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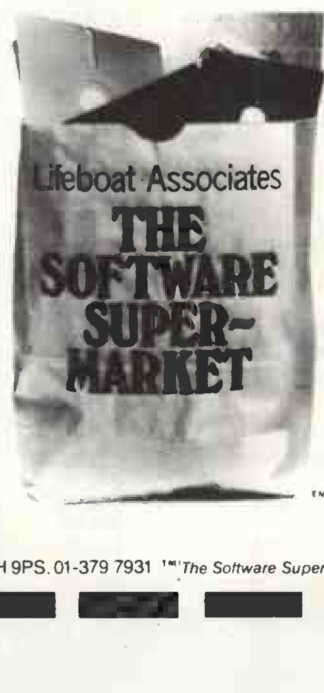

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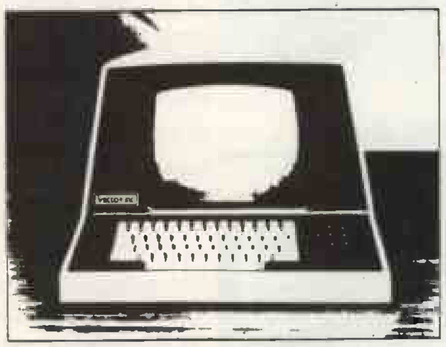

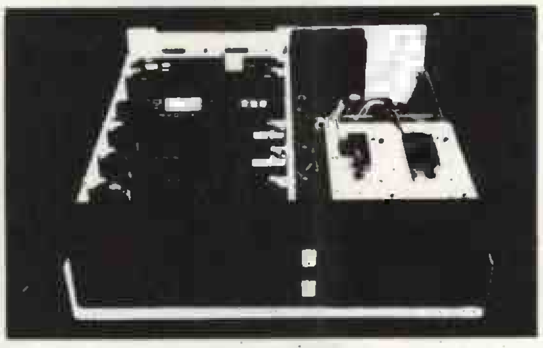

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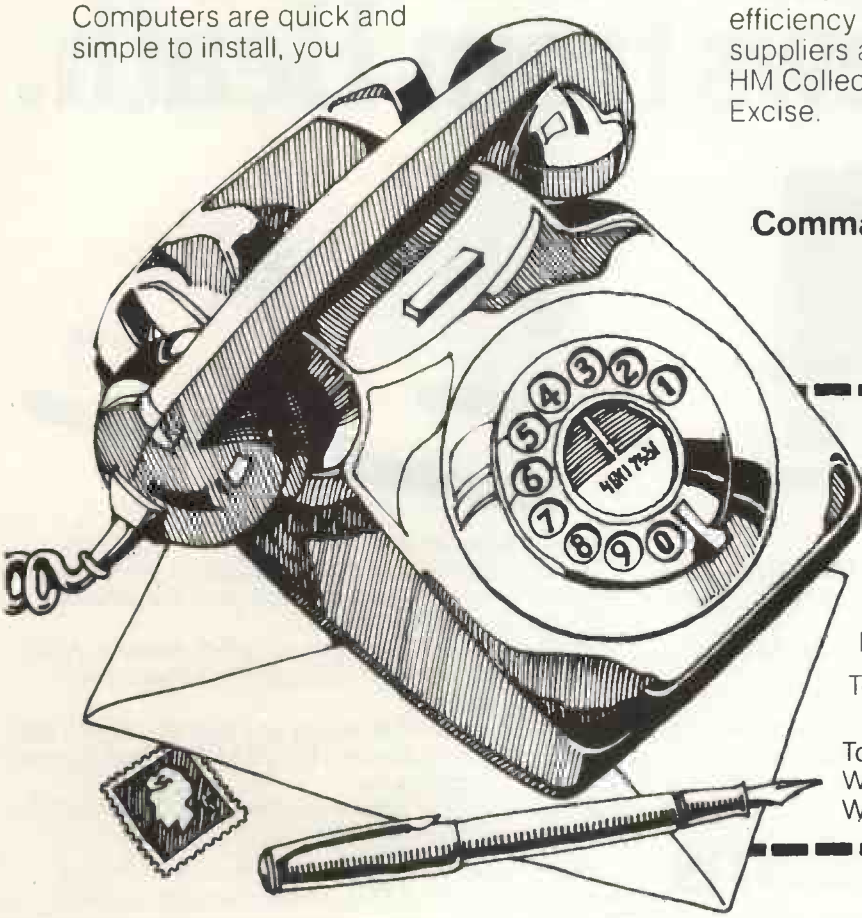

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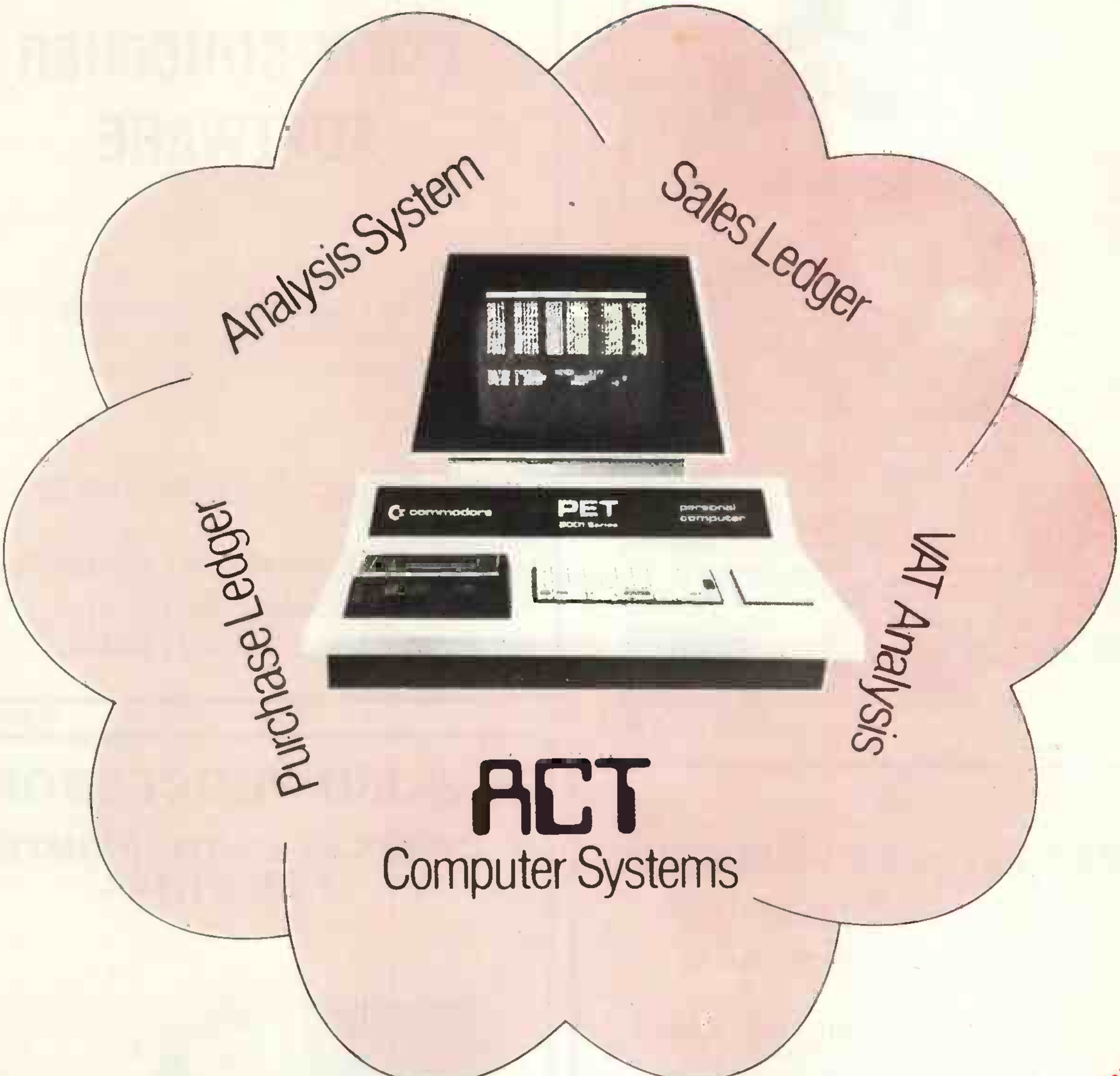

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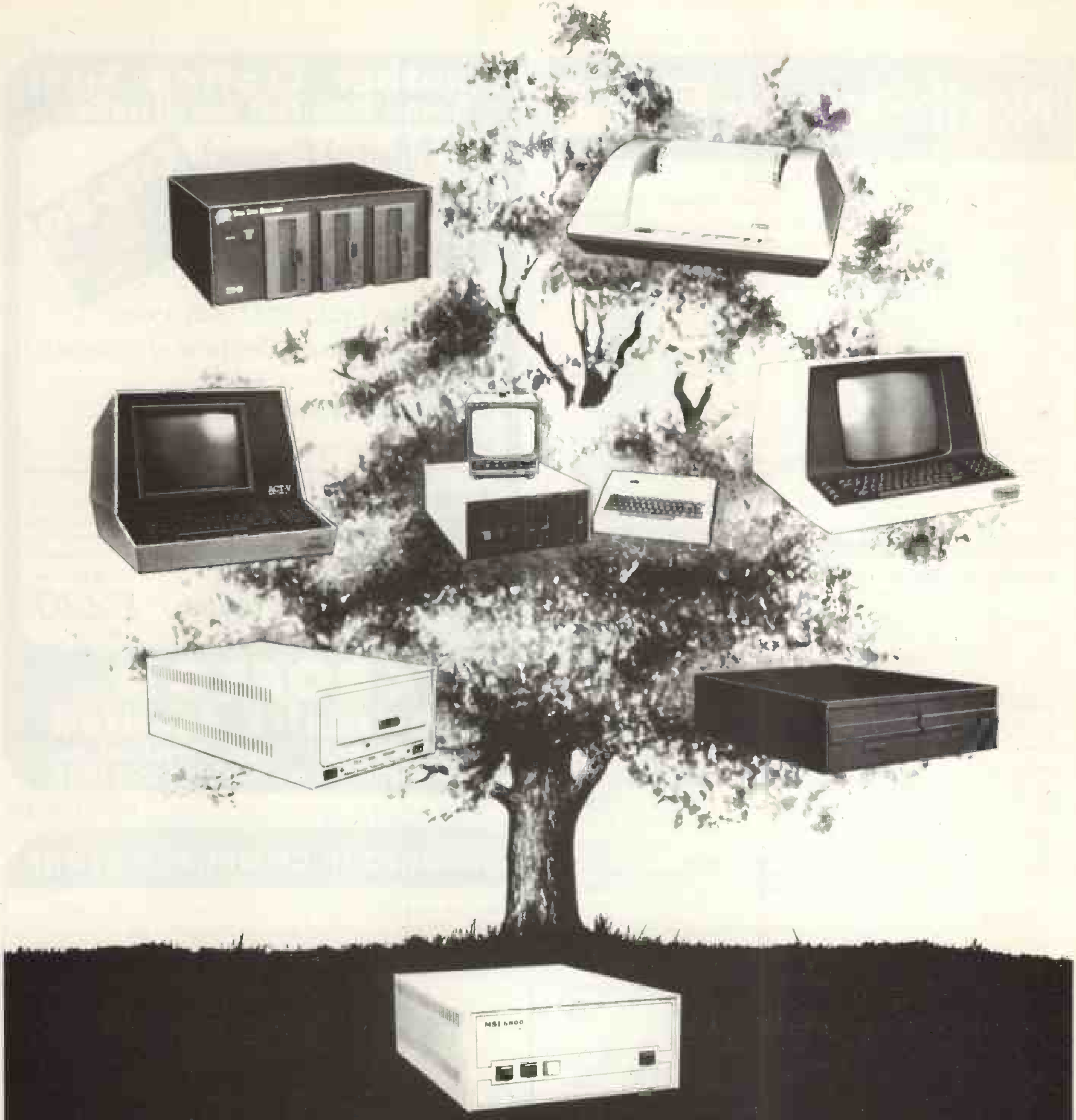
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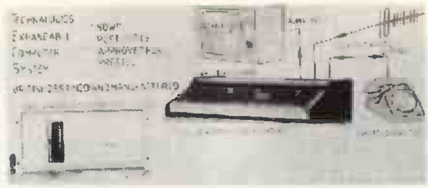

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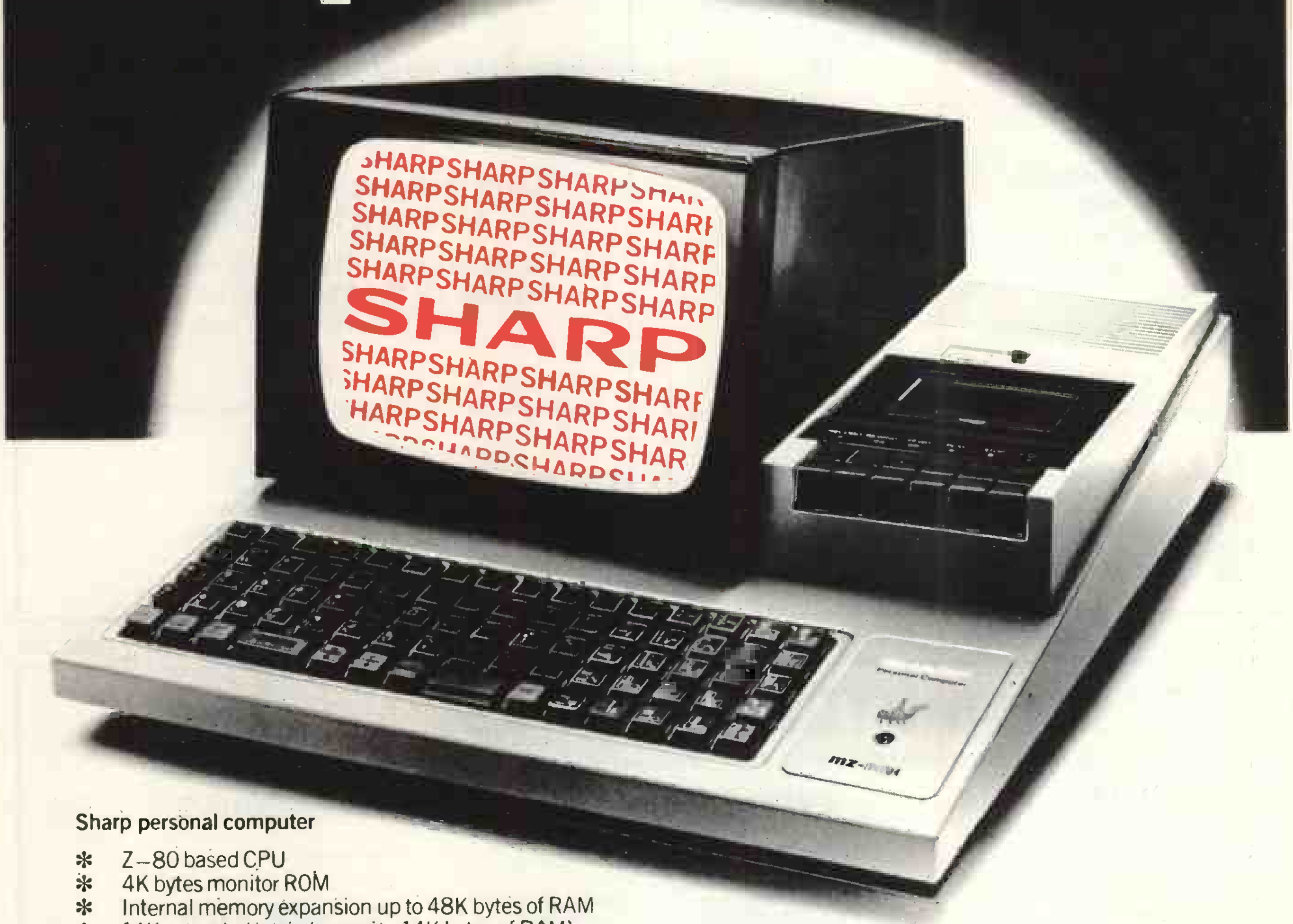

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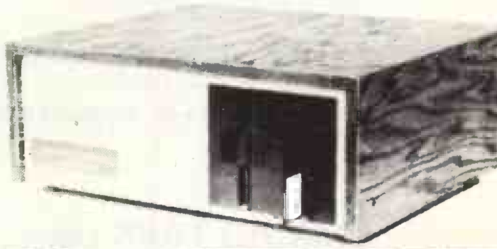

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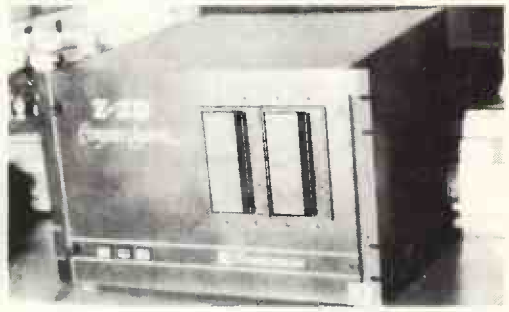

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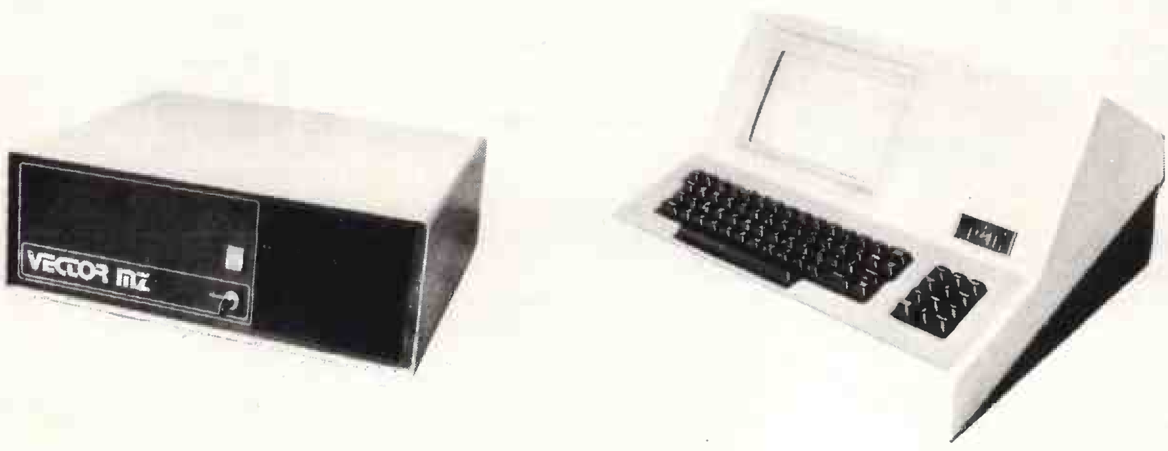

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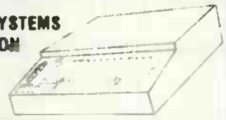

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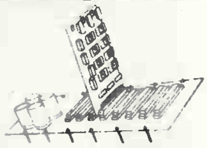

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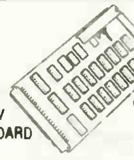

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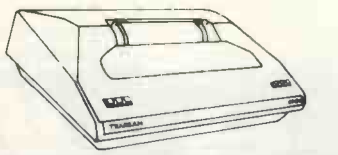

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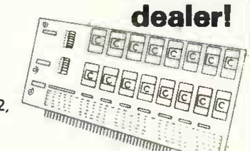

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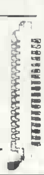

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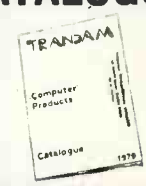

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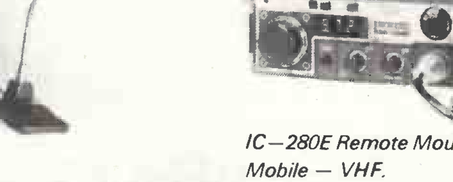

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• Circle No. 179

The language dilemma

OVER THE LAST YEAR there has been talk about a wonderful new language called Pascal. It is said, by those who favour it, that it is much better than Basic in every way; that everyone should immediately learn it; and that when they have done so, a new era of light and harmony will settle on the microcomputing would.

It is further suggested that *Practical Computing* should publish a course on Pascal, as was done for Basic,'and that listings in that language should be published exclusively.

If the suggested end-results of peace and harmony were certain, one would have no doubts but that is far from being the case. There is one striking fact about the microcomputing scene — there is far too much of it. There may well be too many types of computer, too many peripherals, and far too many languages — including some 20 dialects of Basic. We could all probably find satisfaction with only two of three of each item, and far fewer languages.

Basic has many faults. It is slow, badly adapted to building hierarchies of program. One can, no doubt, use five lines of Pascal for what it takes 50 lines of Basic to accomplish, and the result will run in one-tenth the time. The supporters of Pascal say that it is elegant, compact, quick, and so designed that it forces habits of clear thought on to the user.

That comparison ignores the best thing about Basic, that almost everyone in microcomputing understands it. It is the *lingua franca* of microcomputing — pidgin Fortran, perhaps — but a most powerful and welcome unifying force.

That was obvious from perusing the first results of our readership survey. We asked what languages people used and you answered in the following percentages:
Basic 74; Fortran 27; Cobol 16; Algol 11; Pascal four; Pilot three; APL two; LISP one; SNOBOL nought; others 20.
So that people write roughly one-and-a-half languages each, of which Basic is the one.

Is it worth sacrificing this surprising degree of unanimity for the sake of yet another language, however elegant? It is as if Caxton, with his first printing press running, was visited by a clever fellow who said he thought Olde Englysshe was a load of rubbish an why not publish books in Sanskrit, which is such an elegant language; and when Caxton replied that his readers and authors all read and wrote Olde Englysshe but did not know Sanskrit from a dog's calling card, his visitor said: "They can learn it and then write their own books."

It is little appreciated at this stage in microcomputer development how like it is to a printing press. People can and do write English in small amounts but they do not expect to be called upon to write their own newspapers, magazines, novels, histories and scientific texts. The point of written language would be lost if they did.

The first requisite for a culture is a common language and, to a large extent, we already have that. Surely we should be more concerned with standardising Basic than with fragmenting our means of communicating with each other?

It is amusing that while everyone admits that the most serious disadvantage to Pascal is the difficulty of learning it, the people keenest about it are academics in computer science. Can it be, one asks cynically, that they are making work for themselves? No doubt they would answer that the hard work needed to learn Pascal is imposed, not by the language, but by the principles of clear thought which it embodies which would be difficult to learn in any guise.

While those habits may be satisfactory for the professional whose failure to think clearly may cost important computing resources, they may prove an insuperable barrier to the lay recruit. Naturally, perhaps, computing professionals under-estimate the second great virtue of Basic, that it is easy to learn. It was designed specifically to free the computer from the custody of professional programmers, and in that it has succeded to admiration.

The microcomputer provides anyone with a few hundred pounds and a modicum of common sense access to a machine of enormous power. This machine is activated not only by the programs he can write himself but it draws on millions of man-hours of work by people all over the world during the last 10 to 20 years.

The newcomer is wary. He has been conditioned by two decades of ecstatic publicity for the wonder machines and the new breed of supermen who program them and it is hard to shake off the awe. It is vital to the whole development of microcomputing that the first 10 minutes a newcomer spends at the keyboard should be easy, fruitful — and fun.

Basic meets those needs. Turn on any micro, load Basic, and in a few keystrokes anyone should be able to make the machine do something. This first toehold in the edifice of computing is of immense importance.

After that, using Basic, there are few difficult ascents to bar one's progress. In my experience, the hardest single step was understanding disc files but by that stage I was not to be deterred. In retrospect, learning Basic was about half as difficult as learning to drive a car.

Can those who favour Pascal say as much? Can a complete novice write even five lines of program which will run? Because if he cannot the language is not suitable as a *lingua franca* for micros.

The key test is perhaps the frequency of how one hears people complaining: "If only I had wonderful Pascal, I could write this terrific program, but as it is, I'm stuck with Basic and it's all hopeless." That does not happen often. There are plenty of things one would like to do which need something better than Basic but they need something more drastic than Pascal, too.

If we must have a second language, what characteristics should it have? It should:

- Do things Basic cannot do, rather than the same things perhaps a little better.
- Be an interpreted language so that inept programmers like me can debug more or less as they write.
- Be available for at least several micros.
- Open a mass of existing but hitherto inaccessible software.

Even though those criteria are loaded slightly, they lead to only one answer — LISP. As those who read Mike Gardner's article in October will appreciate, one can easily do things in LISP which would be a real performance in Basic. Since textual information will increase rapidly in importance, because of the impact of affordable hard discs and Prestel, we need a language to cope with them rather than one to cope slightly better with what we already have.

If there is a vote, mine would go to LISP rather than Pascal. What do you think?

P.L.

Program of the Year Competition

CONGRATULATIONS to Drs Georgina and Geoffrey Jolliffe on their winning entry, which appears in part in this issue. It was a pleasure to be able to award the prize to an entry which was immaculately conceived, executed and presented, and which uses a microcomputer for an eminently-useful and humane purpose.

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.

Text packing

FOLLOWING my letter in the May issue seeking a text packing scheme to reduce the Adventure II data base, I had several interesting replies but only one detailed suggestion from Kay Dekker of Coventry.

In the meantime, I had devised my own simple scheme and programmed it in Fortran IV. It uses four bits for the common characters — Space E and the like — and eight bits for the rest, including several common two- and three-character combinations. Applied to the 63K characters of the Adventure II database it gives a mean bit rate of 4½ bits/character, which is probably slightly inferior to Kay's scheme, and reduces the total storage requirements of the program from about 50K 16-bit words to about 37K.

Several people now have this version in regular use, and it appears to run without noticeable disadvantages.

If anyone is interested in my scheme, or better still if they think they can improve on it, I would like to hear from them. I am sure that mean bit rates of less than four bits/character can be achieved and possibly even three bits/character, without introducing the unacceptable overhead of a very large word dictionary.

My aim is to promote an improved version of the Fortran subroutines PACKIT and WRITIT used in Adventure II. I am willing to test the efficiency of any version of these routines in packing the Adventure II database, and to include the routines in the program, with due acknowledgment, if they give a substantial improvement.

Incidentally, has any Adventurer yet found the secret of the chalice?

Jack Pike,
Chawston,
Beds.

Bugs in the solder

I AM PROMPTED to write by Nick Laurie's comments on home construction in the August issue. Some time ago I had the task of building a Nascom I for a friend and after the problems we had I would hesitate to buy another kit.

Before soldering anything I took the precaution of checking all resistors, capacitors, diodes, and transistors with a multimeter and battery. That revealed that the 3.3V zener diode for the character generator had no zener characteristics. After replacing it, construction was completed, the soldering checked meticulously, and miraculously on powering-up everything seemed to work.

It was soon obvious, however, that all was not well. Like Laurie's Nascom, ours kept writing its own software throughout RAM. Typically this happened four to five minutes after power-on, just as one had typed-in a program or loaded a tape. We were using the Mark I PSU and although the current being drawn was less than 2A, the power transistor became very hot. It was fitted with a much larger heat sink but the problem remained. No other components appeared too hot. The most annoying thing was that although the computer usually failed after about five minutes, occasionally it would work for hours before dying. The symptoms of death were wobbly screen, loss of keyboard response, followed by refusal to respond to re-set and a blank screen.

We wrote to Nascom describing the fault last January. Six months later the company replied, apologising for the delay, but with no useful suggestions. In the meantime we eventually traced the fault to the bridge rectifier in the PSU. Although it became warm it had not seemed too hot. When it was replaced by a bigger one on a large heatsink, the problem disappeared. Somehow the voltage on the +5V line must have been jittering enough to upset the CPU when the rectifier warmed-up.

Anthony Short,
Coulsdon,
Surrey

African plea

THIS is a plea from the barren lands of Africa to the manufacturers of minicomputers. The development of small computers was aimed originally for the markets of Europe and U.S. Another area of great sales potential, however, must be Africa. Low-cost desk machines, such as the Pet series, have enabled many higher education institutions in Africa to buy their own small computers to increase their teaching options and widen research fields.

Users in countries like Sudan are faced with many difficulties, of which manufacturers may not be aware. Will the machine operate reliably under the prevailing atmospheric conditions — high temperatures, constant exposure to dust or high humidity? A low-cost machine becomes very expensive if a sealed, air-conditioned room is required for it.

Who will service and repair the machine in a country with few, if any, electronic engineers? It would be a great help if makers would find out the problems and provide the answers in their sales information.

One very aggravating problem is the mains voltage supply to a machine. Unlike the U.K., many countries do not have a reliable power supply. In Sudan, where the supply is supposed to be 240 V, the supply over a 12-hour period fluctuated between 180 and 215 V. All areas are also subject to irregular power cuts — extremely frustrating if one occurs during programming.

During a recent visit to the U.K. several possible solutions were investigated. They included using a DC supply from car batteries either by rectifying and then feeding direct or passing through a DC-AC transverter, since car batteries are not subject to cuts and fluctuations and can be re-charged from the mains between cuts.

With the former, installation requires electronic expertise and appears incapable of powering a VDU; with the latter high power consumption limits the life of the batteries drastically. Apparently, the problem of power cuts will have to be accepted as part of life, and for the voltage fluctuation we are having to use a voltage stabilising unit at a cost of £150 — a substantial amount relative to the cost of our Pet 2001.

It would be a great help to African users, and also a good sales feature, if manufacturers were to produce a simple, optional device to enable a DC power supply to be used to power minicomputers.

Finally, is there a user group for people outside Europe?

Michael Robertshaw,
University of Gezira,
Wad Medani,
Sudan.

Those dialects

YOUR SEPTEMBER editorial referred to the difficulty of moving Basic programs between machines. Although the use of Basic is unavoidable because it is by far the most common language supported on microcomputers, I have often felt that it is a mistake to publish complete programs instead of algorithms.

People tend to become too involved with the trivial details of Basic dialects and the attempts to transfer Basic A on to machine B lead to much tearing of hair and wasted time.

Would it not be more sensible, except in specialist cases, for Pet Corner to publish well-documented, structured algorithms and let interested parties re-write the algorithm in their particular dialect of Basic. This method has the advantage that the coder has thorough knowledge of the solution to the problem, and that a structured algorithm generally will result in better final programs.

I think that your magazine could be much-improved if you had more articles on teaching programming and less on teaching Basic dialects. As Dr Barry says, the details of the final language in which a program is to be coded are probably the least important factors in designing a solution to a particular problem.

Apart from this criticism, I find your magazine very interesting and informative. Keep up the good work.

David Birch,
Southampton University.

On target

THE EDITORIAL in September is the only thing I can remember seeing in any computer magazine that came close to portraying the "real world". You are to be congratulated, not just because of its good sense, but also because you had the courage to bite the various hands that feed you — the targets for your criticisms presumably being the same people who provide you with advertising revenue.

At least you will be loved by those among your readers who are engaged in trying to do the job properly either as dealers in micros, or in writing software for them.

Your analogy to the early 'bangers' can be extended. There is one well-known name which looked set to be the Model T of the micro world and certainly it has sold in vast quantities. Unfortunately, it does not work very well and the manuals issued so far contain so many errors that it is almost better to ignore them.

Those attending a dealers' meeting recently

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were horrified to find that none of the company's staff in this country knew very much about how to use the disc drives which had been released, a situation improved only marginally by subsequent issues of copious notes and amendments. The same criticisms apply to the printers, although you cannot buy the tractor feed printer which has been advertised extensively.

It is as though Henry Ford has started the assembly line before he had found out how to fit the engines and wheels, in the hope that his customers would have the skill and patience to do the work themselves.

Incidentally, the three-way telephone conversation you mention arouses a certain amount of envy. We find that communicating with this particular company could not be more difficult if it was located on the dark side of the moon.

One of many letters to it ended with the exasperated question "Is there anybody there?" After three months there has been no reply and the subject of the complaint still sits lifeless, minus cassette drive and chips.

Graham Garner,
Computer and Design Services Ltd.,
Broadstone,
Dorset.

Joystick improvements

DAVID ANNAL'S article on home-made joysticks has a version using four microswitches operated by a moving washer attached to a knob. He says that this does not allow for any special codes to be generated, for instance, to produce a "FIRE" command. If the central washer is replaced by a thin square block (see diagrams) the code generated by all four switches being closed can be produced if the knob is rotated.

The first diagram shows the null positions of the switches. The knob can be moved up, down, left, right and diagonally to give the same results as the original design. By rotating the block as shown in the second diagram it should be possible to make all the switches close.

With practice, and a carefully-made device, it may also be possible to make any three switches close. This would be done by moving the knob away from the switch which is to remain open, and rotating it to close the two switches on the sides of the block.

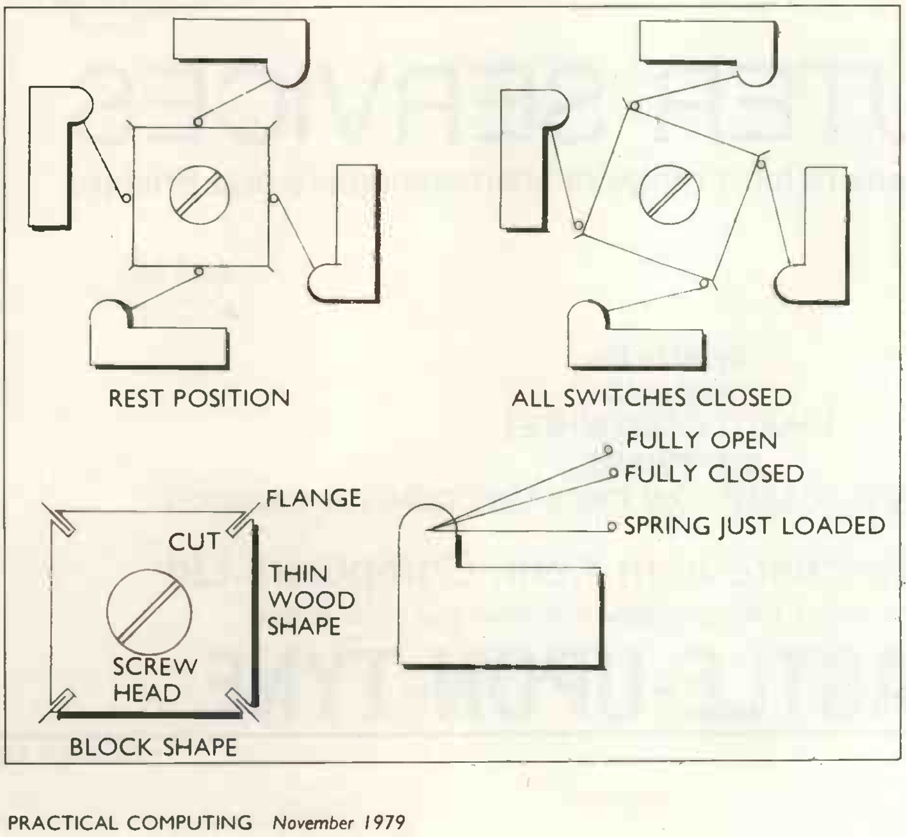
For this to be possible, it may require switches with a large amount of travel to enable the block to move far enough away from the switch which is to remain open, so that it is not closed when the block is rotated.

The third diagram shows the shape of the block. It is a thin square with a cut in each corner into which is placed a small piece of metal or anything else suitable to act as a stop, so that the operator has an indication when the switch arms are at the corners of the square. Otherwise the arms may flip the knob round suddenly when they pass the corners.

When the knob is at rest the springs should be pressing the sides of the block. The flat sides of the block will also mean that the arms press on the sides evenly as the block moves down. This should produce a more even feel, as the original design would have the side pressure lowered as the knob moves down and the arms move round the circular washer.

I have not as yet built this modified joystick and would be interested if anyone manages to make it work reliably.

S. Goudge,
Eastbourne.



Rental charges

AS a company dealing in both television and microcomputers, I feel well-qualified to provide an explanation on apparent high rental charges on small computers.

First and foremost the quoted charges are for short periods. Our hire models spend up to half their life on the shelf, and a considerable proportion of the cost is in the once-only administration associated with a rental.

In addition to the machine, we provide at no extra cost manuals, text books, demagnetisers, tapes and sample programs, not to mention lengthy demonstrations and advice.

We are always pleased to provide computers for long-term hire on the same basis as television, namely an annual rental of about half the new cost, including full maintenance. Nevertheless, it appears that some firms overcharge and require too high a deposit.

With regard to maintenance, our experience is that microcomputers are more reliable and robust, and easier to repair than TVs — U.K. models anyway.

M. M. Zepler,
Super-Vision
Southampton.

Know your rights

IN several recent issues of your magazine, many readers comment on the computer warranty problems they have encountered. A common complaint is the distance they have to travel to return goods to the retailer.

Your readers cannot be aware of recent Consumer Legislation which is summarised in a Retailers' Guide, printed by HMSO.

With bulky purchases it is clear that the consumer does not have a responsibility to return the goods to the retailer. Rather is it the duty of the retailer to provide the service at the house of the purchaser. This legislation has to be interpreted reasonably, but when spending £1,000 or more on a computer, it is not unreasonable to expect the retailer to provide a service over a distance, in return for the very high markups of between 25-60 percent which exist in the trade.

Finally, I would suggest that readers ignore the 30- and 60-day warranties seen on some computers; these statements would not be of any consequence in law.

G.G. Grover,
Brighton.

Complexities

I WOULD like to correct a few serious misrepresentations made by Nick Hampshire in the September *Practical Computing* about the Zilog Z-8000 microprocessor.

His comparison with the Texas 9900 is inaccurate. The Texas machine has a 15-bit address bus and is therefore capable of addressing 32,768 words, each of 16 bits. The Zilog Z-8000 is a byte-addressed machine and can address 8,388,608 bytes of store in each of six possible address spaces, namely for both system and user mode the cpu and an associated memory management unit (Z-8010) can address a code, data and stack storage space each of which would be as much as 8,388,608 bytes.

Thus the total possible memory address space is 50,331,648 bytes (48 Mbytes). The large address space is not, however, linearly addressed; the program counter in the segmented version (Z-8001) of the cpu is divided into a 16-bit offset which points to an even-numbered byte in one segment of the memory, which is chosen by the segment number which is stored in the HIGH byte of the second word of the program counter. This segment number is of six bits only and chooses one of 128 segments — 64 per memory management unit which, with the aid of the

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processor status lines, maps the software address into a physical address.

Also, contrary to Hampshire's assertion, the Z-8000 does not use a pipelined architecture and there is no overlap of fetch and execute cycles of an instruction. For anybody who would like a closer insight into this very powerful processor, the preliminary specification from Zilog or a pair of booklets from Advanced Micro Devices, which is second-sourcing the device, are very informative and may clear any confusion in the minds of anybody thinking of purchasing this extremely powerful processor.

The Z-8000 seems to be the kind of processor needed to take personal computing out of the age of expensive toys and allow individuals to realise their own really powerful machines. Zilog compares the power of the Z-8000 to a Digital PDP 11/45 and it has more memory address capability than a PDP 11/70. It also has all the memory segmentation and protection features necessary to run really advanced operating systems and compilers for languages which are more than the bad joke which Basic has become.

It should be possible to implement languages like Algol 68, which is not dissimilar to Pascal but considerably more powerful.

They offer the micro user the opportunity to implement systems much more complex than is possible with today's 8-bit machines.

A R Kidson,
Bromley, Kent.

●The Z-800 sounds terrific but does it offer any great advantages over 8-bit machines unless it has all that memory to address? Isn't the problem there the old one of hard cash?

Little Sir Echo

ECHOING the complaint of M G Hummel in your September Feedback, I and my colleagues have been attempting to buy a Micropolis dual floppy disc system for use on the Exidy Sorcerer for the last two months.

Among the excuses given for non-delivery have been:

"We've just sold the last of our consignment"; "Micropolis has just re-located its State-Side factory and supplies are a bit disrupted"; "The demand exceeds supply so we are allocating on a queue basis"; and "Oh yes, Tandy has bought the whole of next year's consignment of these systems and its version of the Micropolis disc system is not Sorcerer compatible".

I might say we have reached the depth of cynicism where we image that our supplier plucks his excuses from a tombola so that we don't get bored with having the same story twice.

A.C.J. Pepper,
ITT Components Group,
Harlow, Essex.

North Star game

YOU PUBLISHED my noughts and crosses game and have my 6502 disassembler program. I enclose text of a super game for North Star systems which I have been developing for some time.

It is definitely an adult game and is difficult to play but it represents a genuine challenge.

D.N. Sands,
Intelligent Artefacts Ltd.,
Orwell Royston,
Cambs.

```
1 REM 6502 OPCODE DISASSEMBLER IN BASIC
2 REM WRITTEN D.N.SANDS 1979
10 PRINT"START ADDR";:INPUTA$:A=0
20 FOR K=1TO4
30 IF MID$(A$,K,1)>="A" THEN 50
40 A=A*16+VAL(MID$(A$,K,1)):GOTO 60
50 IF MID$(A$,K,1)="A" THEN A=A* 16+10
51 IF MID$(A$,K,1)="B" THEN A=A* 16+11
52 IF MID$(A$,K,1)="C" THEN A=A *16+12
53 IF MID$(A$,K,1)="D" THEN A=A* 16+13
54 IF MID$(A$,K,1)="E" THEN A=A* 16 +14
55 IF MID$(A$,K,1)="F" THEN A=A* 16+15
60 NEXT
70 INPUT"NO. LINES ";NL
80 FOR LN=1 TO NL
85 N=0:L=A:GOSUB 2000
90 D=PEEK(A):L=PEEK(A+1):H=PEEK(A+2)
95 F=D AND 28:PRINT TAB(10);
97 REM INTERPRET MAIN OPCODE
100 IF (D AND 227)=97 THEN PRINT "ADC";:GOTO 1000
105 IF D=32 THEN PRINT "JSR";:N=3:GOTO990
106 IF D=76 THEN PRINT "JMP";:N=3:GOTO990
107 IF D=106 THEN PRINT "JMP INDIRECT";:N=3:GOTO 990
110 IF(DAND227)=33THENPRINT"AND";:GOTO1000
120 IF D=144 THEN PRINT "BCC";:N=2:GOTO 1100
130 IF D=176 THEN PRINT "BCS";:N=2:GOTO 1100
140 IF D=240 THEN PRINT "BEQ";:N=2:GOTO 1100
150 IF D=48 THEN PRINT "BMI";:N=2:GOTO 1100
160 IF D=208 THEN PRINT "BNE";:N=2:GOTO 1100
170 IF D=16 THEN PRINT "BPL";:N=2:GOTO 1100
180 IF D=80 THEN PRINT "BVC";:N=2:GOTO 1100
190 IFD=112 THEN PRINT "BVS";:N=2:GOTO 1100
200 IF D=24 THEN PRINT "CLC";:N=1:GOTO 980
210 IF D=216 THEN PRINT "CLD";:N=1 GOTO 980
220 IF D=88 THEN PRINT "CLI";:N=1 GOTO 980
230 IF D=184 THEN PRINT "CLV";:N=1 GOTO 980
240 IF D=202 THEN PRINT "DEX";:N=1:GOTO 980
250 IF D=136 THEN PRINT "DEY";:N=1:GOTO 980
260 IF D=232 THEN PRINT "INX";:N=1:GOTO 980
270 IF D=200 THEN PRINT "INY";:N=1:GOTO 980
275 IF D=0 THEN PRINT"BRK";:N=1:GOTO980
280 IFD=234 THEN PRINT"NOP";:N=1:GOTO980
290 IF D=72 THEN PRINT "PHA";:N=1:GOTO 980
300 IF D=8 THEN PRINT "PHP";:N=1:GOTO 980
310 IF D=104 THEN PRINT "PLA";:N=1:GOTO 980
313 IF D=40 THEN PRINT "PLP";:N=1:GOTO 980
320 IF D=64 THEN PRINT "RTI";:N=4:GOTO 980
330 IF D=96 THEN PRINT "RTS";:N=1:GOTO 980
340 IF D=56 THEN PRINT "SEC";: N=1:GOTO 980
350 IF D=248 THEN PRINT "SED";:N=1:GOTO 980
360 IF D=120 THEN PRINT "SEI";:N=1:GOTO 980
370 IF D=170 THEN PRINT "TAX";:N=1:GOTO 980
380 IF D=168 THEN PRINT "TAY";:N=1:GOTO 980
390 IF D=186 THEN PRINT "TSX";:N=1:GOTO 980
400 IF D=138 THEN PRINT "TXA";:N=1:GOTO 980
410 IF D=154 THEN PRINT "TXS";:N=1:GOTO 980
420 IF D=152 THEN PRINT "TYA";:N=1:GOTO 980
430 IF(D AND 227)=2 THEN PRINT "ASL";:GOTO 999
440 IF(D AND 227)=32 THEN PRINT "BIT";:GOTO 1000
450 IF(D AND 227)=193 THEN PRINT "CMP";:GOTO 1000
460 IF(D AND 227)=224 THEN PRINT "CPX";:GOTO 998
470 IF(D AND 227)=192 THEN PRINT "CPY";:GOTO 998
480 IF (D AND 227)=65 THEN PRINT "EOR";:GOTO 1000
485 IF(D AND 227)=194 THEN PRINT "DEC";:GOTO 1000
490 IF(D AND 227)=226 THEN PRINT "INC";:GOTO 1000
500 IF (D AND 227)=162 THEN PRINT "LDX";:GOTO 997
510 IF(D AND 227)=160 THEN PRINT "LDY";:GOTO 998
520 IF (D AND 227)=161 THEN PRINT "LDA";:GOTO 1000
530 IF (D AND 227)=66 THEN PRINT "LSR";: GOTO 999
540 IF (D AND 227)=1 THEN PRINT "ORA";:GOTO 1000
550 IF (D AND 227)=34 THEN PRINT "ROL";:GOTO 999
560 IF (D AND 227)=98 THEN PRINT "ROR";:GOTO 999
570 IF (D AND 227)=225 THEN PRINT "SBC";:GOTO 1000
580 IF (D AND 227)=129 THEN PRINT "STA";:GOTO 1000
590 IF (D AND 227)=130 THEN PRINT "STX";:GOTO 997
600 IF (D AND 227)=128 THEN PRINT "STY";:GOTO 1000
610 PRINT "UNDEF";:N=1
620 L=D
630 PRINT TAB(25);:GOSUB2000
980 PRINT:A=A+N:NEXT LN
985 GOTO 70
990 PRINT TAB(25);:GOSUB2000
995 GOTO 980
996 REM INTERPRET VARIATION OF CODE
997 IF F=20 THEN PRINT " Z-P,Y";:N=2:GOTO990
998 IF F=0 THEN PRINT TAB(24);"#";:N=2:GOTO990
999 IF F=8 THEN PRINT " ACC";:N=1:GOTO980
1000 IF F=12 THEN PRINT " ABS";:N=3:GOTO990
1010 IF F=8 THEN PRINT TAB(24);"#";:N=2:GOTO990
1020 IF F=4 THEN PRINT " Z-P";:N=2:GOTO990
1030 IF F=0 THEN PRINT " (IND,X)";:N=2:GOTO990
1040 IF F=16 THEN PRINT " (IND),Y";:N=2:GOTO990
1050 IF F=20 THEN PRINT " Z-P,X";:N=2:GOTO990
1060 IF F=28 THEN PRINT " ABS,X";:N=3:GOTO990
1070 IF F=24 THEN PRINT " ABS,Y";:N=3:GOTO990
1080 PRINT "UNDEF";:GOTO990
1100 REM RELATIVE ADDR
1105 H=L
1110 IF L>127 THEN H=L-256
1112 PRINT TAB(25);
1115 L=A+H+N:GOSUB 2000
1120 PRINT " (";H;")";
1130 GOTO 980
2000 REM DEC-HEX
2005 IF N=3 THEN L=L+256*N
2010 G=INT(L/4096):GOSUB 2500
2020 L=L-G*4096
2030 G=INT(L/256):GOSUB 2500
2040 L=L-G*256
2050 G=INT(L/16):GOSUB 2500
2060 G=L-G*16:GOSUB 2500
2070 RETURN
2500 IF G=10 THEN PRINT "A";:RETURN
2501 IF G=11 THEN PRINT "B";:RETURN
2502 IF G=12 THEN PRINT "C";:RETURN
2503 IF G=13 THEN PRINT "D";:RETURN
2504 IF G=14 THEN PRINT "E";:RETURN
2505 IF G=15 THEN PRINT "F";:RETURN
2510 W$=STR$(G)
2520 PRINT RIGHT$(W$,1);:RETURN
```

Improvement

I WAS most interested to read your September review of the Anadex DP-8000 printer. To bring your readers up-to-date, however, I should mention that all DP-8000s are now supplied with adjustable paper feed sprockets to accept any paper size up to 9.5in. wide and a self-check facility to print the complete character set, together with a diagnostic routine, is incorporated.

Also, a complete servicing facility is available from our main distributors, Peripheral Hardware Ltd, at East Molesey, as well as from a number of our recognised dealers. In addition, for those customers who require on-site support, a service contract is available from Kode Services Ltd, Calne.

For users who would like to carry-out their own servicing, a maintenance manual is now available from Anadex and we have recently increased our technical services staff to make information of this kind more readily available by telephone.

Finally, we have established that it is possible to stand a cup of tea on the DP-8000 — our service people are now insisting on a re-design of the case.

M.S. Hayward,
Managing director,
Anadex Ltd.

Unhappy

I DO not know how many of your readers have encountered difficulties in dealing with firms in the United States but would like to draw attention to my experience.

At the end of February, I sent a bankers' draft for 21 dollars to Jade Computer Products in California. It was for three months' trial membership of its software exchange (20 dollars), plus one dollar for an air mail reply. I would state that postage was not mentioned in the advertisement. I had no reply.

In April I wrote again, enclosing a photocopy of the original letter and a photocopy of the bankers' draft. I still received no reply.

I contacted my bank, which made enquiries on my behalf, and on June 21 received a reply that the draft had been paid to Jade on March 15. On July 10 I wrote again to Jade, stating that the position was unacceptable, and asking for a refund of my money, or details of the library before the end of the month. I have no goods, no money — and no more patience.

It would be interesting to hear if any other reader has experienced similar difficulties.

John D. Lee,
Loughborough.

Exchange

I INTEND to set up a program exchange, entitled *Micro News*, it would be a newsletter, of about 10 pages covering programs for computers such as the Superboard, Nascom-1 & Exidy Sorcerer.

Martin Black,
11 Moorland Avenue,
Higher Crumpsall,
Manchester, 8.

●BEARING IN mind the national shortage of microcomputer engineers and programmers, we think it may be interesting to publish an article on how people first found jobs in the business.

Since the people concerned know best about that, we would be interested to hear how you did it, whether you were happy with the results, what you think of formal courses as opposed to on-the-job experience, and so on. Please write to 'Getting Started', *Practical Computing*.

Extra protection now for the customer

THE CUSTOMER for microcomputers looks like having some procection now the Computer Retailers' Association has been formed by 23 microcomputer retailers, including Keen Computers, HB Computers and Microdigital.

The object is to "maintain and improve standards within the industry and to present the industry case to the outside world, including the Government and the lay Press."

Colin Stanley, of HB Computers, who has been involved from the beginning, says it intends to protect the rights of the customer and to "eliminate the type of company which asks for money first and sends the computer later."

Conditions of membership are that firms must be microcomputer retailers; they must have a display area where products can be demonstrated; they must have a constantly-manned telephone on their premises during working hours; and they must have "expertise in software and hardware."

The most significant point, is probably that the association will meet the obligations of any of its members who are forced out of business, thus guaranteeing customers of members against loss. It will also continue servicing any machine bought from a company which was in the association and has since failed.

Micros to make your car tick

THE MOTOR CAR of the future may well have a microcomputer at the heart of its operation. A simulation of things to come was shown on the BBC television programme *A Right to Work*.

Built by Scicon, it uses a magnetically-coded board with personal identity code instead of an ignition key. Before starting the engine the computer checks the complete car systems and warns the driver of any deficiencies via a single-line alphanumeric display.

The micro also communicates via a radio link to a central computer database to gain information on the best route to take avoiding obstructed roads. Through that link, the driver could also make hotel reservations, book a table at a restaurant, or receive the latest new headlines.

While driving, the performance of the car, road conditions and journey details are monitored constantly and details written on one of the various displays.

All the features incorporated are geared to safer motoring, energy saving and improved communications.

Geared to safer motoring.

Computhink

JOHN BLACKBURN of B&B Consultants, Bolton, says his partner, Peter Binks, has managed to tweak the Computhink drive for the Pet to such good effect that one machine can now control four drives, storing 50MB.

The alteration consists of a piece of hardware and a piece of software. "If you order one now, I can give delivery in two hours", says Blackburn.

B&B Consultants, 124 Newport Street, Bolton, Lancs (0204 26644).

Line change

THE Disassembler for the 6502 by D. Sands contained an error. The last character in line 2005 should be H, not N.

Construction service

A KIT CONSTRUCTION service with charges of around 10 percent of system value for each kit built is being offered by a Truro company.

Logsign will supply or build kits or construct those the customer wishes to supply. It will also complete kits which customers have started to build and with which they have experienced difficulty.

Popular kits, such as Nascom, Compukit and 77/68, will be dealt with and large systems, such as the Horizon, will cost around 25 percent of the original cost to build.

Enquiries to A. D. Cann, Logsign, PO Box 33, Truro, Cornwall.

Conversion

ACULAB has a conversion box to interface a 7-bit parallel ASCII port to any IBM golf-ball printer. The output is slow but it can be cheap and the printing will look good. The interface will cope with five standard golf-balls.

Aculab Ltd., 24 Heath Road, Leighton Buzzard, Beds, (0525 371393).

Help for CP/M users

WITH disc systems rapidly gaining ground, news about CP/M, the standard operating system for 8080 and Z-80-based machines, if of interest.

Peter Norman, of the Computer Centre, Swansea, says it recently received a new version CP/M 2, which will handle up to 128MB on hard disc. While that is of little use to people who already have CP/M 1 for floppy discs, it will be very useful to those who intend to acquire the 10MB drives.

Norman expects those drives, from DRI, will sell for about £1,500 for the 10MB version and £2,000 for 30MB, with the price falling after two years to about £500 at today's prices.

Incidentally, while the Computer Centre holds the 38 volumes of American software for CP/M, it has also accumulated two volumes of British material.

The Amateur Computer Club has also made an arrangement with Digital Research, owners of CP/M, and will be offering its library and systems at a discount to members. Contact is Alan Secker (868 1144).

Lifeboat compilers

LIFEBOAT ASSOCIATES offers two compilers for "C" language and Version 5 Microsoft ANSI Basic. The compiled version runs five to 10 times faster than interpreted Basic.

Lifeboat has also released CP/M for the Altair disc system, which makes a large library of software available to users. Lifeboat Associates, 2248 Broadway, New York, NY 10024 (212 580 0082).

Petite

PLESSEY has reduced the price of the Petite and Inpet expansion memories for the Pet, because increased demand has led to volume production. Petite will now cost £289 and the Inpet, an add-in card, £249.

WINNERS of the *Practical Computing* Program of the Year competition, Drs Georgina and Geoffrey Jolliffe, with their trolley-mounted Tandy system in a lecture theatre at Chelsea College, where they teach pharmacy.

Impressive winning entry

THE Program of the Year award was won by Drs Georgina and Geoffrey Jolliffe, of the Department of Pharmacy at the University of London.

Entries were invited in five categories — business and administration; science and mathematics; computer art; games and simulations; and education projects.

The program which was judged by Jim Wood, a consultant of several years' experience, and the Editor of *Practical Computing*, to be worthy of the main award is to aid the analytical identification of powdered vegetable materials used in goods and medicines. It would supercede the necessity for lengthy record retrieval by an experienced analyst.

The judges were impressed because the entry was well-thought-out and extremely well-presented, and because the application is a good and useful one.

The prize in the games and simulations category was won by Alan Baylis for his American Election Game, while J J Waters took the laurels in the science and mathematics section for his Analysing Linear Potential Flow problems.

There was no entry in the category for computer art and none of sufficient quality to win a prize in the section for education projects.

New colour board

THE Corvus 10MB disc available from Keen is, at £3,500, considerably more expensive than the promised but not yet available 10MB unit for the Pet.

Keen also has a new colour board for the Apple II, which improves on rather impure colours and defective control signals of the standard board.

The new board is designed for use with a 14 in. Sony, which has to be modified slightly. Two new utilities packs at £50 each are also available, including Sort, Search, Editor, Text Editor, and Super List for Basic programs.

Easier code for Z-8000

ZILOG now has a package of programs to make it easier to write Z-8000 code. You need a simple Z-8000 satellite system connected to any Z-80-based microcomputer with discs.

The software suite contains a Z-8000 assembler, a linker, a translator to turn Z-80 Assembler into source files of the assembler, a macro pre-processor, an imager program to produce loadable binary files containing executable Z-8000 code, ROM programming package, and utilities to transfer data between files in the Z-80 host and the Z-8000 satellite.

Zilog U.K. Ltd., Babbage House, Maidenhead, Berkshire. (0628 36131).

Peter Sommer looks at the background to the use of microcomputers in amateur radio and reviews some hardware. He is deputy editorial director at Granada Publishing and a radio amateur — call sign G8PRR.

Computer aid provides new dimension

AMATEUR RADIO was the first electronic hobby. Until the arrival of the solid-state diode and transistor made reliable low-power 'logic' switching possible, radio in its various guises was almost the entire content of electronics.

Amateur radio shares with astronomy, natural history, archaeology, computing and a few other activities an opportunity for talented non-professionals to make a real contribution to the advancement of knowledge.

Even for the less than highly-skilled, the process of learning about the hobby amounts to valuable self-training, which can be put to good use in other spheres. Some of the more advanced third world countries, for example, encourage 'hams' because it's an amazingly cheap and effective way of creating a pool of skilled electronics engineers.

It is not surprising that strong links exist between computer buffs and radio hams. Some of the earliest home computer constructors also held transmitting licences; the American magazine *Kilobaud* was spawned from a ham magazine called *73*. In the last 12 months many amateur radio stations have acquired micros with fascinating results.

Perhaps the least significant activity of hams is talking on the air. Given a reasonable amount of money, tolerable competence in setting-up and operating equipment — say a grade or so above soldering together hi-fi components and a modest knowledge of propagation — it is no great achievement to talk to someone on the other side of the world.

Hams explore the edges of what is technically feasible. Can you make contact on only five watts of power, or when conventional wisdom insists that a propagation path cannot exist? Can you develop a new antenna design, or adapt the newest transistor and integrated circuit technology to produce equipment which is more efficient, has more facilities, and is lighter in weight than ever before?

How about a speech processor which increases the intelligibility of a signal, or a new form of modulation which occupies less space on the crowded airwaves and causes less interference to others? Or an audio filter which digs-out fading signals and eliminates heterodyne whistles from the background hash?

More ambitiously, can you contribute to a VHF or UHF repeater which, sited on a hill top, will boost low-power signals from a poor location so that they can be heard over a 20-mile radius, or even help with one of the amateur radio satellites? How about bouncing a signal off the surface of the moon, or waiting for a meteor shower or aurora which ionises the upper atmosphere for brief periods to permit freak VHF contacts?

Can you send TV pictures around the world, without recourse to the satellites used by the broadcasting professionals? The picture is compressed into the same bandwidth used for speech — less than 3KHz compared to the 6MHz needed for standard colour TV — and a special slow scan rate used which changes the picture only every eight seconds or so, rather than every 1/25th or 1/30th sec; the mode is called SSTV.

Specialisations

Many of these specialisations can be helped by a computer. In some cases the micro is doing more flexibly and graphically what the calculator did two years ago and what a few years before that was derived from tables, nomographs and slide rules. The amateur station with a micro can perform feats and conduct investigations and experiments which previously were not possible. They fall into the following categories:

- collecting, collating, and recording data which enable an amateur to be aware of advantageous conditions under which to carry-out experiments; movement of the various amateur satellites, calculation of doppler shift — amateur satellites are not geo-stationary so that the appropriate transmit and receive frequencies vary according to whether the satellite is approaching or receeding from the operator; forecast of meteor showers, forecast of propagation conditions — which at high frequency or short wave, to give it the older name, vary with time of day, time of year, and time in sunspot cycle.
- driving the station equipment through micro-control. There are now a number of off-the-shelf transceivers advertised as microprocessor-controlled, and though most readers would find such descriptions rather exaggerated, advances in methods of frequency derivation have made the interfacing of micros with rigs much more worthwhile.

Until recently the standard method of generating a radio frequency signal was via a parallel-tuned oscillator consisting of a variable capacitor and a coil, and driven either by a valve or a transistor. Today the basic oscillator remains unchanged but the variable capacitor can be replaced by a varicap diode, a device whose capacitance changes according to a bias voltage placed across it.

The level of the bias voltage is determined by a multi-turn variable resistor — a typical consumer version are the pre-sets on a domestic TV.

More promising

Now it is easy for a micro to deliver measured bursts of voltage, particularly if there is a circuit with a built-in reference voltage and the appropriate 'comparing' logic.

More promising though, is the device of frequency by mixing the results of several oscillators. Dedicated chips perform all the desirable mixing functions — many chips, incidentally were developed for citizen band equipment — and the choice of frequency depends on feeding the appropriate chain of pulses to the correct pins on the chip.

The microprocessor can store frequencies in a 'memory' so that they can be summoned back at will. It can scan those frequencies to see if there is activity on the air. In one popular version, and in a number of mobile transceivers, the equipment runs up and down between two pre-determined frequencies looking for activity. When it finds a 'busy' channel, it stops, giving the operator an opportunity to decide whether to break in or to respond, and then, unless told to do otherwise, resumes scanning.

It is easy for a micro to display on its VDU all the activity within given frequency limits. It would also not be difficult to switch such transceivers into the frequency-hopping mode beloved of clandestine operators, except that the

Peter Sommer at work in his lair shack. Note the Pet in the foreground sending morse.

transmitting and the receiving station, provided it is locked in step, can hear each other because their frequency changes constantly according to a pre-determined cycle. It is not difficult, it is not legal, but it is difficult to enforce.

Plenty of equipment already allows the input of frequency to be executed from keyboard, rather than a tuning knob. Soon-affordable receivers which cover everything, not only the amateur bands, will have similar facilities; items now being offered to the military/diplomatic market have such arrangements already.

The Bearcat VHF/UHF scanner, popular in the States, will scan and search like amateur transceivers but over a much wider range — the 220 covers 32-50 MHz, 118-136 MHz (airband), 144-176 MHz VHF and UHF frequencies from 416 to 512 MHz.

Twenty channels

It can also store up to 20 discrete channels which can be scanned individually at either of two rates, and will also, on the striking of only one key, scan the entire air band and, on striking another, do the same for the marine VHF bands. Unfortunately there is no direct interface for a micro.

Similar facilities on high-frequency — short wave — equipment would mean that the listener could take advantage of the fact that many signals are sent simultaneously on a number of frequencies to overcome the vagaries of ionospheric conditions.

A computer-controlled HF receiver could sample continuously all the likely frequencies of a given station and present the listener with the best one; the technical named for this is frequency diversity.

The other aspect of equipment control is antennae. For individuals concerned with the tracking of celestial objects, pointing the antenna in azimuth and elevation is essential — professionals have been using computer-driven servos for years. Now, prosperous amateurs can think in the same terms. It should also be possible to control the tuning of an antenna from a micro. Antennae used for transmitting need to resonate precisely in sympathy with the radio frequency in use if they are to work at their most efficient — and if the transmitter is not to be damaged, for RF power which does not reach to the ether tends to re-appear as heat in the final stages of equipment.

It is normal practice to vary the electrical 'length' of an antenna by means of a passive tuning unit consisting of two capacitors and an inductance. This is done by hand these days; soon, direct output from a rig will send instructions to an antenna unit — probably placed in the air where it is most used — to tell it how to adjust itself. These developments are just around the corner:

- Using the micro to create an intelligent signal. Besides speech — or telephony, to use the proper name — other methods can be used to send information over the air. The oldest of the alternatives, and one which predated speech, is the encoded stopping and starting of a continuous radio wave — CW. The best-known form of encoding is, of course, Morse, and because of its simplicity and the ability of CW to 'get through' where other transmission modes would be unsuccessful, it is unlikely to disappear for many years.
- There is no need for Morse, which depends on short and long bursts, as well as properly-timed silences, to be generated by hand and one of the more attractive add-ons instantly available to the micro/radio enthusiast is automatic encoding and decoding of Morse.
- The hardware/software device does more than relieve the operator of the burden of learning Morse Code. The micro can generate and decode at speeds beyond the ability of a human operator. The applications for military/clandestine operations have been known for years, but for hams concerned with, say, meteor scatter, where a propagation path may last only a few seconds, a burst of high-speed Morse may be the only way to establish a worthwhile contact, so that both stations know enough about the other — location, type of equipment, power output — to make the exercise worthwhile.

The other frequently-used encoded transmission mode is a radio version of Teletype (RTTY) which uses a 5-bit code of pre-selected high and low tones to signify 'mark' and 'space' or binary 1 and binary 0, known as the Murray/Baudot Code. The 5-bit format is enough to give capitals, numerals and a few punctuation and instruction symbols, but lacks the versatility of ACSII.

On the other hand, in terms of transmission time, it is more economical. People have tried transmitting ASCII but the value for most applications is questionable. In addition to more dedicated RTTY terminals, one of which operates in Japanese as well as Morse, hard & software packages for a variety of micros are available for such popular

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models as Pet, TRS-80, KIM, Apple/ITT, and Nascom.

There are also micro-assisted devices to generate video for slow-scan television, particularly in association with the Apple/ITT computer. There are a number of experiments in other forms of data transmission, ultimately amounting to the sending, if need be, of computer programs over the air and getting micro to interface with micro by wireless.

Until the American regulatory authority, the FCC, is prepared to relax its restrictions, radio transmission of data — the concern is about encrypted signals which the National Security Agency may not be able to understand — progress in this area may be slow, because both the money and skills needed for expansion are concentrated heavily on the other side of the Atlantic.

Incorporating a micro into a radio station creates a number of difficulties, not all of which are obvious, so I will detail my experiences over the last month or so.

Office test

While most magazines in the business of reviewing expensive hardware or consumer durables would have you believe that their offices are lined with glowing banks of sophisticated measuring equipment and populated by the kind of white-coated, clipboard-clutching laboratory denizens who advise you about headache pills in TV advertisements, that is not always a reality at *Practical Computing*. Experts are available and so is appropriate measuring gear but some reviewers are consultants or enthusiasts not so far removed from readers.

I wanted to review a small piece of interfacing hardware which links a micro — in this case a Pet, but a TRS-80 variant is available — and a transceiver to provide automatic encoding/decoding of Morse and RTTY signals.

The device is the Macrotronics M-65 and it is available either as a kit or assembled, together with software on cassette, well-presented and with comprehensive documentation. The device works as it is intended to do, so what follows is not a product review in the ordinary sense of the term.

My first intention was to set up a receiving station at *Practical Computing* offices in a vain attempt to startle a staff who reckon that, by and large, they have seen most miracles. I arrived with a popular communications receiver covering the short wave bands from 0.5 to 30 MHz — up to 10 metres — known as the Yaesu Musen FRG-7. It had had some fairly standard modifications. There is a digital (A-D) readout, narrow-band filtering for side-band and CW signals, and discriminator for frequency modulation. To feed it with a signal, I erected a Datong active antenna, which while useless for transmission, is excellent for reception because of its short physical length and the lack of need to tune as the reception frequency is altered.

Connections simple

The electrical connections were simple. Mains power for receiver, transformed and rectified low voltage DC for the amplifier in the active antenna, and mains again for the Pet.

The M-65 derives its power from the second cassette interface port on the Pet and the I/O from the unit goes, as one might expect, to the user port. You need some phono connectors to link the receiver audio to the M-65, a connector for a small loudspeaker to check the audio captured by the unit prior to transforming it into a form acceptable to the Pet, and also to act as an audible 'side-tone oscillator' on transmit or for operation of the 'practice' facilities the software also offers.

Yet another connector gives an output for a LED which provides visible indication of reception/capture by flickering in time with the signal. There are also outputs for transmitting, for driving the relays on an electro-mechanical old-style teleprinter and, finally for a Morse key.

So, power up. A great hash of white noise on the receiver audio, and little else. In fact, tuning round the bands, only the most powerful of the broadcast stations, like BBC World Service, was audible. Could it be the neon strip lighting in the office? They were all turned off but the hash remained.

The antenna was taped to a window pointing towards north London; the building was old enough not to have a steel frame, so from where was the noise coming? Answer — the Pet.

Micros need high-speed oscillators to drive their clocks and such oscillators are radio frequency transmitters, operating usually on a number of harmonics as well as a fundamental. In addition, the VDU needs a time-base and you can hear that also, on a receiver. My antenna was all of one metre above the Pet.

Case asset

Radio Frequency Interference — RFI — is a serious problem for the micro/radio enthusiast. In later experiments I was able to tune my receiver around to pick up the various activities of the Pet. In fact, as I executed the usual clutch of commands, I could hear changes in the audio signal. These changes were not audible, as one might suspect, simply when a cassette program was being loaded; LIST and RUN produced characteristic changes in signal.

As it transpires, the Pet is not particularly bad in this respect; its great asset is a metal case which acts as screen. Plastic-cased and open-PCB micros are much worse.

RFI works both ways, for the presence of high-voltage RF signals from a radio transmitter can also upset the micro. Such problems can be solved. Antenna need to be removed from the micro and the feed lines have to be coaxial and well-screened — balanced upon feeders are a definite mistake. All power lines should contain the same kind of filtering recommended for hi-fi equipment used near a radio transmitter.

All audio lines between a micro and a transceiver should be screened, should be as short as possible, and preferably should contain RF traps of standard design, since it is only audio in which the M-65 and similar units are interested. As far as possible all units which either emit RF or could pick it up should be encased in metal. Those requirements are much less horrifying in practice than when set down baldly on paper.

Home solution

Abandoning the idea of Composite Signals Receiving Station (Temporary Location), I moved activity to my home.

Partial solutions to many of the problems indicated manifested themselves gradually, though in the special conditions of equipment review when the goodies have to be returned reasonably intact, perfection was not achieved. Moreover, as my receiver began to produce signals in the way to which I was accustomed and the possibility of having something for the micro to decode loomed on the horizon, another set of difficulties presented themselves.

Amateur radio gear differs from domestic receivers and that produced for military and diplomatic professionals by its multiplicity of knobs. The controls are there to enable you to peak-up various resonant circuits. The domestic receiver has none of them and the professionals have it all done for them almost automatically. Simply to peak-up my modest FRG-7 it is necessary to fix megahertz band, tune and perhaps fine-tune kilohertz knob, peak-up pre-selector, and select transmission mode.

Using a passive antenna, there are two further controls to peak-up its electrical length. After that, there may also be a degree of audio filtering to remove extraneous noise.

Most radio signals, other than very local ones, tend to vary and drift, depending on atmospheric conditions, the stability of the other person's transmitter, and the sudden appearance of third-source signals.

The M-65 will accept audio signals only of a specific frequency. It is necessary to do this so that the internal logic isn't confused with a multiplicity of noise. The audio is captured by a phase-locked loop (PLL). If there are to be any results at all the radio operator has to deliver the correct audio frequency by adjusting the tuning of his receiver. It would be feasible to design an automatic frequency control (AFC) circuit which would do this, but if there were two signals close to each other — a fairly frequent occurrence — the AFC might be confused and capture first one, and then the other. It is possible to adjust the acceptance frequency of the M-65 by playing with the PLL, but it is not recommended.

Valuable addition

The micro/receiver arrangement can be made to work, though by this stage it was significant that when I had seen the system demonstrated a few months earlier, all that was being decoded was a hand-key plugged directly into the M-65 board.

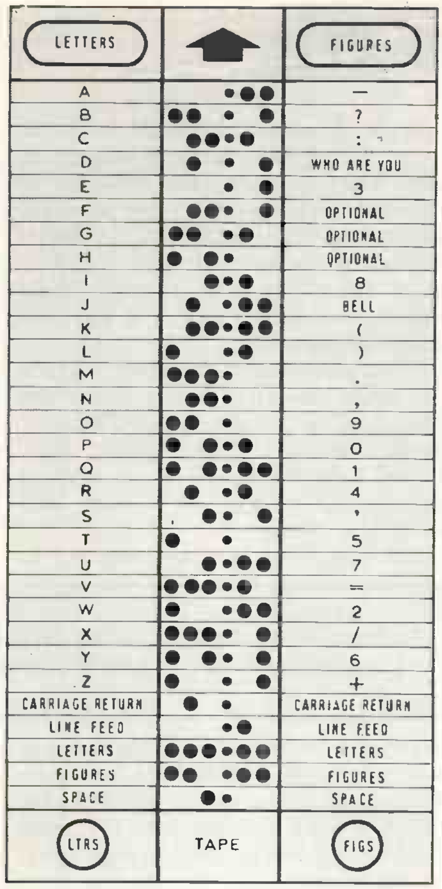
As supplied, the review sample fell far short of what I would like to set up on a permanent basis. No real blame can be attached to the supplier and my results convinced me that the system works and is a valuable addition to any station. But I would recommend purchasers to seal the board in a metal case, to locate the LED tuning indicator as close as possible to the receiver, and to replace all the leads with screened audio cable. An RF trap between the receiver and the board and the usual precautions on all power cables should decrease RFI considerably.

Because of RFI and ergonomic problems I found it more convenient to record samples of Morse and RTTY on tape — I listened to commercial as well as amateur traffic — and then fed them afterwards into the M-65 and Pet. The software will accept Morse at anything between one and 100 words per minute, though you have to fix the speed by keyboard command to within ± 10wpm, which is not difficult to gauge.

A dedicated Morse encoder/decoder, the Xiter, will track any speed of up to 150 wpm and display the speed as it does so. Most auto decoding devices respond badly to badly-sent Morse, as one might expect.

Encoding easy

Encoding Morse on the M-65 was easy; it is a matter of typing-in text on the micro keyboard. The current software has a forward buffer of only 10 characters, which means that typing and transmission can get out of step, with characters lost if you are not careful. In addition, a



International Telegraph Alphabet No. 2.

character is displayed only as it is sent, not when it is typed, so errors are not always easy to detect. There are 10 message stores, giving a maximum of 2,550 characters, so a good deal of routine information can be pre-prepared. The other side of the cassette gives RTTY. Typing 'live' in RTTY is much more difficult, because the ear cannot act as a check for the progress of the message in the same way.

In any case, the standard method of the old 'hardware' approach to RTTY is to pre-prepare a paper tape, as with Telex on the telephone lines. Thus in the RTTY mode, the message stores become essential.

A de luxe version, the M-650, soon to be available in the U.K., overcomes many of these objections. In effect, it splits the VDU into three areas to give a displayed transmit buffer, a displayed receive buffer, and an indication over two lines of what is being sent over the air.

There is also a Morse practice facility, which generates either random characters in groups of five, or five-letter words — ideal for preparing for the Post Office Morse test. It works with relentless efficiency.

Macrotonics Ham Interface, including software cassette and documentation

for 8K Pet	assembled & tested	£61.76
	kit	£47.92
for 16K & 32K Pet	assembled & tested	£67
	kit	£53
for TRS-80	assembled & tested	£82.52
	kit	£66.55

All prices include VAT and postage from Nicomtech, 212 St Stephens Road, Saltash, Cornwall PL12 4NL.

To become a radio amateur, a Home Office licence is required if you wish to transmit. The present cost is £6.40 pa and you need to have passed the Radio Amateurs' Examination, set by City and Guilds, which should present no problems to those of average intelligence and determination.

That gives you the right to transmit in a number of bands from VHF (144 MHz — 2 metres) through UHF to microwave in a variety of modes, including data, provided that the bandwidth used does not exceed that normally used for speech — about 3KHz.

If you wish to go to the short-wave bands a Morse test at 12 wpm is also required.

Oddities

There are special frequency allocations for amateurs. One of the oddities of the situation is that although Morse can now be generated and decoded automatically, a proper examination pass using a straight key is needed before you can put it on the air-waves.

Most amateurs at one time or another join the Radio Society of Great Britain (RSGB) 35 Doughty Street, London WC1N 2AE. The annual subscription, now £10, brings the monthly magazine *Radio Communication,* which has articles on micros from time to time.

Two American magazines worth watching are *Ham Radio* and, when it is obtainable, *73,* which is very micro-orientated.

The RSGB publishes a booklet *A Guide to Amateur Radio* — (£1.71 including postage from RSGB) — and many specialised texts. Its American counterpart, *ARRL,* has a particularly high standard of publication. Neither has yet produced anything on micros and radio.

There is, however, *Amateur Microcomputer Newsletter,* at the moment supplied free by a well-known amateur, Graham Knight GM8FXX, who is also a Nascom dealer. His address is 108 Rosemount Place, Aberdeen, Scotland.

Where to buy

At the time of writing the only dealer to specialise in micros and amateur applications is Nicomtech, run by Nigel Huntley, G4CDU, whose address is 212 St Stephens Road, Saltash, Cornwall.

A number of the big amateur radio dealers are opening micro departments, including Lowe of Matlock, Radio Shack of West Hampstead, and South Midland Communications of Southampton.

Data on the air

Richard Elen, G8RJX, looks at the possibilities available for MPU-based amateur radio data transmission.

AT LEAST two methods of data transmission have been available for many years. One is Morse code; the other, a somewhat later development, is Radio Teletype, usually abbreviated to RTTY. Both systems lend themselves very easily to microprocessor control and signal derivation; programs for both are written easily — particularly Morse. Alternatively, commercial programs can be purchased for most types of microcomputer systems.

FSK and AFSK and other methods of data transmission can be super-imposed on the radio frequency carrier in a number of ways. As these forms of modulation are, in general, common to all forms of data transmission, it is as well to look briefly at some of them.

The simplest mode of transmitting Morse code over a radio system is to switch on and off the RF carrier in the appropriate patterns. Thinking in digital terms, we could perhaps consider Morse 'dots' as a simple 1, and 'dashes' as 11; spaces between dots and dashes could be represented by 0 and spaces between letters could be seen as 00.

Straightforward

Thus the character '-·' could be sent as '00110100', including spaces at each end. In our simple interrupted carrier mode of operation, we consider the 0s as 'carrier off' and the 1s as 'carrier on' — very straightforward and incredibly simple.

As an alternative, we could have the carrier 'up' all the time and switch its frequency by a pre-determined amount. This is referred to as FSK or Frequency-shift Keying. If we think of the two frequencies as f_1 and f_2, with Morse we could send 0 as f_1 and 1s as f_2.

As an alternative, we could keep the carrier up all the time and impose an audio tone on it — via either frequency or amplitude modulation — and interrupt the tone to represent 0 and 1. This is satisfactory, except that it is subject to errors due to interference, which could confuse tone or the lack of it and thus reduce intelligibility.

A useful alternative, therefore, is to use two tones, one to represent 0 and the other 1. This is known as AFSK, or, sensibly enough, Audio Frequency-Shift Keying. Both FSK and AFSK are standard methods for sending both Morse and RTTY over the air.

The transceiver hardware required to interface a micro in either mode is one or two software-controlled tone generators and, on the receive side, a pair of audio-tuned circuits to pick out the tones received and convert them to logic pulses for decoding.

There are internationally-agreed amateur and commercial standards as regards the frequency shifts for FSK and the tones for AFSK. Amateur RTTY, interfaced originally, of course, with mechanical Teletype units, uses a number of standard baud rates — often slow in computer terms — to facilitate sync with the mechanical governors used in such machines.

The elegance of radio data transmission lies in the fact that the hardware needed to add to your computer and transceiver is minimal, leaving you to concentrate more on the exciting possibilities of software to derive the appropriate mode of transmission you want to use.

Thoughts of AFSK, of course, lead us to think about the fact the most of our microcomputers already provide an AFSK-type output — the cassette interface. Why not hook your computer to a transceiver via the cassette interface and type away — given an amateur licence? There is, of course, no reason why you should not. You could set up rather an elegant system whereby you type your message, enter SAVE, and then blast the message into the ether via an ordinary transceiver in any mode — AM or FM — you wish.

A little more software and you could route the keyboard straight to the interface and type vigorously in real-time. Going even further, you could control the system by storing the message temporarily in RAM, clocking it out in short data bursts, switching the transmitter on for the burst and 'resting' in receive mode between times.

That way, a station to which you are talking could 'break-in' or interrupt during the receive part of the cycle, activating the interrupt line on your MPU and bringing-in a secondary interrupt program to decode the message being returned to you. That would facilitate a very fast interchange of information — at least as fast as you could type. Very elegant.

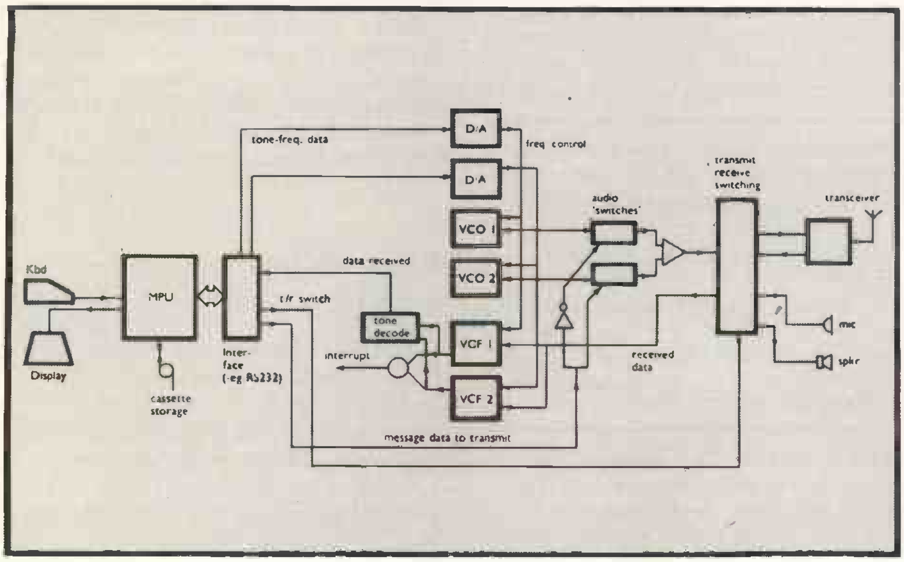
Language problem

There is a problem, though; very few micros talk the same language. Apart from the encoding of characters by your machine to be sent to the cassette port, there are so many standards for baud-rates, tone frequencies and so on, that while your Pet could talk to your friend's Pet, and my ITT2020 could talk to your Apple II, could your friend's SWTP 6800 system talk to my ITT2020? I doubt it. Not without a good deal of fiddling. What is needed is a real standard for this type of data transmission; either an existing one, which should be adopted universally — Kansas City, perhaps, or something else — or an entirely new one which does the job and which everyone can agree is satisfactory.

Another option is to use a suitable terminal interface system like RS232 and encode it with tones of an agreeable standard. The point is that, at present, there is no agreeable standard.

There is a standard being offered for amateur use but it is a little more complex than we have so far discussed. In the meantime, you can talk to people who have the same hardware as yourself. If

Figure 1. Block diagram of a multi-standard transceiver interface unit.



you feel more adventurous you could, no doubt, utilise a program and a bit of hardware which would load the message blocks into RAM, from whatever source you like, and clock them out, at a software-determined baud-rate, into an AFSK encode/decode unit containing a pair of software-controlled, voltage-controlled oscillators and audio filters whose frequencies are determined by the output of a D/A converter or two.

Add a bit of switching and level/impedence matching to cope with the possibility of switching a microphone and speaker into the system to talk direct, and a cassette recorder, if desired, to record messages for reference or store a standard CQ call or whatever for transmission, and away you go (see figure 1).

Normal contact

Contact can be established via the microphone in the normal way and you can then decide what standard — tone frequencies and baud rates — you will use. When a real standard AFSK interface arrives your box will have to convert your own micro standard to that used for transmission and you can dispense with the VCOs and DAs.

The problem with any system of this nature, before an agreed standard is introduced, is that you have to make the initial contact by telephone. That would be a severe disadvantage when trying to communicate over long distances or in difficult conditions.

This is particularly noticeable with 'interrupted carrier' Morse transmissions, known by amateurs as CW, an abbreviation for Continuous Wave. A CW signal is copied simply by beating the interrupted carrier with an oscillator in the receiver, called appropriately a BFO or Beat Frequency Oscillator, to produce a well-defined audio tone.

Contact is possible over very difficult paths in this manner because the operator has to listen for the pattern of audio dots, dashes and spaces. In the same way, a data transmission, consisting of a more complex digital pattern, will be recognised by your equipment far more readily than a variable signal like a voice. There may be the odd error but at least you will have something useful unless conditions are really disastrous.

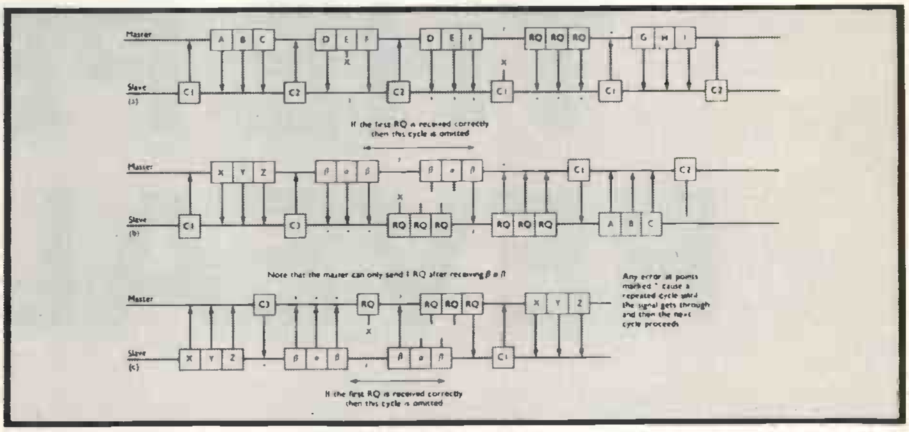


Figure 2. (a) Master sending to slave, with errors; (b) change-over from master to slave sending; (c) change-over from slave to master sending.

This leads the way to developing a beautifully-elegant transmission system in which blocks of data are sent and acknowledged if copied at the other end, or repeated if not.

Such a system had been proposed and is already in use by some amateurs. Called AMTOR — Amateur Microprocessor Transmission Over Radio — it has been developed from commercial systems based on CCIR Recommendation 476, by two amateurs, J P Martinez, G3PLX, and Dave Wicks, G3YYD. The former, who has already done pioneering work on MPU applications for RTTY, published a descriptive article in the August, 1979 issue of the RSGB magazine *Radio Communication.*

In brief, the system is based on a master/slave relationship between the stations in touch with each other. The master station sends three characters of message, after which the slave returns a control character corresponding to characters received or not received. A third control character is used during the change-over of master and slave at the end of an 'over', and a further three characters referred to as RQ — Repeat Request — Alpha and Beta are also utilised in error-correction and change-over.

The standard teleprinter codes and other characters are translated into a seven-bit digitial code with four 1s and three 0s, so an error is detected easily by checking the number of zeros in a character received. A seven-bit code, of course, offers 128 possible variations but as only 32 are recognised as characters, this offers further error-correction possibilities. There are 35 possible variations of a seven-bit code with three 0s and the three which are not teleprinter characters are used as the RQ, Alpha and Beta characters.

Table 1. Translation of CCIR 476 code to standard teleprinter characters. The codes are transmitted right-hand bit first, and logic 1 corresponds to the higher of the two radiated rf frequencies in the frequency-shift-keyed signal.

Amtor code	Letters	Figures	Amtor code	Letters	Figures
100 0111	A	—	100 1110	U	7
111 0010	B	?	011 1100	V	=
001 1101	C	:	010 0111	W	2
101 0011	D	wru	011 1010	X	/
101 0110	E	3	010 1011	Y	6
001 1011	F	%	110 0011	Z	+
011 0101	G		111 1000	carriage return	
110 1001	H	£	110 1100	line feed	
100 1101	I	8	101 1010	letter shift	
001 0111	J	bell	011 0110	figure shift	
001 1110	K	(	101 1100	space	
110 0101	L	)	110 1010	blank	
011 1001	M	.			
101 1001	N	,	110 0110	RQ	
111 0001	O	9	011 0011	beta	
010 1101	P	0	000 1111	alpha	
010 1110	Q	1			
101 0101	R	4	110 0101	Control 1	
100 1011	S	'	110 1010	Control 2	
111 0100	T	5	101 1001	Control 3	

Control signals

Control signals 1, 2 and 3 duplicate some of the teleprinter character codes but as controls are sent only in the reverse direction to the actual message, there is no possibility of confusing them.

Figure 2 shows an example of how these codes are utilised in practice while table 1 indicates the seven-bit codes used by AMTOR. G3PLX and G3YYD have used this system in the 144MHz band over a 200km path with 10dB gain antennae and 10W, and reckon that AMTOR has transformed contacts from being practicable on about 50 percent of attempts to 100 percent. The message speed slows below typing speed when conditions are very poor indeed.

Rair Black Box has many virtues

PROFESSIONAL is a term used all too frequently in the field of microcomputers. The Rair Black Box microcomputer has been around for about two years and one of its claims is that it is a professional system with good support. It was refreshing, therefore, to find that Rair in London took what appeared to be a responsible attitude, when I was asked to review it. Rair was the first supplier to suggest that I had a showroom demonstration of this equipment, to avoid any possible difficulty in the use of the computer when it was delivered.

Equipment

The Black Box is a complete diskette-based microcomputer system using the Intel 8085A running at 3MHz. It is configured with memory in 16Kbyte blocks. The version delivered had 64K of RAM.

The operating system supplied as standard has the *de facto* microcomputer standard disc system, CP/M.

Two minifloppy diskette drives (5¼in.) are built into the computer box. This is the minimum number of drives supplied but the system is capable of supporting up to four drives. The recording standard is the IBM soft-sectored format; the version for review had single-density recording of up to 80Kbytes storage capacity. Double-density recording format is available as an option.

In use

To start up, the Black Box requires the connection of a VDU and powering-on. In theory it should be as simple as that. The terminal delivered with the system was a Rair VDU — a Hazeltine 1410.

On connecting the cable and powering-on, not very much happened. The cursor on the screen remained in the top left-hand corner and that was all. Neither did the disc drives boot-up as shown in the demonstation. The Load button was depressed, drive A became alive, and a few meanlingless characters appeared on the screen. This suggested there might be a baud rate mismatch.

by Vincent Tseng

Remembering that the Black Box runs at 9,600 baud, which I was told in a letter sent with the review equipment, I thumbed through the Hazeltine VDU manual and found how to set up the baud rate.

Powering-on, the disc drives again remained inert but on Load that time, CP/M identified itself and displayed its prompt on the screen. All seemed well, but not completely. Typing on the keyboard produced nothing on the screen and no apparent reaction from the computer.

The RS232C cable was checked and pins 7 and 8 were found to be crossed — Data Carrier Detect was connected to Signal Ground. That was connected and the terminal could receive and transmit. On examining the cable, however, the system worked with pins 2 and 3 not crossed, which is contrary to convention — pin 2 from one end should connect to pin 3 at the other and vice versa.

Dependence

As the Hazeltine VDU had the conventional pinning, I can assume only that the Black Box either has unconventional pinning, on pins 2 & 3 only, which could be awkward when connecting a VDU if that is not apparent, or the version for test had a wiring mistake to the serial socket.

There was some difficulty delivering a review machine, and in the process it had no CP/M system disc. The other discs can be loaded under CP/M but lacked the various system utilities. That illustrates how dependent on discs the machine is, since there is no monitor to work without discs, and without a disc the system is silent.

A full CP/M system disc was sent quickly. A worthwhile note is the importance of copying and backing-up the CP/M system disc, in case of accidents.

Even with the CP/M system disc, the computer still did not load on powering-on, and throughout the test it was necessary to use the Load button to start the

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system. As there is supposed to be a power-re-set with an automatic boot load from disc drive. A the review equipment probably had a fault in the power-on-re-set circuitry, in the firmware bootstrap or in the re-start jump address to it. That did not affect the operation of the system it was not pursued.

CP/M operating system

To the user who does not wish to write machine code, a computer running CP/M is almost invisible, and the user deals directly with the operating system. I found that CP/M was easy to pick up, perhaps because it bore some resemblance the Digital Equipment mini systems with which I am familiar. The facilities offered were the proper ones for a disc-based computer, and although it may not be the best operating system in the world, it is certainly more than adequate.

One of the most useful facilities is the ability to create user's own command files by the use of Submit. The Dir — directory-command — was no more than adequate, since it gave only the names of the files on the disc concerned, with no other information. A better method to use would be "STAT *.*" which would give not only the file names but also the sizes and the amount of free space remaining.

Files have no particular attributes — they cannot be write-protected, or individually made "invisible", so that they are not listed-out on a directory command — useful for security of files — or declared as a system file, so that they are copied across automatically on formatting a new disc to be a system disc. Those may be minor points in a home environment but could be crucial for a business application.

The useful Submit command can have external parameters so that versatile user command files can be created. One of those tried was to be able to format a new disc and then copy all the files from the disc in drive A to drive B — a disc back-up command.

File extensions

Admittedly this was really trivial and to do it step by step using the already-available commands would not have taken much longer, but it was a useful exercise. The Submit command, however, did not seem to like a Format strung together with a PIP and it would not work. Using Format alone in a submit command, however, does work, which seems strange.

All file interchanges were via the PIP — Peripheral Interchange Program — command. PIP allowed versatile inter-connections, such as reading-in from an external device, so long as it is a device recognised in the CP/M repertoire — a paper tape reader or the console keyboard straight into a disc file; or from one device to another — the VDU keyboard on to a printer.

Vincent Tseng gets to grips with the Black Box.

In CP/M, files have an eight-letter name, with a three-letter extension which indicates the file type. For instance, all files created by a program in Basic will take the default extension 'BAS'.

File extensions are used to identify the file type for the various compilers supplied and for certain commands. Any extension could be tagged on to any type of file, since the file type was checked only on calling-up the file for use. The extension were also useful as reminders of the file type for the user.

Other CP/M facilities were a text editor "ED" which operated in a fairly basic way but included a string search command "F". There was no line-numbering in the editor. "DDT" is a Dynamic Debugging Technique, a powerful machine-code monitor which included single step and trace, automatic single step and trace to a pre-specified number of steps, and breakpoint setting. There is a single-line direct assembler or mnemonic entry of code, as well as a disassembler for mnemonic display of code in memory. "DDT" is useful for development of further system facilities, or for control programs where timing is important.

There were no line-editing facilities, other than on the current — unentered — line. Once a line is entered there are no facilities to recall the line and modify it, or to repeat the command.

Software

The Black Box claims extensive software support. Supplied with the test equipment were minifloppy discs with Fortran, Cobol and the expected Basic called MBasic.

The virtue of CP/M is that the machine can run any of the extensive CP/M software library, which now runs to 40 full diskettes. It is distributed by LP Enterprises of 313 Kingston Road, Ilford, Essex 1G1 1PJ.

MBasic is by Microsoft and has an edit command allowing editing by line number. Benchmark runs indicate that this Basic is the same speed class as the Research Machines 380-Z, and slightly faster than the Pet and Apple Extended Basic.

Fortran-80, again by Microsoft, is claimed to be to ANSI 1966 standard with a few extensions added. The compiler seems efficient in compilation time, taking about 22 seconds to compile a 30-line Fortran source, and in the process generated approximately 473 bytes of machine code.

The listings file was good; it gave the Fortran source line statement numbers, listed them and then listed directly underneath the statement concerned the mnemonics of the generated machine code. This type of listing is helpful when debugging a program using "DDT".

Linking loader

There is a linking loader program and a Fortran library for routines and functions. L80, the linking loader program, needed slightly more than one minute to link in the library to the above program, which had referenced 19 external calls to the library, and to load the executable code into memory. The memory image can be kept by using the "SAVE" command in the CP/M utilities, giving the saved file the extension of ".COM" for command, so that CP/M will recognise it as an executable file.

Cobol-80, by Microsoft again, is said to be to ANS-74 standards. It worked in a similar way to the Fortran compiler. A Cobol source file may be created using the CP/M text editor, be given the extension of ".COB", and then submitted for compilation.

Linking loader

The compiler had further overlays and needed approximately one minute to compile 55-lines of source code. Unlike the Fortran compiler, the listing file generated only added line numbers to the source code and there was no display of machine mnemonics, and any indication of program size or external routines referenced.

This type of listing is of little use, except for when there are compile time errors, but once the compile errors are eliminated, one may as well have hand-numbered the source statements. The linking loader is also called L80 and is identical to the one supplied with Fortran. It needed slightly more than one minute to link in the routines from the Cobol library and to load the executable code into memory, for a program with machine-code size of just less than 10Kbytes. Again, the code can be kept as a ".COM" file using the "SAVE" command.

Using the compilers revealed the limited capacity of minifloppy discs. For example, there was not enough room on a CP/M system diskette with all the standard utilities and for either of the compilers with its library files and the linking loader. It is therefore fussy to work with the compilers, since one has to change discs after editing or creating a file. Double-density recording format would probably be a better proposition for more serious use but even that at about 160Kbytes/drive, is only just adequate.

Documentation

Each of the software systems had its own manual. Both the compilers' manuals were brief and to the point and were useful for reference. The CP/M manual was again brief but good, and helpful for those who needed to learn how to use the system as well as being a reference manual.

The MBasic manual is similar but not so good as CP/M. There was no hardware manual supplied. Rair does not supply one usually. At least it could supply a trouble-shooting guide, which should list standard procedures to be tried in the event of problems. This could save time to both customers and Rair in solving some of the more minor problems, as well as giving the user more confidence. Omitted also was any setting-up and getting-started notes; for instance simple instructions on connecting peripherals, making sure that signals and baud rates match. Admittedly, Rair gives potential customers demonstrations at its London showrooms, which is to be applauded, but a note for future reference is always useful.

Hardware

Inside, the Black Box looked neat and tidy. There were only four cards in the 8-slot motherboard. The cards had 86 pins and were not to the S-100 bus standard. There were the CPU card with the 8085A and an 8257 DMA controller, a floppy disc drive controller card, a memory card with 64Kbytes of 4116 dynamic RAMs, and a communications interface card with two UARTs. There was no parallel I/O catered for and the option is not listed in the price list.

Conclusions

- **I liked the Black Box. It offers the proper kind of facilities for a small computer. The main criticism is the low capacity of the minifloppy discs — this is common for minifloppies recording on single-density format and not exceptional to Rair.**
- **All the software systems worked well and CP/M is a good choice as the operating system. The listing file of Cobol could be improved. I hope Rair will re-consider its policy regarding the supply of hardware manuals, or at least give a trouble-shooting guide as well as setting/connecting instructions.**
- **The responsible attitude to its equipment deserves praise. Rair was able to offer me four reference sales, as well as applications sold by other companies using the Black Box as the equipment, to support these claims.**

Practical Computing evaluation

	Yes/No NA	1	2	3	4	5
Ease of construction (where applicable)	N/A					
Quality of documentation					✓	
Dealer support/maintenance						✓
Can handle 32K of memory	YES					
Quality of video monitor (consider resolution and screen size)	N/A					
SS-50 Bus	NO					
S-100 Bus	NO					
Socket for chips	YES					
Numeric, calculator-type pad on keyboard	N/A					
Large amount of removable memory, randomly accessible	YES					
Cassette tape recorder capability: Own	NO					
Built-in recorder	NO					
Communications capability (can talk to other computers)	YES					
Speed of instruction cycle	3HZ					
Ease of expansion				✓		
Low power consumption	?					

	Yes/No N/A	1	2	3	4	5
Assembly language	YES					
Basic language	YES			✓		
Other languages	YES				✓	
Compatibility with other systems	NO					
Reputation of manufacturer					✓	
Appearance					✓	
Portability			✓			
No. of software applications packages available					✓	
Hobby use						✓
Business use					✓	
Educational use					✓	
Suitability for: Commercial applications					✓	
Home applications					✓	
Educational applications					✓	
Ability to add printer(s)	YES					
Ability to add discs	YES					
Ability to add other manufacturers' plug-in memory						

Ratings
1 = poor; 2 = fair; 3 = average; 4 = good; 5 = excellent.
N/A = not applicable.

Tecs the system if you want to be a pioneer

Last month we devoted space to Teletext and computing. At the moment there is only one, or almost, one machine capable of using the computing facilities offered by Teletext/viewdata. Martin Collins looks at the TECS system and finds some 'under construction' signs.

REVIEWING the Tecs system has proved a nostalgic experience. When we started looking at micro-based computer systems 18 months to two years ago we were more concerned with the potential of the system than its immediate capabilities. We expected the documentation then to be incomplete, the software to be a preliminary release — full of bugs — and some hardware capabilities to be "available shortly".

The challenging part of the review was to assess the capability of the system when it was fully developed, which was likely to be at least six months in the future.

Micro systems have grown-up quickly. We are not impressed now by sophisticated hardware and system software but look also for good documentation, application programs, and hardware and software support. The Tecs system we had for review seemed like the early micro systems because, despite it not being fully developed — and this is particularly true of the Software — it offers a very exciting new application in linking viewdata and Teletext with low-cost computing.

Tecs is "a micro-processor-based Teletex/viewdata recorder with powerful local computing facilities". The Tecs is two separate systems based on a common microprocessor:

- Teletext/viewdata receiver;
- A 6800 microcomputer.

The system is housed in a low cabinet similar to that used by the Sol computer. The keyboard, which follows the Post Office preferred layout, contains normal QWERTY keys together with a numeric pad and, optionally, the function keys required for editing data on Prestel. Taking the top off the box reveals two sets of boards; on the left-hand side are those required for interfacing to Teletext and viewdata and on the right-hand side are the 6800 processor, memory, and 1/0 controllers for the computer peripherals.

The system which we had for review had the following components on the left-hand side:

Modem, for interfacing via a Post Office telephone to Prestel. This uses the Datel 1200 service which gives 1,200 baud transmission from the Prestel system and 75 baud to it.

Teletext Reception Card/Teletext Display Board, used for displaying both Teletext and viewdata as they use common formats.

TV interface card, which outputs the display to a normal television set and allows software control of TV channel change.

On the right-hand side were the computer cards, plugged into a Tecs bus. The bottom slot was occupied by the proccessor card which contains the 6800, 4K RAM, an RS232 interface and 4K PROM. The next slot was occupied by the Prestel card which contained the modem interface and 1K PROM containing the software required for handling the Prestel data.

That left four spare slots which could be occupied by the following boards:

General purpose interface card which occupies two slots and provides: RS232 interface; floppy disc controller; Kansas City cassette interface; 4-bit audio interface; two parallel ports and 240-byte bootstrap in ROM.

Memory board which can hold 16, 22 or 48K RAM with 8K, PROM or 56K RAM.

That leaves one spare slot for further expansion.

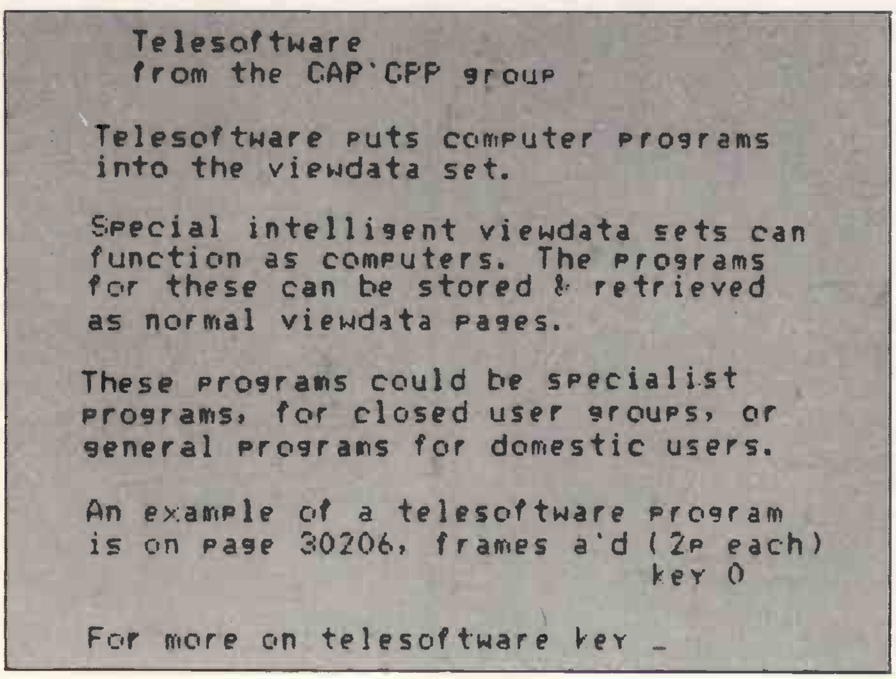
Technalogics chose the 6800 for the system because at the time when the original development was undertaken it was found to be faster than the 8080 for the Teletext software and the Z80 was too new and expensive to be considered as an alternative.

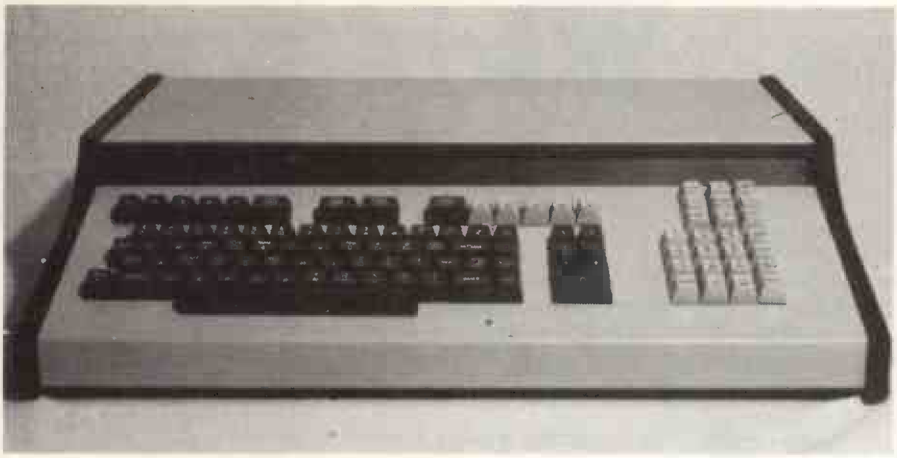
That limits the range of "standard" software available, as the 6800 has lagged behind the 8080 in popularity and therefore in available software.

The software now available is an editor/assembler and two versions of Basic, 3K and 8K. A special feature of both those versions of Basic is that they provide full Teletext colour display functions which allow 24 rows of characters, cursor control, six colours, double-height characters, 80 x 72 resolution graphics in black and white or colour, and any mixture of graphics and characters.

The 2K Basic is a "tiny" Basic with integer arithmetic and 26 variable names. The 8K Basic provides floating-point arithmetic and the normal range of functions. The only disc software available allows display pages to be saved and loaded. Technologics have not decided whether to adopt one of the standard 6800 operating systems or to develop its own.

The system also contains a monitor in PROM which can be used for machine-code programming; that, as is traditional on 6800 systems, is called TECBUG. Finally, the Teletext information is





TECS system box and keyboard. Also needed are a TV set, printer and, at some time, floppy discs.

displayed from 1K RAM which can be addressed by any program and this allows further processing of information extracted from Teletext or viewdata. Under development are Pascal, Microcobol and Pilot compilers.

The Tecs system obviously can be used either as a Teletext receiver or as a stand-alone computer system but its real potential must lie in combining those capabilities. It could therefore be used to prepare information to be entered into Prestel — that would interest people who supply information, known as Information Providers; store and process information extracted from Prestel/Teletext; run programs extracted from Prestel/Teletext. This is known as telesoftware.

Configurations and costs

The system is available as a kit or assembled. Some possible configurations are:

	Kit	Built
Teletext system with 3K Basic and 4K RAM	£895	£1,175
As above, with Monitor 8K Basic and 16K RAM	£1,335	£1,635
Teletext and viewdata system with 2K Basic and 4K RAM	£1,595	£1,995
With sample add-on costs as follows:		
32K RAM	£1,435	£1,735
General purpose interface card with 1 RS232C, 2 cassette ports 2 parallel ports, and Audio OUT	£130	£160
Floppy disc drive with controller card Software	£490	£500

Limitations

As an editing system for an IP the system has some limitations, for example, the lack of a comprehensive disc operating system, but as this is obviously the most important initial market for the system, Tecs is putting most of its software development effort into this area, and the deficiencies should soon be eliminated.

The second area of use, storing and processing information extracted from Prestel/Teletext, is a little more difficult to define. One important difference between the two services is that while Teletext is free, Prestel is not. Prestel charges are based on an amount per page displayed — this can be from ½p upwards and 15p is not uncommon plus the cost of a telephone call.

As anyone who has ever used a time-sharing system knows, it is very difficult to control those kind of charges — they mount at an alarming rate.

Information is located in the Prestel system by working through a series of directories until the detail required is reached. There is a charge for each directory page, so using the Tecs system to store the directory structure, or the identity of the detailed page, would reduce the costs of accessing the data. That would work only if you knew what you wanted to look at and if the information structure remained stable.

As far as storing information is concerned, the easiest way would be to attach a printer and print pages of information as required. Obviously only textual, as opposed to graphics, can be stored this way. The next step would be to store the information on a floppy disc for retrieval as required. To do this effectively, more comprehensive disc software than is available would be needed.

The Tecs system enables programs to access the 1K display buffer and therefore to process data extracted from Prestel/Teletext. One problem is that the pages of data are designed for visual presentation and so make use of the graphic display capabilities to maintain the user's interest. The format of the displayed information is unlikely to remain constant over a period and this will make it difficult to develop programs to extract and process the displayed data.

Standards

The concept of telesoftware — the ability to obtain programs from Prestel/Teletext and execute them in the receiver — is relatively new and at present there is no telesoftware avilable for the Tecs system.

At first sight, telesoftware seems to be a good idea. The distribution of programs via a widely-used information utility seems to be attractive, but it raises at least as many problems as it solves. In particular, it requires a widely-accepted set of standards covering programming languages, transmission formats and, most important as far as the potential user of the Tecs system is concerned, the characteristics of the receiving system. Those standards do not exist.

Conclusions

●It is interesting to compare the capabilities of Tecs, Prestel and Teletext with a new, lost-cost, time-sharing service called the Source, which was launched at the NCC in New York in June.

●The Source provides off-peak, low-cost ($2.75 per hour connect time) time-sharing. As well as programming in Basic, Fortran IV and Cobol, Source allows a user to access a wide variety of information, including the UPI data bank, entertainment and New York Stock Exchange information.

●The Post Office Prestel service clearly was designed for the dissemination of information in a visual form and telesoftware and the Tecs system are attempts to graft computer capabilities on to this.

●Because of their graphic and colour display capabilities, Prestel/Teletext are better at presenting visual information than the Source. On the other hand, the Source looks as if it will provide a much more effective blend of information service and computing.

●With the exception of the requirements of the IPs, there are no fully-developed ways of combining the Prestel/Teletext capabilities of the Tecs system with its computing power. There are obviously many ways in which they can be combined in the future and the Tecs system is an excellent basis for developing software to link the two areas.

●At present there are no other small systems which provide the same capabilities as the Tecs system. There is development work being done on a Prestel peripheral for the Apple but we have no information on when it will be available.

●In its present state Tecs offers access to Prestel and Teletext, together with reasonable basic computing capabilities. On the computing side the major outstanding problem is the lack of a disc operating system, which hopefully Tecs will resolve by adopting one of the available 6800 operating systems. If you want to become a pioneer in linking Prestel/viewdata with microcomputing, Tecs is the system for you.

Wide range ... for H...

MUCH microcomputer software is advertised by manufacturers and a number of microcomputers use the same processor. For example, the Cromemco sytems have Basic, Fortran and a Z-80 macro assembler on mini-floppies at £85 each. They should be sold only to owners of Cromemco computers, and it is a breach of copyright to transfer them to other machines.

Should you attempt to do this illegally, you would be unlikely to succeed. Cromemco uses either IBM-format 8in. floppy discs or 5¼in. soft-sectored floppies and though the latter are the same size as on the Horizon, North Star discs are hard-sectored.

The discs look the same, except that the hard-sectored floppies have a series of 10 holes near the centre which mark the beginning of each sector; and since the North Star Horizon reads and writes information to the discs by sectors, it cannot use soft-sectored discs — which store information in concentric rings on the disc.

An additional complication is that the newer disc control boards may store information on the disc in single-density, double-density, or even quadruple-density formats. So ensure that the software you buy is stored on the correct size of disc, with hard or soft sectoring as required, and written at the appropriate density.

All general-purpose computers, as opposed to dedicated microprocessors, require a program called the operating system to allow interaction between input device(s) — keyboard, disc, cassette, or paper tape reader; the central processor unit and memory; and the output device(s) — printer, cathode ray tube, disc, cassette, or paper tape punch.

Until the operating system is loaded into memory and the CPU is set to read the program, the computer cannot function. The Horizon computer is provided with the North Star Disc Operating System, which supports North Star Basic. While this is a good, robust operating system, it supports few other languages — Pascal is on the way — and relatively few software packages are available to run under this system.

The first step in implementing software from other manufacturers is to replace the operating system by CP/M, a Control Program for Microcomputers, which was written by Digital Research.

Becoming established

In much the same way as the S100 bus has become the *de facto* industry standard for hardware interfacing, CP/M is establishing itself as the standard operating system for microcomputers. A version of CP/M which has been adapted specially to run on any North Star disc system — the Horizon, or the Sol with North Star discs — costs £130 from The Byte Shop or $145 from Lifeboat Associates in the U.S.

CP/M is supplied on a diskette and Horizon users must remove the case from their computer and re-locate the memory before attempting to use the diskette. For example, a Horizon with 24K of memory running North Star Basic has its memory (RAM) starting at address 2000 hex (8K) and continuing up to 8000 hex (32K).

CP/M requires that the switches on the memory board(s) be changed so that the RAM starts at address 0 and continues to 24K. Once you have made this change, on flicking the bootstrap switch CP/M is read from diskette into memory. CP/M is divided into four main parts:

- the basic input output system (BIOS).
- the basic disc operating system (BDOS).
- the console command processor (CGP).
- the transient program area (TAP).

BIOS is machine-dependent and so it is essential that this part has been tailored for a Horizon with hard-sectored minifloppy discs in single- or double-density as required. A consequence of the modification for North Star is that though CP/M is supplied and labelled as a 16K program, it needs 4K more than the nominal size — 20K of memory on a Horizon.

BDOS manages one or more disc drives which contain independent file directories and provides for dynamic file construction with the minimum movement of the disc-heads across the disc. It can search for a named file, open or close the file, re-name it, or read or write information from or to it.

CCP allows the user to access various parts of the CP/M system by means of a set of built-in commands which list the file directory, type the contents of files, and save, re-name or erase files. The CCP also has a set of standard transient commands, which load and execute a named file which is part of the CP/M disc.

The working part of the memory used for these programs is called the transient program area. The fact that only the required parts of CP/M are held in memory at any given time is a simple and clever way of saving core. Supplied on the CP/M disc are the following standard transient programs:

John Lee wrote a user's eye view of the well-liked North Star Horizon microcomputer for our July issue. The Horizon does not stop short at the standard software offered with it by North Star. A wide range is now available from proprietary sources. Lee found several languages, systems, software text processing facilities and a range of applications software, including mailing lists, general ledger, accounts and database systems for storing and retrieving general information. Since most of these packages use the popular CP/M operating system, much of this will interest users of other computers too.

ASM — an 8080 assembler.
DDT — dynamic debugging tool.
DUMP — file dumping program.
ED — text editor.
LOAD — a hexadecimal loader.
NSYSGEN — produces a new disc copy of CP/M either from an existing disc copy or from the version of CP/M in memory.
NRELOC — used to change the size of CP/M to fit the available memory, i.e., to make the transient program area as large as possible. Remember that a 28K version of CP/M requires 32K on a Horizon.
STAT — assigns devices, gives statistical information about file storage, and reports the amount of free space on the disc.
PIP — copies, re-names and merges files.
SUBMIT — a batch mode utility.

In addition, CCP will load and execute any users' transient programs you have written or purchased. Examples of such users transient programs include Basic, Fortran, Cobol, word processing, accounts, data-bases and the like.

CP/M is undoubtedly a powerful and sophisticated operating system for micros. I have three minor criticisms. Firstly, it is a pity that the assembler has only 8080 mnemonics rather than the extended Z-80 set.

Reasonably powerful

Secondly, I found the editor reasonably powerful but it was a little difficult to get used to it. It works by having an imaginary line pointer, and a second imaginary character pointer which may be moved along a line. If it showed with a flashing cursor on a VDU it would be satisfactory, but without it, it is easy to get lost with two imaginary pointers. I prefer an editor which allows you to find the appropriate line and then exchange character strings.

Thirdly, I found the CP/M editor manual difficult to follow. It

is available
orizon

did not explain or clarify all my problems. It is well worth reading the manual for the Cromemco editor which explains the CP/M editor functions more fully. This manual can be obtained from LP Enterprises.

My version of CP/M — North Star, single-density, version 1.41 — appears to contain a bug. The transient program NRELOC was used to produce a 20K version of CP/M on my 24K Horizon. The version so produced claimed to be 20K but a check on the amount of free space indicated that it was only 3K bigger than the 16K version supplied. This proved to be disastrous to me, since I was trying to load CBASIC, which required a minimum of 20K. Lifeboat Associates proved to be friendly and helpful, and are working on it.

A powerful text processing program called TEX has been written by Digital Research to run under CP/M. It turns a Horizon with a Diablo printer into a sophisticated word processing machine for standard letters, reports or books.

Text is split automatically into pages of any specified size. They are numbered and may carry a heading. Paragraphs may be indented optionally and the spacing of a line may be adjusted to right-justify the lines. The various commands are inserted into the text file using the editor before running TEX. The cost is £55 from The Byte Shop ($85 from the States).

Minor criticisms of TEX are that you are obliged to number pages at the bottom rather than having the option of top or bottom; and you cannot print two columns of text on a page without using scissors and glue.

For word processing

The Electric Pencil is a word processing package and is produced by Michael Schrayer Software Inc in the U.S. at prices up to £300, depending on the computer and the printer used. It is debatably the best word processing system for microcomputers because it runs interactively. It will left- and right-justify typed lines, handle any paper size required, indent paragraphs, and number pages, as do a number of other word processors.

Unfortunately, there is a catch — money. You need a memory-mapped VDU board. Two which display 24 lines of 80 characters are the Imsai VIOC board at $465 and Flash Rider II at $320. The Processor Technology VM1 board, which displays 16 lines of 64 characters, is less expensive, and though it may still be available it is no longer being produced. A Diablo printer costs more than £2,000. This system is superb but it beyond the reach of hobbyists.

Digital Research also has an 8080 macro assembler, MAC. It includes the Z-80 library; it produces absolute hexadecimal output and a symbols file which may be used by another program, SID. That debugs and provides a symbolic display of memory labels and equated values. MAC and SID cost £65 and £55 respectively from The Byte Shop — $100 and $85 direct from the U.S.

Another well-known U.S. software house, Microsoft, offers an interesting range of software for the Horizon. A new version of its Disc Extended Basic is claimed to be compatible with the minimal ANSI specification — earlier versions were not — and costs $300.

The Fortran-80 compiler produces re-locatable object modules. A standard library of subroutines is supplied and you may also add your own. The compiler requires 24K plus the space for CP/M and provides all the features in the 1966 ANSI standard except for COMPLEX.

Microsoft also markets Cobol-80. It is based on the 1974 ANSI standard and contains all Level 1 features from the ANSI 1974 specification plus some Level 2 facilities. Cobol-80 consists of two parts, a compiler which produces re-locatable object code and a run-time system for interpreting the object code at execution time. The two occupy about 25K bytes, plus about 7K for CP/M plus about 12K for a 500-line program and the extra 4K needed by CP/M, giving a total of 48K. The price is £521 from Xitan in this country or $625 from the U.S.

MACRO-80 is an assembler which dials with 8080 and Z-80 mnemonics. It produces re-locatable linkable output and together with utilities such as a loader, a cross-reference list and a library manager, costs $149. Another version called MACRO-80 PLUS includes the Fortran library and costs $219.

Xitan Disc Basic occupies 16K of memory and is a fast and powerful interactive interpreter which can open a large number of files dynamically for either serial or random input/output. It also has passwords for security. The price from Xitan in Southampton is £121 — $159 from the U.S.

Super Basic occupies 12K and is a subset, but it does not have random access to files, and costs £76 or $99 from the same sources. Xitan also markets ASM, a macro assembler designed for the 8080 but with Z-80 extensions (£53 or $69); the Linker link-loader handles ASM modules for £53. Z-Bug is a debugger at £68 or $69.

Text editor

Xitan also sells Z-TEL, a text editor £53 or $69. A text output processor called TOP, which creates page-numbered, right-justified documents from a source text file, is available only as part of a package: Z-TEL, TOP, ASM and Super Basic for £189, or Disc Basic, Z-TEL, TOP, ASM, Z-BUG and Linker for £311.

The Xitan Fortran IV sells for £286 in this country, which is cheaper than Microsoft Fortran-80.

Software Systems Commercial Basic (CBasic) is sold for £76 by Xitan in Southampton or $95 from the U.S. It is a disc-extended Basic compiler which works to 14 digits in binary-coded decimal format, thus providing very high accuracy. It will operate in an CP/M system of 20K or more.

From Micropro there are three packages to sort, merge or extract fixed- or variable-length records written in binary, BCD, packed decimal, ASCII or EBCDIC. They are sold as Super Sort 1, 2 and 3 at $250, $200 and $150 respectively.

Micropro also has the Word Master text editor for $150. It works in either of two modes. The first uses a super set of the CP/M ED commands, allowing global searching and replacement either forwards or backwards in file. The second is video mode and provides a full screen editor for users with a serial addressable-cursor VDU.

CORRESPONDER is a mailing list system which can generate letters and can sort and extract customers by names or addresses. It costs $95 and requires Software Systems CBASIC.

ISAM is a useful-sounding system with triple-level index filing which meets the full ANSI level II Cobol capability; it costs $145.

The American software house, Structured Systems Group, offers four programs — General Ledger for $995, Accounts receivable for $750, NAD (a name and address selection system) for $79, and QSORT (fast sort/merge) at $95. All four require CBasic.

WHATSIT is a very interesting interactive base data system which retrieves information by subject. It requires CBasic and costs $125. The Byte Shop offers a base data enquiry system also called WHATSIT; it works on a standard Horizon computer with North Star DOS and costs £45.

SOURCE is an 8080 or Z-80 disassembler which converts a binary disc file into mnemonics which may be used with MAC or their Xitan ASM assembler. It costs $70.

ZASM is a disc-based assembler for mnemonic Z-80 which creates output in absolute hex addresses and costs £45.

Several business programs are available from The Byte Shop. Among them are INVENTORY-1, a stock control program for retailers; up to 1,000 lines may be stored. The package keeps track of items running low, slow-moving items, profitable lines. It costs £85.

Solving printing problem for Cromemco users

ALL COMPUTER USERS at some time will want a printout capability. For those with a Cromemco Z2-D but not fortunate enough to have a parallel printer, printouts will prove something of a problem.

There are now many relatively cheap serial printers on the market. They can be used with the Z2-D by making a few minor changes to CDOS, leaving all its intrinsic commands unaltered; more important, this can be done without hardware changes.

To add any type of printer to an existing Z2-D system with, say, a disc driver board, 32KB of memory and a processor board, an I/O port, will have to be added. This can be done easily by adding a TUART board to the system. The Cromemco board has two universal asynchronous receiver transmitters, hence the acronym.

by Andy Mead

This article shows how users of a Cromemco Z2-D system can use a serial instead of a parallel printer for printouts of programs and results. The hardware required is the same. The only changes are to the software printer driver in the Cromemco Disc Operation System (CDOS). All the intrinsic commands of CDOS and those of other Cromemco software packages remain unaltered.

Each UART has a serial and parallel I/O port. CDOS uses one of the UARTs set at a base address of 50 hex to communicate via the parallel port to a parallel printer. By modifying CDOS, the serial port of that UART can be used to provide printouts. The remaining UART on the TUART board can be set to some convenient base address, which does not clash with any of the I/O ports present in the system. I assumed a value of 60 hex, since this is an easy value to remember.

Figure 1. Original CDOS jump table

```
0000" C3EE71#      0021 WBOOT:  JP     SYBAT    ;WARM START
0003" C3517C"      0022 CSTAT:  JP     COSTAT   ;CONSOLE STATUS
0006" C3597C"      0023 CIN:    JP     CONCIN   ;CONSOLE INPUT
0009" C36E7C"      0024 COUT:   JP     CONOUT   ;CONSOLE OUTPUT
000C" C3A17C"      0025 LOUT:   JP     PLPOUT   ;PARALLEL LINE PRINTER DRIVER
000F" C3C17C"      0026 POUT:   JP     PUNCOUT  ;PUNCH OUTPUT
0012" C3CC7C"      0027 RIN:    JP     PUNIN    ;TAPE READER INPUT
                   0028 ;
                   0029 ; DISK HANDLERS FOLLOW
                   0030 ;
                   0035 ;
0027" C3EE71#      0036 RBOOT:  JP     SYWBAT   ;REEBOOT
002A" C3B97C"      0037 LSTAT:  JP     PLPSTAT  ;PARALLEL PRINTER STATUS
002D" C38B7C"      0038 CSET:   JP     CONSET   ;CONSOLE X,Y ADDRESS SET
                   0039 ;
                   0040 ; END OF JUMP TABLE
                   0041 ;
```

Two features of the TUART board must be taken into account by any changes made to CDOS when incorporating a serial printer into the Z2-D system:

- serial baud rate selection by software;
- base address-swapping between UARTS by software.

The second facility can be disabled by one of the switches on the TUART board. If the sway facility is not disabled, the addresses of the two UARTs can be reversed when the system is turned-on. That can give the unwary many headaches if not spotted quickly!

When any computer communicates with its user, it does so via a driver routine. CDOS is no exception. To add a serial line printer, the parallel printer driver routine in CDOS should be replaced by a serial routine.

Swap facility

The baud rate and the swap facility of the TUART must be included in the changes to CDOS. Since we only need to execute those once, they can be included in the initialising routine of CDOS.

Baud rate	Open-stop bit	Two-stop bit
100	81	01
150	82	02
300	84	04
1,200	88	08
2,400	90	10
4,800	A0	20
9,600	C0	40

Figure 2. The baud rate byte for TUART.

CDOS uses a jump table to find the routines it needs to communicate with the outside world. A jump table is a list of jump instructions which tells the computer where to find a particular routine. The original jump table used by CDOS is shown in figure 1. Following the jump table is the CDOS initialising routine INIT, which sets up all the I/O ports used by the Z2-D.

We then have all the information necessary to make the changes to CDOS. The first thing to be done is to set the addressing mode of the TUART to the normal state, followed by the baud rate of the serial port. Those additions can be done using the DEBUG program with most Cromemco software packages.

Additions

Normal addressing mode is selected by outputing Ohex to the parallel port with based address 60 hex. The baud rate of the serial port is selected by outputting one of the bytes corresponding to the baud rate,

```
                    0001 ;
                    0002 ; MODIFIED CDOS INITALISATION ROUTINE
                    0003 ; ADDRESSING SHOWN FOR DEBUG
                    0004 ;
13B3  F3            0005 INNEW1: DI                  ;DISABLE INTERRUPTS
13B4  3E00          0006         LD      A,00        ;SET TUART NORMAL ADDRESS MODE
13B6  D364          0007         OUT     64H,A
13B8  3E01          0008 INOLD:  LD      A,01        ;ORIGINAL CDOS INIT ROUTINE
13BA  D340          0009         OUT     40H,A
13BC  AF            0010         XOR     A,A
13BD  D303          0011         OUT     03,A
13BF  0E52          0012         LD      C,52H
13C1  3E09          0013         LD      A,09
13C3  ED79          0014         OUT     (C),A
13C5  D322          0015         OUT     22H,A
13C7  0C            0016         INC     C
13C8  97            0017         SUB     A,A
13C9  ED79          0018         OUT     (C),A
13CB  D323          0019         OUT     23H,A
13CD  3E0F          0020         LD      A,0FH
13CF  81            0021         ADD     A,C
13D0  4F            0022         LD      C,A
13D1  30EE          0023         JR      NC,13C1H         ;END OF INIT ROUTINE
                    0024 ;       REMAINING MODIFICATION
13D3  3E88          0025 INNEW2: LD      A,88H       ;BAUD RATE OF SERIAL PORT
13D5  D350          0026         OUT     50H,A       ;OUTPUT TO PORT 50HEX
13D7  C9            0027         RET
                    0028 ;
13D8  (13B3)        0029         END
```

Figure 3. Modifications to the CDOS initalisation routine.

```
0000" C3EE71#    0021 WBOOT:  JP    SYBAT    ;WARM START
0003" C3717C"    0022 CSTAT:  JP    COSTAT   ;CONSOLE STATUS
0006" C3797C"    0023 CIN:    JP    CONCIN   ;CONSOLE INPUT
0009" C38E7C"    0024 COUT:   JP    CONOUT   ;CONSOLE OUTPUT
000C" C3587C"    0025 LOUT:   JP    SLPOUT   ;SERIAL LINE PRINTER DRIVER
000F" C3C17C"    0026 POUT:   JP    PUNOUT   ;PUNCH OUTPUT
0012" C3CC7C"    0027 RIN:    JP    PUNIN    ;TAPE READER INPUT
                 0028 ;
                 0029 ; DISK HANDLERS FOLLOW
                 0030 ;
                 0035 ;
0027" C3EE71#    0036 RBOOT:  JP    SYWBAT   ;REEBOOT
002A" C3577C"    0037 LSTAT:  JP    SLPRET   ;SERIAL PRINTER RETURN
002D" C3AB7C"    0038 CSET:   JP    CONSET   ;CONSOLE X,Y ADDRESS SET
                 0039 ;
                 0040 ; END OF JUMP TABLE
                 0041 ;
```

Figure 4. New CDOS jump table

shown in figure 2, to the serial port with base address 0. Those additions to the initialising routine, together with that routine, are shown in figure 3.

When making the additions to CDOS, all the routines below INIT should be moved down over the parallel driver routine, leaving INIT and the routines below the paper punch output routine unaltered. That, of course, means that some of the entries to the jump table will be altered. The new entries are shown in figure 4.

The serial output routine (figure 5) starts by SAYing the accumulator, which contains the character to be printed, on the stacks. That protects the character from the following loop, which tests the status port of the UART to see if a character may be printed. When the program branches-out of the loop, the printable character is transferred back from the stack to the accumulator, and then output to the printer via the output serial port.

The printed character undergoes a further test after it has been printed, to check whether it was a line feed. If not, the printing routine makes a return; if a line feed has been issued, the printer routine enters a simple count-down delay loop. A null is printed on the console device for every pass round the loop.

That loop allows a mechanical printer the time to perform a carriage return and line feed. The timing of the loop can be tailored to the particular printer used. For figure 5, the printer used is the Axiom EX-800; the delay gives a comfortable printout rate of 1,200 baud. The long delay is needed because the printer does not output any characters until it receives a carriage return/line feed pair. For faster printers the delay can be reduced or even omitted.

It works

The new jump table contains the entry points for the new line printer driver, as would be expected. Since the old table had a line printer status called, the new one has to retain that call. The status was asked for by the old CDOS routine to check the position of the parallel printer during its printing operation; as that is taken care of by the new line printer driver, the entry in the jump table is a reference to a RETURN instruction.

Does the altered CDOS work? The answer is yes, once the modified version of CDOS has been transferred by a WRSTSYS operation to the boot blocks of the disc. This article is confirmation that it works; it was written using Cromemco word processing software and printed-out using a serial printer. ■

Figure 5. Serial line printer driver routine.

```
                 0001 ;
                 0002 ; CDOS SERIAL LINE PRINTER ROUTINE
                 0003 ; ADDRESSING SHOWN FOR DEBUG
                 0004 ;
13D8' F5         0005         PUSH   AF       ;SAVE CHARACTER &FLAGS
13D9' DB50       0006 OUTP:   IN     A,50H    ;GET OUTPUT STATUS
13DB' E680       0007         AND    80H      ;READY TO PRINT?
13DD' 28FA       0008         JR     Z,OUTP   ;WAIT FOR OUTPUT
13DF' F1         0009         POP    AF       ;RESTORE CHARACTER TO A
13E0' D351       0010         OUT    51H,A    ;PRINT IT
13E2' FE0A       0014         CP     A,0AH    ;LINE FEED?
13E4' C0         0015         RET    NZ       ;RETURN IF NOT
13E5' C5         0016         PUSH   BC       ;SAVE B & C
13E6' 0628       0017         LD     B,28H    ;DELAY COUNT
13E8' 3E00       0018 DELAY:  LD     A,0      ;ASCII NULL CHARACTER
13EA' CD097C     0019         CALL   7C09H    ;PRINT CONTENTS OF A
13ED' 10F9       0020         DJNZ   DELAY    ;LOOP UNTIL  B=0
13EF' C1         0021         POP    BC       ;RESTORE B & C
13F0' C9         0022         RET             ;FINISH PRINTING
                 0023 ;
13F1' (13D8)     0024         END
```

Lessons in teaching computers to learn

Mark Witowski, a researcher in Artificial Intelligence, looks at Perceptrons and the problems of making machines learn.

ARTIFICIAL INTELLIGENCE is a wide-ranging subject, involving problem solving, game playing, pattern recognition, theorem proving, automatic program writing, semantic information processing, robotics and learning. All are attempts, some successful, some not so sucessful, to mechanise human thought processes. Of these, the last, learning, is still clouded in too much mystery.

It has been long known that animals and people understand and do things better with experience and that the improvement is related directly to the amount and type of the experience they gain. It seems strange, therefore, that so little attempt is being made to apply the same ideas to computerising, that man-made source of excessive information processing power.

In fact, research goes on all the time and many techniques for computer learning are known, even though the programmer is faced with another level of abstraction above the problem the computer is set.

Great potential

A few examples of learning algorithms are presented, more to show how and what because the "why" is easy, it shows great potential for improved data processing and it stimulates the grey matter. Given the state of the art, a discussion of the social implications of computer learning would be premature but for those interested in very low-grade prediction, science fiction has volumes to say on the subject.

Rote learning is a technique in which some information is stored in a memory, computer or brain, and then recalled verbatim later. Most schools teach multiplication tables in this way. A poem must be learned by heart and repeated word for word. The storing of a byte in random access memory of a computer can be described as rote learning. Data files fall into the same category; one section of code will store some information in a prescribed place and another will recall it.

A practical example of the technique is the 'teach' mode in an industrial robot. A manipulator is required to carry-out repeatedly a sequence of actions with extreme regularity and monotonous accuracy. Before it can do so, it must be told what actions to perform.

One could instruct it by writing a program in machine code, Fortran or one of the languages developed specially for numerically-controlled machines but this is a remarkably time-consuming chore. More often a skilled worker 'leads' the machine once through the task, using a joystick or hand control to 'teach' it the key positions to which it must go and the actions it must perform.

With this set of co-ordinates in the memory of the controlling computers, the robot will cycle through the sequence in a mindless way, sometimes not stopping if the work fails to be fed to it properly.

Adaption or parameter learning represents the next step up in the ladder. In this case, the overall structure of the problem has been solved already and only the final details remain to be worked-out. One major success of adaptive learning machines has been in pattern recognisers and classifiers. The program will be expected to name a pattern when shown, such as a handwritten letter of the alphabet (figure 1), out of a whole class of possible patterns, such as all the letters of the alphabet.

One trains it by showing the machine several samples of each letter. If it misrecognises the letter, a part of the algorithm is called which adjusts internal parameters so that it will do better next time. After a number of attempts, the parameters are well tuned and it almost always recognises the pattern.

Figure 1. Some examples of handwritten 'A's and some NOT('A')s.

Rosenblatt's Perceptron is one of the better-known mechanisms of this type. It dates from the early '60s and was intended to model the idea of a neural-net brain mechanism, with neurones and synapses, inhibitory and excitatory connections and synapse facilitation.

Figure 2 shows a pictorial representation of the structure of a perceptron to classify visual stimuli. In theory, it could be used to predict the weather or any other situation where there are examples giving a well-defined state.

Connected to the retina — typically 20 by 20 points — would be a number of association-units (A-Units). Each A-Unit would be linked to a small number of retinal points by some excitatory links which would add something to the A-Units if that point was stimulated and some inhibitory links.

Weighting factor

For any given pattern, each A-Unit would either output a 1 if more excitatory points were activated than inhibitory, otherwise zero. Each of these outputs is then multiplied by a weighting factor and all the results are fed into a summation unit which, as its name suggests, adds all the values.

If the result is negative the pattern did not belong to the target class; if positive, it did. There will be one set of weights and summation unit for each pattern class. If the operator disagreed with the machine's classification, the values of the weights which contributed to the incorrect classification would have to be modified. This 'training' algorithm is very simple.

The perceptron is surprisingly effective with position invariant data and is very tolerant of noise in the image. It will discriminate a hand-written capital letter from the set A, B, C, D, E, F, G and H with about 95 percent accuracy, after being trained with 10 examples of each.

Interesting as the perceptron is, both as a trainable adaptive learning machine and as a brain model, its popularity waned considerably after a series of essays in the late '60s on computation by Minsky and Papert, of the Massachusetts Institute of Technology, in which it received some heavy, if somewhat unjustified criticism.

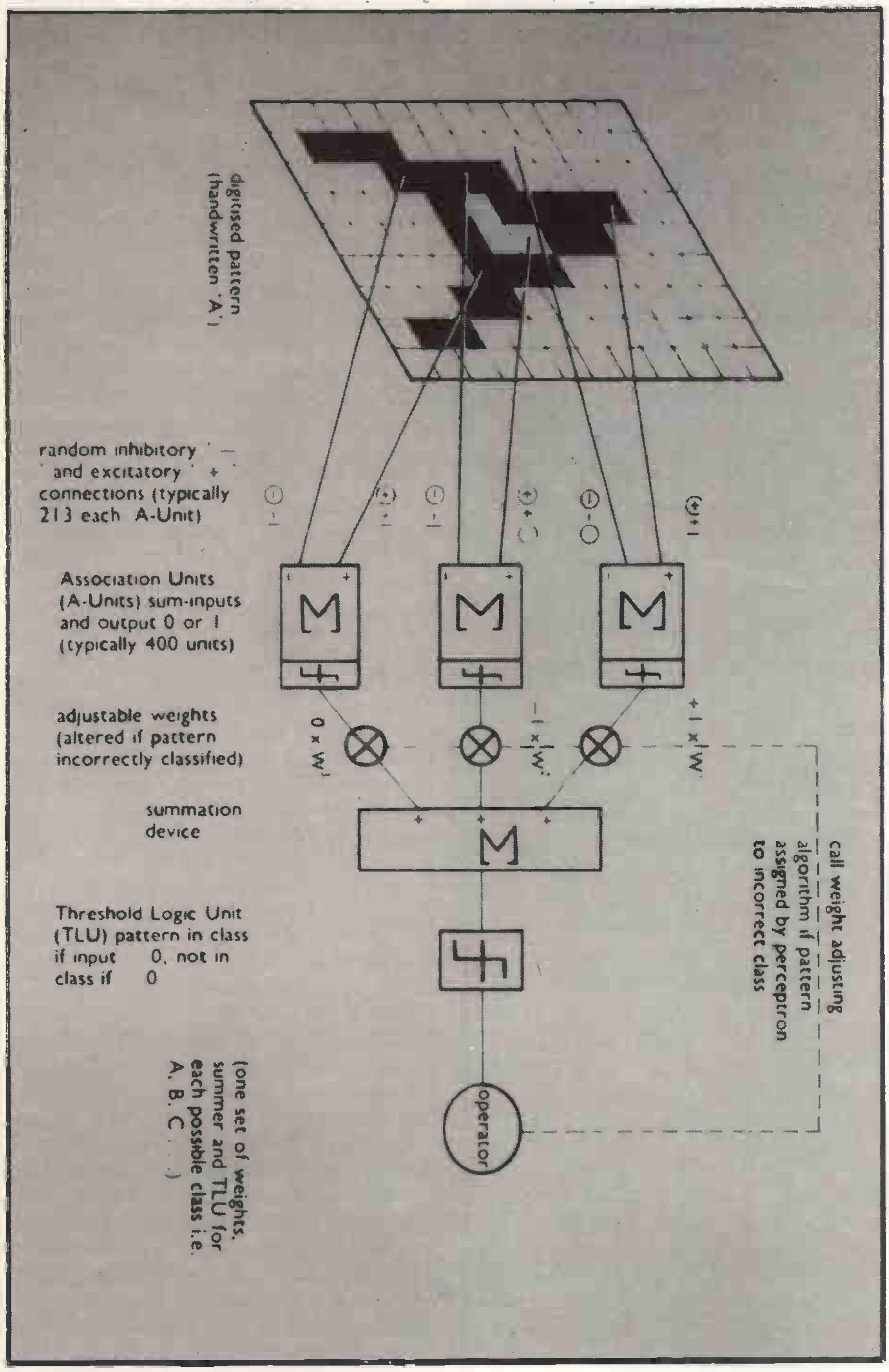
The theory and practice of the technique, however, are still valid; non-parametric training machines and their descendants live on. They are found not so much in visual pattern recognition but in speech recognisers. Because each speaker's voice is sufficiently different from every other's that it is almost impossible to analyse the waveforms, each speaker is asked to say each of the words in the vocabulary to be used several times before using the machine. This turns out to be a quick, convenient and satisfactory idea, giving good recognition rates in almost all cases, with minimal extra programmer effort.

Interest next passed to more formalised programs in which descriptions are matched and the differences used to generate more accurate descriptions. Patrick Winston of MIT made his name with a 'concept' learning program. He input to his program descriptions of simple structures made from blocks.

After being shown a number of examples, some of which are the structure and some of which are 'near-misses', the program would augment its internal description of the scene with notes to tell it whether something must or must not be present, to allow any input description to be a member of the class. Figure 3 shows a very simple example.

The program is being taught what a 'tower' is — a cylinder with a cone on top. The teacher shows it one example and then a near miss. Each generates an internal description, which shows each object and its relationship to all the others — above, below, supported-by.

Figure 2. Basic Perceptron mechanism.



Every time a new example, or a near miss, is presented to the program a set of differences between the old description and the new is produced. If it is a new example, one of nine possible actions stored in a table is applicable, two of which represent contradictions with previous examples.

A near-miss case means that the description must be updated with one of 10 possible actions, depending on the nature of the observed difference, usually by adding a 'MUST-BE' or 'MUST-NOT-BE' node to the model. Figure 4 shows the description after a few more attempts.

While this program demonstrates a point about learning concepts, it has its weaknesses — and other strengths to which this all-too-brief description fails to do justice; it still requires a trainer or teacher. If it is to work well the algorithm should be shown an example first and near misses should have only a single difference from the hit. Paradoxically, it's strongest failing is in the excessive power of its descriptive ability.

Winston could argue that this has to be the case for effective learning. But this holds true only if the pupil and teacher are interested only in towers and houses and arches and other constructions of toy blocks.

Descriptions

As soon as discussion moves to all primitive descriptions, such as 'MUST-BE-SUPPORTED-BY', 'MUST-NOT-TOUCH', the previous descriptions would be inappropriate and of very little use. We can then argue that a learning program must either have a large number of powerful descriptive tools at its disposal, or we search for some weaker but more generally-applicable descriptions about the world. They will then be combined to form the wide range of descriptions needed.

In all learning systems discussed so far a human provided the motivation and the correct examples the program required and generally guided things along. Young children learn, partly by being taught, but also by observing the world as it passes

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them by, and more so by playing with it, pulling an object apart, dropping it, and by general experimentation and investigation.

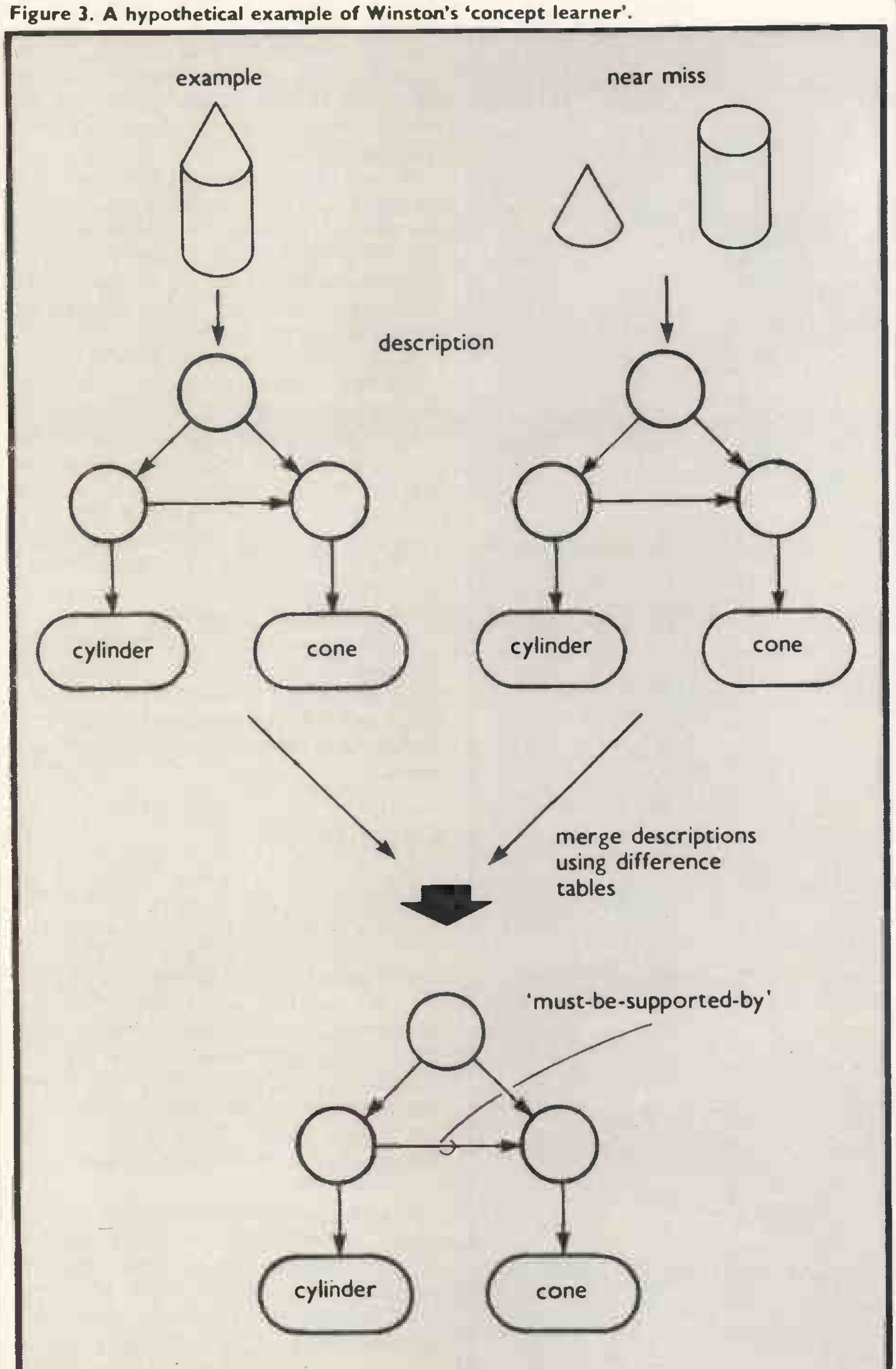
Learning by discovery; such power; a program with curiosity; what a curiosity. No longer can a learning algorithm stay in isolation. Now the computer must be able to perceive its environment.

It must be able to move around and discover the effects of doing. It must behave as well as sense and learn; it can no longer be a passive heap of electronics upon which information is deposited and from which ASCII flows.

Laboratory robots provide the right kind of peripheral for this task. Laboratory robots differ from their industrial counterparts in several ways. They are usually smaller and physically less powerful, but with more sophisticated computers to control them. They must also carry a great many sensors; they will provide the information, the learning, or any other control algorithm will use to make deductions and correct its actions in the world.

Learning programs show enormous potential in the field of robot control. The less you can rely on mechanical accuracy the more the emphasis shifts to using sensory information. A robot's view of the world is egocentric about its own sensory data, which for a typical robot, if there is such a thing, is different from our own.

Figure 3. A hypothetical example of Winston's 'concept learner'.



Theorem prover

A number of robot projects involve all the essential human ingredients. One is SHAKEY, the product of a Stanford Research Institute team. Its 'intellect' was provided by a predicate calculus theorem prover called STRIPS, in which information about the world in which the robot must operate is stored as 'well-formed formulas' (wffs).

For instance, CONNECTSROOMS (D1, R1, R2) tells the system that door 1 connects room 1 with room 2. Robot action routines, such as GOTHRU (D1, R1, R2) would cause the robot to go from room 1 to room 2. The power of these constructs is not from the ability to execute them directly as commands but by being able to plan routes and complex actions using them.

Each action, like GOTHRU, has associated with it a list of things which would change if it were to be executed, and a list of things which must be true before it can be attempted — the pre-conditions wff.

The add and delete functions update the model of the environment as though the action had been carried-out. Thus INROOM (ROBOT, R1) is the pre-condition and will be deleted by GOTHRU(D1,R1,R2); INROOM (ROBOT,R2) would then be added.

Tasks for robot

Every significant object in the robot world and every action it can make are described in this way. Tasks SHAKEY must perform are also described as wffs, for instance:

Goal: (x) [BOX(x) INROOM(x,R1)]

asks SHAKEY to produce a plan for moving box x from where it is into room 1. To do it the robot may have to go through some doors to where the box is, push it through some more doors until it is in room 1. STRIPS builds a plan from the basic operator actions, which is then passed to PLANEX (plan executor system) on a PDP15 system, which will then control the robot directly through the planned sequence of actions in real time.

The main force behind STRIPS and SHAKEY was not in learning but rather in the predicate calculus problem-solving. Sensory information from tactile 'whiskers', a range finder and television camera was used mainly to check that the information in the database was correct, rather than to add new data to it.

Learning, however, is achieved in two ways. First, a triangular table can be constructed of all the steps in a plan. The table is triangular because the add-list becomes longer as more actions are taken. This table shows all the pre-conditions, add-lists and operators at each step. The stored plan can be used at a later stage as a fully-computed sub-plan, saving the resol-

ution algorithm a vast amount of computing.

The second form of learning is one of generalisation. It would replace specific instances of room, box and door by variable names; therefore one plan would fit a number of situations.

All these forms of learning are inadequate, since in them learning must progress by the program and robot doing something, making some action and then observing the effects. It ought still be able to learn passively, by observation, and by imitating a teacher performing the same actions; any final algorithm we devise should take into account all of these forms.

We should be able to command it to do things, only having to specify what should be achieved in the goal state, rather than having to give an explicit instruction sequence. The algorithm would then use a combination of a plan-forming mechanism to work out how to do it, perhaps like STRIPS; and a mechanism which always adds anything new or unexpected into its database memory.

Penalty

It is not necessary that the robot be engaged actively in any specific goal or task for the learning process to continue. At other times it might make movements and actions to test what happens, rather like a toddler. It might use a previous goal as a model, perhaps one which needed a long time to complete, or one of its sub-goals which proved to be inadequate, which was generated during the planning process.

It might have a list of 'things to try' input by the user. It might take a particular sensor and see how its output changes in relation to actions made and the outputs of all the other sensors. Making even random actions is far better than doing nothing. These processes are equivalent to play and curiosity, well-known when applied to people and animals.

All this adds-up to a robot control program which performs better the next time. As a penalty for these potential gains one must dedicate a substantial amount of computing and engineering facility, since learning programs can be expected to learn, as do people, painfully and slowly. It is very difficult, however, to program robots to do anything interesting and this penalty will probably be worth paying.

Although human intervention is not ruled out in learning algorithms, with the other algorithms — adaptive and concept learning — the user was an essential part of the process. Even with the most general algorithms available somebody, somewhere is still required to specify useful goals.

If this type of algorithm becomes widespread, computers will be 'taught' and 'guided' rather than programmed. With our state of knowledge it would seem as if it will be a long time before we can expect the acquisition of natural language through learning, which would open the doors to a wide range of interesting possibilities.

ALP is a learning program developed at London University by David Mott which incorporates a significant number of the ideas discussed, albeit at a fairly primitive level. ALP uses a laboratory robot connected to a mainframe in which the learning program resides.

Instead of SHAKEY's world with rooms, doors and boxes, it lives in a simpler world dominated by a light and battery charger. Its task is to 'survive' by not letting its batteries run down.

The formal logic of STRIPS is not suitable in such a situation. Instead, information is stored in SCHEMA, which have a form better-suited to the uncertainty a naive robot has about its environment. Schema are built as information flows from the sensors into Short Term Memory — STM — a term borrowed from psychology — and are stored in Long Term Memory (LTM).

Each time the contents of the continually-updated STM change it uses, its model of the environment stored in LTM predicts what will happen. Schemas are built up from KERNELS — the elemental sensory and motor information which can be received into STM. A schema is set up

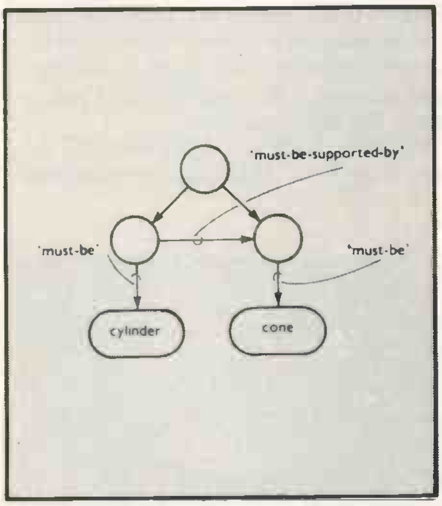


Figure 4. The final description of 'tower' after more 'examples' and 'near misses'.

so that the kernels on its left-hand side predict some kernel on the right-hand side. There are only two kernels known to initially to the system, LOW and HIGH, which the user may include in schema to mean situations which must be avoided and those which should be achieved.

If the contents cause a LOW to be predicted, ALP will use its knowledge in LTM to plan a course of action to avoid this fate; a HIGH would encourage achievement. The progress of the plan is monitored continually because the program has only uncertain information about the effects its actions will produce. If it fails completely to avoid LOW, it must call for help. The environment can then be 'shaped' by placing the robot in a position where it cannot help but discover the answer.

Starting with little or no information about the environment the program attempts to build schema in LTM so that it can always predict what will happen. At a certain level of proficiency the environment might be changed to see how quickly it coped with the alterations.

The prediction mechanism drives the learning part of the program. If STM has predicted correctly, all is well and good. If no prediction is made, a new schema may be formed from the current and previous contents of STM. This happens more often when LTM is still relatively empty.

If an incorrect prediction was made, the schema which caused it may be modified, either by removing a kernel which was obviously redundant and happened to be in STM when the schema was formed, or by adding a new kernel if it was missing at first.

More diverse

The algorithm is non-trivial and schema modification is based on numeric information stored with the schema. ALP has learned to find a battery charger using the light when the robot's batteries began to fail, so that it could re-charge itself. The relevant contents of LTM can be converted automatically into code for a low-level minicomputer which will execute the learned code in real time.

There is always a trade-off between the labour of putting specific information into the database by hand and waiting while the computer laboriously finds out things for itself. Which means, in real terms, that the learning computer is not the all-embracing advantage some have promised. Progress is being made in this field, however, and the ability to learn will make computers useful in even more diverse applications.

Some further information about these projects, which, when you realise they all needed several years' work, often by a team of people, can be found in: Winston's book *Artificial Intelligence* (Addison Wesley) and *The Thinking Computer* by Raphael Freeman. Experimentally-minded readers may be interested to know that LISP, the high-level AI language, which is used for the examples in Winston's book is available for the M6800.

Rewards to be obtained from lucid approach

Susan Eisenbach, of the Polytechnic of the South Bank, explains the use and disciplines of structured programming.

READING the newspapers aimed at professional programmers, one cannot help noticing the phrases 'top down design', 'modular programming' and 'structured programming'. These modern programming methods are being used in commercial installations because their implementation leads to substantial savings in the time needed to develop easily maintainable software.

Initially, computing machinery was so excessively expensive that a saving of one second of execution time or 1/4K of core memory could have been worth a considerable amount of a programmer's time. In consequence, programs were judged as much on their ability to use the hardware efficiently as to produce correct results.

Today's computer managers, with cheaper, faster hardware and mounting salary bills, have inherited a collection of incomprehensible and inflexible programs which are awkward to use and very difficult to maintain. It is not surprising that there has been a shift in emphasis to the production of software which is easy to understand and maintain which can be thoroughly tested and proven.

The small user can benefit from the experience of the professionals in this area. The reduction of development time is not unwelcome, neither is the minimising of maintainance — for instance, when patching old programs to a newly-enhanced system or adapting someone else's program. Since big systems tend to use customised software while the small user often relies on mass-produced packages, the availability of highly-adaptable, easily-understood programs is even more desirable.

In this article I discuss the concepts underlying modern programming techniques. In my next article I will show how the methods can be used to write a games program in both Basic and Pascal. The method is not dependent on a particular language, although implementation is easier and more natural in a language designed by one of its adherents.

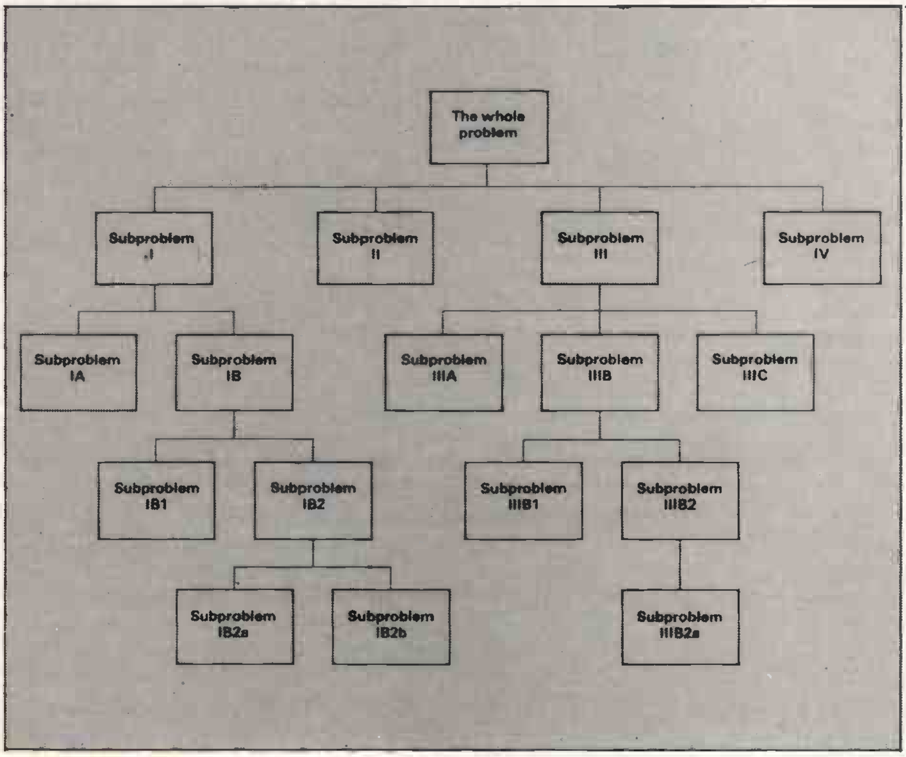
Given a problem to solve with a computer program, the first step is to define the problem clearly. That may sound obvious but it is not uncommon to think 'I'll do something about X' and then expand the problem as one proceeds, at best, finishing only when it becomes uninteresting — the result being, at best, a rather ungainly program.

Once the problem is defined clearly, the next stage is to design the program and data carefully. The design process should be completed before any coding — writing the program — is stored. Designing, whether before or during coding, has a trial-and-error element in it. After completing one part, it may become clear that some previous section should be discarded.

The greater the amount of time already spent on that section, the greater the temptation to patch the program instead. If one designs before one codes there is not the same investment in time — when compared to typed-in code — and so mistakes are psychologically easier to correct. Once the design has been completed it is a more straightforward task to code.

During the design stage of program development, attention is focused on the structure of both the program and the data. Which one is more important depends on the problem.

Figure 1. A hierarch diagram.



Data structures

To design the necessary data structures, one has to consider all the data which is the subject of the program being planned. What are the ways available for representing that data within the program? For example, if your problem is a card game, how should you represent the cards? Three possible alternatives are:

- A 13 × 4 array where the row number gives the value of the card and the column number its suit.
- A 52 × 2 array where the first dimension contains the value and the second the suit.
- A 51 × 1 array where the code of each card is an element in the array.

Should the cards be represented by characters or integers? Time spent at that stage of design, choosing the data structures which best suit the problem, will simplify the rest of the design and coding.

After the data structures have been designed, the next stage is the designing of the program structure. That is sometimes called 'stepwise refinement', because it involves identifying the major problems to be solved and from there expanding the problem progressively into more and more detail, until reaching a low enough level to begin coding.

At the top level, a single block or 'module' — see the hierarchy diagram in figure 1 — solves the entire problem. At the second level, that is subdivided into several subproblems (modules), which in turn are subdivided, and so on.

How does one subdivide a problem in this way? Each module should accomplish a single function. In a card game there could be a module which deals the cards. It could be broken-down into two modules — one which shuffles the cards and a second which distributes them. The fact that it might be difficult to program the function should not cause any worry at that stage. Instead, attention should be paid to defining the module completely. That consists of a specification of input and output parameters and a description of the function to produce the output parameters from the input parameters.

Eventually one will reach a point where the modules can no longer be broken-down into simpler amounts. It is then time to start programming. The top module is the main program, while all other modules are coded in subroutines or procedures. The first line of each module should contain a clear description of its function — e.g. in Basic 100 REM SUBROUTINE TO SHUFFLE CARDS, in Pascal PROCEDURE CARD SHUFFLER. The last line of each module is its only exit. Having exactly one entry and one exit point for each module, reduces program complexity and makes it easier to trace program flow.

Use of stubs

Top down coding — of the program in figure 1 — begins by writing the code for the main module as if the second level modules already exist. The code includes subroutine calls to those modules. Next dummy modules, called 'stubs', are written for modules I, II, III and IV. They consist of a first line with the function description, the return to the calling program and a few lines of code which will allow the main module to be tested. That might accept, from a terminal, the values of the output the data module will compute later.

The use of stubs enables the checking of program logic and interface. When the first module is working properly, the next stage is to replace a stub with code. The code written for this level-two module will contain, if needed, subroutine calls to level-three modules, and stubs for those modules must also be written.

Each time another module is written, it should be tested completely. Data should be input which requires every branch to be traversed. Since the new module will be integrated within the rest of the program, it can be seen that it functions correctly as part of the whole program. The process of replacing, and testing, stubs with code continues until the whole program is coded.

There are many advantages of this 'top down programming and testing'. Firstly, only a small section of code is being tested at any time, so it is easy to pinpoint any

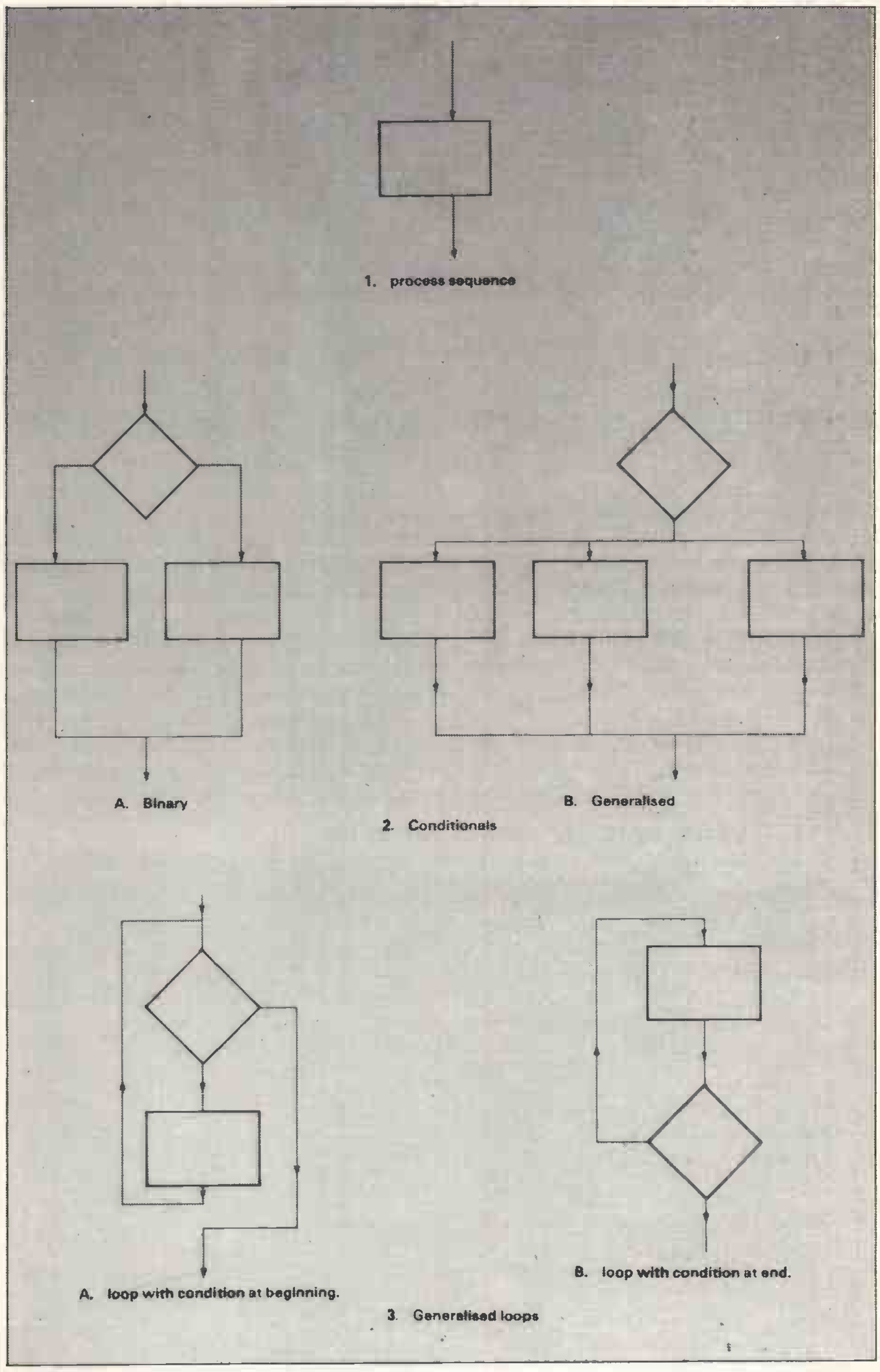


Figure 2. Control structures.

difficulties. Secondly, major errors in program logic are detected before minor ones, because modules are tested in order f importance.

Thirdly, testing is spread throughout the program development, so one is not left with the daunting task of testing a large program, which tends to be tested until it appears to work, rather than until all paths have been traversed. Lastly, the continuous integration of new modules as they are written eliminates interfacing problems between sections of code.

The same type of care and attention used to design the structure of a program is also focused on the coding. Regardless of the language when writing a program, the same component building blocks are used. They are sequential statements — e.g., Basic LET X = Y * Z, Pascal X := Y * Z ; unconditional branches — e.g., BASIC GOTO 10, Pascal GOTO LABEL; and conditional branches — e.g., Basic IF X = Y THEN 100; Pascal IF X>0 THEN Y := Z/X ELSE Y := 0.

Because programs are particularly helpful for solving repetitive tasks, almost all languages provide a loop construct as well — Basic FOR I = 1 TO N . . . NEXT I, Pascal FOR I := 1 TO N DO . . ., WHILE . . DO . . ., REPEAT . . . UNTIL . . — even though this is not

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strictly necessary, since looping can always be achieved with branching. If a language has the correct type of loop and conditional branch constructs, unconditional branching becomes unnecessary.

Structured programming is a technique which lays down rules about which of those constructs should be used in a program to make it simpler, more readable and easier to change. It can be shown that any algorithm, excluding recursion, can be broken into steps using three basic building blocks — sequence, conditionals and loops. They are the only constructs allowed in a structured program.

Variations

Figure 2 shows, in flowchart form, the three control structures, with their variations. A process sequence is one or more program statements, or any other proper computational sequence with one entry and one exit, such as a subroutine or procedure, which move forward the program control.

A binary conditional — IF . . . THEN . . . ELSE . . . — causes execution of one of two choices depending on whether a statement tested is true or false. After the THEN or ELSE branch has been completed, program control moves to the same instruction. The generalised conditional is a logical extension of the binary conditional, in which control switches to one of several alternatives, depending on the value of a test variable. Again, after execution of the appropriate process, control moves to the some instruction.

Loop test

Although all loops can be implemented by a loop controlled by a test at its beginning, there is no need to be so restrictive. Having three loop control structures makes programs easier to read and write. Indefinite loops, those executed until some condition is satisfied — or not satisfied — can have their test either at the beginning or the end of the process. Definite loops, those controlled by a counter, are also allowed.

Structured programming is sometimes called 'GOTOless programming' as it avoids the use of branches except in certain well-defined cases. The liberal use of GOTOs tends to result in the logic of many programs being difficult ot follow. Altering a program which contains indiscriminate branching can lead to unexpected and unwanted results. Some programming languages, such as Pascal, designed within a structured programming framework, have the constructs necessary for its straightforward implementation. In those languages there is no need to use GOTO statements.

In other languages such as Basic, lacking some of the structured constructs, the implementation of the control structures requires a limited use of GOTO statements. REMarks should be used to highlight the control structures. Unfortunately, using structured constructs in a language which does not have them implicitly leads to an awkward programming style. Figure 3 shows possible implementations of the structured constructs in Basic and Pascal.

It should be noted that whatever the language, program flow always moves forward from basic building block to basic building block. Even within the blocks there is only one backwards jump which occurs at the end of a loop. The lack of complexity inherent in a structured program makes it easy to understand and maintain.

Figure 3. Implementation of control structures.

Control Structure	Implementation in Basic	Implementation in Pascal
1. Binary Decision	10 IF CONDITION THEN 30 20 GOTO 70 30 REM THEN : 60 GOTO 100 70 REM ELSE 100 REM ENDIF	IF CONDITION THEN . . . ELSE . . .
2. Generlized Decision	10 REM CASE STATEMENT 20 ON INDEX GOTO 30, 60, 90 30 REM CASE 1 : 50 GOTO 110 60 REM CASE 2 : 80 GOTO 110 90 REM CASE 3 : 110 REM END CASES	CASE INDEX OF 0: BEGIN . . . END; 1: BEGIN . . . END; : N: BEGIN . . . END END ('CASE');

3. Indefinite Loops
A. Test at Beginning
	10 REM CONDITION DO
	20 IF CONDITION THEN 110
	:
	100 GOTO 10
	110 REM END WHILE LOOP
		WHILE CONDITION DO
		BEGIN
		:
		END ('WHILE LOOP');

B. Test at End	10 REM REPEAT : 100 REM UNTIL CONDITION 110 IF NOT CONDITION THEN 10	REPEAT : UNTIL . . .;

4. Definite Loops	10 FOR I = 1 TO N
	:
	100 NEXT I
		FOR I = 1 N DO
		BEGIN
		:
		(END ('FOR LOOP');

Rewards

If a program is to have a long life, to be alterable when conditions make changes necessary, it is most helpful for it to be well-documented. Standardisation is one of the essentials of good documentation, because it makes the program easier to follow.

Good structured programs — well-commented if the language does not contain the structured constructs — are nearly self-documenting. Flowcharts, useful for the unstructured program where it is difficult to follow the program logic, do not add any additional information to the structured program. What is useful is a description of each module — subroutine, procedure — and the relationship between modules.

The description of each module should include a list of input parameters, a list of output parameters and a description of the process performed. A hierarchy diagram such as in figure 1 shows clearly the calling relationships between modules.

It is a tenet of modern programming that documentation should be produced during the design stage. A claim that documentation before coding is a waste of time, as it will need changing, is an admission that designing was not completed before coding started.

People who have programmed without these methods often find them awkward and restricting at first. Perseverance, however, brings, with an increasing ease, the rewards of lucid programs and the satisfaction that the job has been well and professionally done. My next article, which will take a game similar to Mastermind from design stage to final coding, should make the ideas detailed here appear more concrete.

Playing with money

A MODEL is a representation of the real thing. Models are used to discover the reactions of the real thing to changing conditions when it would be exorbitantly expensive, foolish, or just impossible to build the real thing and expose it to the stresses and strains it will encounter.

A corporate financial model is a representation of the operations of a company. The operations of manufacturing, selling, buying, investment, can be represented by sets of related mathematical expressions. For example, total sales equals number of units sold times price.

Price then, can be expressed as, say, cost of production, profit component, overheads, and so on. When all expressions are arranged logically and completely, a model of the company from first purchase of raw material to final nett worth is the result.

The value of such a model is apparent at budgeting time and when new ventures or changes to a company's way of doing business are mooted. Then, "what-if" questions can be put to the model and the chain reaction on all the company operations can be examined and the best course of action in the real world can be decided.

It should be obvious that the examination of a corporate financial model is best performed by using a computer. With a computer you can analyse the effects the changes make on the overall operation of the company.

Try again

Just as quickly, you can change the parameters and provide another result to compare to the first. You continue the process until you obtain the required effect or series of effects which can be examined at leisure.

The use of computers in corporate financial modelling does not have a long history. It was only about 10 years ago that either a system or a language was made available to modellers to ease the tasks involved. Until then it was usual to program the model in a high-level language like Cobol. The handling of time-series of data, as in week-by-week or month-by-month information or calculations, was tedious and subject to error. It was when financial modelling systems and languages began offering simplified notation to handle series arithmetic that modelling was used.

Corporate models produce forecasts of financial reports, such as profit-and-loss or balance sheets but, although their overwhelming use is in financial planning, models are also used to aid marketing decisions, solve problems in distribution or production, and are used also to great effect in the evaluation of capital projects.

Financial modelling, when wholeheartedly supported by the top management of a company, brings benefits undreamed of before the advent of the computer. It is the primary aid for decision makers.

At Carreras Rothmans in Basildon, Essex, financial modelling on the Rair Black Box microcomputer has become a key part of corporate planning activities.

Carreras Rothmans is a leading tobacco manufacturer in the U.K. and has achieved major growth in worldwide markets over last few years, receiving the Queen's Award for Exports in 1977. It began running its computerised financial model in September last year.

Financial modelling is the responsibility of the corporate planning department and comprises a three-year plan of what to sell — choosing markets, prices, determining overheads in selling — in fact, all financial aspects which could influence the profit achievement over a three-year period. As soon as one year of the plan ends, another year can be added to maintain a continuous planning process.

Kay Floyd looks at an up-to-date tool for corporate planning.

The continual company growth led to a re-structuring last year in which a number of regional business development centres were set up throughout the world. That created a need for a computer system to support the complex repetitive calculations involved in financial planning and to provide the facilities for dealing properly with "what-if" questions, thereby assisting the profit planning activities.

The information services division was given the problem of developing a suitable computer model and choosing a system to support its operation at corporate headquarters. The centralised computer installation, equipped with two ICL 1903Ts, was already utilised fully in handling the wide range of accounting, order processing and other company functions.

Natural choice

It was also considered that installation, which is remote from corporate headquarters, would not provide the necessary degree of response and interaction through terminal activities. So microcomputers seemed the natural choice.

Ken Sayce, technical support manager of the division, was responsible for implementing the financial model on to a microcomputer. He described the reasons which led to the choice of the Rair Black Box.

"We looked at desk-top computers but decided the micro field was better for us. They were there and they were much cheaper. We looked at the data volumes we would be using and thought that a micro could cope, so we looked at likely systems.

"The Black Box was the cheapest on the market which could to the job. Most of the others were half as expensive again and didn't have all the facilities. As far as the hardware and software were concerned, it was as good a machine as was available".

The configuration chosen has 64K of storage and is used with a 180 C/S DECwriter, a Hazeltine 1510 screen and two double-density, double-sided mini-floppy discs. Total cost was around £3,500.

The project began in June, 1978 and the financial model was up and running by September. Despite some initial problems with the internal power supply, the project went surprisingly smoothly.

As far as the information services division was concerned, the experiment gave the data processing staff some valuable experience in designing systems and Basic programming, which none of them had done previously. Carreras Rothmans said that the most noticable conclusions during the project were that the Black Box offered mainframe computing capabilities on a micro-scale, conditioned development staff to break-down complex problems into simple, small components and enabled programs to be amended interactively, adopting what is in effect the "what-if" approach using the Black Box equipment.

Installing more

Carreras Rothmans is planning to supplement its existing centralised mainframe system by installing microcomputers in its various locations in the U.K. and overseas. The policy will be to use the facilities of the microcomputer where they offer the most appropriate means of meeting changing needs for business information within the company.

By committing itself to using microcomputers, Carreras Rothmans has realised the importance of using the new technology to support its continued growth.

Director of administration Keith Patterson says: "Financial modelling is important to the company for two reasons. Firstly, in planning and controlling future financial success and, secondly, in providing the knowledge and confidence to take a major step forward in planning and developing a computer service in the 1980s".

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Solving the interface transfer problem

ONE LIMITATION of the Commodore Pet 2001 is that it cannot accept or transfer analogue data. The Pet interface unit described here overcomes this problem, allowing analogue information to be transferred into Pet memory and on to an XY plotter or YT pen recorder. Facilities are also available for inputing data from eight multiplexed channels and from a peak height chart reader unit.

By utilising the IEEE bus and user port lines, available at the rear of the Pet, control and data lines are formed to operate the interface unit. The user port is used for output control lines and the IEEE bus for data transfer and input control lines (figure 1).

The cost of the unit has been kept to a minimum by using slower and less accurate devices for data conversion. The ADC and DACs can, however, be uprated according to need.

Improved reliability

The ADC can be switched to accept analogue voltages from two different sources. Firstly, from a chart reader (CR) via an offset and gain amplifier, and secondly, from an eight-channel multiplexer. A de-bounce circuit is incorporated to improve the reliability of data entry and provision is made for control of the pen lift on the XY recorder.

The ADC was built around the Ferranti ZN425E DAC, using a LM318 high slew rate op. amp as a comparator (figure 2). Once a convert command pulse has been received, the DAC counts up to the value of the analogue voltage applied to the comparator.

The comparator flips and generates a convert complete pulse. A variable attenuator is connected to the comparator as a Full Scale Deflection (FSD) control. The clock pulses are generated by an astable CMOS chip (CD4047). A clock frequency of 250KHz allows a maximum conversion time of about 1ms.

An 8212 buffers the outputs of the ADC and controls the transfer of data on to the data highway.

The CD4051 is an 8-to-1 multiplexer with a three-bit binary counter (CD4520) connected as a decoder (figure 3). Each multiplexed input is provided with an attenuator control to prevent the multiplexer being overloaded. The various inputs are selected by pulsing the re-set and clock lines of the decoder.

Simple switch

The simple switch de-bounce circuit uses cross-coupled gates to produce a latch which is re-set by the convert-complete pulse from the ADC. This ensures correct data entry.

An offset and gain circuit is incorporated for calibration purposes when the chart reader is in use.

To output X and Y information simultaneously, three 8212 line buffers are used (figure 4). X information is output on to the data highway and buffer 2 is clocked, storing the X data. This data is also stored in buffer 3. Y information is then transferred on to the data highway and is stored only in buffer 4, since buffer 2 is not clocked. The outputs of buffers 3 and 4 are then enabled and the data is converted via the DACs to the X and Y outputs. Internal pre-sets set the FSD of the DACs.

A read relay driven by a transistor buffer (BC182L) allows remote control of the pen lift on the XY recorder. Power supply rails are derived from a Vero 3 rail power supply providing +5V at 500 mA and —5V at 50 mA.

The software to control the Pet interface unit is written as subroutines which can be added to any Basic program. They are:

- **Output routine** — GOSUB 2000 (See GOSUB 2300). Allows the pen to move to any position, set by X and Y. $0 \leqslant X \leqslant 255$, $0 \leqslant Y \leqslant 255$. Variable N9 is set automatically, depending on whether the pen up or pen down routines are executed first.
- **Pen down** — GOSUB 2100. The pen is put down and N9 is set, allowing the pen to stay down while executing the output routine.
- **Pen up** — GOSUB 2200. Similarly the pen is put up and N9 set accordingly.
- **Zero start for output routine** — GOSUB 2300. To be executed before output routine. It sets all control lines for output mode and need only be used at the beginning of a program.
- **Delays** — GOSUB 2400, GOSUB 2410, GOSUB 2420. These are loops which act as delays. They enable the XY plotter to draw lines and dots at the correct time. To change the delay, alter the final value of J9. The delay lengths are short, medium and long respectively.

  GOSUB 2410 is also used in other sub-routines.
- **Axis routine** — GOSUB 2500. This draws the axes of a graph with calibration markers. A choice of three positions for both X and Y are available — X axis — top, centre, bottom; Y axis — left, centre, right.

To obtain the calibration markers, enter the maximum value and number of increments for each axis. If not

(continued on next page)

Figure 1. Block diagram of Pet interface unit.

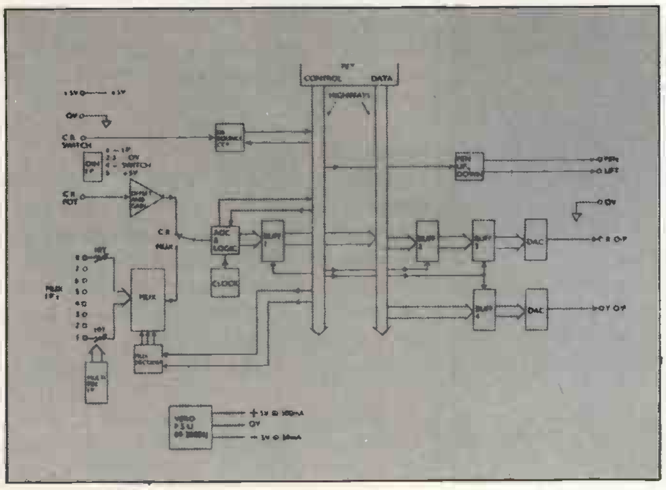
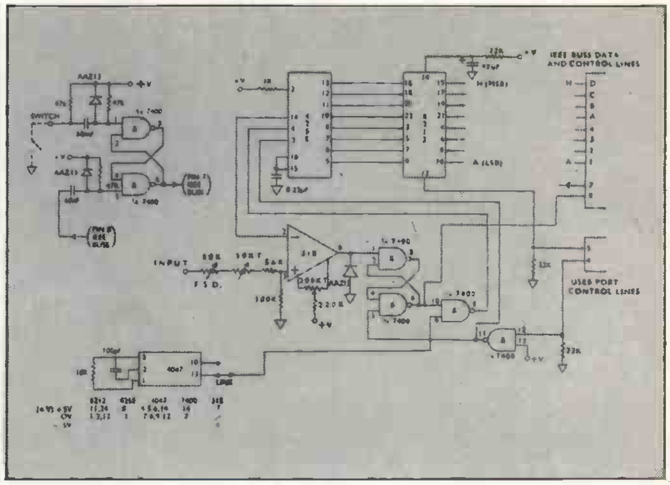


Figure 2. I/P interface board Pet 2.



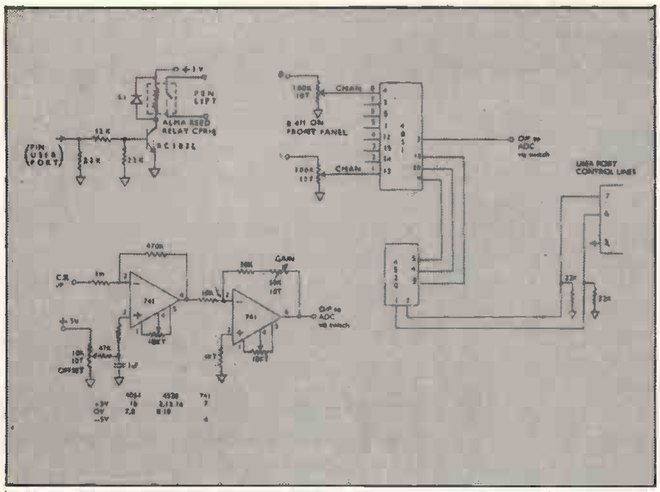


Figure 3. I/P interface board Pet 3.

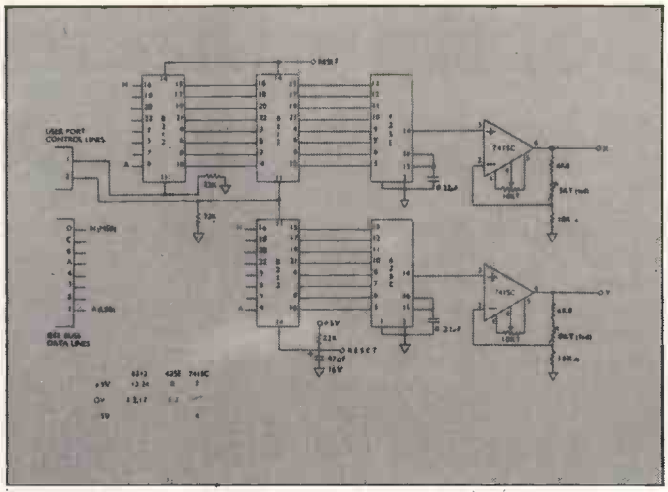


Figure 4. O/P interface board Pet 1.

(continued from previous page)

required, entre 0 for the number of increments.

- **Delay** — GOSUB 2800. Similar to other delays but shorter in time. It is also used in other subroutines.

```
10 DIM C(12,12)
20 GOSUB 3100:GOSUB 2910
30 FOR A=0 TO 11
40 FOR B=0 TO 11
50 GOSUB 3000:C(A,B)=P
60 NEXT B
70 NEXT A
80 PRINT"DATA INPUT COMPLETE"
90 PRINT"OUTPUTTING DATA NOW"
100 Y=C(0,0):X=0:GOSUB 2000:GOSUB 2100
110 FOR A=0 TO 11
120 FOR B=0 TO 11
130 PRINT C(A,B):V=V+1:X=V*255/144
140 Y=C(A,B):GOSUB 2000
150 NEXT B
160 NEXT A
170 GOSUB 2200
180 STOP
```

Figure 7.

- **Wait for Chart Reader**—GOSUB 2900. Pet is instructed to WAIT until the chart reader (CR) switch is closed.

  All keyboard control of Pet is lost until the switch is closed. To break the program, depress STOP and close the CR switch simultaneously.
- **Re-set multiplexer** — GOSUB 2910. The multiplexer is re-set to channel 1.
- **Clock multiplexer**—GOSUB 2920. The multiplexer is incremented one channel every clock pulse.
- **Input routine**— GOSUB 3000 (See GOSUB 3100). The ADC is instructed to convert its input, whether MUX or CR, into binary form. Variable P becomes equal to the binary value. $0 \leqslant P \leqslant 255$. If the value exceeds 255, the ADC will not convert.
- **Zero start for input routine**—GOSUB 3100. To be executed before the input routine. It sets all data lines for input mode. It must precede GOSUB 3000 or incorrect input data will be recorded.

Variables used in subroutines 2000 - 3100 are X, Y, P, A9$, B9$, D9, E9, F9, G9, H9, I9, J9, K9, L9, M9, N9, R9, S9, T9, U9, V9, W9, Z9, IX9, IY9, MX9, MY9.

The printed circuit boards layouts available from the author — are manufactured in the usual way. After the relevant components have been assembled on to the boards, the front panel should be drilled. The various components are mounted on to the front panel and wired to the relevant PCB edge connectors. Figure 5 shows details of how to wire the inter-connecting leads from Pet to the interface unit.

The power supply unit used in the prototype is the Verospeed 3 rail power supply which is mounted on to the PCB card Pet 4 and wired.

Additional mains filtering may be required to remove unwanted glitches from the power supply lines. Standard inductor or inductor/capacitor filters are sufficient.

The prototype was designed originally and built into a half-rack case to aid easy expansion of the system if required. However, the case alone adds considerably to the cost of the unit and could be replaced by a less expensive one.

Very little setting-up is required since the interface unit is mostly digital. After the unit has been switched on and any major mistakes in wiring have been corrected, turn all pre-sets to their central position and all controls on the front panel fully anti-clockwise. Enter the subroutine program in figure 6 and save on tape of disc and then enter the program shown in figure 7.

Execute both programs to check that most, if not all the functions are working correctly. By applying a biased sinewave to channel 1 of the multi-plexer and increasing the gain control to obtain a reasonable swing, the XY plotter should plot the incoming waveform.

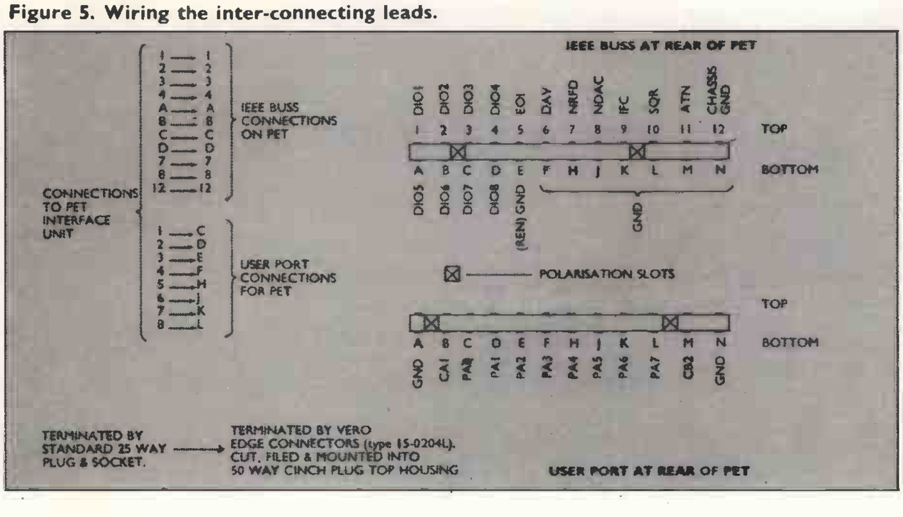
To calibrate the instrument, enter the first of the two programs shown in figure 8. Execute the program and adjust the offset pre-sets on board Pet 1 so that the X and Y outputs read 0.00V exactly.

```
10 GOSUB 3100
20 GOSUB 2910:GOSUB 3000
30 PRINT P:GOTO 20

10 GOSUB 2300
20 STOP
30 X=255:Y=255:GOSUB 2000
40 STOP
```

Figure 8.

Figure 5. Wiring the inter-connecting leads.



Erase line 1 and re-run the program, adjusting the f.s.d. pre-sets so that the X and Y outputs read 4.00V.

Adjust the offset pre-sets on board Pet 3 for each 741 in turn while monitoring their respective outputs. This should be done only when the offset and gain controls are turned down.

To alter the offset and FSD presets on board Pet 2, enter and run the second program shown in figure 8. The equivalent voltage applied to the input of the ADC should be converted to a number between 0 and 255 and displayed on the screen. Short the ADC input to ground (CH1) and adjust the offset pre-set until 0 is displayed.

Check, if possible, the output of the 318 and set to 0.00V. With the MUX gain controls and the ADC FSD control turned fully clockwise, apply the minimum FSD voltage to CHI and adjust the FSD pre-set to obtain 255 on the screen. If in doubt, alter the pre-set so that it is effectively short-circuit. Re-run the test program in figure 7 to check that the unit is functioning correctly.

This interface unit should prove to be a very useful addition to the Pet. It has various limitations, however, some of which are discussed.

Under Basic control, the maximum sampling rate of the ADC is limited to 8Hz. This is decreased further to 1Hz when all eight channels are being multiplexed. The sampling rate can be increased by more than 50 times when Pet is under machine code control.

The ADC operates only in a standard binary code and hence will only accept positive-going signals. Its maximum input voltage depends on the setting of the FSD control and also on the passive gain controls connected to the multiplexer inputs. Offset controls were omitted for simplicity and cost.

When using the chart reader, maximum voltage swing and resolution is obtained firstly by adjusting the offset control and then adjusting the gain and FSD controls located on the front panel. In the MUX mode, only the FSD control is functional.

The Pet interface unit is designed as an economical instrument to aid data transfer to and from the Pet. It costs about £250 to construct, including a half-rack Vero case. It has numerous applications and the software is expandable easily to suit many requirements.

Figure 6. Subroutine program.

```
2000 POKE 59426,X
2010 POKE 59471,N9+1:POKE 59471,N9
2020 POKE 59426,Y
2030 POKE 59471,N9+2:POKE 59471,N9
2040 RETURN
2100 GOSUB 2410:POKE 59471,4:GOSUB 2410
2110 N9=4:RETURN
2200 GOSUB 2410:POKE 59471,0:GOSUB 2410
2210 N9=0:RETURN
2300 POKE 59459,255:POKE 59426,0
2310 POKE 59471,3:POKE 59471,3
2320 RETURN
2400 FOR J9=0 TO 150:K9=J9:NEXT:RETURN
2410 FOR J9=0 TO 300:K9=J9:NEXT:RETURN
2420 FOR J9=0 TO 500:K9=J9:NEXT:RETURN
2500 INPUT"WHERE DO YOU WANT YOUR Y AXIS,L,C,R";A9$:PRINT
2520 IF A9$="L"THEN D9=0:P9=3:S9=0:GOTO2552
2530 IF A9$="C"THEN D9=127:R9=129:S9=125:GOTO 2552
2540 IF A9$="R"THEN D9=255:P9=255:S9=252:GOTO 2552
2550 GOTO 2500
2552 INPUT"MAXIMUM Y VALUE";MY9:PRINT
2554 INPUT"Y INCREMENTS";IY9:PRINT
2556 L9=255/MY9:MY9=L9
2560 INPUT"WHERE DO YOU WANT YOUR X AXIS,T,C,B";B9$:PRINT
2580 IF B9$="T"THEN E9=255:V9=255:T9=250:GOTO 2612
2590 IF B9$="C"THEN E9=127:V9=129:T9=125:GOTO 2612
2600 IF B9$="B"THEN E9=0:V9=4:T9=0:GOTO 2612
2610 GOTO 2560
2612 INPUT"MAXIMUM X VALUE";MX9:PRINT
2614 INPUT"X INCREMENTS";IX9:PRINT
2616 M9=255/MX9:MX9=M9
2620 X=D9:Y=0:GOSUB 2000:GOSUB 2800:U9=0
2630 GOSUB 2100
2640 FOR F9=0 TO 255
2650 H9=H9+1:Y=H9-1:GOSUB 2000
2660 IF Y=INT((IY9*MY9)*U9) THEN GOSUB 2780
2670 NEXT:GOSUB 2200:GOSUB 2800
2690 Y=E9:X=0:GOSUB 2000:GOSUB 2800:U9=0
2700 GOSUB 2100
2710 FOR G9=0 TO 255
2720 I9=I9+1:X=I9-1:GOSUB 2000
2730 IF X=INT((IX9*MX9)*U9) THEN GOSUB 2820
2740 NEXT:GOSUB 2200:GOSUB 2800
2760 X=0:Y=0:GOSUB 2000
2770 RETURN
2780 GOSUB 2400:X=S9:GOSUB 2000:GOSUB 2800:X=R9:GOSUB 2000:
     GOSUB 2800:X=D9:GOSUB 2000
2790 U9=U9+1:GOSUB 2400:RETURN
2800 FOR Z9=0 TO 90:W9=Z9:NEXT:RETURN
2820 GOSUB 2400:Y=V9:GOSUB 2000:GOSUB 2800:Y=T9:GOSUB 2000:
     GOSUB 2800:Y=E9:GOSUB 2000
2830 U9=U9+1:GOSUB 2400:RETURN
2900 WAIT 59456,64,254:RETURN
2910 POKE 59471,64:POKE 59471,0:RETURN
2920 POKE 59471,32:POKE 59471,0:RETURN
3000 POKE 59471,8:POKE 59471,0
3010 WAIT 59456,1,255
3020 POKE 59471,16
3030 P=PEEK(59424)
3040 POKE 59471,0
3050 RETURN
3100 POKE 59426,255:POKE 59459,255
3110 RETURN
```

Components list

3 off	ZN425E DAC	
2	741SC High-slew rate 741	
4	8212 8-bit latch	
1	LM318 High-slew rate op. amp.	
2	7400 Quad 2 input NAND	
2	741	
1	4051 8-channel MUX	
1	4047 Astable	
1	4520 Dual binary counter	
4	10K Presets (10 turn)	
1	200K Presets (10 turn)	
1	50K Presets (10 turn)	
2	5K Presets (10 turn)	
8	100K Potentiometers (10 turn)	
1	10K Potentiometers (10 turn)	
2	50K Potentiometers (10 turn)	
1	BC182L NPN Transistor	
3	AAZ13 Ge diode	
1	IN3062 Si diode	
1	CPRI/J Alma Reed Relay (5v)	
1	luF 35V tant	
2	47uF 16V tant	
6	22uF 25V tant	de-coupling on PCBs
1	0.1uf 100V	de-coupling on PCBs
2	68nF	
3	0.22uF	
1	100pF	
10	22K	All resistors ¼w 5%
1	56K	
1	12K	
3	10K	
1	4K7	
5	47K	
1	1M	
1	470K	
1	1K	
1	100K	
1	220K	
2	18K	
2	6K8	
5	8 PIN DIL sockets	
3	14 PIN DIL sockets	
5	16 PIN DIL sockets	
4	24 PIN DIL sockets	
1	3 rail power-supply (Vero electronics type 89-20886J)	
1	½ rack vero case (3U)	
1	½ rack sub frame (3U)	
1	Mains switch	
1	25 way plug, socket and cover (R.S.)	
1	20mm fuse holder	
4	0.1in. single-sided edge connectors 43 way (Vero or R.S.)	
11	10 turn pot. knobs.	
1	9-way plug, socket and cover	depending on design and application
Various	4mm Banana sockets	depending on design and application
1	S.P.D.T. min. toggle switch	depending on design and application
	General hardware	depending on design and application

Hard-sectoring approach under examination

MOST disc file-handling techniques used in industry and commerce are the esoteric pursuits of software development teams, resulting in sophisticated operating systems. The applications programmer needs to know only how to present information to the operating system to access many types of files.

To the hobbyist, however, the implementation of a disc-based system may become a nightmare, especially with limited disc space and without a clear understanding of basic file types. It is hoped this article will be of assistance in this area and of general interest to users of existing systems.

A file is a contiguous set of records, held usually on contiguous sectors of a disc. For simplicity, let us assume that all records are of equal length and that records do not span sector boundaries. Figure 1 shows a disc file of eight records each of 128 bytes in length using two sectors of disc space.

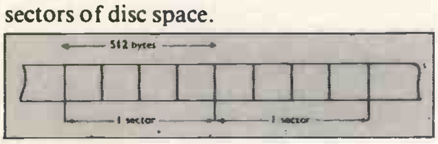


Figure 1.

As its name implies a floppy disc is a flexible circular disc, coated with a magnetic oxide. As the disc rotates the read/write head — or heads for double-sided discs — can read or change the magnetic patterns stored by the oxide. The available storage surface of a disc is split into tracks and sectors. A track is a complete annulus of the recording surface. A sector is a part of a track.

As the disc revolves, the read/write head can move to any track on the available recording surface. A photo cell detects light shining through the start sector holes to show the location of any sector on any track. Each sector can store about 512 × 8 bits of information, by magnetising the oxide in two directions — zeros or ones.

In the first of two articles, B R White looks at techniques for handling files on discs.

This organisation of sectors by their physical position on the disc is known as hard sectoring and has been until now the most common storage technique. On request by the CPU, a given sector is either read into memory or written to disc from memory.

The other approach is called soft sectoring. The position and length of each sector on a track is controlled by software, which writes a start sector marker followed by the sector data and an end sector marker. This can be useful in terms of compatibility for hardware supplied by different manufacturers since the hardware, under program control, will seek the information required independently of its physical location.

Very complex file-handling techniques are common to both hard- and soft-sectored systems and for the sake of simplicity the remainder of the article will assume a hard-sectoring approach.

Let us assume we start with a blank disc and know only how to read or write sectors to and from memory. How do we build to a multi-file disc system?

First, a disc directory is needed which is usually the first one or two sectors of the disc. For each file created on the disc there is a corresponding entry in the directory containing at least the basic information to access the file:

- Alphanumeric file name or perhaps only a file number.
- Start sector.
- Number of records.
- Number of bytes per record.
- Various pointers.

It is advisable to leave room for extra information in each directory entry, since it may be useful as your system expands. For example, a pass number to allow access to the file, the number of 'live' records in the file, and the like.

Most disc-based systems use more than one type of file, since information needs to be stored in different ways and retrieved in the most efficient manner.

To understand how information is held on a multi-file system, the concept of 'file pointers' must be grasped clearly. A pointer is an integer number held as an element of a record on disc, which refers either to another record on the same file or a record on another file. These pointers are used by programs to follow 'drains' of records via any number of files either to:

- Add a new record to a chain.
- Access an existing record in a chain.
- Update an existing record in a chain.
- Delete an unwanted record from a chain, maintaining the integrity of any remaining records in the chain.

There is an exception to the definition of a pointer which is called the 'null' pointer. This is where the pointer held on a record or used in memory by a program must not "point" anywhere.

Direct files are by far the fastest method of random access on disc systems. Suppose you require a customer file of, say, 200 records and it is convenient to code your customer account numbers in the range 1-200. Assume a sector length of 512 bytes and a record length of 128 bytes. Figure 2 shows how this file would be held on disc.

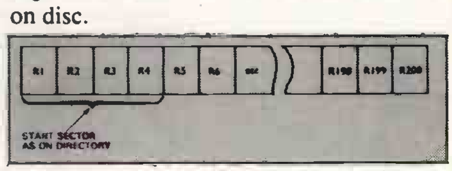
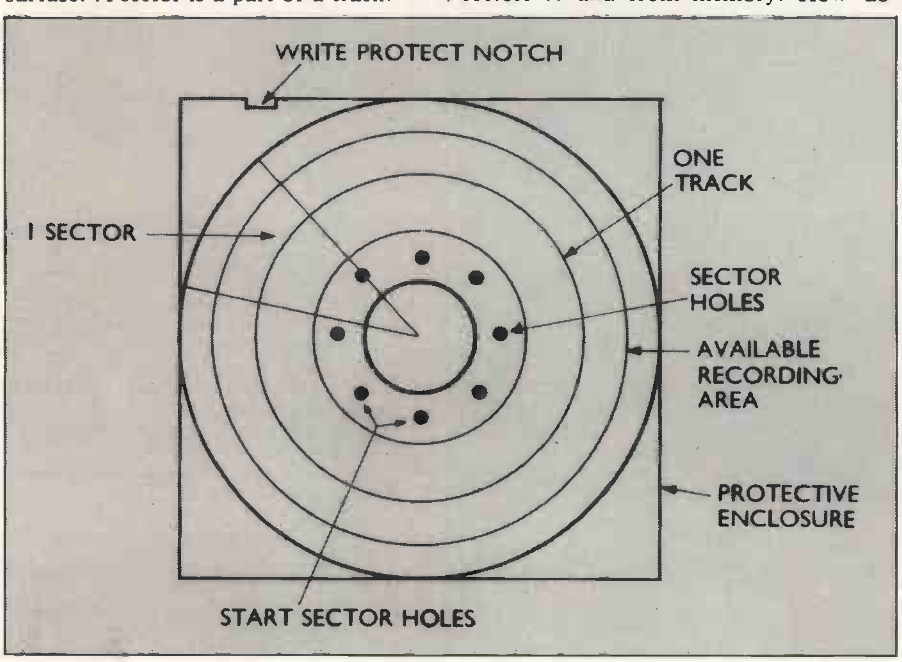


Figure 2.

To calculate the sector containing any



record in the file requires the simple algorithm:

$$\frac{(\text{Record number} - 1)}{\text{Records per sector}} + \text{start sector}$$

The remainder of the division will be in the range 0 to (records/sector —1), hence the byte position within the sector is the remainder multiplied by the number of bytes per record.

The record can be processed either within the single sector disc buffer, since its position is known, or can be copied to a record buffer within the program where the memory address of each element within the record will be same as for any other record from the file. (See figure 3).

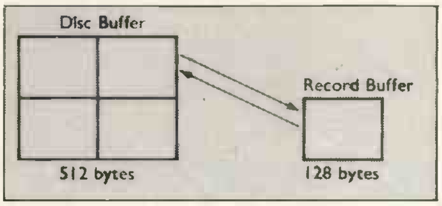


Figure 3.

This technique of using record buffers is common, since after accessing the desired record the disc buffer may be used again to access a record from another file, thus reducing the memory requirements for a multi-file system.

Before copying the record buffer to the disc buffer, the original sector must be read back into the disc buffer to retain the records adjacent to the record being written or re-written to disc. For example, suppose we read record 3 (R3) from our customer file in figure 2. The disc buffer will contain R1, R2, R3 and R4 and the record buffer will contain R3.

If R3 is to be updated with information from other files sharing the common disc buffer, then R1, R2 and R4 will be lost, so the same sector must be re-read from disc before copying R3 back to its original position and re-writing all four records.

Unless record lengths are of the form 2^n (i.e. 1, 2, 4, 8, 16, 32, 64, 128, 256, 512) there will be wasted space at the end of each sector. This can be saved by allowing records to span sector boundaries and by using different algorithms to calculate the record position. The disc buffer, however, must then be at least two sectors, even if the record length is only three bytes. (See figure 4).

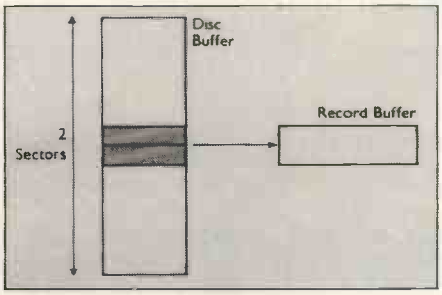


Figure 4.

A serial file is a contiguous set of records, held in contiguous record 'slots'. The determination of the sector and byte position is exactly the same as for a direct file. In fact, a serial file is similar to a direct file, except that it starts empty and records are written to it starting at one end.

Figure 5 shows a serial file containing five records each 16 bytes in length.

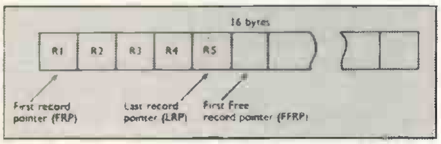


Figure 5.

This file utilises the file pointers mentioned previously which are stored on the disc directory. Before accessing the file, the current state of these pointers must be determined and returned correctly to the directory after the file has been used. A serial file is useful to record events during processing which do not require immediate action.

For example, suppose from our customer file (figure 2) we need a monthly printout showing customers who have exceeded their credit limit during the month. The programs which update customer balances will be 'aware' of those occurrences and need only to write the relevant details to the serial file.

To write a new record, (say R6, figure 5) the new record is written to the slot determined by the FFRP; the LRP then becomes the FFRP used and the FFRP is incremented to point to the next slot.

Serial access

When reading the file, each record is accessed serially from the start of the file to the record preceding the FFRP. The FRP and LRP are superfluous in this case but I have used them to maintain continuity with other file types requiring pointers.

To clear the file, the pointers on the directory need only to be re-set so that they do not point to any record on the file — i.e. the null pointer. Some systems use slot numbers starting at 1, so Ø (zero) is convenient as the null pointer. Where slot numbers start from zero, a bit pattern is used as the null which is recognised by the software and obviously must not equate to a valid slot number.

The processing of direct and serial files is determined by the physical position of records on a file. Although they have distinct advantages for many applications they can become cumbersome in others. Many file-processing techniques require more volatile and flexible environments. Linked files remove the restriction of strict physical processing and incorporate the concept of a logical record sequence by using pointers on each record to indicate where the next logical record is. Within linked files there are two 'chains' of records — the record chain and the free chain. See figures 6(a) and 6(b).

The null pointer in figure 6(a) denotes the end of the file and theoretically will never be used in a volatile file, since the file would be full. The null pointer in figure 6(b) held in R27, indicates the end of the logical chain of records which, in the diagram, are in physical and logical sequence. Note that in this case the record numbers (R1 - R27) are not synonymous with the slot numbers used but their logical position is determined by the pointers in the record chain.

Suppose we wish to add record 16 (R16) to this record chain which must be preceded by R8 and followed by R21. R8 must point logically to the new R16 and R16 must point to R21. Since there is no physical space between R8 and R21, the first free record must be used to hold R1 as shown in figure 6(c).

Though the records are not in physical sequence, they are in logical sequence since the pointers held on each record maintain the integrity of the record chain. The FFRP takes the value held by the pointer in the record to which it was pointing originally. This will always be the rule when using a linked file.

Returning to figure 6(b), suppose we wish to delete R8, R7 then must point logically to R21. Figure 6(a) shows how R8 is removed from the record chain and released to the free chain for future use.

There are four further possibilities for insertions and deletions with this type of file:

- Deletion of record denoted by FRP.
- Deletion of record denoted by LRP.
- Insertion of record logically preceding FRP.
- Insertion of record at end of record chain.

To avoid any confusion at this stage, each case is shown separately (6e to 6h) with the rules governing the update of the pointers. Again, assume a start condition as in figure 6(b).

The FRP now points to the record which was pointed to by the record which has been deleted. As in figure 6(a) the FFRP is set to the slot which has been deleted and its link is updated accordingly to the value of the old FFRP.

In this case the LRP is set to the record which preceded logically R27. Record 21 is now the last record in the chain and has its pointer set to null. The FFRP is updated in the normal manner.

The FFRP becomes the link from the record to which it pointed and the FRP is set to the old FFRP. The pointer in RO becomes the old FRP. In this case the last record on the file precedes the first although the logical sequence is still intact.

After insertion of R35, the FFRP again becomes the link from the record to which it pointed. The null from R27 is changed to point to the record which was the old FFRP. The new record has a null pointer and the LRP becomes the old FFRP.

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With linked files which have a large number of insertions and deletions, although the logical sequence is maintained, the physical sequence can be lost completely, resulting in slower response times, since logically-adjacent records may be separated by many sectors. It is necessary to re-organise the file periodically, where possible, to keep the system speed to a maximum. The technique of re-organisation will be considered when discussing Indexed Sequential Files.

Linked files as described are rarely used in isolation unless the file size is small or the response times are of no importance. For example, to access a record in the middle of the record chain, one has to start reading from the FRP logically until the required record is found. It is much more practical and often necessary to use linked files in relation to other file types where their speed and flexibility are utilised most efficiently.

In part II I will discuss these file processes to describe the following commonly-used file types:

- Partially-linked files
- Indexed sequential files
- Pooled files
- Spooled output files.

To the hobbyist who wishes to write file-handling software using these concepts, I would suggest a start at direct files only, since most files require the calculation of sector and byte position. The software requirements for files using record links and/or directory pointers generally share common sub-routines used independently of the file type to be processed, so it would be a good idea to understand (a) to (g) above before attempting an integrated file control program.

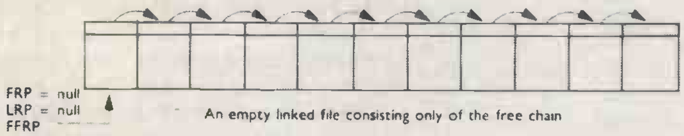


Figure 6 (a).

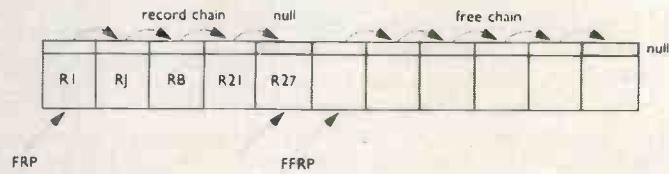


Figure 6 (b).

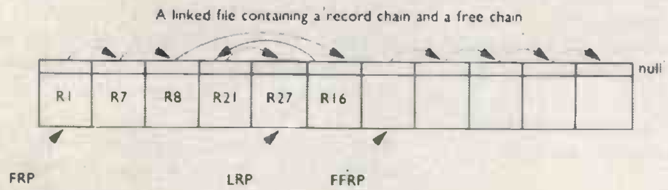


Figure 6 (c).

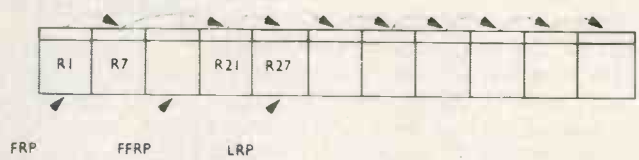


Figure 6 (d).

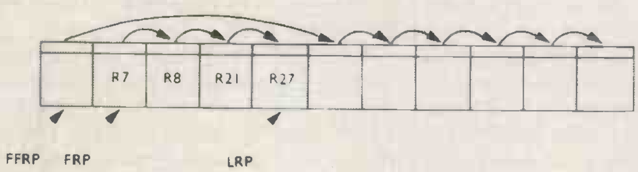


Figure 6 (e).

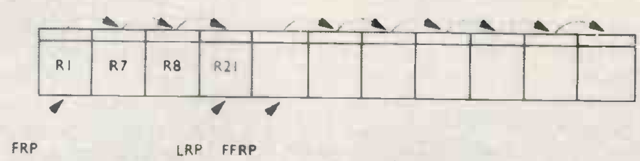


Figure 6 (f).

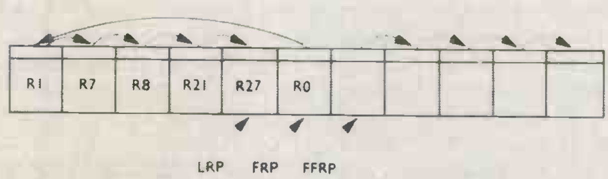


Figure 6 (g).

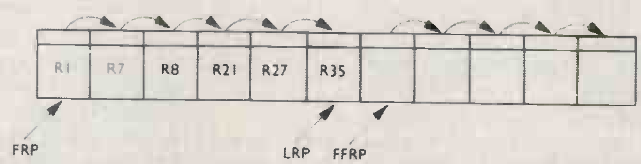


Figure 6 (h).

Process of testing for failures

David Peckett, a professional designer of automatic test equipment, describes how even the wonder-chip can give problems and what to do about it when it does.

YOU'VE BOUGHT your microcomputer and it's working well, but will it work for ever? What do you do if it stops completely? Even worse, what if it works sometimes, but produces garbage at other times? Obviously, it's broken, but how do you find the fault?

I will outline some of the faults which may occur, and show how suitable programs can identify, and sometimes locate, the fault in a corrupt system. I will outline the types of IC failure which may occur, and the broad way in which they can be found. Once we understand the failure modes, we can set-up an ideal test philosophy; and I will give 8080 assembly language programs to test a practical micro.

SSI/MSI and LSI chips fail in similar ways but with different effects. Because no point in even an MSI device is more than one or two gates away from a pin, faults will almost invariably force a pin to a logical '1' or '0', and hold it there. These are called 'stuck-at-1' (s-a-1) and 'stuck-at-zero' (s-a-0) faults.

A failure deep inside an LSI chip, however, won't usually cause a 'stuck-at'. Only when suitable data passes through the device will the fault appear, and then only for a few clock cycles. Such faults are called 'soft' faults, and are usually 'pattern-sensitive'.

Soft faults in memory chips are straightforward to find — invariably cause a bit to be s-a-1 or s-a-0. Soft, pattern-sensitive, faults in less-structured LSI devices, such as microprocessors and USART, however, can be much more difficult to find. LSI devices can, of course, suffer from hard, stuck-at, faults as well as soft faults

Two stages

A software 'self-test' of a microcomputer has two principal stages. Initially it must check for stuck-at faults; the second phase looks for identifiable soft faults, particularly in the system memory. It is also possible to use software to detect a partially-failed microprocessor, or to check-out I/O devices, but the technique is too complex to cover in this article.

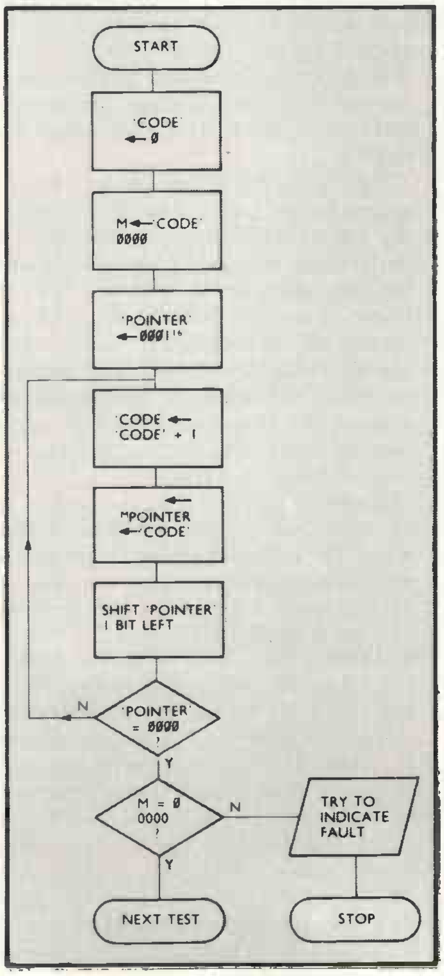
Since the microprocessor communicates with the rest of the system via the address and data busses, they must be checked as fully as possible before doing anything more subtle. Unfortunately, any program will be corrupted by a faulty data bus, so we have to assume that this is in order. We would need special test equipment to find data bus faults.

Although we can often detect a failed address line, it is often more difficult to output the test result, since the corrupt line may well make it impossible to run I/O routines. Having made sure, as far as practicable, that there are no hard faults, we can look for soft faults, particularly in the memory.

● **Memory testing:** Most faults in RAMs force single bits permanently to '1' or '0'. Those faults can be located easily by writing, and then reading, all '0's and all '1's to the RAM. An s-a-1 or s-a-0 bit will be glaringly obvious. Less often, however, RAMs can show pattern-sensitivity, in which faults depend on the data in the chip. There are many complex and lengthy tests to find this type of defect and the test for any particular chip depends on the physical layout of its memory cells.

Straightforward, but effective, tests for any design of RAM, however, are 'walking a 1' and 'walking a 0'. This means that we clear the memory, and then try to set each bit, in turn, to '1', while holding all the others at zero. 'Walking a 0' is obviously the reverse of this process. Using these tests, virtually any soft fault in RAM can be found.

Figure 1. Address bus text.



● **Test program considerations:** The details of the test program, and the faults it can find, particularly the possibility of indicating address bus faults, obviously depend on the system being tested. Certain principles are generally true.

An address line may have 20 devices attached to it; an s-a-0 caused by any of those chips will hold the line at zero. The only 'simple' way to find the faulty device is to change each possible IC in turn; it would be a rare system in which self-test software could go 'beyond the node'. If no blatant stuck-at faults exist, the memory can be tested and, if required, the other LSI chips also checked.

Short as possible

The self-test program must be as short as possible; to run at all it assumes that the data bus and the microprocessor work correctly. The address bus test must use the minimum number of address lines to access the program.

All the tests must, wherever possible, use only the internal microprocessor registers, since the state of the system RAM is unknown. Equally, if the program is in RAM, it should be as short as possible to reduce the chance of it being corrupted by a faulty memory chip. If the self-test routine is re-locatable, it could be re-loaded into a different area of memory if it were corrupted in its original location.

A more reliable approach would be to use a PROM, either plugged-in as needed or permanently on-board, to hold the self-test software. Since the program operates mainly on single bits and must be very short, it must be written in machine code. If it were written in Basic, or any other high-level-language, it would probably be so long that most faults would corrupt the program, rather than being found by it.

Any stand-alone test program relies on the data bus and the microprocessor working correctly. The bus would be easy to check — write and read 00_{16} and FF_{16} to and from any memory location. Unfortunately, any possible program to do this would be corrupted by a stuck data bus line. It is not even possible to carry out the test via the monitor, because a faulty data bus would corrupt the monitor. The first stage, therefore, is to check the address lines and, if possible, try to indicate any fault. If the address bus is in order the RAM can be tested.

● **Testing the address bus.** This test must

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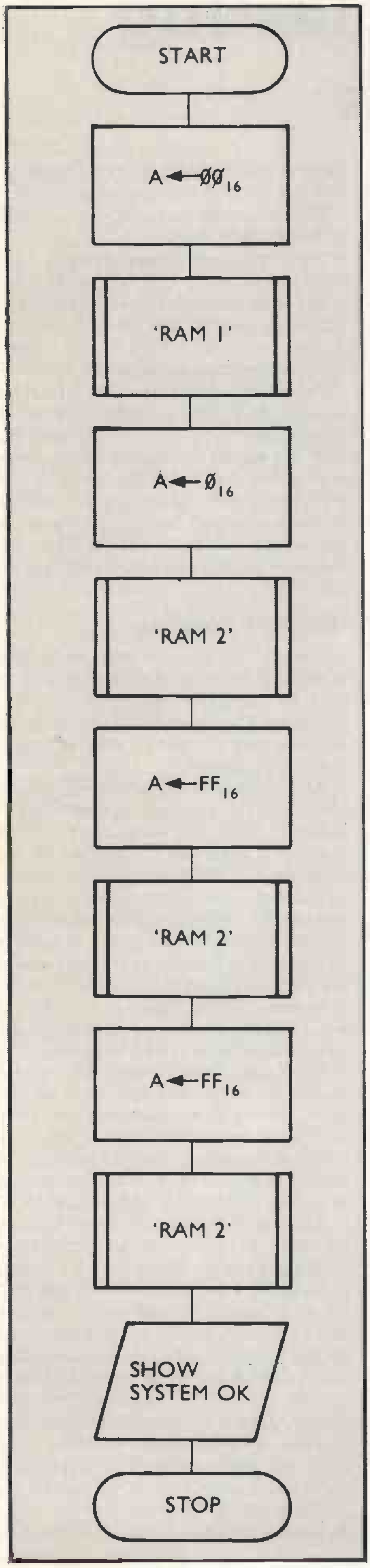
Figure 2. Main program for RAM test.



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check that each line can be set to '1' and '0' independently of all other lines. The simplest way to do this, assuming 16 address lines (A_0 — A_{15}) is to write, in turn, to memory locations 0000_{16}, 0001_{16}, 0002_{16}, 0004_{16}, 0008_{16} . . . .4000_{16},8000_{16} — a total of 17 write cycles. For each cycle, a different code (e.g., 1-17) is loaded into memory. By then reading address 0000 only and checking the code, any faulty lines can be identified.

For instance, suppose line A_3 is s-a-0. Then, when 0008_{16} is addressed, the code (e.g., 4) is loaded into address 0000, overwriting the existing code (1) at that location. The following test would expect 0000_{16} to contain 1 but would find 4. Alternatively, if A_3 was s-a-1, reading 0000 would read the 4 in 0008_{16}. Either way, the faulty address line could be identified easily. If there is a fault, the program should attempt to display it and then stop.

Specially adapted

Obviously, this technique can be used only for addresses in RAM and must be adapted to suit specific systems. It could be extended to test addresses in ROM by, e.g., reading address 0100_{16} and checking for the correct code (e.g., A8). Figure 1 is a flow chart for the general test.

● **RAM test.** Once we are content with the address bus, we can test the RAM. Remember that this test will check that the memory can be cleared and set to all '1's, and will walk '1' and '0' round the RAM. It is obviously convenient to walk the '1' immediately after clearing the memory and to walk the '0' after setting each byte to FF_{16}.

Any failing bit will be obvious and the address of the fault known. With this data and a knowledge of the physical layout of the memory board(s), it is easy to identify the failed chip, and to replace it. Since we know that the address bus is not corrupted, the program can be long enough to display a short fault message. As before, the details of the program will depend on the system being tested. General flowcharts for the program are given in figures 2, 3 and 4.

Having decided what tests are necessary, we can write code to perform them. The following examples are in 8080 assembly language. They would, of course, run on a Z-80 but would not make best use of its abilities.

● **Address test.** The flowchart of figure 1 is for a system with 64K of RAM. This is not very likely but the general program is shown in figure 5. The routine requires 17_{10} bytes of RAM, plus the display function, and thus cannot test address lines A_0-A_4, which must be satisfactory for it to run. It therefore tests lines A_5-A_{15} and the index register (H,L) is initialised to 0020_{16}. A clear run causes a jump to the next test, otherwise the program tries to show the fault. The display procedure will be dependent entirely on the target system; you must assess the best way to write it.

You may well have to modify the program further. It can test only the RAM addresses in your system; calls to ROM addresses are best checked by making sure the correct data is found, e.g:

```
MOV  A,M
CPI  A8
JNZ  'FAULT'
```

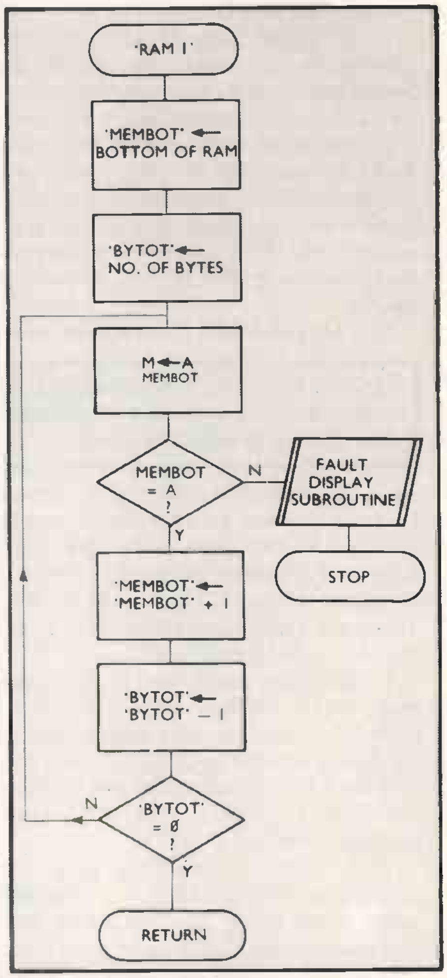

Figure 3. RAM 1 subroutine.

In practical terms, this means that the test is really useful only for systems with a good deal of RAM in them.

● **RAM test.** Figure 6 is an 8080 program for the RAM test of figures 2-4. As you can see from the code, the program uses all the internal registers of the 8080 and only the stack is in RAM. This means that the maximum amount of RAM can be tested. The program, unfortunately, is not re-locatable — it is very cumbersome to achieve this with a 8080 (unlike, e.g., a 6800).

Thus if you do not use a self-test PROM, you may need two versions of the code, so that if the first load is corrupted, you can put it somewhere else in the memory. The program assumes that the stack is at the top of memory, and the (H,L) register is set initially to the lowest address to be tested. It is then incremented through the RAM, testing each byte.

A failure, or a satisfactory test, produces calls to subroutines 'FLTIND' and 'DISPLY respectively. I have not defined them, since they will depend on your own system and its output. They should be easy to write, however; on a failure (H,L) contains the failing address and A contains what should have been in it.

Two areas of the code may need a little explanation. In the 'walking bit' tests, register C is used to re-set each byte to 00 or FF at the end of the byte's test. Without this, the byte would stay at the last value to which it was set, either 80 or 7F. Either way, the program fault cover would be reduced, as the test relies on every bit in the RAM being set to '0' as a '1' is walked, and vice-versa.

The second detail is the way of controlling the outer loops of 'RAM1'

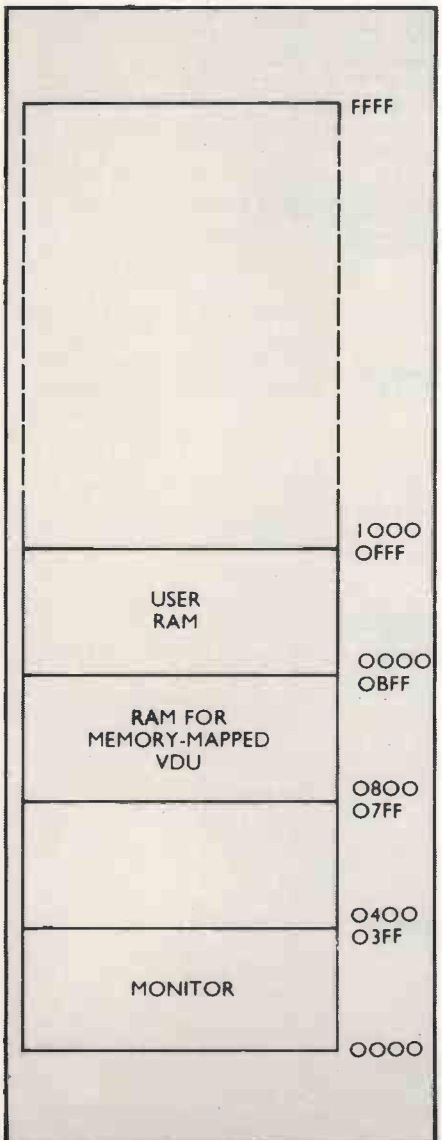

Figure 7. Possible system memory map.

and 'RAM2' via (D,E). The 8080 does not set flags as the 16-bit register (D,E) is decremented through zero; we cannot, therefore, use this for the jump test.

Instead, D and E have to be decremented separately, with the high byte, D,

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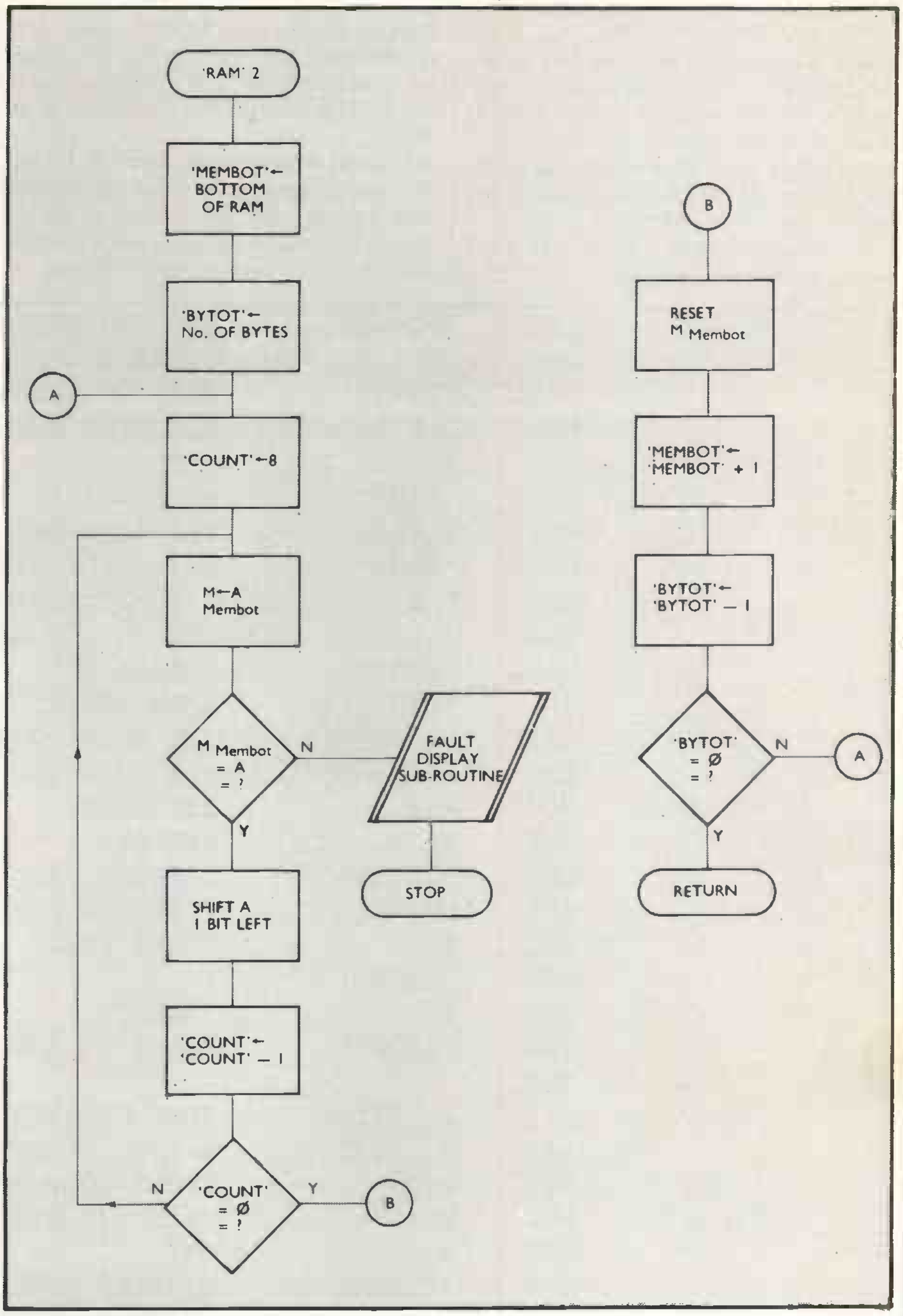

Figure 4. Walking bit test.

Figure 5. Address test program.

```
         LXI   H,0020    H,L USED FOR ADDRESSING
         XRA   A         SET A TO 0
         STA   0000      SET 0000(16) TO 0
'LOOPA'  INR   A
         MOV   M,A
         DAD   H         SHIFT H ONE BIT LEFT
         JNC   'LOOPA'
         MOV   A,M       H,L NOW AT 0000
         CZ    'NXTST'   GO TO NEXT TEST IF OK
          :              TRY TO SHOW FAULT
```

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being decremented each time E passes through zero. The return from the subroutine is made when D reaches zero. D must therefore contain the number of times E is to reach zero, which is given by the number of times that E is decremented wholly or partly to 00 from FF.

To achieve this, D is set to one more than the high byte in 'BYTOT' unless E is initially zero. For example, if $079F_{16}$ bytes are to be tested, set (D,E) to $089F_{16}$, but if 'BYTOT' is 0400_{16}, then (D,E) should be 0400_{16}.

● **Systems with separate areas of RAM.** The test program is designed for systems with a single, contiguous, area of RAM. This is not always the case; some systems have two or more separate blocks of RAM, while in others it is difficult to load programs directly into the lowest RAM addresses (figure 7). Nevertheless, we must still test all the memory ICs.

We can convert the program of figure 6 into a subroutine, with the size of each RAM block ('BYTOTx') and its start address ('MEMBOTx') passed as variables. Figure 8 shows one way of doing this. The two variables are passed in registers (D,E)

Figure 6. RAM test program.

```
           LXI    SP,abcd       abcd IS TOP OF MEMORY
           XRA    A             CLEAR A
           CALL   'RAM1'        TEST TO CLEAR MEMORY
           MOV    C,A           CLEARS C FOR 'RAM2'
           INR    A             A TO 01
           CALL   'RAM2'        WALK A '1'
           MVI    A,FF          SET A TO FF
           CALL   'RAM1'        SET EVERY BIT TO '1'
           MOV    C,A           C TO FF FOR NEXT TEST
           DCR    A             SET 'O' TO WALK ROUND
           CALL   'RAM2'        WALK A 'O'
           JMP    'DISPLAY'     SHOW RESULT IS OK
'RAM1'     LXI    D,'BYTOT'     SET LOOP COUNTER. SEE TEXT
           LXI    H,'MEMBOT'    H,L TO START ADDRESS
'LOOP1'    MOV    M,A           SET BYTE
           CMP    M             SET OK?
           CNZ    'FLTIND'      DISPLAY FAULT
           INX    H             POINT TO NEXT BYTE
           DCR    E             COUNT DOWN
           JNZ    'LOOP1'
           DCR    D             "CARRY"
           JNZ    'LOOP1'       COUNT TO ZERO?
           RET
'RAM2'     LXI    D,'BYTOT'     LOOP COUNTER
           LXI    H,'MEMBOT'    H,L TO START ADDRESS
'LOOP2'    MVI    B,08          INNER LOOP COUNTER
'LOOP3'    MOV    M,A           WALK ONE BIT
           CMP    M             OK?
           CNZ    'FLTIND'      DISPLAY FAULT
           RLC                  SHIFT A
           DCR    B
           JNZ    'LOOP3'       ANOTHER BIT?
           MOV    M,C           RESET BYTE
           INX    H             POINT TO NEXT BYTE
           DCR    E             COUNT DOWN
           JNZ    'LOOP2'
           DCR    D             "CARRY"
           JNZ    'LOOP2'       COUNT TO ZERO?
           RET
'FLTIND'    :                   SHOW FAULT
            :
            :
           RET
'DISPLAY'   :                   SHOW SYSTEM IS OK
            :
            :
```

and (H,L) of the 8080; the first act of the subroutine is to store them in suitable locations, such as the first four bytes of memory. The data is then available for the 'RAM1' and 'RAM2' subroutines.

With the memory map of figure 7, addresses $0C00_{16}$—$0C03_{16}$ could be used as 'STORE1' and 'STORE2', with the program starting at $0C04_{16}$. The stack pointer should be set to 1000_{16}, and the two areas of RAM are that for the memory-mapped VDU, and the remains of the user RAM. The necessary test is then straightforward.

Conclusions

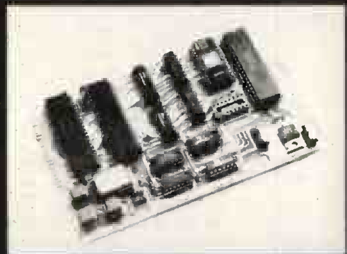
• Microcomputers are fine when they work; they are, however, bound to fail from time to time. Since a major source of failures will be the LIS chips in the system, we must design suitable tests for them.

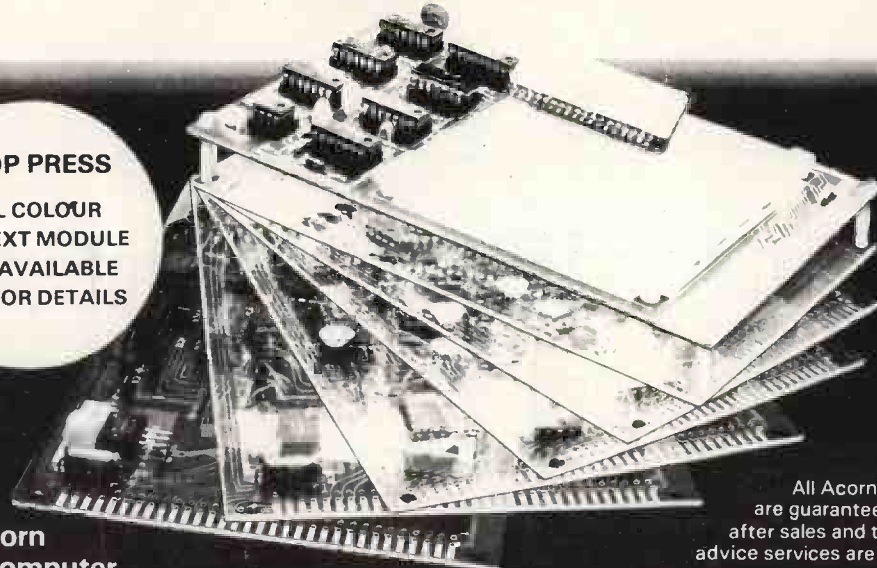
• It is particularly easy to use software to test the RAM in the system and the single failed chip normally can be identified directly.

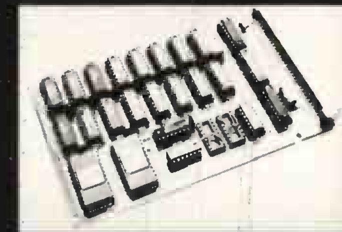
• In principle, it is also possible to test automatically the address lines but the system configuration may well prevent this.

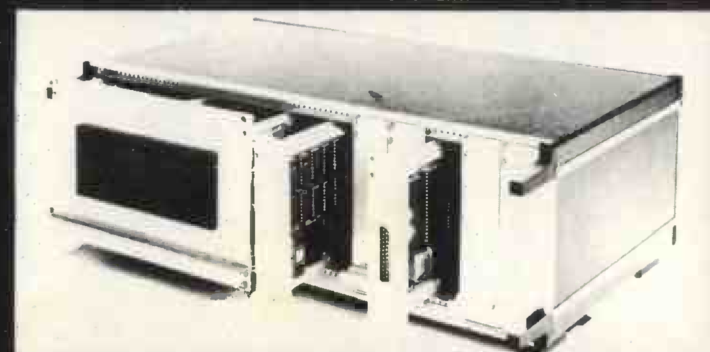
Figure 8. Testing several block of RAM.

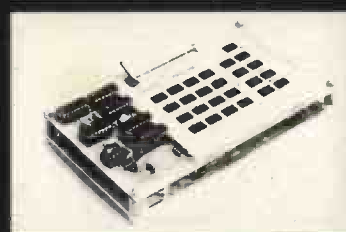
```
          LXI   SP,abcd        abcd IS TOP OF MEMORY
          LXI   H,'MEMBOT1'    START OF FIRST BLOCK
          LXI   D,'BYTOT1'     NO OF BYTES IN FIRST BLOCK
          CALL  'MEMTST'       TEST FIRST BLOCK
          LXI   H,'MEMBOT2'    START OF SECOND BLOCK
          LXI   D,'BYTOT2'     NO OF BYTES IN SECOND BLOCK
          :
          :                    TEST NEXT BLOCK(S)
          :
          JMP   'DISPLAY'      SHOW RESULT IS OK
'MEMTST'  SHLD  'STORE1'       SAVE START OF BLOCK
          XCHG
          SHLD  'STORE2'       SAVE NO OF BYTES
          XRA   A              CLEAR A
          CALL 'RAM1'
          :
          :                    AS FIGURE 6
          :
          CALL 'RAM2'
          RET
'RAM1'    LHLD  'STORE2'
          XCHG                 D,E TO NO OF BYTES
          LHLD  'STORE1'       H,L TO START OF BLOCK
'LOOP1'   MOV   M,A            SET BYTE
          :
          :                    AS FIGURE 6
          :
          RET
'RAM2'    LHLD  'STORE2'
          XCHG                 D,E TO NO OF BYTES
          LHLD  'STORE1'       H,L TO START OF BLOCK
'LOOP2'   MVI   B,08           INNER LOOP COUNTER
          :
          :                    AS FIGURE 6
          :
          RET
'FLTIND'  :
          :                    SHOW FAULT
          :
          RET
          RET                  RETURN FROM 'MEMTST'
'DISPLAY' :
          :                    SHOW SYSTEM IS OK
          :
```











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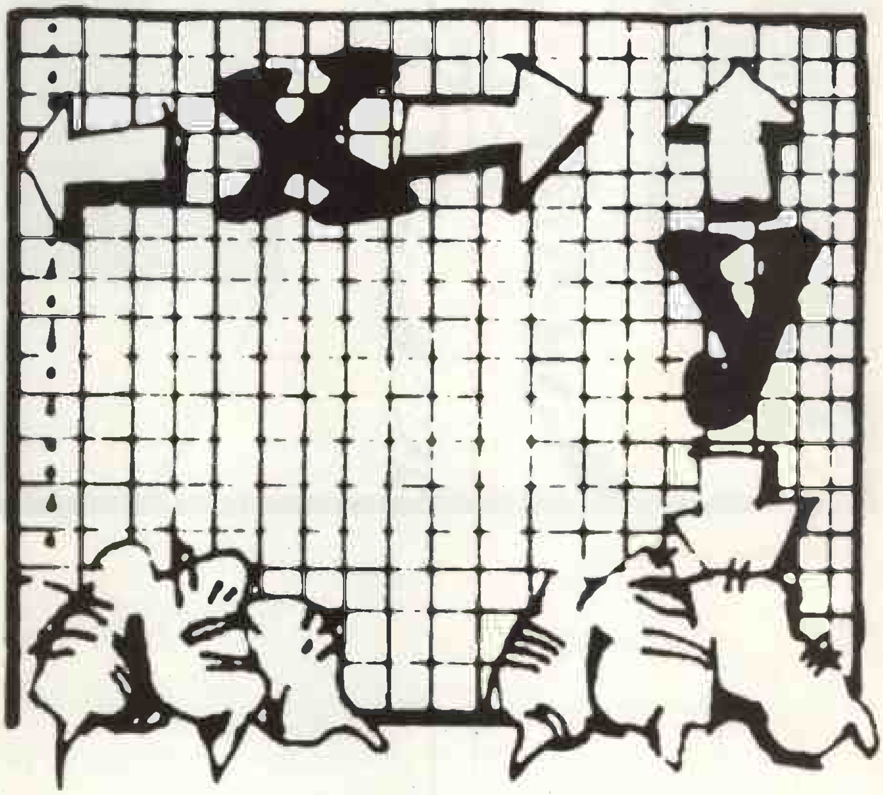
Data — the sword of peace is yours

THIS VERSION of the Kingly Orb was adapted for the 380-Z using XDB by Bennet and Adam Laurie. There may be a problem on other machines caused by function definitions, as at lines 90,100. Those functions may have to be inserted explicitly or done as GOSUBs.

Line 340 is a Print Using alert; if your Basic does not have it, print the integers of X1, X2. Watch for double = , as in line 150. You may have to write: P1 = 2: P2 = 9 'S' in line 120 sets your power.

Good luck, and may megabyte powers be with you.

```
10 CLEAR 1000
20 ?"DO YOU WANT INSTRUCTION
S?(YES,NO OR SPELLS)";
30 INPUT A$
40 IF A$="YES" THEN GOSUB 19
60
50 IF A$="SPELLS" THEN GOSUB
 2340
60 GOSUB 2460
70 DIMA(100,3),D(5)
80 L=1
90 DEFFNR(X)=INT(X*RND(25)+1
)
100 DEFFND(X,Y,X1,Y1)=SQR((X
-X1)*(X-X1)+(Y-Y1)*(Y-Y1))
110 P=3
120 S=500
130 C0=0
140 D=999
150 P1=P2=9
160 FORI=1TO100
170 A(I,1)=FNR(10)
180 A(I,2)=FNR(3)
190 NEXTI
200 X1=X2=FNR(100)
210 D1=FNR(100)
220 D2=FNR(100)
230 IF D1=X1ORD2=X2THEN 210
240 IFFNR(1000)>600THEN270
250 I=FNR(100)
260 GOTO490
270 REM
280 IFC0<1THEN330
290 D=FND(X1,X2,D1,D2)
300 IFC0<2THEN330
310 P1=SGN(D1-X1)
320 P2=SGN(D2-X2)
330 PRINT USING340;X1,X2
340 !YOU ARE AT ### ###
350 IFC0<1THEN390
```

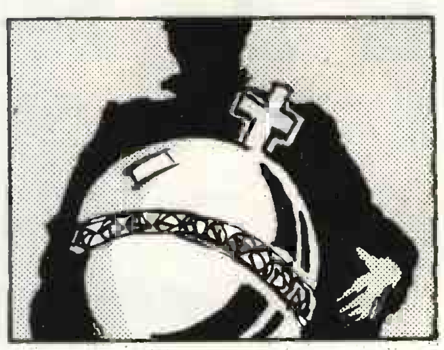


```
360 ?"  AND ARE ";INT(D);"AW
AY FROM THE MAGIC SPOT"
370 IFC0<2THEN390
380 ?"YOUR COMPASS READS ",P
1;P2
390 IF D=0 THEN1080
400 IF C0>0THEN420
410 ?
420 ?"DIRECTION";
430 INPUT C1,C2
440 IF FND(X1,X2,X1+C1,X2+C2
)>20 THEN 1400
450 X1=X1+C1
460 X2=X2+C2
470 GOSUB 1520
480 GOTO240
490 REM
500 READ C$(1),C$(2),C$(3)
510 FOR J=1TOA(I,1)
520 READ B$,S0
530 READ D(0),D(1),D(2),D(3)
,D(4)
540 NEXT J
550 RESTORE
560 S0=S0*L
570 T=A(I,2)
580 IF S<=30*L OR P<>10 THEN
 600
590 T=2
600 ?"YOU HAVE FOUND A";C$(T
);" ";B$;" WITH POWER ";S0
610 ON T GOTO 640,780,620
620 IF FNR(10)<5 AND (S<=30*
LOR P<10)THEN640
630 GOTO930
640 C0=C0+1
650 IF C0>3THEN 670
660 ON C0 GOTO 710,730,750
670 IF S<L*30 THEN 750
680 ?"YOU HAVE BEEN TAUGHT S
PELL NUMBER";P+1
690 P=P+1
700 GOTO 270
710 ?"YOU HAVE BEEN GIVEN A
DISTANCE METER"
720 GOTO 270
730 ?"YOU HAVE BEEN GIVEN A
COMPASS"
```

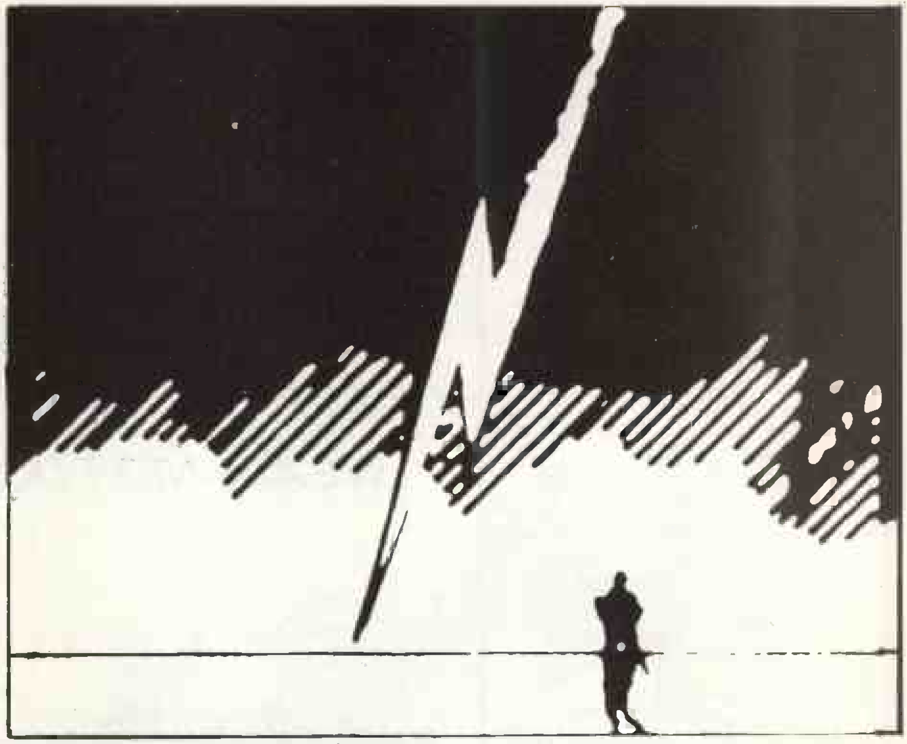
(continued on next page)

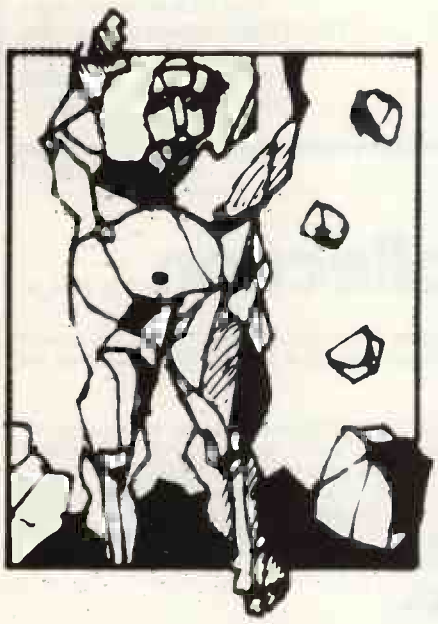
(continued from previous page)

```
740 GOTO 270
750 ?"YOUR STRENGTH HAS BEEN
 INCREASED"
760 S=S+50*L
770 GOTO 270
780 D3=S-50
790 IF D3<0 THEN 930
800 ?"WHAT SPELL NUMBER?";
810 INPUT V
820 IF V=0 OR (V>10 AND V<10
+L AND L>1) THEN 1260
830 IF V>P  OR V<0 THEN 890
840 FOR I2=1  TO 5
850 IF D(I2)=V THEN 880
860 NEXT I2
870 IF FNR(5) <>3 THEN 1060
880 GOTO 910
890 ?"YOU CANNOT USE THAT SP
ELL"
900 GOTO 800
910 S0=S0-V*10
920 IF S0<=0 THEN 970
930 P3=S0/10/L
940 V=FNR(INT(P3))
950 ?"THE ";B$;" USES A SPEL
L NUMBER ";V;" ON YOU"
960 S=S-V*10
970 ?" YOU HAVE A STRENGTH O
F ";S
980 IF S0<=0 THEN 1030
990 IF S>0 THEN 800
1000 ?"YOU HAVE FAILED IN YO
UR QUEST. YOU WERE FOULY"
1010 ?"MURDERED BY A ";B$;".
 BAD LUCK."
1020 STOP
1030 ?"THE ";B$;" IS NO MORE
. ONCE MORE THE POWERS OF GO
OD WIN THROUGH."
1040 ?"NOW CONTINUE WITH YOU
R QUEST."
1050 GOTO 270
1060 ?"YOUR SPELL HAD NO AFF
ECT"
1070 GOTO 930
1080 ?"YOU ARE STOOD ON THE
MAGIC SPOT"
1090 READ A$,A$,A$
1100 FOR I=1 TO 10
1110 READ A$,A,A,A,A,A,A
1120 NEXT I
1130 FOR I=1 TO L
1140 READ A$
1150 NEXT I
1160 RESTORE
1170 ?A$
1180 L=L+1
1190 IF L=6 THEN 1250
1200 IF P=10 THEN 1230
1210 ?"EXTRA WISDOM MEANS TH
AT YOU KNOW SPELL ";P+1
1220 P=P+1
1230 ?"YOU HAVE BEEN TRANSPO
RTED TO ANOTHER LEVEL"
1240 GOTO 200
1250 STOP
1260 IF V>P THEN 1570
1270 ?"DIRECTION TO RUN IN"
1280 INPUT A,B
1290 IF FND(X1,X2,X1+A,X2+B)
<=20 THEN 1320
1300 ?"YOU CANNOT GO THAT FA
R"
1310 GOTO 1270
1320 X1=X1+A
1330 X2=X2+B
1340 GOSUB 1520
1350 IF FNR(1000)>600 THEN 1
380
1360 ?"THE ";B$;" HAS NOT FO
LLOWED YOU"
1370 GOTO 240
1380 ?"THE ";B$;" IS IN HOT
PERSUIT"
1390 GOTO 930
1400 ?"YOU CANNOT GO THAT FA
R"
1410 GOTO 290
1420 X1=1
1430 GOTO 1490
1440 X1=100
1450 GOTO 1490
1460 X2=1
1470 GOTO 1490
1480 X2=100
1490 S=S*.9
1500 ?"YOU HAVE BUMPED INTO
A WALL AND LOST 10% OF YOUR
STRENGTH"
1510 RETURN
1520 IF X1<1 THEN 1420
1530 IF X1>100 THEN 1440
1540 IF X2<1 THEN 1460
1550 IF X2>100 THEN 1480
1560 RETURN
1570 S(V-10)=S(V-10)+1
1580 IF S(V-10)=1 THEN 1610
1590 ?"YOU HAVE ALREADY USED
 THAT OBJECT OF STATE "
1600 GOTO 800
1610 IF V=11 AND B$="ROCK MO
NSTER" THEN 1670
1620 IF V=12 AND B$="MUMMY"
THEN 1670
1630 IF V=13 AND B$="GIANT"
THEN 1670
1640 IF V=14 AND B$="WIZARD"
 THEN 1670
1650 ?"THE ";B$;" IS UNDAMAG
ED"
1660 GOTO930
1670 IF FNR(1000)<100 THEN 1
650
1680 ?"THE OBJECT OF STATE W
ON"
1690 GOTO 1040
1700 DATA " GOOD","N EVIL","
 NEUTRAL"
1710 DATA DRAGON,57
1720 DATA 4,6,7,9,10
1730 DATA WITCH,25
```



```
1740 DATA 2,3,5,8,10
1750 DATA WIZARD,82
1760 DATA 2,3,5,8,10
1770 DATA VAMPIRE,12
1780 DATA 4,6,7,9,10
1790 DATA ROCK MONSTER,36
1800 DATA 4,7,8,9,10
1810 DATA MUMMY,47
1820 DATA 3,6,8,10,2
1830 DATA GOLD HORSE,78
1840 DATA 3,4,6,10,8
1850 DATA SAND MAN,34
1860 DATA 1,4,10,7,5
1870 DATA GIANT,75
1880 DATA 10,3,6,8,7
1890 DATA WATER WORM,30
1900 DATA 10,8,3,2,1
1910 DATA YOU HAVE FOUND THE
 GREAT RING
1920 DATA YOU HAVE FOUND THE
 KINGLY ORB
1930 DATA THE ROBES OF STATE
 ARE YOURS
1940 DATA THE SWORD OF PEACE
 IS YOURS
1950 DATA YOU ARE NOW THE TR
UE MONARCH OF OZ
1960 ?"YOU ARE THE CROWN PRI
NCE OF OZ."
```





```
1970 ?"TO PROVE THAT YOU ARE
 WORTHY OF THE TITLE OF MONA
RCH,YOU MUST PASS A TEST. YO
U ARE CAST INTO A DUNGEON TO
 FIND FOUR OBJECTS OF STATE.
 THESE ARE HIDDEN ON ONE PAV
ING SLAB ON EACH DUNGEON LEV
EL."
1980 ?"THIS IS KNOWN AS THE
MAJIC SPOT. EACH DUNGEON LEV
EL IS 100 SLABS BY 100 SLABS
 IN SIZE. YOU MAY TRAVEL 10
SLABS IN ANY DIRECTION. DIRE
CTION IS GIVEN BY THE VECTOR
 (X,Y). INPUT THIS (WITHOUT
THE BRACKETS) WHEN ASKED FOR
 DIRECTION. YOU MAY MEET "
1990 ?"VARIOUS MONSTERS ON Y
OUR QUEST. NEUTRAL MONSTERS
MAY ACT AS GOOD OR EVIL. GOO
D MONSTERS WILL GIVE YOU THI
NGS WHICH WILL DO YOU GOOD.
THE FIRST WILL GIVE YOU A DI
STANCE METER WHICH WILL SHOW
 HOW FAR AWAY FROM THE MAJIC
 SPOT YOU ARE.(YOU CAN "
2000 ?"FIND THE MAGIC SPOT W
ITH ONLY THIS.)THE SECOND MO
NSTER WILL GIVE YOU A COMPAS
S TO SHOW YOU THE DIRECTION
TO GO (X,Y) THESE ARE -1,0 O
R 1.ALL SUBSEQUENT MONSTERS
 EITHER GIVE YOU ANOTHER SPE
LL OR MORE STRENGTH IF YOU N
EED IT."
2010 ?"  EVIL MONSTERS ON TH
E OTHER HAND TRY TO KILL YOU
.THEY CAST SPELLS ON YOU WHI
CH LOWER YOUR STRENGTH. YOU
DO THE SAME FOR THEM.IF EITH
ERT OF YOUR STRENGTHS DROP B
ELOW ONE YOU ARE DEAD."
2020 ?"  BY CASTING SPELL 8
YOU MAY RUN AWAY FROM THE MO
NSTER HE MAY OR MAY NOT FOLL
OW YOU,IN WHICH CASE YOU HAV
E LOST YOUR CHANCE TO CAST A
 SPELL."
2030 ?"  AS YOU COLLECT THE
OBJECTS OF STATE YOU MAY USE
 THEM TO DESTROY ONE MONSTER
 PER OBJECT.EACH OBJECT IS T
UNED TO ONLY ONE SPECIES AND
 HAS A 10% CHANCE OF FAILURE
."
2040 ?"TO USE THE OBJECTS OF
 STATE TYPE SPELL NUMBERS 11
 TO 14 FOR:"
2050 ?"GREAT RING,KINGLY ORB
,ROBES OF STATE,SWORD OF PEA
CE RESPECTIVELY"
2060 ?"MONSTERS ARE NOT SUSC
EPTIBLE TO ALL OF THE SPELLS
.AT FIRST YOU CAN ONLY USE S
PELLS 1,2 AND 3."
2070 ?"  WHEN YOU REACH THE
FIFTH MAGIC SPOT YOU WIN."
2340 ?"THE SPELLS ARE:-"
2350 ?"(1)LANDSLIDE    (6)MAK
E SWAMP"
2360 ?"(2)WIND         (7)RAI
N OF HOLY WATER"
2370 ?"(3)FIREBALL     (8)EAR
THQUAKE
2380 ?"(4)MAKE POOL    (9)RAI
NSTORM
2390 ?"(5)CREATE HOLE (10)TH
UNDERSTORM"
```

```
2400 ?"THE OBJECTS OF STATE
DESTROY:"
2410 ?"GREAT RING==ROCK MONS
TER"
2420 ?"KINGLY ORB==MUMMY
2430 ?"ROBES OF STATE==GIANT
"
2440 ?"SWORD OF PEACE==WIZAR
D"
2450 RETURN
2460 ?"GOOD LUCK, YOUR IMPER
IAL HIGHNESS!"
2470 ?"(YOU'LL NEED IT )"
2480 RETURN
```

Arithmetic without need for number-cruncher

AT FIRST SIGHT microcomputers seem made for number-crunching. As Owen Bishop points out, however, this is not necessarily so and special measures may be necessary. Bishop is a biologist and author of *Statistics for Biologists*.

IF YOU have attempted an analysis of variance or tried to calculate a co-efficient of regression, you will have become painfully aware that statistical analysis involves a good deal of squaring and summing of many numbers which have an excessive quantity of significant figures.

Beware of trying to simplify the task by reducing the number of significant figures, for, at the end of calculation, you may be required to subtract one large number from another slightly greater number and base your conclusions on the relatively minute difference between them.

If you have already discarded too many significant figures, you may find that you have a negative difference, which is meaningless. Even if the difference is positive it could still be seriously in error.

In the days before electronic calculators, the task of working-out an analysis on paper was one of the most tedious operations imaginable. The coming of the calculator, especially the dedicated statistical calculator with built-in programs, has made a vast difference to the lives of those who have need from time to time to wrestle with statistics.

Now follows the microprocessor but alas, in spite of all its advantages, it is not designed to handle the large arrays of figures and perform the relatively-complex calculations traditional methods of analysis require. Coupling it to a number-cruncher is asking the microprocessor to do your job at the calculator keyboard and is not really taking advantage of the special features of the microprocessor.

Distribution

The mention of traditional methods of analysis is a reference to those tests such as the t-test, the analysis of variance and the chi-square test, which depend on the assumption that the data being analysed is distributed according to a known and clearly-defined pattern.

It is assumed that items of data are likely to be clustered around their mean value in some particular way. Many tests assume that the data is normally distributed. What is meant by the normal distribution needs some fairly complex mathematics to describe it, for the point is that if analysis relies on data being so distributed when the data is not so distributed, our analysis will be faulty. We may arrive at the wrong conclusion.

If we have a large amount of data, it may be possible to find its distribution pattern but if, as usually happens, the amount of data is small, there is no way of knowing how it is distributed.

Distribution-free tests — or non-parametric tests — do not rely on assumptions about distribution. They are easy to understand, they work just as well when the amount of data is small, and they do not require long calculations with innumerable significant figures.

Even a microprocessor can cope with the arithmetic required, without assistance from a number-cruncher. These tests may require somewhat tedious and lengthy manipulation of the data — sorting, ranking, re-arranging rows or columns of tables — but this is all to be done according to simple logical rules. The conclusion is that the microprocessor and the distribution-free test were made for each other.

As an example of a distribution-free test, some can be used for analysing problems not covered by the parametric tests. The Runs Test has several other applications. For example, a simple modification gives a way of comparing the means of two sets of data — an equivalent of the t-test. We can also use the Runs Test for investigating trends.

The Runs Test is concerned with a sequence of events. They may be events in time — a list of the days of the month, marked to show on which days a given piece of factory machinery broke down. Or they may be a series of events in space — the brand of TV set used in each of the houses along a street.

Street survey

If '1' represents a house with a TV set made by manufacturer A, an '0' represents a house with a set made by other manufacturers, a survey of the street of 20 houses might be recorded like this:

1 1 1 0 0 0 1 1 1 1 1 1 0 0 0 1 0 0 0

Now, we could ask, if the brand A owners are clustered together more than we might expect if the people had chosen a brand at random? The long run of brand A owners in the middle of the street could mean that people tend to buy their set on the recommendation of their next-door neighbours. If that is true, it could have marketing implications. But is it true?

To analyse the data we assess the degree of clustering by counting the number of *runs* (= u). For our example, u = 6:

111 000 111111 000 1 000
1 2 3 4 5 6

If people are tending to copy their neighbours, the number of runs will be fewer than would be expected by chance. What number can we expect by chance? We can calculate the probability of occurence of different numbers of runs from the minimum (u = 2) to the maximum (u = 20), using the methods of calculating combinations and permutations you learned at school, and set out the results in a Table of Critical Values.

Such a table tells us that with 20 events, as in our example, the probability of a sequence with six runs or fewer is only one in 20. The chance of more than six runs is 19 in 20. Given this we can say:

either 'this street is the odd one in 20 which has as few as six runs; it tells us nothing about how people choose TV sets;
or 'it is unusual to find as few as six runs; there are 19 chances in 20 that people are copying their neighbours; this is an important fact for the next sales promotion.

Most people would be happier to act on the second statement, while accepting the one in 20 risk that the first statement was correct.

The essence of the Runs Test is to arrange the data in sequence, count the runs, and compare the number to the critical value (U) looked-up in the table. The table has three sets of critical values for each of the probability levels 1 in 20 ($p = 0.05$), 1 in 100 ($p = 0.01$) and 1 in 1000 ($p = 0.001$) so we need to look at each set in turn.

Comparisons

The data is entered in memory as a series of 0s and 1s; the total number of events—e.g. houses—is entered after the last item of data. The program reads the first datum and the second. If the second is not 0 or 1, it must be the total number of events (2n), meaning that the data has all been examined and the program must move on to display the result.

During the operation of the program, each item of data is compared to the item following it, to see whether or not they are equal. If they are equal the run continues;

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if they are unequal, a new run is recorded.

When all data has been examined, the number of runs and the total number of events is in memory. Next 2n is halved to give n, used in locating the appropriate line in the table of critical values.

The program looks up U for the given value of n and for $p = 0.001$. If u is less than or equal to U, P 0.001, and the program builds up this information in the display stores and displays '$p \leq 0.001$'. If u is greater than U, the program looks at the next section of the table, to find U when $p = 0.01$.

If $u \leq U$ at this stage the display reads '$p = 0.001$', but if $u > U$, the program looks finally at the third section of the table for which $p \leq 0.05$. Even at this stage u may be greater than U, indicating that the number of runs is so large as to be unremarkable, and the display then shows '$p > 0.05$', a result which is generally of no interest. These are not the kind of odds on which we would wish to base a major marketing scheme.

Adaptable

The program is given in machine code for the MK-14, to prove that even a small system can handle useful statistical tests. The program is explained in some detail, so that readers can adapt it for other systems. The main program runs in basic RAM, leaving room for some small additions to adapt the test for other applications.

The table of critical values and the table of data are entered in extra RAM. There is room for entering far more than the 40 items of data for which the program is designed. Those users who handle longer series of data frequently can calculate and enter an extended critical values to cater for their requirements.

RUNS TEST

Performs Runs Test on a maximum of 40 values, 0 or 1, entered from 0B00, and displays significance level. Main program relocatable; tables relocatable by changing pointers.

```
0000        = 0F1D
0F1D        u, counts number of runs
0F1E        d1, first datum of a pair
0F1F        d2, next datum after d1
0FCF - 0FD4 stores for display
            characters
0B00        table of data
0B80        table of critical values
            of U
2n= number of values entered and is
stored at end of data table

0F20  C40B  LDI    0B
0F22  35    XPAH   P1
0F23  C400  LDI    00
0F25  31    XPAL   P1
Points P1 to table of data (0B00)
0F26  C40B  LDI    0B
0F28  36    XPAH   P2
0F29  C480  LDI    80
0F2B  32    XPAL   P2
Points P2 to table of critical values
(0B80)
0F2C  C401  LDI    01
0F2E  C8EE  ST
Sets 0F1D to 1, ready for counting
0F30  C501  A:LD @ P1 +1
Loads d1, first datum
0F32  C8EB  ST   at 0F1E
0F34  C501  A:LD @ P1 + 1
Loads d2, next datum
0F36  C8E8  ST   at 0F1F
0F38  1C    SR   gives 00 only if d2
is 00 or 01: tests for end of data list
0F39  9C13  JNZ to C
0F3B  C0E3  LD  d2 from 0F1F
0F3D  E0E0  XOR with d1 from 0F1E;
gives 0 if d1 = d2
0F3F  9807  JZ   to B end of run not
reached yet
0F41  C401  LDI  01
0F43  02    CCL
0F44  E8D8  DAD  u + 1
0F46  C8D6  ST   at 0F1D
Increments runs counter as run ends
0F48  C0D6  B:LD  d2 from 0F1F
0F4A  C8D3  ST    d2 to 0F1E
0F4C  90E6  JMP   to A, to collect
next datum and put in 0F1F
0F4E  C0D0  C:LD  2n, from 0F1F
0F50  1C    SR    2n/2 = n,
discarding any ½
0F51  01    XAE   n in extension
register
0F52  C280  LD    P2, displacement =
n; value of U for p = 0.001
0F54  03    SCL  }
0F55  F8C7  CAD  } U - u
0F57  941A  JP    if u⩽U, significant
for p = 0.001; to D
0F59  C411  LDI  X'11  (= 17 10)
0F5B  02    CCL
0F5C  70    ADE  n + 17
0F5D  01    XAE  n + 17 in extension
register
0F5E  C280  LD   P2, displacement =
n + 17; locates value for U for p=0.01
0F60  03    SCL  }
0F61  F8BB  CAD  } U - u
0F63  9418  JP   if u⩽U, significant for
p = 0.01; to E
0F65  C411  LDI  X'11  (= 17 10)
0F67  02    CCL
0F68  70    ADE  n + 34
0F69  01    XAE  n + 34 in extension
register
0F6A  C280  LD   P2, displacement =
n + 34; locates value for U for p=0.05
0F6C  03    SCL  }
0F6D  F8AF  CAD  } U-u
0F6F  9412  JP    if u⩽U, significant
for p=0.05; to F
0F71  901E  JMP  not significant at
p=0.05; to I
0F73  C406  D:LDI 06 (character, 1)
0F75  C859  ST    store 1 (0FCF)
0F77  C43F  LDI   3F (character,0)
0F79  C856  ST    store 2 (0FD0)
p=0.001, stores characters for two
right-hand digits
0F7B  900E  JMP  to H
0F7D  C406  E:LDI 06 (character, 1)
0F7F  C850  ST  store 2     p=0.01
0F81  9004  JMP  to G
p=0.01, stores right-hand digit
0F83  C46D  F:Ld1  6D (character, 5)
0F85  C84A  ST  store 2
p=0.05, stores right-hand digit
0F87  C400  G:LDI 00 (blank)
0F89  C845  ST  store 1
p=0.01 or 0.05, stores blank to right
0F8B  C469  H:LDI 69 (character, ⩽)
0F8D  C845  ST  store 5
p=0.001, 0.01 or 0.05, stores ⩽
0F8F  900B  JMP  to J
0F91  C46D  I:LDI 6D (character 5)
0F93  C83C  ST  store 2
0F95  C44A  LD   4A (character >)
0F97  C83B  ST  store 5
not significant, stores > & 5, with two
blanks between
0F99  C43F  J:LDI 3F (character, 0)
0F9B  C835  ST  store 3
0F9D  C4BF  LDI  BF (character,0·)
0F9F  C832  ST   store 4
0FA1  C473  LDI  73 (character, P)
0FA3  C830  ST   store 6
For all results, stores P, space, 0.0
0FA5  C40D  K:LDI  0D
0FA7  35    XPAH  P1
0FA8  C400  LDI   00
0FAA  31    XPAL  P1
Points P1 to display (0D00)
0FAB  C40F  LDI   0F
0FAD  36    XPAH  P2
0FAE  C4CF  LDI   CF
0FB0  32    XPAL  P2
Points P2 to stored characters
0FB1  C200  LD    P1 + 0
```

```
0FB3  C901  ST    P2 + 1
0FB5  C201  LD    P1 + 1
0FB7  C902  ST    P2 + 2
0FB9  C202  LD    P1 + 2
0FBB  C903  ST    P2 + 3
0FBD  C203  LD    P1 + 3
0FBF  C904  ST    P2 + 4
0FC1  C204  LD    P1 + 4
0FC3  C905  ST    P2 + 5
0FC5  C205  LD    P1 + 5
0FC7  C906  ST    P2 + 6
0FC9  C206  LD    P1 + 6
0FCB  C907  ST    P2 + 7
0FCD  90D6  JMP   to K
```

Displays characters in stores 1 to 6 in display at digits 1 to 6

END OF MAIN PROGRAM

RUNS TEST - TABLE OF CRITICAL VALUES OF U

Based on Table 84 from BISHOP, O. N. (1971), STATISTICS FOR BIOLOGY (Longman, London, 2nd edn.) Relocatable, if P2 pointed to start address by altering 0F27 and 0F2A altered in main program

```
0000    = 0B80
0B80  00 00 00 00 00 00 00 02
0B88  02 03 04 04 05 05 06 07
0B90  08 08 09 0A 0B 00 02 02
0B98  03 04 04 05 06 07 07 08
0BA0  09 0A 0A 0B 0C 0D 02 03
0BA8  03 04 05 06 06 07 08 09
0BB0  0A 0B 0B 0C 0D 0E 0F
        0BB6 = END
```

RUNS TEST - TYPICAL DATA TABLE

Enter 00 to represent one category of event, 01 to represent the other. Enter events serially in order of occurrence. When all events entered enter the lower byte of the next address in the next address (gives total number of events) Relocatable, if P1 pointed to start address by altering 0F21 and 0F24 in main program

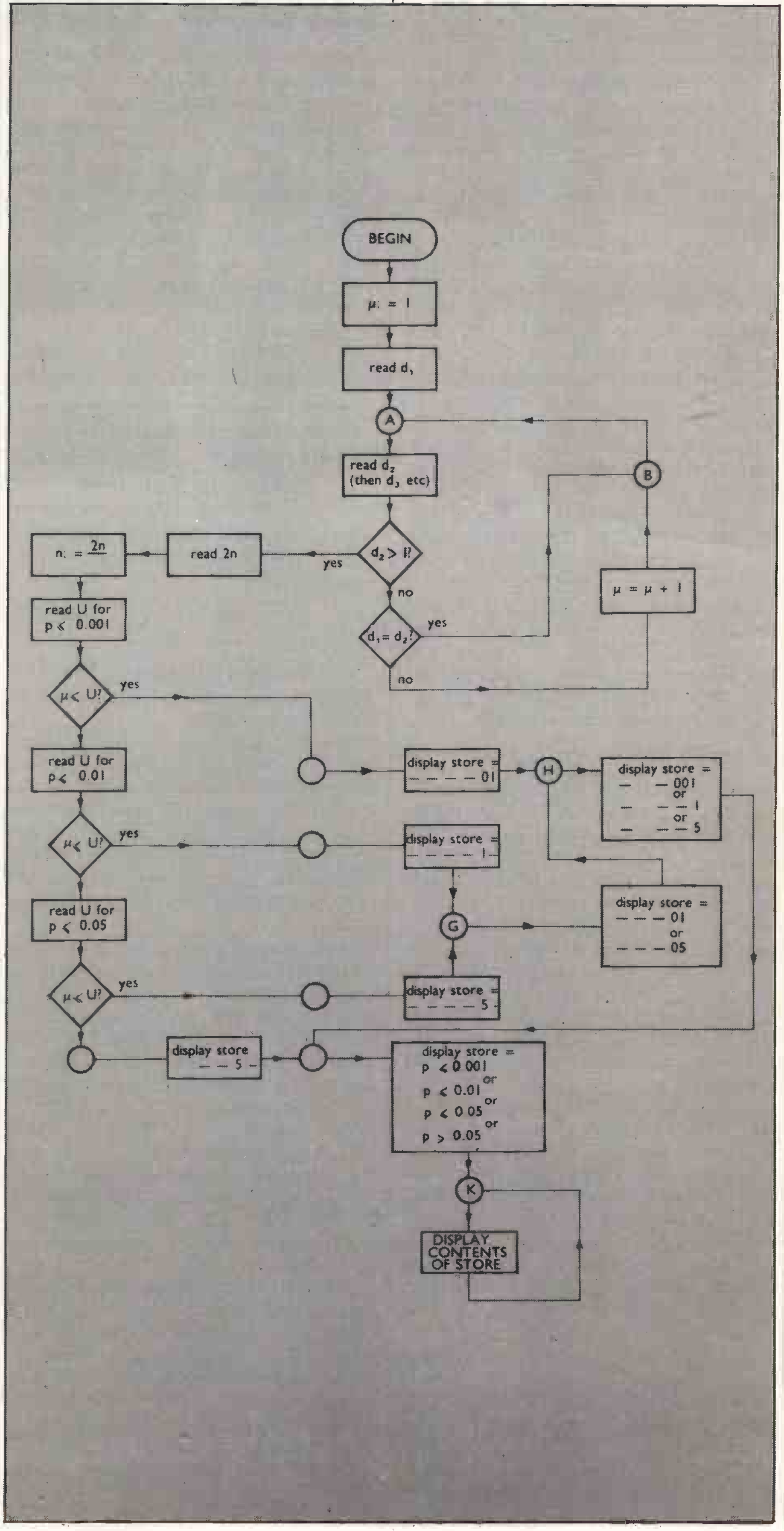
```
0000    = 0B00
0B00  00 00 00 01 01 01 01 01
0B08  00 00 00 00 00 00 01 01
0B10  01 01 00 01 01 01 00 00
0B18  00 00 01 01 01 01 1E
        0B1E = END
```

The typical sequence above represents data with 30 events:

000111110000001111011100001111

Number of runs = 8; n = 15

(14 0's, 16 1's); significant for $p \leqslant 0.01$



How to avoid those bombs

by Derrick R Daines
Deputy Head, Carsic School, Sutton in Ashfield

ARE YOU to scared to PEEK? Does the thought of POKE frighten you? Does USER leave you white and trembling? If so, welcome to the club. Potentially, POKE and USER are the most deadly of Basic commands, since a single-digit error can not only bomb your program but the Basic interpreter as well.

So you are a cautious type and you have taped a copy of your program carefully before entering POKE or USER, so not for you is the appalling chore of entering it by hand all over again, but you still have to re-load your Basic and then re-load the program.

You are facing anything up to an hour of hanging around waiting while Basic and your program are loaded. No, PEEK, POKE and USER are not funny. Even one experience of that kind is too much for many of us.

Disc is not so bad, of course, but it is Murphy's Law that if a program is to bomb, it will do so just at the end of a long evening session of program development, before the most up-to-date version has been saved on disc.

It is no wonder that PEEK and POKE are left severely alone. Yet, treated kindly, we can do many things with them which are not possible in any other way. For example, few Basics have a command giving control over an external device such as a relay, thyristor or uni-selector, despite the fact that many computers will have been bought for the express purpose of environmental control.

Superb for learning

As another example, some simpler versions of Basic do not provide for user-defined functions — the DEF and the FN(X) of better versions. PEEK, POKE and USER provide that facility. Taking an overall view, we can say that Basic is superb for learning programming; easy to write; expensive in its use of memory; slow in execution; strictly limited in its application. On the other hand, machine code is tedious to write; easy to bomb; parsimonious in its memory use; the ultimate in speed of execution; and infinitely variable in application.

The good thing about PEEK, POKE and USER is that we are able to have the best of both worlds. We avoid the tedium of writing huge chunks of machine code but when we need the speed and flexibility of machine code, PEEK, POKE and USER provide it.

Before you can steer the beast you must be able to ride it and that means that we must be fully conversant with machine code.

Assuming that you know something about machine code, how do we use PEEK N' POKE? Let us take a very simple example. Users of the SWTP and others may have a cassette interface giving automatic control of the cassette motor. The AC-30 is one such example. It contains a miniature relay which is switched-in on receipt of a READ ON signal from the control interface, or on receipt of a RECORD ON signal.

In machine code, that is executed very simply by loading the A register with the hex value 11 (READ ON) and branching to a subroutine with sends the appropriate signal (OUTEE). In Basic, however, the only commands which send the appropriate signal are SAVE, LOAD and APPEND, none of which is of much use if you are doing something else with that outgoing signal.

Enter PEEK N' POKE. The job breaks-down into several easy stages. First, we write a subroutine in machine code which does what we want. In the example given, we would write:

```
86 11      LDA A   Load A with READER ON command
BD EL DI   JSR     Output contents of A register
39         RTS     Return form subroutine.
```

The example is for the 6800 micro. That RTS command is absolutely vital and we forget it at our peril.

The next problem concerns the questions of where to put our subroutine. Examination of Basic by means of the PATCH command will show that when Basic is first entered, all contiguous memory from the end of Basic to the top of memory is cleared (00) and that the topmost 256 bytes are reserved for string buffer.

Most Basics clear memory by first entering 00 and then checking to see if the memory addressed contains 00. It continues in that way until it encounters an address which does not respond — no memory there — and then backing-off 256 bytes. The address is then stored as the end-of-memory.

The clearance of memory by Basic renders it impossible for us to load machine code anywhere in memory contiguous with that occupied by Basic, either by hand, from tape or from disc, without it being wiped-out the instant that we enter Basic.

There are three possibilities; we can re-address one memory board to cause a break in the continuity of memory. That will fool the interpreter into 'thinking' that it has reached the end of memory when it has not; we can fool the interpreter about the beginning of available memory; we can find some small amount of memory to spare elsewhere in the system.

The first solution is satisfactory if we expect to use a very large machine code program and is the solution which allows a disc operating system to be co-resident with Basic, but it would be scarcely sensible to allocate 4K of memory for one small subroutine. Those things have to be balanced.

The second solution brings in its wake a complication of finding and altering the memory Basic uses for the retention of the next available address. It is possible and for medium-sized subroutines may be the only solution.

For a tiny subroutine such as the example, the third solution is the best and it is surprising how many bits of unused memory can be found lying around if you search. Users of MIKBUG and SWTBUG will be familiar with the spare RAM at locations A014-A033 and A04A-A07F, for example, and no doubt other systems have unconsidered trifles waiting to be used. They are ideal for our purpose. They are not contiguous with core and so will not be wiped clear by Basic. They offer a small Insurance against bombing, for the same reason, and the alteration of Basic mentioned is not required.

Double check

So we have our machine code program and a location to hold it and the next problem is how to get it in there. Of course, we could enter it by hand if we were not scared and not bothered about the delay, but we will not learn anything, so let us forget it.

Loading from tape or disc might be the best solution if the machine code program is a large one or has be CHAINED, but for small routines it is doubtful if it is worth the extra effort involved. We will still to need POKE commands anyway and the method is simple.

The other possibility is for Basic to enter our machine-code program and obviously POKE is the command with which to do it. The general format is very simple:

```
FOR X 1 TO (number of bytes)
READ Y
POKE ((base address less 1) plus X,Y)
NEXT X
DATA (machine code program)
```

The POKE statement takes the value of Y and places it in the location indicated by the expression before it. Note very carefully that the values and addresses are IN DECIMAL, so we must alter our machine code program and the first assigned into decimal:

```
(40980) A014  86 11      LDA A   (134  17)
        A016  BD E1 D1   JSR     (189  225  209)
        A019  39         RTS     (57)
```

Substitute in the BASIC format given:

```
     10 FOR X 1 to 6
20   READ Y
     30    POKE (040979   X,Y)
     40    NEXT X
     50    DATA 134, 17, 189, 225, 209, 57
```

Notice that in line 30 the base address is decremented by 1 because on the first pass through the loop X will have the value 1.

Double-check everything, particularly the conversion from hex to decimal, and type-in the five Basic commands, taking particular care with the DATA line. Now type RUN and then use the PATCH command to check that the desired machine code program has gone where you expected it to do. If it has not, you have some detective work and double-checking to do.

If everything is satisfactory then before we can jump into the USER command there is one other thing we must do — we must tell Basic where to find our little program. When Basic is first loaded, whenever it encounters a USER statement, it jumps to an address which points to a location containing the value 39.

That obviously is a very necessary insurance, since it returns the program immediately back to Basic, but we must then change the first address and make it point to the start of our program. The address should be listed in the documentation accompanying your Basic and in my case is 0067 — 0688.

Changing those into decimal gives 103 and 104, addresses into which I wish to POKE. Before doing so, however, it would be wise, if not vital, to PEEK into them and make a note of their contents.

The values I wish to POKE make-up the starting address of my program — A014. That must be split into two bytes A0 and 14 before their conversion into decimal, which gives 160 and 20.

Reward

Now we may write our final two POKE statements:

```
60 POKE (103,160)
70 POKE (104,20)
```

Again using RUN and PATCH, we can check that the necessary alterations have been made. If all is well we take a deep breath, add a USER command and RUN. If the method has been followed faithfully, we will be rewarded by the switching-on of the tape recorder motor, followed by a return to Basic.

By itself, the achievement is not very great unless we have been too timid to try POKE and USER before but it becomes exciting when we consider the potential. With that single little routine we have opened a door on a whole new world of computer-controlled environment.

The December, 1978 issue of *Kilobaud*, for example, contained a Spelling Bee program in which the cassette recorder was used to record the sound of the human voice. The method of preparing the Spelling Bee involves a fixed-time loop which runs the cassette for a few seconds.

In that time the user speaks the word, thus recording it. The program asks for the correct spelling of the word and then goes again into the time loop. The process continues until 40 words have been put in, or the user types STOP. The program then loops to a test portion in which another user, a pupil, hears the word being spoken and is scored on his correct response to the request for the spelling.

It is, of course, very similar to the dedicated Speak and Spell, but with the advantage of an infinite variety of words without a mid-Atlantic accent. Unfortunately, the variety of Basic in which the program is written does not seem to be very common here, but our sample program is extended easily:

```
A014   86 12      LDA A   Recorder on    (134 18)
A016   BD E1 D1   JSR                    (189 225 209)
A019   5F         CLR B                  (95)
A01A   CE 00 00   LDX     Loop 1         (206 00 00)
A01D   08         INX     Loop 2         (8)
A01E   8C FF FF   CPX                    (140 255 255)
A021   26 FA      BNE     Loop 2         (38 250)
A023   5C         INC B                  (92)
A024   C1 07      CMP B                  (193 7)
A026   23 F2      BLS     Loop 1         (35 242)
A028   86 14      LDA A   Recorder off   (134 20)
A02A   BD E1 D1   JSR                    (189 225 209)
A02D   39         RTS                    (57)
```

The subroutine switches-on the recorder for five seconds and then switches it off again, the timing adjustment being made by altering the 07 if so desired. In Basic the routine becomes:

```
10 FOR X     1 TO 26
20 READ Y
30 POKE (40979     X, Y)
40 NEXT X
50 DATA      134,18,189,225,209,95,206,0,0,8,140,255,
             255,38,250,92,193,7,35,242,134,20,189,
             225,209,57
60 POKE (103,160)
70 POKE (104,20)
```

For copyright reasons I am reluctant to give more details, except to say that the USER statement should form the major part of a subroutine accessed both by recording half of the program and the playback half. Screened instructions are also required for the pupil to wind back the cassette to the beginning in manual mode before switching to auto.

Obviously, synchronisation of sound and program string matching is achieved by time of record and playback. The tape must therefore start at the spot and the best place is at the beginning of the tape.

There is a time, of course, when one of two things will happen. Either the DATA statements become inordinately long, or we run out of handy little locations in which to POKE our routine. When that happens we have to start tinkering a little more with the Basic interpreter.

The best plan is to place the machine code routine in memory immediately following the Basic interpreter. Basic uses an address to hold in memory the location of the next available address. It is updated constantly as new statements are added or others deleted.

When Basic is first loaded, this address points to a location immediately following the Basic interpreter. The documentation accompanying your Basic will have details. In my case, this address is at 014E-014F, initially being set to 1EAF (SWTP Basic, Version 2.0).

Suppose, therefore, that I load a machine code program from 1EAF to 2048, I must alter locations 014E-014F before typing G for G0, thus entering basic, which would wipe-out the machine code. It follows that this alteration should be an integral part of my machine code recording, together with the USER pointer mentioned earlier.

It may be worth remembering, however, that when we have finished with the Basic program which called the USER subroutine, we have no more use for that subroutine, yet Basic will not over-write it unless and until we change the pointer to next available memory.

That might be embarrassing if memory space is tight in a later program. To overcome that it would be wise to make a note of the original address pointed to and also to add two POKE statements at the end of the parent Basic program which would restore this pointer:

```
9000          .....
9010          PRINT "ANOTHER GAME";
9020          INPUT Q$
9030          IF Q$ "YES" THEN 750
9040          PRINT "GOODBYE"
9050          POKE (334,30)
9060          POKE (335,175)
9070          END
```

We have not discussed the possibility of passing information between Basic and the machine code subroutine in either direction but it should be tolerably obvious that PEEK and POKE is one way of doing it. My version of Basic supports a USER statement of the form.

```
LET X     USER (Y)
```

in which either or both of X and Y may be utilised to transfer information. I also have a 3K Basic without this facility which forces the use of PEEK.

Complicated

Perhaps the simplest illustration would be where a subroutine raises a flag when something is done — or a test completed successfully perhaps and clears it when not. In that case we must reserve memory bytes as integral parts of our machine code routine, adjust or clear them during the subroutine, and then on return to Basic to execute a conditional test using the PEEK command.

If we do not have the facility to compute a desired transcendental as a user-defined command — DEF and FN(X) — and let us suppose we require the Arctangent of a number. Obviously things become a little complicated but the same system is followed. We write a machine code program which computes the desired transcendental and stores it to the desired degree of accuracy in a series of reserved memory bytes.

We can point out that PEEK tests would need to take into account the position of the decimal point and the possibility of calculation overflow.

The C Programming Language

By Brian W. Kernishan and Dennis M. Ritchie; published by Prentice-Hall International, 1978; distributed in the U.K. by Prentice-Hall International, paperback, 228 pages; price, £8.

READ this book to learn how to format attractive telephone directories. It describes a high-level programming language developed by Bell Telephone Laboratories, mainly for use on PDP-11s, for applications such as string processing.

The C language developed partly from ideas in a language called B, which also gave rise to the academically-favoured BCPL. Ritchie's C contains many neat little features to allow users to produce tight, recursive, probably incomprehensible code. There are IF-ELSEs, ELSE-IFs, DO-WHILEs, a "rich set of operators" including pre- and post-increment and decrement. There are variable-length bit fields, user-definable datatypes, variable datatype UNIONs, array pointers, arrays of pointers, multi-datatype data structures.

This cornucopia of features can be used for esoteric string processing and record manipulation as part of "a wide range of applications". The authors describe the features in a clear and readable manner, and the readability probably is improved by being typeset by the authors with a PDP-11 programmed in C using the UNIX operating system.

Limited

The value of reading the book, however, is likely to be limited for the British reader unless he has access to a machine running the UNIX operating system. UNIX was developed to support the C language — it is written largely in C, illustrating again the range of the language application — and although C compilers, mainly written, naturally, in C, have been developed for IBM 370, Honeywell 6000, and Interdata 8/32, UNIX on the PDP-11 remains the main support for C programmers.

UNIX runs only on PDP-11s; it is licensed only for a very large fee by Bell Labs, except for academic use. For universities it is inexpensive and the fact that the operating system is written in C makes it attractive as a teaching tool for university computer departments.

A certain number of commercial users have adopted UNIX in the U.S., presumably for the advantages it has offered in the past for PDP-11 users seeking to escape from assembly language or Fortran programming. As other new "structured" languages such as Pascal, Coral-66, and the forthcoming ADA have become

available for PDP-11s and the newer Digital Equipment VAX-11, it is no longer clear that C provides such exceptional advantages.

The language has some potential disadvantages too. There are dialect differences between newer and older compilers. The "rich set of operators" with asterisks and double plus signs, combined with the inherent dangers of over-kill in the use of recursive code, can produce very slick but incomprehensible programs; this is likely to appeal to programming enthusiasts but not to programming managers.

A future for the C language and this excellently-produced language text-book might lie in the personal computer market, where programming enthusiasm and high-level facilities are valuable. The high licence fees charged for the PDP-11 UNIX system would not, however, be available. Even though the authors claim that a new C compiler can be developed in two months for most machines, there may not be the effort forthcoming to continue the C language on to new machines in the 1980s.

Conclusions

- **The C Programming Language is a well-produced book describing a powerful and interesting language it is probably of more esoteric interest than other literature describing recently-developed programming languages such as Pascal.**
- **Its background as a one-off language produced and marketed by Bell Laboratories for the Digital PDP-11 probably limits continued development of the C language.**

How to profit from your personal computer

By T.G. Lewis; published by Hayden, 1978; distributed in the U.K. by Butterworth; paperback, 192 pages; price, £4.80.

THE BEAUTY of the new computing is that it means many things to many people. If computers are cheap and if computing is easy, the anti-establishment adherent can see in it a return to small-scale values which threatens and ultimately will replace the centralised, controlled facilities for information and calculation which characterise the present way of doing things.

The technological democrat sees cheap computing as a way of automating all the trivial and repetitive aspects of life, taking the dross from existence and allowing us to exploit our potential more fully.

Then there are the pragmatists, the entrepreneurs, who see in small computers the opportunity for many of us to set-up small businesses to do smallish jobs for other small business.

If you want some illumination on the social possibilities, a good place to start is a group of three recent articles in the radical technology magazine *Undercurrents* issues 27, 30 and 32 — highly recommended.

If you are a capitalist at heart, you may well reach for Theodore Gyles Lewis. Like most writers in the field, Ted Lewis is American and a college lecturer (Oregon State).

His 'preface' opens with a curious disclaimer. "My goal in writing this material was to convey the important features of personal computers useful to computer aficionados".

In fact, he has written the kind of introduction to small computers which computer aficionados will probably find too light. It is for novices in particular — people who might be thinking about a personal computer.

Too specific

The book describes the uses of personal computers in common business applications, such as accounting, handling payrolls, managing inventory, and sorting mailing lists. Many Basic language programs are reproduced to illustrate the techniques discussed by the author. Some of them will be too specific to the U.S. for direct use here but the general principles seem sound and, at this fairly elementary level, the programming techniques look good.

The style in which the book is written is more debatable. It is described as "entertaining". It is somewhat less than that. The organisation of the material is confusing, combining definitions, programs, and story-telling in a disorientating jumble. The frequent attempts at humorous paragraph headings are often misleading.

Nonetheless, once you adjust to the idiosyncrasies, the content is generally worthwhile and occasionally stimulating. Of the 10 chapters, five are devoted to detailed case histories of personal computing applications. The variety of techniques used in those applications will give the reader a good foundation for programming most applications occurring in business or in the home.

The case histories include mortgage repayments to a savings and loan company — like building societies; mailing lists; accounts receivable — for a doctor's office; a household budget system and a real estate — estate agents to us — package.

Each has a listed Basic program which the reader can try to use. More likely you will utilise it as a basis for a more or less sophisticated system.

The preceding four chapters, in a roundabout manner, attempt to define personal computer terminology. The last chapter is T. Lewis' look at the future. It is an interesting overview of a world where the microcomputer is ubiquitous with much talk of the 'global village' (Lewis ignores any political and cultural considerations which will spoil his future fun).

The electronic office, the computer-controlled house, the massive, computerised communications network — all there, and according to Lewis, they will all be linked with personal computers on a scale comparable to the current blanketing typified by transistorised radios and calculators. Well it might happen.

Conclusions

- **Lewis has the word Profit exhibited boldly in his title. His case histories, particularly the inventory control system and doctor billing system, demonstrate the way personal computers can be employed profitably today.**
- **His premise — "only lack of knowledge and lack of awareness of the usefulness of computers are barriers to anyone wanting a personal computer" — is too broad, but for a narrower argument — like "don't be afraid of computers, here's why" — this book moves neatly to the rescue.**

Be a Computer Literate

By Marion J. Ball and Sylvia Charp; published in 1977 by Creative Computing Press; paperback, 61 pages; price, £3.00.

THE LADYBIRD book on computers for children has a well-deserved reputation as a good low-level introduction and there are apocryphal stories of large organisations scouring children's bookshops to buy it in bulk for senior executives.

Be a Computer Literate is better. It's more up-to-date, more fun, and its pedigree gives it more class — *Creative Computing* is one of the best U.S. magazines.

This book has been beautifully written and very well-presented. It is very easy to read, with large print — and charming drawings; and the explanations of fundamental points are very easy to understand.

(continued on page 113)

(continued from page 111)

The history of computing is not covered but the book deals with a sensible set of topics. Among them are the definition of a computer as an information processing machine, those capabilities of computers which make them useful to us, their speed, accuracy, and ability to work automatically once they are programmed.

No excuse

The hardware is examined with many examples, and pictures of input and output devices, though we were surprised at the description of a cathode ray tube as an 'input device'. There is no excuse for inaccuracy and our reviewer could remember being confused by the same point when first introduced to computers.

The way in which the memory unit functions is described with an impressively simple explanation of memory addressing; other internal operations also receive the same kind of treatment. In the section on the control unit there is a lovely picture of it holding hands (handshaking) with all the other components of the system.

The last half of the book introduces the reader to programming and in general we were equally impressed by the style and clarity.

The book ends with a chapter on some applications in modern society. There are examples in medicine, entertainment, art, sport, business, banking and industry, all illustrating the essential versatility of the computer. There is also an excellent low-level glossary of the more common computing terms.

Conclusions

• Computer literacy is what our society needs today — enough understanding to appreciate the potential and the restrictions. Like other forms of literacy, it should begin at school level. This book is an elegant, well-produced, comprehensive and sympathetic introduction. Highly recommended.—D.W.

Getting involved with your own computer

by Leslie Solomon and Stanley Veit; published 1977 by Ridley Enslow; paperback, 216 pages; U.S. price: $5.95.

SUBTITLED a guide or beginners, this book is genuinely full of interesting information on most aspects of microcomputers, particularly personal computer systems. Treating it as the low-level introduction it is, we could find no significant omissions in its overview.

One of the authors is technical editor of a U.S. hobby electronics magazine, the other especially strong on the operation of the hardware, the processor, memory chips and serial and parallel interfaces.

In general, the emphasis is on computer hardware. Software has only one short chapter (10 pages) which introduces machine code, assemblers and high-level languages and explains, neatly enough, what an application program is.

There is no discussion of the techniques to be used in writing and testing programs; even at this level the basics of flowcharting and debugging seem to us to be important elements of home computing at least as important as the authors' lucid discussion of busses.

On the whole, we liked the organisation of the book. It starts with a chapter on the history of computers from the abacus via Babbage and Hollerith to the single-card computer. That is interesting, particularly the witty asides about the early electronic machines, ENIAC, EDSAC and MANIAC. Did you know ENIAC had 18,000 valves and was expected to fail every 7.5 minutes?

The chapter on where to discover more is usually relegated to one of the appendices in this genre of book but this time it appears early. Of course, anyone reading this magazine will already know where to find what equipment is available but the authors describe helpfully some of the American magazines available — most of which can be obtained here from specialist shops — and follow with some hints on joining clubs, where to obtain technical information, and how to question your local computer shop. There is some good advice in this section and it will be just as useful in this country as in the States.

There is also an early chapter on number systems and binary arithmetic. An appreciation of binary is essential if you want to understand the fine points of how a digital computer works; and it is particularly important with micro computers, where a good deal of programming is still done in assembler language or machine code.

Right pitch

Solomon and Veit go into some detail on the various devices which make up the central processor unit — the clock, I/O ports, the micro processor ship. Operation and use are all explained in great detail and an explanation of bus structures follows, concentrating particularly on the widely-used format.

Moving to audio cassette interfaces, the discussion embraces as full a list of the various standards available as we have seen; naturally the top three — Kansas City, CUTS, and Tarbell — are there, Video interfaces, I/O boards, prototyping, extender boards and the other components for the chassis or motherboard of the microcomputer are covered in enough detail, and that is one of the best aspects of the book.

It is easy for technical people to lay heavy burdens of unnecessary information on a reader; but Solomon and Veit have the pitch right for their kind of reader.

The catch is that you might not be that kind of reader. The blurb describes you as having "an interest in what makes personal computers work and what can be done with them" and presupposes no knowledge of programming or electronics. Well, we think you might occasionally need recourse to the *Practical Computing* glossary to understand a few of the technical buzzwords, but not too often.

Memory devices have a chapter to themselves. ROM, RAM and PROM are explained and so are the workings of static, dynamic and three-state logic RAM — perhaps not too relevant but at least the level of explanation is such that our reviewer has a better understanding of what they mean.

The middle of the book deals with some systems on the market in 1977. There are many obvious changes and additions but all the top-sellers are there.

In a neat summary of applications possibilities, there are no specific projects but a few words on several potential uses — business, word processing, games among the more obvious; home control, robotics, and personal computer networks are ideas encountered less often.

Conclusions

• We liked the tone of this book as an entry-level introduction. It needs more on software and programming techniques and the authors have a tendency to introduce terms without defining them until later — bootstrap programs are mentioned several times before being explained, and so are ROM and RAM.

• Occasionally Soloman and Velt deal with technical details without giving basic definitions, and some of the definitions that are given are misleading.

• Baud rate is defined as 'bits per second' in the glossary and 'words per second'; both are incorrect, in literal terms at least — 110 baud may be 110 bits per second for a serial interface and 880 bits per second for an eight-bit parallel interface. That apart, the book is a reasonably good introduction — D.W.

Programming for Microprocessors

By Andrew Colin, published 1979 by Newnes-Butterworths; hard cover, 206 pages; price, £7.95.

THE TITLE is somewhat misleading. It is not all about programming. In fact, seven of the 12 chapters could more accurately be described as covering systems design. The publishers say it is directed to electronic engineers without computer knowledge and that seems as good a market as one could define for a book which might have been better called Basic Systems Design or something similar.

Disregarding the title, it could be a useful book for the microcomputer user interested in how a system works. It might also be of relevance for anyone tempted to try to design a system for a particular function, though anyone who wants to design a computer probably knows most of what is in the book already.

For the daring ones who lack knowledge but would still like to design a system, this would be a useful theoretical introduction. It opens with some general information about microprocessors. Early it points out that correct programs are difficult and expensive to design. If that induces a little caution in the reader, so much the better.

The section on aspects of microprocessor design lists desirable features, most of which would be found in most micros. Of course, this is of no interest to anyone who owns or is thinking of buying a ready-made system where the selection of the micro has been done for you by the manufacturer.

Clear treatment

On the other hand, machine code programming which might well be of interest to the Pet or TRS-80 user, receives clear and thorough treatment. Because it is impossible to discuss beyond a very general point without becoming specific, there is a chapter devoted to the Motorola 6800 with a very full exposition of its instruction set and the operations related to them.

The section on programming techniques stresses the necessity for structured design. There is an admonition to the effect that anyone trying to write a program with more than about 100 statements will finish with a disaster unless adopting 'hierarchical', or modular approach. There is good sense there and it should encourage the kind of approach one must have to make full use of the potential of any computer.

Conclusions

• A tasty appetiser for anyone interested in basic systems design; for others, some good hints on machine code programming. If that is your need this is a good-quality publication, well-illustrated, well-written, easy-to-read, and British.—R.G.

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November

1 **Shugart minifloppy discs.** Venue: Reading. Arranged by Thames Valley Amateur Club, 'The Southcote', Southcote Lane, off Bath Road, Reading.

5-6 **Microprocessor project leadership.** Venue: London. Two-day course designed for engineers with sound experience of microprocessors. It will offer the skills necessary to lead a team of engineers developing a microprocessor-based system. Fee: £160. Organised by Bleasdale Computer Systems Ltd, 7 Church Path, Merton Park, London SW19. Telephone: 01-828 6661.

5-7 **Microprocessor course.** Venue: Portsmouth Polytechnic. A follow-on three-day course, with a significant amount of time spent in the laboratory. Organised by the Department of Electrical and Electronic Engineering, Portsmouth Polytechnic, Anglesea Road, Portsmouth, PO1 3DJ. Telephone: (0705) 27681.

5-9 **Microelectronics for non-electronic engineers.** Venue: London. One-week course gives participants an appreciation of the hardware of a microprocessor and how to construct microprocessor-based systems. Fee: £250. Organised by Bleasdale Computer Systems Ltd, 7 Church Path, London SW19. Telephone: 01-828 6661.

6-7 **Fundamentals of computer operations.** Venue: Compower Training School. Designed for trainee and junior dp staff. It gives a basic understanding of the technical aspects, hardware and software concepts, control procedures and provides job orientation. Fee: £125. Organised by Compower Training School, Cannock, Staffs WS11 3HZ.

6-10 **Electrical technology and Professional Electronics Exhibition, Finntec 1979.** Venue: Helsinki, Finland. Contact: ECL (Exhibition Agencies Ltd), 11 Manchester Square, London W1.

7-9 **Microprocessing.** Venue: Kensington Hilton, London. Three-day course on Applications to process control. Fee: £410 + VAT. Organised by JDB Associates and the International Institute of Science and Technology, 33, Warren Street, London W1P 5DL. Telephone: 01-388 4865.

8 **Implications for the curriculum.** Venue: Petersfield School. An evening meeting organised by West Sussex Institute of Higher Education, The Dome, Upper Bognor Road, Bognor Regis, Sussex, PO21 1HR. Telephone: (02433) 5581.

12-15 **JCL for programmers.** Venue: Compower Training School. For programmers using IBM equipment to enable them to code their own JCL. Fee: £215. Organised by Compower Training School, Cannock, Staffs, WS11 3HZ.

12-16 **Designing systems with microprocessors.** Venue: London. Two-week workshop for engineers with knowledge of microprocessors. Covers designing and producing highly-reliable microprocessor-based systems, with particular emphasis on design and development of structured software. Fee: £250. Organised by Bleasdale Computer Systems Ltd, 7, Church Path, Merton Park, London, SW19. Telephone: 01-828 6661.

12-30 **Cobol.** Venue: Compower Training School. Course for trainee programmers includes an introduction to programming, flowcharting techniques, structuring, coding techniques, documentation and standards. Fee: £645. Organised by Compower Training School, Cannock, Staffs, WS11 3HZ. Telephone: Cannock 2511.

13-16 **Microcomputers in manufacturing and industrial control.** Venue: London. Four-day microprocessor course designed for manufacturing and process control engineers and managers. Fee: £470 + VAT. Organised by Integrated Computer Systems, UK, Pebblecoombe, Tadworth, Surrey, KT20 7PA. Tel: (03723) 79211.

14-15 **Microprocessor development systems and their use.** Venue: Manchester. Two-day seminar to demonstrate how to select a microprocessor development system and operate it cost-effectively. Fee: £60 per day + VAT. Organised by Prodex (Seminars) Ltd, 79, High Street, Tunbridge Wells, Kent TN1 1XZ. Tel: (0892) 39664.

16 **Computer studies in school.** Venue: Bognor Regis. Organised by West Sussex Institute of Higher Education, The Dome, Upper Bognor Road, Bognor Regis, Sussex, PO21 1HR. Telephone: (02433) 5581.

19-23 **Microprocessor design and development.** Venue: Sevenoaks, Kent. Five-day residential course designed for project managers and engineers concerned with incorporating microprocessors into measurement and control equipment. Fee: £480 + VAT. Organised by The Sira Institute Ltd, South Hill, Chislehurst, Kent, BR7 5EH. Telephone: 01-467 2636.

19-30 **Systems analysis and design for new systems staff.** Venue: Compower Training School. Covers systems justification, fact-finding and analysis and all aspects of systems design. Fee: £480. Organised by Compower Training School, Cannock, Staffs, WS11 3HZ.

20-23 **Principles of 2900 operating.** Venue: Compower Training School. For staff with at least three months' operating experience; enables them to play their full part in a 2900 environment. Fee: £215. Organised by The Compower Training School, Cannock, Staffs, WS11 3HZ.

21 **Teaching software design techniques for microprocessors.** Venue: London. A forum for discussing methods of teaching software design techniques and to highlight the experience of those responsible for teaching the subject in academic and industrial environments. Organised by Conference Department, IEE, Savoy Place, London, WC2 0BL. Telephone : 01-240 1871.

27-30 **Introduction to supervision.** Introduces supervisory principles to all operations staff below management grades. Practical syndicate exercises are related to work situations. Fee: £215. Organised by Compower Training School, Cannock, Staffs, WS11 3HZ.

27-30 **Microprocessors and microcomputers.** Venue: London. Comprehensive introduction with hands-on workshops, designed for engineers, scientists, systems analysists and managers. Organised by joint technical education activity of Integrated Computer Systems and the Polytechnic of Central London, Pebblecoombe, Tadworth, Surrey, KT20 7PA. Telephone: (03723) 79211.

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Business applications

DEREK ROWE'S company has two TRS-80s running business applications. This progress report states:

"Recently we added two mini-disc drives which work through an expansion interface with a further 16K — the Disc Basic limites the effective increase to 10K.

"So far there have been no breakdowns and virtually no problems with Level II Basic. Even the infamous keyboard bounce is within acceptable limits and it can be eliminated altogether by a software fix provided in the disc system.

"There is a more serious problem which may affect some systems; occasionally everything freezes-up during a program run and RESET provides the only re-start. Tandy is apparently aware of the problem which is due to suspect memory chips; replacement by a high-quality alternative provides the solution.

"A similar but unrelated hiccup takes the form of noticeable pauses. They occur solely with one program which uses a large amount of string space — CLEAR 4000. The delay seems to be caused by machine operation on the string variables; re-programming to reduce string usage, combined with an increase in reserved string space, reduces the number of pauses significantly. Tandy has not produced an answer to this.

Increased potential

"We are now very satisfied with our disc system and it has increased the potential of application areas significantly. Our first week with it was a complete disaster. Fortunately we had considerable assistance from the TRS-80 specialist with whom we do business but the main problems were:

- Inability to SAVE/LOAD programs from disc without continual I/O errors.
- Complete loss of data on a number of discs.
- Total failure of attempted back-up operations.

"Our difficulties were caused by hardware faults compounded by ignorance of the correct way to handle the equipment. Some of the solutions we employed must have a general relevance:

- Install mains filters on the power supply to the system as a whole and also on each disc drive. Even so there is still a risk of corrupting the system if the nearby printer is switched on or off during operation.
- Buy an electronic 'bulk eraser'. Once a disc has been formatted, it is impossible to re-format without first erasing it first; an ordinary magnet is not a reliable alternative.
- Obtain a modified buffered expansion interface. This has an improved approach to the data links.
- Change faulty disc drives. Faults are shown by messages such as 'Motor speed too slow' or 'Disc trap not closed'.
- Implement a software fix to allow retry with I/O errors and avoid a possible system contention.
- Keep floppy discs in a metal cabinet with back-up copies in another separate cabinet.

"The early problems have now been almost totally eliminated; certainly I/O errors with LOAD/SAVE under Basic are now virtually unknown. We are still experiencing failures with BACKUP, COPY and DISC I/O errors with the disc-based version of the Electric Pencil word processing package. We think this may be an internal error due to inadequate verification by the package.

New release

"Problems with BACKUP and COPY may also be due to less-than-perfect cleaning of the source disc or perhaps a problem with DOS. A new release of the operating system is imminent; a number of problems, like keyboard bounce, will be cured in this and I/O integrity may also be enhanced.

"Provided saved files are always test loaded before clearing the system, there is a minimal danger of losing programs. Even with BACKUP failures, individual programs can usually be accessed by COPY or the LOAD/SAVE sequence."

Debounce fix

AFTER a struggle, writes Ed Phipps of Nantwich, I have implemented A. J. Harding's software fix for the TRS-80 keyboard bounce on my 4K level II, using simple Basic commands. Surely there must be many other users without access to assemblers — and hence somewhat 'machine code blind', like me — but who still need a debounce?

The program seems to work well. The only messy bit is line 6 — I can't seem to get around the error message without losing the 'fix'. Is there a better way of calling the code?"

Instructions: on switching on, answer MEMORY SIZE? with 20425. Load the program, run, and follow instructions given. After erasure, 3,230 bytes remain for Basic programs.

```
1POKE16526,201:POKE16527,79
3DATA75,17,10,0,205,11,0,25,34,22,64,205,97,27,207,
25,26,33,54,64,1,1,56,22,0,10,95,174,115,163,32,8,20,44,
203,1,242,226,79,20,1,95,197,1,220,5,205,96,1,10,163,200,
195,251,3
4 S=20425: E=20479
5 FORA=STOE :READB :POKEA, B :NEXT :CLS
:PRINTTAB (15) "DEBOUNCE" :PRINT? 448,"**
IGNORE ERROR MESSAGE**" :PRINT"HIT 'ENTER',
THEN TYPE 'NEW' AND HIT ENTER AGAIN." :PRINT
"KEYBOARD WILL THEN BE FULLY DEBOUNCED
AND MEMORY CLEARED: ONLY 54 BYTES
RESERVED" :PRINT?128,
6 X=USR (0)
```

Line 1 puts the start address of machine code program in the USR address location. Line 4 gives start and finish addresses for placing the machine code detailed in line 3. Line 5 places code in locations specified; instructions printed will follow the error message. Line 6 calls the code and causes it to operate. It results in a syntax error hence the instructions in line 5.

To write this initially I used Basic subrouties for hex/decimal interconversions, PEEK, POKE, and so on. Is it possible to produce a competent mini-assembler using Basic? Presumably memory space and speed could pose problems? Any ideas of sources for TRS-80 Basic listings and ways of creating machine code files on tape?

Control jack

TRS-80 owners might be interested to know that it is not necessary to pull out the remote control jack, or to install a switch to recover control of the tape recorder after a CSAVE or CLOAD, to permit rewinding, writes I. R. Sinclair. The following will do the same job:

```
5 out 225,4 : goto 5 (ENTER)
```

When you want to resume, press BREAK.

Incidentally, this looks like being the first step to a problem I'm trying to solve. Cassette data files are very tedious and cause wear on the cassette motor relay inside the TRS-80 because each data line is preceded by the start routine, followed by the end routine, and with a motor switch-off.

I am trying to find a way to permit one start-up routine, followed by several lines of data, then a single switch-off, as happens during a CSAVE or CLOAD. A routine like this might make the use of INPUT -1 and PRINT -1 much more useful; at the moment, a few lines of data take up more space than the program which generates the data.

Free Life

IF ANY TRS-80 Level II user would like to send a stamped addressed envelope to C Paradine, 59 Merdon Avenue, Chandlers Ford, Hampshire, he will provide a fast, machine-language cassette for Life. In return, he would like to hear about any interesting patterns users discover — in particular, shapes which move about, reproduce or destroy each other.

Software

WE HAVE been sent the first copy of a useful-looking magazine, *TRS-80 Software*. It costs £1 for 19 pages 15cm × 21cm. The issue contains a disc Basic text-editor, a review of the NEWDOS operating system and a Tank Battle game. From: TRS-80 Software, 3 Line Computing, 421 Endike Lane, Hull, HU6 8AG.

Group

WE NEGLECTED to mention the national TRS-80 Group in our August issue. Brian Pain is the secrctary, on 0908 566660 (during office hours) — 40a High St, Stony Stratford, Milford Keynes.

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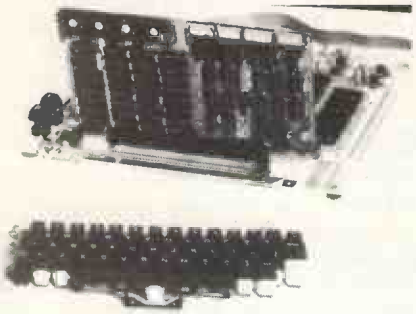

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Software news

THE IPUG swop library has made a good start and a new program has been added to those which IPUG offers cheap to members. This is a version of SPACE-WAR with very intelligent Klingons; it works in real-time with nasty sound effects when things go wrong. There are nine levels of play but I have never managed to survive above level 5. The sound interface is the one mentioned in the February *Practical Computing*.

The program, like the Renumberer, PR40 interface and the Music/Organ/Morse programs, costs £2.50 to members — £5 to non-members. Don't forget, membership is £2.50 for 1979. Contact, Mike Lake, IPUG, 9, Littleover Lane, Derby.

Sound

ON THE SUBJECT of sound programs and interfaces, Mike Lake has had a chance to try the Sound Box offered by Petsoft. It is a small black box, containing a 0.1 watt speaker and the minimum of electronics to form an amplifier which plugs into the second cassette interface. Power is drawn from Pet so no battery is needed. The unit is offered with a demonstration program written by HB Computers of Kettering.

The unit does not seem particularly good value at £13.99 plus 75p p&p. The quality of sound is not good. Programming for music would be difficult and the only good thing to say about it is that it allows you to hear data being streamed-out to cassette when you SAVE or PRINT to cassette unit number 1.

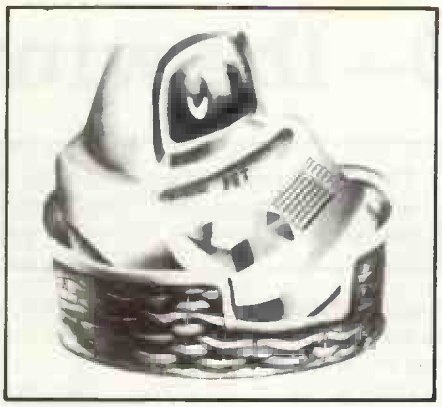
By far the best way to produce sound is from the user port, since this uses the 6522 VIA to produce very clear notes. To produce good sound, connect the user port to any amplifier. If someone would care to produce a cheap amplifier for the user port, complete with connector, on/off switch, volume control and at least 0.5 watt output, many Pet users would certainly be interested, though, as mentioned previously, an Eagle Intercom at about £6 can be used just as well with the right connector.

Inspired

I WAS inspired by your July issue to connect my Pet to a mainframe computer via a Small Systems Engineering interface. Although Michael Whitehead and Pet Users' Club both assert that it is not possible to do this in Basic, I have had no trouble:

It is certainly adequate as a back-up machine for my Teletype. Admittedly there is no time for any sophistication, even though I have shortened line 2 to the minimum possible length and given top priority to incoming characters. I have timed it carefully and the transmission speed is certainly 10 characters per second, writes Laurence Chatfield.

I intend to use machine language on 30 characters per second and save output from the mainframe in core, so that I can list it out after putting down the telephone. This should save me between £200 and £400 per year, so I think my subscription to your magazine is well worth it.



There is one snag. I cannot simulate the Teletype break signal on the Pet — it is not a character — and this is the only signal the mainframe recognises as an interrupt. Can anyone suggest something? At the moment I have to pull-out the plug if I have a lot of unwanted output.

Query

PROVIDED I have not opened the Pet and have connected no equipment to it, can I or not do any damage to the keyboard? There are admonitions in the manual, writes W. Green, such as "This could kill you if you touch the keys," "Be prepared to re-set your machine" and "The beginner should not undertake such and such."

Do these remarks mean that I would not get the desired results? Can I POKE or PEEK anything I like, just to see what happens?

In principle, there is nothing you can do at the keyboard which will damage the machine, other than your program which can all too easily be ruined. If finger slips smash machines, we would like to hear about it.

Floppies

THE COMPUTHINK disc drives using the DISKMON operating system have been around for a few months and apparently have many happy users. The unit offers 200KB user storage and is quick in handling large random access files.

After a short time with it Mike Lake was also impressed with its speed; it was loading a 20K program in about six seconds and finding random records within a large file in less than three. To try the disc he set up a file containing 780 128-byte records and then accessed at random.

At first, the speed seemed unbelievably fast, less than 0.5 second per record; on checking the program — which used the RND function to generate a random number from 1 to 780 — Mike found that the same number was being obtained every time. Apparently the DISKMON operating system overwrites the random number seed in the first 1K of memory and so the same random number appears again and again.

One or two annoying things spoiled an otherwise excellent drive. A FRE(O) after loading a program had a habit of hanging-up the system, requiring that the Pet be turned off and on to clear it. Using sequential files would seem to be difficult, since only one file could be open at one time. The solution to this is fairly simple — don't use sequential files. Instead, set up large random access ones which can be handled very quickly indeed.

The DISKMON system requires the use of a PETBIT memory board which provides an extra 24KB memory on the standard 8K Pet. The disc controller program is contained in EPROM and use is made of some of the extra RAM to store data which is going to and from the disc. The speed of the system is mainly a result of its picking-up a whole track at each read and then allowing access to it from RAM.

At the end of last year, Midland Micronics was offering a dual-drive system for the top of the Pet, retaining the all-in-one image. We understand there have been financial problems in putting this product fully on to the market but now the system is being made and sold by Analog Electronics of Coventry, under the name of the Novapac.

Useful features

The Novapac is placed on top of the VDU of the Pet and the two Wang drives give the Pet the look of an elephant with two large ears. The PDOS operating system supports files kept on diskette in standard IBM format, giving about 80K of user space per diskette.

The operating system offers many useful features — including password protection on writing, so that your files cannot be over-written without someone knowing the password. Each diskette is divided into 40 tracks, each containing 16 sectors of 128 bytes. Read and write operations are at the sector level and the second cassette buffer is used to store sectors read in or ready to write out.

The system uses an Intel 8048 micro and a Western Digital 1771B disc controller; 512 bytes of PROM are provided to boot the system which then resides in 8K at the top of memory. Obviously this means that the unit can be used only on expanded Pets. The interface is connected to the memory expansion board and provides a piggy-back arrangement for anything else plugged in there.

Both the Computhink and the Novapac are set up to use the 8K Pets with expansion memory; both are in the range £800 to £900 before VAT.

Co-ordinator required

MIKE LAKE of IPUG is having to relinquish his role as the prime source of input to Pet Corner. So we are looking for someone to take over the mantle. Write if you are interested to Pet Corner at *Practical Computing*.

MICROAID—the winning entry

This is an edited version of the documentation accompanying the winning program MICOAID which won the Program of the Year competition for Drs Georgina and Geoffrey Jolliffe.

FEW MARRIAGES would appear to have dimmer prospects of success than the one between the rigorous and highly-mathematical applications of computers and the descriptive, empirical and often intuitive approach of the microscopist. Nevertheless, the computer has certain features which permit it to assist in identification problems: it can have an extremely large, permanent and reliable memory; it calculates quickly and the information in its memory can be available when required.

The computer is not influenced by recent experience and personal bias; it can be updated easily but it cannot do the physical examination. At present, for example, it is unable to carry-out the examination of the microscopy of a powdered sample or convert narrative or pictorial information for its use. The program required to imitate completely an experts' thinking would be impracticably large. Advances in pattern recognition, however, will undoubtedly contribute to that end in due course.

There is scarcely an area of study or specialisation which the computer has not touched in one way or another, although there are vast differences in the amount of involvement existing between various fields. It is, therefore, surprising to find a singular lack of application of the computer as an aid to identification of powdered vegetable drugs or foods until the introduction of our programs DRUGID and FOODID in 1976. They involved the use of a mainframe computer (KRONOS CDC 6600) and the main disadvantages were:

- the difficulty obtaining access at any given instant;
- the terminal was situated inconveniently three floors away.

The program MICROAID was developed to give all the advantages accruing from the use of a microcomputer system:

- the computer can be situated in the laboratory;
- the complete system can be moved easily to other laboratories as required;
- the system is under full personal control;
- it is accessible at all times for a given individual;
- the capital cost is a fraction of that of a mainframe computer and running costs are negligible — telephone charges for connection to a computer from a terminal are high.

More efficient

Simple translation of the program DRUGID to suit the TRS-80 proved to be rather slow in use because of the large number of numeric calculations involved and this motivated the development of a new, more efficient programming process.

An analyst may be called upon to identify a powdered crude drug and absolute identity requires detailed microscopic examinations as an essential part of the analytical technique. Reference is then made to suitable keys tables, atlases or a punched-card system. That approach, of necessity, is laborious and considerable experience is required to enable the analyst to identify the powder by microscopy.

Problems

The use of reference atlases, while a valuable aid in confirming identity, does not produce a systematic approach to the problem of identification of powdered vegetable drugs. Tables of histological features are sometimes difficult for the inexperienced analyst to interpret as the description, particularly "inflorescences and floral members" and "seeds and fruits" may apply to the powdered drug or, sometimes, it is more appropriate to the sectional appearance of the drug.

Before an atlas or table can be used, the drug must be referred to its morphological group; error at this stage is time-consuming and results frequently in incorrect identification. The punched-card system requires the assessment of more than 100 characters, some of which

DATA SHEET

CHARACTERS — Enter + if character present, — if absent

Character		No.	+/—
CALCIUM OXALATE	Prisms	1	
	Needles	2	
	Sphenoids	3	
	Clusters/Rosettes	4	
	Microcrystals	5	
	Crystal Layer	6	
	Crystal Sheath*	7	
ALEURONE**		8	
CORK		9	
LIGNIFIED PARENCHYMA		10	
STOMATA	Anomocytic	11	
	Anisocytic	12	
	Paracytic	13	
	Diacytic	14	
	Actinocytic	15	
TRICHOMES	Graminaceous	16	
	Covering	17	
	Unicellular	18	
	Multicellular	19	
	Glandular	20	
	Stalk Unicellular	21	
	Stalk Multicellular	22	
	Head Unicellular	23	
	Head Multicellular	24	
VESSELS/TRACHEIDS	Lignified	25	
	Non-lignified	26	
STONE CELLS		27	
FIBRES		28	
STARCH		29	
POLLEN		30	

* or calcium oxalate localised in the region of the main veins
** protein as grains or amorphous

NOTES
1) Remember GIGO (garbage in, garbage out). The output information can reflect only the accuracy of your observations. If you should make only a few mistakes, however, the output will give some guidance to indicate the location of errors.
2) The program MICROAID requires the input of SIX blocks of FIVE digits with each block separated by a single space. Only the digits 1 and 2 may be used. Any variation will cause an error message to appear on the screen and the data will have to be re-entered.
3) If a hard copy is required the printer should be switched-on and set to print (SELECT ON).

are difficult for the inexperienced analyist to interpret and moreover, entails microscale measurements.

The microcomputer is an ideal tool to aid the inexperienced microscopist to identify rapidly and correctly a powdered drug from as comprehensive a list as possible, not necessarily limited to those in commercial demand. The main problems were, therefore,

- to convert a large data matrix of information into a format suitable for rapid comparison with input data;
- to make allowance for histological features of the powdered vegetable drug present which could be missed due to their relative infrequency;
- to provide a facility for ascertaining the validity of the databank by use of a check digit;
- to keep input data as simple as possible;
- to check that input data is valid;
- to keep the user informed of processing progress, since a blank or unchanging screen while data processing is somewhat frustrating;
- to produce output data in ascending order of errors — the most likely powders to be listed first;
- to provide an option for hard-copy output, if desired;
- to help the analyst by indicating the possible sources of error in his microscopic observations, especially when complete identity is not achieved from his input data;
- to warn the user that final identity must be made only after comparison with an authentic sample — thus avoiding the "calculator" syndrome . . . . "the computer says the drug is . . . ."; which is a common student error.

The program

The program contains a databank of 174 powdered vegetable drugs together with a list of nine morphological groups. Each powder in the databank consists of up to nearly 50 alphanumeric characters. The first 30 indicate, in coded form, the presence or absence of certain histological features. Character 31 is a number from 1 to 9 corresponding to the appropriate morphological group. Character 32 is a check digit based on the first 31 characters; the remaining characters spell out the name of the powder.

Considering the first 30 characters, a "1" represents a histological feature which is definitely absent, "2" a histological feature which is definitely present and "3" a histological feature which is present but often in such a small amount that it could be missed by the inexperienced microscopist.'

The input information required from the user is a string of coded characters comprising six blocks of five digits which indicate the absence or presence — 1 or 2

(continued on page 123)

Listing 1

```
10 PRINT "START ADDR";:INPUT A$:A=0
20 FOR K=1TO4
30 IF MID $(A$,K,1)> ="A" THEN 50
40 A=A*16+VAL(MID $(A$,K,1)):GOTO 60
50 IF MID $(A$,K,1)="A" THEN A=A* 16+10
51 IF MID $(A$,K,1)="B" THEN A=A* 16+11
52 IF MID $(A$,K,1)="C" THEN A=A* 16+12
53 IF MID $(A$,K,1)="D" THEN A=A* 16+13
54 IF MID $(A$,K,1)="E" THEN A=A* 16+14
55 IF MID $(A$,K,1)="F" THEN A=A* 16+15
60 NEXT
70 PRINT "NO. LINES";:INPUT NL
80 FOR LN=1 TO NL
85 N=Ø:L=A:GOSUB 2ØØØ
90 D=PEEK(A):L=PEEK(A+1):H=PEEK(A+2)
100 IF (D AND 227)=97 THEN PRINT "ADC";:GOTO 1000
105 IF D=32 THEN PRINT "JSR";:N=3:GOTO 990
106 IF D = 76 THEN PRINT "JMP";:N=3:GOTO 990
107 IF D=108 THEN PRINT "JMP IND";:N=3:GOTO 990
110 IF (DAND 227)=33 THEN PRINT "AND";: GOTO 1100
120 IF D=144 THEN PRINT "BCC";:N=2:GOTO 1100
130 IF D=176 THEN PRINT "BCS";:N=2:GOTO 1100
140 IF D=240 THEN PRINT "BEO";:N=2:GOTO 1100
150 IF D=48 THEN PRINT "BMI";:N=2:GOTO 1100
160 IF D=208 THEN PRINT "BNE";:N=2:GOTO 1100
170 IF D=16 THEN PRINT "BPL";:N=2:GOTO 1100
180 IF D=80 THEN PRINT "BVC";:N=2:GOTO 1100
190 IF D=112 THEN PRINT "BVS";:N=2:GOTO 112
200 IF D=24 THEN PRINT "CLC";:N=1:GOTO 980
210 IF D=216 THEN PRINT "CLD";:N=1:GOTO 980
220 IF D=88 THEN PRINT "CLI";:N=1:GOTO 980
230 IF D=184 THEN PRINT "CLV";:N=1:GOTO 980
240 IF D=202 THEN PRINT "DEX";:N=1:GOTO 980
250 IF D=136 THEN PRINT "DEY";:N=1:GOTO 980
260 IF D=232 THEN PRINT "INX";:N=1:GOTO 980
270 IF D=200 THEN PRINT "INY";:N=1:GOTO 980
280 IF D=234 THEN PRINT "NOP";:N=1:GOTO 980
290 IF D=72 THEN PRINT "PHA";:N=1:GOTO 980
300 IF D=8 THEN PRINT "PHP";:N=1:GOTO 980
310 IF D=104 THEN PRINT "PLA";:N=1:GOTO 980
315 IF D=40 THEN PRINT "PLP";:N=1:GOTO 980
320 IF D=64 THEN PRINT"RTI";:N=4:GOTO 980
330 IF D=96 THEN PRINT "RTS";:N=1:GOTO 980
340 IF D=56 THEN PRINT "SEC";:N=1:GOTO 980
350 IF D=248 THEN PRINT "SED";:N=1:GOTO 980
360 IF D=120 THEN PRINT "SEI";:N=1:GOTO 980
370 IF D=170 THEN PRINT "TAX";:N=1:GOTO 980
380 IF D=168 THEN PRINT "TAY";:N=1:GOTO 980
390 IF D=186 THEN PRINT "TSX";:N=1:GOTO 980
400 IF D=138 THEN PRINT "TXA";:N=1:GOTO 980
410 IF D=154 THEN PRINT "TXS";:N=1:GOTO 980
420 IF D=152 THEN PRINT "TYA";:N=1:GOTO 980
430 IF(D AND 227)=2 THEN PRINT "ASL";:GOTO 999
440 IF(D AND 227)=32 THEN PRINT "BIT";:GOTO 1000
450 IF(D AND 227)=193 THEN PRINT "CMP";:GOTO 1000
460 IF(D AND 227)=224 THEN PRINT "CPX";:GOTO 998
470 IF(D AND 227)=192 THEN PRINT "CPY";:GOTO 998
480 IF(D AND 227)=65 THEN PRINT "EOR";:GOTO 1000
490 IF(D AND 227)=226 THEN PRINT "INC";:GOTO 1000
```

(continued from page 121)

```
500 IF(D AND 227)=162 THEN PRINT "LDX";:GOTO 997
510 IF(D AND 227)=160 THEN PRINT "LDY";:GOTO 998
520 IF(D AND 227)=161 THEN PRINT "LDA";:GOTO 1000
530 IF(D AND 227)=66 THEN PRINT "LSR";:GOTO 999
540 IF(D AND 227)=1 THEN PRINT "ORA";:GOTO 1000
550 IF(D AND 227)=34 THEN PRINT "ROL";:GOTO 999
560 IF(D AND 227)=98 THEN PRINT "ROR";:GOTO 999
570 IF(D AND 227) =225 THEN PRINT "SBC";:GOTO 1000
580 IF(D AND 227)=129 THEN PRINT "STA";:GOTO 1000
590 IF(D AND 227)=130 THEN PRINT "STX";:GOTO 997
600 IF(D AND 227)=128 THEN PRINT "STY";:GOTO 1000
610 PRINT "UNDEF";:N=1
620 L=D:GOSUB 2000
630 PRINT
980 A=A+N:NEXT LN
985 GOTO 70
990 GOSUB 2000
991 PRINT:GOTO 980
997 IF(D AND 28)=20 THEN PRINT " Z-PY";:N=2:GOTO 990
998 IF(D AND 28)=0 THEN PRINT " IMM";:N=2GOTO 990
999 IF(D AND 28)=8 THEN PRINT " ACC";:N=1:GOTO 980
1000 IF(D AND 28)=12 THEN PRINT " ABS";:N=3:GOTO 990
1010 IF(D AND 28)=8 THEN PRINT " IMM";:N=2:GOTO 990
1020 IF(D AND 28)=4 THEN PRINT " Z-PAGE";:N=2:GOTO 990
1030 IF(D AND 28)=0 THEN PRINT " INDX";:N=2:GOTO 990
1040 IF(D AND 28)=16 THEN PRINT " INDY";:N=2:GOTO 990
1050 IF(D AND 28)=20 THEN PRINT " Z-PX";:N=2:GOTO 990
1060 IF(D AND 28)=28 THEN PRINT " ABSX";:N=3:GOTO 990
1070 IF(D AND 28)=24 THEN PRINT " ABSY";:N=3:GOTO 990
1080 PRINT "UNDEF":N=1:GOTO 990
1100 REM RELATIVE ADDR
1105 H=L
1110 IF L >127 THEN H=L-256
1115 L=A+H+N:GOSUB 2000
1120 PRINT H
1130 GOTO 980
2000 REM DEC-HEX
2005 IF N=3 THEN L=L+256*H
2010 Q=INT(L/4096):GOSUB 2500
2020 L=L-Q*4096
2030 Q=INT(L/256):GOSUB 2500
2040 L=L-Q*256
2050 Q=INT(L/16):GOSUB 2500
2060 Q=L-Q*16:GOSUB 2500
2070 PRINT
2080 RETURN
2500 IF Q=10 THEN PRINT "A";:RETURN
2501 IF Q=11 THEN PRINT "B";:RETURN
2502 IF Q=12 THEN PRINT "C";:RETURN
2503 IF Q=13 THEN PRINT "D";:RETURN
2504 IF Q=14 THEN PRINT "E";:RETURN
2505 IF Q=15 THEN PRINT "F";:RETURN
2510 WØ=STRØ(Q)
2520 PRINT RIGHT Ø(WØ,1);:RETURN
```

(continued from page 121)

respectively — of the histological features being examined. This input data is first checked for validity so that characters 1 or 2 are acceptable and that there is one space present between each block of characters.

The input data is then converted by the program into the same format as the databank by eliminating the spaces. When this validity check has been completed, each one of the first 30 characters in the databank for each powder is compared to the input information and a tally is kept of the number of errors. Note that a 3 in the databank is equivalent to no error, since this allows for the possibility of not observing a feature present in a very small amount.

Errors stored

If more than five errors are detected, further processing of that powder is stopped to save unnecessary processing time. Where five or fewer characters are in error, the number of errors is stored for later access. When all the powders have been thus examined the powders corresponding to zero errors are output first, followed by those having only one error. Optionally, further output of 2, 3, 4 or 5 errors may be obtained on request.

The program requires 11-12 seconds to READ the DATA when verification of the databank is not required. When verification, using the check digit routine, is deemed necessary this time extends to 3.5 minutes. The time required from entry of the INPUT information to printing-out of the first powder ranges from 179 seconds, for powder No. 1 to, 199 seconds, for powder No. 174, an average time of 3.1 minutes.

For teaching purposes, where a limited databank may be used, a program containing 32 drugs takes about 25 seconds to give an answer from inputting the experimental information.

Listing 2

```
0240 18 CLC
0241 A9 LDA IMM 5(0005)
0242 05
0243 8D STA ABS 0251
0244 51
0245 02
0246 A9 LDA IMM 10(000A)
0247 0A
0248 6D ADC ABS 0251
0249 51
024A 02
024B 8D STA ABS 0251
024C 51
024D 02
024E 4C JMP (OR RTS=60) FE00
024F 00}
0250 FE}or wherever your monitor restarts
0251 - answer (0F)
```

The foregoing is a machine code routine to put 5 in loc 251, then add it to 10 in the accumulator, then put back the answer in 251. Finally jump to monitor, or if a subroutine used by USR function then put in 60(RTS) at loc 24E.

Listing 3

The sample machine code disassembled by DIS65.

```
OK
RUN
START ADDR? 0240
NO. LINES? 8
0240 CLC
0241 LDA IMM 0005
0243 STA ABS 0251
0246 LDA IMM 000A
0248 ADC ABS 0251
024B STA ABS 0251
024E JMP      FE00
0251 UNDEF 000F
```

Operation of program

1. LOAD PROGRAM The program is loaded either from tape — loading command CLOAD — or disc — loading command LOAD "MICROAID".
2. TYPE RUN
3. TYPE IN CODED OBSERVATIONS, when requested
4. SWITCH ON LINE PRINTER, if hard copy is required.
5. ANSWER any questions which appear on the screen regarding any further printing requirements.
6. ANSWER questions regarding request for another run.

User intervention during a run is limited to answering the questions asked.

Special preparation

THE POWDER is examined mircoscopically in the following reagents and the appropriate entry made on the analytical data sheet (see INPUT/OUTPUT).

Chloral hydrate solution: Chloral hydrate (50g) dissolved in distilled water (20ml). Used for calcium oxalate, cork, stomata, trichomes, fibres and pollen. The powder should be "boiled in the presence of the mountant to remove unwanted cell content.

Picric acid solution: A saturated solution of picric acid in water made by dissolving 1g of picric acid in 95ml of distilled water. Used for protein in the form of aleurone grains or amorphous protein. As many seeds and fruits contain abundant fixed oil, it is advisable to de-fat the powder by immersion in light petroleum — boiling range 40-60 degrees C for a few minutes before staining. In addition, the background colour can be removed, after staining, by irrigating the mount with water, when the yellow colour given by protein will be clearly visible.

Phloroglucinol solution: Phloroglucinol (1g) plus ethanol (95%) to 100ml. This solution is used, in the presence of concentrated hydrochloric acid, for lignified parenchyma, vessels/tracheids and stone cells. If lignified, these structures will acquire a red coloration.

Iodine water: Mix one volume of a weak solution of iodine BP[16] with a nine volumes of distilled water. Used for starch granules, which yield a characteristic blue-black colour.

The usual format of +/— indicating present/absent is used to record the assessed characters on the data sheet. This information is converted into numerals (— = 1; + = 2) to convert into suitable input data for computer analysis.

Computer analysis of powdered, organised, vegetable, crude drugs

```
1010 DATA 11111111112111122111111121211253 ACONITE LEAF
1020 DATA 11111111111111111111111121222180 ACONITE ROOT
1030 DATA 11121121112111112231111121131156 AILANTHUS
1040 DATA 21121112111111111111111131211160 ALMOND
1050 DATA 21111111211111111111111111222117 ALSTONIA
1060 DATA 12111111111111111111111121222183 AMERICAN VERATRUM
1070 DATA 22111111211111111111111111222115 ANGOSTURA
1080 DATA 11122112112111112211111121221136 ANISE
1090 DATA 11111112131111111111111131221169 ARECA
1100 DATA 11111111132111112222121221111220 ARNICA FLOWER
1110 DATA 21111212111111111111111131222117 ASPIDOSPERMA
1120 DATA 21111111112111112213131321121154 BEARBERRY
1130 DATA 11212113121211112122222221222249 BELLADONNA HERB
1140 DATA 11212111111211112122222221111251 BELLADONNA LEAF
1150 DATA 11212111221111111111111121122180 BELLADONNA ROOT
1160 DATA 11111111111112112122211221111157 BETONY
1170 DATA 21121111211111111111111111212117 BLACKHAW
1180 DATA 11111111131111111111111121212180 BLACK HELLEBORE
1190 DATA 21111112122111111111111121212131 BLACK PEPPER
1200 DATA 11111111112111112221111121121154 BOLDO
1210 DATA 11111111132111112211111121122344 BROOM TOPS
1220 DATA 11111112311111111111111121212189 BRYONY ROOT
1230 DATA 11121111112111112211111121121152 BUCHU
1240 DATA 11121112111111112121111131222167 CACAO
1250 DATA 21111112111111111111111121222188 CALUMBA
1260 DATA 11121111311111111111111111232116 CANELLA
1270 DATA 11212112111211112122211221221130 CAPSICUM FRUIT
1280 DATA 11122112112111113111111121221136 CARAWAY
1290 DATA 21111112111111111111111131212161 CARDAMOM
1300 DATA 21121121211111111111111111222111 CASCARA
1310 DATA 21121111211111112121111111122119 CASCARILLA
1320 DATA 12112111211111111111111111222111 CASSIA
1330 DATA 11111111111112112222211221111248 CATNEP
1340 DATA 11122112132111112211111121221134 CELERY
1350 DATA 11121111132111112122121221211225 CHAMOMILE
1360 DATA 11111111231111111111111121121186 CHICORY
1370 DATA 21112111211111111111111111122115 CINCHONA
1380 DATA 12112111211111111111111111222111 CINNAMON
1390 DATA 11121111132111111111111121221226 CLOVES
1400 DATA 21121121111121111111111121121156 COCA
1410 DATA 21111212111111111111111111222110 COCILLANA
1420 DATA 11111112111111111111111131212162 COFFEE
1430 DATA 11111111111111131111111121112182 COLCHICUM CORM
1440 DATA 11111112111111111111111131112165 COLCHICUM SEED
1450 DATA 11111112122111111111111121211137 COLOCYNTH FRUIT
1460 DATA 11111111112111112121111121111253 COLTSFOOT LEAF
1470 DATA 21121111211111111111111111222113 CONDURANGO
```

(continued on next page)

Diagram 1. Read data.

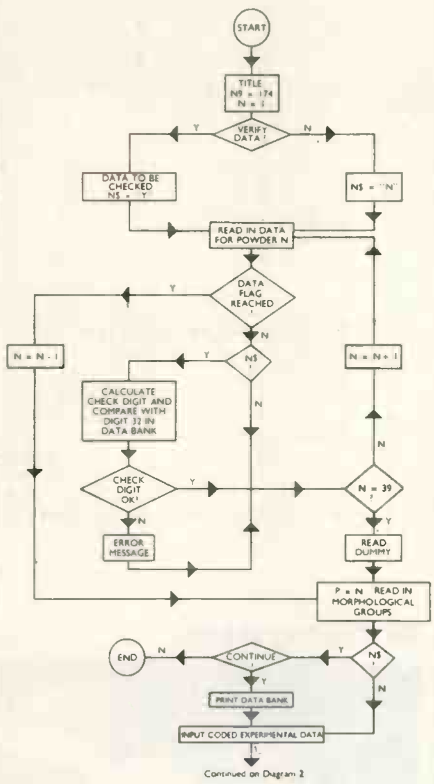
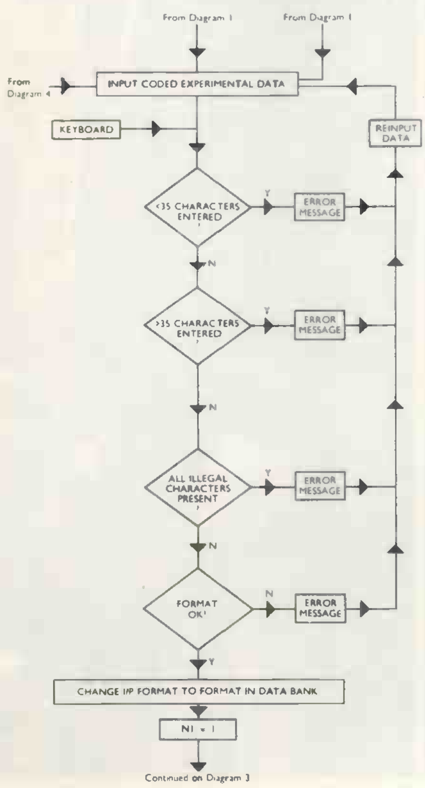


Diagram 2. Input data validation.



(continued from previous page)

```
1480 DATA 21122112113111111111111131231132 CORIANDER FRUIT
1490 DATA 11121111211111111111111111122117 COTTON ROOT BARK
1500 DATA 11111111121111111111111121221183 COUCH GRASS
1510 DATA 11122112112111112121111121221137 CUMMIN
1520 DATA 11121111121121112213311221121251 DAMIANA
1530 DATA 11111111211111112121111121111180 DANDELION ROOT
1540 DATA 21222213121211112122222221222246 DATURA INNOXIA HERB
1550 DATA 21222213121211112122211221222244 DATURA METEL HERB
1560 DATA 21111121221111111111111121222189 DERRIS
1570 DATA 11111111112111112122222221111154 DIGITALIS
1580 DATA 11111111112111111122112211111154 DIGITALIS LANATA
1590 DATA 11122112123111111111111121221139 DILL
1600 DATA 121111112111111111111111121222187 DIOSCOREA
1610 DATA 11212111111211111112211221111153 DUBOISIA LEAF
1620 DATA 21212113121211111112122221222240 EGYPTIAN HENBANE HERB
1630 DATA 11111111231111111111111121121186 ELECAMPANE
1640 DATA 11121111112111112212211221122157 ERIODICTYON
1650 DATA 11111111111111111111111111111140 ERGOT
1660 DATA 21121111212111111111111121111158 EUCALYPYUS
1670 DATA 11111111112111112222213221122245 EUPATORIUM
1680 DATA 11122112123111111111111121121130 FENNEL
1690 DATA 11111112111111111111111111111163 FENUGREEK
1700 DATA 21121121211111111111111111122117 FRANGULA
1710 DATA 11111111111111111111111121122186 GALANGAL RHIOZOME
1720 DATA 21111111111111121111111121211178 GARLIC
1730 DATA 21111111221111111111111121222186 GELSEMIUM
1740 DATA 12112111211111111111111121112180 GENTIAN
1750 DATA 11111111211111111111111112122181 GINGER
1760 DATA 11122111121111111111111121112187 GINSENG
1770 DATA 11111113121111122211111121113246 GRASS
1780 DATA 11123111122111111112211221122245 GRINDELIA
1790 DATA 21111111121111111111111121121198 GUAIACUM
1800 DATA 11122112113111111111111121121132 HEMLOCK FRUIT
1810 DATA 11111111121111111111111121111156 HEMLOCK LEAF
1820 DATA 21222213121211112122221221222245 HENBANE HERB
1830 DATA 21131211111211112122221221111351 HENBANE LEAF
1840 DATA 11121111112111111111111121111150 HENNA
1850 DATA 11121112122111112212121221121240 HOPS
1860 DATA 11111111211111111111111121112189 HORSESADISH
1870 DATA 11111111221111111111111121122170 HYDRASTIS
1880 DATA 11121113112111112212221221221140 INDIAN HEMP
1890 DATA 11121111211111111111111121222185 INDIAN PODOPHYLLUM
1900 DATA 12111111221111111111111121222185 IPECACUANHA
1910 DATA 21121111211111111111111121222184 IPOMOEA
1920 DATA 11111112111111111111111111112168 ISPHAGHULA
1930 DATA 11121111122111112211111121121150 JABORANDI
1940 DATA 21121111211111111111111121212188 JALAP
```

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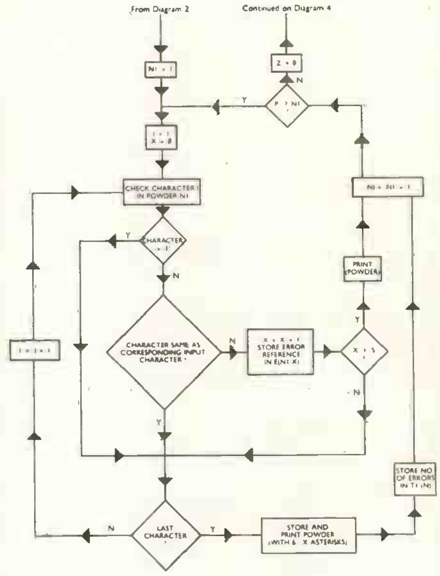
1950 DATA 211111121211111111111111121221135 JUNIPER BERRIES
1960 DATA 211211111321111122121222211111229 KOUSSO
1970 DATA 211111111331131122222222221111227 LAVENDER
1980 DATA 221111111111111211111111121122245 LILY OF THE VALLEY HERB
1990 DATA 111111121111111111111111131211167 LINSEED
2000 DATA 211111212211111111111111121122180 LIQUORICE
2010 DATA 111111131221111122111111121222246 LOBELIA
2020 DATA 211111111211111111111111121122193 LOGWOOD
2030 DATA 211111212211111111111111121222189 LONCHOCARPUS
2040 DATA 211111211323111121222122221123244 LUCERNE
2050 DATA 111111111111111111111111121211166 MACE
2060 DATA 111111111111111111111111121122186 MALE FERN
2070 DATA 211211111321111121221212221211224 MARIGOLD
2080 DATA 111211111211111111111111121122187 MARSHMALLOW
2090 DATA 311211111221111122111111121221155 MATE
2100 DATA 111211111321111122121212221211226 MATRICARIA
2110 DATA 111111121111111111111111131211167 MUSTARD
2120 DATA 111111121111111111111111131112165 NUTMEG
2130 DATA 111111121111111122111111111311163 NUX VOMICA
2140 DATA 211211212211111111111111111222119 OAK
2150 DATA 211111211121111111111111121121152 ORANGE LEAF
2160 DATA 211111113111111111111111121112187 ORRIS
2170 DATA 111111112211111111111111121222187 PAREIRA
2180 DATA 111111112111111111111111121221184 PELLITORY
2190 DATA 111111111211121122222222221122241 PEPPERMINT
2200 DATA 121111111121111111111111121111154 PHYTOLACCA LEAF
2210 DATA 211211121121111122111111121222139 PIMENTO
2220 DATA 111111111211111111111111121112198 PINE
2230 DATA 111211112111111111111111121222185 PODOPHYLLUM
2240 DATA 121111112311111111111111111122185 POKE ROOT
2250 DATA 311211112111111111111111111212116 POMEGRANATE
2260 DATA 111111111121111111111111111111225 POPPY PETAL
2270 DATA 211211111321111122221212221211222 PYRETHRUM
2280 DATA 211111113211111111111111121122191 QUASSIA
2290 DATA 211111113111111111111111111222118 QUILLAIA
2300 DATA 111211111221111122133113211121255 RASPBERRY LEAF
2310 DATA 211111112211111111111111121122189 RAUWOLFIA SERPENTINA
2320 DATA 211111112211111111111111121222186 RAUWOLFIA VOMITORIA
2330 DATA 111211111111111122111111121111227 RED-ROSE PETAL
2340 DATA 211111111211111111111111121122193 RED SANDERS
2350 DATA 211111212111111111111111121122182 RHATANY
2360 DATA 111211113111111111111111112112181 RHUBARB
2370 DATA 111211111121111111111111121111150 RUE
2380 DATA 111111111311111122111111121121225 SAFFRON
2390 DATA 111111111111121121222222212111150 SAGE
2400 DATA 121111111111111122111111121112182 SALEP
2410 DATA 211111111211111111111111121122193 SANDAL WOOD
```

(continued on next page)

Diagram 3. Data processing.



Dr Geoffrey Jolliffe.

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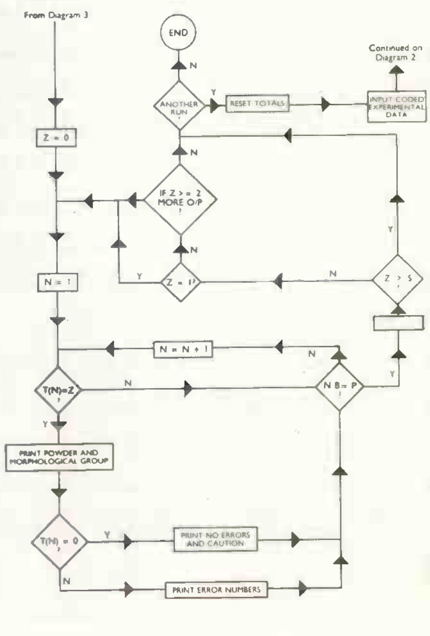
2420 DATA 1112111113211111221212122121122 6 SANTONICA
```

Dr Georgina Jolliffe.

Diagram 4. Output information.



```
1  11111 11111 21111 12211 11112 12112 ACONITE LEAF (LEAF)
2  11111 11111 11111 11111 11112 12221 ACONITE ROOT (UNDERGROUND ROOT/STEM)
3  11121 12111 21111 12231 11112 11311 AILANTHUS (LEAF)
4  21121 11211 11111 11111 11113 12111 ALMOND (SEED)
5  21111 11121 11111 11111 11111 12221 ALSTONIA (BARK)
6  12111 11111 11111 11111 11112 12221 AMERICAN VERATRUM (UNDERGROUND ROOT/STEM)
7  22111 11121 11111 11111 11111 12221 ANGOSTURA (BARK)
8  11122 11211 21111 12211 11112 12211 ANISE (FRUIT)
9  11111 11213 11111 11111 11113 12211 ARECA (SEED)
10 11111 11113 21111 12222 12122 11112 ARNICA FLOWER (FLOWER)
11 21111 12121 11111 11111 11113 12221 ASPIDOSPERMA (BARK)
12 21111 11111 21111 12213 13132 11211 BEARBERRY (LEAF)
13 11212 11312 12111 12122 22222 12222 BELLADONNA HERB (HERB)
14 11212 11111 12111 12122 22222 11113 BELLADONNA LEAF (LEAF)
15 11212 11122 11111 11111 11112 11221 BELLADONNA ROOT (UNDERGROUND ROOT/STEM)
16 11111 11111 11121 12122 21122 11111 BETONY (LEAF)
17 21121 11121 11111 11111 11111 12121 BLACKHAW (BARK)
18 11111 11113 11111 11111 11112 12121 BLACK HELLEBORE (UNDERGROUND ROOT/STEM)
19 21111 11212 21111 11111 11112 12121 BLACK PEPPER (FRUIT)
20 11111 11111 12111 12221 11112 11211 BOLDO (LEAF)
21 11111 11113 21111 12211 11112 11223 BROOM TOPS (HERB)
22 11111 11123 11111 11111 11112 12121 BRYONY ROOT (UNDERGROUND ROOT/STEM)
23 11121 11111 21111 12211 11112 11211 BUCHU (LEAF)
24 11121 11211 11111 12121 11113 12221 CACAO (SEED)
25 21111 11121 11111 11111 11112 12221 CALUMBA (UNDERGROUND ROOT/STEM)
26 11121 11131 11111 11111 11111 12321 CANELLA (BARK)
27 11212 11211 12111 12122 21122 12211 CAPSICUM FRUIT (FRUIT)
28 11122 11211 21111 31111 11112 12211 CARAWAY (FRUIT)
29 21111 11211 11111 11111 11113 12121 CARDAMOM (SEED)
30 21121 12121 11111 11111 11111 12221 CASCARA (BARK)
31 21121 11121 11111 12121 11111 11221 CASCARILLA (BARK)
32 12112 11121 11111 11111 11111 12221 CASSIA (BARK)
33 11111 11111 11121 12222 21122 11112 CATNEP (HERB)
34 11122 11213 21111 12211 11112 12211 CELERY (FRUIT)
35 11121 11113 21111 12122 12122 12112 CHAMOMILE (FLOWER)
36 11111 11123 11111 11111 11112 11211 CHICORY (UNDERGROUND ROOT/STEM)
37 21112 11121 11111 11111 11111 11221 CINCHONA (BARK)
38 12112 11121 11111 11111 11111 12221 CINNAMON (BARK)
39 11121 11113 21111 11111 11112 12212 CLOVES (FLOWER)
40 21121 12111 11211 11111 11112 11211 COCA (LEAF)
41 21111 12121 11111 11111 11111 12221 COCILLANA (BARK)
42 11111 11211 11111 11111 11113 12121 COFFEE (SEED)
43 11111 11111 11111 31111 11112 11121 COLCHICUM CORM (UNDERGROUND ROOT/STEM)
44 11111 11211 11111 11111 11113 11121 COLCHICUM SEED (SEED)
45 11111 11212 21111 11111 11112 12111 COLOCYNTH FRUIT (FRUIT)
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46  11111 11111 21111 12121 11112 11112 COLTSFOOT LEAF (LEAF)
47  21121 11121 11111 11111 11111 12221 CONDURANGO (BARK)
48  21122 11211 31111 11111 11113 12311 CORIANDER FRUIT (FRUIT)
49  11121 11121 11111 11111 11111 11221 COTTON ROOT BARK (BARK)
50  11111 11112 11111 11111 11112 12211 COUCH GRASS (UNDERGROUND ROOT/STEM)
51  11122 11211 21111 12121 11112 12211 CUMMIN (FRUIT)
52  11121 11112 11211 12213 31122 11212 DAMIANA (LEAF)
53  11111 11121 11111 12121 11112 11111 DANDELION ROOT (UNDERGROUND ROOT/STEM)
54  21222 21312 12111 12122 22222 12222 DATURA INNOXIA HERB (HERB)
55  21222 21312 12111 12122 21122 12222 DATURA METEL HERB (HERB)
56  21111 12122 11111 11111 11112 12221 DERRIS (UNDERGROUND ROOT/STEM)
57  11111 11111 21111 12122 22222 11111 DIGITALIS (LEAF)
58  11111 11111 21111 11112 21122 11111 DIGITALIS LANATA (LEAF)
59  11122 11212 31111 11111 11112 12211 DILL (FRUIT)
60  12111 11121 11111 11111 11112 12221 DIOSCOREA (UNDERGROUND ROOT/STEM)
61  11212 11111 12111 11112 21122 11111 DUBOISIA LEAF (LEAF)
62  21212 11312 12111 11112 12222 12222 EGYPTIAN HENBANE HERB (HERB)
63  11111 11123 11111 11111 11112 11211 ELECAMPANE (UNDERGROUND ROOT/STEM)
64  11121 11111 21111 12212 21122 11221 ERIODICTYON (LEAF)
65  11111 11111 11111 11111 11111 11111 ERGOT (HERB)
66  21121 11121 21111 11111 11112 11111 EUCALYPYUS (LEAF)
67  11111 11111 21111 12222 21322 11222 EUPATORIUM (HERB)
68  11122 11212 31111 11111 11112 11211 FENNEL (FRUIT)
69  11111 11211 11111 11111 11111 11111 FENUGREEK (SEED)
70  21121 12121 11111 11111 11111 11221 FRANGULA (BARK)
71  11111 11111 11111 11111 11112 11221 GALANGAL RHIOZOME (UNDERGROUND ROOT/STEM)
72  21111 11111 11111 21111 11112 12111 GARLIC (UNDERGROUND LEAF)
73  21111 11122 11111 11111 11112 12221 GELSEMIUM (UNDERGROUND ROOT/STEM)
74  12112 11121 11111 11111 11112 11121 GENTIAN (UNDERGROUND ROOT/STEM)
75  11111 11121 11111 11111 11111 21221 GINGER (UNDERGROUND ROOT/STEM)
76  11122 11112 11111 11111 11112 11121 GINSENG (UNDERGROUND ROOT/STEM)
77  11111 11312 11111 22211 11112 11132 GRASS (HERB)
78  11123 11112 21111 11112 21122 11222 GRINDELIA (HERB)
79  21111 11112 11111 11111 11112 11211 GUAIACUM (WOOD)
80  11122 11211 31111 11111 11112 11211 HEMLOCK FRUIT (FRUIT)
81  11111 11111 21111 11111 11112 11111 HEMLOCK LEAF (LEAF)
82  21222 21312 12111 12122 22122 12222 HENBANE HERB (HERB)
83  21131 21111 12111 12122 22122 11113 HENBANE LEAF (LEAF)
84  11121 11111 21111 11111 11112 11111 HENNA (LEAF)
85  11121 11212 21111 12212 12122 11212 HOPS (HERB)
86  11111 11121 11111 11111 11112 11121 HORSESADISH (UNDERGROUND ROOT/STEM)
87  11111 11122 11111 11111 11112 11221 HYDRASTIS (UNDERGROUND LEAF)
88  11121 11311 21111 12212 22122 12211 INDIAN HEMP (HERB)
89  11121 11121 11111 11111 11112 12221 INDIAN PODOPHYLLUM (UNDERGROUND ROOT/STEM)
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90  12111 11122 11111 11111 11112 12221 IPECACUANHA (UNDERGROUND ROOT/STEM)
91  21121 11121 11111 11111 11112 12221 IPOMOEA (UNDERGROUND ROOT/STEM)
92  11111 11211 11111 11111 11111 11121 ISPHAGHULA (SEED)
93  11121 11112 21111 12211 11112 11211 JABORANDI (LEAF)
94  21121 11121 11111 11111 11112 12121 JALAP (UNDERGROUND ROOT/STEM)
95  21111 11212 11111 11111 11112 12211 JUNIPER BERRIES (FRUIT)
96  21121 11113 21111 12212 12222 11112 KOUSSO (FLOWER)
97  21111 11113 31131 12222 22222 11112 LAVENDER (FLOWER)
98  22111 11111 11111 21111 11112 11222 LILY OF THE VALLEY HERB (HERB)
99  11111 11211 11111 11111 11113 12111 LINSEED (SEED)
100 21111 12122 11111 11111 11112 11221 LIQUORICE (UNDERGROUND ROOT/STEM)
101 11111 11312 21111 12211 11112 12222 LOBELIA (HERB)
102 21111 11112 11111 11111 11112 11221 LOGWOOD (WOOD)
103 21111 12122 11111 11111 11112 12221 LONCHOCARPUS (UNDERGROUND ROOT/STEM)
104 21111 12113 22111 12122 21222 11232 LUCERNE (HERB)
105 11111 11111 11111 11111 11112 12111 MACE (SEED)
106 11111 11111 11111 11111 11112 11221 MALE FERN (UNDERGROUND ROOT/STEM)
107 21121 11113 21111 12122 12122 12112 MARIGOLD (FLOWER)
108 11121 11112 11111 11111 11112 11221 MARSHMALLOW (UNDERGROUND ROOT/STEM)
109 31121 11112 21111 12211 11112 12211 MATE (LEAF)
110 11121 11113 21111 12212 12122 12112 MATRICARIA (FLOWER)
111 11111 11211 11111 11111 11113 12111 MUSTARD (SEED)
112 11111 11211 11111 11111 11113 11121 NUTMEG (SEED)
113 11111 11211 11111 12211 11111 13111 NUX VOMICA (SEED)
114 21121 12122 11111 11111 11111 12221 OAK (BARK)
115 21111 12111 21111 11111 11112 11211 ORANGE LEAF (LEAF)
116 21111 11131 11111 11111 11112 11121 ORRIS (UNDERGROUND ROOT/STEM)
117 11111 11122 11111 11111 11112 12221 PAREIRA (UNDERGROUND ROOT/STEM)
118 11111 11121 11111 11111 11112 12211 PELLITORY (UNDERGROUND ROOT/STEM)
119 11111 11112 11121 12222 22222 11222 PEPPERMINT (HERB)
120 12111 11111 21111 11111 11112 11111 PHYTOLACCA LEAF (LEAF)
121 21121 11211 21111 12211 11112 12221 PIMENTO (FRUIT)
122 11111 11112 11111 11111 11112 11121 PINE (WOOD)
123 11121 11121 11111 11111 11112 12221 PODOPHYLLUM (UNDERGROUND ROOT/STEM)
124 12111 11123 11111 11111 11111 11221 POKE ROOT (UNDERGROUND ROOT/STEM)
125 31121 11121 11111 11111 11111 12121 POMEGRANATE (BARK)
126 11111 11111 21111 11111 11111 11112 POPPY PETAL (FLOWER)
127 21121 11113 21111 12222 12122 12112 PYRETHRUM (FLOWER)
128 21111 11132 11111 11111 11112 11221 QUASSIA (WOOD)
129 21111 11131 11111 11111 11111 12221 QUILLAIA (BARK)
130 11121 11112 21111 12213 31132 11212 RASPBERRY LEAF (LEAF)
131 21111 11122 11111 11111 11112 11221 RAUWOLFIA SERPENTINA (UNDERGROUND ROOT/STEM)
132 21111 11122 11111 11111 11112 12221 RAUWOLFIA VOMITORIA (UNDERGROUND ROOT/STEM)
133 11121 11111 11111 12211 11112 11112 RED-ROSE PETAL (FLOWER)
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134 21111 11112 11111 11111 11112 11221 RED SANDERS (WOOD)
135 21111 12121 11111 11111 11112 11221 RHATANY (UNDERGROUND ROOT/STEM)
136 11121 11131 11111 11111 11111 21121 RHUBARB (UNDERGROUND ROOT/STEM)
137 11121 11111 21111 11111 11112 11111 RUE (LEAF)
138 11111 11113 11111 12211 11112 11212 SAFFRON (FLOWER)
139 11111 11111 11121 12122 22221 21111 SAGE (LEAF)
140 12111 11111 11111 12211 11112 11121 SALEP (UNDERGROUND ROOT/STEM)
141 21111 11112 11111 11111 11112 11221 SANDAL WOOD (WOOD)
142 11121 11113 21111 12212 12122 12112 SANTONICA (FLOWER)
143 21111 11112 11111 11111 11112 11221 SAPPAN (WOOD)
144 12111 11112 11111 11111 11112 13321 SARSAPARILLA (UNDERGROUND ROOT/STEM)
145 12112 11122 11111 11111 11111 12221 SASSAFRAS BARK (BARK)
146 11111 11112 11111 11111 11112 11221 SASSAFRAS WOOD (WOOD)
147 21112 11112 11111 21111 11112 11211 SAVIN TOPS (HERB)
148 11111 11122 31111 12211 11112 12111 SENEGA (UNDERGROUND ROOT/STEM)
149 21121 12211 23111 12211 11112 12211 SENNA FRUIT (FRUIT)
150 21121 12111 11211 12211 11112 11211 SENNA LEAF (LEAF)
151 11111 11121 11111 11111 11112 13221 SERPENTARY (UNDERGROUND ROOT/STEM)
152 21111 11121 11111 11111 11111 12211 SIMARUBA (BARK)
153 21111 12131 11111 11111 11111 11221 SLIPPERY ELM (BARK)
154 21111 11211 11111 11111 11113 12131 SOY BEAN (SEED)
155 12111 11111 21111 11111 11112 11121 SQUILL (UNDERGROUND LEAF)
156 21111 11213 21111 11111 11112 12311 STAR ANISE (FRUIT)
157 11111 11211 11111 11111 11112 11111 STAVESACRE (SEED)
158 21222 21312 12111 12122 21122 12222 STRAMONIUM HERB (HERB)
159 31121 21111 12111 12122 21122 11113 STRAMONIUM LEAF (LEAF)
160 31121 11211 11111 12211 11113 13111 STROPHANTHUS (SEED)
161 21121 13131 11111 11111 11112 11221 SWEET FLAG (UNDERGROUND ROOT/STEM)
162 11121 11111 11112 12211 11112 12211 TEA (LEAF)
163 11212 11111 12111 12122 22222 11211 TOBACCO (LEAF)
164 11111 11121 21111 12211 11113 11121 TURMERIC (UNDERGROUND ROOT/STEM)
165 11121 11123 11111 11111 11112 12221 TURPETH (UNDERGROUND ROOT/STEM)
166 11111 11112 11111 12211 11112 12221 VALERIAN (UNDERGROUND ROOT/STEM)
167 22111 11212 21111 12211 11112 12211 VANILLA (FRUIT)
168 11121 11121 11111 11111 11111 11121 WAHOO (BARK)
169 12111 11111 11111 11111 11112 12221 WHITE HELLEBORE (UNDERGROUND ROOT/STEM)
170 21121 11121 11111 11111 11113 12221 WILD CHERRY (BARK)
171 21111 12121 11111 11111 11113 12231 WITCH-HAZEL BARK (BARK)
172 21121 12112 11211 12121 11112 12211 WITCH-HAZEL LEAF (LEAF)
173 11111 11111 21111 12122 12122 11111 XANTHIUM (LEAF)
174 11111 11121 11111 12211 11112 11221 ZEDOARY (UNDERGROUND ROOT/STEM)
```

```
10 CLS:PRINT@466,"M I C R O A I D     EDN 05/06/79":CLEAR500:DEFINTA-Z
15 D=1:REM TO LIST UPWARDS FROM A PARTICULAR POWDER NO. CHANGE D ACCORDINGLY (USEFUL IF A DATA BANK LISTING IS FAULTY)
20 Z$=CHR$(28)+CHR$(31)+CHR$(23):Z9=14312
30 DIM B$(174),E(174,6),T(174):N9=174'DIM STATEMENTS HERE
40 PRINTZ$:STRING$(33,61)"MICROAID POWDER IDENTIFICATION"STRING$(33,61)
45 N=1:PRINT"DO YOU WANT TO VERIFY DATA BANK?";
50 N$=INKEY$:IFN$="N"THEN60ELSEIFN$="Y"THEN55ELSE50
55 PRINT,,"DATA BANK INFORMATION IS BEING  CHECKED FOR ACCURACY"
60 READB$(N)
70 IFB$(N)="*":N=N-1:GOTO95
75 IFN$="Y"THENPRINT@972,"VERIFYING",ELSEIFN$="N"PRINT@976,"READING",
80 PRINT" POWDER NO:";N::IFN$="Y"GOSUB800
85 IF N=N9 READA$:GOTO95
90 N=N+1:GOTO60
95 P=N:FORI=1TO9:READM$(I):NEXTI:PRINT:IFN$="Y"PRINT" SWITCH ON PRINTER FOR DATA BANK LISTING":INPUT"PRESS ENTER TO CONTINUE",A$:GOS
UB910
100 PRINTZ$,P,"POWDERS ARE IN THIS PROGRAM",,"ENTER -",,,,"1 FOR CHARACTER ABSENT",,,"2 FOR CHARACTER PRESENT"
110 PRINT,,"YOU MUST TYPE IN SIX BLOCKS OF  FIVE DIGITS (SEPARATED BY SINGLESPACE) ON ONE LINE ":PRINT,," ",
120 INPUTP$
130 IFLEN(P$)<35PRINT"YOU HAVE NOT ENTERED ENOUGH DATA";:GOTO190
135 IFLEN(P$)>35PRINT"YOU HAVE ENTERED TOO MUCH DATA";:GOTO190
140 FORI=1TO35
150 IFMID$(P$,I,1)="1"THEN200
160 IFMID$(P$,I,1)="2"THEN200
170 IFMID$(P$,I,1)=" "THEN200
180 PRINT"YOU HAVE ENTERED A ";MID$(P$,I,1);" AND THIS IS NOT ALLOWED";
190 PRINT"  - RE-INPUT DATA":FORQ=1TO1000:NEXTQ:GOTO100
200 NEXTI
210 FORI=6TO30STEP6
220 IFMID$(P$,I,1)<>" "PRINT"INCORRECTLY FORMED DATA BLOCKS":GOTO190
230 NEXTI
240 D$=MID$(P$,1,5)+MID$(P$,7,5)+MID$(P$,13,5)+MID$(P$,19,5)+MID$(P$,25,5)+MID$(P$,31,5)
290 X=0:N1=1:PRINTZ$;"  THE MORE ASTERISKS THE BETTER THE AGREEMENT BETWEEN INPUT DATA AND THE DATA BANK ",,,"****** = NO ERRORS ",
295 PRINT" ***** =  1 ERROR","  **** =  2 ERRORS","   *** =  3 ERRORS","    ** =  4 ERRORS","     * =  5 ERRORS","   ( ) = >5 ERRORS
":PRINT:PRINT"SWITCH ON PRINTER FOR HARD COPY":PRINT
300 FORI=1TO30
310 IFMID$(B$(N1),I,1)="3"THEN350
320 IFMID$(B$(N1),I,1)<>MID$(D$,I,1)THENX=X+1:E(N1,X)=I
330 IFX>5PRINT@896,CHR$(30),N1,TAB(7);"(";MID$(B$(N1),34,25);")"; T(N1)=6:GOTO380
350 NEXTI
360 PRINT@832,STRING$(6-X,42);TAB(7);MID$(B$(N1),34,25);CHR$(30):PRINT:PRINT
370 T(N1)=X
380 N1=N1+1
390 X=0
400 IFP>=N1THEN300
450 PRINT:PRINT"RESULTS ARE ABOUT TO BE LISTED":PRINT:Z=0
460 C$="   NO ERRORS ****** COMPARE YOUR POWDER WITH AN AUTHENTIC SAMPLE ******"
470 IFPEEK(Z9)<200LPRINT"INPUT DATA:  ";P$;CHR$(10),CHR$(10);"REF"
490 FORN=1TOP
500 IFT(N)=Z LETB$=MID$(B$(N),33,25)+" - ("+M$(VAL(MID$(B$(N),31,1)))+")"
510 IFT(N)=ZPRINTB$:IFPEEK(Z9)<200LPRINTN;TAB(6);B$
515 IFT(N)<>ZTHEN570
520 IFT(N)=0PRINTC$;:IFPEEK(Z9)<200LPRINTTAB(5);C$,CHR$(10),CHR$(10)
521 IFT(N)=0THEN570
525 PRINTT(N);"ERROR(S) -";:IFPEEK(Z9)<200LPRINTTAB(8);T(N);"ERROR";:IFT(N)>1LPRINT"S -";ELSELPRINT" -";
530 FORX=1TO5
540 IFE(N,X)>0PRINTE(N,X);:IFPEEK(Z9)<200LPRINTE(N,X);
550 NEXTX
560 PRINT:IFPEEK(Z9)<200LPRINTCHR$(10),CHR$(10)
570 NEXTN
580 Z=Z+1
585 IFZ>5THEN620
590 IFZ>=2PRINT@960,"DO YOU WANT O/P FOR";Z;"ERRORS?";ELSE610
600 N$=INKEY$:IFN$="Y"THEN610ELSEIFN$="N"THEN620ELSE600
610 PRINT@960,CHR$(30);"LOOKING FOR";Z;"ERROR(S)":GOTO490
620 PRINT@960,CHR$(30);"DO YOU WANT ANOTHER RUN?";
630 N$=INKEY$:IFN$="Y"THEN900ELSEIFN$="N"THEN640ELSE630
640 PRINTZ$:PRINT@466,"G O O D B Y E"
650 PRINT@896,:END
800 'DATA VERIFICATION
810 GOSUB9060
860 IFMID$(B$(N),32,1)<>RIGHT$(T$,1)THENPRINT"   CHECK ";MID$(B$(N),33,25);" DATA":PRINT
870 RETURN
900 PRINT@960,CHR$(10);"PLEASE WAIT A FEW SECONDS . . .":FORN=1TOP:T(N)=0:FORX=1TO5:E(N,X)=0:NEXTX,N:GOTO100
910 IFPEEK(Z9)<200PRINTZ$;"LISTING -";CHR$(10),CHR$(10)ELSERETURN
915 FORN=DTON9
920 LPRINTN;TAB(5);MID$(B$(N),1,5);" ";MID$(B$(N),6,5);" ";MID$(B$(N),11,5);" "MID$(B$(N),16,5);" ";MID$(B$(N),21,5);" ";MID$(B$(N),
26,5);" "MID$(B$(N),34,25);" (";M$(VAL(MID$(B$(N),31,1)))")"
925 PRINTN;TAB(5);MID$(B$(N),34,25):NEXTN
930 RETURN
```

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Practical Computing Back Issues

If you are interested in microcomputers you will want to read the *Practical Computing* reviews of the machines in which you are interested. Each month *Practical Computing* carries at least one hands-on test of a popular microcomputer for use in business, the home, schools and colleges. Each review contains the kind of information you need – technical data and unbiased critical comment on the strengths and weaknesses of each system.

Each issue is packed with essential reading on microcomputers, including all our regular monthly features: Book and cassette reviews; Glossary of computer terminology; Computabits; Pet Corner (February onwards); Apple Pie (May onwards); Tandy Forum (March onwards); serialised *Illustrating Basic* (October 1978 onwards).

All this makes *Practical Computing* the invaluable source for the whys, wherefores, hows, ifs and buts of microcomputing.

October 1978
Review 1: Commodore Pet I. Review 2: VDUs – Computer Workshop CT-64, Strumech Engineering ACT-1. Music on a KIM. Micro v. Calculator: VAT accounting complete program Part 1.

November 1978
Review: Tandy TRS-80. Projects for KIM: Pet goes to school: VAT accounting complete program Part 2: Complete game program – Mastermind: Software Dynamics Basic compiler review.

December 1978
Review: Research Machines 380Z. Choosing your first computer: ITT interview: Complete games programs – Battleships, Racing Cars and Monsters: A microcomputerised reservation system.

January 1979
Review: Nascom I. Convert an IBM typewriter into a terminal Part 1: In-car computing – Pet in the Panther DeVille: Report from the Los Angeles Computer Faire. Pascal v Basic

February 1979
Reviews: Cromemco Z-2D. Low-cost peripherals: Systems for estate agents and doctors: A £1000 payroll system. IBM typewriter conversion Part 2: Complete game program – Warlock Warren.

March 1979
Review: Single-board computers for less than £50. Low-cost stock-control systems: IBM typewriter conversion Part 3. New monthly column – Tandy Forum. Complete game program – NIM

April 1979
Review: North Star Horizon Business accounting systems. Apple II design story Part 1: Computerised school meals: Finance for school computing: Build your own frequency meter: Star Trek game.

May 1979
Reviews: Exidy Sorcerer. Science of Cambridge Mk 14. Printers for less than £1000. Order processing/invoicing packages. Retire with your computer: Apple II design story Part 2. Slalom game.

June 1979
Reviews: Compucolor II. Ohio Superboard II. Low-cost word-processing: Computing in a pharmacy. Designing a small business application Part 1. Computer v. Brain. Zombie game.

July 1979
Reviews: AIM-65. SOL-20. Choosing your first computer: Interfacing Pet with a mainframe: Nascom story: Designing a small business application Part 2: Biorhythms program.

August 1979
Reviews: Pet II. KIM Pros and cons of PASCAL: Microcomputer user groups: Designing a small business application Part 3: Interfacing Pet with a mainframe Part 2: Life game program.

September 1979
Reviews: Powerhouse 2. Acorn. Anadex and Heathkit printers Artificial intelligence: Build your own joystick. Computer scene in the North-West: Mathematics on a Pet: Self-teaching games program.

October 1979
Reviews: Disc systems for Pet, Apple II and Tandy; Build an electronic scoreboard; Inside Speak & Spell; Introduction to LISP; Inside Prestel.

Only the above issues are still available. To keep your copies of *Practical Computing* in good condition and convenient for reference you will need a special binder. In blue, with *Practical Computing* in silver-style lettering on the spine, each holds twelve issues comfortably. Fill in the coupon opposite and return it with your remittance to *Practical Computing*, Room 125, Dorset House, Stamford Street, London SE1 9LU.

Possum on the Pet

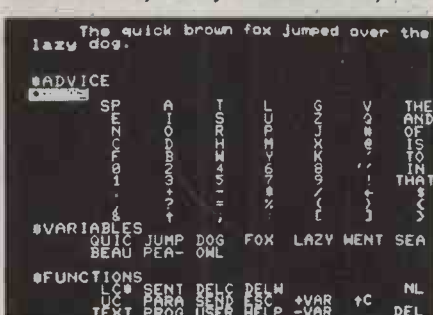
The versatility of the microcomputer makes it particularly useful to the severely disabled. In the first of two articles we look at a *Possum* system for the Pet.

SOME TIME AGO *Practical Computing* ran a competition in which entrants were invited, with an Apple II as the prize, to devise a useful and interesting application for a microprocessor. The Seagrave family won with an entry for a microprocessor-based typewriter system for aiding the severely physically handicapped.

There is a very wide range of ills to which people can fall victim, both mental and physical. Considerable effort has gone into the search for gadgets and aids to help these individuals. Often the simplest ideas can be of most value; a knife fork or spoon can be re-designed, a chair modified, to the enormous everyday benefit of the handicapped. At the other end of the scale, houses can be re-designed to suit an individual, or cars can be altered, to give the disabled person greatly-increased independence and to reduce the degree to which they must rely on nurses, friends and relatives.

It is in that light that the following text and program is presented. The source of the program is in Basic, and it runs on the Commodore Pet.

While the program is long and fairly complicated, it has been developed and tested over an extended period and has proved to be robust. It should not be difficult to modify it to suit individual circumstances. It is a prototype laboratory set-up, never having been used by anyone who couldn't, if they became bored, walk

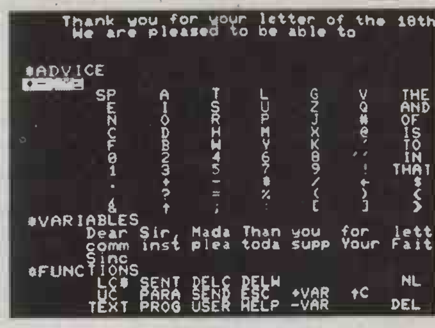


The Possum display. The cursor is at Home, shown by reverse display in the top left-hand corner of the menu, shown by reverse character display.

away or, if it did not do as they wanted, to change or modify it.

It is the dual problem of reliability and usability which must be given special priority if computers are to help the disabled. Those considerations should be met by conservative design principles and thorough testing even though the cost, in both effort and money, will be increased.

The idea is not new. Equipment to do these things has been available for years and has helped countless people. By departing little from this well-tried and tested formula, only by adding new features and making small improvements can we hope that computer-based equipment, with its potential for greater flexibility and power, will gain rapid acceptance.



Possum being used to write a business letter. Standard words and phrases have been chosen from the variables list and loaded into the text buffer at the top of the screen.

My interest in these machines was inspired by a visit to an exhibition aimed at demonstrating a wide range of aids for the disabled, writes Nick Hampshire. Among other exhibits was a Possum typewriter control system.

In essence, the user is provided with modified electric typewriter, a control board which displays the letters of the alphabet, the digits and other symbols a typewriter can print, arranged as a matrix, with a mouth switch, operated by sucking and blowing down a tube.

Variation

Carriage return and upper/lower-case shift are also displayed on the board. A character is selected first by blowing into the tube. An illuminated cursor will move across each of the columns in turn. Sucking selects the row containing the wanted option which can then be printed on the typewriter. When the user sucks and blows, each little box in a row or column is illuminated in turn to show which is being selected. The speed at which the cursor or pointer moves may be altered to suit the person using the machine.

The idea of selecting a column and then a row in turn is a variation of the menu selection technique, which may be employed whenever there is a limitation to the speed with which the user can communicate to the machine, rather than the speed the machine can communicate to the person.

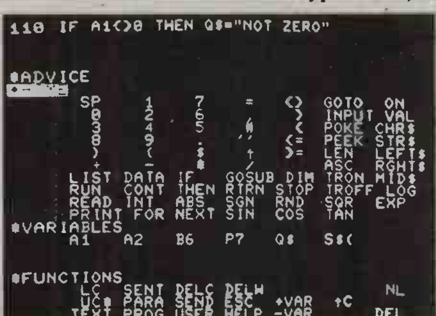
The computer will display a variety of options and the user types a digit or moves a cursor to the one required. Figure 1 shows the layout of the program display. It is similar in construction to commercially-available units. This arrangement is by no means the only one which could be used but it has the advantage of having been proven effective and usable.

It will also be entirely familiar to anybody who has already used the commercially-available equipment. It has more options present on the one screen than the basic commercial unit. We can also change at will the contents of the screen and hence the letters, words and the effect each selection will have.

The screen in figure 1 is divided into five distinct regions. At the top is the text buffer. Since characters are not printed as soon as they are selected, mistakes can be corrected before a whole line is finally printed at once. The fifth line occasionally will display advice or warnings to the user, so as to print the text buffer when it is full.

Next there is a 7 × 10 matrix of characters and ready-made words. While commercial units use the character set of the electric typewriter, this version uses the ASCII set. The replacement of fractions by the special symbols is the main difference.

While it should be feasible to interface the Pet to an IBM Selectric typewriter, it is more compatible with a high-quality matrix or daisywheel printer through the IEEE port.



By selecting the function PROG, the user can write Basic, which is loaded into the text buffer line by line.

Assumes worst case

Any of those 70 places can be selected by moving around the cursor. The program assumes the worst case, that of a person able only to operate a single on/off switch, possibly by blowing down a tube to a pressure-sensitive device or by a slight movement in one hand.

Commercial equipment is available with a wide range of possible input mechanisms, tailored by the manufacturers to the individual requirements. Our simple input allows typing speeds up to about 10 words per minute. Less handicapped people can use inputs which have more than one or two states, such as pressure switches with more than one level of pressure or a joystick-type switch giving eight possible directions, allowing speeds up to 40 words per minute.

When the switch is pressed the first time, with the cursor in the "HOME" position, the cursor will move downwards, first to the row with "SP" — for space character — "A", "T" . . . . "THE". About one-third of a second later it will move to the next row, "E", "I" . . . . "AND" — if the switch remains pressed. While the switch remains pressed it will move down each row in turn. When the switch is released the cursor halts, pointing to the row selected.

The downward pointer or cursor is, in fact, five 'reverse' spaces, with a greater than sign in the fourth position. On pressing the switch for the second time, the cursor moves across the screen, along the row selected previously. The cursor is apparent as it reverses the box being selected. By default, it moves across the screen slightly faster than when going down.

When the character or word one wishes to print is selected, one releases the switch and it is appended to the text buffer. If the row, or column is overshot the cursor can be returned to 'HOME' by letting hit the right-hand side or bottom of the screen. It stays there until the switch is released and pressed again, when the whole cycle will repeat.

Frequency

It is important to note that if one misses the desired row or column, all will be well providing one leaves the switch pressed.

Some care has been taken on the layout of the 70 boxes. Since it takes a noticeable time for the cursor to travel down and then across, it follows that the most commonly-used characters should be closest to the "HOME" position. Every English word is separated by a space and as this is by far the most commonly-used character, it is only one down plus one across.

As for the other letters, printers have long known that they are used with different frequencies in the English language. Type is, or was, purchased according to a set number of 'a's, with all the other letters in proportion. Thus a font which contains 48 a's may contain 64 e's, the most common letter — two down, one across. The font will contain an equal number of a,i,n,o,r,s and t's all at 48, those being the next most common, and they are clustered about the "HOME" position.

All the other letters have a decreasing probability of use and that is reflected in

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their distance — though not particularly rigorously — from the Home position. The other special characters are dotted around the edge. A few English words which occur frequently, such as "THE", "AND" and "OR" have been included down the right-hand side and it is very convenient to have them. One early idea was to include frequently-used letter pairs, such as "TH", but that is less easy to do.

The fourth region is labelled "VARIABLES". Those boxes will contain words, phrases or complete sentences the user decides he or she will need to use frequently. Photograph 1 shows some of the individual words used in the text at the top, set up as variables.

Each of the 21 boxes contains the first four characters of the contents of the variable. Thus "QUIC" contains "QUICK", "BEAU" contains "BEAUTIFUL" and "PEA-" contains "PEA-GREEN" one of the examples is "The owl and the pussycat went to sea in a beautiful pea-green boat".

Edit boxes

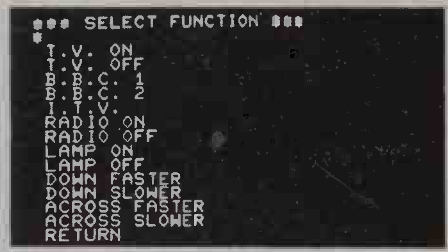
It was a major design decision how the generation of a new variable word be arranged. Initially I assumed that a variable should be made from the most-recently-typed word in the text buffer. The final program makes the whole of the text buffer into the variable, although only the first four characters are displayed on the screen. One must therefore type each of the words or phrases to be stored and put them in their locations before starting in earnest. Figure 2 shows a more realistic situation. Each of the variable boxes contains some small part of a potential business letter. As most business letters seem to be of a kind the scheme is well matched. Such phrases as "Dear Sir or Madam", "Thank you for your", "unless your account is", "Yours faithfully" and so on, may all save a huge amount of effort. A small selection of candidates — most of them single words — is shown. If a set of words proves to be very useful they could be built into the program. The Possum company supplies a word storage add-on module with eight or 64 words which it claims can cover up to 20 percent and 50 percent of word usage.

The final region on the screen is labelled "FUNCTIONS"; by selecting those boxes more interesting things happen. The functions can be divided into a number of types. By far the largest group is formed by the edit boxes. They help the user to type English into the text buffer, which will then be printed on to the external printer.

"UC" and "LC" are obvious. The first sets the shift-lock; all letters added to the buffer will be in upper-case, the second unshifts it and letters are added in lower-case. The current mode is indicated by a "*" against the relevant function.

There are some exceptions to the rule concerning the words and variables. The words "THE", "AND" are stored in upper-case and will be printed in upper-case if "UC" is set and in lower-case if "LC" is set, including the stored capitals — figure 2 — but will be printed as they "LC" is set, including the stored capitals. — figure two — but will be printed as they are stored, lower as lower, capital as capital if "UC" is set. That is probably the best compromise in the circumstances.

"SENT" is another function which,



USER function produces a menu of external devices which can be controlled using the cursor.

affects "UC" and "LC": it stands for 'end of sentence'. Its effect is to add a full stop and three spaces to the buffer and make the next letter a capital, so that "THE" would be added to the buffer as "The".

"DELC", deletes the most recent character in the buffer and "DELW", deletes the most recent word, back to, but not including, the next space. There are true editing commands which give the microprocessor system a great advantage over direct control versions. If you make a mistake — and it isn't difficult to overshoot the desired box accidently — it can be corrected before the printer makes it indelible. "DEL" removes the whole text buffer with no other effects. It is put in the bottom right-hand corner to try to prevent accidential erasure.

So far, none of these functions has affected the printer but the next group do. "SEND" prints the contents of the text buffer on the printer, takes a new line and erases the contents of the text buffer. One of the design options was to have "SEND" format the text either partially or fully. Perhaps this might have been done using a full text formatter but more probably by printing the buffer until the line on the printer was long enough — newline IF tab 60 and char = space. This addition would be valuable if longer variable phrases were to be used often.

Combination

"NL" takes a new line on the external printer, with no other effect. "PARA" is the special case of a new paragraph. Its effect is a combination of the previous three. It prints-out and erases the current buffer, takes three new lines, adds three spaces to the new text buffer to indent the text, and sets the next letter to be a capital.

"+VAR" and "—VAR" make and remove variables. The effect of "+VAR" is to add a variable. The contents of the text buffer are stored and the first four characters are displayed in the next free variable box, as an *aide-memoire.*

"*ADVICE" messages are generated if there is no free variable location. When a variable is no longer required, or some free space is needed, any variable can be removed with "—VAR". The "*ADVICE" given then is to select the variable to be removed. When that is done, the remaining variables move up to fill the empty space. The progam tests and then advises if the variable location selected is already empty or some non-variable box is selected inadvertently.

So far we have discussed typing only in English. It is, however, possible that the user will be interested in other types of text generation for which the rules and assumptions made already do not apply. A case in point might be a keen musician. A totally different notation would be required and the micro would have to be interfaced with a synthesiser to complete the system.

Alternatively, by selecting the function "PROG" the whole screen and system is changed to be a Basic typewriter — Figure 3 — instead of displaying the letters of the alphabet and English words, it shows the digits, special Basic characters, system calls and function names typical of the Basic language.

Good person

The 'variables' and 'functions' are unchanged between "TEXT" and "PROG" modes, so a list of up to 21 variables — this time Basic variables like 'Al' or 'Qs', rather than words or phrases — may be set up and the system works as before. Words are created in "TEXT" mode and Basic things in "PROG" mode, so one can easily skip between the two to generate strings like "NOT ZERO" in figure 3.

There is no need to display on the screen exactly what will be added to the buffer; the "PROG" frame shows that to a greater degree than "TEXT". Some of the boxes contain abbreviations, such as "RTRN" for "RETURN" and "TRON" for "TRACEON". Moreover, each of the functions also includes its opening left bracket, so "ASC" is actually "ASC(" and "RIGHT" is "RIGHT(", which improves the shorthand facilities.

You will notice that the commands and functions are not those of Pet Basic, but SWTP 8K Basic. This is for a good reason: it is not advisable to run an untested and undebugged user program on the Pet if it is your only means of communication.

When your program crashes, goes into an infinite loop or whatever, you are very stuck. Instead, the system sends the Basic text generated in the text buffer to a second microprocessor, using the "ESC" or 'escape' function.

That is similar to "SEND", except that it transmits the text to a different file number through the IEEE port and terminates the line with an escape character — at the moment CR/LF, but it could be an escape or an ASCII control character. "↑C" is a second special programming function which sends the ASCII character 3 to the second micro, allowing a 'break-in' to occur if the program fails. One must contrive to have the second micro output to the printer as it runs.

This month the bulk of the program is presented. In part two the working and structure of the program will be explained and documented.

```
4 POKE 59459,127:POKE59471,127
5 POKE59468,14
6 PR=5:MC=6
10 DATA" LC  "," SENT "," DELC "," DELW ","      ","      "," NL  "
20 DATA" UC  "," PARA "," SEND "," ESC  "," +VAR "," ^C  ","      "
30 DATA"TEXT ","PROG ","USER ","HELP ","-VAR ","      ","DEL  "
100 DATA" SP  ",A,T,L,G,V," THE "
110 DATAE,I,S,U,Z,Q," AND "
120 DATAN,O,R,P,J,#," OF  "
130 DATAC,D,H,M,X,@," IS  "
140 DATAF,B,W,Y,K,'," TO  "
150 DATA0,2,4,6,8," ''  "," IN  "
160 DATA1,3,5,7,9,!,"THAT "
170 DATA.,+,-,*,/,_,$:
180 DATA",",?,=,%,(,),<
190 DATA&,^,";",":",[,],>
200 DATA" ",A,T,L,G,V,THE
210 DATAE,I,S,U,Z,Q,AND
220 DATAN,O,R,P,J,#,OF
230 DATAC,D,H,M,X,@,IS
240 DATAF,B,W,Y,K,',TO
250 DATA0,2,4,6,8, ,IN
260 DATA1,3,5,7,9,!,THAT
270 DATA.,+,-,*,/,_,$
280 DATA",",?,=,%,(,),<
290 DATA&,^,";",":",[,],>
400 DATA" SP  ",1,7,=," <>  ","GOTO "," ON  "
410 DATA0,2,6,",",>,"INPUT"," VAL "
420 DATA3,4,5,#,(,"POKE ","CHR$ "
430 DATA8,9,.," ''  "," <=  ","PEEK ","STR$ "
440 DATA),(,$,^," >=  ","LEN  ","LEFT$"
```

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```
450 DATA+,-,*,/," ","ASC  ","RGHT$"
460 DATA"LIST ","DATA ","IF   ","GOSUB"," DIM ","TRON ","MID$ "
470 DATA"RUN  ","CONT ","THEN ","RTRN ","STOP ","TROFF"," LOG "
480 DATA"READ ","INT  ","ABS  ","SGN  ","RND  ","SQR  ","EXP  "
490 DATA"PRINT"," FOR ","NEXT ","SIN  ","COS  ","TAN  ","     "
500 DATA" ",1,7,=,<>,GOTO,ON
510 DATA0,2,6,",",),INPUT,VAL(
520 DATA3,4,5,#,<,POKE(,CHR$(
530 DATA8,9,.," ",<=,PEEK(,STR$(
540 DATA),(,$,^,>=,LEN(,LEFT$(
550 DATA+,-,*,/,"",ASC(,RIGHT$(
560 DATALIST,DATA,IF,GOSUB,DIM,TRACEON,MID$(
570 DATARUN,CONT,THEN,RETURN,STOP,TRACEOFF,LOG(
580 DATAREAD,INT(,ABS(,SGN(,RND(,SQR(,EXP(
590 DATAPRINT,FOR,NEXT,SIN(,COS(,TAN(,""
1000 RESTORE
1010 DIMDF$(2,6),DA$(1,9,6),TA$(1,9,6),DV$(20),TV$(20)
1020 FORI=0TO2:FORJ=0TO6
1030 READDF$(I,J)
1040 NEXTJ:NEXTI
1050 FORI=0TO1
1060 FORJ=0TO9
1070 FORK=0TO6
1080 READDA$(I,J,K)
1090 IFLEN(DA$(I,J,K))=1THENDA$(I,J,K)="  "+DA$(I,J,K)+"  "
1100 NEXTK:NEXTJ
1110 FORJ=0TO9
1120 FORK=0TO6
1130 READTA$(I,J,K)
1140 NEXTK:NEXTJ
1150 NEXTI
1170 TA$(0,5,5)=CHR$(34)
1190 TA$(1,3,3)=CHR$(34)
1200 FORI=0TO20
1210 DV$(I)="       ":TV$(I)=""
1220 NEXTI
1700 UP=59471:UX=128
1710 VN=0:M=0:A$="":UC=1:ED=0:HP=0:TV=0:NV=0
1720 PD=70:PQ=50:FM=0
1730 GOSUB 20000
2000 PRINT"^S^Q^Q^Q^Q^Q*ADVICE";
2010 PRINT"^S^Q^Q^Q^Q^Q*HOME";
2020 PRINT"^S^Q^Q^Q^Q^Q^Q";
2030 FORI=0TO9:PRINT"      ";
2040 FORJ=0TO6:PRINTDA$(M,I,J);
2050 NEXTJ:NEXTI
2055 PRINT
2060 PRINT"^S^Q^Q^Q^Q^Q^Q^Q^Q";"^Q^Q^Q^Q^Q^Q";"*VARIABLES";
2070 PRINT"^S^Q^Q^Q^Q^Q^Q^Q^Q^Q^Q^Q^Q^Q^Q";
2080 FORI=0TO2:PRINT"      ";
2090 FORJ=0TO6:PRINTDV$(I*7+J);
2100 NEXTJ:NEXTI
2110 PRINT"^S^Q^Q^Q^Q^Q^Q^Q^Q^Q^Q^Q^Q^Q^Q^Q*FUNCTIONS";
2120 PRINT"^S^Q^Q^Q^Q^Q^Q^Q^Q^Q^Q^Q^Q^Q^Q^Q^Q^Q";
2130 FORI=0TO2:PRINT"      ";
2140 FORJ=0TO6:PRINTDF$(I,J);
2150 NEXTJ:NEXTI
2160 PRINT"^S";A$;
3000 PRINT"^S":PRINT
3005 IFHP=0GOTO3040
3010 PRINT"^S^Q^Q^Q*ADVICE ^RSELECT ANY BOX FOR HELP^R";
3020 HP=HP+1
3030 GOTO3200
3040 IFLEN(A$)+LEN(N$)+LEN(Y$)+LEN(Z$)<160GOTO3070
3050 PRINT"^S^Q^Q^Q*WARNING^RPRINT STRING -- NOW!^R";:GOTO3200
3070 FORI=1TOLEN(N$)
3080 NB$=MID$(N$,I,1)
3090 IFUC>0GOTO3130
3110 IFNB$<"A"ORNB$>"Z"GOTO3130
3120 NB$=CHR$(ASC(NB$)+128)
3130 A$=A$+NB$
3141 IFUC=2THENGOSUB20100
3142 IFUC=2THENUC=0
3143 NEXTI
3145 N$=""
3146 IFUC=3THENUC=2
3150 PRINT"^S";A$;
3160 IFED=0GOTO3180
3170 PRINT"^R";Y$;"^R";Z$;
3180 PRINTFL$:FL$=""
3200 PRINT"^S":PRINT:PRINT"^S^Q^Q^Q^Q^R*HOME^R";
3205 IF(PEEK(UP)ANDUX)=0THEN3205
3210 IF(PEEK(UP)ANDUX)GOTO3210
3212 IFHP>0THEN3220
3213 IFED>0THEN3220
3214 IFNV>0THEN3220
3215 PRINT"^S^Q^Q^Q*ADVICE
```

```
3220 PRINT"^S^Q^Q^Q^Q*HOME";
3230 PRINT"^S^Q^Q^Q^Q^Q";
3240 FORI=0TO15
3250 PRINT"^R    > ^R";
3260 FORJ=1TOPD: IF(PEEK(UP)ANDUX)GOTO3400
3265 NEXTJ
3270 PRINT"←←←←←      ←←←←←";
3280 PRINT"^Q";: IFI=9ORI=12THENPRINT"^Q";
3290 NEXTI
3310 GOTO3200
3400 IF(PEEK(UP)ANDUX)GOTO3400
3420 PRINT"←←←←←     ";
3430 IFI>9GOTO3600
3440 FORJ=0TO6
3450 PRINT"^R";DA$(M,I,J);"^R";
3460 FORK=1TOPQ: IF(PEEK(UP)ANDUX)GOTO3490
3465 NEXTK
3470 PRINT"←←←←←";DA$(M,I,J),
3480 NEXTJ
3485 PRINT"←←←←←";DA$(M,I,J-1);:GOTO3200
3490 PRINT"←←←←←";DA$(M,I,J);
3500 IFHP=2GOTO10000
3505 IF NV>0 GOTO7720
3510 N$=TA$(M,I,J):GOTO3000
3600 IFI>12GOTO3800
3610 II=I-10
3620 FORJ=0TO6:PRINT"^R";DV$(II*7+J);"^R";
3630 FORK=1TOPQ: IF(PEEK(UP)ANDUX)GOTO3670
3635 NEXTK
3650 PRINT"←←←←←";DV$(II*7+J);
3660 NEXTJ
3665 PRINT"←←←←←",DV$(II*7+J-1);:GOTO3200
3670 PRINT"←←←←←";DV$(II*7+J);
3680 IFHP=2GOTO10000
3685 IF NV>0 GOTO7740
3690 N$=TV$(II*7+J):GOTO3000
3800 II=I-13
3810 FORJ=0TO6 PRINT"^R";DF$(II,J);"^R";
3830 FORK=1TOPQ: IF(PEEK(UP)ANDUX)GOTO3860
3835 NEXTK
3840 PRINT"←←←←←";DF$(II,J);
3850 NEXTJ
3855 PRINT"←←←←←";DF$(II,J-1);:GOTO3200
3860 PRINT"←←←←←";DF$(II,J);
3870 SS=(II*7+J)+1
3875 IF NV>0 GOTO7720
3880 IFHP=2GOTO10000
4000 IFSS>7GOTO4020
4010 ONSSGOTO4100,4300,4500,4700,4900,5100,5300
4020 IFSS>14GOTO4040
4030 ONSS-7GOTO5500,5700,5900,6100,6300,6500,6700
4040 ONSS-14GOTO6900,7100,7300,7500,7700,7900,8100
4100 REM SET TO LOWER CASE
4110 UC=0:GOSUB20100:GOTO3200
4300 REM BEGIN A SENTENCE
4310 UC=3:GOSUB20000:A$=A$+".    ":GOTO3000
4500 REM DELETE CHARACTER
4505 IFLEN(A$)=0GOTO3200
4510 IFLEN(A$)>1GOTO4530
4520 A$="":FL$=" ":GOTO3000
4530 A$=LEFT$(A$,LEN(A$)-1):FL$=" ":GOTO3000
4700 REM DELETE WORD
4701 IFLEN(A$)=0GOTO3000
4702 IFLEN(A$)=1GOTO4745
4705 FORI=LEN(A$)TO2STEP-1
4710 NB$=MID$(A$,I,1)
4720 IFNB$=" "GOTO4750
4730 A$=LEFT$(A$,I-1):FL$=FL$+" "
4740 NEXTI
4745 IFLEN(A$)=1ANDLEFT$(A$,1)<>" "THENGOSUB4800
4750 GOTO3000
4800 A$="":FL$=FL$+" ":RETURN
4900 REM NOT DEFINED
4910 GOTO3200
5100 REM NOT DEFINED
5110 GOTO3200
5300 REM CR-SENDCR/LF TO PRINTER
5310 OPENPR,PR
5320 PRINT#PR
5330 CLOSE PR
5340 GOTO3000
5500 REM SET TO UPPER CASE
5510 UC=1:GOSUB20000:GOTO3200
5700 REM PARAGRAPH
5710 OPENPR,PR
5720 GOSUB 21000:GOSUB 20900
5725 GOSUB 20000
5730 PRINT#PR:PRINT#PR:PRINT#PR
```

(continued on next page)

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5740 A$="     "
5750 UC=3
5760 CLOSE PR
5770 GOTO3000
5900 REM PRINT CONTENTS OF A$
5910 OPEN PR,PR
5920 GOSUB21000:GOSUB20900
5930 A$=""
5940 CLOSEPR
5950 GOTO3000
6100 REM SEND LINE TO MICRO
6110 OPEN MC,MC
6120 PRINT#MC,A$
6125 GOSUB20900
6130 A$=""
6140 CLOSEMC
6150 GOTO3000
6300 REM ADD A MAKE A$ THE NEXT VARIABLE
6310 IF VN<21 THEN 6340
6320 PRINT"^S^Q^Q^Q^Q*ADVICE - NO ROOM FOR NEW VARIABLE";
6330 GOTO3000
6335 IF A$=""THEN3000
6340 TV$(VN)=A$
6350 DV$(VN)=LEFT$(TV$(VN)+"      ",5)
6360 DV$(VN)=LEFT$(DV$(VN),4)
6365 DV$(VN)=DV$(VN)+CHR$(32)
6370 GOSUB22000
6380 VN=VN+1
6390 GOTO3000
6500 REM SEND ASCII 3 TO MICRO (BREAK-IN)
6510 OPEN MC,MC
6520 PRINT#MC,CHR$(3);CHR$(3);
6530 CLOSE MC
6540 GOTO3000
6700 REM UNDEFINED
6710 GOTO 3200
6900 REM TEXT MODE
6910 M=0 GOTO2000
7100 REM PROGRAM MODE
7110 M=1:UC=1:GOSUB20000:GOTO2000
7300 REM USER MODE
7310 GOTO2000:REM NOT IN THIS VERSION
7500 REM HELP SUB-SYSTEM
7510 HP=1:GOTO3000
7700 REM DELETE VARIABLE
7701 IF VN>0 GOTO7710
7703 PRINT"^S^Q^Q^Q^Q*ADVICE - NO VARIABLES TO REMOVE";
7705 GOTO3000
7710 PRINT"^S^Q^Q^Q^Q*ADVICE - SELECT VARIABLE TO BE REMOVED";
7713 NV=1
7715 GOTO3000
7720 REM UNKNOWN VARIABLE
7725 PRINT"^S^Q^Q^Q^Q*ADVICE - NO VARIABLE SELECTED!          ";
7730 NV=0
7735 GOTO3000
7740 REM DELETE SELECTED VARIABLE
7745 PRINT"^S^Q^Q^Q^Q*ADVICE - O.K                            ";
7750 FOR K=II*7+J TO 19
7755 DV$(K)=DV$(K+1)
7760 TV$(K)=TV$(K+1)
7762 NEXT K
7765 DV$(20)="     "
7770 TV$(20)=""
7780 GOSUB 22000
7785 NV=0
7790 VN=VN-1
7795 GOTO3000
7900 REM UNDEFINED
7910 GOTO3200
8100 REM DELETE BUFFER
8110 GOSUB20900:A$="":GOTO3000
10000 PRINT"^S^Q^Q^Q^Q*ADVICE NO HELP IN THIS VERSION";
10005 HP=0
10010 GOTO3000
20000 PRINT"^S^Q^Q^Q^Q^Q^Q^Q^Q^Q^Q^Q^Q^Q^Q^Q^Q^Q^Q^Q^Q      LC  ";
20010 PRINT"^Q       UC* ";
20020 DF$(1,0)=" UC* ":DF$(0,0)=" LC  "
20030 RETURN
20100 PRINT"^S^Q^Q^Q^Q^Q^Q^Q^Q^Q^Q^Q^Q^Q^Q^Q^Q^Q^Q^Q^Q      LC* ";
20110 PRINT"^Q       UC  ";
20120 DF$(1,0)=" UC  ":DF$(0,0)=" LC* "
20130 RETURN
20900 PRINT"^S";
20910 FORL=1TO10
20920 PRINT"                        ";
20930 NEXT
20940 RETURN
21000 PRINT#PR,A$
21010 RETURN
22000 PRINT"^S^Q^Q^Q^Q^Q^Q^Q^Q^Q^Q^Q^Q^Q^Q^Q^Q";
22010 FORI=0TO2:PRINT"      ";
22020 FORJ=0TO6:PRINTDV$(I*7+J);
22030 NEXTJ:NEXTI
22040 RETURN
READY
```

BUYERS' GUIDE

The Buyers' Guide is a summary of low-cost computers available in this country. It appears each month; we add new computers and amend existing information, as required, to keep it up-to-date. Systems are listed by manufacturer.

ACORN COMPUTERS

Acorn. Single Eurocard-sized microcomputer with 6520 processor, IKB RAM, 16-way I/O. Max size; a second Eurocard adds hex keypad and CUTS cassette interface. Monitor and machine-code programming now. Basic and disc operating system in the future. "Highly cost-effective basis for a computer or an industrial development system". Available from Acorn (0223) 312772 or Microdigital (051) 236 0707.

£74.75 kit, £86.25 assembled

APPLE COMPUTERS

Apple II. Min size: 16K memory; 8K ROM; keyboard; monitors; mini assembler; colour graphics; Pal card; RF modulator; games; paddles and speakers; 4 demo cassettes. Max size; Expandable to 48K memory; floppy discs and printers are now available. Two versions of Basic, PASCAL; Assembler; games; business packages. An American system regarded as suitable for any kind of aplications. Maintenance contracts offered. Microsense Computers is the sole U.K. distributor and has a national dealer network. Tel: (0442) 41191/48151 (24-hour answering service).

Around £1,000

ATTACHE

Attache. Min size: system with 10 slots, S100 bus, 8080 processor and 16KB housed in desk-top case with built-in keyboard. Max size: 64KB, parallel printer interface, two single- or double-density 8in. floppies, video screen. Disc Basic; business applications produced by Moncoland, the sole U.K. agent. Distributors include Keen, GBH, Alba, and Lion.

From £1,737. Full business system about £5,000

BRUTECH ELECTRONICS.

BEM-CPUI. Single-board processor with 6502 and no RAM. Applications software. Available from Data Precision Equipment (04862 67420). (Reviewed March, 1979.)

£133 exc VAT

BYTRONIX MICROCOMPUTERS

Megamicro. 8080A/Z-80 processor. 64K. Double-sided discs, two-page addressable VDU, 140 cps printer. Software includes Basic, Fortran, Cobol and Pascal, all running under CP/M. Applications include automatic letter writer, sales ledger and stock control, payroll and bought ledger. Self-diagnosis utilities. Aimed at business and university user. Available from Bytronix (0252) 726814.

From £6,080.

COMART

Microbox. Chassis with three to six PCB sockets for S100 boards, plus fan. Several S100 boards available. Aimed mainly at OEM industrial users and perhaps the serious hobbyist. It will take Cromemco, North Star and other processors. Available from Comart (0480 215005). — *£255*

COMMODORE SYSTEMS DIVISION

Pet. Single unit containing screen, tape cassette and keyboard. Floppy disc, printer and full-size keyboard are options, as are external cassettes. Basic; games; business packages. The British subsidiary of Commodore Systems of the U.S. sells Pet for home, educational and small business applications. About 80 distributors. — *£460-£795 exc VAT*

Kim-1, processor (6502 chip); small calculator-type keyboard; LED six-digit display; built-in interfaces for audio-cassette and Tele-type; IK RAM; 2K ROM (can add up to 64K). No software available, but it has three good manuals. An American import which gives Pet-type capabilities with a maximum configuration. For the hobbyist but used mainly as an evaluation board for the 6502 chip. Twelve to 15 dealers. (Reviewed October, 1978.). — *£99.95*

COMPELEC ELECTRONICS

Series I. Z-80 processor 512MB floppy, 32KB, Centronics printer, VDU. Up to 4MB disc and 64KB. CP/M, Basic, Cobol, PASCAL, Fortran IV, Assembler, Business and word processing packages available. From Compelec (01-580 6296), which is also sole supplier of Altair systems. — *Less than £5,000 for basic system*

COMPUCOLOR

Compucolor II. Packaged system including 13in. eight-colour display with alphanumerics and graphics, 72-key detachable keyboard, 8KB, and bult-in mini-floppy. Max size: 32KB. Extended disc. Basic in ROM, graphics progams and games. The system now ranks fourth behind Pet, TRS-80 and Apple in personal computer sales. Abacus (01-580 8841) is sole U.K. agent and is arranging distributors, including the Byte Shop and Transam. (Reviewed June, 1979.) — *From £1,390*

COMPUCORP

610: desk-top unit using Z-80 and incorporating screen, 150KB floppy, 48KB. Up to 60 KB memory, four floppies, printers. Basic, Assembler, DOS, text editor, file manager; business packages. Nine dealers. — *From £3,890*

COMPUTER CENTRE

Mini kit: Z-80 CPU, CTC, USART, serial and parallel I/O, 16 bytes memory, Western Digital disc controller, SA400 5in. drive plus CP/M, cables and connectors. — *Mini kit: £786*

Maxi kit: As above but with DRI 7100 8in. drive instead of 5in. drive. All (33) volumes of CP/M user group library available for cost of media. Library includes utilities, games. Basic compilers/interpreters and Algol compiler. Microsoft Basic, Cobol, Fortran also available. Computer Centre (02514 29607). — *Maxi kit: £886*

COMPUTER WORKSHOP

System I. Typical size: 40K memory; dual 8in. floppy disc, total storage capacity 1.2MB; Ricoh daisywheel printer. — *System I, £5,000 plus*

System 2. Typical size: 24K memory; dual minifloppy discs of 80K bytes each; Centronics 779 dot matrix printer; VDU. — *System 2, around £3,000*

System 3. 12K memory, cassette interface; 40-column dot matrix printer. Editors, Assemblers, Basic, games, information retrieval package. The systems were designed and built in Peterborough and are suitable for educational and small business users and perhaps the more serious hobbyist. Twenty-five dealers. — *System 3, from £1,300*

CROMEMCO

Single-card computer. 4MHz Z-80 CPU, S100 bus, IKB RAM, sockets for 8K ROM. 20mA/RS232 serial interface and parallel bidirectional interface. Basic in ROM and Z-80 monitor. For OEM and industrial users; used with backplane for "full computer capability". Datron Interform and Comart are agents, the latter with 12 distributors. (Reviewed February, 1979.) — *£247—£281*

Z-2. Min size: chassis, 31A power supply, motherboard, Z-80 processor, 16KB memory. Max size: 512KB, 21 sockets, three minifloppies or four 8in. floppies. Basic, Fortran, Cobol, assemblers. For serious hobbyists, OEMs, educational applications, and industrial/scientific users. — *£372 (in kit form) to more than £4,000*

System Two. Min size: factory-assembled system with 32KB, dual 90K minifloppies, dual printer interface, serial interface. Max size: two additional floppies, 512KB, up to seven terminals, CP/M-compatible operating system (CDOS), Fortran, Cobol, Basic, assemblers, word processing, database manager. Multi-user system for software development, or scientific/industrial/business users. — *£1,995 upwards*

System Two/64. New configuration featuring mini-diskette drives and 64K bytes memory. Software and applications as System Two. — *£1,995*

System Three. Min size: 32KB, dual 256KB floppies, dual printer interface, 20mA/RS232 serial interface, Z-80 processor. Max size: two additional discs, 12KB, seven terminals, multi-channel A/D and D/A interface, PROM programmer. Software as for System Two. Described as appropriate for small to medium business, scientific and industrial users — "rivals minicomputers at more than twice the price". — *£2,995 to more than £8,000*

System Three/64. New configuration featuring dual 8in. diskette drives; Z-80A processor; 64K of 4MHz memory; console and printer interfaces. Macro Assembler, Fortran IV, Extended Basic, Cobol, Multi-user Basic. Prices quoted by Micro Centre (031-225 2022). — *£3,293*

DYLE HOUSE

Business Computing System 2000. Z-80A. Dual 8in. discs, 140 cps 132 char printer. Dyle House Business Basic, and disc operating system. Accountancy, payroll and parts control suites. Applications: Sales acknowledgments, sales invoices, delivery notes, purchase orders, customer statements, remittance advice. Dyle House Ltd (01-529 2436). — *No price announced*

EQUINOX

Equinox 300. Min size; 48K memory; dual floppy discs giving 600K bytes of storage; 16-bit Western Digital m.p.u. Max size; up to 256K memory; up to four 10MB hard discs. Basic, Lisp, PASCAL, Macro Assembler, Text Processor. All software bundled. The system is a multi-user, multi-tasking, time-sharing system for two to 12 users. Application software available for general commercial users. Sole distributors Equinox Computers Ltd (01-739 2387). — *£5,000-£40,000 plus*

EXIDY

Sorcerer: based on Z-80, 16K and 32K; cartridge and cassette interfaces; 79-key keyboard; 256-character set (128 graphics symbols), 12in. video monitor; expandable with Micropolis floppy discs. Basic, Assembler and Editor; games, word processor. Other pre-packaged programs plus EPROM Pack for your own programs on cartridges. Factor One is sole distributor for U.K. (Reviewed March, 1979.) — *From £760 without VDU to £1,200 with floppy discs*

HEATH SCHLUMBERGER

H8. 8080 CPU. 4664K PAM. Serial/cassette I/O; front parallel monitor; keypad; optional parallel I/O; serial multiport; breadboard I/O and disc system. Basic, Ext. Basic, Mierosoft Basic, HDOS, CPM. — *From £262 (in kit form)*

WH89. All-in-one computer. Z-80 processor plus Z-80-controlled VDU. 16K expandable to 48K, user-accessible. Two RS232 I/O ports. Operating system includes Benton Harbour Basic, two-pass absolute assembler, text editor, utility programs, Mierosoft Basic and Fortran word processor package. Heath Schlumberger (0452 29451). — *About £1,600*

SHOPWINDOW

HEWART MICROELECTRONICS

Mini 6800 Mk II. IK monitor; IK user RAM, IK VDU RAM; CUTS. Upper- and lower-case VDU with graphics option. 128-byte scratchpad; decoder/buffer; power supply; Basic in ROM; monitor command summary. SWTPC programs; Newbear 6800; Scelbi 6800 Cookbook. Markets are small business, education and home user. Cash with order to Hewart. (0625) 22030.

From £127.50 plus VAT

6800S. 16K dynamic RAM; IK Mikbug-compatible monitor; room for 8K Basic in ROM; upper- and lower-case graphics; single floppy disc drive; printer and high-speed tape interfaces. "Mountains of software available." Test tape with CUTS test tones, test message and games with kit.

From £275 plus VAT

DIGITAL MICRO SYSTEMS

DSC-2. Min size; 32KB, but 64K standard; Z-80; over IMB floppy disc on two single-sided 8in. drives; four programmable RS232 and one parallel interface. CP/M and Basic included in price. Extended Basic, Fortran, Cobol, text processing, Macro Assembler, Link Loader, business packages and CAP-CPP business software. Add-on rigid disc system (14 and 28MB) available soon. Modata (0892 39591) is sole U.K. distributor; dealers being appointed.

From £4,465

IMSAI

VDP 40: 32K or 64K RAM memory; 9in. display screen, standard keyboard. Two 5¼in. floppy disc drives; serial I/O. Full software support, and packages available for the VDP 42, which has larger disc capacity. Packages for VDP 80 could be converted for smaller systems. This would be from about £700 per package. Two main dealers in the country.

£4,507 for 32K model. £4,950 for VDP 42

ITT

2020. Identical to Apple II. Min. size: 4K memory; 8K ROM; keyboard, monitor, colour graphics, mini assembler; Powell card; RF Modulator, games, paddles and speaker; Max size: 48K with floppy discs and printers. Basic, Assembler, games, business packages. Generally suited to any type of application. Fifteen wholesalers, including Fairhurst Instruments.

From £827 to £3003 for 48K, two floppies and printer

LUXOR

ABC 80. Min size: 35K with keyboard, CPU 12in. screen and cassette. Max size: 40K RAM with discs. Z-80 processor, loudspeaker with 128 effects, real-time clock. Options: printers, plotter, discs, module cards, digitiser, modem. 60 compatible I/O memory boards. Software: Basic with resident editor; assembler; games; business and educational packages. Personal computer aimed at home market, small business and education. CCS Microsales is U.K. agent and is looking for distributors.

£795 plus VAT

MICRONICS

Micros. Typical size: IK monitor; 47-key solid state keyboard; interfaces for video, cassette, printer and UHF TV; serial I/O, dual parallel I/O parts; 2K RAM; power supply. 2K Basic; British-designed and manufactured system. Claimed to be the cheapest data terminal — a system with an acoustic coupler and VDU for £1,020. Prospective applications for small businesses, process controllers and hobbyists. Manufacturer is sole distributor (01-892 7044).

From £400, assembled

MICRO V

Microstar. Single box with twin 8in. flopy discs, 64K RAM, three RS232 serial inputs, STARDOS operating system enables system to have three VDUs, plus a fourth job running simultaneously. Word processing software available. Packages being developed include invoicing system, payroll, accountancy type system. Price includes a reporter generator language. Imported by a Data Efficiency subsidiary, Microsense Computers, Microsolve is London agent; other distributors being arranged.

£4,950 machine and software

MIDWEST SCIENTIFIC INSTRUMENTS

MSI 6800. Min size: 16K memory Act I termnal; cassette interface. Max size: three disc systems — minifloppy system with triple drives of 80 bytes each and 32K memory, large floppy system with up to four 312K-byte discs and 56K of memory mounted in a pedestal desk, or hard disc system with 10MB and 56K. Basic interpreter and compiler; editor; assembler; text processor on small disc system. American-designed system being manufactured increasingly in the U.K. Sole U.K. agent is Strumech (SEED) (05433 4321) but a distributor network is being established.

Basic system: £1,100 (£815 as kit); Minidisc, £2,500; floppy disc £3,200; hard disc, £8,000-£12,000

NASCOM MICROCOMPUTERS

Nascom I. Min size: CPU; 2K memory; parallel I/O; serial data interface; IK monitor in EPROM. Max size: CPU, 64K memory; up to 16 parallel I/O ports. Mostly games, but also a dedicated text editor system written by ICL Dataskil. Nascom is working on large versions of Basic, and 8K Microsoft Basic should be available soon. Eleven distributors in U.K. Nascom is negotiating to increase the number. (Reviewed January, 1979.)

£165 exc VAT

NATIONAL MULTIPLEX

Pegasus. Min size: 48K, Z-80; double-density floppies (320KB); S100 bus; 12in. CRT; 58-key keyboard; two serial and one parallel interfaces; bi-directional printer. Options: 8in. drives; 1·2MB additional drives; digital recorder 9,600 baud. Assembler, Cobol, Fortran, Extended Basic. General business package available as well as text editing and mailing list. All run under CP/M. Suitable for education, business and home users. London Computer Store (01-388 5721) sole supplier.

£2,700 exc VAT

NETRONICS

Elf II: single-board computer in kit form or assembled. RCA Cosmac 1802 processor, hex keyboard, 256 bytes RAM; options include up to 64KB, ASCII keyboard, cassette and RS232 I/O, and video output. Machine code or Tiny Basic. Promoted as a teaching system in minimal form, but expandable for more general use. Sole U.K. distributor HL Audio (01-739 1582).

Basic kit £79.95. Assembled £99.95. I/O board £35

Explorer 85: Min size: 4K. Max. size: 64K. 8085A processor, VDU board, ASCII Keyboard, S100 expansion. Cassette, RS232, TTY interface on board. I/O ports, programmable timer. Disc software, Microsoft Basic on cassette, 8080 and Z-80 software can be used. Aimed at hobbyist, OEM and small business. Available from Newtronics (computer division of HL Audio).

From £297 plus VAT

NEWBEAR

7768. CPU board, 4K memory, cassette and VDU interfaces. Range of Basics and games. British-manufactured system for hobbyists. Expandable to 64K memory available only in kit form. From Newbear; also from Bearbag dealers, Microdigital, Microbits.

From £45

NORTH STAR

Horizon. Min size: 16K memory; Z-80A processor, single minifloppy disc drive (180KB). Max size: 56K memory, four minifloppy disc drives (180KB), any acceptable S100 peripheral boards. Basic (includes random and sequential access), disc operating system and monitor. Options: Basic Compiler, Fortran, Cobol, Pilot, PASCAL and ISAM. The system is suitable for commercial, education and scientific applications. Application software for general commercial users. Twenty distributors. (Reviewed April, 1979.)

£995 to £2,500

OHIO SCIENTIFIC

Ohio Superboard II. Min size: 6502 processor, 8K Basic in ROM; 2K monitor in ROM; 4K RAM; Cassette I/F, full keyboard; 32 x 32 video I/F, 8K Basic in ROM; Assembler/Editor; American single-board system with in-board keyboard. Aimed at hobbyist/small business. Ohio makes games, personal maths tutors, and business programs. This and other Ohio products have six U.K. distributors. (Reviewed June, 1979.)

From £298

PERTEC

System 1300. Min size: 32K memory; dual minifloppy discs 71 bytes each, formatted; serial interfaces. Max size: 64K memory; four serial parts. Basic (single and multi-user), Fortran, Cobol. The hardware for Compelec Altair systems is from Pertec but the software is Anglo-Dutch. Sole distributor Compelec (01-580 6296).

£3,000-£5,000

POWERHOUSE MICROPROCESSORS

Powerhouse 2: desk-top unit using Z-80 with 5in. built-in VDU and built-in mini cassette. 16K or 32K RAM, full keyboard, real-time clock, two spare slots. RS232 interface. Software: Disc and cassette operating system, programmable keyboard, 16K PROM, extended Basic. Options: 14K Basic, X-Y graphics, 2K monitor, larger screen, discs. Compatible with all computers. Aimed at OEMs and expert users such as scientists or researchers. Applications include real-time process control, engineering calculations. Availability: Powerhouse only (0442) 42002. Reviewed, September 1979.

£1,480-£1,760

PROCESSOR TECHNOLOGY

Sol. 808-based S100 microcomputer packaged with cassette and video interfaces (including graphics), keyboard with numeric pad, and 16KB RAM. Basic, assembler, word processors. Floppy disc systems available. Several distributors including Comart (0480 215005), which can offer nationwide maintenance contracts (Reviewed July, 1979.)

From £1,750 (excluding monitor and cassette). Complete floppy disc systems with word processing about £5,000

RAIR

Black Box. Min siz: 32K memory dual minifloppy discs, 80K bytes each; two programmable serial I/O interfaces. Max size: 64K memory; eight serial interfaces; IMB disc storage (or 10MB hard disc); range of peripherals. Basic, Fortran IV, Cobol, Hardware distributors are being signed and agreements made with software houses to add software. A warranty and U.K.-wide on-site maintenance is given. From manufacturer (01-836 4663) and systems houses.

From £2,300

RESEARCH MACHINES LTD

380-Z. Min size: 4K memory; 380-Z processor, keyboard. Max size: 56K memory. Options: cassette, single or dual minifloppy discs, dual 8in. double-sided. discs (IMB); serial interfaces; parallel interfaces; analogue interface; printer available. Basic Interpreter, Z-80 Assembler; interactive text editor; terminal mode software; data logging routines; CP/M, DOS, text processor, CBasic, Fortran, Algol, Pilot, Cobol, CP/M users' club library. Sold principally to higher and secondary education, and for scientific research, data processing and data logging. Available from Sintel and the manufacturer. (Reviewed December, 1978.)

From £830-£3,500

280-Z. Board version of 380-Z system, 4K or 32K (identical in performance to the 380-Z). Interfaces, software as for 380-Z.

4KB version at £398; 32KB for £722

RCA

Cosmac. 1802 micro with hex keypad and output to TV screen. Assembler and machine code programming; options include Tiny Basic. Available by mail order from HL Audio (01-739 1582).

Kit £79.95. Assembled £99.95 exc VAT

ROCKWELL

Aim-65. Kim-compatible with full keyboard and on-board printer. 1K or 4K RAM. The 4K version is described as a development system rather than a personal computer. Assembler, editor, Basic. Available from Pelco, Microdigital and Portable Microsystems (Reviewed July, 1979.)

1K — £249.50
4K — £315

SCIENCE OF CAMBRIDGE

Mk 14. SC/MP processor, 256 bytes user memory; 512-byte PROM with monitor program; hex keyboard and eight-digit, seven-segment display; interface circuitry; 5V regulator on board. To this can be added: ¼K RAM (£3.60); 16 I/O chip (£7.80); cassette interface kit

£39.95 basic

(£5.95); cassette interface and replacement monitor (£78.95); PROM Programmer (£9.95). No software provided but a 100-page manual includes a number which will fit into 256 bytes covering monitors, maths, electronics systems, music and miscellaneous. Based on American National Semiconductor chips. Science will soon have a VDU Interface and large manual on user programming. Mail order from manufacturer (0223 312919) and by selected dealers. (Reviewed May, 1979.)

SDS

SDS 100. Single unit containing 32K memory (expandable to 46K); up to 8K PROM; twin double-sided floppy disc drives of 500 bytes each, serial and parallal RS232 interfacing; keyboard; 12in. video display; power supplies; SD monitor program: line printer available. CP/M, 8080 assembler, E Basic, Editor supplied with system; M Basic, Fortran, Cobol available for business use, industrial process monitoring and control (with additional hardware). All CP/M games and business packages. Sole supplier Airamco (0294 65530).

From £3,750

SEMEL

Semel I. Min size: 4K with CPU, keyboard and monitor. Max side: 64K with single floppy disc unit, printer, VDU and keyboard. Can be coupled to any external device and controls up to 8 x 250K floppy disc units. Four configurations available. Options: Light pen attachment; 12V DC power supply; remote terminals. Software: Editor, Assembler, debug, full file-handling capabilities in Basic, Fortran and Cobol available on 64K machine; user-defined programs written and compiled by agreement; word processing. General-purpose unit for use as a terminal controller. Suitable for small business and OEMs. Available from Semel exclusively (0822) 5439.

£1,950 with Basic

SORD

M100. Min size: 16K RAM; 4K ROM Monitor; full keyboard plus function keypad; two-channel joystick dual cassette I/F; 11K E Basic on cassette; video; graphics; printer; S100 bus; converters; speaker; 24-hour clock. Max size: 48K RAM, 8K ROM; black and white or colour graphics; mini-floppy discs. Suitable for OEMs, small business, education, laboratory and scientific and home computing. Main distributor is Dectrade, but for London and South contact Midas Computer Services (0903) 814523.

From £726

SYNERTEK

Sym 1. 6502 chip and keypad with memory available in 4K blocks up to 64K. Port expansion kit, TV interface card, RAM expansion kit, cassette and Teletype interfaces. Any Kim software, Basic interpreter, Assembler/Editor, American, meant to be the foundation system for every small business and hobbyist users. Available from Newbear (0635 49223).

From £160 plus VAT.

TANDY CORP.

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MICRO ADS

A PRACTICAL GLOSSARY

Continuing the terminological gamut from O to P

Operator
Bored, underpaid human with aching back — bad posture for data entry work — and two bad eyes. Also an operator is a symbol denoting a mathematical operation (like + for plus and ÷ for divide) or a logical operation — they vary, but check Boolean algebra for some examples if you're really interested.

Opm
Operations per minute. A measure used only by appendectomy surgeons, American dp heavies, and glossary compilers.

Optical character recognition
Recognising characters by looking at them, or rather the machine equivalent. An OCR reader scans the surface of a sheet of paper, analyses the light patterns made by anything printed or written on it, compares that information to a known set of patterns, and transmits to the computer anything it recognises. Some clever OCR systems can recognise handwriting but most can read only typescript in a particular character formation.

Each letter of the alphabet obviously must be identifiably different and this meant that the first standard OCR-readable script — it was called OCR-A — was characterised by ugly blobs and blocks on the letters. Film-makers and advertising agencies like to use this kind of script for the instant connotation of 'computer'. In fact, most OCR uses a much more ordinary, and more readable, script called OCR-B. It looks fairly normal; OCR equipment is becomng more sensitive and more discriminating, so that it can determine finer differences between one character and another.

You can have OCR-B golf-balls for an ordinary Selectric-style electric typewriter, and some printers are available with OCR fonts.

OCR has never really been clever enough, fast enough or cheap enough to replace the keyboard as a way of transferring information from people into computers. In any case, someone probably has to use a keyboard somewhere to create the OCR input in the first place. OCR has found a niche, however, in applications where the alphanumeric input is fairly well standardised and where there is not much of it — for forms, for instance, where many documents have to be read and input somehow. *OMR* is simpler, cheaper and generally more useful at this stage of the technology.

Optimise
Obviously this means to amend something to make sure it performs at maximum efficiency. It's in the glossary because you might find it being applied to computer programs. For instance, an optimising compiler is a *compiler* which does some automatic optimising of your carefully-produced code. There are also special programs called optimisers through which you can run your own code subsequently; they tweak your program a little so that it makes more efficient use of the internal resources available within the computer system.

OS
Operating system. Several manufacturers have operating systems called — with singular lack of imagination — OS. The big IBM computers are a prime example; so are Interdata minicomputer operating systems.

Output
As a noun, it's what you get from a computer, sometimes given the blanket term "results". It is also a verb, in which case it means to transfer information from the computer to some kind of clever device — usually a CRT screen or a printer. Less common these days are paper tape or card punches. Esoterica will include graph plotters and electronic gizmos which convert computer data into some near-recognisable representation of the human voice.

OV
Abbreviation for overflow.

Overflow
The computer has to assume that internal work areas are a specific size. If it uses a 16-bit word, it probably uses *accumulators* — also called registers — which are eight or 16 or 32 bits long; that way it knows that anything inside that particular string of bits is relevant to the operation in question, and nothing else is. But what happens when the result of an arithmetical operation needs more bits than are in that accumulator? (try dividing 22 by 7).

Well, overflow is what happens. Your computer might not be able to handle this. Perhaps your accumulator will contain the first eight (or 16 or 32 or whatever) bits of the answer and the rest will be lost. That generally happens in pocket calculators, doesn't it? Perhaps it will round-up the result. Or it might set aside a special 'overflow accumulator' to hold at least some of the overflowing number. Several computers will set a *flag* (qv) to tell you that overflow has occurred, without letting you know where or why.

Overlay
Overlaying is a popular technique used by the clever kind of operating system for bringing routines, generally called overlays, into main memory from disc or some other kind of mass storage during the execution of a program. With overlaying, several overlay routines can occupy the same main memory storage locations at different times. The technique is used when main memory is not large enough to satisfy total storage requirements of a program.

The other widely-used method in operating systems is *virtual memory*. We shall reach this eventually but basically virtual memory is an automatic kind of overlaying — overlays are specified and controlled by the programmer. In virtual memory systems, the computer pretends to have a larger memory in a fashion not seen by the programmer.

Over-write
Another obvious one. It means to store information in such a way that it destroys whatever was previously stored there. Since disc, tape and internal computer memory are all re-usable, it follows that re-using them — by storing new information — will over-write their previous contents. One of the virtues of ROM will be equally obvious — you clearly can't over-write anything in read-only memory.

Pace
An early 16-bit micro from National Semiconductor.

Pack
Packing is a way of compacting information to economise on storage space inside a computer. Usually it means lopping-off zeros and omitting spaces in data to be stored, replacing them with some kind of marker which takes-up less space. When the data is read subsequently, *unpacking* takes place and the zeros and spaces are re-instated.

Package
In electronics, a package is what you have when you embed a *chip* in a block of plastic so that it can be used on a PCB, though that is usually called 'packaging'.

You are more likely to meet this word when it is applied to software; a package is a program developed for a particular application which is designed to be usable by more than one person. This is normal outside computing, of course; you don't often find books designed to be read by only one person. Most applications software is custom-written to suit one user; that is because every computer user has different requirements, even in doing the same basic work.

An application package tries to be all things to all people. Or rather, it tries to be most things to some people. In theory, the user has a tried and tested program which is available more quickly and more cheaply than it would be if it had to be designed and written from scratch and if only he were bearing all its costs.

There have been problems in practice, of course. The package may not be flexible enough to cope with all the idiosyncrasies you require. It was probably written in the first place as a customised job for one user and tweaked subsequently to make its appeal more general. That might not be the best way of producing software; it has to be sufficiently general in its approach to appeal to many users. You may be paying for facilities you will never use and the software may be voluminous and inefficient when it is inside your computer.

The thinking on design of software packages usually means one of two compromises. Either you will amend your ways of doing things to suit the package — quick and cheap; or the package will be capable of amendment, perhaps by being initially a bare-bones framework on to which can be attached some custom-

(continued on next page)

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written routines to make it suit you better.

The critical point is economic, particular for business programs. People who can design and develop elegant programs are not inexpensive and they are not common either. Software packages frequently are the only affordable option.

Packet switching
A clever data transmission process whereby packets or blocks of data are sent on their way with an 'address', rather like ordinary mail. The alternative is more like the telephone system, where a connection has to be established first before any information can pass from one end to the other. Here we are talking about big national or international data communications set-ups, of course.

Padding
Adding blanks or some other non-significant characters to a record to increase it to a fixed size. It is usually done automatically if the programmer specifies it. Padding will be necessary if you are working with fixed-length records and some contain insufficient data to be processed.

Page
Either a screen-full of characters — or rather character positions on a VDU: or chunk of storage, usually defined fairly arbitrarily; 512 and 1,024 words are page 'lengths' employed frequently.

Page printer
Compare *line printers*, which print a line at a time. Page printers generally assemble a page of output in a small internal memory and then put it out very quickly.

Paging
A facility on some operating systems; a procedure for transferring 'pages' of information between disc storage and main memory. Memory is expensive and you may find you don't have enough of it to hold the programs and data you want. Disc storage is much cheaper and your operating system may allow you to overcome the problem by swapping chunks of information between disc and memory — you are putting part of the current contents of memory temporarily on to disc and reading into the space so freed a piece of program or data you need. As presented, this is *overlaying*; when it is done automatically, it's paging.

With paging, pages of memory are moved in and out at a time. Since this is automatic, the programmer doesn't have to know what is happening and when. To the programmer it looks as though the total memory available is the capacity of main memory plus whatever disc storage there is. That is why paging is also called *virtual memory*.

Paper tape
Long strips of paper. Usually people mean punched paper tape when they use the phrase, though punching holes in it isn't the only way to store information on paper tape — some esoteric systems print dots on it, impregnate it with chemicals to hold data, and so on.

Punched tape is simple. A single row of holes across the tape encodes one character, rather as on punched *cards*. Paper tape has one big advantage over card, though — a card normally has room for no more than 80 or 96 characters. Paper tape has no such restriction and you can have blocks of characters up to any length.

You will need the software to cope with that. It is much easier to write programs which expect information in pre-defined record lengths of, say, 80 characters.

Paper tape is cheap, less bulky than cards, and can be read at speeds of up to 1,000 characters per second. No-one uses it much these days, though, becaue it's messy — all those hole-sized bits of paper fluff — and noisy — a paper tape punch is a fairly crude mechanical device — and you have to buy special hardware — the reader and punch. Cassette or floppy disc are much to be preferred if you can afford them, principally because they are so much faster and are more difficult to tear accidentally.

Two exceptions spring to mind. There are still hundreds of Teletypes around, cheap and noisy terminals which, frequently, have a built-in reader/punch for paper tape, so you might as well use it. Some older high-speed printers also utilise pre-punched paper tape, typically a loop of it; this is being read while the printing is proceeding and it determines vertical format — when to start a new page.

There is one largely-unexplored and extremely flippant use for paper tape, which incidentally is available in several colours. Remember those ticker-tape welcomes in New York City which no longer seem to happen? Well, ticker tape is paper tape from teleprinters and that is the same as a computer's paper tape.

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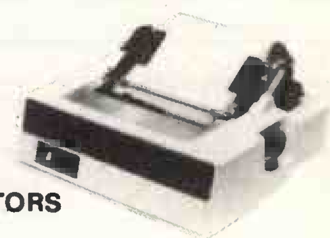

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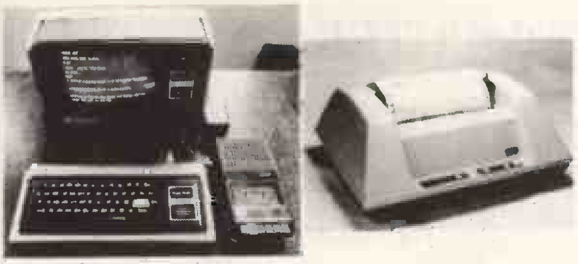

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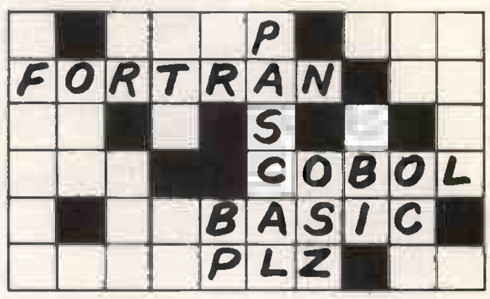

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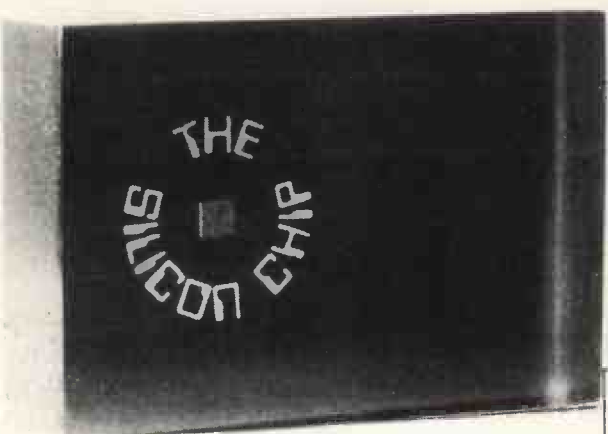

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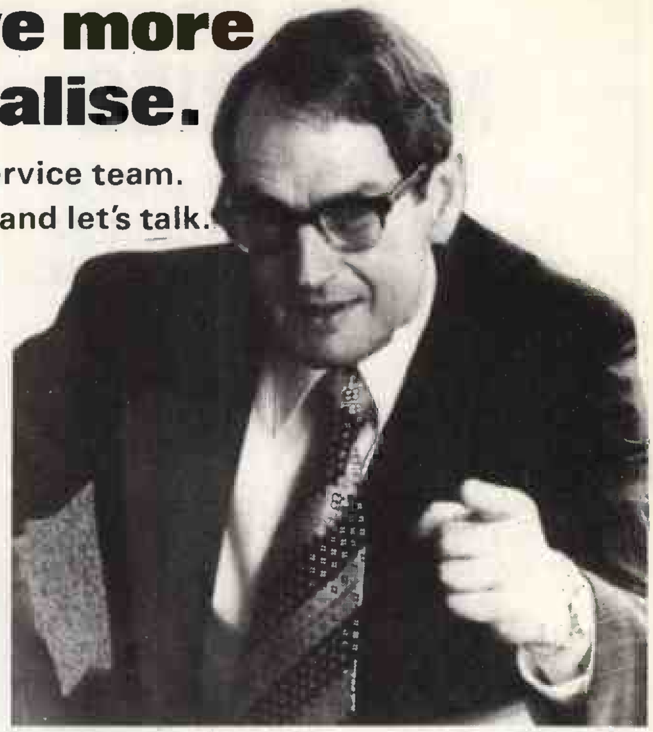

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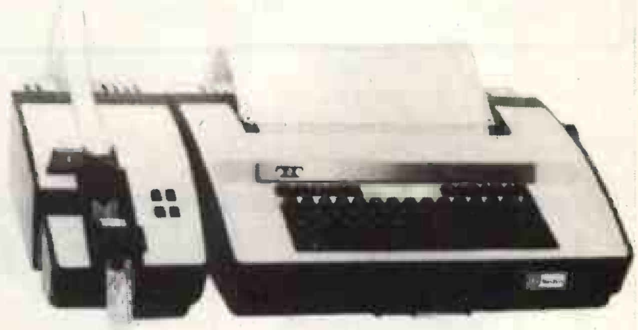

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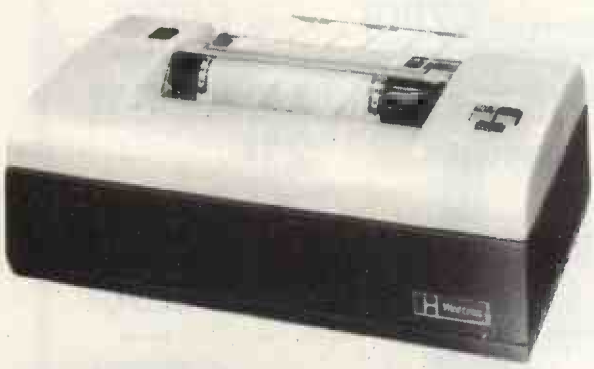

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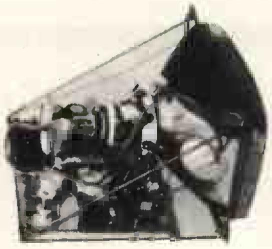

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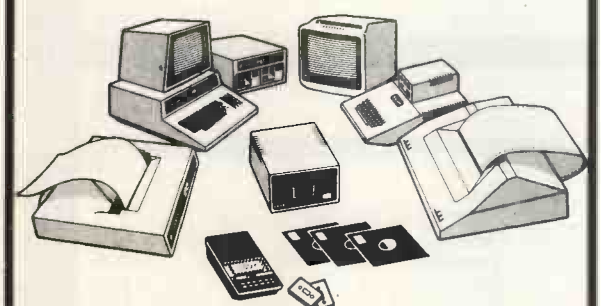

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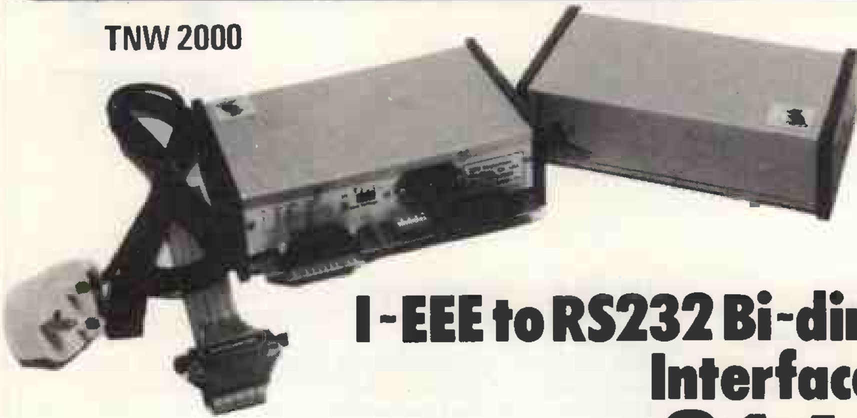
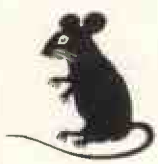
TNW 2000



I-EEE to RS232 Bi-directional Interface for Pet

£140 plus VAT



110 Baud to 9600 Baud (switch selectable)
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Pet 8k	**£550**
Pet 16k	**£675**
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Many others in stock, both hard and soft sectored.

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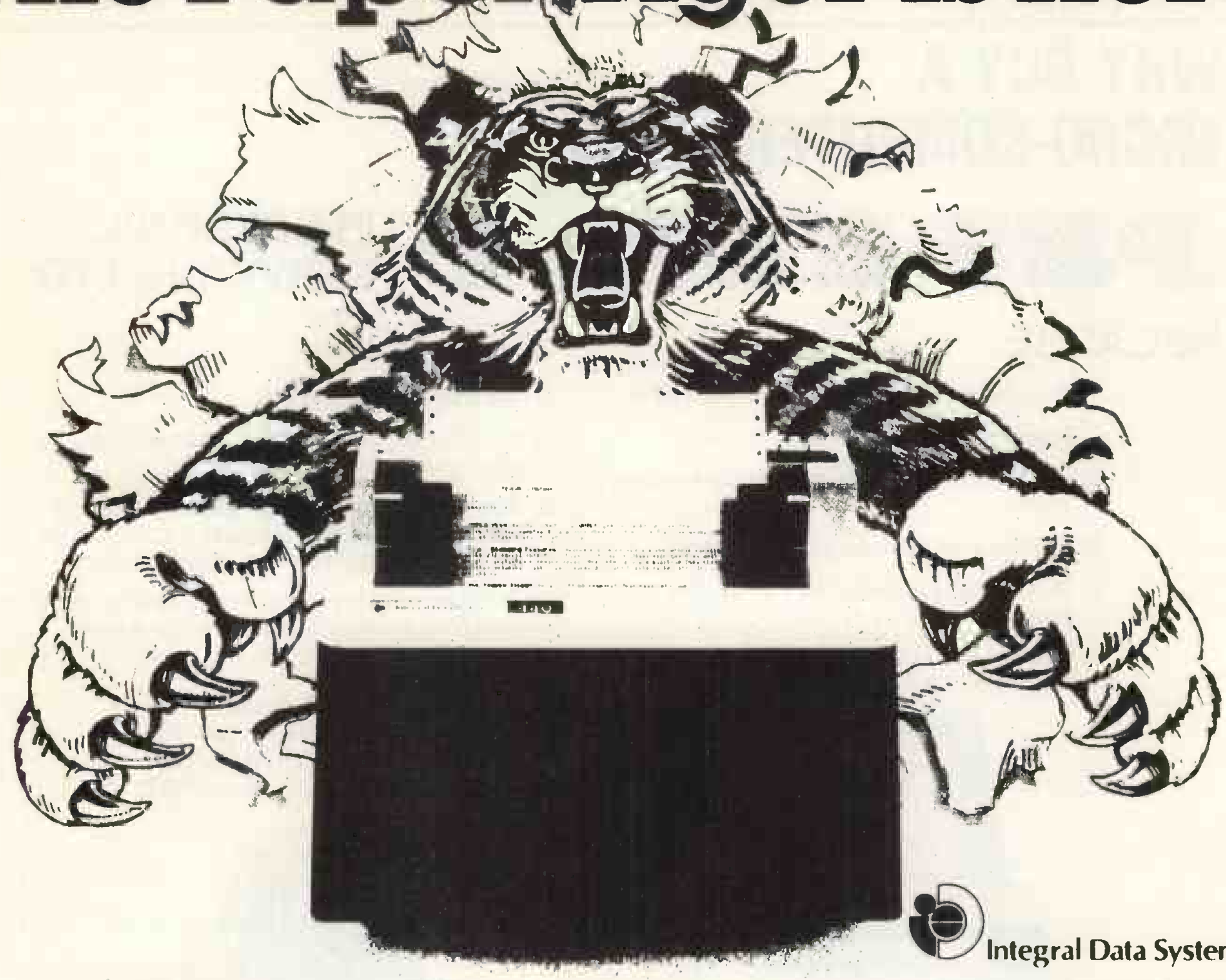
• **Circle No. 298**

The Paper Tiger is here.



The Paper Tiger sets a new standard for low-cost impact printers. More capability. More versatility. For just £575.

You get a full upper and lower case 96-character set. Eight software-selectable character sizes. Plain paper, multiple copies. Forms length control. Parallel and serial interfaces. Multiple line buffer. Tractor feed. Automatic re-inking. 80 and 132 columns.

It's all standard with the Paper Tiger.

Unbeatable capability.

The Paper Tiger prints just about any paper form you need. From address labels to multicopy invoices and legal-size reports.

Adjust the tractor width from 1-3/4 to 9-1/2 inches. Choose from 8 switch-selectable forms lengths. Print 6 or 8 lines per inch.

Unmatched versatility.

Want graphics? Add the Paper Tiger's software-selectable full dot plotting graphics. Print illustrations, block letters, charts, graphs, and more.

Need a bigger buffer? The Paper Tiger features an optional 2K-byte memory that holds a full 24-by-80 CRT screen.

And there's more.

The Paper Tiger is small, lightweight, and compact. That's because it's designed especially to work in small computer systems.

And it's built rugged and simple. For high reliability and easy maintenance. Just like the thousands of IDS printers already in the field.

Feature \ Printer	Integral Data 440	Anadex	Heathkit
Columns	132	80	132
Software Selectable Characters	8	2	3
True Tractor Drive	YES	NO	NO
Parallel and RS232 Serial Interfaces	YES	YES	NO
115-230 Volt 50-60 Hz Switch Selectable	YES	NO	YES
Full Dot Plotting Graphics	OPTION	NO	NO
Selectable ½-Line Increments	YES	NO	NO
Six or Eight Lines Per Inch Switch Selectable	YES	NO	YES
Software Select/Deselect	YES	NO	NO
Re-Inking Ribbon	YES	NO	NO
Power-on Diagnostics	YES	NO	NO
Automatic Paper Out Detection	YES	YES	NO
CRT Screen Buffer	OPTION	OPTION	NO
UNIT PRICE	£575	£575	£553

Comparison data from available manufacturer's literature.

See for yourself.

Check the comparison chart. Find out why this Paper Tiger just set a new standard for low-cost impact printers.

Whether you are a potential end-user or a dealer, why not ask for our free brochure? We will also send dealers details of our unique support service.

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Upgrade your system as your needs increase. Contains sockets for additional 16K or 32K RAM and a disk controller for up to 4-mini-disks. Software selectable dual cassettes can be used. Features a Centronics parallel port, real time clock, and a connector for an RS-232C interface or whatever. Requires Level-II Basic. 220/240V AC.

0 RAM £229 16K RAM £458 32K RAM £587

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video 100

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- Ideal for home, personal and business computer systems
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- Composite video input
- Compatible with many computer systems
- Solid-state circuitry for a stable & sharp picture
- Video bandwidth - 12MHz + 3DB
- Input impedance - 75 Ohms
- Resolution - 650 lines Minimum in Central 80% of CRT; 550 Lines Minimum beyond central 80%.

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LEVEL II BASIC WITH 16K USER RAM provides you with possibly the most powerful micro around. All our TRS80s are fully converted to English Television Standard and include a U.K. Power Supply, Cassette Leads, Sample Tape, Level I & Level II programming manuals, and special lead that enables you to connect direct into your own television.

Special features of Level II Basic enable you to:- — Set or reset any point on the screen — Test for the presence of a point on the screen (these features enable easy animation) — Save or load data from cassette under program control — File handling capabilities on cassette using named files. — Graphics blocks as standard — design your own pictures and many many more features for only **£399** + VAT

PET COSTS LESS AT COMP and it's a pedigree

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32K Sorcerer — £790.00 + VAT
S100 Expansion Box — £210 + VAT

Word Processing Pac and Development Pac now available.
Word Processing Pac — £70 **Development Pac — £70**

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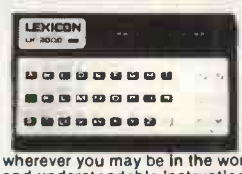

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