,50,AD,0B,50,8D,0F,50,AD,0C,50,38,ED,0E,50,8D,10,50,AD,0D,50
1400 DATA4C,00,51,EA,EA,EA,EA,ED,0F,50,8D,11,50,10,32,A9,FF,8D,12,50
1410 DATAA9,00,8D,13,50,AD,0E,50,8D,18,50,AD,0F,50,8D,19,50
1420 DATAAD,0C,50,8D,1A,50,AD,0D,50,8D,1B,50,AD,0B,50,10,03
1430 DATA4C,37,51,A9,01,8D,12,50,4C,69,51,A9,00,8D,12,50,A9,FF
1440 DATA8D,13,50,AD,0C,50,8D,18,50,AD,0D,50,8D,19,50,AD,0E,50
1450 DATA8D,1A,50,AD,0F,50,8D,1B,50,AD,09,50,10,03,4C,69,51,A9,01,8D,13,50
1460 DATAAD,18,50,8D,1C,50,AD,19,50,8D,1D,50,AD,1A,50,8D,22,50
1470 DATAAD,1B,50,8D,23,50,AD,18,50,38,ED,1A,50,8D,1E,50,AD,19,50
1480 DATAED,1B,50,8D,1F,50,4E,19,50,6E,18,50,AD,1A,50
1490 DATA38,ED,18,50,8D,20,50,AD,1B,50,ED,19,50,8D,21,50
1500 DATAAD,1C,50,D0,08,AD,1D,50,D0,03,60,EA,EA,AD,21,50,10,25
1510 DATAAD,20,50,18,6D,22,50,8D,20,50,AD,21,50,6D,23,50,8D,21,50
1520 DATAAD,13,50,8D,17,50,AD,12,50,8D,16,50,20,00,54,4C,1D,52
1530 DATAAD,15,50,8D,17,50,4C,00,52,EA,EA,EA,EA,EA,EA,EA,EA,EA,EA
1540 DATAEA,EA,EA,EA,EA,EA,EA,EA,EA,EA,AD,14,50,8D,16,50,20,00,54
1550 DATAAD,20,50,38,ED,1E,50,8D,20,50,AD,21,50,ED,1F,50
1560 DATA8D,21,50,AD,1C,50,38,E9,01,8D,1C,50,AD,1D,50,E9,00,8D,1D,50,4C,AD,51
1570 DATA*
1580 GOSUB730
1590 RETURN
1600 DATA21504
1610 DATAAD,17,50,F0,0B,10,06,20,2F,54,4C,10,54,20,24,54,AD,16,50
1620 DATAF0,0B,10,06,20,4A,54,4C,20,54,20,3F,54,20,5A,54,60
1630 DATAA9,1C,8D,4F,E8,A9,1E,8D,4F,E8,60,A9,1A,8D,4F,E8,A9,18,8D,4F,E8
1640 DATAA9,1E,8D,4F,E8,60,A9,16,8D,4F,E8,A9,1E,8D,4F,E8,60
1650 DATAA9,0E,8D,4F,E8
1660 DATAA9,06,8D,4F,E8,A9,1E,8D,4F,E8,60,A2,30,A0,30,88,C0,00
1670 DATAD0,FB,CA,E0,00,D0,F4,60
1680 DATA*
1690 GOSUB730
1700 RETURN
1710 PRINT"CS":CC=FF
1720 PRINT"9CD     RIF WORKPIECE IS IN POSITION PRESS ANY      KEY TO CONTINUE"
1730 GETZ$:IFZ$=""GOTO1730
1740 GOSUB2070
1750 PRINT"CH PLOT OF DRILLED CO-ORDS
1760 GOSUB2120
1770 DC=20000:POKE0,0:POKE1,83
1790 SYS(20535)
1795 POKE48,PEEK(DC):POKE49,PEEK(DC+1):DC=DC+2:POKE50,0:POKE51,[illegible]
1800 IFCC>0THENSYS(826)
1810 CC=CC-1:IFCC= -1THEN1860
1820 POKE59471,190:FORI=1TO2000:NEXT
1830 POKE59471,222:FORI=1TO2000:NEXT
1840 POKE59471,30
1855 GOTO1790
1860 GOSUB2120
1870 PRINT"CHCUPANOTHER CYCLE 'Y' OR 'N' ?
1880 GETZ$:IFZ$=""GOTO1880
1890 IFZ$="Y"THENBC=BC+1:GOTO1710
1900 BC=BC+1
1910 PRINT"CH 10CD 30CR                                 RUN TIME="
1920 PRINT"CH 11CD 29CR                                 "TIME$
1930 PRINT"CH 13CD 30CR                                   BATCH QTY="
1940 PRINT"CH 14CD 34CR                                       "BC
1950 PRINT"CH 16CD 30CR                                     JOB NO "J$
1960 PRINT"CH
1970 PRINT"CHKEY1 FOR PRINT OF COORDS...
1980 PRINT"CHCDOR KEY2 DATA ONLY.
1990 GETZ$:IFZ$=""THEN1990
2000 IFZ$="1"THEN2150
2010 OPEN4,4
2020 PRINT#4,"RUN TIME="TIME$
2030 PRINT#4,"BATCH QTY="BC
2040 PRINT#4,"JOB NO="J$
2050 CLOSE4
2060 RUN70
2070 PRINT"CS":FORI=32848TO32876:POKEI,102:NEXT
2080 FORI=32888TO33745STEP40:POKEI,102:NEXT
2090 FORI=32916TO33773STEP40:POKEI,102:NEXT
2100 FORI=33728TO33756:POKEI,102:NEXT
2110 RETURN
2120 FORI=1TO15:POKE59467,16:POKE59466,15:POKE59464,117:NEXT
2130 POKE59464,0:POKE59466,0:POKE59467,0
2140 RETURN
2150 OPEN1,4:OPEN2,4,6
2160 X=0
2170 FORQ=0TO919:A=PEEK(Q+32848)
2180 IFA>100THENB=A+64:GOTO2200
2190 B=(AAND127)OR((127-AAND32)*2)
2200 PRINT#1,CHR$(B);
2210 X=X+1:IFX=40THENPRINT#2,CHR$(17):PRINT#1,:X=0
2220 NEXT
2225 PRINT#2,CHR$(24)
2230 CLOSE1:CLOSE2
2240 RUN70
2250 PRINT"CS               COORDINATE DRILLING
2260 PRINT
2270 PRINT"THE USER PORT IS USED TO DRIVE A TWO    AXIS COORD DRILLING";
2280 PRINT" MACHINE. THE X AND Y AXIS ARE DRIVEN BY STEPPER MOTORS WHILE THE";
2290 PRINT" Z AXIS AND DRILL USE A DC MOTOR.        COORDS ARE INPUT IN THE";
2300 PRINT" FORM:X,Y                EG.500,200 WITHIN LIMITS OF X,Y 1310,1310
2310 PRINT
2320 PRINT"AT EACH INPUT THE USER IS ASKED IF THIS IS THE LAST COORD.WHEN THE L
AST";
2330 PRINT" COORD IS INPUT A PLOT IS MADE OF THE DRILL PATH.AFTER CONFIRMING";
2340 PRINT" THAT THE WORKPIECE IS  IN POSITION A TONE IS GENERATED TO WARN OF";

2350 PRINT" DRILLING AND AS EACH POINT IS DRILLED IT IS ALSO PLOTTED.
2360 PRINT
2370 PRINT"FINALLY THE PRINTER LISTS JOB NO., BATCH QTY. AND RUN TIME.
2380 PRINT:PRINT"          PRESS ANY KEY TO CONT.
2390 WAIT158,1
2400 RUN40
READY.
```

IN THIS LISTING,CS=CLEAR SCREEN,CH=CURSOR HOME,CU=CURSOR UP,CD=CURSOR DOWN
R=REVERSE FIELD

READY.

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## Memory routine

THIS IS a simple yet very useful routine for searching for a block of memory — starting at HL, length BC — for the presence of a string — starting at DE, length is contained in the byte pointed to by IX writes Alan Gibson of Alexandra Park, London.

There are three points to note:

- The routine is fully re-locatable.
- The parameters are preserved so the search may be continued to test for further occurrences.
- The routine is small and very fast compared to the equivalent Basic routine.

```
Enter with:
  HL = start of search area
  BC = length of search area
  DE = start of string
 (IX) = length of string
Exits with:
  Successful      Carry set
                  HL = start of
                  found string + 1
  Unsuccessful    Carry cleared
                  HL = end of
                  search area + 1
  In either case all other
  registers correct, so search may
  continue.

          SEARCH ORG  $
          ;
          ;
1A        TRYAGN LD   A,(DE) ;search for
EDB1             CPIR        ;first byte
201E             JR   NZ,NOTFND;not
                      here
          ;
          ;Found first
          ;
C5               PUSH BC
          ;
          ;Set up BC as counter
          ;
DD4600           LD   B,(IX)
05               DEC  B
          ;
2814             JR   Z,FOUND;got it
E5               PUSH HL
D5               PUSH DE
2B               DEC  HL
          ;
          ;See if the other bytes follow
          ;
13        LOOPS  INC  DE
23               INC  HL
1A               LD   A,(DE)
BE               CP   (HL)
2006             JR   NOTYET;No
10F8             DJNZ LOOPS
          ;
          ;We've found it
          ;
D1               POP  DE
E1               POP  HL
1805             JR   FOUND
          ;
          ;
          NOTYET ORG  $
          ;
          ;Restore the values
          ;
D1               POP  DE
E1               POP  HL
C1               POP  BC
18E0             JR   TRYAGN
          ;
          ;
C1        FOUND  POP  BC
37               SCF         ;set carry
C9               RET
          ;
B7        NOTFND OR   A      ;clear carry
C9               RET
          ;
          ;
          ;End of subroutine
```

For all users of systems based on the Z-80 chip, Z-80 Zodiac offers an opportunity to have programs and ideas published. We pay at least £5 for each contribution used.

## Full-screen copy

A PROBLEM faced by many candidates for public examinations is that of being able to produce hard copy of examples of course work to indicate the successful implementation of computer programs writes MJ Pearson of St Neots, Cambridgeshire. That has often meant that the only programs suitable for consideration were those which presented a line-by-line output to a printer.

With the introduction of the microcomputer into schools and the use of video display, it became possible for students to present graphic output to the screen, a facility which undoubtedly increases interest. Inexpensive printers with graphics capability are also now available.

Those involved in education, may, therefore, be interested in the following Basic subroutine which can be included in any program and which allows the user to copy the full-screen display to the printer. The machines used for the example were the RML 380Z with an OKI Microline 80 printer.

The program can be adapted easily to work for other systems and will even work for a Teletype if graphics characters are represented by suitable ASCII characters.

For those not familiar with 380Z Basic, these comments may be useful. Lines 1020 and 1120 make the screen memory accessible to the user and restore the display — the screen will go blank during printing. Lines 1030-1110 build a string until it occupies a full line — 40 characters on the 380Z — by PEEKing at memory locations.

The beginning of screen memory is at 61440 (F000H) and each line requires 64 memory locations although only 40 are displayed. Line 1070 converts the null characters '□', which is ignored by the Microline 80, into ASCII '0'.

```
1000 REM *** SUBROUTINE TO DUMP
     CONTENTS
1010 REM OF SCREEN MEMORY TO
     PRINTER ***
1020 GRAPH 2
1030 FOR I=0 TO 19
1040 A$=""
1050 FOR J=0 TO 39
1060 A=PEEK (61440+J+64*I)
1070 IF A=0 THEN A=79
1080 A$=A$+CHR$(A)
1090 NEXT J
1100 LPRINT A$
1110 NEXT I
1120 GRAPH 3
1130 RETURN
```

```
10 CLEAR 100
12 FOR R=0.1 TO 0.9 STEP 0.1
15 GRAPH 1
20 A$="SYMMETRY DISPLAY SCREEN
   PRINT ROUTINE"
25 FOR I=0 TO 15
30 PLOT 14+2*I,47,ASC(MID$(A$, I+1,
   1))
40 NEXT I
45 FOR I=0 TO 13
50 PLOT 12 +2*I,44,ASC(MID$(A$, I+
   18, 1))
60 NEXT I
70 FOR X=0 TO 29
80 FOR Y=0 TO 20
90 C = RND (1)
100 IF C>R THEN C=2 ELSE C=0
110 PLOT X,Y,C:PLOT 59-X,Y,C:PLOT
    X,41-Y,C:PLOT 59-X, 41-Y,C
120 NEXT Y
130 NEXT X
135 Y=0
140 FOR X=0 TO 59
150 PLOT X,Y,2
160 NEXT X
170 IF Y=41 THEN 190 ELSE Y=41
180 GOTO 140
190 X=0
200 FOR Y=0 TO 41: PLOT X,Y,2:NEXT Y
210 IF X=59 THEN 230 ELSE X=59
220 GOTO 200
230 GOSUB 1000
235 NEXT R
240 GRAPH 0
250 END
```

## Basic recursion

BOTH *Practical Computing* in the June 1980 editorial, and your correspondent, P Shackleton in Feedback, October 1980, seem to think that in Basic, you forego recursion writes Harry Fisher of Harpenden, Hertfordshire. Recursion is so undemanding that even the simplest Basic is adequate. Ackermann's function is pure recursion and this short Basic program prints out a table of Ackermann values which have been calculated recursively.

```
100 DIM J(255)
110 A=1E6
120 FOR M=0 TO 3
130 FOR N=0 TO 5
140 K=2
150 J(K)=M*A+N
200 B=J(K)
210 IF INT(B/A)=0 THEN 400
220 IF INT(B/A)=B/A THEN 300
230 J(K)=B-A
240 K=K+1
250 J(K)=B-1
260 GOTO 200
300 J(K)=B-A+1
310 GOTO 200
400 K=K-1
410 J(K)=B+1+INT(J(K)/A)*A
420 IF K>1 THEN 200
500 PRINT TAB(N*8+1) B+1;
510 NEXT N
520 PRINT
530 PRINT
540 NEXT M
550 END
OK
```

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

## Animated display

HERE IS my best approximation at the moment to an animated display on the ZX-80 writes Pete Rowan of Jesmond, Newcastle-upon-Tyne. All INPUTs are self-explanatory with yes or no answers for repeating the game. When asked for "1ST?" and "2ND?", the players should INPUT a single initial or character to identify their racer to save program space, I have omitted the usual "HIT NEWLINE TO CONTINUE" — the race continues by hitting NEWLINE. To change speeds, change RND in lines 110/120 to a different number.

Race Track copyright 1980 P M ROWAN

```
 10 PRINT"aaRACE-TRACKaa"
 20 PRINT
 30 LET G$ = "ss WINNER ss"
 40 PRINT "1ST?"
 50 INPUT X$
 60 PRINT "2ND?"
 70 INPUT Y$
 80 CLS
 90 LET A = 3
100 LET B = 3
110 LET A = A + RND(3)
120 LET B = B + RND(3)
130 IF A>30 AND B>30 THEN GO TO 530
140 IF A>30 THEN GO TO 560
150 IF B>30 THEN GO TO 580
160 FOR L = 1 TO 2
170 IF L = 1 THEN LET P$ = X$
180 IF L = 2 THEN LET P$ = Y$
190 LET C = (L = 1) AND A OR (L = 2) AND B
200 FOR J = 1 TO 2
210 FOR K = 1 TO (C—3)
220 PRINT " ";
230 NEXT K
240 GO SUB 500 + J*10
250 IF C>29 THEN GO TO 290
260 FOR K = 1 TO (30—C)
270 PRINT " ";
280 NEXT K
290 PRINT "ss"
300 NEXT J
310 PRINT
320 NEXT L
330 INPUT A$
340 CLS
350 GO TO 110
360 PRINT
370 PRINT "SAME AGAIN?"
380 INPUT C$
390 CLS
400 IF CODE(C$) = 62 THEN GO TO 90
410 PRINT "NEW RACERS?"
420 INPUT C$
430 CLS
440 IF CODE(C$) = 62 THEN GO TO 30
450 LIST
510 PRINT CHR$(128); CHR$(CODE(P$) +
    128);" ";
515 RETURN
520 PRINT CHR$(134);CHR$(131);CHR$
    (135);
525 RETURN
530 PRINT "ddddddITS A DRAWffffff"
540 GO TO 360
560 PRINT G$," ";X$;" s"
570 GO TO 360
580 PRINT G$," ";Y$;" s"
590 GO TO 360
```

Characters are indicated by lower-case letters, e.g., d indicates the character at SHIFT D, f the character at SHIFT F.

## Cassette loading

LOADING a program from a cassette player not filled with a counter can be a hit-and-miss affair writes E W Fothergill of Lowton, Warrington in Cheshire.

If a small personal AM transistor radio is placed near to the ZX-80, the characteristic buzz of the program can be picked-up and if the program does not appear on the screen when the buzzing ends, you know immediately that the loading has not taken place.

## Memory saver

A MEMORY saving tip when you require the use of inverse graphics in print statements has been submitted by Richard Wildash of Basingstoke, Hampshire. For instance, you may require a line of inverse spaces, he writes. Normally, the line looks like this:

PRINT CHR$ (128);CHR$ (128); etc.

My trick is to reserve my first line of program as a print statement with spaces:

10 PRINT "UP TO 32 SPACES" OR AS MANY AS YOU REQUIRE

Then POKE, e.g., POKE 16428, 128 as a direct command into the spaces the graphic codes I require, the first space is location 16428. When that is done, it is a simple matter of bringing line 10 down to the bottom position in program. This trick is great for drawing playing boards for games, etc.

## Code conversion

THE first program is a decimal to binary, Hexadecimal or octal converter — lines 1 to 55, while the second one is a displacement calculator — lines 100 to 180 — writes Egidio Debono of Qormi, Malta. Both are very useful when writing programs in machine code.

RUN causes the first program to be executed and RUN 100 executes the second program. To exit from the first program, either input a negative number or a number greater than 32,767. The second alternative is also valid for exiting from the second program.

I have found that the shortest way of inputting a number greater than 32,767 is 6**6 — 6 to the power of 6 — which resolves to 46,656, in just three key presses.

Here are some useful notes on the programs. Line 5 validates the input. Any character other than "B", "H" or "O" reduces the expression after GO SuB to Ø, and so the program is re-executed from line 1 until the correct letter is pressed. If "B" is input the program performs the subroutine starting at line 39 — the character code for the letter "B". "H" directs the program to line 45 while "0" to line 52.

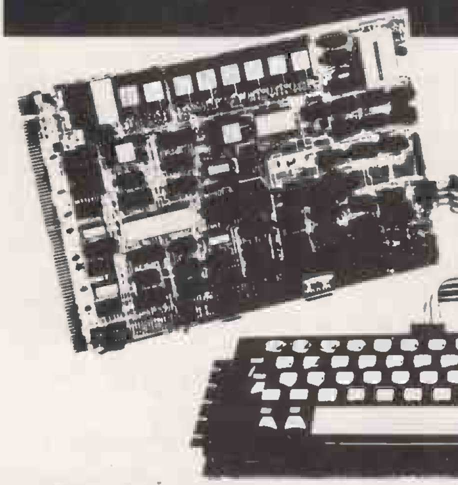
Those subroutines set the initial value of three variables: H$, V and Q. Lines 6 to 28 contain the main procedure which is based on the principle of keeping the remainder after successive divisions by two, eight or 16, depending whether you are converting to binary, octal or Hex.

The two formulae used for calculating the displacement for jumps are: Backward jump = jump address — target address + 1, then complement. Forward jump = target address — jump address — 2.

The program expects the address in decimal — there is no need to input the greater address first — and returns the displacement in Hexadecimal. Of special interest is line 150 which adds one to the difference of the two addresses and only subtracts three if N = 2, i.e., a Forward Jump is being computed. Lines 155 and 160 perform the conversion to Hex. Lines 165 and 170 complement the result only if N = 1, i.e., a backward jump is being calculated.

```
  1 REM EAD (3Ø/Ø6/8Ø) RUN 1ØØ FOR
    DISP.
  2 CLS
  3 PRINT "INPUT (B) IN (H) EX (O) CT"
  4 INPUT M$
  5 GO SUB —CODE(M$)*(M$ = "B" OR
    M$ = "H" OR M$ = "O")
  6 CLS
  7 PRINT "   DECIMAL TO "; H$
  8 PRINT
  9 DIM F(Q)
 1Ø LET A = Ø
 11 INPUT N
 12 IF N<Ø THEN STOP
 13 FOR I = 1 TO 4
 14 IF N<1Ø**(5—I) THEN PRINT " ";
 15 NEXT I
 16 PRINT N; " = ";
 17 LET X = N/V
 18 LET R = N—X*V
 19 LET F(Q—A) = R + 28
 2Ø LET A = A + 1
 21 LET N = X
 22 IF N>Ø THEN GO TO 17
 23 FOR I = 1 TO Q
 24 PRINT CHR$(F(I));
 25 LET F(I) = Ø
 26 NEXT I
 27 PRINT
 28 GO TO 1Ø
 39 LET H$ = "BINARY"
 4Ø LET V = 2
 41 LET Q = 16
 42 RETURN
 45 LET H$ = "HEXADECIMAL"
 46 LET V = 16
 47 LET Q = 4
 48 RETURN
 52 LET H$ = "OCTAL"
 53 LET V = 8
 54 LET Q = 5
 55 RETURN
1ØØ PRINT "B/WARD JMP = 1",
1Ø5 PRINT "F/WARD JMP = 2"
11Ø INPUT N
115 PRINT N
12Ø PRINT "ADDR.1 = ";
125 INPUT A
13Ø PRINT A,
135 PRINT "ADDR.2 = ";
14Ø INPUT B
145 PRINT B
15Ø LET C = (ABS(A—B) + 1—(—3*(N = 2)))
155 LET D = C/16
16Ø LET E = C—D*16
165 LET D = ABS(D + 15*(N = 1))
17Ø LET E = ABS(E + 15*(N = 1))
175 PRINT "DISPLACEMENT = ";CHR$
    (D + 28);CHR$(E + 28)
18Ø GO TO 11Ø
```

# interface components



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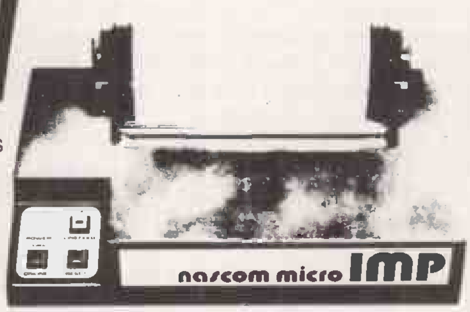


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**TANDY FORUM is devoted to the Tandy TRS-80. Sometimes we will use it to pass on news about the TRS-80 but, above all, it is for users, and would-be users, of the well-established model I and now the new model II. With your tips, queries, moans and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

## String storage

THE PROBLEM of string storage is one people avoid because "it's all too complicated" writes Ken Smith of Linton on Ouse. The Level II manual gives little encouragement as the treatment of VARPTR is a little sketchy to say the least. What is straightforward has taken on the proportions of a monster. Let us run through the problem in a slightly different way and see if our TRS-80 is, after all, being logical.

There are two distinct types of string as far as the TRS-80 is concerned, one is the literal and the other the variable:

Literal A$ = "FRED"
Variable A$ = CHR$(70) + CHR$(82) + CHR$(69) + CHR$(68)

Both examples would have produced A$ to equal FRED. The major difference is that the literal requires no reserved string space and is held in the portion of memory which contains that line, whereas the variable is held in a reserved portion of memory set aside specifically at run time by the clear command. Now, there is the reason why we obtain the dreaded O/S error. If we ask the machine to store more string variables than it has set space aside for, it blows. The authors of Level II Basic Microsft 5.1 were very smart, though. As you will recall, RUN executes a clear 50 command automatically for you. If you require more than that, you must say so with a CLEAR in the program itself. Remember, a CLEAR + NUMBER will also dump all other variables to null or zero, so use it very early.

That explanation should be enough for you to see that the process of storing strings is a simple matter of determining whether it is a variable or literal and either stashing it away in high RAM or leaving it in the program line. The only thing the machine has to do is to remember where it put or left it. To that end, every time a string variable is encountered at run time, the TRS-80 will hold the details of that string in a form of buffer area. It is the information contained in the buffer that is made available to you by VARPTR.

The only information required about where you have stored or left something is: how big? And where? Each string variable is allocated three bytes in the buffer to store just that information; length and position. The first byte for the length and the last two for position.

Why two bytes should be used for a memory location should be evident and the single-byte allocation to length is the reason for the maximum length of a string being 255 bytes. So far so good.

Turn-on your TRS-80 and type in the following:

```
10 A$ = "FRED"
20 A = VARPTR(A$)
30 PRINT A
40 PRINT PEEK(A)
50 B = PEEK(A + 1) + 256*PEEK(A + 2)
60 PRINT B
70 FORX = 0TOPEEK(A)—1
80 PRINT PEEK(B + X),CHR$(PEEK
   (B + X))
90 NEXT
```

Line 10 gives the machine a string on which to work. Line 20 allocates 'A' the beginning of the variable transfer address for A$. Line 30 gives you a copy. Line 40 looks at the first location of the VARPTR in question. That is where the length is held — it is a 4.

Line 50 has the address stored in the last two bytes. As you probably know, the TRS-80 stores its numbers backwards, so the first byte of the storage pair is the least significant and the second the most significant. All you have to do to turn the storage bytes into a decimal number is multiply the most significant byte, A + 2, by 256 and add the result to the least significant byte, A + 1.

Line 60 passes the gem on. Line 70 starts a loop which is really 1 to LEN(A$), but starting at zero so that you can use the numbers more easily. Line 80 prints the contents of the memory locations holding our string, displaying the raw numbers and the ASCII characters they represent. Line 90 continues the operation until the whole word has been displayed.

What we have discovered is the real location of A$ in the memory and had a PEEK at it. Now we know where it is we can have some real fun.

POKE B, 191

Now list the program if nothing has changed, you have either miskeyed or for some reason the variables have been cleared down. Type RUN and try again. All those with:

10 A$ = "USINGRED"

You should now try PRINT A$ and be further amazed. What has happened is that we have replaced the first character of the string with a CHR$(191), which is, as you should know, a graphics character. The machine knows or cares not for that subtle change and will display it normally on the screen when asked. The interpreter, however, usually uses the graphic codes as compressed storage for the Basic commands so, when we list, the TRS-80 sees a 191 as a USING if you examine page E/1 or your Level II manual, those codes will be explained.

By setting strings of a specific length and then poking in the graphics or control codes, we require, it is possible to build some really elaborate graphics.

## Anagram method

LISTING A is for crossword buffs — it takes an anagram of up to 19 letters and gives solutions based on a random method writes AJ Chadwick of Wembley Park, Middlesex. To avoid giving the same solution twice, it stores the result in an array. The program as listed is very simple and could be built on by, say, storing letters already known in the solution. It can, of course, be used the other way around for creating anagrams.

Listing B is for those who do not have a re-number facility or append a program. It is very simple and I store it in lines 1-9 of each program. Lines can be re-numbered, starting at a number and in increments of your choice. The program being appended must have lines numbered greater than those in the stored program. You cannot of course use line numbers 1-9 and your start line must be greater than nine.

Words of warning: the re-number does not action GOTOs etc. If you fail to follow the command in line 2, you do not, of course, append the program. If line numbers on the tape are lower than those stored in memory, you cannot edit them out — you have to start again.

I have now had a TRS-80 for two years and am delighted with my choice. Finally, keep up the good work; an excellent magazine.

**Listing A**

```
10 CLS
20 CLEAR(8000)
30 DEFSTR A
40 DEFINT X
50 DIM AA(800)
60 INPUT"ANAGRAM FOR (NOT MORE THAN 19 LETTERS PLEASE) ";AB
70 X1=LEN(AB):IFX1<3THEN60
80 AA(1)=LEFT$(AB,1):AA(X1)=RIGHT$(AB,1):AA(50)=AB:X7=X1:FORX6=X1-1TO1STEP-1:X7=
X7*X6:NEXTX6:X7=X7+50
90 FORX2=2TOX1-1:AA(X2)=MID$(AB,X2,1):NEXT
100 X5=51
110 FORX2=21TOX1+20:AA(X2)="*":NEXT
120 RANDOM
130 FORX2=1TOX1
140 X3=RND(X1+20):IFX3<21THEN140
150 IFAA(X3)="*"THENAA(X3)=AA(X2)ELSE140
160 NEXT
170 AC="":FORX2=21TO(X1+20):AC=AC+AA(X2):NEXT
180 FORX4=50TOX5:IFAA(X4)=ACTHEN110
200 NEXT
210 PRINTAC+" ";:AA(X5)=AC:X5=X5+1:IF(X5=800)OR(X5=X7)THEN60
220 GOTO110
```

**Listing B**

```
1 X0=17129:X1=0:X2=10:CLS:INPUT"APPEND PROGRAM(0) RENUMBER(2) RUN(3)";X3:IFX3>0T
HEN4
2 PRINT"TYPE CLOAD FOLLOWED BY POKE16548,233 AND POKE16549,66":IFPEEK(16633)>1TH
ENPOKE16548,PEEK(16633)-2:POKE16549,PEEK(16634):END
3 POKE16548,PEEK(16633)+254:POKE16549,PEEK(16634)-1:END
4 IFX3<>2THENGOTO9
5 INPUT"PROGRAM LINE INCREMENT";X6:INPUT"STARTING AT";X5:X2=X6:X1=INT(X5/256):X7
=X6+(X1*256):IFX2>256THENX1=X1+1:X2=X2-256
6 FORX3=1TO9:X0=PEEK(X0)+256*PEEK(X0+1):NEXTX3:FORX4=1TO5000:PRINT@0,X4:IFPEEK(X
0+1)>0THENPOKE(X0+3),X1:POKE(X0+2),X2:X0=PEEK(X0)+256*PEEK(X0+1)
7 X2=X2+X6:IFX2<257THENNEXTX4:GOTO1
8 X1=X1+1:X2=X2-256:NEXTX4:GOTO1
9 PRINT"DONT FORGET -- IF YOU HAVE USED RENUMBER THEN GOTO'S MUST BE
        CHANGED":FORX3=1TO1000:NEXT
```

## Question of connection

I HAVE an enhanced Ohio Challenger 1 with RS232 interface at 110 baud and a Teletype with 110 baud V24 interface writes Tony Goodhew of Peterborough, Cambridgeshire. How do I connect them so that I can print and use papertape I/O?

I am thinking in terms of a battery-powered black-box, switched on/off by the relay in the computer to save energy drain. I need a circuit diagram and components list and would be most grateful for a solution. I would also like other Ohio users in the Peterborough area to contact me to exchange ideas; 60 Wype Road, Eastrea, Whittlesey, Peterborough PE7 2HG.

## Special page tips

AFTER a cold-start, the UK101 always generates an identical sequence of random numbers writes Stewart Peppiatt of Chelmsford, Essex. That can be overcome for example in a games program, by calling the function several times:

```
10 INPUT"Seed ";S: FOR I = 1 TO S: X =
   RND(1): NEXT
```

However, an easier and quicker way is to POKE directly into the memory used to hold the random number, i.e., 212 to 215. The first byte also contains the sign bit, so it is best to use memory 213:

```
10 INPUT"Seed ";S: POKE 213, S AND 255
```

ANDing S with 255 ensures that the number POKED into memory is not over-range.

The numbers given in the keyboard-polling array, e.g., 191 and 223, look very illogical until it is realised they are given by the expression:

$$(255 - 2^n)$$

where n is the row/column number. Many do not realise that using this, it is possible to detect and interpret two keys pressed simultaneously in the same row. For example, if both columns two and five are pressed then the necessary PEEKing will give a result:

$$255 - 2^2 - 2^5 = 219$$

In general, column C has been pressed if

$$(PEEK(57088)\ AND\ 2^C) = 0$$

To determine whether, for example, key three, column five, has been pressed, regardless of other keys use a sequence:

```
10 POKE 530,1: K = 57088
20 POKE K, 127
30 IF (PEEK(K) AND 32) = 0 THEN . . .
```

where $2^5 = 32$.

## Key combination

WITH reference to Superboard tips in the November 1980 edition, it is possible to use a PEEK instruction to look at the individual shift keys with the shift lock key down, by PEEKing 250 for the left shift key instead of 251 and 252 for the right shift key instead of 253 writes Jefferey Clarke of Potton, Bedfordshire. In fact, it is possible to recognise any key combination in a row. To investigate the possibilities, this program is useful:

```
10 POKE 57088,A
20 PRINT PEEK (57088)
30 GO TO 10
SAVE
RUN
```

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Where A = Row Address under investigation. Typing SAVE before RUN makes the display run slowly enough to be read. To find the location to PEEK for a particular key combination, press that combination and the location will be displayed.

To enable you to use keys not in the same row address where one key will be chosen from a selection, i.e., C for Crawl, F for Fast, W for Wait etc.

```
10 POKE 11,0
20 POKE 12,253
30 X=USR (X)
40 PEEK (531)
```

Returns the decimal character code of the key being pressed. To return the character itself change

```
40 CHR$ (PEEK(531))
```

To try that:

```
40 IF CHR$ (PEEK(531)) = "Z" THEN ....
```

where Z = key character from which you want a response from. Does anyone know what Error Code B — character 212 — means?

## List problems

JACK PIKE presumably has the same problem with LIST on Superboard as he would have on the UK101 writes Alfred Pauson of Bearsden, Glasgow. The following is an attempt to answer the question he put in the November issue.

Memory locations three, four and five contain the instruction JMP $A8C3. The routine at $A8C3 prints a sequence of characters terminated by a null; the low and high bytes of the start address are specified in the X and Y registers respectively. That is usually the OK which indicates that the machine has finished doing as instructed, i.e., that the command or program has terminated.

Pike does not want the program to terminate; he wants a return to the point immediately after the call of LIST. All that is required, therefore, is to poke location three with an RTS instruction — 60 Hexadecimal.

## Second solution

IN REPLY to Jack Pike's letter in the November issue I have solved the problem of using the LIST command within a program writes Steve Purdy of Down Place, near Windsor, Berkshire, so that it does not terminate the program, as follows:

```
100 POKE 4,194: POKE 5,165: LIST LN-LN:
PRINT: POKE 4,195: POKE 5,168
```

Where LNs are line numbers and can be used exactly as in the command mode, i.e., either or both may be left out. The program works as follows: after a LIST the CPU is sent to pick up a pointer at locations four and five which normally points to the OK message printer by changing the pointer to the Basic code for: "Go and execute the next Basic statement". The machine can be fooled into continuing the program.

The first two pokes set this pointer to A5C2(Hex)

LIST DOES ITS JOB

Print starts a new line as List leaves the machine as if its last command was a PRINT" "; The final two Pokes put the pointer back to A8C3(Hex) to enable the machine to function correctly in future.

By using the same pointers, the command-mode OK message can be changed to anything you want using this Basic program which uses the unused RAM below the program text area and thus does not affect operations at all.

```
10 INPUT"MESSAGE PLEASE";A$
20 FOR X=560 TO 569
30 READ D:POKE X,D:NEXT
40 FOR X=1 TO LEN(A$)
50 D=ASC(MID$(A$,X,1)) : POKE 569+X,
   D:NEXT
60 FOR X=570+LEN(A$) TO 573+LEN(A$)
70 READ D: POKE X,D:NEXT
80 POKE @,48: POKE 5,2
90 DATA 160,2,169,55,76,195,168,10,13,10,
   10,10,13,0
99 NEW
```

The program will be in operation until a cold-start is performed or until you Poke 4,195 and Poke 5,168 which returns the machine to normal. Line 99 is included to self-destruct and leave the machine in the normal command mode.

Although I have a UK101 on which these programs were written, I believe all the techniques used are identical on the Superboard.

## Check-sum loader

IAN PAWSON of Leicester has sent 6502 Special a check-sum loader program for the UK101 and gives assembler and a Hex dump. The following notes apply to the program, he writes.

The program lists a eighth check-sum loader for the UK101. It sits at the top of the eighth K and the entry address is $1EFD. That can be changed in line 20. Two monitor routines are used — input and output — and these are shown for the GEGMON monitor in lines 70 and 80. They will have to be changed for either of the two other monitors.

Because the assembler does not output a re-start address as most check-sum savers do, hitting the SPACE bar at the end of the load, or at any time, will cause a jump to the monitor at $FE00. That is in line 890. *(continued on next page)*

*(continued from previous page)*

```
A
 10 0000                                    ;CHECKSUM LOADER
 20 1EFD                  *=$1EFD
 30 1EFD                  S1=$0240          ;TEMP DATA STORE
 40 1EFD                  S2=$0241
 50 1EFD                  S3=$0242
 60 1EFD                  SAVE=$0203        ;SAVE FLAG
 70 1EFD                  OUTPUT=$FF9B      ;OUTPUT ROUTINE
 80 1EFD                  INPUT=$FB46       ;INPUT ROUTINE
 90 1EFD 20A11F   BGN     JSR OUT
100 1F00 C93B             CMP £$3B
110 1F02 F013             BEQ B1
120 1F04 C924             CMP £$24
130 1F06 D0F5             BNE BGN
140 1F08 20821F           JSR SUM2
150 1F0B 8D4202           STA S3
160 1F0E 20821F           JSR SUM2
170 1F11 8D4102           STA S2
180 1F14 4CB41F           JMP MESS
190 1F17 A900     B1      LDA £$00
200 1F19 8D4102           STA S2
210 1F1C 8D4202           STA S3
220 1F1F 206F1F           JSR SUM1
230 1F22 AA               TAX
240 1F23 206F1F           JSR SUM1
250 1F26 85FA             STA $FA
260 1F28 206F1F           JSR SUM1
270 1F2B 85F9             STA $F9
280 1F2D 8A       B3      TXA
290 1F2E 48               PHA
300 1F2F A200             LDX £$00
310 1F31 206F1F           JSR SUM1
320 1F34 81F9             STA ($F9,X)
330 1F36 68               PLA
340 1F37 AA               TAX
350 1F38 E6F9             INC $F9
360 1F3A D002             BNE B2
370 1F3C E6FA             INC $FA
380 1F3E CA       B2      DEX
390 1F3F D0EC             BNE B3
400 1F41 20821F           JSR SUM2
410 1F44 CD4202           CMP S3
420 1F47 D008             BNE B4
430 1F49 20821F           JSR SUM2
440 1F4C CD4102           CMP S2
450 1F4F F0AC             BEQ BGN
460 1F51 A000     B4      LDY £$00
470 1F53 B9BC1F   B6      LDA MESS2,Y
480 1F56 F006             BEQ B5
490 1F58 209BFF           JSR OUTPUT
500 1F5B C8               INY
510 1F5C D0F5             BNE B6
520 1F5E A900     B5      LDA £$00
530 1F60 8D0302           STA SAVE
540 1F63 2046FB           JSR INPUT
550 1F66 209BFF           JSR OUTPUT
560 1F69 C947             CMP £$47
570 1F6B D0F1             BNE B5
580 1F6D F08E             BEQ BGN
590 1F6F 20821F   SUM1    JSR SUM2
600 1F72 18               CLC
610 1F73 6D4102           ADC S2
620 1F76 8D4102           STA S2
630 1F79 9003             BCC B7
640 1F7B EE4202           INC S3
650 1F7E AD4002   B7      LDA S1
660 1F81 60               RTS
670 1F82 20851F   SUM2    JSR SUM3
680 1F85 20A11F   SUM3    JSR OUT
690 1F88 C941             CMP £$41
700 1F8A 9002             BCC B8
710 1F8C E907             SBC £$07
720 1F8E 290F     B8      AND £$0F
730 1F90 0A               ASL A
740 1F91 0A               ASL A
750 1F92 0A               ASL A
760 1F93 0A               ASL A
770 1F94 A004             LDY £$04
780 1F96 2A       B9      ROL A
790 1F97 2E4002           ROL S1
800 1F9A 88               DEY
810 1F9B D0F9             BNE B9
820 1F9D AD4002           LDA S1
830 1FA0 60               RTS
840 1FA1 A9FF     OUT     LDA £$FF
850 1FA3 8D0302           STA SAVE
860 1FA6 2046FB           JSR INPUT
870 1FA9 2C0302           BIT SAVE
880 1FAC 3003             BMI B12
890 1FAE 4C0CFE           JMP $FE0C      ;JUMP OUT ADDRESS
900 1FB1 4C9BFF   B12     JMP OUTPUT
910 1FB4 A900     MESS    LDA £$00
920 1FB6 8D0302           STA SAVE
930 1FB9 6C4102           JMP (S2)
940 1FBC 0D       MESS2   .BYTE 13,10,10
940 1FBD 0A
940 1FBE 0A
950 1FBF 4F               .BYTE 'OBJECT CHECKSUM ERROR'
950 1FC0 42
950 1FC1 4A
950 1FC2 45
950 1FC3 43
950 1FC4 54
950 1FC5 20
950 1FC6 43
950 1FC7 48
950 1FC8 45
950 1FC9 43
950 1FCA 4B
950 1FCB 53
950 1FCC 55
950 1FCD 4D
950 1FCE 20
950 1FCF 45
950 1FD0 52
950 1FD1 52
950 1FD2 4F
950 1FD3 52
960 1FD4 0D            .BYTE 13,10,10,'REWIND PAST ERROR'
960 1FD5 0A
960 1FD6 0A
960 1FD7 52
960 1FD8 45
960 1FD9 57
960 1FDA 49
960 1FDB 4E
960 1FDC 44
960 1FDD 20
960 1FDE 50
960 1FDF 41
960 1FE0 53
960 1FE1 54
960 1FE2 20
960 1FE3 45
960 1FE4 52
960 1FE5 52
960 1FE6 4F
960 1FE7 52
970 1FE8 20               .BYTE ' - TYPE G TO RESTART'
970 1FE9 2D
970 1FEA 20
970 1FEB 54
970 1FEC 59
970 1FED 50
970 1FEE 45
970 1FEF 20
970 1FF0 47
970 1FF1 20
970 1FF2 54
970 1FF3 4F
970 1FF4 20
970 1FF5 52
970 1FF6 45
970 1FF7 53
970 1FF8 54
970 1FF9 41
970 1FFA 52
970 1FFB 54
980 1FFC 0D               .BYTE 13,10,10,0
980 1FFD 0A
980 1FFE 0A
980 1FFF 00
O
       D  E  F  0  1  2  3  4  5  6  7  8  9  A  B  C
1EFD  20 A1 1F C9 3B F0 13 C9 24 D0 F5 20 82 1F 8D 42
1F0D  02 20 82 1F 8D 41 02 4C B4 1F A9 00 8D 41 02 8D
1F1D  42 02 20 6F 1F AA 20 6F 1F 85 FA 20 6F 1F 85 F9
1F2D  8A 48 A2 00 20 6F 1F 81 F9 68 AA E6 F9 D0 02 E6
1F3D  FA CA D0 EC 20 82 1F CD 42 02 D0 08 20 82 1F CD
1F4D  41 02 F0 AC A0 00 B9 BC 1F F0 06 20 9B FF C8 D0
1F5D  F5 A9 00 8D 03 02 20 46 FB 20 9B FF C9 47 D0 F1
1F6D  F0 8E 20 82 1F 18 6D 41 02 8D 41 02 90 03 EE 42
1F7D  02 AD 40 02 60 20 85 1F 20 A1 1F C9 41 90 02 E9
1F8D  07 29 0F 0A 0A 0A 0A A0 04 2A 2E 40 02 88 D0 F9
1F9D  AD 40 02 60 A9 FF 8D 03 02 20 46 FB 2C 03 02 30
1FAD  03 4C 0C FE 4C 9B FF A9 00 8D 03 02 6C 41 02 0D
1FBD  0A 0A 4F 42 4A 45 43 54 20 43 48 45 43 4B 53 55
1FCD  4D 20 45 52 52 4F 52 0D 0A 0A 52 45 57 49 4E 44
1FDD  20 50 41 53 54 20 45 52 52 4F 52 20 2D 20 54 59
1FED  50 45 20 47 20 54 4F 20 52 45 53 54 41 52 54 0D
1FFD  0A 0A 00
```

## Find, a search program

THIS MACHINE-code program searches for the occurrence of variables, strings, part strings, program tokens, and in fact anything whose first character is non-numeric within Applesoft/Palsoft program lines writes Mike Perry.

The program was written on an ITT 2020 using the mini-assembler provided by ITT for those users who do not have the Integer Basic ROMS. It will work equally well for those who have Palsoft in ROM and no integer on Apples.

An understanding of the way Applesoft/Palsoft programs are stored in memory is required to follow the way the program works. This schematic illustrates this:

| | | |
|---|---|---|
| 0—0FF | | Page 0: used by the monitor and Applesoft/Palsoft |
| 100—1FF | | Page 1: the subroutine stack |
| 200—2FF | | Page 2: the keyboard input buffer |
| 300—3FF | | Page 3: some space for machine code programs, and DOS entry points. |
| 400—7FF | | Pages 4-7: first screen buffer |
| 800— | | Start of RAM |
| 801 | 0E | |
| 802 | 08 | Address of the next Basic line — in this case 080E |
| 803 | 0A | |
| 804 | 00 | Line number of this Basic line — in this case 000A = 10 |
| 805 | XX | |
| 806 | XX | |
| 807 | XX | |
| 808 | XX | Tokens and characters making up this Basic line |
| 809 | XX | |
| 80A | XX | |
| 80B | XX | |
| 80C | XX | |
| 80D | 00 | The end of Basic line token |
| 80E | 18 | |
| 80F | 08 | Address of the next Basic line — in this case 0818 |
| 810 | 0F | |
| 811 | 00 | Line number of this Basic line — in this case 000F = 15 |
| 812 | YY | |
| 813 | YY | |
| 814 | YY | Tokens and characters making up this Basic line |
| 815 | YY | |
| 816 | YY | |
| 817 | 00 | End of this Basic line |
| 818 | ETC | |
| 819 | ETC | |
| 81A | ETC | |

If the address of a Basic line is 00 00, that indicates the end of the Basic program. The program sits in page three, and protected when loading and saving are taking place. It is not protected during a DOS boot. The program is 112 bytes long ($70) and starts at $300.

To operate, enter as the first Basic line — I always use line 0 — the name of the variable or string, etc., you wish to find, e.g., 0 R7$(X (return). That would be perfectly acceptable, as no syntax checking is done in Applesoft/Palsoft until RUN time. Make sure that this search statement is the first line of your program.

If you have a disc system then BRUN FIND and the machine-code program will be loaded into page three and it will start running. The program will always find the variable, etc., that you are searching for in line 0 if, like me use line 0 to hold the variable etc. If the variable, etc., occurs elsewhere, the line number in which it occurs will also be reported.

**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.**

Once loaded, the program can be run from the monitor with 300G, return, or from Applesoft/Palsoft with a CALL 768, return. Once I had discovered that, I decided to use the '&' facility. When Applesoft/Palsoft encounters an '&' as the first character of a Basic line, in either immediate or deferred mode, a jump to 3F8 is performed and any program pointed to by those locations is executed. By placing 4C 00 03, Jump 0300, in locations 3F8,3F9,3FA the '&' command will run a program starting at $300, e.g., & (return).

```
START
300-  08        PHP          Save status register and the contents of locations
301-  A2 05     LDX £$05     zero to five on the stack. We need some page zero room.
303-  B5 00     LDA $00,x
305-  48        PHA
306-  CA        DEX          count = count-1
307-  D0 FA     BNE $0303    if not zero so round again
309-  A9 01     LDA £$01     Put start locations in two, three
30B-  85 02     STA $02
30D-  A9 08     LDA £$08     i.e., 0801 in two, three
30F-  85 03     STA $03
NEW ADDRESS
311-  A5 02     LDA $02      Transfer two, three to zero, one
313-  85 00     STA $00
315-  A5 03     LDA $03
317-  C9 00     CMP £$00     Test for end of Basic program — address = 0?
319-  F0 48     BEQ $0363    Yes — end
31B-  85 01     STA $01
NEXT LINE
31D-  A0 00     LDY £$00     Set up pointers in two-five for this Basic line
31F-  B1 00     LDA ($00),Y  Set counter to zero
321-  EA        NOP
322-  99 02 00  STA$0002,Y   Indexed so that first time around, 803-806 are placed in two-five
325-  C0 03     CPY £$03     Around four times?
327-  F0 04     BEQ $032D    Yes goto next character
329-  C8        INY          No increment counter
32A-  4C 1F 03  JMP $031F    Go round again
NEXT CHARACTER
32D-  C8        INY
32E-  B1 00     LDA($00),Y   Obtain next character
330-  C9 00     CMP £$00     End of Basic program line?
332-  F0 DD     BEQ $0311    Yes — go to new address
334-  CD 05 08  CMP $0805    Match with test character?
337-  F0 04     BEQ $033D    Yes — go to match
339-  C8        INY          No
33A-  4C 2E 03  JMP $032E    Obtain next character
MATCH
33D-  A2 00     LDX £$00     Set counter to zero
33F-  E8        INX          Increment counter
340-  C8        INY          Increment pointer
341-  BD 05 08  LDA$0805,X   Obtain next test character
344-  C9 00     CMP £$00     End of test characters?
346-  F0 09     BEQ $0351    Yes — so print the line number
348-  B1 00     LDA ($00),Y
34A-  DD 05 08  CMP$0805,X   Does it match?
34D-  F0 F0     BEQ $033F    So far so good, go round again
34F-  D0 DD     BNE $032E    No good, go start again
SUCCESS
351-  98        TYA
352-  48        PHA          Save the Y register on the stack
353-  A5 005    LDA $05      Put the line number in A,X
355-  A6 04     LDX $04
357-  20 24 ED  JSR $ED24
35A-  20 8E FD  JSR $FD8E    Print a carriage return monitor
35D-  68        PLA          Restore the Y register
35E-  A8        TAY
35F-  C8        INY
360-  4C 2E 03  JMP $032E    Go try again
END
363-  A2 00     LDX £$00     Set counter to zero
365-  68        PLA
366-  95 00     STA $00,X
368-  E8        INX
369-  E0 05     CPX £$05     Done six times?
36B-  D0 F8     BNE $0365
36D-  4C D0 03  JMP $03D0
36D-  4C 3C D4  JMP $D43C    Back to Basic
```

```
]CALL-151
*300L.3FF
0300-  08 A2 05 B5 00 48 CA D0
0308-  FA A9 01 85 02 A9 08 85
0310-  03 A5 02 85 00 A5 03 C9
0318-  00 F0 48 85 01 A0 00 B1
0320-  00 EA 99 02 00 C0 03 F0
0328-  04 C8 4C 1F 03 C8 B1 00
0330-  C9 00 F0 DD CD 05 08 F0
0338-  04 C8 4C 2E 03 A2 00 E8
0340-  C8 BD 05 08 C9 00 F0 09
0348-  B1 00 DD 05 08 F0 F0 D0
0350-  DD 98 48 A5 05 A6 04 20
0358-  24 ED 20 8E FD 68 A8 C8
0360-  4C 2E 03 A2 00 68 95 00
0368-  E8 E0 05 D0 F8 4C D0 03
0370-  08 4A 4A 4A 4A 26 3C 4A
0378-  26 2A 1D 66 09 91 40 C8
0380-  A5 2A 29 07 1D 99 09 91
0388-  40 C8 A5 3C 29 07 1D CC
0390-  09 91 40 C8 CA 10 B3 AD
0398-  99 08 4A 4A 4A 0D FF 09
03A0-  91 40 A6 2B 60 FF FF FF
03A8-  FF FF FF FF FF FF FF FF
03B0-  FF FF FF FF FF FF FF FF
03B8-  FF FF FF FF FF FF FF FF
03C0-  FF FF FF FF FF FF FF FF
03C8-  FF FF FF FF 36 FF FF FF
03D0-  4C BF 9D 4C 84 9D 4C FD
03D8-  AA 4C B5 B7 AD 0F 9D AC
03E0-  0E 9D 60 AD C2 AA AC C1
03E8-  AA 60 4C 51 A8 EA EA 4C
03F0-  59 FA BF 9D 38 4C 00 03
03F8-  4C 00 03 4C 65 FF 65 FF
```

## Restoring lost listings

HERE IS a short machine-code program which might be useful writes DF Haslam of Stockport, Cheshire. Are there times when you have written or modified a Basic program and at some stage performed the basic command NEW and immediately wish you had not? I keep this routine on my Novapac disc system and by typing .OLD <cr>, it is a simple matter to restore the lost Basic program. OLD is my file name on disc.

However, the code is re-locatable and could, therefore, be made amenable to wherever in memory you may wish to store it or load it too. It uses one subroutine in ROM, and is applicable to the new ROM machines, also for its page zero references. I have already found it useful on a number of occasions.

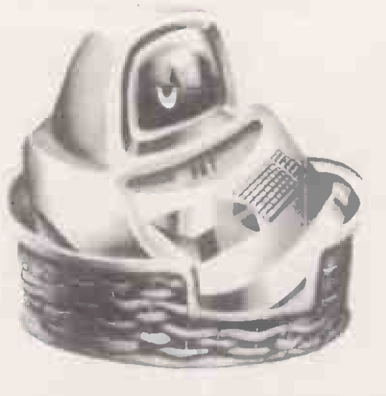
```
7400-  A5 28        LDA $28
7402-  A4 29        LDY $29
7404-  85 1F        STA $1F
7406-  84 20        STY $20
7408-  18           CLC
7409-  A0 01        LDY #$01
740B-  B1 1F        LDA ($1F),Y
740D-  D0 28        BNE $7437
740F-  A0 04        LDY #$04
7411-  C8           INY
7412-  B1 1F        LDA ($1F),Y
7414-  D0 FB        BNE $7411
7416-  C8           INY
7417-  98           TYA
7418-  65 1F        ADC $1F
741A-  AA           TAX
741B-  A0 00        LDY #$00
741D-  91 28        STA ($28),Y
741F-  A5 20        LDA $20
7421-  69 00        ADC #$00
7423-  C8           INY
7424-  91 28        STA ($28),Y
7426-  20 42 C4     JSR $C442
7429-  A5 1F        LDA $1F
742B-  69 02        ADC #$02
742D-  85 2A        STA $2A
742F-  A5 20        LDA $20
7431-  90 02        BCC $7435
7433-  69 00        ADC #$00
7435-  85 2B        STA $2B
7437-  60           RTS
```

Listing of .OLD a machine-code program which restores the Basic program immediately after you had performed the command NEW, i.e., before you enter a new line number.

## Upgrading to 16K

M TUNBRIDGE of Penrith, Cumbria writes in response to Peter Dolphin's letter in the November issue. In theory, upgrading the Pet is very easy, he writes. 16K of 4116 can be obtained for £25 and as a 16K Pet costs £100 more than an 8K Pet; Commodore has soldered in the memory chips to make this simple change harder.

I have upgraded my 8K to 16K and



from experience would warn anyone planning to do that to invest in a solder sucker. Removing the 4108s without one was very difficult and some tracks were lifted and damaged. I used sockets for my 4116s and then spent a worrying day tracing loose contacts and shorts where the board was damaged.

The link connections for 8K of 4116 are not the same as for the 16K Pet with 4108s and are as follows:

| | |
|---|---|
| *A Open | M Closed |
| B Open | N Open |
| *C Closed | P Closed |
| D Closed | R Open |
| *E Open | S Closed |
| *F Closed | |
| H Open | |
| *I Closed | |
| J Closed | |
| K Closed | |
| *L Open | |

*These are the changes from the 8K Pet.

## Input from keyboard

JEREMY McGee of Maidenhead, Berkshire, has supplied Pet Corner with a useful routine for accepting input from the keyboard. Many Pet users, old and new ROM, may have had the problem of accepting a single line of text from the keyboard he writes. INPUT will take in a string but only if there are no commas or colons.

Worse, that form of text input bombs-out and returns to Basic if the return key is typed. The question mark prompt can also produce some meaningless questions.

This routine is also a good illustration of a useful technique of incorporating a short machine-code subroutine in a Basic program. If the program is less than 80bytes long, it can be incorporated in a REM line at the beginning of the Basic program. Do that by producing a dummy REM at the start — I suggest line 0. Fill this with As. Then look for the start of the As in memory thus:

```
FOR I = 1025 TO 1100: PRINT I, PEEK (I):
NEXT
```

Type this as a command in direct mode. As soon as you see the number 65 — ASCII A — appear on the right stop the loop with the STOP key and note the number on the left. That is the start of the REM line. Assemble the machine-code routine to start at this location and POKE it there — either in direct mode or by using a loader such as that in program 2.

In my program, the As of the dummy REM in line 0 started at location 1032. There are still some limitations with the technique, however — occasionally, some programs can produce spurious out-of-data errors. The only thing to do in that case is to try another way of writing the program. If anyone can find a reason why this happens, I should be interested to know.

The routine will input any text into the string AS$ whatever is typed on the keyboard. After the program has been loaded and run successfully, the machine-code loader in lines 63000 on can be deleted, as the machine-code subroutine will be saved with the rest of the program. There will be jibberish in the dummy REM line, so do not type return over this line or you are liable to corrupt the data. Thanks for an excellently-produced magazine. Keep up the good work.

Program 1: Input a line and transfer typed data to input buffer at locations 10-80 decimal.

```
0442 AE FF 03 LDX $03FF  ;clear X register to
                          zero
0445 20 CF FF JSR $FFCF
0448 C9 0D    CMP £$0D   ;CR?
044A F0 05    BEQ +5     ;read all data
044C 95 0A    STA $0A,X  ;transfer byte to
                          buffer
044E E8       INX
044F D0 F4    BNE —12    ;read next byte
0451 86 07    STX $07    ;store length of
                          text read
0453 60       RTS        ;return to Basic
```

Program 2: Basic loader for program 1.

```
0 REM AAAAAAAAAAAAAAAAAAAA
63000 FOR I = 1032 TO 1049
63010 READ A: POKE I,A
63020 NEXT I: END
63030 DATA 175, 255, 3, 32, 207, 255, 201,
      13, 240, 5, 149, 10
63040 DATA 232, 208, 244, 134, 7, 96
```

Program 3: Basic subroutine to input a line and return text in A$.

```
62000 SYS 1032: A$ = "": IF PEEK (3) =
      0 THEN PRINT
62010 IF PEEK (7) <> 0 THEN FOR I = 10
      TO 9 + PEEK (7): A$ = A$ +
      CHR$ (PEEK (I)): NEXT
62020 IF A$ = " " THEN A$ = ""
62030 RETURN
```

## Clever technique

I READ with interest the letter by Bill Skipton in the November 1980 issue of your excellent magazine writes CM stanford of Impetus Computer Systems London NW4. I do not wish to become involved with his comments about the rights and wrongs of protecting programs. However, Acraman's suggestion about pointing line zero at itself works. I too assumed that it would cause GOTO and GOSUB to hang but I took the trouble to try it before risking making a fool of myself.

I do, however, like Skipton's suggestion for those programmers who "find themselves knee-deep in Gosubs". It is an example of extremely clever programming. However, there are two minor problems: the Pet lacks an "ONERR"

*(continued on next page)*

*(continued from previous page)*
statement and it is also lacking a "POP" statement. Otherwise his suggestion is perfect.

I now turn my attention to the letter from Philip Deakin in Pet Corner. Here, we have someone who to my mind is worse than Skipton in that he, indeed, has a Pet. Also, he evidently has Compu-think disc drives and presumably a manual. I would suggest that he read that manual. While the coding that he has given works perfectly, if he were to substitute line 120, for the following, his entire letter would become unnecessary.

120 $X;1, "P1"

The semicolon after the X tells the disc operating system that the overlay should be a warm one and the variables are, therefore, not re-set. Deakin obviously does not have Commodore discs or he would know that his line 120 invariable does a warm overlay. Indeed, it is frequently a problem when writing complex business packages that if a small program must call a larger program to be overlaid then it is necessary to expand the Basic area of memory and to commence the larger program with the statement CLR.

## Format program

PET BASIC is fun writes HK Kohler of the Department of Mechanical Engineering at Sheffield University — and useful, but many users have been brought up on Fortran. The facility missed most is the ease of formatting output data by Fortran format statements. On the Pet, printer aspects are not too bad, though there are some residual difficulties. On the Pet screen, most attempts to present data in a clear and well-tabulated manner are doomed to disaster.

So, with the good string-handling abilities of Basic, why not write a simple formatting program to improve matters? What should it do? Well, naturally format f(x.y) should mean x places before the decimal point and y after; but what else?

It would be useful to avoid numbers with an unrealistic number of significant figures, so in addition the number of significant figures in the data should be definable. It would also be helpful to choose to either right-justify with zeros, or right justify with blanks, within the available field, of width (x + y + 1).

It still does not sound too difficult, until you try it. This subroutine is one rather complicated attempt.

There are, incidentally, many other constraints. Suppose the number is too big, or too small, or zero, or, more subtly, when rounded increases its numbers of digits, or is less than 1 in the least significant figure, but greater than .5 beyond that, so has to carry into the format.

Any suggestions for an easier method would be welcome, in the meantime, at least this one works — probably.

```
100 REM TEST ROUTINE
110 INPUT"FS$";FS$
120 OPEN2,4:CMD2
130 PRINTFS$
140 GOSUB230
150 N=VAL(LEFT$(FS$,1))
160 FO=(SGN(RND(3)-.2))*(10↑((RND(3)-.5)*2.1*N))
170 PRINTFO
180 GOSUB350
190 PRINTTAB(22);"*";V$;"*"
200 GOTO160
210 REM********** FORMAT
220 REM FS$="A.B,C,D" DEFINES F(A.B),
230 REM C IS NO. OF SIG. FIGURES.
240 REM D=0 TO RIGHT PAD ZEROS,
250 REM D=" " TO RIGHT PAD BLANKS,
260 REM ENTER WITH VARIABLE 'FO',
270 REM RETURNS 'V$' OF LENGTH A+B+1
280 REM VAR. NAMES ALL 'Z*'
290 REM DECODE FORMAT
300 ZA=VAL(MID$(FS$,1,1))
310 ZB=VAL(MID$(FS$,3,1))
320 ZC=VAL(MID$(FS$,5,1))
330 ZZ$="000000000":ZB$="         "
340 ZQ=0:ZQ$=ZB$:IFRIGHT$(FS$,1)="0"THENZQ=1:ZQ$=ZZ$
350 REM ******** ENTRY IF FORMAT SET
360 ZO=FO
370 REM CHECK IF TOO SMALL, RETURN ZERO
380 IFABS(FO)>(.499*(10↑(-ZB)))THEN420
390 V$=LEFT$(ZB$,(ZA-1))+"0.0"
400 V$=V$+LEFT$(ZQ$,(ZB-1)):RETURN
410 REM MAKE FO + & KEEP SIGN
420 ZS=SGN(FO):FO=FO*ZS
430 REM ROUND UP LAST DIGIT
440 IFFO<(10↑(-ZB))THENFO=(10↑(-ZB))*ZS:GOTO420
450 REM GET MAGNITUDE OF FO
460 ZL=INT(LOG(FO)/LOG(10))
470 IFZL>(ZA-2)THENPRINT"FO TOO BIG":V$=STR$(ZO):RETURN
480 REM ENSURE LAST DIGIT ALWAYS ROUNDED
490 ZW=ZC:IFZC>(ZB+ZL+1)THENZW=(ZB+ZL+1)
500 REM SET NO. OF SIG. FIGURES
510 FO=FO*(10↑(ZW-ZL-1))
520 ZF=INT(FO+.000001)
530 FO=INT(FO+.5)
540 REM CHECK OVERFLOW ON ROUNDING AND
550 REM COMPENSATE IF NECESSARY
560 IFLEN(STR$(ZF))<LEN(STR$(FO))THENZL=ZL+1
570 IFZL>(ZA-2)THENPRINT"FO TOO BIG":V$=STR$(ZO):RETURN
580 ZT$=MID$(STR$(FO),2)
590 REM RESTORE SIGN
600 ZS$=" "+ZT$:IFZS=-1THENZS$="-"+ZT$
610 REM STRIP TRAILING ZEROS
620 ZG=LEN(ZS$):ZI=0
630 FORZJ=1TO(ZG-2)
640 IFASC(RIGHT$(ZS$,ZJ))=48THENZI=ZI+1:GOTO660
650 GOTO670
660 NEXT
670 ZS$=LEFT$(ZS$,(ZG-ZI))
680 REM BRANCH IF V$ NEEDS '0.'
690 IFZL<0THEN840
700 REM SET LEADING BLANKS
710 V$=LEFT$(ZB$,(ZA-ZL-2))
720 REM BRANCH IF NO DECIMAL PART, AND
730 REM NEEDS TRAILING BLANKS
740 IF(ZL+2-ZG)>0ANDZQ=0THEN760
750 GOTO780
760 V$=V$+LEFT$((ZS$+ZZ$),ZL+2)+LEFT$(ZB$,ZB+1):RETURN
770 REM INTEGER PART
780 V$=V$+LEFT$((ZS$+ZZ$),ZL+2)
790 REM IF NO TRAILING ZEROS, RETURN
800 IF(ZL+2-ZG)=0ANDZQ=0THENV$=V$+LEFT$(ZB$,ZB+1):RETURN
810 V$=V$+"."+MID$((ZS$+ZQ$),ZL+3,ZB)
820 RETURN
830 REM FO <1.0
840 V$=LEFT$(ZB$,(ZA-2))+LEFT$(ZS$,1)+"0."
850 V$=V$+LEFT$(ZZ$,(-1-ZL))+MID$((ZS$+ZQ$),2,(ZB+ZL+1)):RETURN
READY.
```

**The Micromouse page is for anything that moves. It is edited by Nick Smith who won the 1980 European Micromouse Competition. The aim is to help readers who do not have a clue where to start, learn enough to enter, and perhaps win, the 1981 competition. We will pay the usual £5 for each idea published.**

## Chassis design

DESIGNING a chassis means thinking about size and shape, location of wheels and method of steering. The first thing to do, therefore, is to lay down your requirements. If you are designing for the micromouse contest, it means racing round a grid of 7in. squares at high speed. Sterling Mouse runs at about 7in./second, although I was aiming for 18in./second.

High speed means a mouse which can drive round corners — rather than stop, spin, and start — and that can go equally well forwards and backwards — useful for dead ends. As a simple test, draw what springs to mind.

I sat down with a ruler and compasses and produced an eliptical chassis with a pair of independently-driven wheels for steering on the short axis and a ball-bearing stabiliser fore and aft. That is a good, stable, mouse-like shape which will slide round corners without stopping. Being symmetrical, it will go forwards equally well as backwards.

That design lasted about a week. Driving round corners requires great precision in terms of position and movement. Anything less is bound to involve scraping the inside corner or running into the facing wall. Building the sensors required to monitor progress and writing the software to interpret the information and control the steering are not jobs for the faint-hearted. In the same way, a reversible mouse requires more sensors, and either two sets of instructions — one for forwards and one for backwards — or one set three times as clever.

Sheer cowardice forced me, therefore, to use the standard robot design. A circular mouse can always go forwards no matter where it goes. Even in a dead end it can turn round by spinning on its axis without any danger of crashing and then wander forwards.

Peter Robinson, owner of the Pascal Mouse-Engine, told me he chose a toy-car chassis to save constructions time. I wonder how much he thought about the software before he took that decision? A toy car will always have trouble with corners and dead ends are a disaster.

Anyone with some bomb-proof rules for steering a car backwards, should send them to the Micromouse page. The alternative to reversing is three, or four-, or eight- or more point turns. If you saw the Pascal Mouse-Engine on the BBC television program Nationwide you will understand.

Nick Smith and Sterling Mouse.

The Swiss mouse, Lami, was square with four drive wheels, one parallel to each side. To discover how it could move up, down, left or right with all four wheels on the ground see November, *Practical Computing*. The software for Lami was probably reasonably simple as it never had to turn but I defy any amateur to build one, together with the fully-independent suspension necessary for it to work properly.

Looking at Sterling in greater detail will reveal that it is octagonal because the turn-ups give greater rigidity. It has four-point contact with the ground with one of the two ball-bearing stabilisers sprung to allow for uneven ground.

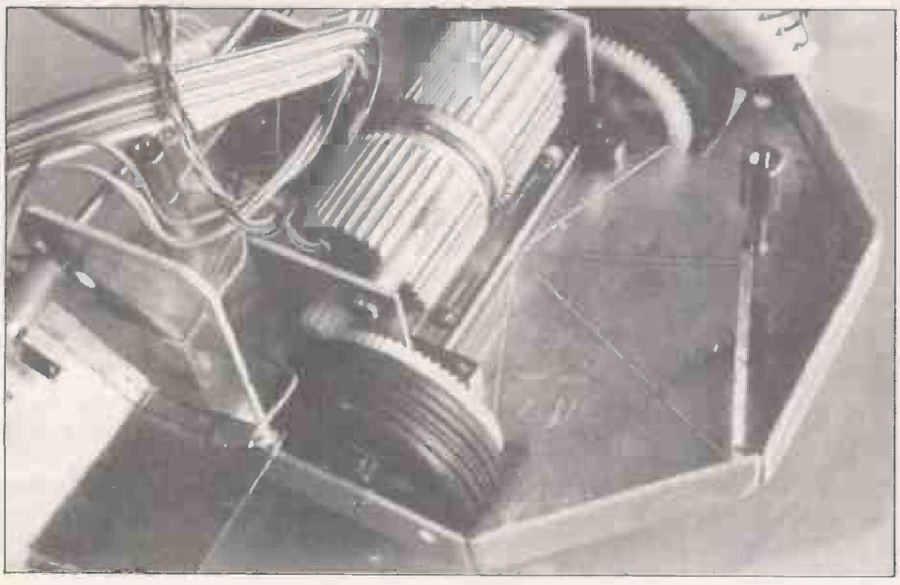
Three-point contact needs the centre of gravity well away from the main drive wheels or it might tip over. That will make spinning about the axis harder on the motors.

The two drive wheels spin freely on a common axle to make sure the wheels are parallel. The tyres are big and slightly spongy for excellent grip. The large gear-wheels are glued to the tyres.

The smaller the diameter of your mouse, the better as steering control becomes less critical. On the other hand, stability will suffer, especially if your mouse becomes taller at the same time. Micromouse maze passages are about 6½in. wide after ½in. thick walls are allowed for. Sterling at 5½in. diameter is a little large, 4½in.-5in. would be better.

Whether you are building a mouse, or a robot, or whatever, always think about all the mechanics, all the hardware and all the software before doing anything. What you finish with will inevitably be a compromise between performance, ease of construction and ease of programming.

Close-up of the mouse's chassis.



## Weekend workshop

EDDIE GEORGE of ICL is organising a weekend workshop for mouse builders at the end of March or beginning of April. If you are interested in talking shop, and carrying out trouble-shooting with experts, you can reach him on Stoke on Trent (0782) 29681.

## Preliminary trials

THE FINALS of the 1981 micromouse competition will be held in Paris at the next Euromicro Symposium on September 7-10. Preliminary trials will be held in Paris on May 5-7 and in London at the Online Exhibition on July 28-31.

If last year is anything to go by, competing in a preliminary trial is a sure-fire way of winning a prize. Only one of the five mice present at last year's trials went further than the first corner — yet they all won a prize.

Whether your mouse is ready or not, I strongly recommend that you go to one of the trials. It gives you ideas and lets you see how the competition is doing.

Send your entries to: Dr John Billingsley. Portsmouth Polytechnic, Department of Electrical and Electronic Engineering, Anglesea Building, Anglesea Road, Portsmouth, PO1 3DJ.

## Copyright: intellectual property in the information age

*By E W Ploman and L C Hamilton. Published by Routledge and Kegan Paul, £12.50, hardback, ISBN 0 7100 0539 3.*

RECENT technical developments have greatly stretched copyright legislation, by producing problems of definition and practice which the original framers of copyright laws did not foresee.

Photocopying machines, telecommunications and computers have all uncovered ambiguities or oversights in what is meant by copying or publication. Other problems are raised by the attempts to stretch the concept of copyright to provide protection for computer programs.

Copyright seeks to protect the rights of authors in their works, by prohibiting unauthorised copying, publication, adaptation, or performance. That prohibition creates a property in the work which can then be sold, wholly or in part, by the owner.

The Universal Copyright Convention defines works as "literary, scientific or artistic works", but that leaves great problems of knowing whether, for example, income tax forms, records of chess games, and photographs of clouds are included. The situation becomes even more complex when information which crosses international boundaries is considered.

The book provides a detailed view of copyright, from its historical origins to present-day statutes. The international copyright position is described and the national legislation of 10 important countries is analysed to show approaches taken to the various problems.

After describing the new challenges to copyright posed by recent technological developments, the authors discuss the rights of the various parties, authors, publishers and the public, in an attempt to discover where the balance of interest lies.

Finally, a proposal, which may provide a way forward, is examined by considering the way information flows through communications channels rather than concentrating on the static form in which the information is often published.

Ploman and Hamilton have done an excellent job in making the complexities of this esoteric but important subject intelligible to the lay reader. The book is interesting, informative, and occasionally entertaining; it is valuable reading for anyone who wishes to understand current copyright law, and especially so for those who want to be able to follow or participate in the debates about how copyright legislation should be adapted to protect computer software more effectively.

### Conclusions

- **An impressive and authoritative book, deserving a wide circulation.**
- **Recommended especially to non-lawyers who are interested in this important and complex subject.**

## Foundations of programming through Basic

*By Peter Moulton. £5.*

ALMOST any fool can write a computer program — and many do.

However, writing a program which works is rather different, and far more difficult. Writing one that both works and can be followed by someone else is a different again, but it is the only kind of program of lasting value, even to you.

Being able to write such a program is being able to do something really worthwhile. Peter Moulton's book will help you to do just that.

Of course, it teaches you programming, and Basic, but it does more — it teaches you how to build a program, and how, by using REMs, to build a program you can follow in six months and alter without its crashing.

Anyone else, faced with your program, now or in the future, will be able to see what you are trying to do, and why, and what the program is trying to do, and how — no mean achievement.

The book is not meant to be an easy primer to Basic — mastering the book will mean work.

Perhaps the book does not go so deeply into programming, or Basic, as some, but it covers the main essentials thoroughly and well. Input and print and let, of course, read, data and restore, for-next loops, and — handled in a most valuable and original way — the construction of If-Then-Else statements. Also chapters on arrays, matrices, files, sorts, searches and user-defined functions.

Instead of taking each Basic statement or command and telling you how to use it, it starts each time with a real-life problem and then shows you how a Basic statement or command can help to solve it.

### Conclusions

- **The author refers to the book as a textbook and mentions students and instructors so possibly the book is not intended as a teach-yourself manual.**
- **There are no answers to the exercises, which is irritating.**
- **For £5, it is a book every serious Basic programmer should certainly have in his library.**

## TRS-80 disc and other mysteries

*By H C Pennington.*

THE FIRST volume of four which form a system programmers' guide to the TRS-80. It describes the standard directory and disc file formats, including Basic files — ASC11 and binary — Editor/assembler files, object-code files, system files, electric pencil files and Macro-80 files.

The book explains how to recover lost data, repair disc corruptions, copy damaged discs, convert files from one format to another, and bypass the security of password protection. The key to these mysteries is a utility program called SUPERZAP which sounds as though it is based on the program of the same name used widely in many IBM installations round the world.

SUPERZAP allows data on disc to be inspected and modified by absolute address, bypassing the file-handling — and security checks — of the operating system by controlling the disc directly.

In that way, directory blocks can be modified, files rechained and passwords deleted. In the wrong hands, SUPERZAP can be lethal.

SUPERZAP for TRS-80 is distributed as part of the NewDOS+ operating system package from Apparat Corporation. Although much of the book describes how to use SUPERZAP to recover from disasters or to save time, TRS-80 owners will find much to interest them.

The risk they take is that the author's enthusiasm will convert them to NewDOS+ and send them hunting through the pages of *Practical Computing* for a supplier.

The style of the book is informal, but the information is well-structured and designed for easy reference. Fact is clearly separated from opinion, and the cartoons and occasional ominous warnings suggest that the author has worked hard to obtain the facts.

### Conclusions

- **In all, a book worth owning; do not be put off by the cover, the content is far better than you might think.**

## The incredible secret money machine

*By Don Lanchester*

MAKE a better mousetrap, said Emerson, and the world will beat a pathway to your door. If, says Don Lanchester, the world knows where you are and knows about the mousetrap.

Inside every one of us is a little, secret, mad idea of what we would really like to do with our lives. In six months, if you use the ideas in the book, you will wonder why you wasted all those years in a steady job.

What has all this to do with microcomputers? One of the ideas explored in the book is to invest your redundancy money in a micro, a printer and a disc system.

Agreed, the book has very little to say directly about micros, and of course nothing about flowcharts, Basic, or how to avoid GOTOs, but it has many good things to say on how to set-up and run a little, with the emphasis on little, business of your own.

### Conclusions

- **Even if you never take the step of starting on your own, you will find the book very readable.**
- **It is occasionally extremely funny which is more than can be said for some books on micros or small businesses.**

# Secrets of special Z-80 instructions

**The additional esoteric commands of the Z-80 make its performance superior to that of almost any other eight-bit device. To help you appreciate fully the extra facilities, David Peckett re-examines Z-80 architecture.**

THE architecture of the Z-80 is shown in figure 1. The major differences between it and the 8080A are the twin sets of working registers and the two index registers, IX and IY.

A major weakness of the 8080A is that it has only a relatively limited choice of addressing modes. Almost all memory-referenced operations use the register pair HL as a pointer; in particular, all the arithmetic and logical commands have to use HL. In consequence, HL tends to be used mainly as a pointer, thus limiting the number of general-purpose registers available to this register-orientated micro.

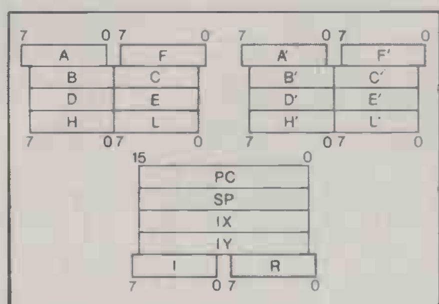



**Figure 1. Z-80 architecture.**

The Z-80 inherits the 8080A inability to refer directly to memory in its dyadic operations. However, it has the 16-bit registers IX and IY which give it an indexing capability and which free HL for other operations, such as 16-bit addition and subtraction.

The Z-80 indexing mechanism differs from that of the 6502, despite having the same name. In the 6502, indexed instructions have mnemonics of the form:

ADC BASE, X

When this instruction is executed, the micro discovers which address to go to by adding the contents of, in this case, X to the base address to form a new address (BASE + X). The indexing operation gives a variable, eight-bit, unsigned displacement to a fixed 16-bit address.

In a way, the Z-80 does just the opposite; the equivalent Z-80 addition mnemonic would be:

ADC A, (IX+d)

IX contains a variable 16-bit quantity to which is added the signed — two's complement — fixed eight-bit displacement "d". It is important to understand that difference since it greatly affects the use of the two Z-80 index registers. It makes it particularly easy to manipulate items held in memory as small, related groups within a long list.

For example, suppose one area of memory holds a long list of numbers grouped in threes. Each group of three is to be added together and the sum placed as an element of another list — figure 2. That kind of application is tailor-made for indexing.

Initially, we set IX and IY to point to the appropriate places as shown in figure 2; the basic addition can then be performed by:

```
LD   A, (IX+0)   ;A=A1
ADD A, (IX+1)    ;A=A1+A2
ADC A, (IX+2)    ;A = A1 + A2 + A3
LD   (IY+0),A    ;STORE SUM
```

This segment could form the core of a loop, with suitable manipulation of IX and IY at each end.

**Indexed instructions.** You can use indexing with virtually any eight-bit command, whether working on one byte, e.g., INC (IY+d), or on two bytes, e.g., SUB (IX+d). In fact, whenever you can use (HL) in place of a reference to a register, you can also index. You will infer that you can index only once in any instruction. For instance, "LD (IX+3), (IY+3)" would be illegal. Table 1 is a full list of indexable instructions.

| | | | | |
|---|---|---|---|---|
| ADC A,I | ADD A,I | AND I | BIT b,I | CP I |
| DEC I | INC I | LD I,r | LD I,n | LD r,I |
| OR I | RES b,I | RL I | RLC I | RR I |
| RRC I | SBC A,I | SET b,I | SLA I | SRA I |
| SRL I | SUB I | XOR I | | |

Notes: "I" — (IX+e) or (IY+e)
"b" — Bit number
"n" — Data
"r" — Register

**Table 1. Indexable instructions**

The indexing operand follows the usual Z-80 conventions. It is enclosed in brackets, because it is a reference to memory, and it always has the basic form (IX+d) or (IY+d). Whenever you can index, you can use either register.

The format of "d" will depend on your assembler. You cannot normally replace it with a label — since "d" represents a displacement, a label would have little meaning. Often, however, if "d" is zero, you can use the shortened forms (IX) and (IY). If you have a negative displacement, you could use a minus sign, (IY-d).

Although, in principle, "d" could be Hex or binary, they are not much use. A

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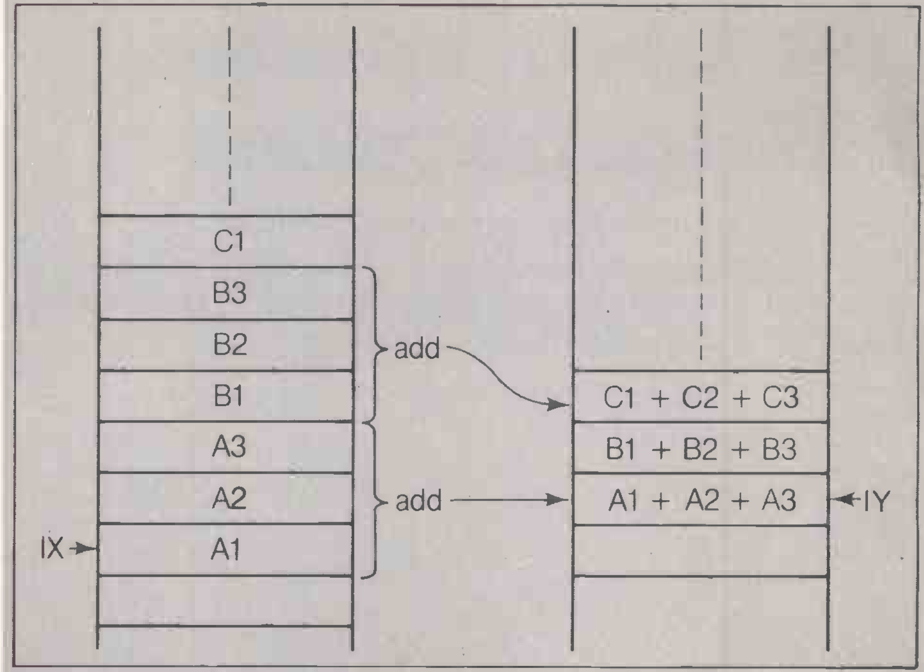



**Figure 2. Adding several bytes.**

*(continued from previous page)*

decimal displacement is most easily understood and all that some assemblers will allow. In fact, it is unusual for "d" to leave the range ± 5, or so.

**Manipulating the index registers.** The two index registers offer many possibilities to the Z-80 programmer, as long as he is able to manipulate them. Table 2 shows this month's new instructions, most of which are concerned with modifying IX and IY in one way or another. In many ways, but not all, the two registers can be treated like HL. In descriptions, I normally refer

```
        LD   B,COUNT     ;COUNTER
        LD   DE,TARGET   ;RESULTS HERE
        LD   HL,ORIGIN   ;START OF FILE
LOOP    LD   A,(HL)      ;A=A1
        INC  HL          ;POINT TO A2
        ADD  A,(HL)      ;A=A1+A2
        INC  HL          ;POINT TO A3
        ADC  A,(HL)      ;A=A1+A2+A3
        INC  HL          ;POINT TO B1
        LD   (DE),A      ;STORE RESULT
        INC  DE          ;NEXT SPACE
        DJNZ LOOP        ;MORE?
;
;CONTINUE
```

**Figure 3a.**

to "IX"; unless I say otherwise, that also means 'IY'.

The most basic operation is that of setting the registers. They can be loaded in either an immediate mode (LD IX, data), or directly from memory (LD IX, (addr)). As usual in the direct mode, the address or label points to the low byte, and the high byte is at (addr + 1). It is also possible to save the registers in memory by using LD (addr), IX.

Index registers of all kinds are normally used, of course, to step through lists of data, either from the bottom or the top. Those operations demand a basic ability to increment and decrement the indices, for which Zilog provides "INC IX" and "DEC IX".

In an interrupt-driven system, it is important to save the micro's environment in the stack at the start of a service routine. When we looked at interrupts last month, we were concerned only with saving registers A-L in the stack. Sometimes, though, the service routine will have to use IX or IY; it, therefore, has to save the existing values of the registers. "PUSH IX" and "POP IX" meet that need.

PUSH and POP also give a way of transferring data between the two index registers, or between an index register and an ordinary register pair. Unfortunately, the Z-80 does not have specific instructions to do the job. As an example, to load IX into IY, and to move BC to IX, we could use:

```
PUSH IX   ;SAVE IX
PUSH BC   ;SAVE BC
POP  IX   ;IX=BC
POP  IY   ;IY=IX
```

To be honest, we are unlikely to do that very often. Frequently, a fixed value is held in an index register while several adjacent memory locations are processed. We had an example earlier, when we added three numbers together. If those three numbers were just one of many blocks of three in a long list, we would have to add three to the value of IX on each iteration of the loop. One way would be:

```
INC IX
INC IX
INC IX
```

It works, but it is a clumsy and slow, and impractical if we have to add more than about five to the index. To obviate the problem, we can perform 16-bit addition in the two registers via "ADD IX,rp". The operation is similar to "ADD HL,RP", and sets the same flags, but the three 16-bit ADDs of the Z-80 are all subtly different.

"ADD HL,rp" can add any of the four RPs BC, DE, HL or SP to HL. However, HL cannot be added to either IX or IY, although BC, DE and SP can. Furthermore, you can add IX to IX — thus doubling it — but not IY to IX. To make it even more complex, you cannot add IX to IY, but you can add IY to itself. You must be careful with those instructions.

You can also load the SP with the contents of an index register, by using "LD SP, IX". That is not a particularly useful instruction, unless you have saved temporarily the SP in one of the registers:

```
LD     IY,0
ADD    IY,SP  ;IY=SP
```

while you use a second stack. Also like HL, you can swap an index register with the data on top of the stack (EX (SP), IX). That gives a way of accessing and/or changing a return address during a subroutine.

The final trick you can play with IX and IY is to use them as pointers for indirect jumps (JP (IX)). The contents of the register is used as the address to which the jump must take place. As I pointed out when we met "JP (HL)", that is an instruction to use with caution. It is a computed "GOTO", and it can make programs very difficult to debug or modify.

IX and IY are, in many ways, alternatives to HL, particularly when the latter might be used as a pointer. With the registers, you can perform bizarre operations with index registers. Apparently, the Z-80 uses the same block of internal logic to decode instructions that use HL, IX and IY. It is probably more accurate to regard them as general-purpose 16-bit registers also used for indexing.

Although the big attraction of the two registers is that they free HL, and BC and DE, for more useful things, there is an

```
        LD    B,COUNT         ;COUNTER
        LD    IX,ORIGIN       ;START OF FILE
        LD    IY,TARGET       ;RESULTS HERE
        LD    DE,3            ;TO ADJUST POINTER
LOOP    LD    A,(IX)          ;A=A1
        ADD   A,(IX+1)        ;A=A1+A2
        ADC   A,(IX+2)        ;A=A1+A2+A3
        LD    (IY),A          ;STORE RESULT
        ADD   IX,DE           ;IX=IX+3
        INC   IY              ;NEXT SPACE
        DJNZ  LOOP            ;MORE?
;
;CONTINUE
```

**Figure 3b.**

important point that you should be wary of. Instructions using IX take longer to perform than equivalent HL-based operations. For instance, let us return to the task of adding three numbers, and putting the sum in a fourth location.

To do that a number of times, we would put the instructions in a loop, which could use either the normal registers, or the index registers. Figures 3a and 3b show versions of the same program using ordinary and index registers respectively.

At first sight, the indexing version looks better — it uses only 11 lines of assembly code against the ordinary version's 12 lines. That difference is more marked inside the loop, where the IX/IY version is two lines shorter.

Table 3 shows how many bytes each instruction occupies, and how long it takes to execute — assuming a 4MHz clock. There is a major difference now — the assembled version of figure 3a will occupy 18 bytes, while the indexing version will take up 72.2 percent more space at 31 bytes.

The difference is even more striking if we look at how long each iteration of the loop takes. The ordinary loop will complete itself once every 15 μ Sec. The one using IX and IY will run for 27.25

*(continued on next page)*

**Table 2. This month's instructions.**

| Operation | Mnemonic | | Flags | Effect |
|---|---|---|---|---|
| Add RP to HL with carry | ADC | HL,rp | All | HL = HL + RP + CY |
| Add RP to index register | ADD | I,rp | C | I = I + RP |
| Decrement index register | DEC | I | None | I = I—1 |
| Exchange top of stack and index register | EX | (SP),I | None | (SP) = I(1) (SP + 1) = I(h) I(1) = (SP) I(h) = (SP + 1) |
| Increment index register | INC | I | None | I = I + 1 |
| Indexed jump | JP | (I) | None | PC = I |
| Relative jump | JR | e | None | PC = PC + e |
| Conditional relative jump | JR | cc,e | None | PC = PC + e if condition true |
| Load A with R | LD | A,R | None | A = R |
| Load R with A | LD | R,A | None | R = A |
| Load RP from memory | LD | rp,(addr) | None | RP = (Address) |
| Load memory from RP | LD | (addr),rp | None | (Address) = RP |
| Load index register from memory | LD | I,(addr) | None | I = (Address) |
| Load memory from index register | LD | (addr),I | None | (Address) = I |
| Load index register immediately | LD | I,data | None | I = Data |
| Load SP from index register | LD | SP,I | None | SP = I |
| Index register to stack | PUSH | I | None | |
| Index register from stack | POP | I | None | |
| Subtract RP from HL with borrow | SBC | HL,rp | All | HL = HL—RP—CY |

Notes:
- "rp" Register pair, see ADD I,rp
- "CY" Carry flag
- "I" Index register — either IX or IY
- "I(h)" High byte of I
- "I(l)" Low byte of I
- "e" Displacement
- "cc" Condition code — Z, NZ, C, NC

*(continued from previous page)*

μSec., an increase of 81.67 percent.

On average, instructions using (IX + d) take twice as long to execute as those which use (HL). The worst cases are the commonest instructions, inherited from the 8080A, which manipulate single bytes, e.g., AND, CP, etc. The indexed versions of those instructions take 2.71 times as long as their (HL) counterparts.

Why is that? The answer is easy — the instructions need more bytes to store them in the program. Many commands which work on single bytes are inherited from the 8080A, and have single-byte opcodes, accompanied, if necessary, by one or two data bytes. Thus the opcode for "ADD A, (HL)" is $86_{16}$.

| Mnemonic | Bytes | Time (μS) |
|---|---|---|
| ADC A,(HL) | 1 | 1.75 |
| ADD A, (HL) | 1 | 1.75 |
| DJNZ addr | 2 | 2.0 |
| INC rp | 1 | 1.5 |
| LD r,data | 2 | 1.75 |
| LD r, (HL) | 1 | 1.75 |
| LD rp,data | 3 | 2.5 |
| LD (rp),A | 1 | 1.75 |
| ADC A, (IX + e) | 3 | 4.75 |
| ADD A, (IX + e) | 3 | 4.75 |
| ADD IX,rp | 2 | 3.75 |
| INC IY | 2 | 2.5 |
| LD A, (IX + e) | 3 | 4.75 |
| LD IX,data | 4 | 3.5 |
| LD (IY + e),A | 3 | 4.75 |

**Table 3. Instruction timings.**

When the designers of the Z-80 added all its extra functions, there were not enough single-byte opcodes, and so the extra functions need as many as four bytes. For example, the opcode for "ADD A, (IX + d)" is $DD_{16}$ $86_{16}$ $dd_{16}$. It takes longer to read three bytes from memory than it does to read one, and so the instructions take longer to execute.

As a matter of interest, all "IX" operations have $DD_{16}$ as their first byte, while "IY" commands all start with $FD_{16}$. The second byte — and the third if the original used two bytes, as in BIT B, (HL) — are identical to the opcode of the corresponding (HL)-based instructions. The last byte contains the displacement "d" in two's complement form. If you are that way inclined, it gives you an interesting insight into the internal Z-80 machinations.

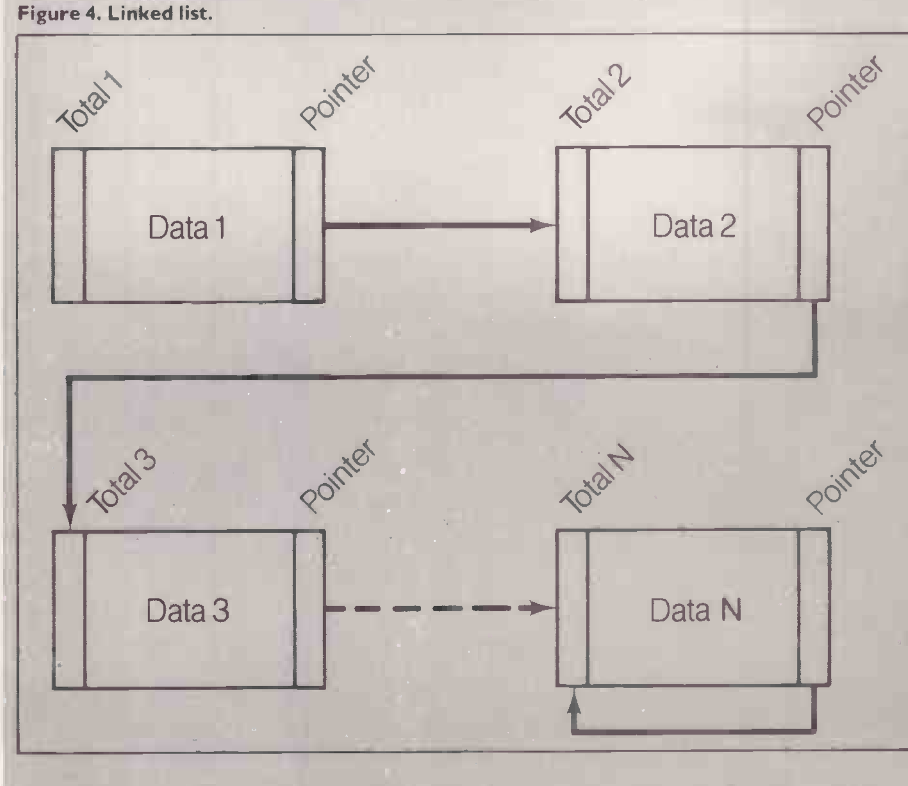
The lesson is clear; if you have to write efficient code, i.e., space and/or time, you do not use the index registers. Often, though, it does not matter a great deal — for instance, the machine may be spending all its time waiting for outside events anyway.

There are two major advantages to using IX and IY. In the first case, it frees the other registers, particularly HL, for other jobs, such as temporary data storage and arithmetic. The second advantage is an aesthetic one — I think that assembly-code listings which use the index registers make it easier to understand what the program is doing — figure 3b. In the end, though, you must decide each case on its merits.

**Example using indexing.** Let us look at an example where indexing is useful. Data is often stored in memory in the form of linked lists — figure 4. There are various kinds of them, but in my example I assume that each block has three elements.

The first byte indicates the total number, T, of data bytes in the block; there will never be more than 255 bytes in a single block. The data then follows, plus two final bytes containing a pointer to the next data block. The pointer is normally the start address of the next block, but in

**Figure 4. Linked list.**



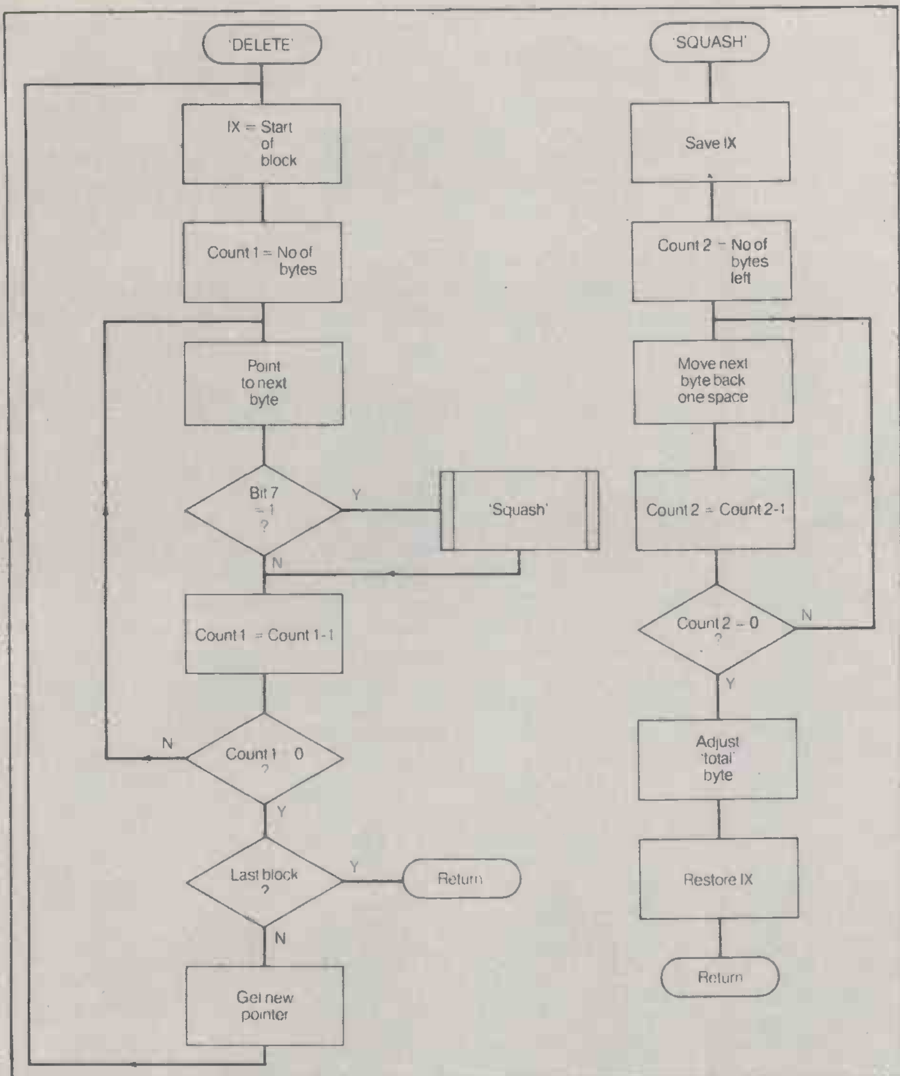



**Figure 5. Flowchart for byte deletion.**

the last block it points back to the start of the same block. There will thus be (T + 3) bytes in each block.

We aim to produce a subroutine, 'DELETE', which will go through all the data and delete every negative number, i.e., those with MSB = 1. Every time a number is deleted, the rest of the data in that block must be re-positioned to close the gap without affecting any other blocks. The routine must detect the end of the last block, and the only parameter which the calling program will give it will be the address of the start of the first block.

My flowchart for the routine is at figure 5, and shows the three main elements of the procedure. There is a basic loop which checks each byte to see if it is negative. If it is, a call is made to a second subroutine, "SQUASH", to delete the byte. Finally, after checking each block, the routine reads the pointer to the next block. If it is looping back on itself, the routine exits, otherwise it goes on for more.

Figure 6 is my program. It uses, at different points, virtually all the internal Z-80 registers, but data is transferred only to the subroutine in IY. That is loaded with the start address of the first block. You might also want to save the other registers in the stack to make the routine transparent; it is, however, totally re-entrant.

At the start of each major loop, IX is loaded with the data in IY, via the stack — we use IX to read each byte. B will be the inner loop counter, and is set to the number of bytes in the block by an IY-indexed load.

The routine then enters its inner loop where the first job is to increment IX to point to the next byte to be tested. On the first entry to the inner loop, the "INC IX" moves IX from the "total" byte. It is easy to test the MSB of each byte, and a conditional CALL is used to go to "SQUASH" when necessary. The DJNZ makes the inner loop a little shorter.

**Squash.** Deleting a byte and re-packing the data is a ideal task for a subroutine, and the approach should make the whole procedure easier to develop. IX has to be saved during "SQUASH", so it is pushed on to the stack, and B is saved in L. B is then free to be used as the "SQUASH" loop counter.

We have to remember to move the pointer to the next block back, as well as all the so-far-untested bytes — figure 7. When we enter "SQUASH", B contains

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the number of bytes not tested plus one for the byte we are to delete. The total number of bytes to be shifted back is, therefore, (B—1+2), or (B+1). That is why we increment B. All the bytes are then moved back one — the first one shifted automatically overwrites the one to be deleted.

Once all the bytes have been shuffled back, we recover the original IX and decrement it once. Once it has been "INC IX"ed, at label "LOOP", it points to the first byte shifted, which is the next to be tested. The original value of B is recovered from L, and we must not forget to decrement the total byte in the block of data. "SQUASH" leaves a copy of the high byte of the pointer address in its original location. It is not deleted because it does no harm there.

After going through a block of data, the existing value of IY — the address of the start of that block — is saved in HL. It is then adjusted to access the next pointer, which is stored temporarily in DE. The high and low bytes of the old and new pointers are compared — if they are the same, we have just finished the last block, and the subroutine exits. If they are different, IY is loaded with the new pointer from DE, and everything returns to the start.

The Z-80 inherited the 8080A ability to load HL from, and store HL in, memory; the mnemonics we have seen are "LD HL,(addr)" and "LD (addr),HL". You can see, though, from table 2 that the Z-80 can, in fact do 16-bit loads and stores of any of the three RPs BC, DE and HL, and also of SP. The relevant instructions are "LD rp,(addr)" and "LD (addr),rp".

Those extra instructions are four-byte commands, whereas the basic 8080A ones use three bytes — opcode plus two bytes of address. Because of the way the Z-80 is designed, it can handle HL with either type of command. For instance, "LD HL,($ABCD)" can have the Hex opcodes 2A CD AB or ED 6B CD AB. The first one is the 8080A-compatible instruction. The second version is obviously redundant, as well as slower, and any assembler worth its salt will always choose the first version.

The 8080A allows us to perform 16-bit addition into HL; that is extended by the Z-80 to give addition into IX and IY also. In fact, the Z-80 has some very useful 16-bit arithmetic facilities, because it can also add-with-carry, and subtract-with-borrow, into HL. They can make life much easier when we do multi-byte arithmetic, particularly as they set more flags than the basic 16-bit ADD.

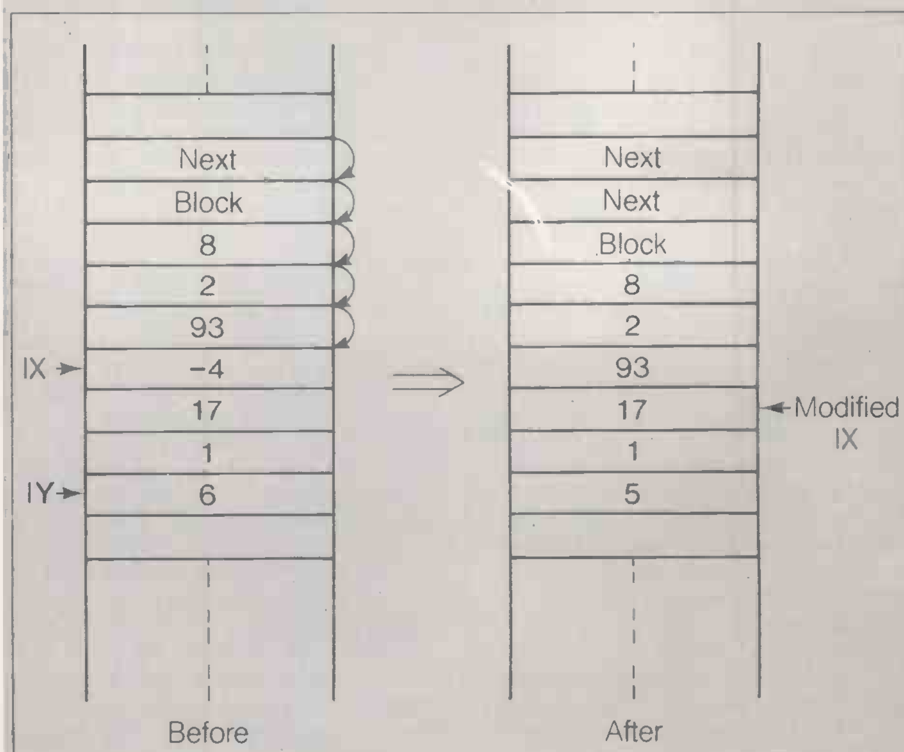
Suppose that we have two sets of 32-bit numbers to add, starting at "BASE1" and "BASE2", with the answer going to "BASE2". Until now, we would have used, for example:

```
      LD    DE,BASE1        ;FIRST
                             POINTER
      LD    HL,BASE2        ;SECOND
                             POINTER
      LD    B,4             ;LOOP
                             COUNTER
      CCF                   ;NO CARRY
                             FIRST TIME
SUM   LD    A,(DE)
      ADC   A,(HL)
      LD    (HL),A          ;SINGLE
                             BYTE DONE
      INC   DE              ;POINT TO
      INC   HL              ;..NEXT
      DJNZ  SUM             ;FINISHED?
```

Now we can use:

```
      LD    HL,(BASE1)
```

**Figure 7. Action of "Squash".**



```
;SUBROUTINE TO ELIMINATE ALL NEGATIVE BYTES
;FROM A LINKED LIST DATA STORAGE AREA
;START ADDRESS OF THE FIRST BLOCK IS
;PASSED IN IY
;
DELETE  PUSH IY
        POP  IX           ;IX=IY
        LD   B,(IY)       ;B=BLOCK TOTAL
LOOP    INC  IX           ;POINT TO NEXT BYTE
        BIT  7,(IX)       ;NEGATIVE?
        CALL NZ,SQUASH    ;DELETE NEG'VE BYTES
        DJNZ LOOP         ;FINISHED BLOCK?
;FIND OUT IF ANOTHER BLOCK.  IF NOT,
;POINTER AT END CONTAINS CURRENT VALUE OF IY
        PUSH IY
        POP  HL           ;HL=CURRENT IY
        LD   E,(IY)       ;E=NO OF BYTES
        LD   D,0
        INC  DE           ;OFFSET TO NEXT POINT
        ADD  IY,DE        ;IY POINTS TO POINTER
        LD   E,(IY)       ;DE CONTAINS
        LD   D,(IY+1)     ;..NEXT POINTER
        LD   A,E
        CP   L            ;LOWER BYTES SAME?
        JP   NZ,DIFF      ;JUMP IF DIFFERENT
        LD   A,D
        CP   H            ;HIGHER BYTES SAME?
        RET  Z            ;IF YES, FINISHED
DIFF    PUSH DE           ;MORE TO COME
        POP  IY           ;IY=POINTER
        JP   DELETE       ;BACK FOR NEXT BLOCK
;
;NEXT SUBROUTINE ELIMINATES A BYTE, AND
;CLOSES UP THE GAP
;
SQUASH  PUSH IX           ;SAVE IX
        LD   L,B          ;SAVE B
        INC  B            ;BYTES TO BE MOVED
MORE    LD   A,(IX+1)     ;MOVE ONE BYTE
        LD   (IX),A       ;..BACKWARDS
        INC  IX           ;POINT TO NEXT
        DJNZ MORE         ;FINISHED?
        DEC  (IY)         ;ADJUST TOTAL
        POP  IX           ;RESTORE IX
        DEC  IX           ;ALLOW FOR DELETE
        LD   B,L          ;RESTORE B
        RET
```

**Figure 6.**

```
LD   DE,(BASE2)
ADD  HL,DE
LD   (BASE2),HL     ;FIRST PAIR
                     DONE
LD   HL,(BASE1+2)
LD   DE,(BASE2+2)
ADC  HL,DE
LD   (BASE2+2),HL   ;SECOND
                     PAIR DONE
```

The assembled version of the second segment would occupy 23 bytes, whereas the first would only need 16. However, at the maximum Z-80 clock rate of 4MHz, the second version would run in 32.5 µSec., while the old-style routine would need 51.5 µSec. That is a worthwhile time saving, particularly if a good deal of arithmetic is to be done.

Using the 16-bit subtraction, we could have simplified the program in figure 6. At the end of the outer loop, we compare the data in DE and HL to see if it is identical. We had to do it one byte at a time, via A. It would have been much quicker and neater to have used:

```
CCF           ;NO BORROW
SBC  HL,DE    ;HL=DE?
RET  Z        ;IF YES, FINISH
```

When we were looking at the 6502, we saw that its conditional jumps, branches, used relative addressing, but the 8080A lacked such a facility. The Z-80 DJNZ is very useful for controlling loops and gives a relative, rather than absolute, jump.

The Z-80 also has relative jumps: an unconditional form (JR e) and a limited range of conditional ones (JR cc,e). Unlike conditional absolute jumps, the "JR cc"s can only test the presence or absence of the carry and zero flags, and cannot monitor sign or parity; that is rarely a problem.

The "e" is treated as a signed, two's complement, number, giving a displacement of —128 to +127 from the address of the next instruction. Since all the relative jumps are two-byte instructions, that gives, like the 6502, a displacement range of —126 to +129 from the address of the jump itself.

There is a point to beware of when you use the JRs. Although they are only two-byte instructions, compared with the "JP"s three bytes, they do not necessary execute faster than absolute jumps.

All the JPs take 2.5µSec. at 4MHz to execute, but an unconditional JR actually needs three µSec. The conditional JRs also take 3µSec. if the jump takes place but, if the comparison fails, the operation is over in 1.75 µSec.

So, the relative jumps do not compare as favourably to the direct jumps as is the case with the 6502. However, they have the major advantage of producing completely re-locatable object code since they do not use absolute addresses. In general, unless the program timing is absolutely critical, I recommend that you use JR rather than JP wherever you can.

One final pair of instructions this month: the Z-80 has a memory-refresh register (R), which is used to maintain dynamic memories. A problem with those devices is that every address must be read from, or written to, at maximum intervals of, typically, 2 mSec., if they are to retain data. Guaranteeing that can slow a system, because hardware solutions, interrupting the micro, often have to be used.

The Z-80 solves the problem very neatly by outputting the contents of R on to the lower byte of the address bus during every instruction. That happens when the micro is not using the bus, and effectively gives a dummy read operation, maintaining the memory, without interfering with the program.

R is incremented after each dummy read, which makes sure that all the memory locations are read well within the 2mSec. time limit. The micro can load R from A (LD R,A), and read R into A (LD A,R) — that is academic.

The Z-80 has two 16-bit index registers, giving it far more flexibility than its 8080A precursor. The two registers can be used and manipulated much like HL, thus freeing the main registers for more important tasks. Although their use gives a program size and running time penalty, IX and IY are a very valuable feature of the micro.

Other extra facilities of the Z-80 include its ability to transfer any of its RPs to and from memory. The micro also has a more powerful set of 16-bit arithmetic instructions than the 8080A, which can speed mathematical programs. It has a range of relative jumps, including conditional versions. Although those operations are slower than absolute jumps, they facilitate the production of re-locatable code.

Next month, the final part of the series describes the remaining Z-80 instructions. They are commands which can speed certain standard operations, particularly those which handle blocks of data.




# BUYERS' GUIDE

# Software

**Software packages are listed by application, in alphabetical order, with the systems on which each package will run also listed alphabetically. The guide is not exclusively for business applications : if your company is the source or dealer for a package with a more unusual application, send us the details and we will create a new category.**

**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.**

## Machine type by application

### Combined-Ledger/Stock/Invoicing

| Machine Type | Supplier Name | Price | Capacity |
|---|---|---|---|
| Apple II | Vlasak Electronics Ltd | £855 | |
| Apple II/ITT 2020 | Informex London Ltd | £298 | 500 A/Cs |
| Commodore 3032 | Compfer Ltd | £400 | varies |
| Commodore 3032 | Bristol Software Factory | £300 | 1,000 A/Cs 6,000 trans |
| Commodore 3032 | G W Computers Ltd | £275-- £575 | 1,000 |

| | | | |
|---|---|---|---|
| Commodore 3032 | Analog Electronics | £550 | |
| Commodore 3032 | Stage One Computers | £600 | varies |
| Commodore 3032 | Logma Systems Design | £600 | 1-6 shops |
| Commodore 3032 | Commodore B M (U.K.) Ltd | £650 | 650 A/Cs/ledger |
| Commodore 3032 | Compfer Ltd | £600 | 500 A/Cs 1,000 items |
| CP/M | Minicomputer CS Ltd | £650 | varies |
| CP/M | Computastore Ltd | £1,000 | |
| CP/M | Minicomputer CS Ltd | £850 | varies |
| CP/M North Star | Benchmark CS Ltd | £950 | 200 A/Cs 500 trans 300 items |
| CP/M North Star | Profcomp Ltd | P.O.A. | |
| CP/M North Star | Intelligent Artefacts | £510 | 1,500 A/Cs 5,000 trans |
| CP/M North Star | Instar Business Systems | £999 | 600-2,900 |
| Metrotech System | Metrotech | £500--£1,000 | |
| Ohio Scientific | Microcomputer B M | £656 | |
| Tandy TRS-80 | Microcomputer Applications | £90 each | |
| Tandy TRS-80 | T & V Johnson Ltd | £110 | 750 trans/disc |
| Tandy TRS-80 | Microcomputers Applications | £350 | |
| TECS | Jar Software Systems | £650 | 500 A/Cs 300 nom A/Cs |
| Z-80/8080 | Graffcom Systems Ltd | £995 | |
| Z-80/8080 | Great Northern C S Ltd | £995 | varies |

## General Ledger

| Machine Type | Supplier Name | Price | Capacity |
|---|---|---|---|
| Apple II | Vlasak Electronics Ltd | £225 | 200 A/Cs 1,000 trans |
| Apple II | Computech Systems | £295 | 500 A/Cs 1,700 trans |
| Apple II/ITT 2020 | Systematics International Ltd | P.O.A. | |
| Commodore 3032 | Analog Electronics | £450 | |
| Commodore 3032 | HB Computers Ltd | £200 | Linked to S/L & P/L |
| Commodore 3032 | Bristol Software Factory | £300 | 1,000 A/Cs 6,000 trans |
| CP/M | Haywood Associates Ltd | £500 | |
| CP/M | Median-Tec Ltd | £500 | 500 A/Cs 600 trans |
| CP/M | Computastore Ltd | £500 | 999 A/Cs 99 centres nine companies |
| CP/M | Ludhouse Ltd | £500 | 200 A/Cs 5,000 trans |
| CP/M | Comput-A-Crop | £400 | |
| CP/M | Benchmark CS Ltd | £250 | 500 A/Cs 5,700 trans |
| SD100/200 | Barcellos Ltd | £250 | |
| Tandy TRS-80 | Tridata Micros Ltd | £225--£375 | 500 A/Cs 1,000 trans |
| Z-80/8080 | Great Northern C S Ltd | £275 | varies |
| Z-80/8080 | Graffcom Systems Ltd | £390 | |

## Incomplete Records

| Machine Type | Supplier Name | Price | Capacity |
|---|---|---|---|
| Apple II | Personal Computers Ltd | £250 | 1,000 trans 2,600 A/Cs |
| Apple II/ITT 2020 | Padmede Computer Services | £450 | 900 A/Cs 2,000 trans/disc |
| Commodore 3032 | Stage One Computers | £750 | 500 centres 2,300 A/Cs |
| Commodore 3032 | Micro Computation | £555 | 120 A/Cs 5,000 trans |
| CP/M | Profcomp Ltd | P.O.A. | 2,000 entries |
| Durango F85 | Kesho Systems | £1,000 | |
| Exidy Sorcerer | Basic Computing | £350 incl. | see also Micropute |

SHOPWINDOW



SHOPWINDOW



## Job Costing/Billing

| Machine Type | Supplier Name | Price | Capacity |
|---|---|---|---|
| Apple II/ITT 2020 | Padmede Computer Services | £300 | 1,000 A/Cs 99 centres |
| Apple II/ITT 2020 | Padmede Computer Services | £300 | 150 A/Cs |
| Commodore 3032 | Stage One Computers | £100 | 300 appointments |
| Commodore 3032 | CSM Ltd | £600 | 1,000 jobs 100 people |
| CP/M | Graffcom Systems Ltd. | P.O.A. | 100 activity codes |
| Z-80/8080 | Great Northern C S Ltd | £300 | varies |

## Mailing Systems

| Machine Type | Supplier Name | Price | Capacity |
|---|---|---|---|
| Apple II | Keen Computers Ltd | £300 | 500 addresses |
| Apple II/ITT 2020 | Systematics International Ltd | £300 | 500 addresses |
| Apple II/ITT 2020 | Guestel Ltd | £190 | 400 addresses |
| Apple II/ITT 2020 | The Software House | £57 | 750 names & adds |
| Commodore 3032 | Stage One Computers | £100 | 350 records |
| Commodore 3032 | MMS Computer Systems | £250 | 3,000 records |
| CP/M | Graffcom Systems Ltd | £250 | varies |
| CP/M | Median-Tec Ltd | £500 | |
| CP/M | Structured Systems Group | £50 | varies |
| CP/M Horizon | Microtek Computer Services | £500 | varies |
| CP/M North Star | Micromedia Systems | £195 | |
| Tandy TRS-80 | Comput-A-Crop | £78 | varies |
| Tandy TRS-80 | Cleartone ADP | £50 | 660 entries |
| Tandy TRS-80 | T & V Johnson Ltd | P.O.A. | 3,000 names/addresses |
| Z-80/8080 | Micro Focus | £90 | varies |
| Z-80/8080 | Intereurope S D Ltd | £500 | 3,000 entries |

## Payroll

| Machine Type | Supplier Name | Price | Capacity |
|---|---|---|---|
| Apple II/ITT 2020 | T W Computers Ltd | £145 | |
| Apple II/ITT 2020 | Informex London Ltd | £50 | |
| Apple II/ITT 2020 | Informex London Ltd | £198 | 200 employees |
| Apple II/ITT 2020 | Algobel Computers Ltd | £295 | 500 employees |
| Apple II/ITT 2020 | Vlasak Electronics Ltd | £360 | |
| Apple II/ITT 2020 | Minster Micro System | £199 | 100 month 50 weekly |
| Apple II/ITT 2020 | Computech Systems | £379 | 300 employees |
| Commodore | Petsoft Ltd | £50 | 200 employees |
| Commodore 3032 | Landsler Software | £95 incl. | 200 employees |
| Commodore 3032 | Commodore B M (U.K.) Ltd | £150 | 200 employees |
| Commodore 3032 | Analog Electronics | £90 | |
| Commodore 3032 | ACT (Petsoft) Ltd | £195 | 600 employees |
| Commodore 3032 | L & J Computers | £220 | |
| Commodore 3032 | Intex Datalog Ltd | £195 | 200 employees |
| Commodore 3032 | Computastore Ltd | £200 & £350 | 275 & 500 employees |
| CP/M | Haywood Associates Ltd | £350 | |
| CP/M | Median-Tec Ltd | £500 | |
| CP/M | Selven Ltd | P.O.A. | |
| CP/M | Graffcom Systems Ltd | £500 | 250 employees |
| CP/M | PCL Software Ltd | £600 | 800 employees/MBYTE |
| CP/M | Ludhouse Ltd | £450 | 300 employees |
| CP/M | Comput-A-Crop | £450 | |
| CP/M Horizon | Microtek Computer Services | Lease | varies |
| CP/M North Star | Micromedia Systems | £495 | 350 employees |
| Durango F-85 | Kesho Systems | £500 | |
| Sharp MZ-80K | Tridata Micros Ltd | £250 | 400 employees |
| Tandy TRS-80 | A J Harding (Molimerx) | £95-£200 | |
| Tandy TRS-80 | Tridata Micros Ltd | £218-- £375 | 400 employees |
| Tandy TRS-80 | 3-Line Computing | £140 | |
| TECS | Jar Software Systems | £250 | 300 employees |

| | | | |
|---|---|---|---|
| Z-80/8080 | Graffcom Systems Ltd | £490 | 250 employees |
| Z-80/8080 | Liveport Data Products | £250 | 500 employees |

## Property Management

| Machine Type | Supplier Name | Price | Capacity |
|---|---|---|---|
| Apple II/ITT 2020 | Cyderpress Ltd | £650 | 500 properties; 420 applicants |
| Apple II/ITT 2020 | Informex London Ltd | £298 | 300 entries |
| Apple II/ITT 2020 | Algobel Computers Ltd | £650 | 400 buildings 250 Own 2,000 trans |
| CP/M | Algobel Computers Ltd | £650 | 2,000 trans |
| Z-80/8080 | Graham Dorian Software | £325 | varies |

## Purchase Ledger

| Machine Type | Supplier Name | Price | Capacity |
|---|---|---|---|
| Apple II | Vlasak Electronics Ltd | £315 | 200 A/Cs 1,000 trans |
| Apple II | Computech Systems | £295 | 500 A/Cs 1,600 trans |
| Apple II/III 2020 | Padmede Computer Services | £300 | 900 A/Cs 4,500 trans/disc |
| Apple II/III 2020 | Systematics International Ltd | P.O.A. | |
| Commodore 3032 | Microact Ltd | £350 | 2,000 A/Cs 7,000 trans |
| Commodore 3032 | HB Computers Ltd | £350 | 800 A/Cs, 4,000 trans |
| Commodore 3032 | Compfer Ltd | £300 | 1,000 A/Cs 7,000 entries |
| Commodore 3032 | ACT (Petsoft) Ltd | £120 | 200 A/Cs 700 trans |
| CP/M | Haywood Associates Ltd | £350 | |
| CP/M | Median-Tec Ltd | £500 | 500 A/Cs 600 trans/ACs |
| CP/M | Structured Systems Group | £460 | varies |
| CP/M | Ludhouse Ltd | £500 | 500 A/Cs 5,000 trans |
| CP/M | Comput-A-Crop | £400 | 500 A/Cs |
| CP/M | Computastore Ltd | £400 | 500 A/Cs 3,100 trans |
| CP/M North Star | Benchmark CS Ltd | £250 | 500 A/Cs 2,000 trans |
| Durango F-85 | Kesho Systems | £500 | |
| Exidy Sorcerer | Basic Computing | £125 incl | See also Micropute |
| SD-100/200 | Barcellos Ltd | £250 | |
| Tandy TRS-80 | AJ Harding (Molimerx) | £225 | 1,100 entries |
| Tandy TRS-80 | Tridata Micros Ltd | £225-£375 | 125 A/Cs 1,000 trans |
| Z-80/8080 | Great Northern CS Ltd | £275 | varies |
| Z-80/8080 | Graffcom Systems Ltd | £440 | |

## Records Management

| Machine Type | Supplier Name | Price | Capacity |
|---|---|---|---|
| Apple II | Courtman Micro Systems | £106 | 100K Characters |
| Apple II/ITT 2020 | Diskdean Ltd | £120 | varies |
| Apple II/ITT 2020 | Systematics International Ltd | £125 | 1,000 references |
| Apple II/ITT 2020 | Informex London Ltd | £198 | 500-1,200 records |
| Apple II/ITT 2020 | T & V Johnson Ltd | £95 | 112K per drive |
| Apple II/ITT 2020 | Systematics Intl Ltd | £72 & £175 | |
| Apple/ITT 2020 | The Software House | £140 | 900 records |
| Commodore 3032 | CPS (Data Systems) Ltd | £200 | varies |
| Commodore 3032 | Amplicon MS Ltd | £140 | 1,500 records |
| Commodore 3032 | Compsoft Ltd | £95-£170 | 600-5,000 records |
| Commodore 3032 | Microact Ltd | P.O.A. | 400K-800K |
| Commodore 3032 | Commodore BM (U.K.) Ltd | £150 | 650 |
| Commodore Pet | Stage One Computers | £130-£250 | 165K |

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|---|---|---|---|
| CP/M | Clenlo Computing Services | £90-£325 | varies |
| CP/M | Median-Tec Ltd | £500 | |
| CP/M SWTPC | Verwood Systems | | |
| Metrotech System | Metrotech | £200-£1,000 | |
| Ohio Challenger | U-Microcomputers Ltd | £175+ | |
| Ohio Scientific | Microcomputer BM | £175 | |
| SD-100/200 | Barcellos Ltd | £500-£1,000 | |
| Tandy TRS-80 | T & V Johnson Ltd | £200 | |
| Z-80/8080 | Structured Systems Group | £135 | varies |
| Z-80/Cromenco | Xitan Systems Ltd | £850 | 4,000 records/disc |

## Sales Ledger

| Machine Type | Supplier Name | Price | Capacity |
|---|---|---|---|
| Apple II | Vlasak Electronics Ltd | £315 | 200 A/Cs 1,000 trans |
| Apple II | Computech Systems | £295 | 500 A/Cs 1,600 trans |
| Apple II/ITT 2020 | Padmede Computer Services | £300 | 900 A/Cs 4,500 trans/disc |
| Apple II/ITT 2020 | Systematics International Ltd | P.O.A. | |
| Commodore 3032 | Microact Ltd | £350 | 2,000 A/Cs 7,000 trans |
| Commodore 3032 | Anagram Systems | £320 | 500 A/Cs |
| Commodore 3032 | ACT (Petsoft) Ltd | £120 | 200 A/Cs 700 trans |
| Commodore 3032 | HB Computers Ltd | £350 | 800 A/Cs 600 trans/ACs |
| CP/M | Median-Tec Ltd | £500 | 500 A/Cs 600 trans/ACs |
| CP/M | PCL Software Ltd | £500 | 1,000 A/Cs/MByte |
| CP/M | Ludhouse Ltd | £500 | 1,000 A/Cs 5,000 trans |
| CP/M | Ludhouse Ltd | £1,000 | |
| CP/M | Computastore Ltd | £400 | 500 A/Cs 3,500 trans |
| CP/M | Haywood Associates Ltd | £350 | |
| CP/M North Star | Benchmark CS Ltd | £250 | 500 A/Cs 2,000 trans |
| Durango F-85 | Kesho Systems | £500 | |
| Exidy Sorcerer | Basic Computing | £125 incl. | See also Micropute |
| SD-100/200 | Barcellos Ltd | £250 | |
| Tandy TRS-80 | Tridata Micros Ltd | £225-£325 | 175 A/Cs 1,350 trans |
| Tandy TRS-80 | AJ Harding (Molimerx) | £225 | 1,350 entries |
| TECS | Jar Software Systems Ltd | £550 | 500 A/Cs |
| Z-80/8080 | Graffcom Systems Ltd | £440 | |
| Z-80/8080 | Great Northern CS Ltd | £275 | varies |

## Stock Systems

| Machine Type | Supplier Name | Price | Capacity |
|---|---|---|---|
| Apple II/ITT 2020 | Microdigital Ltd | £225 | 625 items |
| Apple II/ITT 2020 | Systematics Intl Ltd | £500 | 200-2,500 items |
| Apple II/ITT 2020 | Vlasak Electronics Ltd | £285 | |
| Apple/ITT 2020 | The Software House | £80 | 800 items |
| Commodore 3032 | SMG Microcomputers | £395-£495 | 2,450-7,000 items |
| Commodore 3032 | Logma Systems Design | £600 | 1-6 shops |
| Commodore 3032 | L & J Computers | £230 | |
| Commodore 3032 | ACT (Petsoft) Ltd | £75 | 2,400 items 1,000 A/Cs |
| Commodore 3032 | Compfer Ltd | £350 | 200 lines 20 bars |
| Commodore 3032 | Microact Ltd | £350 | 2,500 items, 1,000 A/Cs |
| Commodore 3032 | Bristol Software Factory | £300-£360 | 2,300 |

| | | | |
|---|---|---|---|
| Commodore 3032 | Commodore B M (U.K.) Ltd | £150 | 650 |
| Commodore 3032 | Anagram Systems | £395 | 500-600 items 255 A/Cs |
| Commodore 3032 | SA Systems | £650 | 300 records/disc |
| Commodore 3032 | Petsoft Ltd | £50 | 2,500 items |
| Commodore 3032 | L & J Computers | £60 | 500 items |
| Commodore 3032 | Rockliff Brothers Ltd | £120 | 3,900 items |
| Commodore 3032 | Stage One Computers | £100 | 650 items |
| CP/M | Haywood Associates Ltd | £350 | |
| CP/M | Median-Tec Ltd | £500-£800 | |
| CP/M | Graffcom Systems Ltd | £350 | 520-6,000 items |
| CP/M Cromemco | Micromedia Systems | £1,000 | |
| CPM/Horizon | Microtek Computer Services | £1,000 | varies |
| CP/M North Star | Benchmark CS Ltd | £450 | 1,000 items 750 trans |
| Exidy Sorcerer | Basic Computing | £125 Incl | See also Micropute |
| Tandy TRS-80 | Microgems Software | £150 | 1,000-2,000 items |
| Tandy TRS-80 | A J Harding (Molimerx) | £225 | 630 items |
| Tandy TRS-80 | Cleartone ADP | P.O.A. | |
| Tandy TRS-80 | S A Systems | £650 | 300 stock records |
| Tandy TRS-80 | T & V Johnson Ltd | £115 | 1,000 items |
| Tandy TRS-80 | T & V Johnson Ltd | £145 | 1,000 items/invoices |
| Tandy TRS-80 | Tridata Micros Ltd | £200-£375 | 630 items/disc |
| TECS | Jar Software Systems | £800 | 10,000 items 5,000 orders |
| TECS | Jar Software Systems | £850 | 1,000 items 300 A/Cs |
| Z-80/8080 | Graham Dorian Software | £325 | varies |
| Z-80/8080 | Rogis Systems Ltd | £500 | 900-3,500 items |
| Z-80/8080 | Great Northern C.S. Ltd | £275 | varies |
| Z-80/8080 | Graffcom Systems Ltd | £340 | |
| Z-80/8080 | Graffcom Systems Ltd | £580 | |
| Z-80/MCZ | Software Architects Ltd | £600 | varies |

## Word Processing

| Machine Type | Supplier Name | Price | Capacity |
|---|---|---|---|
| Apple II | Personal Computers Ltd | £150 | 17 A4 pages |
| Apple II/ITT 2020 | Vlasak Electronics Ltd | £120 | |
| Apple II/ITT 2020 | Systematics International Ltd | £75 | |
| Apple II/ITT 2020 | Guestel Ltd | £190 | 100K characters |
| Apple II/ITT 2020 | Algobel Computers Ltd | £75 | 800 lines |
| Commodore 3032 | Act (Petsoft) Ltd | £325 | 12,000 bytes |
| Commodore 3032 | Act (Petsoft) Ltd | £325 | 12K bytes |
| Commodore 3032 | Dataview Ltd | £159 | |
| Commodore 3032 | HB Computers Ltd | £70 | 39 A4 pages |
| Commodore 3032 | Commodore BM (U.K.) Ltd | £75 & £150 | 170 pages |
| Commodore 3032 | Stage One Computers | £100 | 130 pages |
| CP/M | Median-Tec Ltd | £300 | |
| CP/M | Computastore Ltd | £400 | |
| CP/M | Southdata Ltd | £350 | 160,000 words |
| CP/M North Star | Micromedia Systems | £495 | |
| Ohio Scientific | Microcomputer B M | £116 | |
| Tandy TRS-80 | T & V Johnson Ltd | £109 | 10,000 words |
| Z-80/8080 | Structured Systems Group | £120 | varies |
| Z-80/8080 | Intereurope S D Ltd | £500 | varies |

**There is an increasing number of packages which do not fit into any of the standard categories we have created and so we have consequently listed them under the title Miscellaneous. They appear in alphabetical order by machine type. The names of**

similar packages can be very different so users of the guide should check every entry under their machine type. The full address of the supplier can be found at the end of the guide.

## Miscellaneous applications for all machine types

| Machine Type | Application and Supplier Name | Price | Capacity |
|---|---|---|---|
| Apple II/ITT 2020 | Auction system<br>Cyderpress Ltd | £650 | 400 entries |
| Apple II | Cashflow/Bank forecast<br>Vlasak Electronics Ltd | £80 | |
| Apple II | Credit control<br>Microdigital Ltd | £130 | |
| Apple II/ITT 2020 | Employment Agents' system<br>Informex London Ltd | £298 | 600 entries |
| Apple II/ITT 2020 | Estate Agents' system<br>Cyderpress Ltd | £650 | 280 properties<br>360 applicants |
| Apple II/ITT 2020 | Estate Agents' system<br>Systematics International Ltd | £850 | |
| Apple II | Estate Agents' register<br>Vlasak Electronics Ltd | £120 | |
| Apple II/ITT 2020 | Financial planning<br>Systematics International Ltd | £295 | |
| Apple II | 3D graphics package<br>Fylde Microcomputer Services | £150 | |
| Apple II/ITT 2020 | Hospital administration<br>Informex London Ltd | £198 | 300-600 records |
| Apple II/ITT 2020 | Insurance records<br>Informex London Ltd | £198 | 600 records |
| Apple II | Letter writer<br>Vlasak Electronics Ltd | £80 | |
| Apple II/ITT 2020 | Medical records<br>Informex London Ltd | £198 | 300-600 records |
| Apple II/ITT 2020 | Modelling, VisiCalc<br>Microsense Computers Ltd | £95 | Variable |
| Apple II/ITT 2020 | Pipeline engineering<br>Aerco-Gemsoft | £175 | |
| Apple II/ITT 2020 | Property/Estate system<br>Cyderpress Ltd | £650 | 500 properties<br>420 applicants |
| Apple II/ITT 2020 | Property/Estate Agents'<br>Informex London Ltd | £298 | 300 entries |
| Apple II/ITT 2020 | Property valuation<br>Cyderpress Ltd | £650 | |
| Apple II | Sales analysis<br>Microdigital Ltd | £200 | 500 A/Cs |
| Apple II | Structural engineering design<br>James C Steadman | £200 | |
| Apple II/ITT 2020 | Time recording—solicitors'<br>Informex London Ltd | £198 | 300 clients |
| Apple II/ITT 2020 | TV rental management system<br>Diskwise Ltd | £395 | |
| Commodore 3032 | Appointments planner<br>Commodore BM (U.K.) Ltd | £50 | 200 entries |
| Commodore 3032 | Bank account reconciliation<br>Stage One Computers | £100 | |
| Commodore 3032 | Building conversion<br>Micro Computation | £300-<br>£400 | 320 clauses |
| Commodore 3032 | Cash book<br>L & J Computers | £90 | |
| Commodore 3032 | Estate Agents' package<br>Stage One Computers | £250 | 325 properties |

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|---|---|---|---|
| Commodore 3032 | Financial planning<br>ACT (Petsoft) Ltd | £150 | Varies |
| Commodore 3032 | Hotel room system<br>Landsler Software | £430 | 200 rooms |
| Commodore 3032 | Hotel system and billing<br>Landsler Software | £295 | 280 rooms |
| Commodore 3032 | Insurance Brokers' system<br>Stage One Computers | £100 | |
| Commodore 3032 | Invoicing/Costing—jewellers'<br>CPS (Data Systems) Ltd | £575 | |
| Commodore 3032 | Job/Appointments planner<br>Stage One Computers | £100 | 300 appointments |
| Commodore 3032 | Machine hire<br>L & J Computers | £420 | |
| Commodore 3032 | Order control<br>MMS Computer Systems | £250 | 3,600 orders |
| Commodore 3032 | Printers' job control<br>Stage One Computers | £450 | 130 jobs/disc |
| Commodore 3032 | Printers' quote system<br>Microland | £175 | |
| Commodore 3032 | Sales analysis<br>Logma Systems Design | £600 | 1-6 shops |
| Commodore 3032 | Service company package<br>Stage One Computers | £1,000 | |
| Commodore 3032 | Stock/farming livestock<br>S.A. Systems | £650 | 300 records/disc |
| Commodore 3032 | Window replacement<br>CSM Ltd | £500 | |
| Commodore 3032 | Work measurement<br>The Alphabet Company | £150 | |
| CP/M | Cashflow forecasting<br>Ludhouse Ltd | £250 | |
| CP/M | Financial analysis<br>Median-Tec Ltd | £500 | |
| CP/M | Hire purchase system<br>Graffcom Systems Ltd | P.O.A. | Depends on system |
| CP/M | Invoice discount/factoring<br>Micromedia Systems | £1,000 | |
| CP/M | Order entry & invoicing<br>Graffcom Systems Ltd | £350 | 500-5,000 orders |
| CP/M various | P & L budgeting system<br>Micromedia Systems | £495 | |
| CP/M North Star | Personnel records<br>Micromedia Systems | £595 | |
| CP/M | Purchasing system<br>Graffcom Systems Ltd | £450 | 540-7,000 invoices |
| CP/M | Statistical analysis<br>Research Resources Ltd | £240 pa | |
| CP/M | Time recording<br>Haywood Associates Ltd | £500 | |
| CP/M North Star | Vehicle maintenance<br>Micromedia Systems | £195 | |
| Tandy TRS-80 | Financial analysis<br>A J Harding (Molimerx) | £55 | |
| Tandy TRS-80 | Invoicing<br>Tridata Micros Ltd | £75-150 | Linked to stock and sales |
| Tecs | Production analysis<br>Jar Software Systems | £600 | 1,000 products<br>2,500 items |
| Durango F-85 | Time recording/ledger<br>Kesho Systems | £1,000 | |
| Z-80/8080 | Appointments system<br>Great Northern CS Ltd | £220-275 | Depends on system |
| Z-80/8080 | Civil/structural engineering design<br>Equinox Computer Systems | £500 | varies |
| Z-80/8080 | Conference organiser<br>Intereurope SD Ltd | £500 | 30,000 entries |
| Z-80/8080 | Financial modelling<br>Intereurope SD Ltd | £500 | 1,000 items<br>100 reports |
| Z-80/8080 | Personnel records<br>Intereurope S D Ltd | £500 | 200-300 items |

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|---|---|---|---|
| Z-80/8080 | Sales analysis retail<br>Graham Dorian Software | £325 | Depends on system |

## Alphabetical list of suppliers

| Supplier | Address | Sales contact |
|---|---|---|
| 3-Line Computing<br>0482-445496 | 36 Clough Road<br>Hull HU5 1QL | Tim Hill |
| Minster Micro Systems<br>04254-4751 | 88 Christchurch Road<br>Ringwood, Hampshire, BH24 1DR | R Kilpatrick |
| ACT (Petsoft) Ltd<br>021-454-5341 | Radclyffe House<br>66-68 Hagley Road, Edgbaston<br>Birmingham | M Wauchope |
| Aerco-Gemsoft<br>04862-22881 | 27 Chobham Road<br>Woking, Surrey GU21 1JD | Nigel Tylor |
| A J Harding (Molimerx)<br>0424-22039 | 28 Collington Avenue<br>Bexhill-on-Sea, East Sussex | John Harding |
| Algobel Computers Ltd<br>021-233-2407 | 33 Cornwall Buildings<br>Newhall Street, Birmingham B3 3QR | Steven Linden |
| Amplicon M S Ltd<br>0273-562163 | 143A Ditchling Road<br>Brighton, Sussex BN1 6JA | Jim Hicks |
| Anagram Systems<br>0403-68601 | 9 Michell Close<br>Horsham, West Sussex RH12 1JT | Jon Quigly |
| Analog Electronics<br>0203-417761 | 47 Ridgeway Avenue<br>Coventry | |
| Barcellos Ltd<br>Leicester 26584/5 | Kimberley House<br>Vaughan Way, Leicester | K Tapp |
| Basic Computing<br>0535-65094 | Oakworth Road<br>Keighley, West Yorkshire BD22 7LA | Mike Collier |
| Benchmark CS Ltd<br>0726-61000 | Tremena Manor<br>Tremena Road, St Austell Cornwall<br>PL25 5QG | S Willmott |
| Bristol Software Factory<br>0272-314278 | Micro House<br>St. Michael's Hill, Bristol BS2 8BS | W J Kyle-Price |
| Cleartone ADP<br>0495-244555 | Prince of Wales Industrial Estate,<br>Abercarn, Gwent NP1 5RJ | E Balding |
| Clenlo Computing Services<br>01-653-6028 | 15 South View Court<br>The Woodlands, Beulah Hill, London<br>SE19 | T Froud |
| Commodore B M (U.K.) Ltd<br>0753-74111 | 818 Leigh Road<br>Trading Estate, Slough, Berkshire | Nick Green |
| Compfer Ltd<br>0772-57684 | Preston Computer Centre<br>6 Victoria Buildings, Fishergate,<br>Preston, Lancashire | D Steele |
| Compsoft Ltd<br>0483-39665 | Old Manor Lane<br>Chilworth, Guildford, Surrey | Nick Horgan |
| Comput-A-Crop<br>01-771-0867 | 32 Whitworth Road<br>London SE25 6XH | Jenny Wilson |
| Computastore Ltd<br>061-832 4761 | 16 John Dalton Street<br>Manchester | David Nicholson |
| Computech Systems<br>01-794-0202 | 168 Finchley Road<br>London NW3 | Laurence Payne |
| Courtman Micro Systems<br>0222-495257 | 48 Melrose Avenue<br>Penylan, Cardiff | G Stuckey |
| CPS (Data Systems) Ltd<br>021-707-3866 | Arden House<br>1102 Warwick Road, Acocks Green,<br>Birmingham B276BH | N Ashbourne |
| CSM Ltd<br>021-382-4171 | Refuge Assurance House<br>Sutton New Road, Erdington,<br>Birmingham B23 6QX | Peter Mart |
| Cyderpress Ltd<br>0491-37769 | 2 Church Lane<br>Wallingford, Oxfordshire | C Murphy |

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|---|---|---|
| Diskdean Ltd<br>01-242-7394 | 23 Bedford Row<br>London WC1R 4EB | |
| Diskwise Ltd<br>05793-3780 | 25 Fore Street<br>Callington, Cornwall | R Cornforth |
| Equinox Computer Systems<br>01-739-2387/9 | Kleeman House<br>16 Anning Street, New Inn Yard,<br>London EC2 | M Kusmirak |
| Fylde Microcomputer Services<br>0253 692954 | 48 Lomond Avenue, Blackpool,<br>Lancashire | B Seedle |
| G W Computers Ltd<br>01-636-8210 | 89 Bedford Court Mansions<br>Bedford Avenue London WC1 | T Winter |
| Graffcom Systems Ltd<br>01-734-8862 | 52 Shaftesbury Avenue<br>London W1V 7DE | Barbara<br>Castledine |
| Graham Dorian Software<br>01-379-7931 | c/o Lifeboat Associates<br>32 Neal Street, London WC2H 9PS | J Clifford |
| Great Northern C S Ltd<br>0532-589980 | 116 Low Lane, Horsforth,<br>Leeds LS18 8PX | P Clark |
| Guestel Ltd<br>0225-65379 | Refuge House<br>2-4 Henry Street, Bath BA1 1J | Allen Timpany |
| Haywood Associates Ltd<br>01-428-9831 | 11 Station Approach<br>Northwood, Middlesex | I Clarke |
| HB Computers Ltd<br>0536-83922 & 520910 | 22 Newland Street<br>Kettering, Northamptonshire | Stuart Whittaker |
| Informex London Ltd<br>01-318-4213/7 | 8-12 Lee High Road<br>London SE13 5LQ | K Tayfoor |
| Instar Business Systems<br>01-680-5330 | 61 High Street<br>Croydon, Surrey | S Kent |
| Intelligent Artefacts<br>022020-689 | Cambridge Road<br>Orwell, Hertfordshire | D Sands |
| Intereurope SD Ltd<br>0734-789183 | 19-21 Denmark Street<br>Wokingham, Berkshire RG11 2QX | E Stoneham |
| Intex Datalog Ltd<br>0642-781193 | Eaglescliffe Industrial Estate<br>Eaglescliffe, Cleveland TS16 OPN | T Ingle |
| James C Steadman<br>0903-814923 | 18 Manor Road<br>Upper Beeding, Steyning, Sussex<br>BN4 3TJ | James Steadman |
| Jar Software Systems<br>Bolton 26644 | 124 Newport Street<br>Bolton, Lancashire | J Blackburn |
| Keen Computers Ltd<br>0602-583254 | 5B The Poultry<br>Nottingham | Bob Ellis |
| Kesho Systems<br>041-226-4236 | 72 Waterloo Street<br>Glasgow G2 | Angus Nial |
| L & J Computers<br>01-204-7525 | 3 Crundale Avenue<br>Kingsbury, London NW9 9PJ | Jack Goodman |
| Landsler Software<br>01-399-2476/7 | 29A Tolworth Park Road<br>Surbiton, Surrey KT6 7RL | E Landsler |
| Liveport Data Products<br>0736-798157 | The Ivory Works<br>St Ives, Cornwall TR26 2HF | G Wilkinson |
| Logma Systems Design<br>Bolton 389854 | 2-10 Bradshawgate<br>Bolton, Lancashire | R Odell |
| Ludhouse Ltd<br>01-679-4321 | 2-6 Marian Road<br>London SW16 5HR | M Ward |
| Median-Tec Ltd<br>0734-596842 | 120 Oxford Road<br>Reading, Berkshire RG1 7NL | W Stevenson |
| Metrotech<br>0895-58111 | Waterloo Road<br>Uxbridge, Middlesex UB8 2YW | C Ogilvy |
| Micro Computation<br>01-882-5104 | 8 Station Parade<br>Southgate, London N14 | Graham Dicker |
| Micro Focus<br>01-379-7931 | c/o Lifeboat Associates<br>32 Neal Street, London WC2H 9PS | C Barnes |
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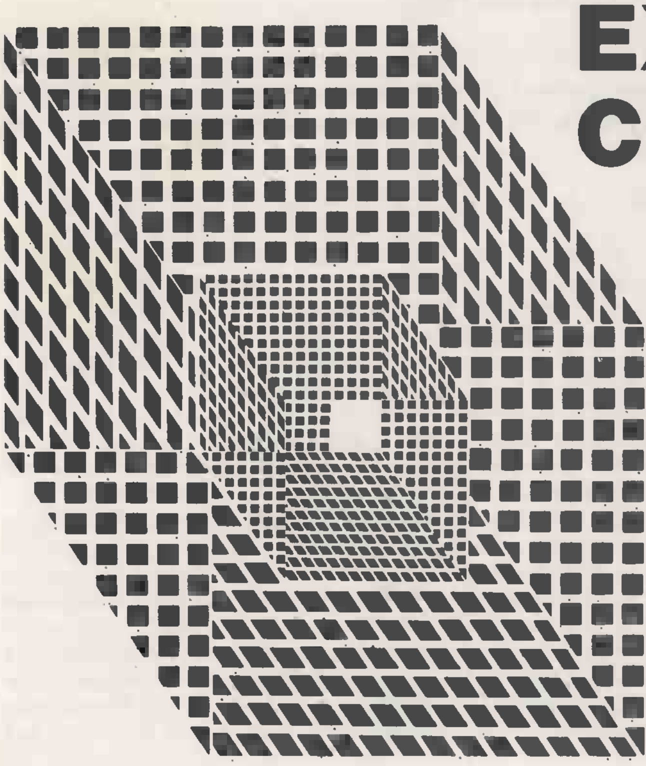

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# Son of Hexadecimal Kid

## A parable in eight virtual pages by Richard Forsyth

## Page 5 — page thrashing

**Young Samson's fatal curiosity about computers has led him to Bill Bootstrap's buried hoard of semiconductor components. There, Bootstrap proudly unveils his creation, the Moonshine Micro, and tries to dazzle him with terminology, but Samson is unimpressed. What he wants to know is whether it can play Space Invaders.**

"Sure, it can play Space Invaders. It has at least 13 versions — two of them in ROM. Here", Bootstrap tossed over a stack of discs. "The best version's among those".

Some of the discs fell on to the sand beside him, making Bootstrap glower ferociously at his clumsiness. Samson scrabbled around, quickly putting them in a pile again though he shuffled them in the process. Then he started rummaging through them. There was a cross-assembler for the PDP-11, a sort-merge package, an accounting suite and several colour graphics demonstration programs. It was not until the last disc but one that he found one labelled Mae West Catalog #0000 — Star Wars, Star Trek, Space Invaders, Galactic Warfare.

He handed it to Bootstrap, who shook his head and gave it back.

"What's that in your hand"? asked Bootstrap.

Samson read out the label of the last disc: "Mae West #0001 — Star Wars, Star Trek, Space Invaders, Galactic Warfare: this one works".

"That's the one you want", said Bill Bootstrap.

Soon the hillside was ringing with the thin electronic screeches of alien spacecraft exploding.

After an entertaining afternoon spent destroying spaceships, planets — including earth — alien civilisations and entire galaxies, they packed up, covered the chest with earth and trudged back home.

As they walked Bootstrap explained in detail to the uncomprehending boy the prodigious feats of improvisation into which he had been forced by the lack of proper equipment.

Even before they drew in sight, Samson sensed that something was wrong, and when they crested the ridge overlooking Sprocket's Hole, he saw what it was: more than 100 villagers from Happy Valley had congregated round the wooden houses armed with hoes, machettes and scythes. It was a Nullard vigilante party.

They had already been seen, so there was no sense in turning back. When they reached the welcoming committee, the gang-leader stepped forward and pointed at Bootstrap: "You are accused of heresy. What is your defence"?

Samson looked anxiously for his mother, but couldn't see her in the crowd. Bootstrap said nothing to the charge. He just stood staring defiantly at his accuser.

"Speak now metal man", ordered the leader waving his pitchfork, "in the name of Tony Bony".

"Tony Bony was a phoney", spat Bootstrap, eyes narrowed. His answer condemned him at once. There was no longer any need even for the pretence of a trial. The mob surged forward, shouting angrily, and Samson found himself grabbed by a pair of strong hands. Bootstrap meanwhile was subdued, kicking and struggling, under a ruck of bodies. When he had finally been overpowered, the leader gave orders for a fire to be built, and many eager hands began gathering brushwood.

The irony was that it was a flash of human bitterness which had betrayed the android. By feigning dementia — a role he had maintained successfully for 10 years — he might well have escaped with a tarring and feathering or a beating. He might even have been hauled before an ecclesiastical tribunal, as was his right in Nullard law, for an interminable investigation.

If he had been a purely rational calculating engine, that would have been the obvious course. Yet if he had been that, he would never have survived the Great System Crash. Here was a man, or rather a man/machine system, who had had an entire cerebral hemisphere excised to make space for electrological equipment which had been rendered defunct at a stroke — leaving him partially paralysed, unable to speak coherently and, in short, a mental wreck.

His very survival to that date was a testimony to the extraordinary recuperative powers of the human brain. Such had been the tenacity of his biological half that he had clawed his way back to near-normality — though without betraying his recovery with any outward sign.

He had even reached a position where he could effect some repairs on the hardware side, which he did by scouring the country for abandoned robot and android corpses whose precious semiconductor components, if they were in working order, he cannibalised.

He owed his life to his humanity, to the fact that he had been imperfectly cybernated which was why he had been exiled to Sprocket's Hole in the first place; but this served only to increase his poisonous resentment towards the human race. Now, in a sense, that debt was being paid.

When he had been securely bound and dumped on the top of the bonfire, the leader stood holding a burning brand and asked him if he had anything to say before he died.

"The System is dead, long live the System", cried the android.

The leader bent down and lit the pyre. Samson turned away, but the grip on his shoulders tightened and he was forced around. "No sonny", said a voice from above, "you watch. See what happens to those who dabble in computing".

Not another sound escaped the android's lips as the flames licked upwards. He just stared fixedly at Samson. Samson knew that he was being entrusted with the safe-keeping of the Moonshine Micro and its accessories.

When the fire died down, the crowd began milling around, and some melted away into the gathering dusk. There was no longer a focus for them. The man who had been holding Samson walked off, and at last his mother rushed over to him. She had been locked in the house before his arrival, and only just released.

Before all the people had dispersed, however, a voice called out: "What about the boy"?

"Yes", chimed in another. "He must know something about it". Suddenly Samson felt many eyes boring into him. The mob leader reappeared.

"Perhaps you'd like to tell us, young man, what you were doing with that heretic? Where did all those noises come from"?

Samson swallowed hard.

"What's the matter? Devil got your tongue"?

"Leave him alone", cried Cleo. "He's too young to understand".

"I think he understands me all right. Don't you, you little computer freak"? There was menace in his voice.

At that moment McNull barged through the encircling ring of bodies. He held up his hand. "Harm not the boy, for I say unto you all that whosoever harms so much as one hair of his head shall be cast into everlasting perdition".

McNull's words silenced them for a moment, but then the ringleader turned on him. "How come you know so much Holy Man"? he asked with a sneer. "You've been hobnobbing with a heretic". A murmur of agreement buzzed round the crowd. Cleo clasped her son more tightly to her.

Cannot even preacher McNull's eloquence prevail over the ugly mood of the crowd? Follow the adventures of Samson Synapse next month. 

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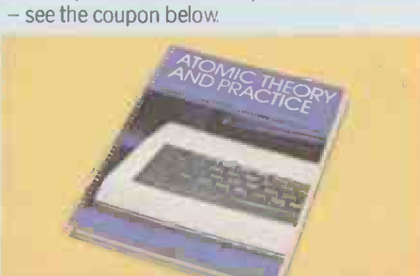


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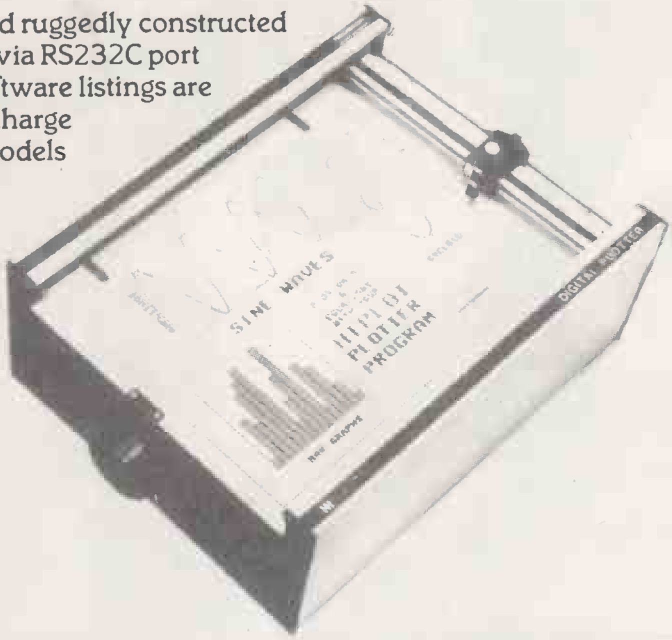


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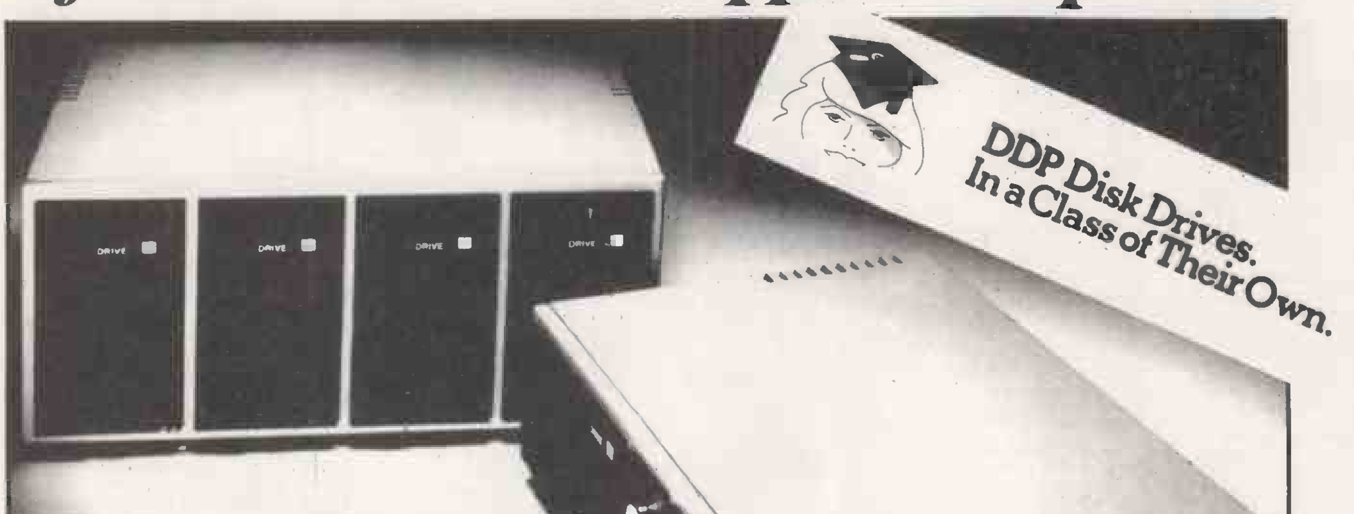


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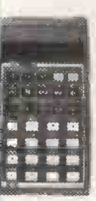

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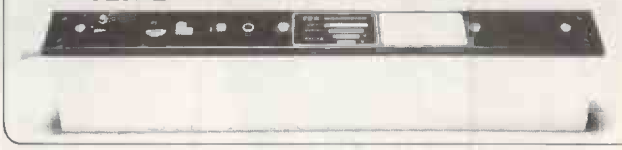

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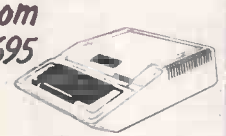

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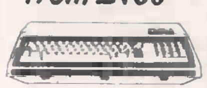

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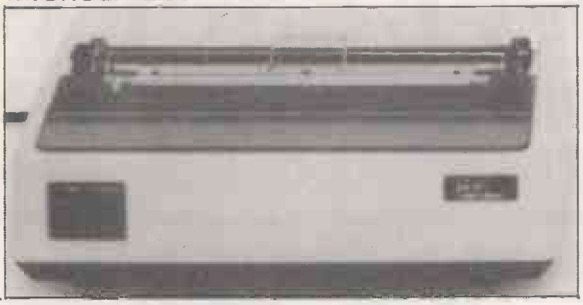

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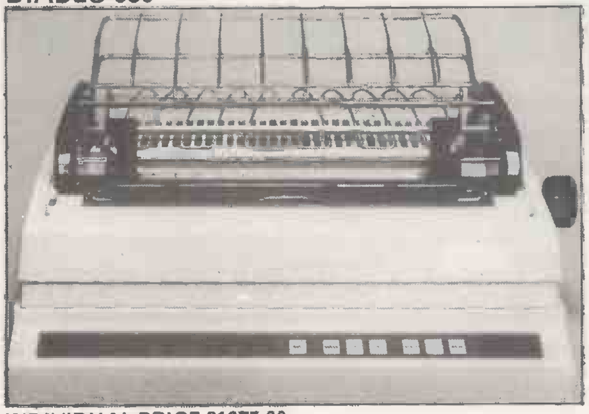

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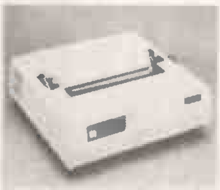

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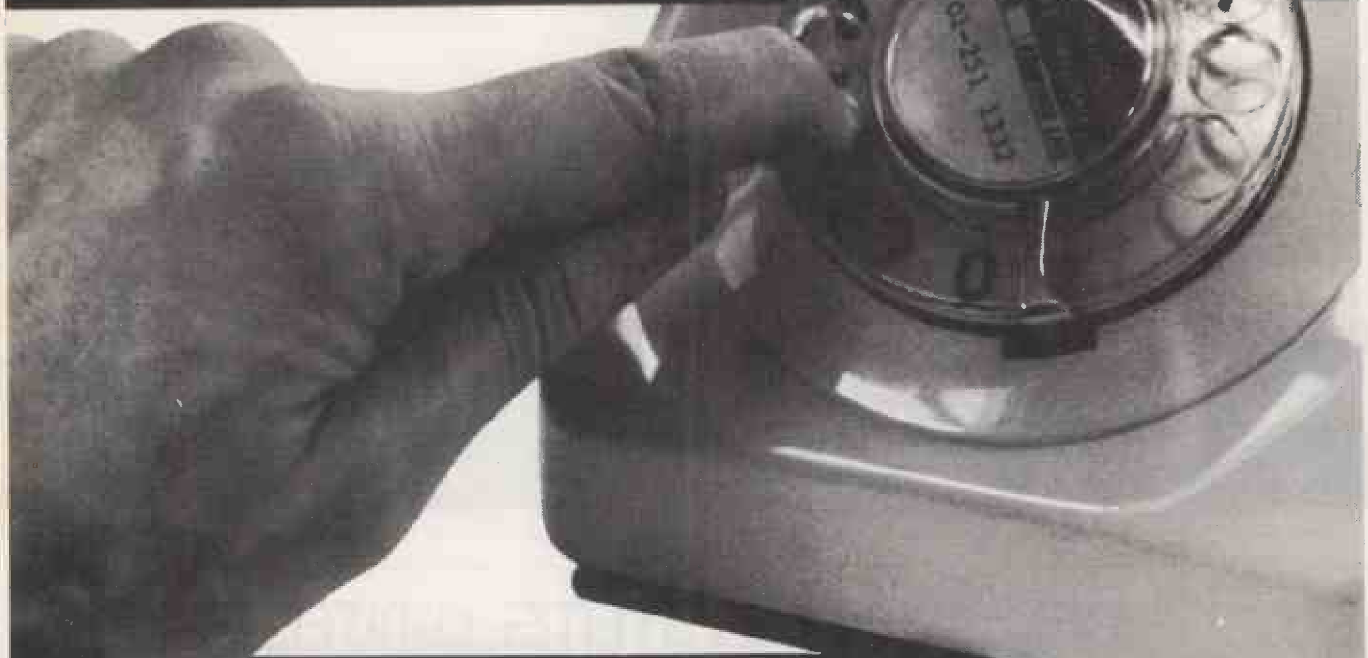

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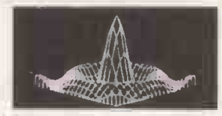

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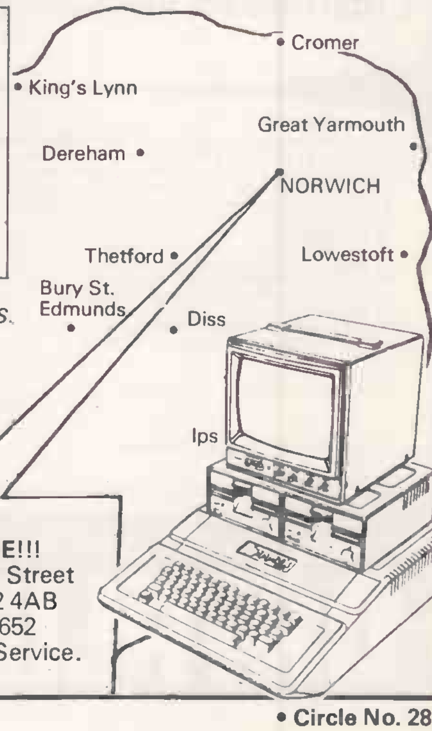


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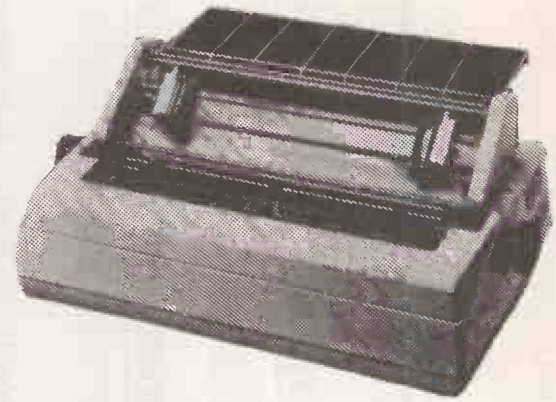

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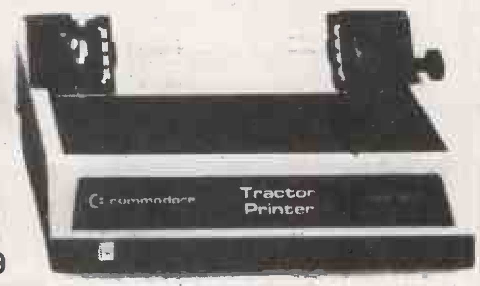


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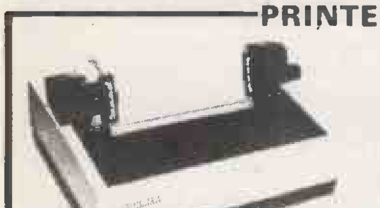
BUILT & TESTED. INTERFACES TX80 PRINTER DIRECT, CAN BE PROGRAMMED TO OPERATE RELAYS, MOTORS, VARIOUS OTHER PERIPHERALS 'CENTRONICS COMPATABLE' PLUS INTO IC SOCKET. RED !!!!!! DISPLAY LED BINARY DISPLAY FULL DOCUMENTED £29.95

## PRINTERS



**EPSON TX-80**
**£349**

Dot-matrix printer with Pet graphics interface: Centronics parallel, options: PET, Apple and serial.

## UK101

**£179** IN KIT FORM
**£229** READY BUILT & TESTED
**£255** COMPLETE IN CASE

5K EXPANSION (8 × 2114) now only **£18.00**


No extras required

- ★ Free sampler tape
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- ★ 8K basic
- ★ Ram expandable to 8K on board (4K inc)
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Access We welcome Access

• **Circle No. 301**

# SYSTEM 4000
## EPROM EMULATOR/PROGRAMMERS

**P4000 PRODUCTION EPROM PROGRAMMER**
This unit provides 'simple, reliable' programming of up to 8 EPROMs. It has been designed for ease of operator use — a single 'program' key starts the blank check — program — verify sequence. Independent blank check and verify controls are provided along with mode, pass/fail indicators for each copy socket and a sounder to signal a correct key command and the end of a programming run. Any of the 2704/2708/2716 (3 rail) and 2508/2758/2516/2716/2532/2732 EPROMs may be selected without hardware or personality card changes.
2 year warranty. Price **£545+VAT:**

**VM10 VIDEO MONITOR**
This compact, lightweight Video Monitor gives a clean crisp picture on its 10" screen. Suitable for use with the EP4000, SOFTY and other systems. 12 month warranty. Price **£88+VAT, carriage paid.**

**EP4000 EPROM EMULATOR/ PROGRAMMER**
The microprocessor based EP4000 has been designed as a flexible, low cost, high quality unit for emulating and programming all the popular NMOS EPROMs without the need for personality cards, modules or hardware changes. Its software intensive design permits selection of the 2704/2708/2716 triple rail EPROMs and the 2508/2758/2516/2716/2532/2732 single rail EPROMs for both the programming and emulating modes.
The video output (T.V. or monitor) for memory map display in addition to the built-in Hex LED display, for stand alone use, is unique in this type of system. This, with the double function 28 key keypad, powerful editing features, powered down programming socket, buffered tri-state simulator cable and 4k×8 data RAM gives you the most comprehensive, flexible and compact systems available today.
2 year warranty. Price **£545+VAT:**

## MODEL 14 EPROM ERASERS

**MODEL UV140 EPROM ERASER**
Similar to model UV141 but without timer. Low price at **£61.50+VAT, postage paid.**

**MODEL UV141 EPROM ERASER** EX-STOCK
- 14 EPROM capacity
- Fast erase time
- Built-in 5-50-minute timer
- Safety interlocked to prevent eye and skin damage
- Convenient slide-tray loading of devices
- Avalable Ex-Stock at **£78+VAT** Postage Paid
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DISTRIBUTORS REQUIRED — EXPORT ENQUIRIES WELCOME

## SOFTY SYSTEM
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Low cost card 2704/2708 emulator/programmer features:
• Direct output to T.V. • High speed cassette interface • On card EPROM programmer • Multifunction Keyppad • 1K monitor in 2708 • 1K RAM • 128 byte scratchpad RAM • 22 in/out ports • Access at card edge to all buses • 1K EPROM EMULATION • Direct memory access for fast data transfers • Editing facilities, including — data entry/deletion, block shift, block store, match byte, displacement calculation • Supplied with Zif socket, simulator cable and comprehensive manual
SOFTY Kit of parts **£100+VAT**
SOFTY Built & tested **£120+VAT**
SOFTY Built power supply **£20+VAT**
**P&P IS INCLUDED IN ALL PRICES**
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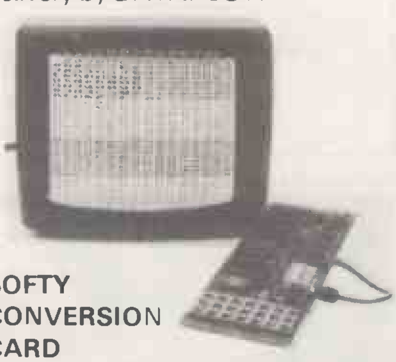

**SOFTY CONVERSION CARD**
Enables SOFTY to program the single rail EPROMs, 2508/2758/2516/2532. Selection of device type and 1K block are by pcb slide switches. Programming socket is zero insertion force. Easy connection to SOFTY with the DEP Jumper supplied. Built and tested: **£40+VAT**, postage paid.

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• 40 column electrosensitive printer • 5×7 dot matrix • print sizes • Push button hex print-out of SOFTYs RAM, EPROM or inter-cursor contents • On card PSU • Selection of bytes per line. Built and tested **£145+VAT**, postage paid.

**EX-STOCK EPROMS**

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| 2716 (single rail) | 6-95 | 6-50 | 5-95 |
| 2708 | 4-00 | 3-80 | 3-60 |
| 2532 | 23-40 | | |
| 2732 | 21-00 | | |

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## New! – Improved! RP-1600 NEW LOW PRICE £1095
## Additional Facilities – + Built in proportional spacing + Look-ahead logic + On-off switch

60 CHARACTERS PER SECOND THE FASTEST DAISY WHEEL PRINTER.
FAST, heavy duty commercial DAISY WHEEL printer, with high quality printout, coupled with low noise necessary for office environment. 124 char: upper/lower case. * 10/12 chars: per inch giving 126 or 163 columns. * 15 inch wide frintion platen. * BOLDING, underline, and host of other features. * Centronics type parallel interface as standard options: serial interface £60 * PET interface £65 * APPLE interface £75.
Made by Ricoh in Japan
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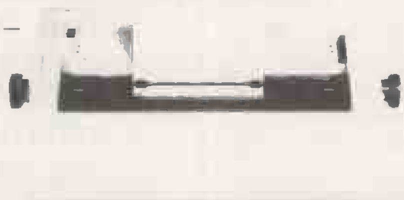

← TRS 80 Model I & II
← SUPERBRAIN
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TRACTOR FEED O/E £175
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### NEW MAXI ANADEX WITH GRAPHICS £895

Takes up to 13.6 inch wide paper * Upper/lower case with descenders * £ sign * 132 or 175 chrs/line with double width printing* Fast 150 CPS bi-directional logic seeking printing * Heavy duty print head giving 650 million chrs print life * serial, Parallel and Current Loop Interfaces built in * Host of other features found on printers costing twice as much.
Also Available
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DP 9501 £995 (Same as 9500 Illus)

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TRS—80 Graphics * Prints 48, 66, 80 and 132 columns with true descenders at 90 cps * logic seeking, bidirectional 9 × 9 point head * upper and lower case * forms handling: Top of form, horizontal and vertical tabs * Centronics parallel interface standard * optional extras: seral, PET and Apple Interfaces
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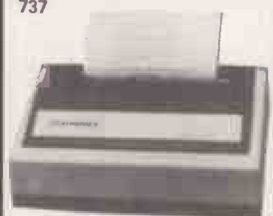
### 737



80 CPS + double spacing and mono spacing 10 and 16.7 CPI * nx9 proportional spacing, 3 way paper handling * 96 character set * Expanded print * Right margin justification * Underlining * Bidirectional * Pound sign centronics parallel and serial Interfaces standard * optional extras: PET & Apple Interfaces.

### OKI MICROLINE 80/132. THE QUIET PRINTER YOU CAN LIVE WITH

NOW WITH £ SIGN

The quietiest Dot Matrix available. 40, 80 or 132 cols per line * excellent print quality * 3 way paper handling: letterheads, fanfold, or paper rolls * graphics * Ideal for software written for large 132 col printers * continuous rating printing day in and day out * centronics parallel standard. Options: Rs-232, PET, Apple.
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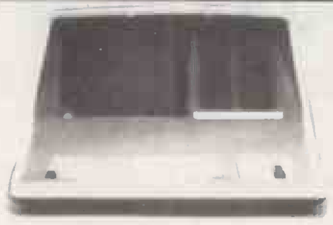
NEW LOW PRICE £350

### TRS-80 MODEL II

State the art second generation computer. Over 10,000 already sold in USA; 8 slot bus ensures expansion of hard discs & other peripherals., 76 Key professional keyboard, self test on power up, TRSDOS & Level III basic standard. CP/M available as option, making a wide range of accounting, educational, scientific & word processing packages instantly usable.
Nationwide service through 180 Tandy stores & computer centres.

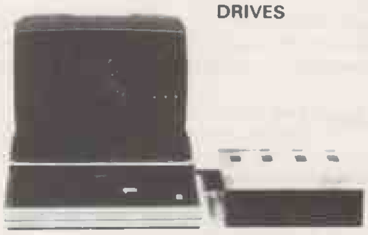
NOW WITH CP/M 2.24 £1999



### NEW SUPER BRAIN DUAL DENSITY £1595 QUAD DENSITY £1995

Now with CP/M 2.2 & increased disc storage. Twin Z80-A MHZ * 2 disc drives, dual density 320 K qud density 700 K storage * 64K ram * High resolution 12 inch CRT. 80 × 24 lines upper/lower case * 2 RS-232 printer ports * CPM 2.2 operating system * M basic, Cobol, Fortran, Pascal, Word processing & accounts packages available.
Dealer enquiries invited.

### NEW TRS-80 MODEL 1 48K SYSTEM WITH DUAL DISC DRIVES



NEW LOW PRICE £1095
WITH DESK AND EPSON PRINTER £1495

New greenscreen VDU, with rock steady display. Redesigned 32K expansion interface with trouble free disc operation, two 40 track teac disc drives, complete with cables.
Tridata sales, purchase, invoicing, payroll packages available.

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| Accounts Packages | from 295.00 |
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| Electric Pencil (cassette) | 35.00 |
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### MISCELLANEOUS

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### LOW COST WORD PROCESSOR I

Based on TRS-80 level 2 16K cassette recorder, electric pencil software, upper/lower case mod, printer interface and OKI Dot Matrix printer. Complete ready to go £895 free mailing list program.

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Same as above but with 48K, 2 disc drives and ricoh daisy wheel printer £2195

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| 2114L 300 NS | 250p | 225p | 195p |
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| 4118 250 NS 8K NEW!! | £9.95 | £8.95 | £7.95 |
| HM6116 16K (2K × 8) 150 NS 24-pin NEW! | £26 | £23.95 | £19.95 |

### DYNAMIC RAMS

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|---|---|---|---|
| 4116 200 NS Ceramic | 225p | 195p | 175p |
| 4116 150 NS | 375p | 350p | 325p |
| MB8264 64K (65K × 1) 200 NS Single +5V supply, 16-pin NEW! | £40 | £35 | £30 |

All prices exclude p&p and VAT. Please refer to 'Ordering Information' before ordering.

### CMOS RAMS

| | | | |
|---|---|---|---|
| 5101 1K (256 × 4) 450 NS | 350p | 325p | 295p |
| 4315 4K (4K × 1) 450 NS | 995p | | |
| TC5514P 4K (1K × 4) 450 NS | 550p | 525p | 495p |
| HM6116 16K (2K × 8) 150 NS 24-pin NEW!! | £26 | £23.95 | £19.95 |

### EPROMS

| | | | |
|---|---|---|---|
| 2708 450 NS | 375p | 350p | 325p |
| 2716 Single 5V 450 NS | 495p | 450p | 425p |
| 2532 Single 5V 450 NS | 1895p | 1595p | 1395p |
| 2732 Intel-type 450 NS | 1895p | 1595p | 1395p |
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*DON'T DELAY — BUY TODAY — SPECIAL OFFERS DON'T LAST FOR EVER!!!!*

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- * Meets IEEE S-100 Standard!
- * Uses Motorola's Powerful MC6809 CPU!
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All this, yet for only (plus p&p £1.00) **£49!!!**

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### EPROMS

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|---|---|
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### MEMORIES

#### STATIC RAMS

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| 2114L 300 NS | 250p |
| 2114L 200 NS | 275p |
| 4118 250 NS 8K NEW! | £9.95 |
| HM6116 16K (2K × 8) 150 NS 24-pin NEW! | £26 |

#### DYNAMIC RAMS

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| 4116 200 NS Ceramic | 225p |
| 4116 150 NS | 375p |
| MB8264 64K (65K × 1) 200 NS Single +5V supply, 16-pin NEW! | £40 |

#### CMOS RAMS

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| 5010 1K (256 × 4) 450 NS | 350p |
| 4315 4K (4K × 1) 450 NS | 995p |
| TC5514P 4K (1K × 4) 450 NS | 550p |
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"Perhaps the next famous composer will not direct a 150-piece orchestra but, rather, a trio of microcomputers controlling a bank of AY-3-8910s." BYTE July '79.

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4K CMOS RAM (1K × 4) 450 NS
ONLY £5.50
The TIC 5514P from Toshiba, CMOS equivalent of the 2114!

- Lower Power Dissipation
  - 10pW/BIT (TYP.) at 3.0V (STANDBY)
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Ordering information. Unless otherwise stated, for orders under £50 add 50p p&p. Add 15% VAT to total (no VAT on books). All devices are brand new, factory prime and full spec and subject to prior sales and availability. Prices subject to change without notice. Minimum telephone order using ACCESS is £10. If ordering by post with ACCESS, include name, address and card no. written clearly. Please allow 4/6 weeks delivery on books.

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* Two Disks in one Cabinet
* Has its own Power Supply Unit
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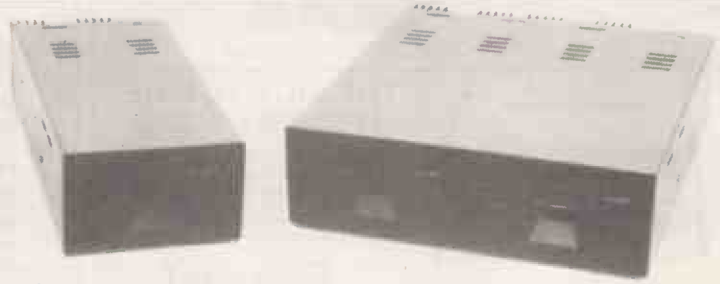

*TRS-80 DEALERS:- Write or phone direct to Cumana and specifications plus dealer discounts will be mailed to you.*

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| Commodore Tractor 80 col (for Pet) all Pet graphics | £375 |
| Epson Tractor 80 col Pet graphics | £325 |
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| 1.6Mb | £1195 |
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| Quad | £775 |
| 77 track single | £325 |
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| Quad | £1155 |
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For others please ring

C12 Blank Cassettes
10 for £4
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# VISUAL 100

**£1150 +VAT**


The VISUAL 100 is a new microprocessor based video display terminal that offers total compatibility with the DEC VT100* from both a software and operator point of view.

For the operator, the detached solid-state keyboard has been customized so that all key positions and LED indicators are in identical location to that of the VT100.

For the software, all codes and features have been implemented in a manner identical to the VT100 assuring plug-to-plug compatibility.

The big difference between the VISUAL 100 and the DEC VT100 is that the VISUAL 100 offers features not available on the VT100, or available only as extra-cost options. These added features include

- ETCHED NON-GLARE FACEPLATE
  Your operator will appreciate viewing characters through an etched non-glare faceplate. This feature assures crisp, sharp character resolution even in the brightest office environments. Further, the tilt screen feature allows an adjustable viewing angle, 10° to 15°, for optimal viewing comfort.
- ADVANCED VIDEO PACKAGE IS STANDARD
  Blink, bold, reverse video, and underline video attributes which can be used alone or in any combination for enhanced video presentations.
- CURRENT LOOP INTERFACE IS STANDARD
  A 20mA current loop interface as well as an EIA RS232C interface.
- BUFFERED PRINTER INTERFACE OPTION
  This option allows independent print/communication baud rates and independent parity. The printer option also allows the VISUAL 100 to function as a controller between host and printer, using "XON XOFF" protocol. Printer busy can also be monitored using XON XOFF, or control line.

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# VISUAL 200

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The VISUAL 200 is a new, low cost, microprocessor based video display terminal which truly stands above competitive teletype compatible terminals in its price range.

In addition to the most popular features available (or partially available) on competitive terminals, such as numeric pad, upper/lower case, editing, current loop, cursor addressing, columnar and field tab, etc., standard features which set the VISUAL 200 apart and reach the optimum in human engineering and operator comfort include:

- Detachable Keyboard
- Smooth Scroll
- Tilt Screen (10° to 15° viewing angle)
- Large 7 × 9 Dot Matrix Characters

Perhaps the most distinctive feature of the VISUAL 200 is the Switchable Emulation capability. A switch on the rear panel programs the terminal for code-for-code emulation of a Hazeltine 1500, ADDS 520, Lear Siegler ADM-3A or DEC VT-52. To an O.E.M. customer it means no change in software to displace the older, less powerful terminals in his product line with the new, reliable and low cost VISUAL 200. To a Distributor it means offering a single modern terminal which is compatible with all the software his customers have written for the older terminals. And you're not limited to merely emulating these older terminals; you can outperform them at the same time by taking advantage of the additional features of the VISUAL 200.

Reliability designed into the VISUAL 200 is evidenced by its solid state keyboard, single P.C. Board and self test diagnostics on power up.

Seeing is believing, so see for yourself. For a demonstration and a pleasant surprise on quantity pricing of the powerful, easy to use and reliable VISUAL 200, call or write us today.

**Standard Features**

- 24 × 80 Screen Format
- 7 × 9 Dot Matrix
- Upper/Lower Case
- Numeric Pad
- Background/Foreground
- Blink Line
- Insert/Delete Line & Character
- Columnar and Field Tab
- Set/Clear Tab
- Security Mode (non-display)
- Clear End Line, Field & Page
- Clear Line
- Clear Screen
- Line Drawing
- Current Loop or RS-232 Interface
- Secondary Channel
- Composite Video
- Serial Copy Port
- Hold Screen
- Baud Rates to 19,200
- Self Test
- Cursor Addressing
- Cursor Control Keys
- Read Cursor Address
- Typamatic Keys
- Smooth Scroll
- Microprocessor
- Detachable Keyboard
- Solid State Keyboard
- Read Terminal Status
- Tilt Screen
- Switchable Emulations

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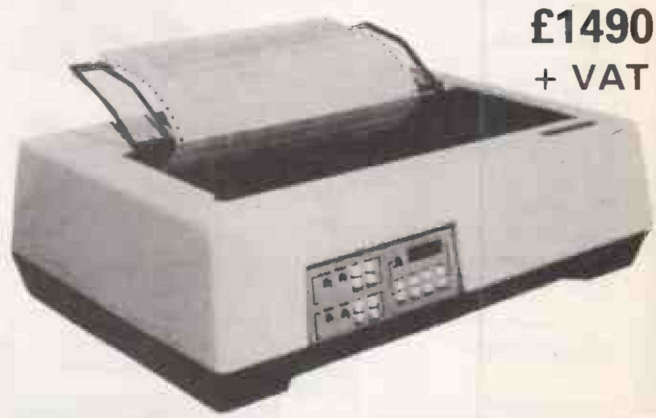
# DATASOUTH DS180

## HIGH SPEED MATRIX PRINTER

**£1490 + VAT**



The Datasouth DS180 is a dot-matrix serial impact printer designed for high performance at an economical price. Application flexibility and a long list of standard features make the DS180 an ideal device for small business systems, distributed communications networks and intelligent terminals.

### HIGH SPEED PRINTING

Utilizing 180 cps optimized bidirectional printing, the DS180 offers higher throughput than any printer in its class. Its 9-wire printhead produces highly legible 9x7 characters with decenders for lower case letters and true underlining. All 96 ASCII characters may be printed across a 132 column line at 10 characters per inch. Expanded characters (5 cpi) may be selected for highlighting portions of the text.

### USER PROGRAMMABLE

The DS180 offers a large number of user programmable features, yet is easy to operate. A unique programming keypad with a non-volatile memory makes printer set-up quick and simple. Top of form, horizontal and vertical tabs, perforation skip-over and auto line feed are just a few of the features the user may select. Communications status may also be programmed and monitored using the indicator panel lights and LED display.

### ATTRACTIVE DESIGN

Compact, desk-top packaging allows the DS180 to fit into almost any installation. Its noise dampening cover makes it suitable for use in a quiet office environment. The cartridge ribbon makes routine changes clean, fast and convenient.

### MICROPROCESSOR ELECTRONICS

Through the use of state-of-the-art microprocessor electronics, reliability and maintainability have been greatly improved. The simple modular design of the DS180 provides easy access to all major components. A single printed circuit board contains both the power supply electronics and digital controller for the printer. A self-test feature and diagnostic display panel help the user verify proper operation of the unit and isolate problems should they occur.

### COMMUNICATIONS

Interfaces on the DS180 include RS232 and 20mA current loop serial interfaces, and a Centronics compatible parallel interface. Baud rates from 110-9600 and parity selection may be keyed in by the user for his specific application.

### FORMS HANDLING

Adjustable tractors accomodate forms from 3-15 inches wide. A head-to-platen gap adjustment ensures optimum print quality on up to 6-part forms. Fanfold paper may be fed from the front or bottom of the DS180. A paper out sensor may be programmed to send a stop transmission character and sound an audible alarm.

### QUALITY MANUFACTURING

Reliable performance is ensured by a stringent quality control program. Datasouth uses pretested, high reliability parts from leading manufacturers. Multiple tests are performed on subassemblies during each stage of production, with each completed unit undergoing a final 24 hour print test and burn-in. The DS180 carries a 90 day warranty on materials and workmanship.

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8K £399 + VAT
16K £499 + VAT
32K £599 + VAT

RRP £795 for 32K

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Decoded £77.00 + VAT

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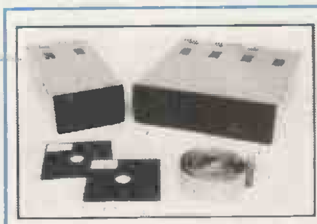

## TEAC DISK DRIVES

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Disk controller card. Real time clock. Requires Level II Basic. Interface for 2 cassette decks. complete with power supply.

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**WITH** ● 16K user RAM plus extended 12K Microsoft BASIC in ROM ● Fully TRS-80 Level II software compatible ● Huge range of software already available ● Self contained, PSU, UHF modulator, and cassette ● Simply plugs into video monitor or UHF TV ● Full expansion to disks and printer ● Absolutely complete — just fit into mains plug.

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For the common or garden hobbyist, a high quality personal computer is a real temptation. But let's face it: in the world of business, engineering and scientific applications, you need a system that has been designed from the ground up to allow flexibility and expansion.

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