Practical Computing

60p

August 1980

Volume 3 Issue 8

Adventure II– a game for the intrepid

Reviews: Rair hard-disc

Texas Instruments TI-99/4

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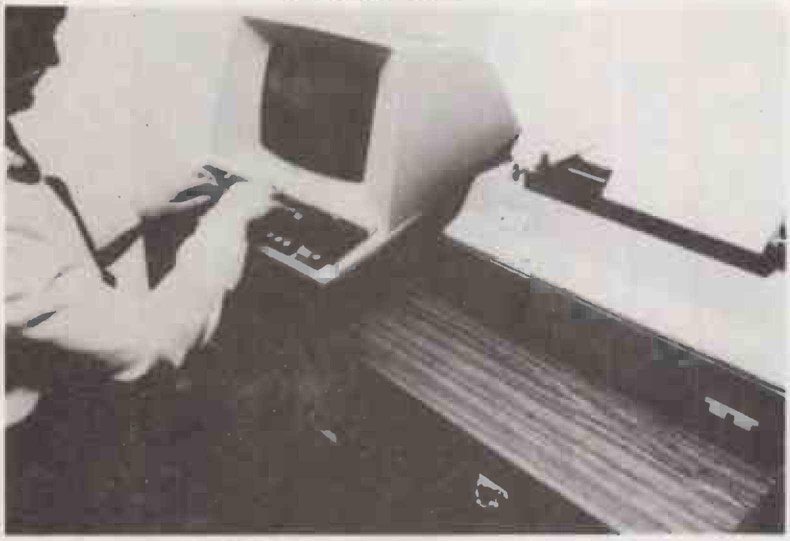

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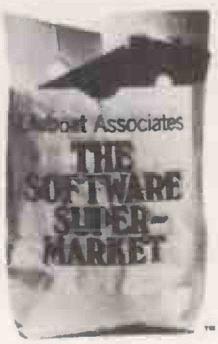

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There's been a lot of talk lately about intelligent terminals with small systems capability. And, it's always the same. The systems which make the grade in performance usually flunk the test in price. At least that was the case until Intertec introduced its SuperBrain line of video terminals with the best PPRs (Price/Performance Ratios) in the history of the industry.

SuperBrain users get exceptional performance for just a fraction of what they'd expect to pay. Standard SuperBrain features include: two double density mini-floppies with 350K bytes of disk storage, 32K of ram memory (expandable to 64K) to handle even the most sophisticated programs, a CP/M Disk Operating System with a high powered text editor, assembler, debugger and a disk formator. And, with SuperBrain's S-100 bus adaptor, you can add all the programming power you will ever need...almost any type of S-100 compatible bus accessory.

SuperBrain's CP/M operating system boasts an overwhelming amount of available software in BASIC, FORTRAN, COBOL, and APL. Whatever your application... General Ledger, Accounts Receivable, Payroll, Investory or Word Processing, SuperBrain is tops in its class. And the SuperBrain QD boasts the same powerful performance but also features a double-sided drive system to render more than 700K bytes of disk storage and a full 64K of RAM. All standard!

Whatever model you choose, you'll appreciate the careful attention given to every engineering detail. A full ASCII keyboard with numeric pad and user-programmable function keys. A non-glare, specially focused, 12-inch CRT for sharp images everywhere on the screen. Twin Z-80 microprocessors to insure efficient data transfer to auxiliary peripheral devicess. Dual universal RS-232 communications ports for serial data transmission. And, a single board design to make servicing a snap!

Your operators will appreciate SuperBrain's good looks and you'll appreciate SuperBrain's outstanding value. Because as your processing neds become more sophisticated, you can add auxiliary hard disk storage...up to 96 megabytes.

Truly incredible performance. All in a single, smart looking, self-contained desktop unit. And, all for a price that's substantially less than the competition.

COMPUSTAR™

MULTI-USER TERMINAL SYSTEM

At last, there's a multi-user microcomputer system designed and built the way it ought to be. No more ugly, bulky boxes and those endless miles and miles of entangled cabling. With the CompuStar, there is only one box - the unit itself. Complete with screen, keyboard, dual drive system and multi-user connectors. And what a beautiful addition it makes to any environment. The sleek, desk-top enclosure houses all the computer power you'll ever need and allows for the convenient connection of up to 15 additional users, a printer, a modem and a hard-disk drive system - all via a single, user-accessible rear panel. Now that's truly amazing, isn't it?

But the real beauty of the CompuStar is its "shared logic" design concept. Each user station contains its own distinct microprocessor and RAM. The result is lightning fast program execution. Even when all 16 users are on-line. Even when all are performing different tasks! A special multi-plexor circuit in the CompuStar ties all external users together to "share" the system's disk resources so that no single user ever need wait on another. An incredibly exciting concept!

A remarkable breakthrough in price/performance, the CompuStar boasts nearly 1 megabyte of online mini-disk storage (almost 2 megabytes on CompuStar II) and can be easily expanded to 20, 36 or 96 megabytes of hard-disk in just seconds. And since each user station can accommodate up to 64K of RAM, a total of over one million bytes can be incorporated into the system to tackle even your most difficult programming tasks.

CompuStar user stations can be configured in a countless number of ways. A series of three intelligent-type terminals are offered. Each is a perfect cosmetic and electrical match to the system. The CompuStar 10 - a 32K programmable RAM-based terminal (expandable to 64K) is just right if your requirement is a data entry or inquiry/response application. And, if your terminal needs are more sophisticated, select either our CompuStar 20 or CompuStar 40 as user stations. Both units offer dual kisk storage in addition to the disk system in the CompuStar. The Model 20 features 32K of RAM (expandable to 64K) and 350K of disk storage. The Model 40 comes equipped with 64K of RAM and over 700K of disk storage. But, most importantly, no matter what your investment in hardware, the possibility of obsolence or incompatability is completely eliminated since user stations can be configured in any fashion you like whenever you want - at amazingly low cost!

Software costs are low, too. CompuStar's Disk Operating System is the industry standard CP/M. And, an impressive array of application software is readily available to run on this system. Some powerful programming languages are available, too. Basic, Fortran and Cobol. As well as several specialised communication packages. All in all, the CompuStar handles just about all of your data processing needs at only a fraction of the cost of comparable systems.

DISK STORAGE

Options for the Superbrain and Compustar Video Terminal
Three Specially-Designed Models

Now there's a sound and simple solution to your disk storage needs. Intertec has devised three "small" solutions to what used to be a big problem for intelligent terminal and microcomputer users. How did we do it? Easy.

In just seconds, a Century Data Systems "Marksman" Winchester drive or a Control Data Corporation Cartridge Module Drive (CMD) can be interfaced via a single connector on either our CompuStar Multi-User Terminal System or the SuperBrain Video Computer. And we've taken all the guess-work out of the interface. Our uniquely designed disk controller/interface is "pre-installed" at the factory in preparation for quick and easy connection to your Intertec system. Just plug the drive into the nearest power source and plug your Intertec system into the drive. Really! It's that simple! All of the interfacing software has already been written. So you can be up and running...with up to 96 megabytes of super powerful hard disk storage... in just seconds.

"Backup" for the 20 megabyte Century Data drive is provided via the dual disk system housed in the CompuStar or the SuperBrain. The Control Data CMD Drive features a removable, front-insertable top loading cartridge of 16 megabyte capacity plus a fixed disk capacity of either 16 or 80 megabytes.

Each drive is shipped equipped with an EIA standard 19" rack mounting system and heavy duty chassis slide mechanisms to permit easy accessability for fast and efficient servicing.

Whether your choice is the Winchester type drive or the CDC CMD, you'll appreciate their ease of installation and inherent reliability. And, the wide variety of field maintenance programs available on each model will help you maintain your system and protect your original investment for many years.

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****** TESTED AND PROVEN ******
****** POWER AT YOUR FINGERTIPS ******
****** JUST COMPARE THIS LIST ******

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+ + COMPREHENSIVE DATABASE MANAGEMENT SYSTEM INCLUDES
**** FILE CREATE / DELETE / SEARCH
**** RECORD CREATE / DELETE / SEARCH / AMEND / PRINT 4 WAYS
**** RECORD SORT BY ANY FIELD BOTH ALPHA OR NUMERIC
**** RECORD INDEX, FIELD, & FIELD ELEMENT SEARCH (EG NO., TOWN OR SURNAME)
**** FOUR ARITHMETIC FUNCTIONS TO USE AS CALCULATOR ON LAST FOUR FIELDS
**** AUTO CHECK TO PREVENT DOUBLE ENTRY WITH FILE MANAGEMENT SYSTEM DYNAMICALLY ALLOCATING INFORMATION FOR MINIMUM DISK SPACE CONSUMPTION.
+ + AUTO INVOICE NUMBERING (WITH OVERRIDE OPTION), PLUS AUTO PRINTOUT INTEGRATED WITH ADDRESS AND STOCK FILES FOR PAYMENT TERM DISCOUNT, AGENT ALLOCATION, PRICE INDEX RETRIEVAL AND AUTO STOCK UPDATE; NOMINAL CODES RETRIEVED FROM ADDRESS FILES MAY BE OPTIONALLY OVERRIDDEN.
+ + POWERFUL ALTERNATIVE DOUBLE ENTRY SYSTEM (GENERAL AND OPEN ITEM) INCLUDING NOMINAL CODES PROVIDING A BUREAUX TYPE FACILITY FOR TRACKING MONTHLY TRADING FIGURES AND TAX ACCRUALS.
+ + CURRENTLY USING 16 SALE AND 66 PURCHASE COMMODITY CODES WHICH ARE AUTOMATICALLY WRITTEN INTO LEDGERS FROM ADDRESS FILES (INCLUDES OVERRIDE OPTION)
+ + AUTOMATIC TRIPLE POSTING OF SALES / PURCHASES TO INVOICE & GENERAL & OPEN ITEM LEDGERS WITH COMPLETE AUDIT TRAIL TO INCLUDE ACCOUNT VERIFICATION OF PAYMENTS IN / OUT, SO THAT DISCREPENCIES ARE RE-ALLOCATED TO OUTSTANDING ACCOUNTS, OR OPTIONALLY WRITTEN OFF AS DISCOUNTS TO THE CASH BOOK. THIS FACILITATES PART PAYMENTS.
+ + FINAL LIQUIDITY STRIKES A COMPLETE AUDIT TRAIL BALANCE WITH CREDITORS AND DEBTORS O/S AMOUNTS, BANK BALANCES, STOCK MOVEMENTS, AND REMAINING STOCK VALUE TO GIVE PROFITABILITY OF COMPANY IN BOTH FINANCIAL AND STOCK ASSET TERMS.
+ + POWERFUL ACCOUNT TRACKING FACILITIES INCLUDE AUTO STATEMENT PRODUCTION FOR ALL ACCOUNTS EXCLUDING NIL BALANCES, WITH DATE COMPARISON AGE ANALYSIS TO " CURRENT " 30 DAYS " 60 DAYS " 90 DAYS " AND APPROPRIATE MESSAGES WHEN A DATE BLOCK HAS AN INCLUSION.
+ + COMPLETE SEARCH / CREATE / AMEND / DELETE / SORT / FACILITIES ON ANY SIGNIFICANT LEDGER HEADING AGAINST EITHER OPEN OR GENERAL LEDGER IN DATE / INVOICE / ACCOUNT / AGENT / NOMINAL CODE / HEADINGS, FOR FULL INFORMATION RETRIEVAL SUCH AS A SHORTLIST OF OVERDUE ACCOUNT FOR A SPECIFIED MONTH, ACCOUNT LEDGER CARD RETRIEVAL, NOMINAL ANALYSIS ETC.
+ + FAST INPUT ECHO FUNCTION TO ENABLE REDUCTION OF KEYSTROKES ON REPETITIVE DATA, PLUS PRINT AUDIT TRAIL OF ANY FILE CHANGES.

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+ + ADD-ON OPTION OF AUTO STOCK MOVEMENT REPORT AND UPDATE QUANTITY ON HAND PLUS VALUATION OF RESIDUE AS RESULT OF PURCHASES AND SALES.
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+ + PET STORES UP TO 2200 ADDRESSES OR UP TO 4000 SIMPLE LEDGER RECORDS ON ONE DISKETTE WITH 160K OF USER MENU CALLABLE PROGRAMS FROM OTHER DISK. — — ONLY ONE PROGRAM DISK — — AND THE HARD CORE PROGRAMS CAN'T BE BUSTED.
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+ + CPM VERSION SPECIAL NOTE *** WRITTEN ON THE NEW SUPERBRAIN PROCESSOR WITH THREE HIGHER LEVELS OF OPERATION.
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***** 2 = ENTIRE FORMER SET OF PET PROGRAMS ARE NOW JUST ONE PROGRAM RESIDENT IN CORE. ONCE INVOKED FROM DISK (UNDER MBASIC) THE USER MAY INSERT TWO EMPTY DATA DISKS IN BOTH DRIVES OF THE SYSTEM ENABLING A HIGHER MAGNITUDE OF DISK SPACE FOR MORE DATA STORAGE. (STANDARD SUPERBRAIN TWIN DRIVES CAN STORE 3000 STOCK ITEMS OR 4500 LEDGER RECORDS. . 800K SUPERBRAINS CAN STORE 7000 NAMES AND ADDRESSES OR 9000 STOCK ITEMS OR 12000 LEDGER RECORDS " ALL INSTANTLY RETRIEVABLE) NEW 20 MEGABYTE HARD DISK STORAGE CAN HANDL 40000 NAMES AND ADDRESSES OR 60000 LEDGER ENTRIES.
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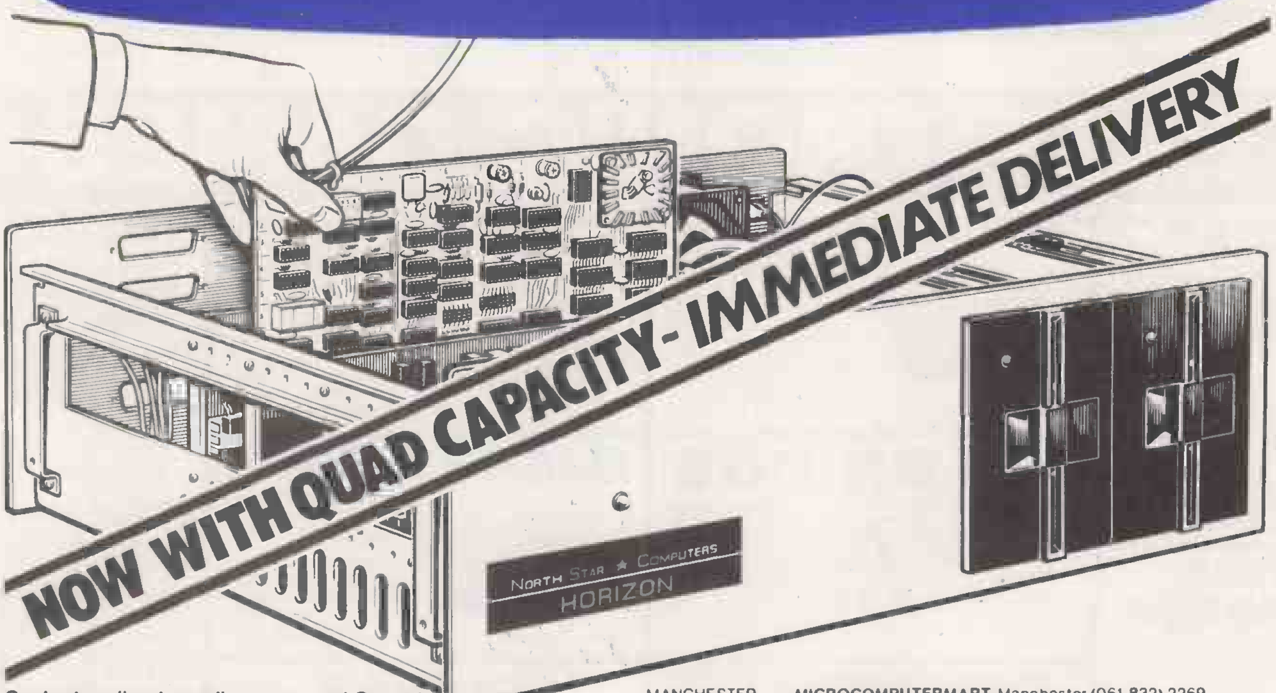

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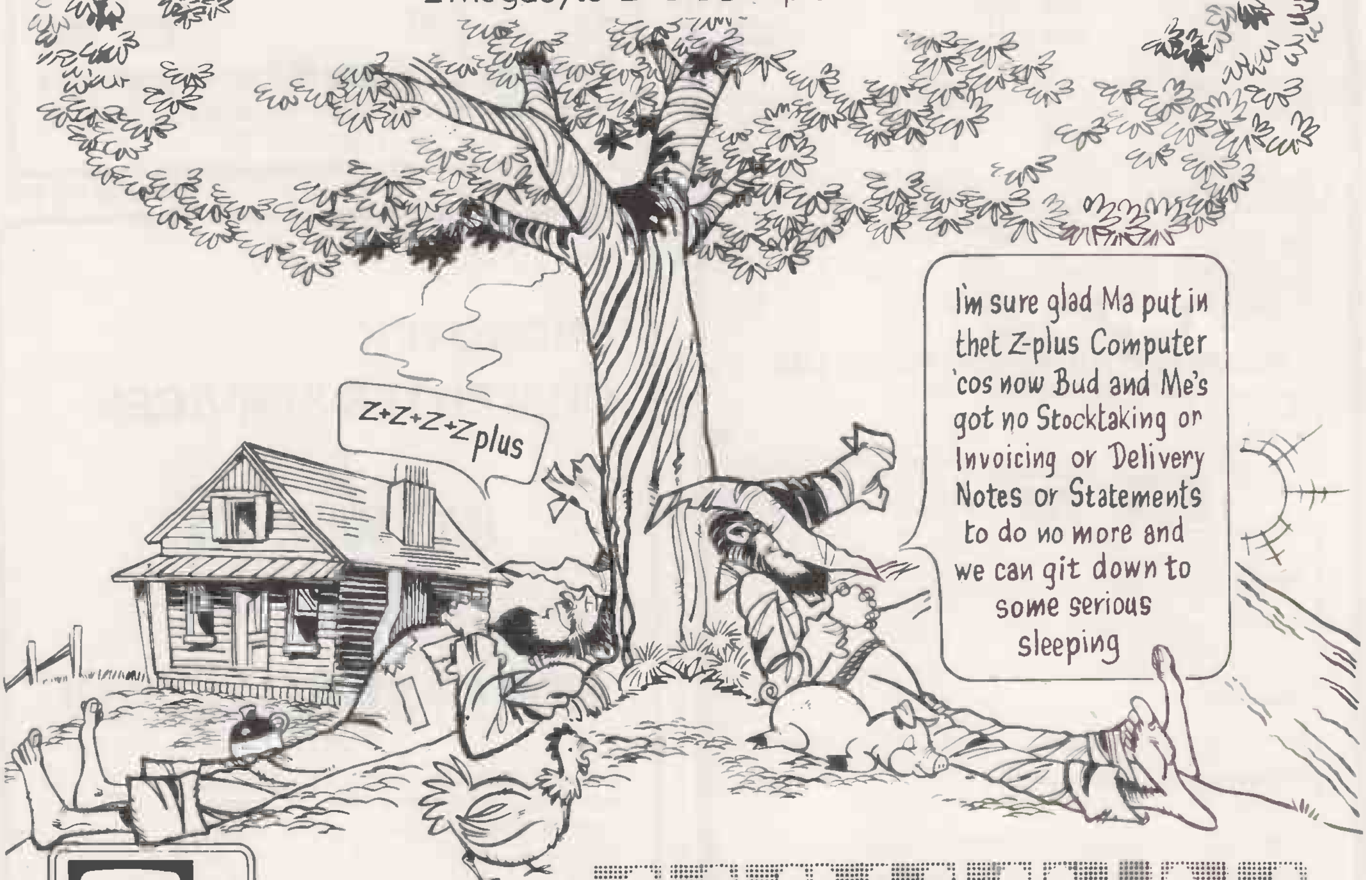

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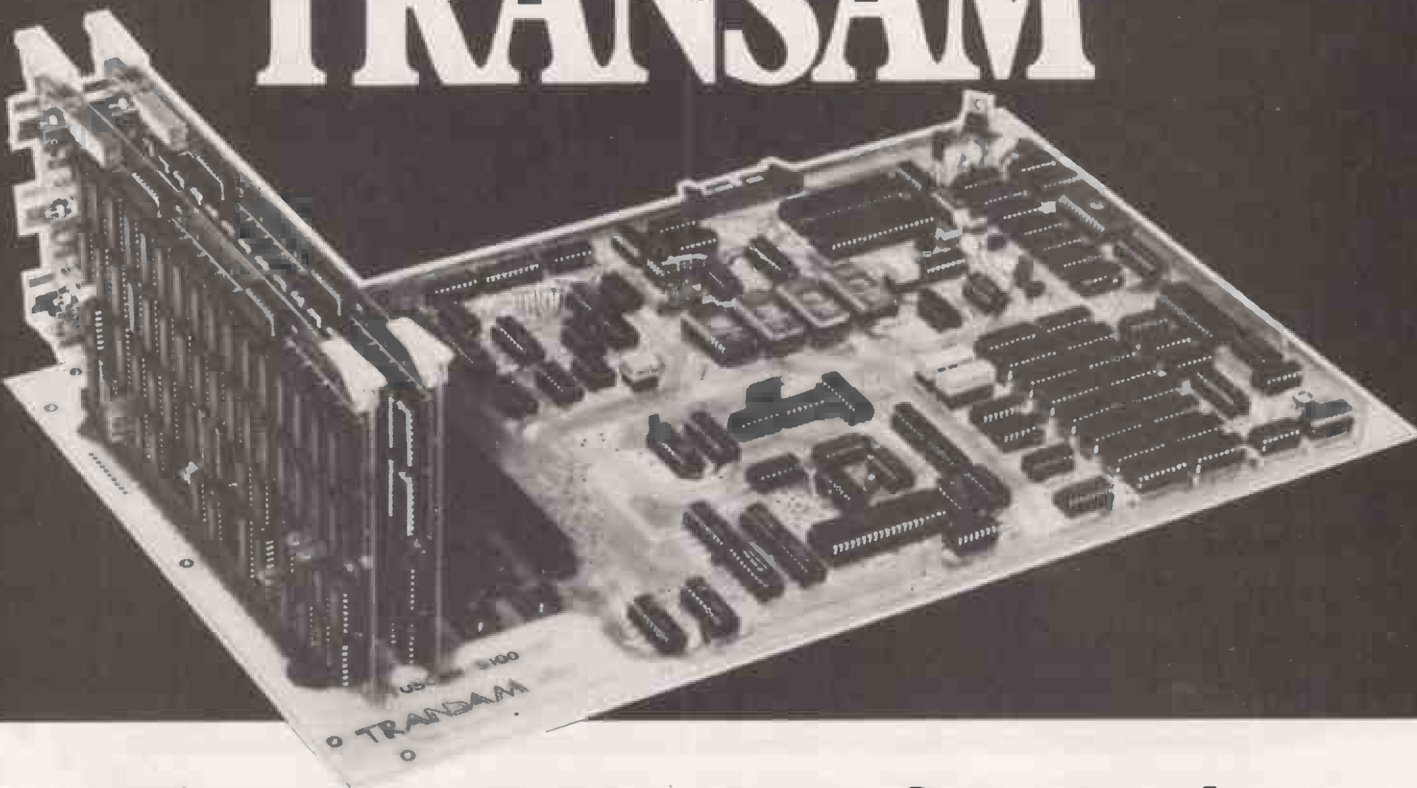

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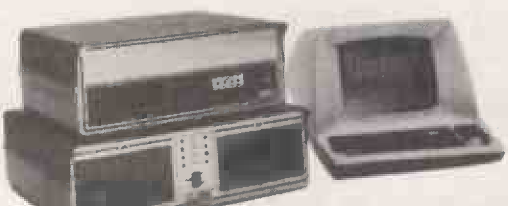

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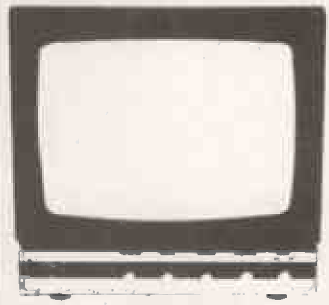

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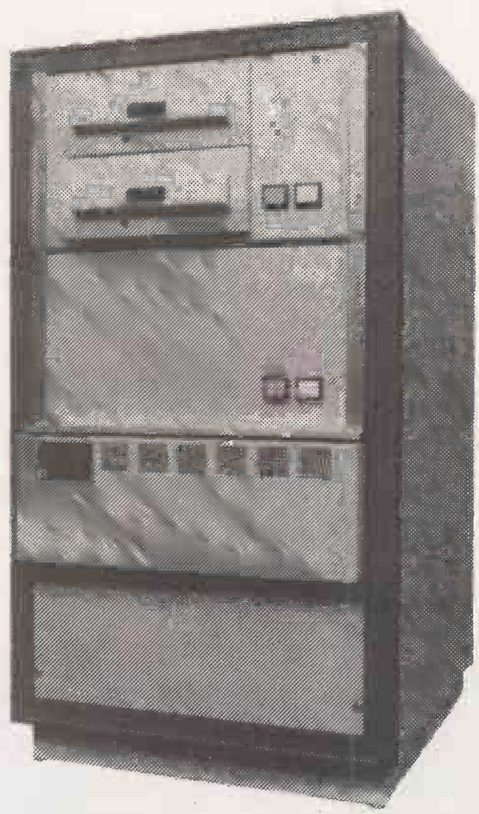

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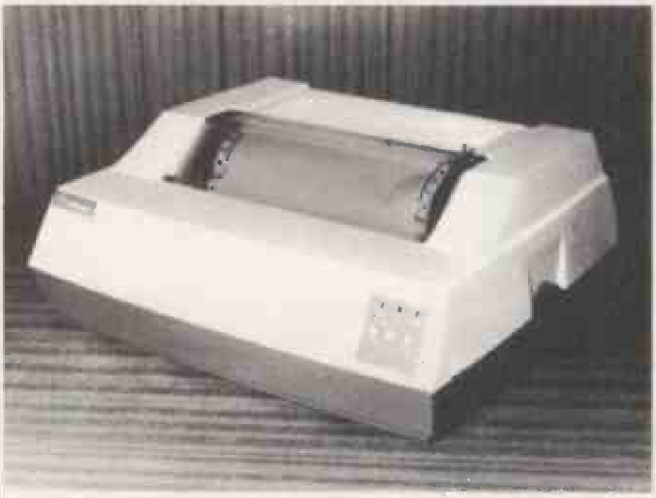

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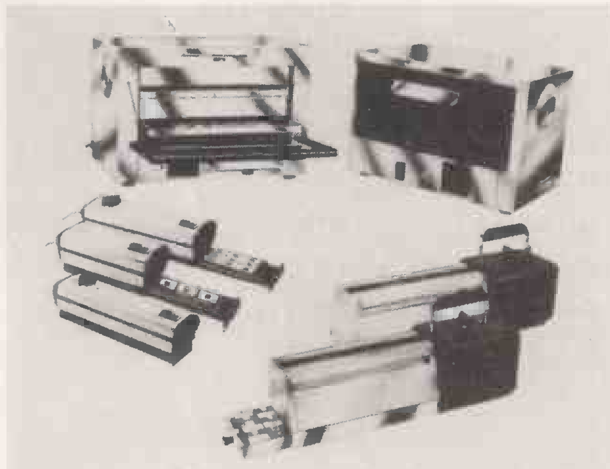

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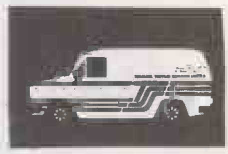

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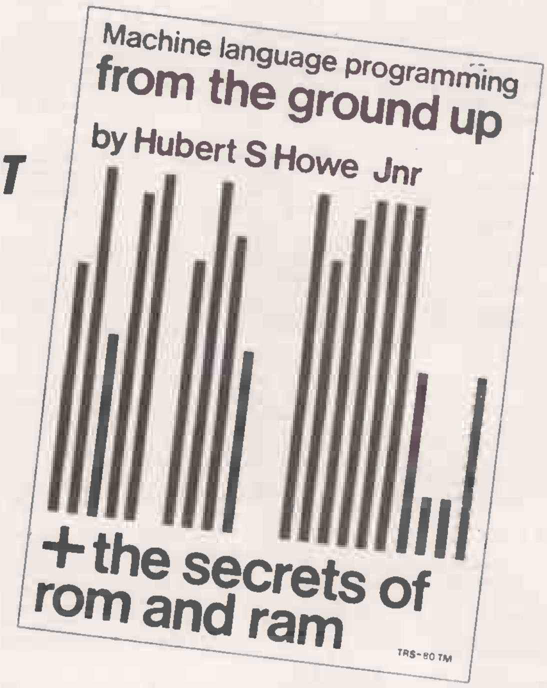

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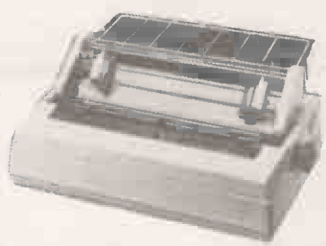

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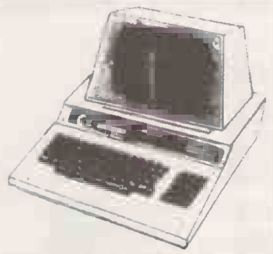

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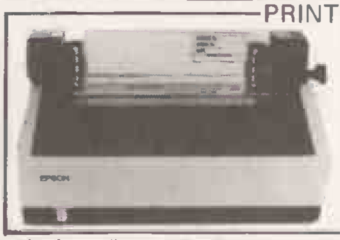

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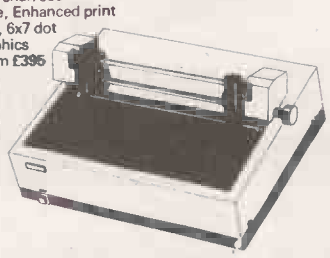

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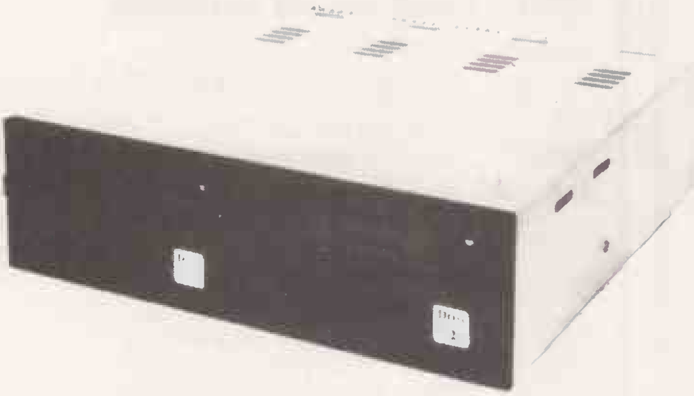

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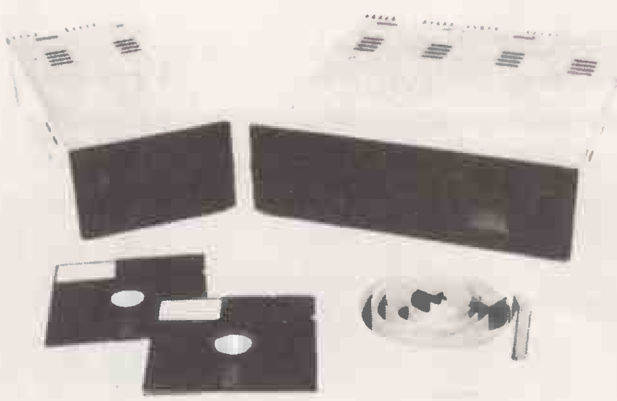

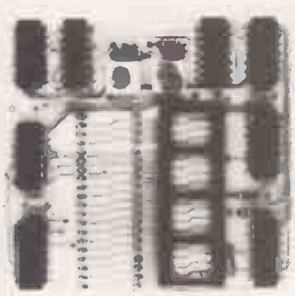

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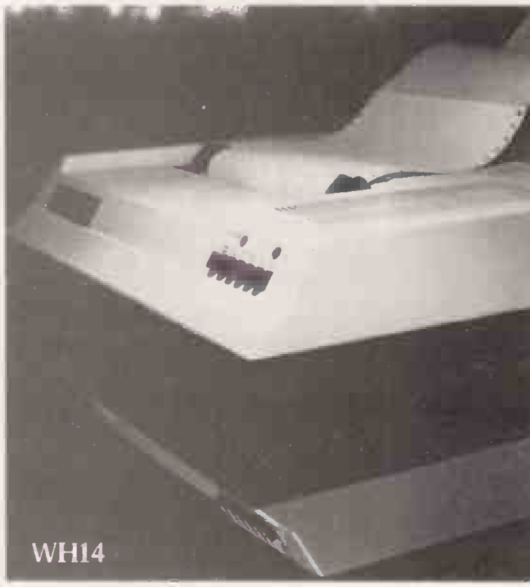

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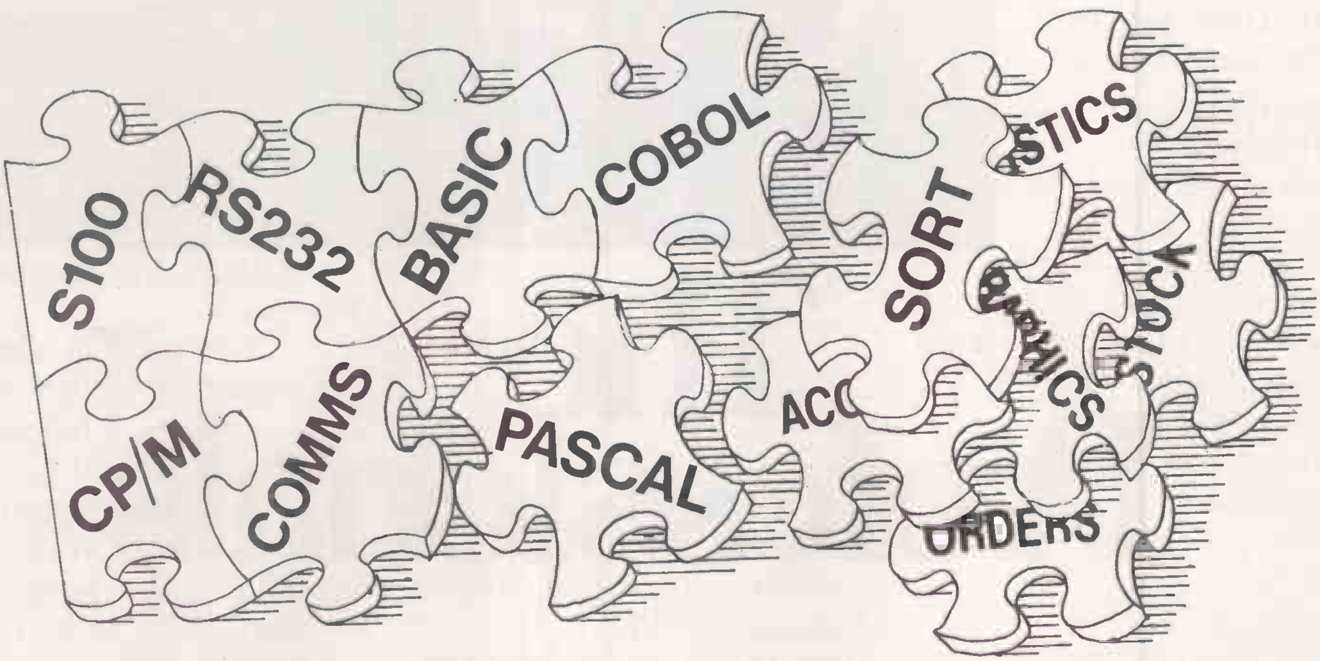

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• Circle No. 158

The copyright controversy

LAST MONTH, we drew attention to what may be a glaring gap in English law — computer software may not be protected by the Copyright Act.

The problems seems to be that the Act protects "literary works" which include "any written table or compilation" and writing is "any form of notation, whether by hand or by printing, typewriting or any similar process". It is quite possible that a program in ROM or on a magnetic medium is not "writing" in that sense because it is invisible to the eye.

However, once a literary work is copyright, it is protected from unauthorised publication in "any material form". The effect might be that you would have to obtain copyright by listing the program on paper. Only then would reproduction in ROM or disc be protected.

Unfortunately, until someone fights a very expensive case in the High Court, we will have no precedent. *Practical Computing* feels that there should be an Act of Parliament to make it clear that computer software has the same protection as every other intellectual work.

Copyright is a type of protection best suited to essentially inactive things. Books, plays, poems do not alter directly other literary works: computer programs can be quite different. Let us consider three examples:

You buy a word processor program from Mr Programmer and use it to edit and format a book you are writing. Does Mr P have any copyright in the result?

You buy a sub-editing program from Mr P and use it in the same way. The program does not just follow orders as the word-processing program did, it makes some decisions about literary style. It prefers short words to long ones; it prefers "he ran for the train" to "he was running for the train". It breaks up long paragraphs into shorter ones. Its effects are sufficiently marked that one can often tell that an author has used it. Who owns the copyright in the finished book?

You buy a chess playing program, like Sargon, and feed it some mid-game positions. The program then runs and you publish a book of end-games consisting of the positions generated by the program. Who owns the copyright — you or the writer of Sargon?

The commonsense view is that in the first case you have the copyright, in the second case, it is doubtful, in case three, the author of Sargon ought to have it.

The simple approach to computer software copyright simply asks who owns the copyright in the input — he then owns the copyright in the output. That obviously applies to the first case. In the second case, one might have doubts. It is obviously wrong in case three — the input there is simply some board positions which may demand no skill at all.

The trouble with this analysis is that input and program are different kinds of thing. They can alter in relative intellectual weight but not in essential character.

That fact is not really appreciated by commentators on computing who are not intimately involved in it. They tend to assume that a program is a series of mechanical commands that produce a fixed result.

For instance, a recent Bill introduced into the U.S. House of Representatives, called the Computer Copyright Act of 1980, defines a computer program as a "set of statements or instructions to be used directly or indirectly in a computer to bring about a certain result".

That is clearly only half the story. Quite apart from the "certainty" of the result — the author obviously has not had much to do with computers — what a program does depends as much on the data it is fed as the "set of statements or instructions". The data may be simple and the program complex as in the chess example, or the data complex — at least to human perceptions — and the program simple as in the text editor.

As we know only too well, programs incorporate a great deal of creative thought. Sargon is a good example. It is possible to show that the complete game of chess is transcomputational — that is, even if you made all the matter and energy in the universe into a computer and ran it since the beginning of time, you could not analyse all the possible moves in the game of chess.

Consequently, any game which plays chess can do so only because its author has built in his own skill and judgment about how a game should go. In the third example, it is quite clearly that element which prevails in the output — it is that element which makes Sargon a better or worse chess-playing program than another.

One ought to treat the program in law as if it were a person, or the stored intellectual attributes of its author. If it does a purely mechanical task, it has no copyright. If it contributes the main intellectual content, with the human simply pressing the buttons to make it go, it ought to have the credit.

The next stage — not very far away — is when one program calls another to produce an output far removed from the abilities of the nominal owner of the input — which may be no more than a request. For instance, you have an expert system which is good at précis writing. You tell it to access the Encyclopaedia Britannica on Prestel and write a 300-word report on sickle-cell anaemia. Who own the copyright in the report?

The issue can clearly become so complicated that copyright may not be the best way to analyse it.

Law exists to resolve and, ideally, to prevent quarrels. In the field of copyright, it exists to assure authors the just fruits of their intellectual labour. In the process, it is to the benefit of all because if there were no protection, no-one would embark on intellectual work. The return in computing is not so much from the value of the output as the value of using the program which produces it. In other words, if I had written the précis-writing program in the example, I would not be terribly interested in the copyright in the 300-word report.

In most cases, I think, we can ignore copyright in the output as being of transient value. What matters is the programs themselves. At the moment, they are written by human hands and present no fundamental problem.

Yet the analysis merely delays the day when we will have to take copyright seriously. What happens when a program is used to create a program? Far-fetched? Unless you write in Hexadecimal machine-code instructions, you do it every day with high-level languages. The copyright problem in this case is obviated either by contract or neglect.

People are talking about proper program-writing programs and, in a sense VisiCalc — reviewed in June, *Practical Computing* — is one. You could presumably use VisiCalc to create a business-control program and sell it to users. Should the publishers of VisiCalc have a slice of your money?

Maybe they should, but in the real world, this kind of accounting is going to become too complicated to be worthwhile. The convention of the industry may be that if you sell a program used to make other programs, you allow for that in the price you charge. So long as copyright law prevents people stealing the original software, you will be content.

Yet convention is not good enough because, as we pointed out last month, the man who is prepared to take what appears to be a hopeless case to court may well win simply because his opponents cannot afford to fight it. Uncertain law makes for bullies but a bad law may be better than no law at all.

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.

Mainframe glossary

MAY I offer a glossary of terms from my mainframe days.

Computer: A machine for transferring boring clerical operations into boring manual operations.

Program: A set of instructions telling a computer how to loop and halt unexpectedly.

System: A collection of mutually incompatible programs.

Parameter: A means of introducing an element of uncertainty into a process.

High-level language: A programming language in which instructions are written in standard English. e.g.,

```
A.AC% = VAL(MID$(FN.A3$(B.AC$
(4,30))) + CHR$(0))
```

Debugging: The process of replacing one error by another.

Working program: A program from which quite a few errors have been removed.

Enhancement: A way of re-introducing errors into a working program.

Sort: A program which enables random-accessed files to be held sequentially.

Implementation: The re-writing of a system in a hurry.

Operator: A person employed to slow a computer down to a manageable speed.

Punched card: The most inefficient form of data storage ever invented. The data is stored in holes in the card. As the card serves only to hold the holes in place, it is 100 percent redundant.

Security dump: Something you never have time to do because of all the disc crashes.

Turn-round: The delay between submitting a deck of cards to the computer and receiving back their remains.

John McMillan,
Reading,
Berkshire.

Unjust rejection

I HAVE just read the editorial in the June issue of *Practical Computing,* and I feel I must comment on it.

I have no desire to enter the debate as to which languages should be used on micros in the future, that depends on the application and, as I hope to show, the programmer's previous experience. I am writing because I think that your rejection of Pascal on the basis of the fact that you were unable to get along with it is unjust.

High-level computer languages split into two groups, unstructural — Basic, Fortran, etc. — and structured — Algol, Pascal, etc. Anyone who has learnt one type of language and not the other finds it difficult to convert to the other. That, incidentally, is the main reason why Fortran is still so popular among engineers when a structured language would be much better for their purposes in the long run.

To give a parallel example, in the field of typing. The QWERTY keyboard was designed originally to slow typists — the machines of that time could not keep up — but it is now so well established that a new, and considerably faster keyboard lay-out will find it almost impossible to break into the market even though it enables typing at dictation speed.

The point that I hope I have demonstrated is that changes requiring people to think in a new or considerably-revised way will usually be rejected even if they do provide considerable improvements in the long run.

You also say that recursion is only useful in solving a few mathematical problems. That is not so; recursion, in fact, makes the writing of most games programs a good deal simpler once you have mastered the technique — the same problem of rejection of new ideas occurs again.

The rejection of new ideas on the basis of not wanting to change old habits often means that the real benefits and disadvantages of, in this case, new programming languages become obscured.

T K Porter
University of Warwick
Coventry

● **Our point is that the problem confronting the microcomputing community is not which language to use, but how to make micros useful to the world at large. The way forward will be through the introduction of computers to more professionals in many fields — it is more important that they find the standard language easy and natural to use than that it should be powerful in the way a computer scientist would use the word.**

Teletype 33 interface

WE HAVE a Teletype 33 and would like to use it to print from our Pet. For that, we need an interface. Has anyone built one that works? I understand that they are not available commercially. The difficulty is that it is 120V.

K R Wilkinson,
Abbotsholme School,
Uttoxeter,
Staffordshire.

Printer survey

IT SEEMS that at the moment the market is being flooded with various matrix printers in the £300 to £600 price bracket.

As I and, I am sure, many other potential buyers are waiting to see which offers the best value for money before taking the plunge and buying one, I would be glad if you could do a survey of the various types — some I suspect are the same printer in a different box — perhaps including the follwing: Nascom Imp, Superprint 800, Anadex DP-8000, RM 8300, Oki Microline and the Epson TX-80.

David Green,
Nairobi,
Kenya.

● **A thorough guide to all the printers on the market will be appearing shortly.**

Viatron equipment

I HAVE recently acquired a Viatron System 21 together with a matching tape drive. If any readers have any relevant manuals they would be willing to loan or general information they could pass on regarding this and any other Viatron equipment, I would be very grateful. If there is anyone else struggling with one of these machines, perhaps we could start a Viatron users' group? Also, is there a 6800 — specifically MEK 6800 D2 — group still going somewhere?

Paul Dion,
London, NW3.

Microchess loses

I WONDER if your readers would be interested in the following very short win for white against Peter Jennings Microchess 2 program?

IQ level = 8

White	Pet
1. D2-D4	G8-F6
2. E2-E4	F6-E4
3. F1-C4	D7-D5
4. D1-F3	E4-F2?
5. C4-D5	F2-H1??
6. D5-F7+	YOU WIN

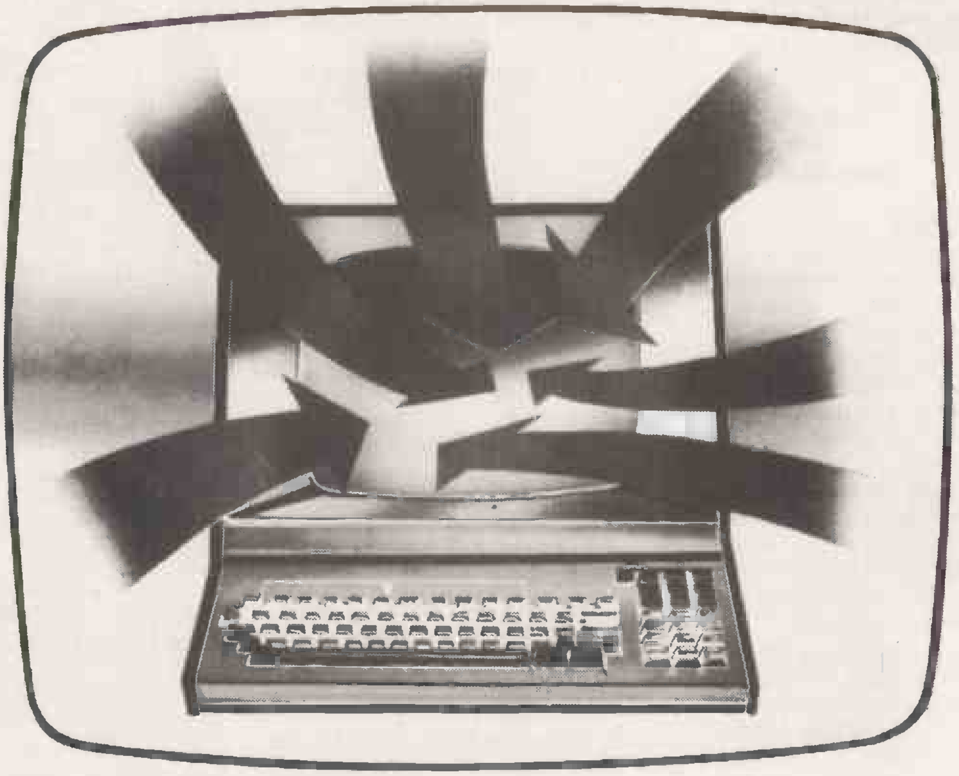
Black's time, 5 minutes 36 seconds.

An interesting feature of the game is that at level 8, Microchess 2 resigns by declaring 'You Win' one move before the impending mate.

Like the quick wins in the article, Foxing the Pet, *Practical Computing,* April, 1980, the mate is obtained by offering Black an advantage in material. However in this game, there is also an element of Microchess trying to be too clever.

That can be illustrated by attempting to repeat the moves with the IQ level set at 1. Moves 1 to 4 for White and moves 1 to 3 for Black turn out to be the same, but at move 4 Black now plays simply 4. D5-C4 easily avoiding the mating trap.

(continued on page 46)



(continued from page 44)

In contrast, at IQ level 4, the game proceeds along the same moves as level 8, except that in this case, black does not resign and is mated in 48 seconds by:

6. D5-F7 + E8-D7
7. F3-D5 + +

P Schofield,
Horsforth,
Leeds LS18 5HD.

Aids for disabled

THE BRITISH Computer Society has a committee for the disabled, among whose aims are the development of computer-based aids for the disabled.

In the U.K., a number of people are developing aids for sufferers of almost every kind of disability, and the advent of the microcomputer has accelerated the trend to new inventions.

So far, little has been done to provide a means for such people to contact each other and discover what is being attempted. Many aids have been invented and developed one-off by the inventor for himself or for a friend or relation.

Such an inventor could have gained help from contact with others working on the same problem. As a first step towards the information service which we believe essential, the sub-committee is collecting the names and addresses of people and organisations working in the field.

We should be very glad to hear from any who are interested whether as sufferers, inventors or manufacturers. We feel sure that this is not merely a national problem and are seeking similar help from organisations for information science in most of the English-speaking world.

Helen Townley,
The British Computer Society,
13 Mansfield Street,
London W1M 0BP.

Apple for teacher

I AM an enthusiastic user and proud owner of an ITT 2020 Apple with a disc drive and use it to conduct highly-structured seminars in which audience participation produces data and the computer generates results which lead to further discussion.

It is also very useful for lecture presentation of standard teaching material as problems can be set and worked on-line. It saves slide preparation and is endlessly re-usable. Paging a screen of notes is very handy — I use a large black and white TV for that.

In my Palsoft version of Basic which I have in ROM, I cannot run integer or binary programs directly on disc. I wonder if any readers have a solution — the conversion routine to integer Basic supplied by the dealer works only with tapes and you cannot load integer programs with the DOS. Most published software is in integer Basic and if you buy a disc you can't run it on the ITT 2020 in Palsoft ROM — any suggestions?

Do any readers have an L-P package on disc in Applesoft Basic? If anyone does, I would be happy to trade a correlation program in Applesoft on disc which I have developed for teaching purposes and which has been used successfully by students.

Thanks for your Apple Pie features.

F W Lukey,
Kumasi,
Ghana.

Machine-code master

I HAVE been reading with not a little frustration your series on machine code programming for the 8080 and 6502 microprocessors. Frustration not because of the quality or content of the series which is excellent, but because from my point of view you are about a year too late.

Having written a fair number of machine-code routines for a multiplicity of subsequent applications, I found it useful to be able to transfer the routine efficiently into a Basic program in the form of data lines. With that in mind, I offer for sacrifice the enclosed tit-bits for your consideration in the hope that some of your budding machine-code freaks might find it useful.

The two routines are written so that one of them writes data lines and the other deletes them, which may seem obscure but it is frequently useful to be able to delete lines as new ways of writing the source code are discovered. Repeated typing of the line numbers followed by return can be wearisome if you are trying to get rid of 20 or 30 redundant Data lines.

Of course, the delete routine can be used to delete any lines — not necessarily data lines and I use it to delete both those program segments once their usefulness has been exhausted and the final version of the main program is being prepared.

DATA-LINER <DELETE>

```
60000 REM*******************************
60010 REM*********LINE DELETER*********
60020 REM*******************************
60030 PRINT"
60040 PRINT"            LINE DELETER "
60050 PRINT"
60060 REM* * * * * * * * * * * * * * *
60070 REM* ENTER FIRST AND LAST LINES*
60080 REM*   OF BLOCK TO BE DELETED  *
60090 REM* * * * * * * * * * * * * * *
60100 INPUT"START LINE";SL
60110 INPUT"END LINE  ";EL
60120 PRINT"";
60130 IFSL>ELTHENPRINT"":END
60140 REM* * * * * * * * * * * * * * *
60150 REM*    SET LINE NO.COUNTER    *
60160 REM* (STEP NO. CHOSEN TO SUIT) *
60170 REM* * * * * * * * * * * * * * *
60180 FORI=SLTOELSTEP10
60190 X=X+1
60200 IFX>9THEN60240
60210 PRINTI
60220 NEXT
60230 X=X+1
60240 REM* * * * * * * * * * * * * * *
60250 REM*    PRESERVE  VARIABLES    *
60260 REM*    AFTER LINE DELETION    *
60270 REM* * * * * * * * * * * * * * *
60280 PRINT"SL="I":EL="EL":GOTO60120"
60290 REM* * * * * * * * * * * * * * *
60300 REM*  AUTOMATIC 'RETURN'  KEY  *
60310 REM* LOAD KEYB/D INPUT  BUFFER *
60320 REM*AND EXECUTE 10(MAX.)RETURNS*
60330 REM* * * * * * * * * * * * * * *
60340 PRINT"";
60350 POKE158,X
60360 FORJ=1TOX
60370 POKE622+J,13
60380 NEXT
60390 END
```

DATA-LINER <WRITE>

```
60400 REM*******************************
60410 REM******DATA-LINE  WRITER******
60420 REM*******************************
60430 PRINT"
60440 PRINT"            LINE  WRITER "
60450 PRINT"
60460 PRINT"YOU WILL BE ASKED FOR";
60470 PRINT" THE START"
60480 PRINT"AND END ADDRESS OF THE";
60490 PRINT" MEMORY BLOCK"
60500 PRINT"TO BE SAVED AS DATA";
60510 PRINT" STATEMENTS"
60520 PRINT"PRESS D TO SPECIFY";
60530 PRINT" THEM IN DECIMAL"
60540 PRINT"OR ELSE H TO SPECIFY";
60550 PRINT" THEM IN HEX"
60560 GETA$:IFA$=""THEN60560
60570 IFA$<>"D"ANDA$<>"H"THEN60560
60580 REM* * * * * * * * * * * * * * *
60590 REM*   SPECIFY  MEMORY BLOCK   *
60600 REM*   LOCATION AND  CONVERT   *
60610 REM*   ADDRESSES TO  DECIMAL   *
60620 REM* * * * * * * * * * * * * * *
60630 INPUT"START ADDRESS";SA$
60640 INPUT"END ADDRESS  ";EA$
60650 IFA$="H"THEN60690
60660 SA=VAL(SA$)
60670 EA=VAL(EA$)
60680 GOTO60750
60690 H$=SA$
60700 GOSUB60940
60710 SA=N
60720 H$=EA$
60730 GOSUB60940
60740 EA=N
60750 REM* * * * * * * * * * * * * * *
60760 REM*   CHECK SPACE AVAILABLE   *
60770 REM*    FOR NEW  DATA LINES    *
60780 REM* * * * * * * * * * * * * * *
60790 INPUT"STARTING LINE NO.";SL
60800 LL=INT((EA-SA)/17*10+SL)
60810 IFLL<60000THEN60840
60820 PRINT"STARTING LINE TOO HIGH"
60830 GOTO60790
60840 REM* * * * * * * * * * * * * * *
60850 REM*     WRITE  DATA LINES     *
60860 REM* * * * * * * * * * * * * * *
60870 PRINT""SL"DATA ";
60880 FORI=SATOEA
60890 IFPOS(A)>75THENGOSUB61070
60900 PRINT""PEEK(I);
60910 NEXT
60920 GOSUB61070
60930 GOTO61300
60940 REM* * * * * * * * * * * * * * *
60950 REM*    HEX.CONVERSION SUBR.   *
60960 REM* * * * * * * * * * * * * * *
60970 N=0
60980 L=LEN(H$)
60990 FORI=LTO1STEP-1
61000 MN=ASC(MID$(H$,I,1))
61010 IF MN<65THEN61040
61020 N=N+(MN-55)*16↑(L-I)
61030 GOTO61050
61040 N=N+(MN-48)*16↑(L-I)
61050 NEXT
61060 RETURN
61070 REM* * * * * * * * * * * * * * *
61080 REM*    INSERT COMMAS  SUBR.   *
61090 REM* * * * * * * * * * * * * * *
61100 PRINT
61110 SL=SL+10
61120 LN=LEN(STR$(SL))+6
61130 X=X+1
61140 S=32768+LN+X*80
61150 F=S+80-LN
61160 FORC=STOF
61170 Y=PEEK(C):Z=PEEK(C+1)
61180 IFY=32ANDZ=32THENC=F:GOTO61200
61190 IFY=32THENPOKEC,44
61200 NEXT
61210 IFI>EATHENRETURN
61220 IFX<9THENPRINTSL"DATA ";:RETURN
61230 REM* * * * * * * * * * * * * * *
61240 REM*    PRESERVE  VARIABLES    *
61250 REM*   AFTER  LINE INSERTION   *
61260 REM* * * * * * * * * * * * * * *
61270 PRINT"SL="SL":SA="I":EA="EA;
61280 PRINT":GOTO60840"
61290 REM* * * * * * * * * * * * * * *
61300 REM*  AUTOMATIC 'RETURN'  KEY  *
61310 REM* LOAD KEYB/D INPUT  BUFFER *
61320 REM*AND EXECUTE 10(MAX.)RETURNS*
61330 REM* * * * * * * * * * * * * * *
61340 PRINT"";
61350 POKE158,X+1
61360 FORJ=1TOX+1
61370 POKE622+J,13
61380 NEXT
61390 END
61400 REM*******************************
61410 REM*WRITTEN BY  D.J.H.WARR 1980*
61420 REM*******************************
```

D Warr,
Oxford.

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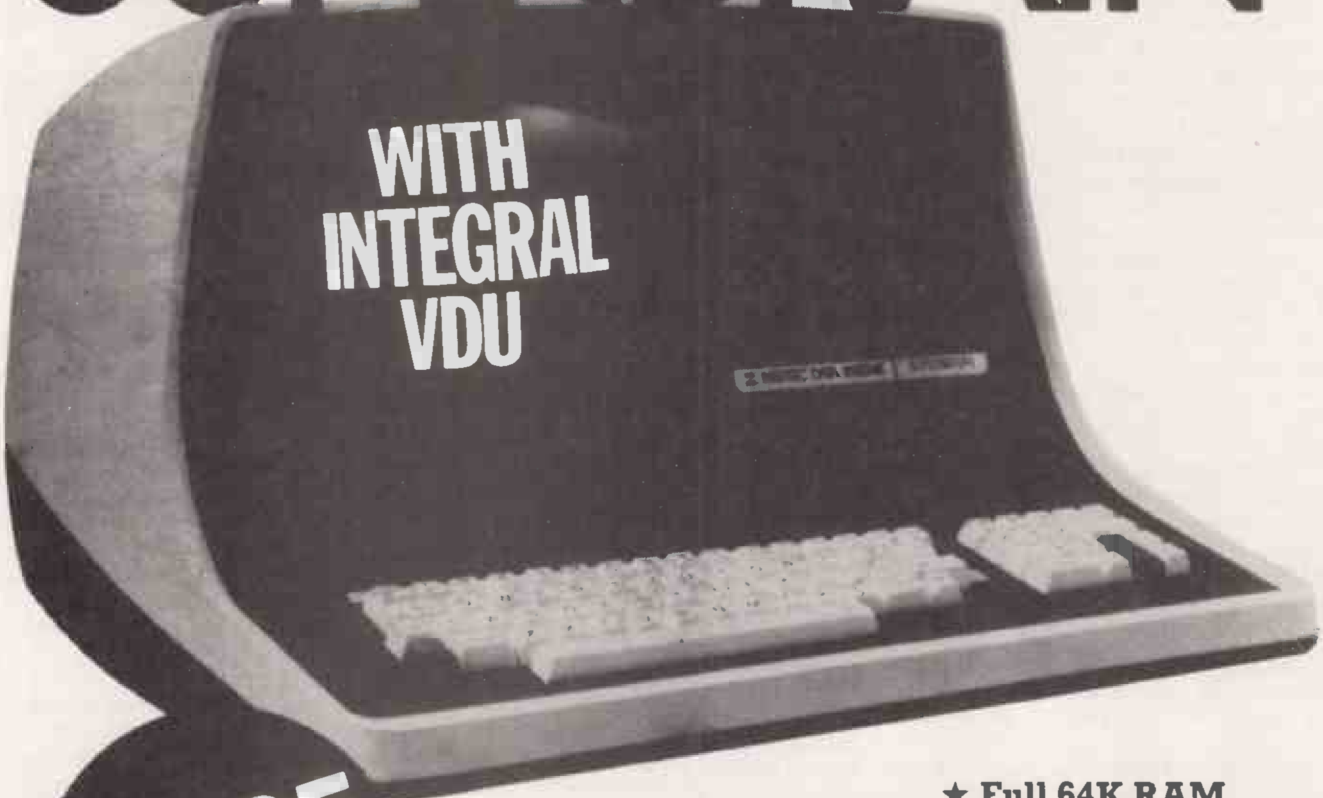

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• **Circle No. 160**

Exidy withdraws from microcomputer market

WHILE Nascom was sliding into receivership in the U.K., Exidy announced that it, for very different reasons, was pulling out of the micro field. It has sold the Sorcerer to Personal Micro Computers, a subsidiary of Recortec which has hitherto sold cassette-copying equipment for music and software publishers.

PMC also recently negotiated the U.S. distributorship rights for the Video Genie — the Hong Kong-built TRS-80 look-alike, which it is selling by mail order as the PMC-80.

Some reports claim that PMC has been able to sell only 200 of the systems. There are about 1,500 Sorcerers in the U.K., nearly 10 percent of the total Exidy world sales of what was its only microcomputer system. Exidy claims that it was unable to make the investment required to penetrate the microcomputer market.

Bureau offers new microlink

SYSTEMSHARE, the Edinburgh-based computer services bureau owned by Northern Engineering Industries, has announced a new microlink service. It will allow hobbyists and owners of small businesses to use time-sharing facilities.

New range of software at substantially lower cost

APPLIED Computer Techniques (ACT) has launched a new series of business software packages for the Pet which, it is claimed, offer competitive performance for substantially lower cost than their opposition.

Stock control, payroll and ledger packages will cost between £50 and £125, which, says ACT, is less than half the cost of comparable packages from other software houses.

Other packages available from ACT Petsoft, which is now aiming for the business market, include the Wordcraft word-processor package and financial and business-modelling system VisiCalc.

Prices have been pitched deliberately low for maximum business, and user-support will still be from dealers, who will probably not be slow to point out that the lease cost per month of the latest Pet plus packages to run a small business amount to around £100 — less than the hire purchase payments on a car and substantially less than it costs to hire even a part-time office worker, and the Commodore Pet has a further extension of its capabilities with a new disc drive which doubles its memory capacity. The new floppy disc drive unit is rated at 2MB unformatted and offers the user a total of 1.6MB on-line at what is said by the maker to be a lower cost per byte than any other system available. In practical terms, that means it is capable of storing, for example, 13,000 stock records.

Technical features include a double-sided, quadruple-density drive unit with 79 tracks per side; the Diskmen operating system and random or sequential file access. It is also compatible with existing ACT software through a conversion unit supplied with the drive unit. The manufacturer is CompuThink of California.

Teletext colour graphics add-on board for Nascom

MANY still seem to have faith in the Nascom and are confident that a market will still thrive for products which can enhance it. Winchester Technology, of Eastleigh, Hampshire, has just announced the first in what it claims will be a series of Nascom add-on boards, the WT625, a teletext colour graphics board which comprises a video buffer, control logic, PAL encoder and UHF modulator.

The WT625 board plugs directly into the Nascom extension board and provides the full range of teletext display features including 13 colours, flashing characters and single-row, double-height characters. Prices are £136 with a 42-page manual. Details from (04215) 66916.

The WT625 colour graphics board.

64K RAM chip steps forward

HERE AT last — the 64K RAM chip is finally being shipped to European dealers and developers and is now available for the general market. Manufactured by Motorola, it has, for some incomprehensible reason, been called the MCM6665L25.

It is a 65,536-bit, high-speed — 250 nanosecond access — dynamic RAM requiring eight address lines. Complete address decoding is done on-chip with address latches incorporated. Operating from a single 5V power supply the chip dissipates less than 300mW.

The only reservation about this great advance in chip development is the price. A quick calculation on our 16K RAM micro shows that the price per byte of a 16K RAM is 0.3p whereas that of the 64K RAM works out more like 2p per byte. No doubt the price will eventually fall. Details from Crellon Electronics (06286) 4300.

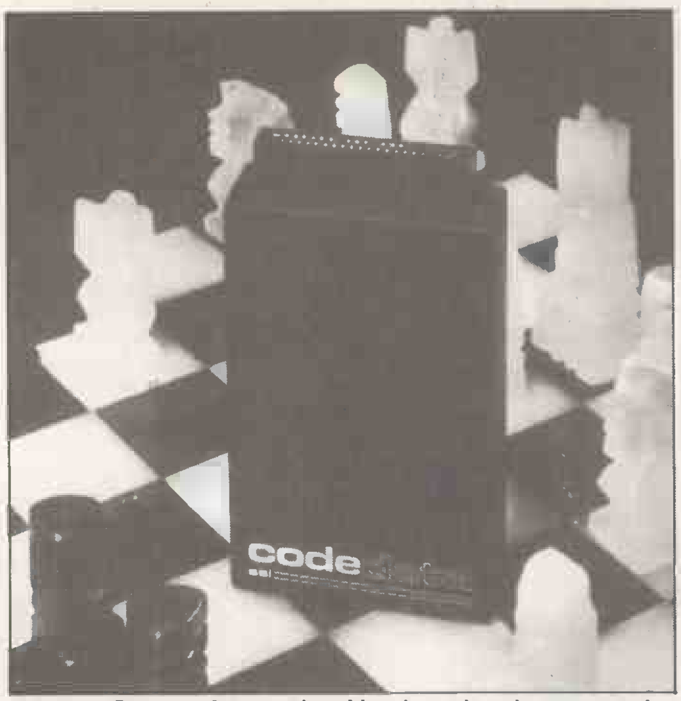
Memorex makes fresh advance with first removable-storage mini disc system

WINCHESTER technology hard disc drives continue to develop rapidly. The latest advance is from Memorex which has just launched the first mini disc drive with removable storage, a total capacity of 25Mbytes; 12.5Mbytes of fixed storage and an additional 12.5Mbytes of removable disc storage.

The fixed/removable, eight-in. rigid disc drive, the Memorex 201.

Used with the 201 drive, the Memorex 2001 removable cartridge not only provides the drive with its own back-up, but allows the 201 to act as a back-up for other devices.

The size of the front panel of the 201 allows the disc drive to fit into a standard floppy drive cavity. Access times can be brought down to only 30 milliseconds and seek errors are estimated at one per 10^6 reads.



SECURITY Systems International has introduced an encryption system, Codedata, to secure vital data in microcomputer systems. Encryption time is 20microseconds per character and input/output time is about 2μs per character, so that relatively-large data rates, up to 15,000 characters per second, can be handled. Most systems will need a special interface. Details from SSI, Cambridge (022029) 223.

First floppy disc drive for the AIM-65

MANY hobbyists must be feeling lost without a disc drive as more and more are being launched for even bottom-of-the-line systems. Portable Microsystems, of Brackley, Northamptonshire, has now announced the first floppy disc system for use with the AIM-65.

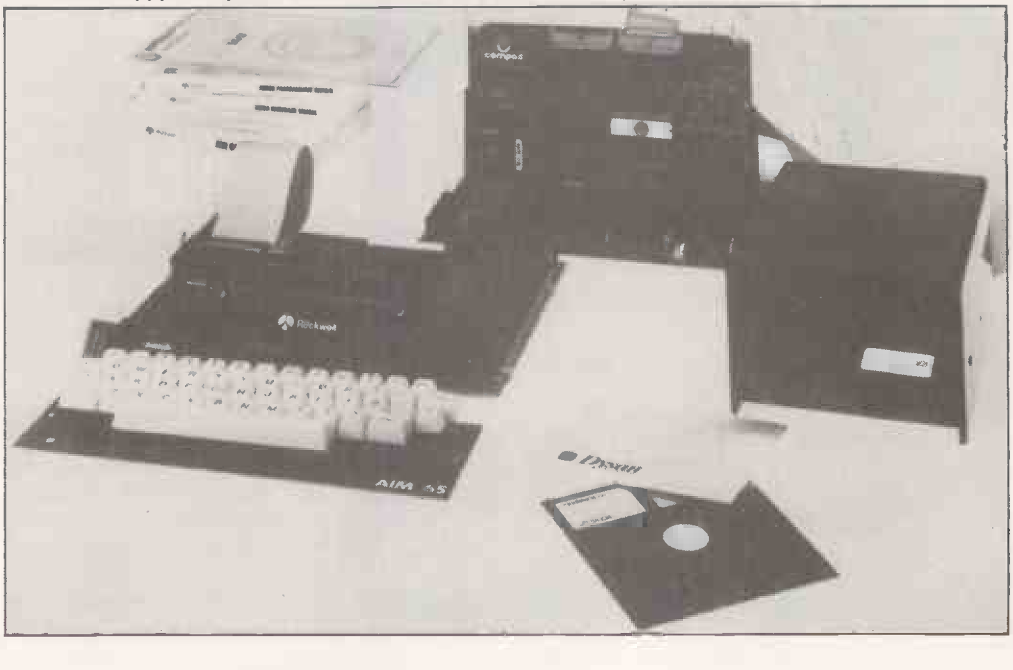
The minifloppy 5¼in. system, DAIM, includes a controller board, with 3.3K resident disc operating system, which plugs directly into the Rockwell expansion motherboard. The controller can take up to two drives giving 160K bytes of read/write memory.

DAIM is claimed to be completely compatible in both format and system functions with the System-65. Commands are provided to load/save source and object files, initialise a disc, list a file, list a disc directory, re-name files, delete and recover files and compress a disc to recover unused space.

DAIM was designed in the U.S. by the same company which developed the System-65 microprocessor / development system for Rockwell and is the first and only floppy disc system available for use with the AIM. It costs £695 + VAT for a single drive, controller and power supply unit. PM Ltd, (0280) 702017.

PL/65, a high-level, system-implementation language, is now available for the AIM-65. Pelco Ltd, (0273) 722155.

The DAIM floppy disc system for use with the AIM-65 microcomputer.



High technology must have venture capital

SIR KEITH Joseph, Secretary of State for Industry has repeated his call for more venture capitalists, of the kind he met on his recent visit to Silicon Valley in California, to invest in high technology.

Appropriately enough, a U.S. venture capital corporation, Venture Founders, has established a British subsidiary to finance new technology firms starting in the south of England.

The National Economic Development Council has published a study which shows that the West German government is spending £240 million a year subsidising its computer and microelectronics industry; Italy £1.5 billion over five years and France £3 billion a year just on its viewdata experiment.

Linker merges programs

"PROGRAM development can be halved", or so claims the supplier of a new Pet package which helps you merge commonly-used routines into new Basic programs. Called Linker, it has been designed for use with Commodore discs. The program is a cross between a link-editor and the append statement.

The main features are that when a subroutine is included in the program, it is not appended on to the end. Instead it is merged using the line numbers. Up to three subroutines can be merged simultaneously and one subroutine which has already been included can request another subroutine.

Also if a subroutine is changed on the main file, it should be a simple matter to update any programs which include the original version. Details from Dovetail Blackburn (0254) 665867.

Rescue bid for Nascom

THE FIRST signs of a rescue attempt for the ill-fated Nascom are beginning to emerge.

John Margetts, a Nascom user and member of the Nascom microcomputer club, is considering forming a company, financed by Nascom users and distributors, to buy the company from the receiver. The receiver is reported to believe that the plan could be viable, although it is still unknown how much money would be required.

Margetts apparently hopes to raise the money by selling 50p shares in the company in blocks of 20. If any reader is interested in the scheme telephone Margetts at Cheltenham (0242) 511472.

Pet Show report

THE Commodore-organised Pet Show, held at the Café Royal in London proved a useful opportunity for Pet dealers to show an impressive range of goods. Inside the ornate and chandaliered setting of the Empire Napoleon suite, 100 Pets lay waiting. There were little Pets, SuperPets, colour Pets, disco Pets and even a MuPet.

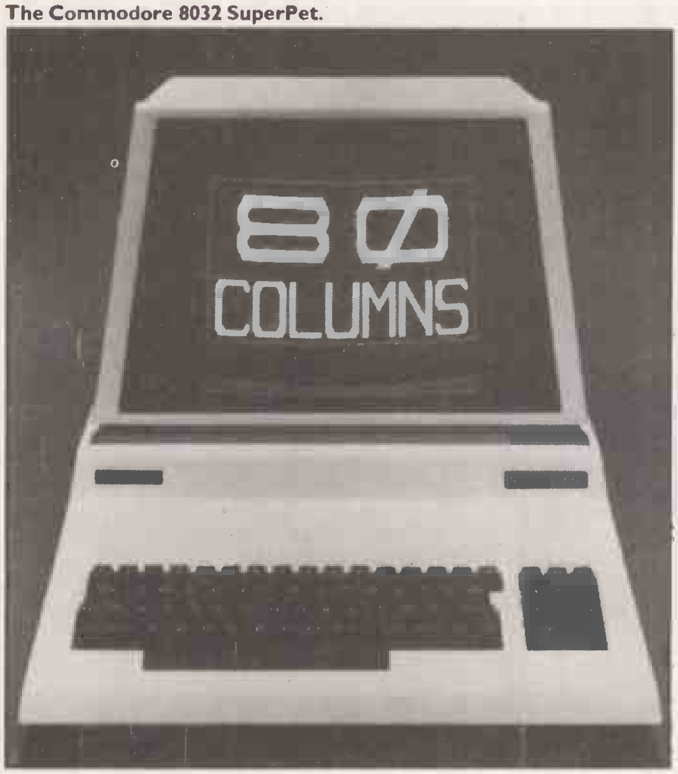
Officially the show was the launch of the new 8000 series

The Wordcraft 80 word-processor package on the SuperPet.

— the Commodore bid for the business market. The 8032 is an intelligently-designed upgrade of the original Pet. The screen is expanded from nine in. diagonally to 12 in., allowing 80 characters to be displayed on each of 25 lines — making it suitable for word processing and accounting applications.

Seasoned Pet users frowned over the business keyboard, standard in the industry but new to Pet, and tinkered with

The Commodore 8032 SuperPet.



Tab, repeat and ESCape keys. Nervous-looking Commodore personnel demonstrated how the latter could be used to ESCape from quotes-mode or, followed by reverse, to activate some useful new programmed characters for screen editing.

In fact, screen control is now extremely versatile with scrolling up and down, line insertion and deletion, programmable screen eraser between specified points and a variable screen-window facility.

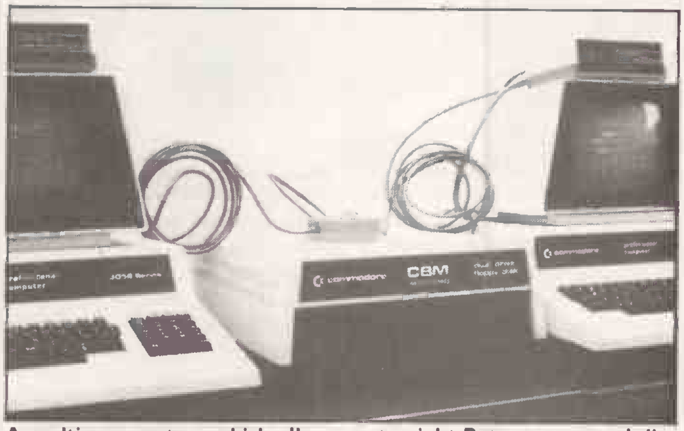
Improved Basic

The Basic has been improved, garbage collection no longer appears to be taking industrial action, and disc operating commands are now included. That makes disc-handling almost a pleasure. Disc initialisation is automatic for one thing, and for another, the first program on a disc can now be called and run, simply by depressing the RUN/STOP key shifted — a definite improvement.

Dataview Ltd, the Colchester word-processing specialist, had wasted no time and was offering a version of the Wordcraft package on the SuperPet for £375.

A retail price of only £895 for the 8032 means the cost of a word-processing system based on Wordcraft or Commodore Wordpro, plus disc and letter-quality printer, starts at around £3,200 + VAT. Rather better value than the dedicated word-processing systems which do not compute.

In contrast to the absurdly grand surroundings, some 50 companies conducted a cheerful trade from trestle-tables. Goodies on sale ranged from the plain daft — a computerised light rope — to the latest in multi-user disc systems. In the latter category was Canadian Bill Maclean's MuPet, a multi-plexed system linking up to eight Pets to a single disc drive.



A multi-user system which allows up to eight Pets on a central disc drive is available from Taylor-Wilson of Solihull, West Midlands.

Once daisy-chained together, the multi-user system operates in exactly the same way as any standard Pet and disc system. One likely application area must be in word processing where multiple-work-station systems still cost big money. Information from CompuScience of Canada, P.O. Box 121, Milton, Ontario.

Multi-user system

Solihull, West Midlands dealer Taylor-Wilson was busy taking orders for a British multi-user system. Again, up to eight Pets can be connected to a central disc drive, the difference being that the system allowed positive lock-out to prevent the corruption of files by intruders. Any or all Pets so connected can have a printer, which is said to be usable at all times.

Taylor-Wilson suggests that the ideal application would be where file updates are to be made at one location, for example, the stock room, and file interrogations at others, say the sales office and purchase ledger sections. Details from 05645-6192.

The sight of Arabic characters flashing across a colour TV screen attracted crowds to the stand of the Southern Users of Pet Association — SUPA for short. That was the Chromadaptor, an imaginative concept which allows a Pet to address 1,000 screen positions in which are 16 colours. Developed by Saleh Sadek, the prototype board shown is expected to cost less than £200 when it goes into production.

Software supplies were raking in the cash. Intex Datalog in particular seemed to be going good business with a new Payroll system priced at £195. The hands-on enthusiasts, some of surprisingly tender years, had headed straight for the Commodore stand for the new Transam disc-based TCL Pascal compiler at the remarkably modest price of £120 + VAT.

Petsoft launched a new range of key business programs at low prices, including a new Stock package at £75, handling more than 6,000 items online, and a disc payroll system for £50.

Meanwhile, B&B Computers had produced a solution to what was described as the random-access problem. The cure consisted of a set of machine-code routines dubbed BBDOS which enable direct-access files as used in CompuThink disc systems to be implemented on Commodore disc drives. BBDOS costs £120. Information from B&B on 0204-26644.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ZX80 and manual: £69.52
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You've seen the reviews... you've heard the excitement... now make the kit!

This is the ZX80. 'Personal Computer World' gave it 5 stars for 'excellent value.' Benchmark tests say it's faster than all previous personal computers. And the response from kit enthusiasts has been tremendous.

To help you appreciate its value, the price is shown above with and without VAT. This is so you can compare the ZX80 with competitive kits that don't appear with inclusive prices.

'Excellent value' indeed!

For just £79.95 (*including* VAT and p&p) you get everything you need to build a personal computer at home... PCB, with IC sockets for all ICs; case; leads for direct connection to a cassette recorder and television (black and white or colour); *everything*!

Yet the ZX80 really is a complete, powerful, full-facility computer, matching or surpassing other personal computers at several times the price.

The ZX80 is programmed in BASIC, and you can use it to do quite literally anything from playing chess to managing a business.

The ZX80 is pleasantly straightforward to assemble, using a fine-tipped soldering iron. It immediately proves what a good job you've done: connect it to your TV... link it to an appropriate power source... and you're ready to go.

Your ZX80 kit contains...
- Printed circuit board, with IC sockets for all ICs.
- Complete components set, including all ICs – all manufactured by selected world-leading suppliers.
- New rugged Sinclair keyboard, touch-sensitive, wipe-clean.
- Ready-moulded case.
- Leads and plugs for connection to domestic TV and cassette recorder. (Programs can be SAVEd and LOADed on to a portable cassette recorder.)
- FREE course in BASIC programming and user manual.

Optional extras
- Mains adaptor of 600 mA at 9 V DC nominal unregulated (available separately – see coupon).
- Additional memory expansion boards allowing up to 16K bytes RAM. (Extra RAM chips also available – see coupon).

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

The unique and valuable components of the Sinclair ZX80.

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

The unique Sinclair BASIC interpreter offers remarkable programming advantages:
- **Unique 'one-touch' key word entry: the ZX80 eliminates a great deal of tiresome typing. Key words (RUN, PRINT, LIST, etc.) have their own single-key entry.**
- Unique syntax check. Only lines with correct syntax are accepted into programs. A cursor identifies errors immediately. This prevents entry of long and complicated programs with faults only discovered when you try to run them.
- Excellent string-handling capability – takes up to 26 string variables of any length. All strings can undergo all relational tests (e.g. comparison). The ZX80 also has string input – to request a line of text when necessary. Strings do *not* need to be dimensioned.
- Up to 26 single dimension arrays.
- FOR/NEXT loops nested up to 26.
- Variable names of any length.
- BASIC language also handles full Boolean arithmetic, conditional expressions, etc.
- Exceptionally powerful edit facilities, allows modification of existing program lines.
- Randomise function, useful for games and secret codes, as well as more serious applications.
- Timer under program control.
- PEEK and POKE enable entry of machine code instructions, USR causes jump to a user's machine language sub-routine.
- High-resolution graphics with 22 standard graphic symbols.
- All characters printable in reverse under program control.
- Lines of unlimited length.

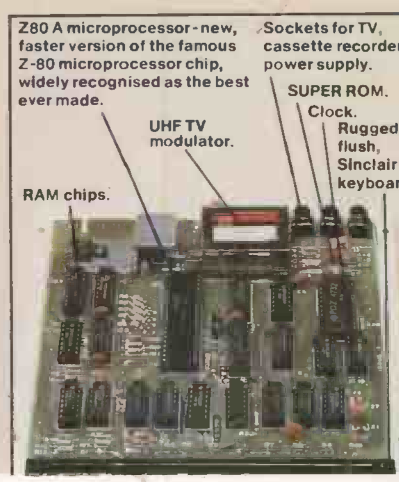
Fewer chips, compact design, volume production – more power per pound!

The ZX80 owes its remarkable low price t its remarkable design: the whole system is packed on to fewer, newer, more powerful and advanced LSI chips. A single SUPER RON for instance, contains the BASIC interpreter, the character set, operating system, and monitor. And the ZX80's 1K byte RAM is roughly equivalent to 4K bytes in a conventional computer – typically storing 100 lines o BASIC. (Key words occupy only a single byte

The display shows 32 characters by 24 line

And Benchmark tests show that the ZX80 is faster than all other personal computers.

No other personal computer offers this unique combination of high capability and low price.



plete

150 LET T(N)=X
160 NEXT I
165 PRINT
167 PRINT
170 PRINT "NUMBER OF DUPLICATES IS ";D
180 STOP
200 LET N=(N+1)-((N+1)/75)*75
210 GO TO 130
A Course in BASIC Programming
sinclair
ZX80
ZX80 Operating Manual

AVON
Bristol Computing Club
Leo Wallis
6 Kilbernie Road
Bridge Farm Estate
Bristol BS14 0HY.
Tel: 0272 832453.
Brunel Computer Club
Sid Rabone
18 Castle Road
Worle
Weston Super Mare
Avon BS22 9JW.
Tel: 0934 513068.

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Luton LU3 1EG
Tel: 0582 26967 (evenings)
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Lewis Hard
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Tel: 0234 41685.

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Irvine, California 92713 U.S.A.
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or 01-207 2000 Ext. 233.
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Sussex RH13 6AU.
Tel: 0403 61156.
Southern Users' of Pets Association (SUPA)
Howard Pilgrim
42 Compton Road
Brighton BN1 5AN
Sussex.
Tel: 0273 561982.

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Newcastle-Upon-Tyne
NE6 5AN
Tel: 0632 650653 (work)
or 0632 651707 (home).

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Sue Dunn
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Midland User Group Amateur Computer Club
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Datacall Ltd
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Leeds 4.
Tel: 0532 459625.
South Yorkshire Personal Computing Group
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15 Horndean Road
Sheffield 5
F5 0UJ.
Tel: 0742 387795.
West Yorkshire Micro-Computer Group
Phillip Clark
Suite 204
Crown House,
Armley Road
Leeds 12.

This month, we review the Computech sales ledger package which runs on the Apple II and ITT 2020. It is based on a brought-forward principle, is not dependent on the usual fixed-period accounting and employs an efficient two-file system.

Flexibility and system security are very impressive

by Mike McDonald

COMPUTECH Systems is a private company based in London and involved in the production of commercial applications packages for the Apple II/ITT 2020 and other systems. With the sales ledger, there is a purchase ledger and nominal ledger package.

We ran the sales ledger system on an ITT 2020 with 48K of RAM and two mini-floppy drives with a Centronics 703 bi-directional matrix printer as the hard-copy device.

The sales ledger is based on a two-file system — one for customer account details and the other for sales transactions recording. The customer file and transactions file may reside on the same disc or separate discs and have a total capacity of 500 customers and 1,600 transactions per disc.

The design of the package is based on a brought-forward accounting principle and is not dependent on the usual fixed-period accounting. Transactions are held on disc and at all stages of reporting may be printed off within a range of start and finish dates defined by the user.

Control account

A control account is held for each system which means that a large ledger may be spread over several discs each acting as an independent sales ledger, i.e., one for trade customers, one for wholesale customers and so on. As and when the transactions fill a disc, an accounts-rendered-carried-forward facility is available to clear the file.

The user has the option of configuring his own system in the way the machine slots are utilised for discs and printer and also in terms of the location on the discs of the respective files and programs.

The configuration ability also provides a high level of security, particularly where a user will wish to spread the ledger over several discs. It is achieved by logging into the configuration information the location and volume serial numbers of the discs containing the relevant files. The package checks each drive at run time and verifies that the correct discs are loaded before processing can continue.

The configuration file may be altered as the first activity in running the sales ledger and contains the following data:

a. Type of printer — serial or parallel.
b. Printer interface slot number.
c. Printer lines per page.
d. Disc controller slot.
e. Program drive number.
f. Customer file drive number.
g. Transactions file drive number.
h. Program volume number.
i. Customer file volume number.
j. Transactions file volume number.

The program is a single-source code module loaded into memory automatically as part of the disc boot procedure. The program occupies about 30K but does not have to be held on disc for further access once loaded, thus maximising disc storage. For smaller volumes of data, users may hold all information on a single disc and need purchase only a single drive.

On loading and running the program, the user is given access to a master menu from which all functions are accessible. They are:

1. Sales invoice.
2. Credit note.
3. Cash and discount received.
4. Cash paid.
5. Journals.
6. Statements.
7. Balances.
8. Control account.
9. Customer.
10. C/FWD accounts rendered.

The first four options are transaction entries, the next four produce printed reports, option 9 is the customer file maintenance routine and 10 is a clear-down facility.

The sales ledger is a number-orientated package but permits the entry of account or customer names for search purposes. Once a match is made the user is requested to indicate if the name found is correct. A no will cause the system to continue the search.

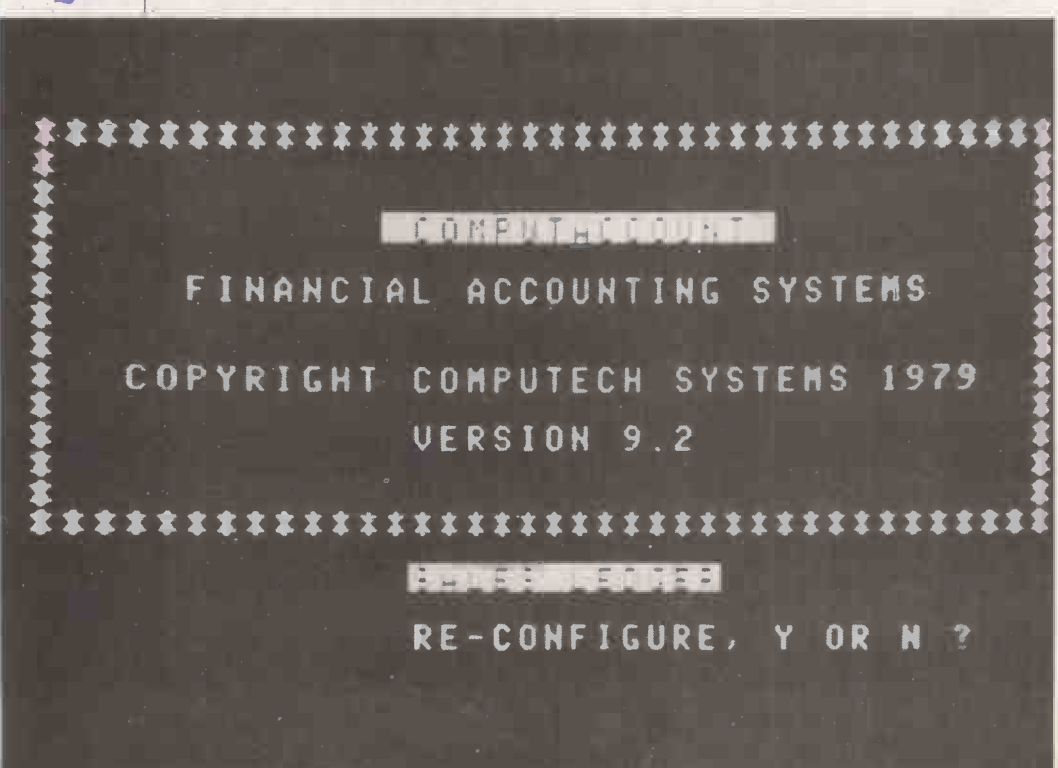
Display facilities

As well as displaying the full company name on a string search, the system also displays the account number which must then be entered before any processing can be performed.

Our first exercise was to set-up some customer accounts on file. The customer facility produces a screen format on which all details are entered, which comprise:

Account number	1-500
Account name	31 characters' maximum.
Three address lines	31 characters' maximum.
Credit limit	0.01 up to 999999.99 (entry).
Balance (opening)	-999999.99 to 999999.99 (totals).
Turnover to date	-999999.99 to 999999.99.

Once entered, accounts cannot be deleted and only the name and address can be altered. Alterations to customer details are also handled as part of the customer facility. If a valid account number is entered against the number or name prompt, the system retrieves the account information detailed above and displays it on the screen format.



The user is then given the opportunity to alter any fields or move on to the next transaction. Account numbers are issued sequentially and the user may not allocate his numbers randomly.

The next available account number is shown if a string search is entered against which no match can be found, i.e., xxx. Instead, the system responds with a warning and the first free account number.

In the course of processing the balance and turnover to date, fields are updated with each transaction entered and the customer facility can be a useful account look-up routine showing the up-to-date status of account balances on the screen.

For entering transactions, the manual recommends that users should batch input documents into date and numerical order before entry. That causes the reporting to be more logical and could help prevent inadvertent entry of the same document. The four input transaction types all use the same screen format which shows:

Account number	Analysis
Account name	Amount
Date	VAT code
Reference	VAT/discount
Description	Total

Once a valid account number is keyed, the system displays the associated company name and prompts the user for each of the above fields. Each entry is validated for content and format, i.e., date, where possible. The reference is a five-digit field for invoice or docket number. We felt that it should be slightly larger for general application in a variety of businesses.

The description field may be up to 19 characters and is very useful. The analysis code is a two-digit numeric which the user may nominate say to identify a product or customer type.

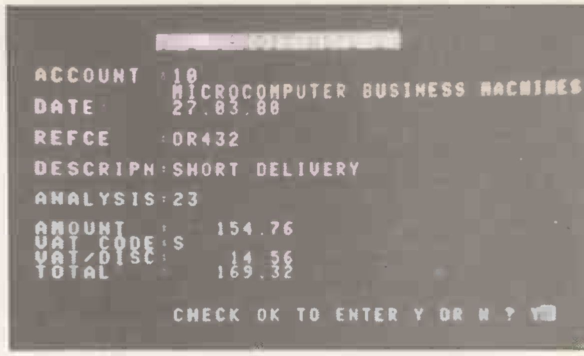
Analysis code

All transactions are grouped in value against each analysis code when the journals are printed and a value printed for each code. Up to 99 codes may be entered. The amount and VAT amount must be keyed as a number containing two decimal places which we found to be a nuisance but which is, no doubt, a good security feature against miskeying of, say, too many zeros.

A VAT code of A, higher rate, S, standard rate, Z, zero rate, or E, exempt, must also be entered. They are used strictly for summary reporting and there is no calculative check on the VAT amount entered. The system produces a total of VAT — plus goods automatically and allows the user to alter details — by re-entering the transaction — if entered incorrectly before posting. On posting, confirmation of entry is displayed and the screen format cleared ready for the next transaction.

Each of the other transaction types, i.e., credit note, cash received and cash paid, use the same screen format. In the cash received element, the discount is prompted instead of VAT and entered as a numeric value to produce a total value of the posting.

The cash paid facility hardly seems



necessary or appropriate but its existence is described as a means of manually countering incorrect entries to the ledger or refunding amounts after settlement of an invoice. The entry is a single value and does not include a VAT or discount element.

Each transaction is written to the disc when posted and is not held in core where it could be lost easily in a system crash or power loss.

Within each transaction facility, the string search routine is available and is started by entering a customer name instead of an account number. Each match is displayed with the account number and the user is asked whether it is the one. If a no is entered, the search continues. A yes returns the prompt — Enter Name or Number?

We felt that an improvement could be made to the invoice entry routine whereby accounts exceeding their credit limit are

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flagged or drawn to the operator's attention. That is done in the customer section when displaying account details and could be carried across to the transaction stage easily.

If accessing an overdrawn account, the offending balance is flashed in reverse and a bleep sounded. The manual recommends that input documents are batched and that batch totals are produced manually beforehand. Although the data entry is interactive and batch totalling is not carried out, a check can be performed by producing a journal print of the invoices within menu facility 5 for the date period of the transactions keyed.

Totals will be produced on that listing and should agree with the pre-check batch totals — hence the importance of sorting the input invoices into date/number sequence. If data is spuriously entered, the checking facility will be of little use.

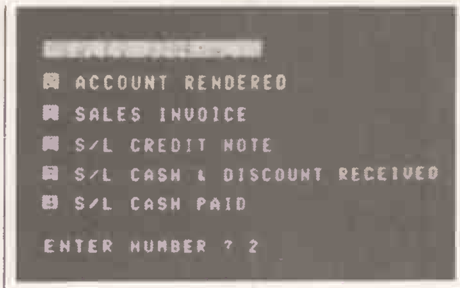
This ledger package is unusual in that it does not rely on a fixed period of accounting for the purposes of account clearance, statement production and so on. All of the reports offer the user the facility of entering the start and finish dates of the period being reported.

Because that could be dangerous due to overlapping reports, the user is advised to pre-set his accounting period dates and adhere to them — that provides plenty of flexibility. The running of the sales ledger could be geared better to the variations of seasonal peaks and troughs encountered in the course of business.

Archival discs

It also means that accounts can be held on archival discs and reports produced for quarterly or half-yearly analysis for current or past years. Aging of balances is also on a nominated basis at the reporting stage and is highly flexible.

The only disadvantage of an open-ended system such as this is that keyed transactions are not date-checked and controls must be provided manually to ensure that documents are posted correctly. It would have been an advantage to have an automatic date facility at the time of entry for those



wishing to post on a same-day basis.

The most basic print routine is the journal listing facility, 5. The user is given a sub-menu from which he can choose:

0. Accounts rendered.
1. Sales invoice.
2. S/L credit note.
3. S/L cash & discount received.
4. S/L cash paid.

Each journal is printed from a nominated start-date to a nominated finish-date and each transaction on file produced under the headings; date, account number, account name, description, reference, analysis, VAT or discount, amount and amount total. For accuracy and aging calculation the print will include those transactions grouped within the date range on the disc.

If an invoice is entered late in the middle of a later period, it will not be listed, i.e., the listing stops when a date greater than the upper limit is reached — hence the importance of entering invoices in the correct date order.

Account balances

The account-rendered listing is a simple summary of account balances rendered and does not produce the date. On each report, a total is produced for each column as well as a VAT analysis of goods and VAT and a total printed for each analysis code.

The statement print routine, option 6 of the menu, produces a standard-format statement print which may be for all accounts or for selected names or numbers. The headings are: date, description, reference, debit, credit, and balance.

The description is not that which is keyed by the user but one indicating the transaction type. The format is neat and arranged deliberately so that ordinary headed paper can be used for stationery.

The balances print facility 7 is a debtors' analysis report showing aged balances for a selected period. Balances are aged over four separate contiguous periods comprising current, plus one, plus two, and plus three.

On entering the routine, the user is prompted for a start date and then a plus one and plus two date. The plus three is assumed to be residual and brought forward sums.

A tabular report is then printed showing: account number, account name, credit limit, turnover to date, date of last transaction, balance, and totals for current, plus 1, plus 2, and plus 3. Each column is totalled at the end of the report. The basic accounting assumptions made by the authors are:

- Accounts rendered are always allocated to the oldest period.
- Invoices are allocated strictly according to their date to the period defined by the user.
- Credit notes, cash and discount received and cash paid are all allocated to the earliest available balance.
- Credit balances are always treated as current period balances.

The control account is a print routine that produces the totals for accounts rendered, invoices, cash received, discount, cash paid, credit notes, and balances with totals, under the appropriate debit and credit headings. It is a self-balancing report that must also tally with the previous balance print run.

The final facility, 10, is the carried-forward-accounts-rendered routine. Its purpose is to clear-down the transactions on file and create new discs with carried-forward balances. That would be run normally according to the pre-set accounting periods and subject to the volume of transactions being passed through the package during those periods.

The system will warn the user automatically when volumes on the customer or transactions files are nearing their limits and will require the user to run the 10th option.

In general, the standard of reporting is very good and we liked the flexibility of altering the dimensions of the print formats through the configuration file. It means that almost any printer can be used with the package and a wide variety of pre-printed or plain stationery can be utilised.

The paging facility is also well programmed — i.e., skipping to a new page and re-printing headings for lengthy statements, etc.

The package is supplied as a manual and a floppy disc and costs £295. The manual is clear and easy to read and goes into great detail about the way the package works and the assumptions used in processing. There is a long section at the front that is a do-it-yourself guide to double-entry bookkeeping and a variety of tips for more advanced users on how to obtain the best results from the system or stretch it to deal with larger accounting systems. It states that all equipment is liable to go on the blink at some time or other.

That statement typifies the common-sense approach of the authors to the subject of security and disc back-ups although more could have been said about how to implement a rotational system of discs.

Recovery from accidental re-set is covered in sufficient detail to prevent most users from completely wreaking havoc. A whole series of numbered add-on bulletins had been appended to the manual covering such subjects as: Use of the high-speed serial interface, DOS-reserved words and disc-error message numbers and descriptions, DOS 3.2 upgrades and dynamic allocation of devices, tips and hints for running under Applesoft (ROM) and Autostart, and disc errors and bugs.

While the manuals cover a good deal of grund and all possible contingencies, they are not well designed as reference documents. Finding particular items of information was not easy. Each user is supported directly by Computech both for news and upgrades and *ad hoc* queries.

Conclusions

- **We were impressed with the quality of the programming and security of the system.**
- **The screen formats are consistently applied making familiarisation easy and avoiding erroneous entries.**
- **Data entry fields are well validated and information is easy to change and alter.**
- **The analysis code system provides a user-definable reporting facility which should meet most prospects requirements.**
- **For the maximum benefit to be gained from the Computech sales ledger, prospective buyers should plan the way they intend to use the flexibility of the package rather than just installing and running.**
- **There is scope for planning transfer from manual systems to the package that should be taken advantage of.**

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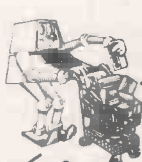

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Texas TI-99/4 home computer lives up to expectations

by Vincent Tseng

IN 1978, the microcomputer industry was roused into animation by the announcement that a giant in electronics was to produce a personal computer. The giant was Texas Instruments.

Most people involved in electronics will know that when they examine a TTL, Transistor to Transistor Logic, IC, it is more often than not a Texas Instruments component. The Texas Instruments TTL Data book is accepted generally as the bible among reference works on components.

The opinion at the time of the announcement was that Texas Instruments would market the computer with its usual aggressiveness and make a major impact on the personal computer market. Questions were even posed about the survival of other microcomputers. Texas Instruments played the game well, of course, being deliberately reticent about details of its products.

News and views

Then details began to filter through at Easter, 1979, and by mid-1979, a few people had even seen the product and the general opinion was that it was a damp squib, a disappointment — but with such high expectations what could one expect? The rivals in the industry breathed a sigh of relief.

Now that the TI-99/4 has been launched and will be available for purchase — it has been available in the U.S. for a few months already — it is worth asking whether the press and its rivals have been unfair to it.

The Texas Instruments TI-99/4 is supplied as a terminal keyboard with 41 keys in the QWERTY lay-out. To the right of the keys is a slot for plug-in solid-state software command modules — they resemble the plug-in cartridges on programmable TV games, i.e., encased ROMs on a circuit board.

It is supplied only with a 14in. colour TV monitor — the keyboard computer is not supplied on its own, and it is not compatible with U.K. domestic TVs. The colour monitor sold in the U.K. is a modified dual-standard, portable colour television, capable of receiving normal TV programmes. The display is 29 characters by 24 lines, displayable in 16 colours.

Graphics capability is available down to a single Pixel-point by user-defined characters, giving an effective resolution of 256 × 192, using only part of the screen — the edges of the screen are not used due to the fall-off in definition. The 64-character ASCII upper-case set is available, but with user-definition, up to 128 characters are accessible.

The computer is based on the Texas TMS 9900 16-bit microprocessor maximum addressing range 64Kbytes. It has 26K of ROM for its Basic, monitor and utilities; 16Kbytes of RAM, and the plug-in modules can add up to 30K of extra ROM, making a total memory capacity of up to 72K.

Command modules

The plug-in solid-state software command modules provide ready-to-run programs on various subjects — the concept is similar to the programmable TV games, although the TI-99/4 provides programs of a more serious nature. An important point to note is that Texas Instruments is marketing the TI-99/4 as a home/personal computer, and has, therefore, deliberately used some familiar and recognisable concepts, e.g., the TV, and plug-in cartridges.

The equipment is delivered in three large cardboard boxes. One for the colour TV, one for the computer with power supply and connecting cables, and one containing a number of plug-in modules. The documentation pack of manuals is in the same box as the comuter.

In the pack was a very useful booklet entitled "Read this first — quick steps to get you set-up and started". It is exactly what is needed, and other suppliers of equipment would do well to follow this example. Unfortunately, the first item in the booklet was a belated explanation on unpacking the equipment — to find the booklet, you must have done this already.

Perhaps Texas Instruments ought to consider attaching the booklet in a transparent polythene bag to the outside of the packing box. Another point is that the setting-up information looked as though it was for the U.S. version. Although that does not affect safety aspects, it is different in some details to the U.K. machine.

The components look obvious enough — one just attaches the power supply to the computer and connects the appropriate lead from the computer to the TV. The power supply is wedge-shaped, looking like a foot-pedal control of an electric sewing machine — not particularly attractive.

Switching-on the power from the mains, every thing worked as it said in the read-this-first booklet. That was fortunate, because the TV supplied has eight channel selectors and no mention was made of which channel had been pre-tuned for the computer.

Pre-set tuners

Mine happened to be selected on channel seven — the required channel — already, but it might easily have been on another channel or de-selected in transit. No instructions, in fact, are supplied with the TV, and it was quite a while before I discovered how it could be tuned for TV programmes using the pre-set tuners.

The first screen displayed, announced "Texas Instruments Home Computer" with two multi-coloured bands and a beep sounded from the built-in speaker in the top-left-hand corner of the computer, just above the slot for plug-in modules. That is a confidence booster to reassure the user that everything is working. Sound can also be transmitted via the TV speaker with another connector and cable attached.

By pressing any key on the keyboard, as instructed on the first screen displayed, a menu of two or more items was displayed. The number of items depends on whether or not a plug-in module has been inserted. The first two items were always constant, being for Texas Instruments Basic and for equation calculator.

Items three and upwards are from the plug-in modules. A beep normally accompanies all computer operations. There is a volume control for the built-in speaker, although again it is not mentioned in the manuals.

The keyboard consisted of keys which were similar to largish calculator keys. They were reasonable in both feel and size, but were not particularly good for fast typing. There is only one shift key, orange in colour, near the bottom-left-hand corner, and many of the common punctuation characters were on the shifted positions on the alphabetics — that is non-standard for both typewriters and terminals.

Having only a single shift key makes the typing of shifted characters awkward and what makes it worse is that the key in the position where the second shift key is usually found, is, in fact, the enter key — also in orange. Part lines may be inadvertently entered when one is trying to shift a character.

Some of the often-used punctuation characters, which are not usually shifted in either terminals or typewriters, have to be shifted on the TI-99/4. The one I found most irritating was the comma key which is used frequently in Basic and really slows entry from the keyboard. Also, if flicked, the keys can be made to pop-out and, therefore, cannot be very child-proof.

The screen was very clear and stable, free from interference. Although the characters displayed were not as high-resolution or sharp as some of the other VDU screens, they were, nevertheless, very clear, mainly because of the size. The colour and separation was also very good, with only a tinge of colour fringing found when displaying alpha-numerics in black. All in all, a commendable performance, considering that it is only a domestic TV. The TV reception of normal programmes was poor using the built-in aerial.

Summary specifications

CPU — Texas TMS-9900, 16-bit micro.
Memory — 26K ROMs with the monitor, Basic utilities, 16K RAM, with plug-in modules of up to an additional 30K.
Keyboard — 41-key QWERTY lay-out, some non-standard shift positions.
Display — 14in. modified, dual-standard, domestic TV.
Mass storage — audio cassette recorders, possible to cater for two recorders.
Sound — output by built-in speaker with volume control, also via the TV speaker.
Software — Texas Instruments Basic, equation, calculator and additional plug-in modules.

Texas Instruments Basic has most of the common commands found in other popular versions of Basic. Noticeable by their absence are the PEEK and POKE statements, and any other command which allows the user to access the machine memory directly.

User-defined functions are not the usual "USER" or "USR", where they are machine-code routines, but are routines written in Basic which can be called by a user-defined name — more like a "macro", but in Basic.

Graphics are catered for by a number of sub-program routines which allow the user-definition of characters (CHAR), the colour of that character (COLOR), repetition of a character horizontally or vertically (HCHAR or VCHAR) and the colour for the rest of the screen (SCREEN).

The COLOR command defines background and foreground colours for characters. Any character code from 32 to 159 decimal can be defined by the user. Note that the codes from 32 to 95 have default values to the standard 64-character ASCII set, but can be re-defined. The characters are in an 8 × 8 dot matrix and are defined by switching on the dots, in eight rows of eight bits, and each row is defined by two Hexadecimal characters.

Good features

Other good features are the trace and untrace facilities, and the break (point) and unbreak setting commands. The stop command does not cause a break in the program, but is more like an end statement.

The range and accuracy of this version of Basic is good, with accuracy to 13 or 14 digits internally, with 10 displayed or six with exponentials. The range is more or less $\pm 10^{-128}$ to $\pm 10^{+128}$, thus making it better than most scientific calculators.

The usual benchmarks, however, show that this is quite a slow Basic, being approximately three times slower on BMK 6 and 7 when compared to, say, the Nascom 2 and more than six times slower on BMK 8.

The equation calculator facility turns the TI-99/4 into a calculator, as well as enabling the writing of equations with a name — the unknown — on the left-hand side of the equals sign, and a number of variables of parameters on the right-hand side expression.

By entering values for the variables, the answer for the left-hand side will be given. The equation cannot be solved for an unknown on the right-hand side, as any unassigned value for parameters on the right is defaulted to the value of zero; any value assigned to the name on the left side is ignored in obtaining the result of the right-hand expression.

Program checks

The range and accuracy are the same as in Texas Instruments Basic. I did not find this feature of any outstanding value as the functions are also available under Texas Instruments Basic.

Provisions exist for recording on to audio cassette tape — a lead is supplied to allow two audio cassette recorders to be used. Both can be read-from, but only one can be recorded-to. Remote-control jacks for starting and stopping both recorders are also provided via the lead.

The save command allows a read-after-write check of the program — a useful feature. To read-back a file, the command was OLD instead of the usual READ or LOAD. File names could not be given

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under Save with cassettes under Basic — one has to keep a separate record of the programs stored.

Under test, I found that it worked reasonably well with my cheap cassette recorder, but there were occasional errors in data on reading back. As there were no instructions in the manuals for cassette adjustments and since one could not drop into machine code to do more extensive testing, I can only report on a very limited usage. With the documentation there was a list of recommended recorders but most of them appear to be for the U.S. market.

Eight plug-in, solid-state software command modules are supplied with the machine.

These were:

1 Demonstration
2 Video graphs
3 American football
4 Physical fitness
5 Household money management
6 Pre-school early learning fun
7 Beginning grammar
8 Number magic

Others are available from Texas Instruments among which "Diagnostics" and "Video Games — 1" are impressive.

Video graphs

Demonstration is exactly what it says it is — it was produced as a self-selling aid for shops and showrooms and gives a good demonstration of the range of capabilities of the TI-99/4. Video graphs was slightly disappointing: it consists of a few graphics games and demonstrations such as colour Life and the capability to have a keyboard-controlled sketchpad.

Although a screen can be recorded and loaded from cassette, there does not seem to be any link into Basic to allow preparation of graphics under this module for use in other programs.

Household money management is the most serious program in the group, allowing the construction of a budget which shows the money figures in tabular form or in form of bar graphs in colour for easy assimilation and for judging trends.

There are 34 pre-selected numbered categories and they are changeable. There are more numbered categories from which to choose, 99 in fact, but the names associated with each number of the categories are fixed by the module. The program obviously allows cross-referencing of categories and the display of data from selected categories.

Data saving

Saving of data can be to cassette, again no naming of files, but advice to mark the cassette clearly and backing-up is given in the instruction booklet. The three modules listed as 6, 7 and 8 are of an educational nature.

The Video games —1 module was very impressive for the graphics capability demonstrated. For example, shapes — user-defined — can be given different priorities so that they can appear to "walk' behind or in front of other objects, without disturbing other neighbouring shapes.

A screen can have several independently-moving shapes. The games were very addictive — control was through a set of plug-in, hand joy-sticks — particularly the pin-ball game, where the rumoured highest score is more than 100,000.

The diagnostic module was more of a confidence test. The cassette test did little more than save data and perform a read-after-write check.

Overlays are provided for the keyboard with some of the modules for easier recognition of keys which have been re-defined for new functions.

Various expansion accessories exist, including RS232 interfaces, floppy disc drives and modems. The most interesting, though, was a voice-synthesis module and attachment which can, in effect, talk with a vocabulary of about 370 words.

All these accessories are connected in a cascade fashion via an edge-connector output which is behind a shutter on the right side of the TI-99/4.

Texas Instruments has maintained its high standard of documentation for the manuals supplied with the TI-99/4 which were the "Users' reference guide", "Beginners' Basic" and "Read this first". They were all readable and good for reference; the first two also gave many illuminating examples.

The only criticism is that some of the intial setting-up details are different for the machine available in the U.K. The booklets supplied with the modules, on the other hand, are not quite as consistent, some are obviously more than adequate, e.g., for games, but others, like Household money management and Diagnostic modules, could do with more details and illustrating examples, and possibly even explanations of how certain functions work.

Conclusions

- **Although many would claim that Texas Instruments has not gone far enough with the TI-99/4, or that it is a disappointment after all the build-up, I found that it lives up to expectations.**
- **The price of around £990, which includes the 14in. colour TV monitor, is perhaps slightly high, though.**
- **The plug-in module concept is good.**
- **The range already available shows at least that Texas Instruments can supply the applications for which its computer is intended.**
- **One major criticism is that the modules do not inter-link with the Basic which can extend the programming power of the TI-99/4.**
- **The addressing capability of up to 72Kbytes, when the maximum addressing range of the CPU, the TMS9900, is only 64K, is achieved by memory paging.**
- **Hence possibly the non-linking of the modules to Basic, but that can be overcome, especially if only certain parts of the module's routines are required.**
- **The absence of PEEK, POKE and machine-code accessibility may deter some potential buyers.**
- **The robustness of the unit to stand up to home use may be open to question.**
- **Documentation should be checked by Texas Instruments to ensure that details which were correct for the original U.S. model still hold true.**
- **Instructions are needed for the setting up and adjustment of the TV set supplied.**

Greater speed and storage for Winchester-based Rair system

by David Watt

RAIR, the maker of the Intel 8085-based Black Box microcomputer system, started recently to supply a hard-disc system. Neatly styled, the same size and shape as the Black Box, 20in. by 16in. by 5¾in., the hard disc is supplied as one unit with self-contained power supply and disc controller.

The system uses the new Winchester storage technology and is based on International Memories Incorporated 7710 disc. That was one of the first of the new disc units available and is also used in the Corvus system for Apple microcomputers. The storage capacity is 11.5Mbytes unformatted which is reduced to 9.7Mbytes available to the user when formatted.

Increased capacity

Rair also supply single- and double-sided, double-density mini-diskette drives. The single-sided drives provide 153Kbytes on-line storage per drive, and the double-sided drives 268Kbytes. Therefore, a system with four double-sided drives has a maximum capacity of slightly more than 1Mbyte — a hard disc increases that by nine times.

There are two parallel ports at the rear of the disc drive; the top port connects via a 5ft. ribbon cable to the Black Box, and the lower port is for connecting daisy-chained up to seven other disc units. Only one disc controller is needed to drive all the discs, which may be up to 25ft. apart if screen cabling is used. That gives almost 80Mbytes of directly-accessible information.

Power is supplied via the Black Box, so the disc goes on when the power switch on the computer is pressed. It takes about 15 seconds for the disc to come up to the operational speed of 3,600rpm. The Black Box uses the Digital Research CP/M operating system with some enhancements provided by Rair.

File maintenance

The current version for use with the hard disc is version 2.0. It has been adapted to address up to 12 drives, four mini-diskette drives and eight hard discs. In addition, a forum of disc partitioning has been provided which allows up to 16 users to maintain files on the system. When in one user area, the operator may not access or update the files in another user's area.

Unfortunately, individual user areas may not be protected in any way, by entering password for example. To access the files in area two, the command "USER 2" is all that need be entered.

An additional command has been provided in version 2.0, the assignment command "ASS". It may be used to display the current user number, and disc assignments, and to change the disc assignments if required. Disc drives have physical numbers 0-11, 0-3 for diskettes and 4-11 for the hard discs. They may be assigned logical names A to L — drive A is always used for loading the operating system when the re-set button is pressed on the computer.

When the computer is switched on, or the load button pressed, the system waits 15 seconds automatically for the hard disc to reach its operational speed, before continuing with the start-up procedure. That may not be necessary in future versions, as the operating system will be able to detect whether or not the disc is up to speed.

Besides the vastly-increased storage capacity of Winchester discs over floppy-disc systems, the other advantage of a hard-disc system is the improvement in speed of accessing the data compared to diskettes. Tables 1 and 2 illustrate something of the improvement on the RAIR system. Table 1 shows the manufacturer's published figures for disc accessing on mini diskettes and hard discs.

	Double-sided, double-density mini-diskettes (Msec)	Hard disc (Msec)
Track-to-track access time, minutes	30	10
Latency	100	8.3

Table 1.

Latency is the average time taken for a particular disc sector to be located under the read/write heads once an access has been initiated, and is calculated simply as half the time taken for one revolution of the disc. Minimum track-to-track access time is time taken for the read/write heads to be positioned on an adjacent track. The maximum track-to-track access time on the hard disc is 100 Msec.

Table 2 shows the results of cover programs written in Microsoft Basic-80 to give the time taken to write 1,000 records sequentially, to write 1,000 records randomly, and to read 1,000 records randomly. The random tests were performed without re-seeding the random number generator, so in each case the records were accessed in the same order.

The record size used in all the programs was 128bytes. The results show that for random file processing, which is required in the majority of data processing applications, the hard disc is four and a half to five times faster than floppy discs.

The write tests took longer than the reads because the system reads a record after writing it to check for errors.

More efficient

It can also be seen that the time for 1,000 sequential writes was nearly identical for the hard disc and the diskette. According to Rair, that is due to inefficient input/output routines in CP/M, which were designed for floppy diskettes. In addition, the disc controller, made by IMI, transfers data over a byte-parallel interface rather than using direct memory access (DMA), which is much more efficient.

Rair is waiting for both a new controller to be developed and an improved version of CP/M, which together should offer a claimed 400-500 percent improvement in performance. The controller should provide DMA transfers, the option for not performing read-after-write checking — which is not as important for hard-disc systems as floppy discs because of the improved reliability — and firmware blocking and de-blocking. The controller will be capable of transferring records of sizes up to 16Kbytes.

The major problem with Winchester disc drives is how to back-up the data. Larger computers have exchangeable discs which may be copied and stored in a safe place, but this is too expensive for microcomputer systems.

Two methods

At present, there are two methods for copying Winchester discs on microcomputers, either to copy to floppy discs, which is slow and requires a good deal of floppy discs but reliable and straightforward for the manufacturer to provide as it has not had to develop any new technology, or to copy to magnetic tapes.

New methods are being developed for copying large volumes of data to magnetic tapes using a process known as streaming which involves reading or writing the whole tape in one continuous operation — the tape is wound through at a constant rate from start to finish.

Rair has adopted the first method, because it claims tape streaming is not sufficiently reliable at the moment. It is not possible to do read-after-write verification with streaming tapes and although there are methods for providing automatic error correction, they will not cope in cases where an area of tape is corrupt, as opposed to isolated errors.

Back-up program

The back-up program has been provided to copy files from the hard disc to floppy discs. To make back-up as efficient as possible, the program copies to a whole diskette, including the three tracks used normally for the CP/M kernel, so each diskette may store up to 280Kbytes. Also, the back-up program provides facilities for copying only selected areas of the hard disc.

1. All files in all user areas.
2. Files matching a particular specification in all user areas.
3. All files in the current user area.
4. Selected files in the current user area.

Also the 'EXTRACT' option is provided to copy only those files which were updated since the last full back-up or extract. If it is necessary to copy files back from the floppy discs, the re-store option is used, first to copy back files from the last full back-up, then to copy back files from successive extracts.

Copying discs

To copy a completely full disc would take about 33 double-sided, double-density diskettes, but, in practice, it should never be necessary to copy a full disc — at least on a single hard-disc system.

Test	mini diskettes seconds	hard disc seconds	improvement percentage
Sequential write	46	44	.05
Sequential read	40	26	53
Random write	1302	288	352
Random read	1200	227	428

Table 2. Time taken to access 1,000 records.

Directory listing

Each diskette takes about one minute and 15 seconds to copy, and copying 1.3Mbytes takes about 20 minutes including changing diskettes and obtaining a directory listing of files you wish to back-up.

The list price for a disc drive with a controller is £2,750; additional drives cost only £2,500. The disc drive is extremely reliable although the power supply and controller are less so. Rair reckons on one fault a year, and cover the drive on their standard terms of one percent of cost price per month for full cover of parts and labour.

Conclusions

- **The Rair hard disc system offers significant advantages over floppy discs in increased data storage capacity, speed of operation and improved reliability.**
- **The hard disc is reasonably priced and attractively styled, at £2,750 for disc and controller, and £2,500 for additional drives. The Black Box will stack neatly on top of the disc unit, so storage is no problem.**
- **The system was reviewed at the Rair offices, so any problems were quickly answered by Rair staff, but they had very little documentation available on CP/M Version 2.0 and the back-up program.**
- **Rair has provided a solution to the problem of taking back-up copies of files, but I do not think it is ideal. Unfortunately, until more reliable and faster methods of back-up are found, it is a problem with which people are going to have to live.**
- **The enhancements due to version 2.2 of CP/M and the new disc controller should make an appreciable difference to the performance of the disc.**

Adventure II — an epic game for non-disc systems

We present an Adventure-creating program for almost any system.

ADVENTURE is a very popular and addictive computer game, run on many large systems throughout the world. However, despite its popularity among those with access to large machines, it does not seem to have appeared on many microcomputers. The reasons for that are easy to see; Adventure is complex, large, requiring disc back-up and difficult to modify to produce new games.

More general

Consideration of those problems led to the design and implementation of the simpler and more general Adventure program described in this article, suitable for most systems without the need for disc-backing store.

Adventure is a computerised version of the game Dungeons and Dragons, both of which are enormously popular. In Dungeons and Dragons a player is assigned the role of dungeon master, devising the dungeons which the other players explore in an attempt to acquire the treasures hidden there, often after having fought their way past monsters of various kinds.

Each player announces his action to the dungeon master who then tells him of the outcome, usually after spinning various dice to generate a random element.

Adventure, run on PDP-11 systems everywhere, is similar to Dungeons and Dragons except that the dungeons are devised by the original programmer and the computer then assumes the role of dungeon master.

Interactive technique

The computer describes the situation to the user who replies with the action he has decided to take. The computer, in turn, informs him of the result. This player/computer interaction is best illustrated by a sample run of the program — the user response is in capital letters.

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

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

ENTER BUILDING

You are inside a building. A well house for a large spring.

There are some keys on the ground here. There is a shiny brass lamp nearby. There is food here. There is a bottle of water here.

GET KEYS

OK

GET LAMP

OK

RUB LAMP

Rubbing an electric lamp is not particularly rewarding. Anyway, nothing exciting happens.

EXIT

You're at the end of the road again.

GO SOUTH

You are in a valley in the forest beside a stream tumbling along a rocky bed.

GO SOUTH

You are in a 20-ft. depression floored with bare dirt. Set into the dirt is a strong steel grate mounted in concrete. The grate is locked

UNLOCK GRATE

The grate is unlocked.

Once having opened the grate, for which he must have the keys, the player then has access to Colossal Cave where there are problems to solve and treasures to gather. However, if he does not have the keys, there is no way that the grate can be opened. In fact, it may take him a while to find the entrance as it is all too easy to become lost in the forest.

by Ken Reed

As you can see from the example, playing Adventure is rather like reading a novel, with one important difference. Instead of following the story passively, the reader is involved actively, deciding what is the best action to take in a given situation, often having to think very carefully as the wrong decision may lead to death.

That afinity with a novel is Adventure's main disadvantage. Once all the problems have been solved, which may take several weeks, interest wanes and another Adventure is required.

The original version of Adventure, programmed by Will Crowther at Stanford Research Institute, is coded in Fortran, requires 64Kbytes of memory, disc back-up and is very difficult to modify to generate new games as many of its features are buried deep within the program code. That explains the current shortage of Adventures.

A better solution would be to have a general Adventure program driven by a separate database allowing new games to be generated without having to overcome the programming complexities every time. In fact, that approach was used by Scott Adams who has now produced a number of excellent adventures for some of the more popular systems such as the TRS-80 and Sorcerer.

The program described here carries this concept one step further. Instead of one person producing adventures for a limited range of systems the idea is to describe a program which can be implemented on almost any system and driven by an entirely separate and machine-independent database. That allows owners of the program to write adventures in a simple form and swap games with someone who may have an entirely different processor.

Two segments

As mentioned earlier, Adventure II is split into two parts. The first is the program and the second the driving database. Before describing the program, it is worthwhile to look at the general structure of the database which has four main sections:

1. The vocabulary of words recognised in the game.
2. The objects that may be manipulated.
3. The places that may be visited.
4. The actions performed by specific words.

All that is required to produce the database, and the program is an assembler and examples of various table entries are shown for a Z-80-type assembler.

The vocabulary is held as the first four letters of a word followed by an identifying code. That permits the program to reduce words to simple numbers which are much easier to manipulate. It also allows different words to have the same code and hence the same meaning.

Identifying code

For example, the words "DESCEND" and "DOWN", having roughly the same meaning, may be assigned the same identifying code. Hence the commands from the user "DOWN STEPS" and "DESCEND STEPS" may be handled by the same function. The table may be entered thus:

```
VOCAB: DEFM  'NORT' ; Word "NORTH"
       DEFB  1      ; Identifying code
                      "1"
       DEFM  'EAST'
       DEFB  2      ; EAST has code
                      "2"
```

DEFM is the instruction to define an ASCII string and DEFB is to define a byte. The table has the name "VOCAB" and terminated by a byte of 0FFH (255 or —1). The words for movement — north,south,etc. — must have codes in the range 1 to 12 as the program prints the message — I cannot go in that direction — if it cannot find anything to do with words in that range. Other unmatched words generate the simpler response: I can't.

Objects are anything which may be moved from one place to another and/or transformed from one thing to another. A lamp, for example, may be carried with the player and it may be transformed from a "LIT LAMP" to an "UNLIT LAMP" and, of course, back again.

Each object has an entry in each of two tables: the object location table which records the current position of the object and the object description table which contains the text used to describe the object.

The current location table is named "OBJLOC" and the descriptive text table "OBJTXT". OBJLO is terminated by a byte of 0FFH, OBJTXT needs no termination.

```
OBJLOC: DEFB  3,0       ; Object 0 at
                          location 3
        DEFB  5,0       ; Object 1 at
                          location 5
                        ; Similary for
                          other objects
OBJTXT: DEFW  M0        ; Address of text
                          for object 0
        DEFW  M1        ; Address of text
                          for object 1
M0:     DEFM  'A little ; Description of
              axe'        object 0
        DEFB  80H       ; String termin-
                          ator
M1:     DEFM  'A bunch
              of keys'
        DEFB  80H
```

Note that the object position information is two bytes to allow it to be at a location — first byte is 0-225 — or in some special place, such as carried by the player — second byte is used. Also, the object description table OBJTXT contains the address of the actual description for each object.

Simple indexing

That allows simple indexing by object number into the table to locate the real text. If it were not done that way, the table would be much harder to use as each entry would be of an unknown length. The byte 80H is used to terminate the string.

The locations are the places that the player may visit. They may be rooms, caves or anything desired by the Adventure writer. Each location has an entry in two tables: The description of the location and the list of directions the player may go from there. The location descriptions are held in a table named LOCTXT and the possible movements in MOVEMT. Both of those tables consist of pointers to the actual data as described for the object descriptions above.

```
MOVEMT: DEFW  D0   ; Pointer to loc-
                     ation 0 moves
        DEFW  D1   ; Pointer to loc-
                     ation 1 moves
                   ; etc. for rest of
                     locations
```

The following example movement shows an entry that says that word 0 takes

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us to location 1 and word 3 will take us to location 5. Note that a —1 terminates the list.

```
D0:      DEFB  0,1,3,5,-1
LOCTXT: DEFW  L0        ; Pointer to descriptions
         DEFW  L1        ;
L0:      DEFM  'I am in an empty room'
         DEFB  80H
L1:      DEFM  'I am by a stream'
         DEFB  80H
```

The action table is the section of the database interpreted or executed by the main program. It consists of words, conditions and actions performed. If there is an entry in the table for the words entered by the user and the conditions specified are met, the actions are performed.

Action table

For example, if the command "GET LAMP" has a corresponding entry in the action table and the condition that the lamp must be in sight are met, the database will instruct the program to mark the location of the lamp as carried. There is a similar table scanned before the player's turn to see if the computer wants anything to happen.

For example, he may be in the same room as a Vampire without a crucifix so the computer may make the Vampire attack. The user action table is named EVENT and the computer's table STATUS. Both have the same format:

```
EVENT: DEFB  0,1         ; Words 0 and 1
       DEFW  C0          ; Pointer to conditions
       DEFW  A0          ; Pointer to actions

       DEFB  3,-1        ; Only word 3 required
       DEFW  C1          ; Pointers
       DEFW  A1          ;

C0:    DEFB  0,1,1,2,-1  ; Must be at location 1 (0,1)
                         ; Ojbect 2 must be here (1,2)

A0:    DEFB  5,3,-1      ; Print message 3
```

The lists of actions and conditions are terminated by a byte of 0FFH (-1). Note that the examples are only very small extracts from a real table. A full-size database may have up to 255 locations and any number of entries in the event and object tables.

Pseudo-code

The requirement that the program be as small as possible means that it must be entered as an assembler program. However, as we want the program described to be suitable for any system, it leads to a slight problem over how we represent it.

Assembly listings for every processor would occupy far more space than the magazine can provide and flowcharts would not really describe the action of the program at the level of detail we want. For those reasons, the program is represented in pseudo-code.

For those not familiar with the term, pseudo-code is a non-existent language or shorthand representation of a program often used by programmers for detailed design when the actual target language is not yet known. Pseudo-code provides far more detail than flowcharts and is, in fact, detailed instructions for the actual coding of the program.

Although the listing should be more or less self-explanatory, it is worth mentioning two conventions used. If a variable is preceded by a "@", it means that the variable is used as a pointer to the data. For example, if "HL" contains the value 100 and we say "A=@HL", "A" is loaded with the contents of memory location 100.

A similar convention is used to identify the address of a variable except the "#" character is used — also used by the IF statement for not equal to. For example, if we say "HL=#OBJLOC", it means that the variable HL is loaded with the address of OBJLOC and not the contents.

Variables used are defined as either BYTE, 8-bit, or WORD, 16-bit, and the contents are assumed to be set to zero unless a value is included between two 'P's. For example, to define two 8-bit variables in memory, one set to zero and the other to 3 we use:

```
BYTE VARA,VARB/3/
```

A memory block is reserved by:

```
BYTE VARC/<7>/
```

which means reserve seven bytes of memory starting at label "VARC".

Program arrays

That leads to the implementation of arrays used by the program. All references to arrays mean an offset to the base label of a memory area. For example, VARC(3) simply means the address found by adding three to the value of label VARC.

Thus VARC(0) is exactly equivalent to VARC. Remember that words occupy two bytes, so, if VARC was a word array, VARC(3) would actually be addressing VARC+6 and also VARC+7 for the top byte.

Knowing this, you should now be able to produce a version of the program for your particular system by working through the listing and generating the appropriate assembly code for your machine. If you have access to a medium-level language, such as PL/M for example, that is, of course, equally acceptable.

The pseudo-code program shown here has in fact been compiled by a specially-written compiler to ensure that it is sound.

Let us work through the program considering what makes it tick and explaining the meaning of the pseudo-code representation.

Referring to the listing, we can see that the first section is simply the definition of items not within this listing, that is the items marked "GLOBAL". Four subroutines not described here are called, but as these are relatively simple entities they should present no problem in coding.

The first subroutine required is called "$REPLY" and it is simply a routine to read a respose from the user and return a value of one if it was a "Y", and a value of zero if it was a "N". The routine should check that either a "Y" or a "N" was entered and prompt "PLEASE ANSWER YES OR NO" for any other reply.

The second routine is named $MESS and is the routine used to print messages on the console. It must take the ADDRESS of a message as a parameter and print all the bytes found there until a byte with the most significant bit set is encountered. The routine used also had the additional feature that it printed a return/line feed if it was called with an address of zero.

The next routine, $LINE, is the opposite of $MESS; it obtains a line from the user and passes back the address of the stored text.

Random numbers

Finally, $RAND is a routine which returns a random number in the range 0 to 100. Many people shudder at the thought of writing random-number generators but as we want only one number at a time and not a series, that is not as difficult as you may think.

It can be done by reading the refresh register if you have a Z-80 system, or if your keyboard is software-controlled, you may increment a counter in the keyboard — wait loop and use that value as the random number. If you want a more elegant solution, the random numbers used in the prototype program were generated using the algorithm:

[Generated number] = 11x[Last generated number] + 999 MOD 101 although this does require 16-bit multiply and divide.

The next group of globals refer to the addresses of the various tables in the database.

Variable definition

The last part of the section is the definition of the variables used by the program. Although some of them are defined as words, the only items which must be 16-bit are "Here" as it is compared to a 16-bit object location and the three "pointers" BC,DE and HL as they hold addresses used to point to the actual data required.

A further point is that some items are used for temporary storage only and may be replaced by the processor registers if you desire. The only variables that must be in memory are Here, the current location and User, the variables the database may access. If you run out of registers, remember they may be saved on the stack while a register is used for something else.

Proceeding to the code, we can see that the program begins at label "Start" which simply sets the first location to zero. The code beginning at "Desc" describes the current location by printing the description found adding the contents of 'HERE' to the base address LOCTXT and using the pointer there.

The current location will, of course, change as the game progresses. A small piece of code checks to see if the database has set user flag zero and if so, we are in dark locations and object zero must be present (a lamp) to obtain the location description. Otherwise the message "Everything is dark. I cannot see" is displayed.

Time limits

Two of the user flags are also decremented automatically if the database has set them non-zero. That allows time limits to be implemented for things like being in dark locations. A further flag is decremented a little later once per player's turn.

The code then goes on to scan through the object location table "Objloc" and if any objects position is the same as the current position "Here", the object description is printed.

Next, the program looks quickly as the status table which is effectively the computer's turn at the game. However, as the same mechanism which decodes the player's command is used, we will consider it later. That function, when completed, returns to the label "PROC".

The routine that obtains a line from the user is called ($LINE) and the address of the entered text obtained. The routine used returned the address on the top of the stack and the instruction "HL = @ SP" finds that address.

Line reduction

We then pick the first four letters of the first word and look it up in the vocabulary table. If the word is found, we do the same to the second word. If a particular word does not have an entry in the vocabulary table, we discard it and try the next.

That reduction of the line allows complex sentences like "TURN ON THE LAMP" to be reduced to simpler entities like "ON LAMP", provided the words TURN and THE are not in the vocabulary. Hence it is important to consider carefully which words are not in the vocabulary as well as which ones are.

If none of the entered words is found in the vocabulary, the message "I don't understand" is printed and we go and obtain another line from the player.

After we have converted the user's command into one or two single-byte codes, we take the first code and see if it is one of the words which cause movement at the location. If it is, the current position (HERE) is updated and we return to label "MOVED" to describe the new place. If it is not, we proceed to examine the main event table to see if there is an entry there.

If the first word code "W1" matches the first byte of an entry and "W2" matches the second byte, we proceed to extract the conditions and test them. If all the conditions are satisfied, we extract the list of actions and execute them.

If all the conditions do not match or the two-word codes do not match, we try the next entry in the table. That is repeated until an explicit command to leave the table is given or the table is exhausted.

The action or condition is decoded by using it as an index into a list of addresses for the function we want and simply moving the address to the program counter (PC). It can usually be done on most machines by pushing the address on to the stack and executing a return from subroutine instruction.

The comments in the program listing explain the operation in greater detail and indicate what actions and conditions are available.

Looking at some examples of a database should further clarify the operation of the program. To make the database more readable, the example extracts shown below were produced using a macro assembler and calling various macros to make the entries in the appropriate table.

Vocabulary details

The following is a small section of the vocabulary from the author's test database. Note how abbreviations are also entered for words and given the same code. Hence "E" is equivalent to "EAST".

```
VOCAB::
TABLE<SOUT>  ,1
TABLE<S>     ,1

TABLE<EAST>  ,2
TABLE<E>     ,2

TABLE<WEST>  ,3
TABLE<W>     ,3

TABLE<NE>    ,4
TABLE<NW>    ,5
TABLE<SE>    ,6
TABLE<SW>    ,7

TABLE<UP>    ,8
TABLE<U>     ,8

TABLE<DOWN>  ,9
TABLE<D>     ,9

TABLE<NORT>  ,12
TABLE<N>     ,12

TABLE<END>   ,13
TABLE<STOP>  ,13
TABLE<QUIT>  ,13
TABLE<ABOR>  .13
```

In the objects shown here, note how items which can change state are two objects although only one of the pair may exist at any given time.

```
OBJECT 0, <0,8>, <A lit lamp>
OBJECT 1, <S7,0>, <An old oil lamp>

OBJECT 2, <S5,0>, <A small cloth bag>

OBJECT 3, <S5A,0>,<A bottle of holy water>
OBJECT 4, <0,8>, <An empty bottle>
OBJECT 5, <0,8>, <A match>
OBJECT 6, <0,8>, <A spent match>
```

The first byte of the location information is used to mark the location of the object. If the second byte is non-zero, the object is at one of the special places. These are:

2 — Object is carried [512]
4 — Object is worn [1024]
8 — Object does not exist (yet) [2048]

The value in "[]" indicates the number obtained when the two bytes are considered as a single 16-bit word.

Movement words

The first two locations of the example illustrate how movement can be accomplished by any words and not just directions. For example, the word "HELP" moves the player to location S1 which simply contains instructions for him. The word "BEGIN" is used to start the game.

```
LOC S0, <HELP,S1, BEGI,S2>
TXT <Welcome to Adventure!>
TXT <If you know what to do type BEGIN
     otherwise type HELP>


LOC S1, <BEGI,S2>
TXT <I have managed to get myself lost in the
     forest on my>
TXT <quest for the seven golden keys of
     Waydor and I don't know>
TXT <what to do next. So it is up to you to
     help me.>
TXT <>
TXT <Give me your instructions and I will
     obey. For example, >
TXT <if you want me to go to the north, type
     "GO NORTH", if>
TXT <we should come across some keys and
     you want me to get>
TXT <them, type "GET THE KEYS".>
TXT <Some other words that you may find
     useful are:>
TXT <INVENTORY to find out what I'm
     carrying>
TXT <QUIT to give up.>
TXT <>
TXT <Type "BEGIN" when you are ready to
     to start.>


LOC S2, <S,S4, PATH,S4>
TXT <I am in a clearing in a very dense
     forest.>
TXT < There is a path leading off to the
     south.>
LOC S5, <N,S2,E,S5,W,S6>
TXT <I am at a "T" junction with exits to the
     north, west and east>

LOC S5, <W,S4,EXIT,S4,E,S5A,ALTA,
     S5A>
TXT <I am amongst the ruins of a church.
     At the far end there>
TXT <are the remains of an altar. The exit is
     to the west.>

LOC S5A, <EXIT,S5,W,S5>
TXT <I'm beside the altar.>


LOC S6, <E,S4, IN,S7, CRYP,S7>
TXT <I'm outside the entrance of a crypt.>

LOC S7, <EXIT,S6, DOOR,S6>
TXT <I'm in a vaulted chamber. Thick
     cobwebs hide the ceiling.
TXT <There is an empty coffin in the corner
     and a passage leading>
TXT <off into darkness to the north.>

LOC S8, <D,S9, STEP,S9>
```

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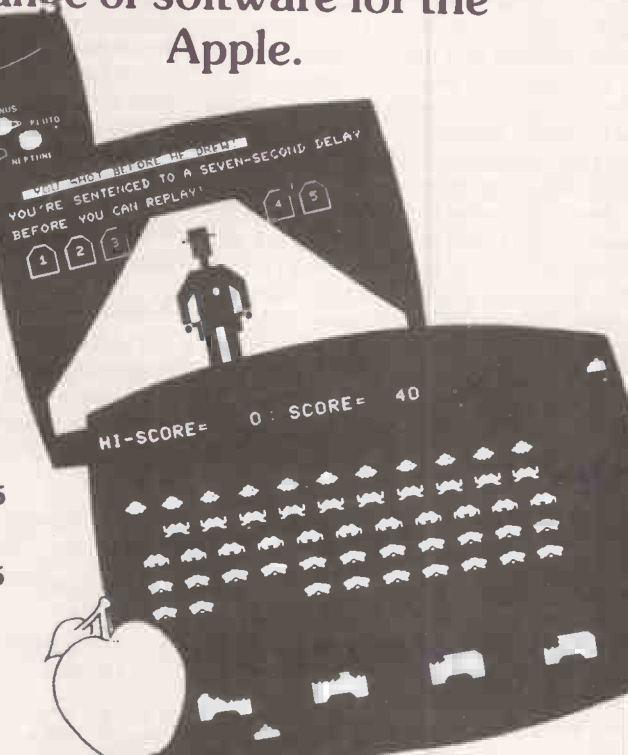

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```
TXT <I'm at the top of a steep flight of steps.
    I can see a>
TXT <dim light to the south.>
```

The event table is the real heart of the database as it contains the actions performed by each command from the user. This section also contains the various messages which may appear under database control.

```
EVT 2  <N   ,-1 >      <0,S7,-1>   <9,0,8,
                                    S8,6>
EVT 3  <S   ,-1  >     <0,S8,-1>   <10,0,
                                    8,S7,6>

EVT 4  <GET ,LAMP>     <1,0,-1>    <2,0,
                                    13>
EVT 5  <GET ,LAMP>     <1,1,-1>    <2,1,
                                    13>
EVT 6  <DROP,LAMP>     <1,0,-1>    <3,0,
                                    13>
EVT 7  <DROP,LAMP>     <1,1,-1>    <3,1,
                                    13>
EVT 8  <LIGH,LAMP>     <1,1, 1,5,  <11,0,
                        -1>         11,5,
                                    5,11,18,
                                    ,-1>
EVT 9  <OFF ,LAMP>     <1,0,-1>    <11,0,
                                    13>
EVT 10 <LIGH,LAMP>     <1,1,-1>    <5,14,
                                    -1>

Status:
EVT A  <-1,-1>         <7,5,5,0,2,10,-1>
                       <5,7,15,2,8, 9,5, -1>
EVT B  <-1,-1>         <6,2,1,     <5,8,
                        -1>         12>
EVT C  <-1,-1>         <5,2,-1>    <5,5,
                                    -1>

EVT Z  <-1,-1>          -1          7

MSG 5,<I feel sick and dizzy!>

MSG 7,<Some one has lept out of the shadows
  and BITTEN MY NECK!!!!>
TXT <He vanished as suddenly as he
  appeared!>

MSG 8,<Everything is getting dark! I Think
  I'm dy ...>

MSG 11,<I have lit the lamp with the match
  which has now burned out>

MSG 14,<I don't have anything to light it
  with.>
```

It is worthwhile examining some of the entries in the table in detail to show just what can be accomplished in the database. For example, in the location S7 shown, there is a passage leading north, but there is no entry in the movement list for it.

That is because rooms past there are dark and we want to tell the program. So let us look at entry 2. The word codes which must match are "N" (north) and anything will do for the second. There is a single condition, namely that he must be at location S7. If that is so, actions are performed which are : 9,0 — Set flag zero; 8,S8 — Go to location S8; 6 — Describe the location and obtain another command from the player.

Updated positions

The lamp, being two objects, the lit lamp and the unlit lamp, has two entries for the GET and DROP commands. Each entry determines which of the objects is here and updates the position of the appropriate one. To light the lamp, the conditions are that the unlit lamp and the unused match must be present. If that is so, the unlit lamp is destroyed, the lit lamp created and the match is transformed to the spent match.

An informative message is also printed. The final command (18) aborts the scanning of the table as a little later in the table, there is an entry for LIGHT LAMP when no match is present — which gives message 14 — and we do not want to fall through to it if we have already lit the lamp.

The table is terminated by a word code of zero. Note that in the example the words GET, DROP etc., are shown but in a real table the word code is used.

The entries in the STATUS table show an example of how a "wandering monster" may be implemented. The conditions are: Flag 5 must be zero; he must be in "dark" locations and 10 percent probability will generate the actions. The actions are: print message 7; store 8 in flag 2 — counted-down by the program — and set flag 5 to prevent more vampires.

Message printed

EVT B checks if flag 2 has reached 1 and if so, says we are dead and EVT C prints message 5 if flag 2 is non-zero. Hence we have a 10 percent probability of being bitten by a vampire. We then receive the message 'I feel sick and dizzy' for seven turns before we die. In the authors' database, drinking some holy water clears flag 2 and hence prevents EVT B from executing so we survive the bite.

Now that we have described the operation completely perhaps some ideas on implementing it and swapping databases may be useful. In terms of hardware, all that is required is about 16K bytes of memory for a decent adventure.

The program should fit in less than 4K but you will find that the descriptive text, particularly for locations, will eat memory.

In terms of software, all you need are an editor and an assembler. However, if you have access to a disc-based system, all the better. Perhaps the best way to go about it is through your local computer club working on the program as a team and generating your own adventures.

As the database is pure data, any database will run on any machine — providing there is enough memory. However, the program still needs to know the position of the tables in memory.

Assembled listing

The simplest way to do this is to assemble the program to suit the database. Say we have Fred Smith's database which occupies memory from 0 to 2000 Hex and he has provided details of the start of each table. We assemble the program so that it starts above the database and we also define the table addresses by adding a small header to the program of the form:

```
       ORG 2000H ;Start of program
LOCTXT EQU 200H  ;Define table address
VOCAB  EQU 1000H ;ETC for rest of tables
OBJLOC EQU 50H
```

Another approach would be to make the tables of a fixed length and define specific addresses for them. That removes the need to re-assemble the program for each database but does not use memory very efficiently.

Unfortunately, Adventure is not the kind of game you can describe in such a way that the program can be blindly copied and played. However, I hope that the description given here will allow anyone to implement it on his system. If you're wondering if it is worth the effort, ask anyone who has played before.

```
!        ***********************************************************
!        *                                                         *
!        *                      ADVENTURE                          *
!        *                                                         *
!        * Programmed by - K Reed                                  *
!        * Date          - 12-May-80                               *
!        *                                                         *
!        ***********************************************************

         BEGIN DATA
!        External subroutines
!
!        $REPLY  - Gets a YES/NO response from the user
!        $MESS   - Ouput to console
!        $LINE   - Read a line from the console
!        $RAND   - Get a random number (Range 1-100)

         GLOBAL $REPLY,$MESS,$LINE,$RAND

!        Driving database labels
!        Message - User messages
!        Vocab   - Basic vocabulary
!        Loctxt  - Location descriptions
!        Objloc  - Object locations
!        Objtxt  - Object descriptions
!        Event   - Main event table
!        Movemt  - Location movements
!        Status  - Status check table

         GLOBAL Message,Vocab,Loctxt,Objloc,Objtxt
         GLOBAL Event,Movemt,Status

         WORD Here,HL,BC,DE,Rnum,I,J,User/<15>/

         BYTE Flag,W1,W2,Btemp,Ctemp,Doneit
         BYTE Word1/<4>/,Space/' '/,Cret/0/,Bneg1/-1/,Bzero/0/

         END DATA

         PROGRAM Adventure
start:   here=0                             ! Start at location 0

moved:   CALL $mess(0)                      ! New line

!        User flag 0 when set indicates a dark location
!        He cant see unless object 0 is here
```

(continued on next page)

(continued from previous page)

```
!        Note that Objloc(0) is equivalent to simply Objloc
Desc:    BEGIN IF (User#0)
             IF (User(3)#0)User(3)=User(3)-1
             IF (Objloc=Here)GO TO Seen    ! Object here
             IF (Objloc=512)GO TO Seen     ! Carried
             TYPE 'Everything is dark. I cannot see'
             IF (User(4)#0)User(4)=User(4)-1
             GO TO Command
         ENDIF

Seen:    CALL $Mess(Loctxt(Here))          ! Describe Here

look:    Flag=0                            ! List objects here
         I=0
look1:   IF (objloc(I)=-1)GO TO command    ! End of objects
         IF (objloc(I)#here)GO TO next
         BEGIN IF (Flag=0)                 ! Object here
           CALL $mess(0)                   ! New line
           TYPE 'I can also see'
           Flag=1                          ! That message only once
         ENDIF
         CALL $mess(objtxt(I))             ! Describe object
         CALL $mess(0)
next:    I=I+1                             ! Next entry
         GO TO look1


Command:
         HL=#Status                        ! See if anything happens
         GO TO Active
Proc:                                      ! Returns here
         IF (User(2)#0)User(2)=User(2)-1   ! Count down active
         CALL $RAND(#Rnum)                 ! Keep random spinning
         CALL $Mess(0)
         CALL $Line                        ! Get a line
         HL=@SP                            ! Point to it
GETWD:   CALL Lookup(#W1)                  ! See if we know it

         BEGIN IF (W1=Bneg1)               ! Not found in table
            BEGIN IF (@HL=Cret)            ! No more words
Err1:          TYPE 'I Just dont understand what you mean'
               BEGIN IF (Word1>90)
                  TYPE 'Perhaps if you used UPPER CASE ....'
               ENDIF
               GO TO Command               ! Try again
            ENDIF
Scan:       BEGIN IF (@HL=Space)           ! Next word
               HL=HL+1
               GO TO Getwd
            ENDIF
            IF (@HL=Cret)GO TO Err1        ! No more words
            HL=HL+1
            GO TO Scan
         ENDIF

!        If we fall out here we have a known word in W1. Now see
!        if we can find one for word number 2

         W2=Bneg1                          ! No word yet
Scan2:   IF (@HL=Space)GO TO Second        ! Found one
         IF (@HL=Cret)GO TO Allin          ! NO more
         HL=HL+1
         GO TO Scan2

Second:  HL=HL+1                           ! Point to word
         CALL Lookup(#W2)                  ! See if an object
         BEGIN IF (W2=Bneg1)               ! Not found
Scan3:      IF (@HL=Cret)GO TO Allin
            IF (@HL=Space)GO TO Second     ! Another word found
            HL=HL+1                        ! Keep looking
            GO TO Scan3
         ENDIF

!        See if this word causes a change of location

Allin:   HL=Movemt(Here)                   ! Point to movements
Moveit:  IF (@HL=Bneg1)GO TO Nomove        ! End of list
         BEGIN IF (@HL=W1)                 ! Entry found
            HL=HL+1                        ! Point to dest
            Btemp=@HL                      ! Go there
            Here=Btemp                     ! Keep to bytes
            GO TO Moved
         ENDIF
         HL=HL+2                           ! Next entry
         GO TO Moveit

Nomove:


!        Look up the words in the main event table to see
!        what (if anything) happens.

         HL=#Event                         ! Point to table
         Doneit=0                          ! Clear flag
Active:  BEGIN IF (@HL=Bzero)              ! End of table
            IF (Doneit#0)GO TO Command     ! We did something
            BEGIN IF (W1'13)               ! Explicit movement
               TYPE 'I cannot go in that direction'
            ELSE
               TYPE 'I cant'
            ENDIF
            GO TO Command                  ! Get another command
         ENDIF

         IF (@HL=Bneg1)GO TO Entry         ! Any match
         IF (@HL=W1)GO TO Entry            ! Exact match
         HL=HL+6                           ! Next entry
         GO TO Active

Entry:   HL=HL+1                           ! Point to 2nd word
         IF (@HL=Bneg1)GO TO Match         ! Any match
         IF (@HL=W2)GO TO Match            ! Exact match
         HL=HL+5                           ! Next entry
         GO TO Active

Match:   HL=HL+1                           ! Condition pointer
         BC=@HL                            ! Get it
         HL=HL+2                           ! Point to actions

Check:   IF (@BC=Bneg1)GO TO Doit          ! End of conditions
         Btemp=@BC                         ! Get this condition
         BC=BC+1                           ! Next operand
         Ctemp=@BC                         ! Preload
         PC=TABLE1(Btemp)                  ! Computed GO TO

         BEGIN DATA
         WORD TABLE1/C0,C1,C2,C3,C4,C5,C6,C7,C8/
         END DATA


C0:      IF (Ctemp=Here)GO TO passed       ! Check current location
Cont:    HL=HL+2                           ! Next word pair
         GO TO Active                      ! Try next table entry

C1:      IF (Objloc(Ctemp)=Here)GO TO passed ! Object present
         IF (511<Objloc(Ctemp)<1025)GO TO passed
         GO TO Cont

C2:      CALL $Rand(#Rnum)                 ! Probable event
         IF (Ctemp>Rnum)GO TO passed
         GO TO Cont

C3:      IF (Objloc(Ctemp)=Here)GO TO Cont ! Object not here
         IF (511<Objloc(Ctemp)<1025)GO TO Cont
         GO TO Passed

C4:      IF (Objloc(Ctemp)#1024)GO TO passed ! Object not worn
         GO TO Cont

C5:      IF (User(Ctemp)=0)GO TO Cont      ! Flag not zero
Passed:  BC=BC+1                           ! Next condition
         GO TO Check

C6:      BC=BC+1                           ! Check flag value
         Btemp=@BC                         !
         IF (User(Ctemp)#Btemp)GO TO Cont
         GO TO Passed

C7:      IF (User(Ctemp)#0)GO TO Cont      ! Flag zero
         GO TO Passed

C8:      IF (Objloc(Ctemp)#512)GO TO Cont ! Object carried
         GO TO Passed

!        Condition met so perform the actions

Doit:    BC=@HL                            ! Point to actions
         HL=HL+2                           ! Point to next entry
         Doneit=1                          ! Say we have done something
Nxtact:  IF (@BC=Bneg1)GO TO Active        ! All done
         Btemp=@BC                         ! Get action
         BC=BC+1                           ! Point to next
         Ctemp=@BC                         ! Preload value
         PC=TABLE2(Btemp)                  ! Computed GO TO

!        In the following TABLE3 is simply a continuation of TABLE2
!        and not a sperate entity. It is done this way to keep the
!        compiler happy as it can't handle continuation lines

         BEGIN DATA
         WORD TABLE2/A0,A1,A2,A3,A4,A5,A6,A7,A8,A9,A10/
         WORD TABLE3/A11,A12,A13,A14,A15,A16,A17,Done/
         END DATA


A0:      TYPE 'I Have with me'             ! Inventory
         Flag=0
         I=0
inven:   IF (Objloc(I)=-1)GO TO inven0     ! End of list
         BEGIN IF (511<Objloc(I)<1025)     ! Carried
            Flag=1
            CALL $mess(objtxt(I))
            BEGIN IF (Objloc(i)=1024)      ! Worn
               TYPE ' which I am wearing'
             ELSE
               CALL $mess(0)               ! New line
            ENDIF
         ENDIF
nextob:  I=I+1
         GO TO inven                       ! Next entry
inven0:  IF (Flag=0)TYPE 'Nothing at all'
         GO TO Done

A1:      BEGIN IF (Objloc(Ctemp)#1024)     ! Remove worn object
            TYPE 'I am not wearing it'
            GO TO Done
         ENDIF
         BEGIN IF (User(1)=4)              ! Hands full
            TYPE 'I cant. My hands are full'
            GO TO Done
         ENDIF
         Objloc(Ctemp)=512                 ! Say carried
         User(1)=User(1)+1                 ! Update tote
         GO TO Nxtop


A2:      BEGIN IF (User(1)=4)              ! Pick up object
            TYPE 'I cannot carry any more'
            GO TO Done
         ENDIF
         BEGIN IF (Objloc(Ctemp)=Here)
            Objloc(Ctemp)=512              ! Say carried
            User(1)=User(1)+1              ! Update total
            GO TO Nxtop
           ENDIF
         TYPE 'Im already carrying it'
         GO TO Done
```

```
A3:     BEGIN IF (Objloc(Ctemp)=Here)     ! Drop object
           TYPE 'I dont have it'
           GO TO Done
        ENDIF
        IF (Objloc(Ctemp)=512)User(1)=User(1)-1
        Objloc(Ctemp)=Here
        GO TO Nxtop


A4:     BEGIN IF (Objloc(Ctemp)=512)      ! Wear it
           Objloc(Ctemp)=1024             ! Say carried
           User(1)=User(1)-1
           GO TO Nxtop
        ENDIF
        BEGIN IF (Objloc(Ctemp)=1024)
         - TYPE 'I am already wearing it'
        ELSE
           TYPE 'I dont have it'
        ENDIF
        GO TO Done


A5:     CALL $Mess(Message(Ctemp))        ! Type message
        GO TO Nxtop                       ! Get next action

A6:     GO TO Desc                        ! Describe location
A7:     GO TO Proc                        ! Procede

A8:     Here=Ctemp                        ! Immeadiate move
        GO TO Nxtop

A9:     User(Ctemp)=255                   ! Set flag
        GO TO Nxtop

A10:    User(Ctemp)=0                     ! Clear flag.
Nxtop:  BC=BC+1
        GO TO Nxtact

A11:    DE=Objloc(Ctemp)                  ! Swap objects
        Objloc(Ctemp)=Objloc(Ctemp+1)     ! Move 1st object
        Objloc(Ctemp+1)=DE                ! Move 2nd object
        GO TO Nxtop

A12:    STOP                              ! Stop the program


A13:    TYPE 'Okay'                       ! Say okay
        GO TO Done                        ! And procede

A14:    TYPE 'Are you sure you want to quit now'
        CALL $reply(#i)
        IF (i=0)GO TO Nxtact
        STOP 'Okay ... bye'

A15:    BC=BC+1                           ! Store value in flag
        Btemp=@BC                         ! Get it
        User(Ctemp)=Btemp
        GO TO Nxtop

A16:    Objloc(Ctemp)=Here                ! Create object
        GO TO Nxtop

A17:    Objloc(Ctemp)=2048                ! Destroy object
        GO TO Nxtop

Done:   GO TO Command


!       Lookup - Find word in table
!       Each entry consists of a four byte name
!       followed by an byte identification code. Eg 'FRED',2
!       This code is returned if found, otherwise -1.

        SUBROUTINE lookup(DE)

        LOOP J=0 TO 3                     ! Clear out word
           Word1(J)=Space
        ENDLOOP J

        LOOP J=0 TO 3                     ! Extract 1st 4 letters
           IF (@HL=Space)GO TO Gotwrd     ! End of word
           IF (@HL=Cret)GO TO Gotwrd      ! End of line
           Word1(J)=@HL                   ! Get character
           HL=HL+1
        ENDLOOP J


Gotwrd: BC=#Vocab                         ! Point to table
        @DE=Bneg1                         ! Assume no match

Find:   Flag=0                            ! Init Flag
        LOOP I=0 TO 3                     ! 4 bytes
        IF (@BC=Bneg1)RETURN              ! End of table
        IF (Word1(I)#@BC)Flag=1           ! No match
        BC=BC+1
        ENDLOOP I

        BEGIN IF (Flag=0)                 ! Matched
           Btemp=@BC                      ! Get ID
           @DE=Btemp                      ! Pass it to caller
           RETURN
        ENDIF

        BC=BC+1                           ! Skip over ID
        GO TO Find                        ! And try again

        END
```

Hornets' nest

by

G K Blackwell

For around the thousandth time since leaving the house, the young man felt for the shiny new ultra-intelligent-machine (UIM) pendant round his neck. Third generation — same technology, they had told him, as the unit now directing operation MOP.

The pendant was a going-away present from his parents, and now Mark was heading downtown for a goodbye drink with some friends. He was early, but he didn't mind, he could use the time to think things over. Events had moved so fast in the last few months; it seemed like he'd just left college and tomorrow he was off to join the project team. Just at the right time, too. The Mars Oxygenation Programme, the big project of the decade, had been something of a sick joke until recently, but the latest news was that things were really moving now, thanks to the new director.

This thought sent his hand straying towards the pendant again, as he pushed open the barroom door. Whether he was just making sure it was still there or clutching it as a lucky talisman, no-one, not even he, could say — it just felt good to know it was there.

"Mind it don't bite you, sonny". He looked round sharply, grinned in response to the open, friendly smile from the old-timer who had spoken. The leathery face assumed a serious look as the man spoke again: "That's a mighty fine gadget, boy. A mite tidier than the first of them, way back in '83".

Mark looked with a new respect into those deep, piercing eyes, eyes which he suddenly realised, must have spent more hours prising secrets from glowing VDU screens and fathoming the intricacies of hand-soldered circuit boards than he would care to guess. Never before had he met one of the now almost legendary Silicon Valley prospectors.

The so-called prospectors had had their heyday in the '70s and '80s, when the rush to exploit the micro explosion was closely akin to the gold rush of a century or so before. Pioneers and visionaries, their uncanny talents for making microprocessors sing and dance or anything else that was useful or profitable — preferably both — were much in demand. Until, that is, the big business combines stepped in and everything became much more organised and much less exciting. Yet developments were still accelerating, and there were stories.

Mark hadn't missed the cue in the other's last comment. Sensing a story, he returned the response clearly expected of him: "How do you mean, back in '83? It's well known that the first of the ultra-intelligent machines was Randolph's system, just after the turn of the millenium. It wasn't until '88 that the first system was generally accepted to have passed the Turing test for a thinking machine, and it was another 15 years before Paul Randolph coaxed such a system to produce the design for the first-generation UIMs. They produced the second generation just eight years ago and they were responsible for —", and he glanced down at his pendant, embarrassed suddenly by his schoolboyish enthusiasm.

The oldster smiled. "You learned your lessons well, boy, but they don't tell you everything at school. In college they tell you a lot about Babbage and Hollerith, and fill your head with facts and figures about ACE and ENIAC, but they leave out the in-between years — the most interesting years, I reckon. They can't make you feel the heat, the smell, the taste of the atmosphere between those racks of valves; I was just a kid then, but I'll never forget".

He paused, sipped his beer. "By the time I left school, we were into the second generation, and the field was wide open. If you could spot a dud nickel delay line, or code a neat set of input/output routines, you could write your own ticket.

"Of course, when IBM produced 360s, then the 370s with their megabyte mainstore and nanosecond cycle times, everyone said it was all up for the seat-of-the-pants programmers. Anyone with a Fortran or Cobol course behind them — they taught you about programming languages, didn't they? — could do anything they wanted as quick as it was needed, and even flowchart it in a way that everyone could understand. I got a nice little number with a communications firm, doing work on CAD and control systems. I was just having some interesting results from the gadgets I'd hooked up when the micro started to make a splash, back in the mid-70s.

"Well, I could see the way the world was turning and I lashed out on as much of the stuff as I could. Soon, I'd wired together my own little multiprocessor set up, and I was adding to it every week. After a while, I looked round and found a few others who were interested, and we formed a kind of club. We'd meet at my place, some of them would bring systems they had put together, and we would trade ideas.

"There was a kid, about your age; no hardware of his own but, boy, there wasn't much he couldn't make a system do. Used to tap away at my set-up for hours, all night sometimes; didn't seem to have any other interests, nor any friends either, except us I suppose. I worried about that kid — just didn't seem healthy somehow.

"We had been going about five years, must have been '81, when a new 'gent' joined our club. I say gent' because he didn't seem our type at all, always wore a suit and tie and talked about microelectronics like he'd just learnt it from a textbook. Turned out later that he had; he was a director for one of the big automobile firms".

At this point the man paused, as if startled at the revelation, and Mark took the opportunity to top up the glasses.

"Thanks, son. Well, as I was saying, it seems the automobile giants were worried. It was just before the petroleum synthesis process was perfected and it looked like the internal combustion engine was a dying breed. This gent's firm was diversifying, putting its capital into other profitable enterprises, and they had recently bought one of the biggest silicon chip producers in the States. This director was, so to speak, a talent scout for the firm, and he was impressed by the things we were doing. So much so, that he offered the kid and me key posts in a hush-hush project they were starting.

"Like everyone else, they were on the

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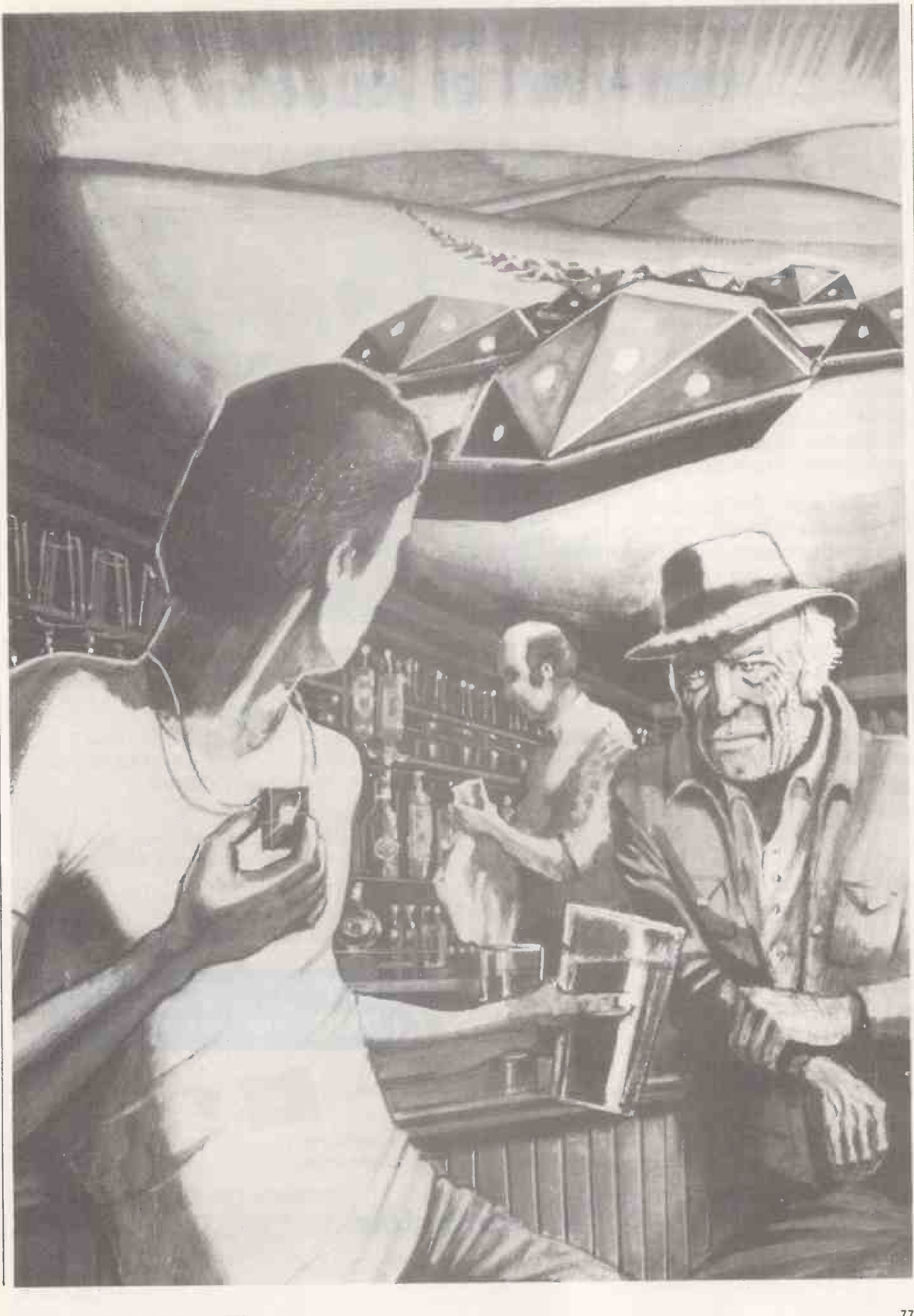

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• Circle No. 169

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artificial intelligence kick, and had this big idea about machines building cleverer machines. The only difference was, they had the cash to back their big ideas. They already had a new site in the sticks, on the edge of the Colorado Desert; production lines set to roll off any design of chip you cared to ask for — all we had to do was to hook up a system that would design the new chips and control production.

"I was taken on as systems analyst, and when I heard what the system had to do, I insisted on taking the kid along to do the programming. They wanted to bring in a team of programmers, but this had to be a one-man job if we were going to succeed. The job specification was concise: rig-up a system that would turn out the most advanced processor possible, using all the CPUs, memory and backing store we wanted.

"Setting-up the database was a big job, of course; quite a lot of the scientific data we wanted still wasn't on chip at the time, and we had to set-up a text-reader to input nearly a library-full of science texts and formulae into the data banks. I figured any system aiming to design new circuits would have to be strong on electro-magnetic field theory, so we piled in everything we could find on that. Seems unfair how you can get into such a heap of trouble just by being right.

"The other smart-Alec was one of the company directors. Reckon he was a sci-fi fan — had some scary ideas about machine intelligence and insisted we built Asimov's first law of robotics into the system. You know the deal"?

The younger man nodded and intoned, almost reverentially: "No robot can harm a human being, or, through in-action, allow a human being to come to harm". Mark, too, was a sci-fi fan, and to him Asimov was the Old Master.

"Yeah, that's it". The other sounded less enchanted, for some reason. "Well, that gave the kid some problems in his programming, I can tell you. It also meant we had to add a whole stack of human psychology and sociology journals to the data input, so the system would know about human behaviour. Mind you, that was nothing to the problems it landed us in later — friend Asimov has plenty to answer for.

"Well, I rigged up the sweetest little 12-processor system you ever did see, though I do say so myself. About five gigabytes of backing store, and direct control of the processing plant. As an afterthought, I linked in another CPU, out of phase with the others, to cut-in between cycles and check they were all OK; any CPU that went down would be switched out of the system automatically. Some say that was the unlucky move, adding the 13th processor, but I ain't superstitious.

"I didn't see anything of the kid for months. Sometimes when I looked in on him he'd be working through a mile or two of program listing, else he'd be tapping away at his terminal, or putting a subroutine through its paces. He had his meals brought in to him, and even slept on a camp bed he had brought in. Didn't seem bothered about social niceties, either — you know, washing, shaving, changing his clothes — details like that. Visitors always left quickly — I think that suited him. Like I said before, there was something about that kid that wasn't healthy, and I don't iust mean the smell.

"You know, the more I tell this story, the more I wonder. How could I have not seen it coming? Perhaps I was just too busy — perhaps I was just too dumb.

"Anyway, one day the kid wandered casually into my office, mentioned that the system was up and running, left and crashed out on his camp bed for 24 hours. It took me a few minutes to realise what he meant. I rushed out to the production lines to see. Nothing, of course. The system was chewing over all the facts and figures and formulae we had given it, and it was going to be some hours at least before it started spewing out the bright new future we were hoping for, in the shape of some super-powerful chip.

"Two days later, still nothing happening, I was getting worried. The kid, who by this time had even washed and shaved, tapped away at his monitor and told me confidently it was all OK. Apparently the system was referencing data on optimisation techniques; he figured it must have worked-out the circuit it wanted and was deciding on the best way of laying it. I was whacked — I'd been up for the last 48 hours — so I left him watching the show and went for some sleep".

The old-timer paused, stared reflectively into his glass for a few moments. Then he spoke again, more to himself than to Mark, as if the other's presence no longer mattered.

"I don't know how long I slept, but I woke up with one of the technicians shaking the living daylights out of me. He didn't say a word, just stepped across and pulled open the curtains, then waited for me to come and look.

"My first impression was that we were being invaded. A column of insects, soldier ants or locusts maybe, was heading into the complex from out in the desert, as far as the eye could see. Then I realised my mistake — the column was moving, slowly but steadily, away from the complex. Something was heading out of our production plant at the rate of thousands an hour, and had been for quite a few hours, by the looks of it.

"In the 10 seconds it took me to dress and get down there, the technician told me that the plant had started in the middle of the night. The products were unusual, but they'd decided to turn in and leave it until I woke to study them — nothing odd was gong on then.

"Down on the sand, I watched them creeping out under one of the cargo doors. Not ants or locusts, more like beetles, Colorado beetles perhaps; brownish, with gold spots all over. I picked one up; it was shaped like a beetle, too — kind of oval, but with flat surfaces all round it and at the ends. The gold spots were on the flats, some sort of contacts, I suppose. I put it down, and it moved off again, same direction, same speed as all the others. We figured later that they all had a kind of linear motor built in, and were dragging themselves along the earth's magnetic field lines. You know, like the monorail systems, a kind of magnetic induction process. Very efficient, and no moving parts.

"Well, of course, we shut the plant down. Any fool could see that the system had gone a bit neurotic — leastways, that is what this particular fool figured. The kid settled back to his monitor to try and debug the system, while I took a team out to debug the desert — literally.

"Two technicians had been out in a jeep to see where our bugs were heading, and they came back with a report that they were all piling up at a spot about three miles out, like some massive seething antheap. All we had to do was to get out there, wait till they all arrived, then shovel them into the back of a truck. On impulse, I took a few instruments out with us. I had a theory.

"I don't know how many there were in that pile, must've been thirty or forty thousand, and more arriving by the minute. I set-up my instruments as close to the pile as possible, and quickly confirmed my guess: this spot in the desert was a node in the earth's magnetic field, a kind of magnetic powerhouse. I was just congratulating myself on figuring this irrelevant detail when, all of a sudden, the lights went out. In the middle of the desert, mid-morning, it just went black. I stumbled around, tripped over my instruments, then hit a rock about four foot high. But there were no rocks here. I backed off, that heap of bugs had suddenly set rock-solid.

"I heard people calling me, and ran towards the voices. Suddenly I was in blazing sunlight again, with the others just a few feet away. I looked back the way I had just come and saw nothing. Nothing but sand, and sky, and the stream of bugs from the plant, now disappearing as soon as they hit a certain point on the sand. The technicians told me I had suddenly disappeared, along with the heap of bugs, then just as suddenly stepped out from nowhere in front of them. I told them about the dark, and waved my arm back

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the way I'd just come — my arm disappeared. I pulled it back, stepped carefully in that direction. The technicians gasped — seems I had disappeared again — and I was back in the black.

"Electro-magnetic wave distortion — the old sci-fi invisibility field. So simple, just bend the light rays round whatever you want to hide, and you see past it, or through it as if it were not even there. Our heap of bugs was the first brain to overcome the technical problems and make it happen.

"We wasted about 10 minutes pacing out the size of the distortion field — walking in what looked like straight lines, but weren't — before it occurred to me to wonder just why our brainchild wanted to hide itself. We laid out some markers for the bombers — I was beginning to think at last — then piled into the truck. It only took us 10 seconds to confirm that the truck's electrics were dead, and figure where the blame lay. As we ran back to the complex I crossed-off mentally aircraft and guided weapons from my list of possibilities, and cursed myself for a fool for giving the monster such a thorough education.

"I was the last back, and I found the technicians with a group of workers, watching weird patterns drifting across one of the system's monitors which were dotted round the place. I turned away, and yelled at them to do the same, but I was too late. I went looking for the kid, and found him tapping away at his console while those patterns flickered across his VDU. He was keying in the parameters to re-start the system. That heap sure had everything under control — everything except me. I pulled off my shoe and knocked him cold, then I pulled the plug on that screen. While he came round, I disconnected all the other VDUs, though it didn't seem to do much for the zombies standing round them.

"The kid seemed none the worse for wear, apart from a lump on the head. I cut short his questions about the system, and asked for some straight answers to some very personal questions. I asked him about his childhood, his family, his friends, regular headshrinker stuff. He squirmed, it wasn't easy for him, but there were things I had to know.

"At last I had it. The kid had a standard set of hang-ups, was no more or less neurotic than your average introvert, but he majored on the theme of mankind being man's worst enemy, man needing protection from himself. That idea was bound to carry over, subconsciously, into a program as complex as ours. Any superbrain with Asimov's first law built in had to disable man's worst enemy — harmlessly, of course.

"Our heap of bugs wasn't nuts. It was terrifyingly sane.

"There wasn't much time, it was sure to try and regain control somehow. There was no way of knowing how far afield it was interfering with TV broadcasts, taking over unsuspecting viewers, or what other tricks it had up its junctions. I told the kid the data modifications I wanted, and he keyed them in from his terminal, blind, with the screen covered over. Then he started the program again, from a restart point shortly before the production routine, so it would refer to the new data before it set up the next production run. We sat back and waited.

"Four hours later the exodus began again, little electronic Colorado beetles creeping out to their rendezvous with nothingness. After another four hours I started switching-in one of the system monitors every 10 minutes, just for a few seconds. On the ninth try, the screen was clear. We drove out to the abandoned truck with a spare battery, and it started, no trouble. There was still no sign of the heap, and those new bugs were disappearing at steady rate".

Up to this point, Mark had listened, fascinated, but now he felt he must query what seemed to be an inconsistency. "Surely, if you had corrupted the database, the new chips would be faulty", he objected. "Wouldn't your bugheap, as you call it, simply have rejected them"?

The older man nodded. "That's true, son, it would, if my modifications had been out of line with the original data — but it wasn't.

"You see, boy, I wasn't the first one with bug problems. Middle of the last century, scientists controlled some types of insect pests effectively by sneaking large numbers of strong males, radiation-sterilised, into a swarm. These fellas came on strong with the lady bugs, making sure a whole load of the eggs never hatched. Wasn't long before the swarm dwindled and died away.

"My new chips were the sterile males for the bugheap. They were accepted because their data was consistent with the original chips".

"But what mod' did you make, to have that effect"? asked Mark. "Surely not just the old tie-the-computer-up-with-a-paradox routine"?

"Well, I suppose it was a kind of paradox, but I didn't see it like that. Not the type you mean — the statement I am now making is not true — or some such. I've never yet met a computer that became knotted-up in words the way we seem to. No, I simply added to its logic design data the fact that the original system had been designed, programmed and provided with data by humans. As I saw it, our only hope was if the new bugs carried that fact, in some shape or form, out to the heap".

Mark looked puzzled for about a minute, then smiled. "Clever, but how did you know it would work"?

"I didn't, but when it let go the monitors, I knew we had got through to it. The way I figure, it withdrew while it considered this fact that it was a product of man's worst enemy, so it might actually be a weapon without realising it, aimed at those it was trying to protect. Far as I know, it's still considering".

Mark gasped: "You mean it's still out there"?

"Well, I ain't moved it, son. You'll never find it, though, unless you walk straight into it. Don't look so worried, it's not done anything for a good few years, don't reckon it's fixing to start now.

"The workers came round in 48 hours. So did all the others — local news said nearly every man, woman and child in an 80-mile zone had suffered a mysterious blackout. We never let on why — serves them right for watching so much TV.

"The auto bosses dismantled the plant, of course. Blamed us for wasting millions of their capital, and gave us the sack. They never discovered exactly what happened — the workers couldn't remember a thing, and we weren't set to tell them — they had enough to worry about keeping their investors happy.

"Well, boy, wouldn't you agree that our heap qualifies as the first of them ultra-intelligent machines? No, don't feel obliged to answer, I can see you have your doubts about my story. Reckon you'll be convinced soon, though, when your new director up on Mars starts thinking about those tracks up there they keep calling canals. I don't reckon that new machine will take long to figure it out. I just wish I'd been up there to help them when their systems cut loose, that's all. Well, 'bye son, good luck. Thanks for the drinks".

Mark had glanced down in embarrassment a moment before, but now his thoughts were in a turmoil. How did this man know where he was heading? Was he implying what he seemed to be implying? Mark looked-up, his mind full of questions, but only the swinging bar-room door marked the man's exit. From the door, there was no sign of him, up or down the street.

Mark raced to the bar. "Who was that man? Where does he live? What does he do"?

The bartender shrugged. "Old Jed? Oh, he's just some hillbilly lives out in the woods. Comes into town regular to pick up packages from the post office — electrical bits and such like, mostly. Some say he's got a still out in the woods, fixing moonshine. Few times folks been out looking for his place. Always come back saying they found themselves going back the way they came. Reckon they must have stopped off and sampled his produce".

The bartender grinned at his own joke, and turned back to wiping glasses.

Up-to-date Z-80 has trouble impersonating simpler 8080

How do you make a Z-80 chip drive the S-100 busbar designed for use with the 8080 chip? That is the problem confronting Mike Hughes in the second part of the Transam Tuscan development story.

ALL microprocessors have a number of common hardware features. For a start, they all need power of some form — even though the number of power rails and voltages will vary from device to device. Every processor requires a clock signal — some draw it from an external source, some require more complex multi-phase clocks while others have all the necessary clock circuitry built into them.

They also have provision to control a system by means of groups of signals which spread like arteries interconnecting memory chips, I/O devices and the like back to the microprocessor which operates as a CPU. Those groups of signals are carried on wires called busbars.

The busbars fall into three classifications. The simplest to understand is the address busbar — abbreviated to address bus. In the more common microchips, it comprises 16 wires carrying binary signals in all permutations from 0000000000000000 to 1111111111111111 which can be written as 0000 to FFFF in Hexadecimal notation — 0 to 65535 in decimal.

The binary codes on those lines can be decoded by external circuitry to produce 65,536 signals which are used to interrogate a similar number of memory locations within the system architecture.

The locations are called addresses and for convenience, we say there are 64K possible addresses within a system having a 16-bit address bus. 1K is 1,024 addresses, including zero, therefore 64K is equivalent to our 65,536 locations. For this reason, most systems based on microprocessors are limited to 64K of memory.

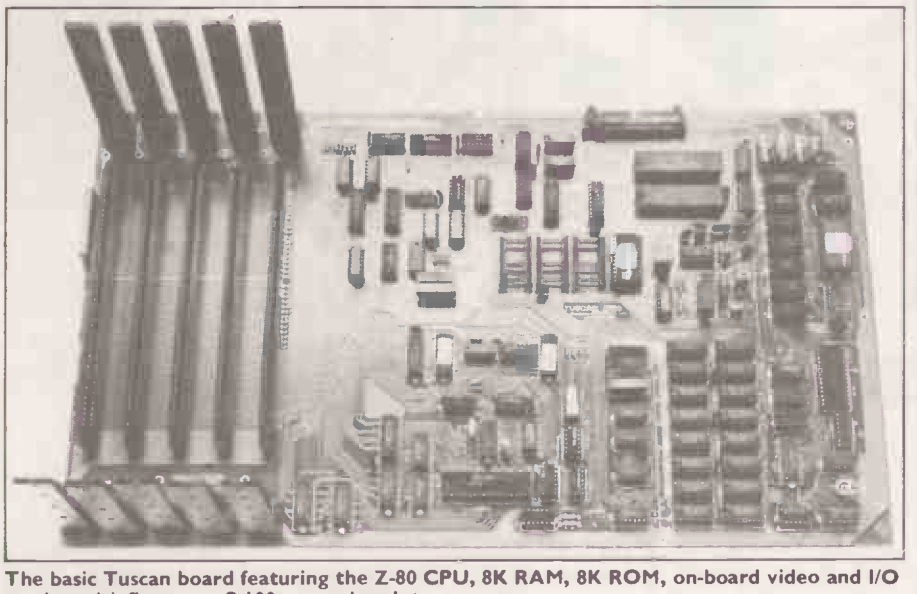
It is not mandatory to have all that memory and some very small systems will operate with as little as 256 locations. It just means that the full potential of the microprocessor is not being used in those applications.

Because a microprocessor can do only one thing at a time, it has to perform operations sequentially receiving the timing from the clock. It does not, therefore, need to interrogate memory all the time and there will be many occasions when the address bus is not being used for its prime purpose.

Some processor chips have a secondary use for the address bus during those periods. In the case of the 8080, it is used to provide up to 256 special addresses to access what are called I/O ports. A port is a name to describe a gate or flip flop which is used to interconnect the main computer system with peripheral devices in the outside world — keyboards, printers, VDUs, tape recorders and the like.

Because only 256 port addresses are permitted, it is necessary to use only eight bits of the address bus and the designers of the 8080, therefore, thought fit to duplicate I/O addresses on the least significant eight and the most significant eight address lines.

The Z-80 chip is similar in that it uses time-sharing to put out I/O addresses on the least significant eight bits of the bus but, instead of duplicating the information on the most significant half, it places the contents of its accumulator — one of its most important internal registers — on those bits.



The basic Tuscan board featuring the Z-80 CPU, 8K RAM, 8K ROM, on-board video and I/O section with five spare S-100 expansion slots.

The reason is that the contents of the accumulator usually need to be conveyed to the outside world and having the data there at the same time as the address speeds the process.

Before becoming bogged-down, let us move on to another set of connections called the data bus. Most low-priced processor chips have eight lines in that busbar and they fall into the category of eight-bit processors.

There is another group of processors called 16-bit devices which, although similar, are not so common and are usually considerably more expensive. Tuscan was conceived as an eight-bit system.

To describe the function of the data bus, it is simpler if we stick to memory considerations. In an eight-bit system, every memory location will be capable of holding eight bits of data — a group of eight bits is called a byte.

Data source

In the case of Random Access Memory (RAM), data can be put into the location or obtained from it. In the case of Read Only Memory (ROM or EPROM), the data contained in the memory is permanent and cannot be altered — hence it can only be used as a source of data.

A RAM location consists of eight flip flops which can contain binary codes from 00000000 to 11111111 — 00 to FF in Hexadecimal or 0 to 255 in decimal. It would seem an insoluble problem to have 65,536 of those locations connected individually back to the microprocessor chip — 524,288 wires would be needed.

Furthermore, that figure would have to be doubled if we had one set of wires for sending data out to the memory and another for receiving it from memory. To obviate the problem, the inputs to the eight flip flops are brought together throughout the whole memory system so that a common set of eight lines can feed data to all the locations simultaneously and that is where the decoded address signal from the address bus enters the picture — figure 1.

By having suitable gating on the inputs to the flip flops, only one location will be activated to accept the data which is on the common lines — the gating is enabled by the uniquely-decoded address. If we imagine those eight common lines emanating from the processor chip, we could call it a data output bus. What about obtaining data from a memory location to the processor?

Each memory location has a set of tri-state buffers — high, low or disconnected — on the outputs of its flip flops and in a similar manner, the outputs of those buffers are commoned together into eight lines. In simple terms, the address signal is used to activate only one of the 65,536 possible locations and the state of those flip flops is placed on the common lines.

Differentiation

Again, imagine the eight lines fed back to the processor and we could call these a data input bus. In practice, a system based on that principle could work but further consideration reveals that a microprocessor will never want to write to and read from a memory location at the same time.

It is possible to parallel together the data output and data input busbars to produce what is called an eight-bit bi-directional data bus. The only problem encountered by doing that is how memory can differentiate between a memory-read and a memory-write operation.

The address signal alone is not sufficient to convey the information and if used by itself, would make the memory location attempt to accept and provide data simultaneously — clearly it would result in nonsense. Without going into the same detail, a similar problem exists when handling I/O ports.

To overcome the problem, we need extra signals to control the gating of the memory locations and I/O ports and those signals are provided by our third busbar called the control bus. The signals we require are defined easily and are four in number. They are memory read, memory write, I/O read and I/O write.

Clearly, they are signals which must have precise timing which is controlled by the microprocessor chip. It was the generation of those signals which required most thought in the design of the Tuscan system because it was in this area that the greatest conflict arose when trying to make a Z-80 chip drive an S-100 busbar.

The S-100 busbar was designed originally to be a standard arterial system to carry address, data, control and other signals throughout computers using the 8080 microprocessor as the central processing unit. As the 8080 is an early-generation device, the signals it produces are not ideal by present-day standards.

Furthermore, the S-100 busbar was introduced before the advent of some specialised chips which modify the 8080 outputs to bring them more in line with current practice. It was designed with early semiconductor memory technology in mind. Having said that, one might think the S-100 busbar system a strange choice.

Powerful changes

There have been, however, a number of changes to the S-100 specification which, although retaining much of the original 8080 requirements make it one of the most powerful and sophisticated of busbars. Above all, the S-100 is now accepted by the IEEE in the U.S. as standard and is being adopted rapidly as such internationally. There is a tremendous flurry of activity among manufacturers to produce accessories designed to interface with it.

To appreciate the problems in driving an S-100 bus from a Z-80, it is first of all necessary to understand some of the fundamental differences between the address, data and control busbars of the Z-80 and the 8080. First, it should be understood

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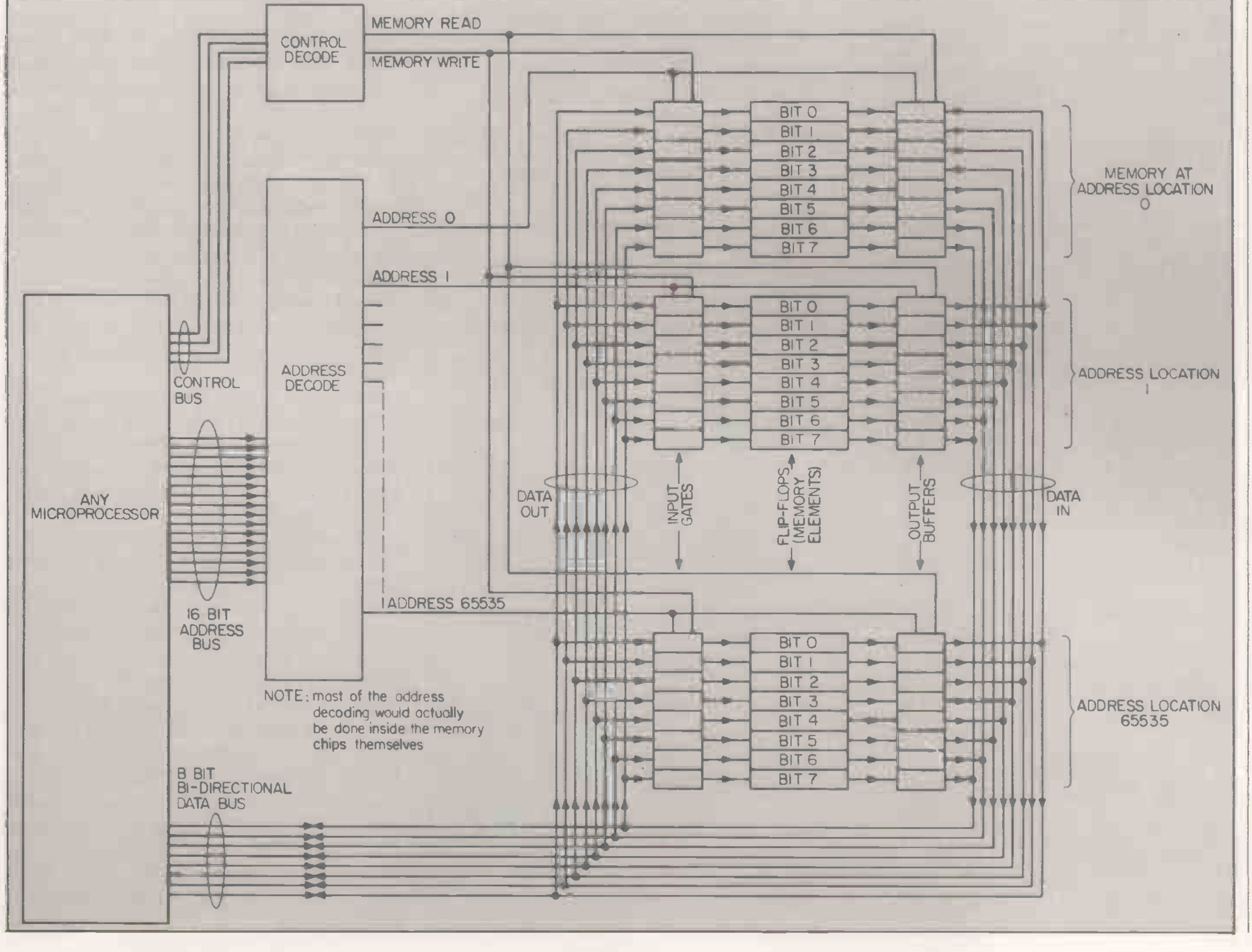
Figure 1. Schematic illustration showing how the data, address and control busbars can be used to control a vast amount of memory with a minimum of common lines.



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that while the Z-80 needs only a rudimentary single-phase clock pulse to provide its timing, the 8080 needs a rather more complex two-phase clock with reasonably critical relative timings between the phases.

The two phases are called $Ø_1$ and $Ø_2$; the former is a narrow pulse while the latter is broader. The S-100 bus expects to have both signals appearing on a pair of its 100 lines so, although I was using a Z-80 chip which did not need both clock pulses, they would still have to be generated to comply with the standard — figure 2.

The only significant difference between the address lines of the two devices is that the 8080 duplicates I/O port addresses on the high- and low-order bytes whereas the Z-80 puts out accumulator data on the high byte with the port address on the low byte.

Clearly a conversion had to be made to those signals to make them comply with the 8080 specification but, as will be shown later, that was comparatively easy. The biggest difference occurs between the data and control busbars.

Easy conversion

Although the 8080 has a number of rather special control signals it has nothing directly equivalent to the four fundamental control bus signals already defined. The Z-80, being a more up-to-date device, is more helpful in that respect and has four signals defined write, read, memory request and I/O request — figure 3a.

Between the four of them, it is reasonably easy to produce the four fundamental control-bus signals by simple gating. To obtain signals of near equivalence from the 8080, one has to look rather more closely at its data bus specification.

I have already implied that the data bus can be carrying output data and the next moment be transmitting input data. There are other times within the 8080 operating cycle when conventional data is not required on the busbar at all and good use is made of those moments. The internal circuitry of the 8080 is arranged to share the data bus in a third direction. Very early in the processor's operating cycle, it outputs what is called a status byte on the eight bits of the data bus. The moment that occurs is defined by the coincidence of the $Ø_1$ clock pulse and one of the special control signals mentioned called SYNC — figure 3b.

Useful moments

That coincidence is detected usually by gating and is used to trigger a set of eight flip flops called catches whose inputs are connected to the data bus. The fleeting appearance of the status byte is thus caught in the latches and held for the duration of the machine cycle.

The eight bits of the status byte have specific designations which describe the type of operation the processor is executing during the cycle in progress. Going in order from the least to the most significant bit, the designations are as follows:

D0	INTA	This is "1" when an interrupt is acknowledged
D1	$\overline{\text{WO}}$	This is "0" whenever data is to be written to memory or to an output port.
D2	STACK	This is "1" whenever data is to be written to or read from the stack portion of memory.
D3	HLTA	This goes to "1" whenever the processor is halted.
D4	OUT	This goes to "1" whenever data is to be written to an output port — note the subtle difference between this and $\overline{\text{WO}}$.
D5	M1	This is set to "1" to define an instruction fetch or an interrupt acknowledge cycle.
D6	INP	This goes to "1" during a read from an input port.
D7	MEMR	This is "1" whenever the memory is to be read.

That rather complicated looking set of signals is latched and present during the period between the current and the next machine cycle of the processor and can be used to define precisely what the chip is expecting to do during the current cycle.

Although the signals have to be obtained by de-multiplexing the data bus at the correct moment, they convey a good deal of information about the status of the machine and it could be said are more comprehensive than the control bus signals produced by the Z-80.

On their own, those latched signals are not of much value in controlling memory or the like because they are static for the duration of the machine cycle and to make memory, for example, output its data on to the data bus at the exact moment when the processor expects to set it, they have to be strobed by timing signals.

Control lines

They are two more of the special control lines coming from the 8080 called DBIN and $\overline{\text{WR}}$. The former is a short pulse which goes to "1" at the precise moment the processor is expecting to receive an input — from I/O or memory — from the data bus while the latter goes to "0" at the moment the processor has placed valid output data on the busbar.

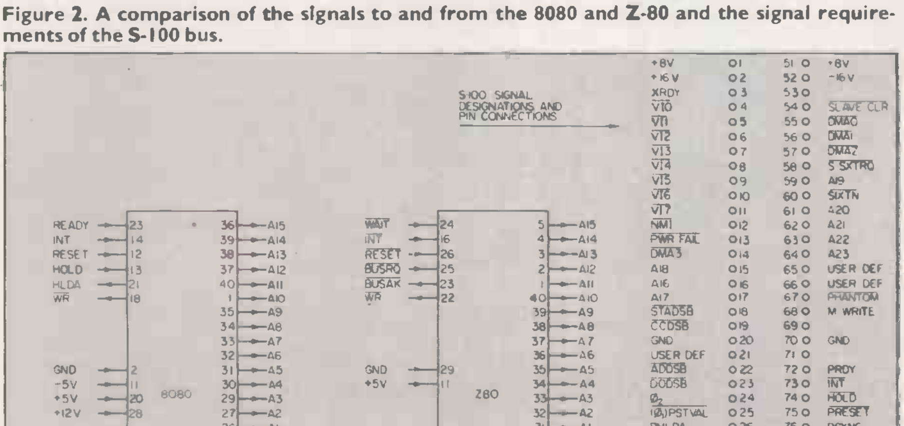
If DBIN is gated with the INP line of the status byte, it produced a signal equivalent to the I/O read signal of our fundamental control bus. Likewise, $\overline{\text{WR}}$ suitably inverted and gated with the inverted out line of the status byte will give memory write.

Similarly, it is possible to produce an I/O write and a memory-read signal. It is further possible to produce other useful signals using different combinations of gating; one very important one is called interrupt acknowledge.

Although it is more complex to produce an operating control bus from an 8080 compared to that of a Z-80, the whole of the latching and decoding can be done with a single 8080 system control chip. Remember, however, I said that the S-100 busbar was conceived before the advent of some of the more sophisticated chips.

It is for that reason that the S-100 bus expects to see signals in the form of the latched status byte rather than the finally-decoded control signals — it was always assumed that the necessary gating from the status byte would be done on the individual peripheral S-100 cards. That requirement is retained in the current S-100 standard.

Figure 2. A comparison of the signals to and from the 8080 and Z-80 and the signal requirements of the S-100 bus.



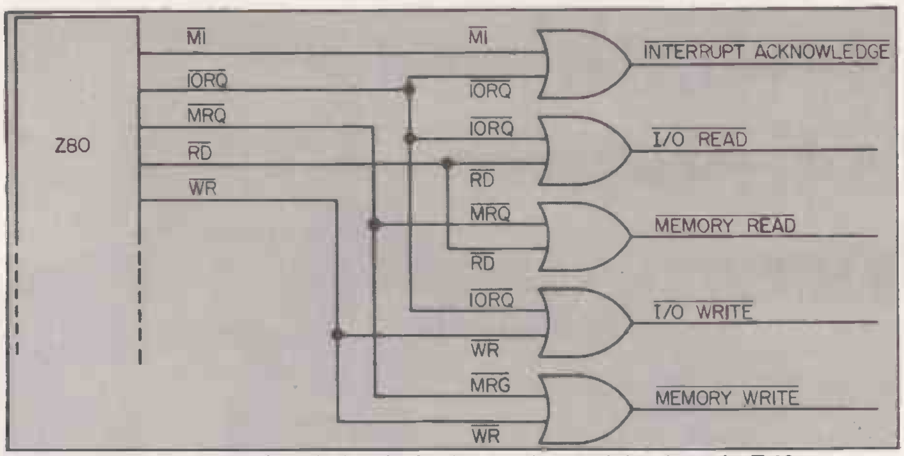


Figure 3a. The simplicity of producing the fundamental control signals on the Z-80.

Within the general area of status and control lines, the S-100 bus expects to see the following signals — a prefix of S denotes latched status while a prefix P implies a pulsed command type of signal. They should be compared to the status and control signals already described:

SOUT SINP SMEMR	PSTVAL	Strobe defining the moment when the status data is valid — equivalent to Ø1.
SHLTA SM1 $\overline{SINTA}$ $\overline{SWO}$	PHLDA	Confirmation that the processor has released the system following a DMA request.
	PSYNC PWR PDBIN	

They by no means represent all the signal requirements of the S-100 bus but include the ones which are most difficult to generate from a Z-80. In a nutshell, we have to take the end signals we require, i.e., the control signals from the Z-80, and degrade them backwards to the more complex fundamental signals originally produced by the 8080.

Specific to general

While it is reasonably easy to work logically from the general to the specific, in this case one has to work from the specific back to the general which can be difficult when all the parameters you require are not contained within the initial specific example. That is precisely the problem I faced.

The only control signals the Z-80 produces are:

BUSAK	This acknowledges a DMA request and conveniently is almost identical to the PHLDA required by the S-100 bus.
$\overline{M1}$	Again this is very similar to the 8080 M1 status bit.
$\overline{HLTA}$	Similarly, it is identical to the 8080.
$\overline{MRQ}$	Memory request — not directly equivalent to any 8080 signals.
$\overline{RD}$	Read. This is a general read for memory or I/O.
$\overline{IORQ}$	I/O Request — not equivalent to the 8080.
$\overline{WR}$	Write. This is almost equivalent to PWR but its timing has to be controlled carefully.

Note, in particular, the absence of the important timing signals equivalent to PDBIN, PSYNC and $\overline{PSTVAL}$.

It is easy to obtain most of the S-100 signals from the Z-80 by gating the control lines in various ways. However, the timing will not necessarily be correct. For example, the inverse of $\overline{WR}$ "Anded" with the inverse of $\overline{IORQ}$ will produce a pulse going to "1" whenever data on the data bus is to be output to an I/O port.

It represents the same condition which is described by the S-100 SOUT line but the S-100 standard requires this status signal to be latched and held for the full duration of the machine cycle — a pulse is not sufficient. The S-100 signal $\overline{SWO}$ should be at "0" whenever the cycle is a writing operation to memory or I/O and as far as the Z-80 is concerned, the condition is met whenever the cycle is not a read or an interrupt-acknowledge cycle — negative logic, I'm afraid.

If we could gate the Z-80 $\overline{RD}$ signal and its interrupt acknowledge with the correct logic, we would be well on the way to obtaining something like the signal required. The problem is that the Z-80 does not produce a straightforward interrupt-acknowledge signal; that has to be obtained by gating $\overline{M1}$ with $\overline{IORQ}$ — just one of those things sent, so successfully, to try us.

Without wasting time on the detail of the logic required to do that, let it be assumed that a pulse equivalent to the 8080 WO could be obtained with suitable gating. That alone will still not meet the S-100 specification because it has to be latched for the whole of the cycle. The same problem arises for SINP, SMEMR, and SM1.

To generate the correct S-100 status signals, it is necessary to have some complex gating together with a latch and a suitable signal to trigger the latch when all the gate-derived signals are valid. Furthermore, to comply with S-100 specification, the latched signals must be stable early in the machine cycle during PSYNC — but PSYNC is not produced by a Z-80.

PSYNC is a pulse which, in the case of the 8080, occurs at the start of every machine cycle and has to last for a period of time related precisely to the clock phase. For the Z-80, that moment is very closely related to the start of the $\overline{IORQ}$ and $\overline{MRQ}$ pulses but the Z-80 has a rather special memory request cycle which does not occur for the 8080 — this is the refresh cycle — so we would not want a PSYNC during the latter.

By gating together $\overline{IORQ}$, $\overline{MRQ}$ and the Z-80 special RFSH, it is possible to obtain an "Edge" which occurs at the same moment we want PSYNC to start. Unfortunately, the duration of the ensuing signal would be far too long to meet the S-100 specification — figure 4.

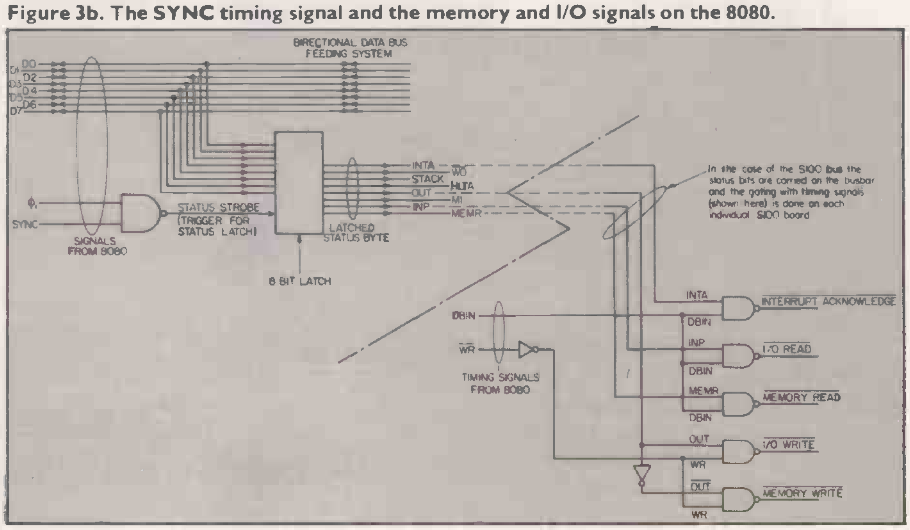
Best solution

It is, however, possible to use the onset of the signal to trigger a monostable multivibrator which is set for the period required for the PSYNC pulse — the timing has to be defined by a resistance-capacitance (RC) circuit and obviously would have to be altered for different clock frequencies. I do not like mixing RC-dependent timing with logic but there seemed to be no better solution to derive the very important missing signal.

The timing of the PSYNC signal derived would be very close to the point of time when I would wish to latch the status signals but, due to propagation delays and other imponderables, one would not be able to use a conventional edge-triggered

(coninued on page 87)

Figure 3b. The SYNC timing signal and the memory and I/O signals on the 8080.



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(continued from page 85)

latch — some of the setting-up signals would not be stable before the rising edge of PSYNC — so a D-type transparent latch would be necessary.

Another point which was worrying was the potential time delay caused by propagation through the various gates — some of which would cascade through as many as four or five stages. I was also concerned by the thought of all the chips required to carry-out the gating, remembering that all the "P"-type signals had to be generated as well.

The concept of Tuscan containing all the options we required embodied on a single manageable board raised considerable doubts as to the feasibility of discrete gating. To overcome both those issues, I decided that the best solution would be to use bi-polar read only memories to substitute for all the conventional logic. Not only would it reduce the chip count greatly, but it would ensure that all the propagation delays would be easily predictable — even though bi-polar PROMs are slightly slower than low-power TTL.

I would also have the added advantage that the PROMs would not need to be programmed until after the board had been laid-out and that would give me complete flexibility in deciding which pins out of the PROMs would carry which functions.

As an extra bonus, I would have the assurance that if I made a mistake in the logic design all I would need to do was re-program the PROM in question rather than alter the PCB lay-out.

Conventional logic

The only area where I could foresee trouble was the gating needed to trigger the PSYNC monostable — I did not feel it wise to use a PROM for that application due to the high risk of "Glitches" during address changes so for safety, I decided to stick to conventional logic.

A very simple expedient was used to produce the correct phasing for the $\emptyset_1$ and $\emptyset_2$ clock signals. I chose to use the 8224 chip which had been designed specifically to produce an 8080 clock. As well as the two signals I required for the S-100 bus, it has a TTL output which would match the clock input requires of the Z-80 perfectly — figure 5.

I would, however, have to specify the manufacturer of the chip carefully because not all sources are capable of running satisfactorily with a single 5V power supply — for use with the 8080, +5V and +12V are needed but the +12V would have caused interfacing problems with the S-100 bus.

All output signals feeding the S-100 bus have to be buffered to ensure there is sufficient drive capability to cope with as many extra boards as the user might wish to plug into the busbar. A buffer in this context is a circuit element which increases the strength of a logic signal.

Using the PROMs for decoding the control signals proved very convenient because the ones I had decided to use have a very high output-drive capability and requires no further buffering.

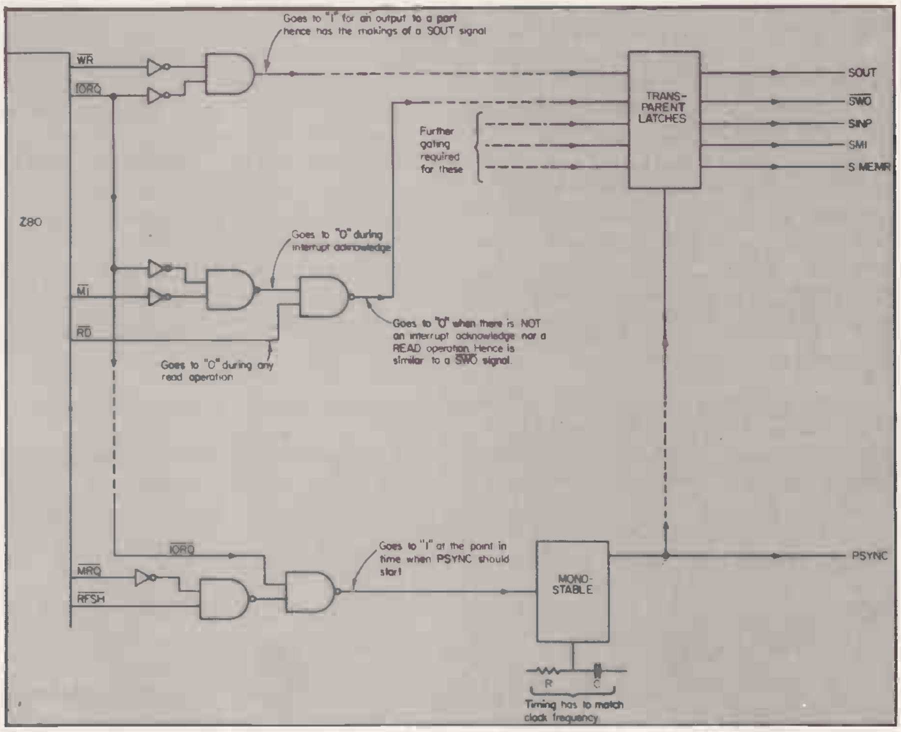

Figure 4. Combinational logic, generation of the SYNC pulse and the transparent latch.

The transparent latch for the status lines similarly has high-drive potential. The clock signals form the 8224, on the other hand, do not have the same degree of "guts", so standard TTL inverters were used as buffers.

The 16 lines of the address bus had to be buffered suitably and at the same time, I had to carry-out the conversion from Z-80 standard to 8080 standard which proved relatively simple. Data selector chips would be used to allow the high-order byte of the address to be output under normal situations but during I/O operations the low-order byte would be switched on to the high-order byte lines. The Z-80 IORQ signal proved to be suited ideally as the control for this operation.

Having already said that microprocessors usually have bi-directional data busbars it seems, at first, strange that the S-100 busbar requires data to be transmitted on two separate busses. They are called data in and data out.

One reason for that requirement is historic and is related to the fact that early memory chips were designed to handle bi-directional data signals so it seems rather a retrograde step to split the data bus to comply with S-100 standards only to have to re-combine it later on.

The recent modifications to the S-100 standard have turned this apparent anomaly into a positive bonus because, by the clever use of extra control signals, the 16 lines given over to the data-in and data-out busbars can change over automatically to represent a single bi-directional 16-bit data bus.

That means that a single standard busbar can, if properly managed, double for eight-bit or 16-bit microprocessors. In really complex operations, it is even possible to have the two types of processor operating on the same busbar in the same system.

It is a simple matter to split a bi-directional busbar into its two components by using controlled tri-state buffers connected back to back. The buffer feeding the data-out bus can be operational all the time, but the signals from the data in buffer must be placed only on the internal bi-directional bus when the microprocessor expects to see them.

That moment corresponds to the PDBIN signal already described so I intended to use the control line, decoded from the PROM, to activate the tri-state outputs of the input buffer.

Buffer factor

One important factor remained which involved the buffers. The S-100 bus has a very comprehensive set of DMA (Direct Memory Access) request lines called STADSB, CCDSB, ADDSB, DODSB and PHOLD. The first four signals force the internal processor to relinquish its control of the STATUS, CONTROL, ADDRESS and DATA OUT busses respectively whereas PHOLD forces the internal processor to relinquish control completely of the whole system including, in my interpretation, responsibility for refreshing dynamic memory.

To do that requires the lines in question to go tri-state for the duration of the DMA request. When the PHOLD request is received the internal processor has to acknowledge that it is prepared to release the busbars by issuing a signal back down

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the busbar which is called HLDA.

All the buffers I used for these sensitive regions had, therefore, to be capable of being forced into a tri-state condition on receipt of the correct signal. Again, to produce the correct signals, I would use a PROM to decode from the various DMA options.

There remained a number of other important S-100 signals either to generate or decode but none presented any significant problems.

Input provision

To complete communications between the processor and the S-100 bus, I had to make provision for the input signals PRDY and XRDY which have identical functions. If either of these lines is taken to "0", the processor must half operations — in Z-80 parlance the processor must enter a wait state for the duration of the signal.

Various applications require the processor to suspend operations for a short period, particularly when slow peripheral devices are involved. Where it is necessary, the peripherals in question are expected to pull either of the lines to a low-logic level. The Z-80 has a convenient wait input pin which could easily have been connected reasonably to the ORED combination of the two signals but I had a further complication with which to contend.

From the outset, I had been given a specification for Tuscan which required it to operate at a clock frequency of 2MHz as standard but with provision for it to be upgradable to a 4MHz system if ever it were required. Doubling the frequency would normally require halving of the access times for memories, making considerable increases in cost — much more than many people would be prepared to pay.

It is possible, however, to introduce a short delay in the operation of a Z-80 during all machine cycles by judicious use of the wait input which means that one could operate at a frequency of 4MHz but introduce a delay of about 20 percent which would allow low-speed memory to be used while still obtaining an 80 percent improvement in machine speed.

I obviously did not want to introduce this 20 percent delay when operating at 2MHz so had to introduce it as a simple option selected by an on-board jumper connection.

The delay would be required during I/O request and memory request operations so the signals were taken and conditioned by the clock $Ø_2$ in a two-stage counter before being combined with the $\overline{XRDY}$ and $\overline{PRDY}$ to feed the WAIT input of the Z-80.

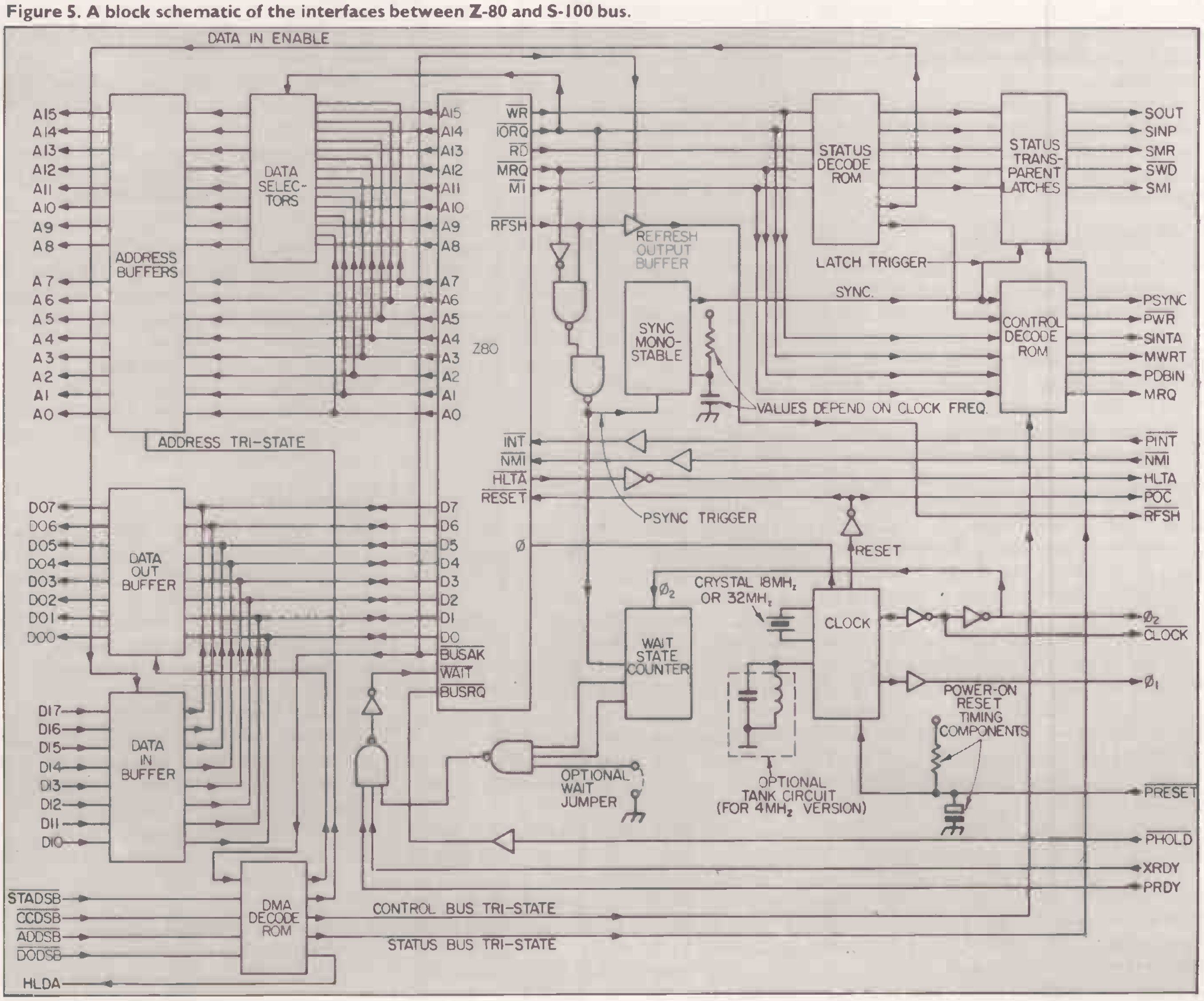
Reduced chip count

With this design philosophy, I would be able to make the Z-80 look, in hardware terms, as though it was an 8080 and therefore be fully-compatible with the S-100 busbar. Furthermore, I would be able to make the best possible use of PROMs to reduce the chip count thus saving board space.

All told, including buffers, the CPU of Tuscan would need only 21 chips and many of the types would be duplicated which would save money — it is always cheaper to buy several of a few devices rather than singles of many different types.

Having resolved the heart of the matter, I shall describe how the CPU was brought under control by resident firmware.

Figure 5. A block schematic of the interfaces between Z-80 and S-100 bus.



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Producing any kind of software is an expensive business. Charles Sweeten explains how funding for software development for secondary education is limited severely and how time and money will be wasted if individual schools write programs which cannot be transferred subsequently to other schools.

Standardising software will avoid unnecessary waste

MUSE (Microcomputer Users in Secondary Education) has recently published a set of standards for Basic as implemented on the microcomputers commonly used in schools. The manufacturers whose systems have a significant share of the education market are Apple Computers, Commodore Business Machines, Research Machines and Tandy. Users of other equipment will be able to identify a subset of the language to conform with those standards.

Idiosyncrasies

To have made the standards applicable to the last generation of computer systems would have been to deny the progress already achieved. It would also restrict future systems to such an extent that such standards would be ignored. By chance, the microcomputers noted use forms of Basic which have derived indirectly from the Microsoft version.

It is also surprising that most of the idiosyncrasies of the original version have survived through several generations. Thus, there exists an exceptional opportunity to fix a common language within education with a series of conventions which everybody can understand.

The purpose of those standards is to make it easier for program writers to write programs, to provide standards which program writers should attempt to meet and to make it possible to transfer programs between different systems.

Foolproof input

A further purpose is to set a standard which programs written for the classroom should attempt to meet. To do that, there are suggestions about making input foolproof, and output program-proof, about providing initial values for the inexperienced user and about the options presented to the user while running the program.

It is important to stress that the standards do not attempt to achieve a non-trivial subset of Basic to run on any machine. Although restrictions have been made on the use of Basic keywords, it has been made possible to use the full range for any system.

It is, arguably, more important to have standards for the appearance of software to the user than to have standards for the construction of programs. It would be immensely difficult to do that and yet allow individual style and collective progress.

If the linear Chelsea style, which at the time seemed revolutionary, had become mandatory, perhaps we would never have seen the prompt-orientated Hatfield style which now seems to represent an equal advance. For the moment, it is best to provide a sound framework on which to base any presentation and to ensure that those standards do nothing to inhibit ideas and experimentation in the areas of presentation to the user and teaching style.

Presentation style

Nevertheless, a few recommendations about the style of presentation have been made since, to some extent, it affects the style of program construction.

Programs must keep to the subset of Basic that is defined. That allows the use of such functions as MID$ (X$, A, B) and such statements as ON FNA (X) GOSUB 1100, 1200, 1300. The way that Basic should actually be expected to behave is also described. For example, VAL ("JOHN 23RD") will, in practice, produce different results on different machines. The exact value of the control variable after completion of a FOR NEXT sequence is unpredictable.

Programs must be constructed in modules — sometimes called subroutines or procedures. The modular concept is crucial to the understanding of the standards as it means that when a program is being composed, the author can concentrate on educational aims. A program specification might consist of:

1. Set default values.
2. Draw diagram.
3. Accept user command.
4. Display values.
5. Amend diagram.
6. Go to 3.

Each of the modules can be broken down into smaller ones, tested independently and even used again in another program. A number of tested subroutines has been made available to deal with more common needs and authors will be expected to use them or to use their own versions starting at the same line numbers.

Variable names

Wherever possible, the subroutines have been written in Basic common to most machines and using special variable names. To find ZX, correct to ZY significant figures.

```
8200 REM
8210 J = INT (LOG (ABS(ZX))/LOG (10))
8220 J1 = 10^(ZY-J-1)
8230 ZX = INT (ZX*J1 + 5)/J1
8240 RETURN
```

That is a reasonable attempt but critical readers may discover that the routine gives annoying results on some machines at certain times. It is, therefore, capable of improvement, but until someone produces that improvement, we will have to make do.

When such an improvement is made, it will be a small task to substitute the new for the old, if we have followed the standards dutifully for line numbering our subroutines.

Self-contained modules

Modules should be self-contained as far as possible. Program writers are encouraged to avoid writing modules which are forever calling other modules and so on. It makes the programs quite incomprehensible and requires a forbidding number of variable names to be used.

Subroutines should be neither so long that they are difficult to understand, nor so short that their use obscures the flow of the program. GOTO statements should be used only for small local jumps within a single module.

There has been much discussion about whether subroutine calls should be to a REM statement, which labels the subroutine, or to the next statement. While being aware that some older computers must transfer to an executable statement, today's popular educational micros are more flexible. The standard recommends that subroutine calls (GOSUB) are to a REM statement. Modules and program sections are of four types:

MIPI	machine independent + program independent
MDPI	machine dependent + program independent
MIPD	machine independent + program dependent
MDPD	machine dependent + program dependent

Machine refers to the environment created by the combination of hardware and software. Machine-independent plus program-independent modules seem too good to be true, but a few are possible.

Sample list

Here is a sample list of some of the types of subroutines which are useful within individual programs.

MIPI
- command decoding
- program exit
- input procedure

MDPI
- display routines
- graphical and tabular output

MIPD
- specific procedures for a given purpose

MDPD
- lines 80-90 only

Machine-dependent plus program-dependent modules are extremely inefficient since they involve the maximum of translation. It is for that reason that they are discouraged. Any single statement of that type is usually at lines 90-99. An example of such a statement would be CLEAR 400. However, any substantial program sections of that type, such as file handling, will have to be kept in self-contained sections in the main body of the program.

Where it is not possible to write in machine-independent Basic, a number of subroutines have been written for particular machines. To produce a histogram with graphics characters on the 380-Z, requires a subroutine at line 7000 and 12 variables need to be set. It must be easier than writing one's own version.

Immediate advantage

So, authors will have an immediate advantage in having a range of standard routines available which have been tested thoroughly and which work in any program. There will be a further advantage in that these routines will have already been translated on to other machines.

Naturally, many authors want the fun of writing their own routines and standards such as these do not prevent it. Authors will have to follow the line-numbering and variable-naming conventions if they wish to participate in exchanging programs.

It is proposed that the standard for each machine should be free of copyright and MUSE has undertaken to form a library of routines which may prove useful to authors and teachers. They will be published from time to time with the latest versions for a number of common machine configurations.

For the moment, those routines whch have been implemented are being released with the standards so that everyone who is interested will have the opportunity to contribute to the routines on any machine.

There would be chaos if the modules had overlapping line numbers. It is, therefore, proposed that MUSE maintains its library in an orderly fashion with particulr routines at particular line numbers. Authors may ignore that but must realise that the job of transferring their work to other systems can only be done easily if machine-dependent routines can be swapped directly without altering the line numbers of control-transfer statements. To create maximum flexibility, re-numbering programs will be developed for each machine.

Line numbering

Standard subroutine/modules will be either machine-dependent or machine-independent but in both cases they will be independent of the programs which use them. An example of a machine-dependent - plus - program - independent subroutine is.

```
8000 REM NUMERIC INPUT**************
8010 INPUT ZX ^
8020 IF LEN (ZX$) = 0 THEN ZX$ = "NUL"
     :RETURN
8030 FOR J = 1 TO LEN (ZX$)-2
8035 IFMID$(ZX,J,1) = "E"THEN
     IFABS(VAL(MID$(ZX$,J + 1,3)))>20
     THEN ZX$ = "ERR":J = 100
8040 NEXT J
8050 ZX = VAL(ZX$)
8060 IF LEFT$(ZX$,1) = "0" OR LEFT$
     (ZX$,1) = "." THEN ZX$ = "":
     RETURN
8070 IF ZX + "HELP" THEN RETURN
8080 IF ZX = 0 THEN ZX$ = "ERR":
     RETURN
8090 ZX$ = "":RETURN
```

On the Pet, line 8101 must be replaced by a GOSUB to a subroutine which prevents a null input from stopping the program. The principles behind the standard line numbering and variable naming need to be outlined.

It is recommended that every program begins with lines 10 to 40 as shown. Lines 80 to 89 should contain statements peculiar to a particular version of Basic on that machine. An example follows:

```
10 REM *******TEACH******
20 REM ****A.N. Author***
30 REM ****380Z DBAS9****
40 REM ***13/9/79,V1.2***
50 REM *******PRINTER*****
80 ZW = 79   : REM SCREEN WIDTH
90 CLEAR 400
```

The main program should start at line 1000 with a REM statement and should be split into convenient modules. In a complicated module, it may be useful to have a control module betwen lines 500 and 999 which calls modules lying between lines 1000 and 4999. To clarify the idea of a control section, a simple example is given. It is not put forward as an example of good programming.

```
500 REM CONTROL
510 PRINT"command: ";
520 INUT ZC$
530 GOSUB 9000
540 GOSUB 600
600 IF ZC$ = "OPT" THEN 1200
610 IF ZC$ = "VAL" THEN 1300
620 IF ZC$ = "MOR" THEN 1800
630 IF ZC$ = "RUN" THEN 1500
640 IF ZC$ = "BYE" THEN 900
650 PRINT
660 PRINT"Command not recognised"
670 PRINT
680 RETURN
900 CLOSE
910 END
```

It is recommended that the main program is numbered as follows:

100-145	arrays, functions definitions
150-195	display program titles
200-495	program initialisation control
500-995	main program control if needed
1000-4990	main program (possibly subroutines) MIPD
5000-7990	subroutines : MDPI
8000-9990	subroutines : MIPI

Major modules should start at multiples of 1,000 and minor modules at multiples of 100. An explanation of the distinctionn between lines 500- and lines 1000- is in the full set of standards. Some machines do not have a re-numbering facility. In those cases, programs should be written starting at line 1000 and incrementing by 10. That leaves room to enter the essential lines at the beginning and to make use of standard subroutines.

Main program subroutines will not necessarily be able to start at round numbers, but authors should try to achieve that.

Agreed routines

So that the standard routines should be available to different writers on different machines, it is necessary to reserve some variable names within the routines for passing values to and from the routines.

Some machine- and dialect-dependent parameters, such as screen height and width, need to be stored under agreed names. It is suggested that the following variable names are reserved:

G**	Mainly for graphics handling.
J**	Mainly for number formatting.
J and J1-J9	For loops counting within program-independent modules.
Q*	For loop counting in the main program.
Z**	For system variables or for values to be passed to program-independent modules.

Of course, any letters chosen in that way are bound to conflict with somebody's ideas on variable naming. Mathematicians use I and J for matrix subscripts; G is gravity; Q is queue length. Every letter has its connotations, so an arbitrary choice was made. I and O were

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ruled out to avoid confusion with 1 and 0. That left J unattached, and Z and Q stand for less than other letters. G stands for graphics since that might need more standard variables than anything else.

The routine for converting a number to a given number of significant figures makes use of the variables J and J1. If these variables were being used elsewhere in the program to store certain values, use of the subroutine would alter the values and this would obviously be inconvenient.

Possible problems

This example illustrates the kind of problems that could arise.

```
1000 REM EXAMPLE
1010 J1 = 5000
1020 ZY = 4
1030 FOR J = 1 to 5
1040 ZX = SQR(J1)
1050 GOSUB 8200
1060 PRINT ZX
1070 J1 = J1 + 100
1080 NEXT J
```

Instead of printing the square roots corrected to four significant figures of the number 5,000, 5,100, 5,200, 5,300, 5,400, the program will print the square root of 5,000 and will then print the square root of 102 again and again.

As we have seen, the variable names which start with Z are used for passing values to and from routines. In the routine 8200 in the first illustration, ZX holds the value to be shortened and ZY holds the number of figures of accuracy required.

In another routine, ZX and ZY are the co-ordinates of a position on the display screen, and ZX is a string of symbols to be placed on the screen at the position ZX, ZY.

Main principles

At this stage, it is worth reiterating the MUSE minimum program standards for educational applications software. Programs may use only the subset of Basic as defined. Other features of Basic may be used only in machine-dependent-plus-program-independent modules, which must be placed at the line number suggested. Programs must have the modular structure and be user-proof as described.

Default values

Default values must be set automatically by the program and the essential line numbering must be used as defined. Programs must not use lines 5000 to 9999 except for program-independent modules. Variables starting with G, J, Z must not be used except with program independent modules.

The minimum documentation must be provided — specimen input and sample or diagram of output, operating instructions if needed and a list of variables used with meanings.

The command style of presentation as developed by Hertfordshire is commended. Recommendations are made for option lists and menus and default values are recommended. The syntax of Basic is defined in great detail, not only in terms of the syntax itself, but in terms of the effects. The standards finish with 13 pages of subroutines and specifications for subroutines.

Criticism easy

Copies of MUSE program standards are available from Charles Sweeten, 10 Rockingham Hills, Oundle, Peterborough PE8 4QA. It is easy to raise objections to any set of standards, but I hope that anyone who wishes to be destructive will also try to re-construct what they have destroyed.

Many people have co-operated in assembling the standards, but I do not expect that the result is by any means complete or even correct. We are at a stage of rapid development in computer use and it would be wrong to try to freeze progress or experimentation. Nonetheless, if a standard is accepted and an effective library established, the painful re-invention of square wheels will be avoided.

Supertank

In part one, Bob Merry looked at the first section of the game and discussed its development. This month, he gives the remaining listing and explains how the problems were finally solved.

THE PROGRAMS for Supertank use the facility in Pet for overlaying a program with a new one while retaining the variables. It is done by using the command LOAD in the first program. The only condition is that the second program is the same length or shorter than the first.

In fact, after loading, the second program appears to be identical in length to the first. To understand that, consider how Pet knows where to find the end of a program — illustrated by figure 1.

Each line of program in memory consists of a link which tells Pet where to find the next line, the line number, the text of the line and a zero. The last line in the program is followed by a double zero.

When memory is empty after first switching-on, it contains a zero, a link and the double zero. As new lines are entered, the double zero is pushed higher in memory. Pet also keeps track of the end of Basic, the position of variables and so on, by the use of various pointers in memory locations 122 to 135.

Second program

The loading of the second program does not alter the pointers or the position of the double zero in memory. That does not, of course, matter normally, except when you are trying to edit the second program.

Let us suppose you have developed the first program to the point where it seems to work. You now set about writing and entering the second program. The only way to test it is to SAVE it, return and LOAD the first one again, RUN it and make it call the second program.

Naturally enough, it does not work the first time and needs amending. If you add to the program in memory, however, you will push the double zero back and will finish with a program which appears to be longer than the first one.

What you must do before making amendments is to go back and re-load the second program. It is very useful at that stage to make spare copies of both programs, as we are going to spend a good deal of time SAVEing the latest versions on to a master tape so that they can be tested.

If nothing else, a spare copy can be a godsend when, in a moment of confusion after so many re-recording sessions, you press PLAY and RECORD instead of just PLAY.

New variables

Although new variables can be added by the second program to those already there from the first, it is a wise precaution to include them in the first program by assigning them an initial value. It has the effect of occupying seven bytes of memory and will give an out-of-memory error message if the first program grows too long.

Now let us look at the program itself. Originally, I had intended to use a straightforward sequence:

1. Player moves
2. Player attacks
3. Supertank moves
4. Supertank attacks

My first working program was of that form. However, during play-testing I found it was far too easy for Supertank to win. The player had to move his mobiles in close to score a reasonable number of hits and that left him a sitting target for the more powerful batteries of Supertank.

I solved the problem by making the mobiles more manoeuvrable — an extra movement turn between their attack and Supertank's move simulated it. Since the mobiles now moved twice, that is contained as a subroutine which occurs twice during each turn.

The program starts, in line 100, by filling the two strings, AC$ and DN$. Although they were used in the first program and space is still reserved for them in memory, the contents of each string are not carried forward and they must be re-defined.

Line 110 clears the top line, since we no longer need the co-ordinates along that edge, and subroutine 1220 prints Supertank's current strength along that line. It will be updated periodically during each turn. Subroutine 1520, called in line 120, counts the number of mobiles which have five engines or more left and are able to move.

If the player is not immobilised, Line 130 clears the bottom of the screen — subroutine 1240 — and goes on to the move subroutine at 1010. Subroutine 1230 enters a pause to let you read the message.

In the move subroutine, each mobile is taken in turn and checked for its ability to move. The number of spaces it can move depends on the number of engines it has left. The direction of move is selected by the player using the keypad. After each move has been entered, the new position is calculated in lines 1050-1130.

Legality check

That must now be checked for legality. The mobile must stay on the map — 1140 — and can move only into a clear space or ram Supertank — he cannot move into a crater or a space occupied by one of his own men.

That is checked and if it is illegal, the rest of that mobile's move is forfeit via line 1280. If the required space is occupied by Supertank itself, the program branches to the ramming Supertank routine at 1290 which calculates a number of hits, H, depending on the strength of the mobile. Those hits reduce the number of Supertank's engines.

The mobile is also destroyed and a space is printed at its last position (1320). You could have finally defeated Supertank by that move, so it has to be checked (1330), but otherwise the values of MM(I), MF(I) and N are updated and the program returns for the next mobile.

A normal move is completed in lines 1170 to 1200 and when all mobiles have been moved, the subroutine is ended.

The next phase is the player's attack, starting with a check in lines 140-150 of the remaining firepower. When Supertank reaches its secret target, it sets a flag, T, to 1 which triggers the message that this is the last attack.

Each mobile and each artillery unit attack in turn. The number of hits, H, is calculated using a formula based on the unit's firepower, a random factor, and the distance between the unit and Supertank.

The weighting factor of .9 at the end is chosen so that even the most distant units have a chance of scoring, although the maximum number of hits is limited to the firepower of the unit and can be scored only by an adjacent unit.

Each unit has the choice of aiming for engines or armament and the appropriate variable is adjusted. Various messages detailing results are contained in subroutines at 1430-1450.

Last attack

If that was the last attack, Line 480 would direct the program to the loss sequence at 1550, but otherwise there is another movement phase similar to the first. In line 510, the flag, T, is checked — a value of 2 indicates that Supertank cannot move. That flag would have been set the first time subroutine 1500 was called.

Supertank's first choice of move is determined in lines 550-580 which cause

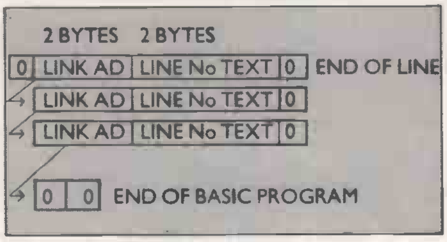

Figure 1.

Supertank to move along the X axis towards the TX column. It will move diagonally when the angle exceeds a certain value. The program also takes account of the possibility that the direct path to the target is blocked by craters.

Should Supertank's choice of move not be possible due to a crater or an artillery unit, Supertank will try all possible moves in turn (650-730). One other possibility is that it will ram a mobile. That is dealt with by subroutine 1360, which identifies the mobile it is destroying and calculates the damage caused to its engines.

Following the movement phase, Supertank attacks each defender in turn, dividing its firepower amongst the N survivors. That phase completes the turn and the program returns to 120.

As an exercise for the reader, try to discover all the possible twists and turns which arise from various combinations of factors. Everything is there for a reason — I produced several versions of Supertank before arriving at this one.

Each session of play-testing revealed new needs for modifications. Sometimes they were obvious errors, but sometimes they were more subtle. For example, in an earlier version, I had not thought of what would happen if all the defenders were destroyed before Supertank reached its target.

In the event, Supertank kept moving until it reached the target. Line 990 now puts you out of your misery. I also had to include checks in each phase to see whether the phase was possible before announcing it on the screen.

If you write a program like Supertank and have play-tested it to your satisfaction, there is one final test you should perform — the idiot test.

I had reached an advanced stage with the program and had put it to one side as an almost finished project, when I was visited by a friend who shared my liking for games but had not played with a Pet before. "Try this", I said, offering him Supertank.

Idiot factor

When I had played the game, I had evolved various tactics, which included withdrawing all my mobiles in the second movement phase as far as possible from harm's way.

John, however, left one of his in Supertank's path and it was rammed. All appeared to be well, except that Supertank's engines were not reduced — I had omitted SM = SM-H from line 1370 and would never have found it with my normal style of play.

From that, I learned that you cannot rely on the intelligence of the user and you must include checks on the validity of inputs.

```
100 AC$="▶▶▶▶▶▶▶▶▶▶▶▶▶▶▶▶▶▶▶▶▶▶▶▶▶▶▶▶▶▶▶▶▶▶▶▶▶▶▶▶":DN$="QQQQQQQQQQQQQQQQQQQQQQQ"
110 PRINT"■";:FORI=1TO40:PRINT" ";:NEXT:GOSUB1220
120 GOSUB1520 :IFR1=0THEN140
130 GOSUB1240 :PRINT"YOU MOVE":GOSUB1230
140 GOSUB1010 :GOSUB1240 :F=0:FORI=1TOMN:F=F+MF(I):NEXT
150 FORI=1TOAN:F=F+AF(I):NEXT
160 IFF=0THENPRINT"YOU HAVE NO FIREPOWER LEFT!!":GOSUB1230 :GOTO480
170 IFT=1THENPRINT"SUPERTANK AT TARGET!!!":PRINT"THIS IS YOUR LAST ATTACK":GOTO
190
180 PRINT"YOUR ATTACK"
190 GOSUB1230 :FORI=1TOMN:IFMF(I)=0THEN330
200 H=INT(MF(I)*RND(1)/SQR((MX(I)-SX)↑2+(MY(I)-SY)↑2)+.9)
210 GOSUB1240 :PRINT"MOBILE #";I;"ATTACKING-FIREPOWER";MF(I)
220 PRINT"ARMAMENT OR ENGINES(A/E)?":GOSUB1260
230 IFR$="A"THEN260
240 IFR$="E"THEN290
250 GOSUB1240 :PRINT"ANSWER A OR E":GOSUB1260 :GOTO230
260 SF=SF-H:IFSF<1THENSF=0
270 IFH=0THENGOSUB1450 :GOTO320
280 GOSUB1430 :PRINTSF;:GOTO320
290 SM=SM-H:IFSM<1THENSM=0
300 IFH=0THENGOSUB1450 :GOTO320
310 GOSUB1440 :PRINTSM;
320 GOSUB1230 :GOSUB1220 :IFSF=0ANDSM<10THEN1540
330 NEXT:FORI=1TOAN:IFAF(I)=0THEN470
340 H=INT(AF(I)*RND(1)/SQR((AX(I)-SX)↑2+(AY(I)-SY)↑2)+.9)
350 GOSUB1240 :PRINT"ARTILLERY #";I;"ATTACKING-FIREPOWER";AF(I)
360 PRINT"ARMAMENT OR ENGINES(A/E)?":GOSUB1260
370 IFR$="A"THEN400
380 IFR$="E"THEN430
```

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```
390 GOSUB1240 :PRINT"ANSWER A OR E":GOSUB1260 :GOTO370
400 SF=SF-H:IFSF<1THENSF=0
410 IFH=0THENGOSUB1450 :GOTO460
420 GOSUB1430 :PRINTSF;:GOTO460
430 SM=SM-H:IFSM<1THENSM=0
440 IFH=0THENGOSUB1450 :GOTO460
450 GOSUB1440 :PRINTSM;
460 GOSUB1230 :GOSUB1220 :IFSF=0ANDSM<10THEN1540
470 NEXT
480 IFT=1THEN1550
490 GOSUB1520 :IFR1=0THEN510
500 GOSUB1240 :PRINT"YOU MOVE AGAIN":GOSUB1230 :GOSUB1010
510 IFT=2THEN770
520 IFSM<10THENGOSUB1500 :GOTO770
530 GOSUB1240 :PRINT"SUPERTANK MOVING":GOSUB1230
540 FORL=1TOINT(SM/100+.9)
550 IFABS(SY-TY)<.5*ABS(SX-TX)THENY=SY:GOTO570
560 Y=SY+SGN(TY-SY)
570 IFSX=TXANDY<>TYTHENX=SX+1:GOTO590
580 X=SX+SGN(TX-SX)
590 J=0
600 IFX<1ORX>39ORY<1ORY>19THENJ=J+1:GOTO650
610 GOSUB1350 :IFPEEK(R1)=42ORPEEK(R1)=129THENJ=J+1:GOTO650
620 IFPEEK(R1)<>32THENGOSUB1360
630 PRINT"■";LEFT$(AC$,SX);LEFT$(DN$,SY);" "
640 PRINT"■";LEFT$(AC$,X);LEFT$(DN$,Y);"■■":SX=X:SY=Y:GOTO750
650 X=SX:Y=SY:ONJGOTO660 ,670 ,680 ,690 ,700 ,710 ,720 ,730 ,740
660 X=SX+1:GOTO600
670 X=SX+1:Y=SY-1:GOTO600
680 X=SX+1:Y=SY+1:GOTO600
690 Y=SY-1:GOTO600
700 Y=SY+1:GOTO600
710 X=SX-1:GOTO600
720 X=SX-1:Y=SY-1:GOTO600
730 X=SX-1:Y=SY+1:GOTO600
740 GOSUB(
750 GOSUB1230 :IFSX=TXANDSY=TYTHENT=1:GOTO770
760 NEXT
770 IFT=2ANDF=0THEN1550
780 IFSF=0THEN1000
790 FORI=1TOMN:IFMM(I)=0ANDMF(I)=0THEN900
800 GOSUB1240 :PRINT"SUPERTANK ATTACKING MOBILE #";I:GOSUB1230
810 H=INT(SF*RND(1)/(N*SQR((SX-MX(I))↑2+(SY-MY(I))↑2))+.9)
820 IFH=0THENGOSUB1450 :GOTO900
830 IFMM(I)/30>=MF(I)/10THEN860
840 MF(I)=MF(I)-H:IFMF(I)<1THENMF(I)=0
850 GOSUB1430 :PRINTMF(I);:GOTO880
860 MM(I)=MM(I)-H:IFMM(I)<1THENMM(I)=0
870 GOSUB1440 :PRINTMM(I);
880 IFMM(I)=0ANDMF(I)=0THENGOSUB1460
890 GOSUB1230
900 NEXT:FORI=1TOAN:IFAF(I)=0THEN980
910 GOSUB1240 :PRINT"SUPERTANK ATTACKING ARTILLERY #";I:GOSUB1230
920 H=INT(SF*RND(1)/(N*SQR((SX-AX(I))↑2+(SY-AY(I))↑2))+.9)
930 IFH=0THENGOSUB1450 :GOTO980
940 AF(I)=AF(I)-H:IFAF(I)<1THENAF(I)=0
950 GOSUB1430 :PRINTAF(I);
960 IFAF(I)=0THENGOSUB1480
970 GOSUB1230
980 NEXT
990 IFN=0THEN1550
1000 GOTO120
1010 FORI=1TOMN:IFMM(I)<5THEN1210
1020 GOSUB1240 :PRINT"MOVE MOBILE #";I
1030 PRINT"UP TO";INT(MM(I)/10+.5);"SPACES-FIREPOWER IS";MF(I)
1040 FORJ=1TOINT(MM(I)/10+.5):GOSUB1260 :R=VAL(R$):IFR=0THENR=5
1050 X=MX(I):Y=MY(I):ONRGOTO1060 ,1070 ,1080 ,1090 ,1170 ,1100 ,1110 ,1120 ,113
0
```

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```
1060 X=MX(I)-1:Y=MY(I)+1:GOTO1140
1070 Y=MY(I)+1:GOTO1140
1080 X=MX(I)+1:Y=MY(I)+1:GOTO1140
1090 X=MX(I)-1:GOTO1140
1100 X=MX(I)+1:GOTO1140
1110 X=MX(I)-1:Y=MY(I)-1:GOTO1140
1120 Y=MY(I)-1:GOTO1140
1130 X=MX(I)+1:Y=MY(I)-1
1140 IFX<1ORX>39ORY<1ORY>19THEN1280
1150 GOSUB1350 :IFPEEK(R1)<>32ANDPEEK(R1)<>147THEN1280
1160 IFPEEK(R1)=147THEN1290
1170 PRINT"■";LEFT$(AC$,MX(I));LEFT$(DN$,MY(I));" "
1180 PRINT"■";LEFT$(AC$,X);LEFT$(DN$,Y);"■";RIGHT$(STR$(I),1);"■"
1190 MX(I)=X:MY(I)=Y
1200 NEXT
1210 NEXT:RETURN
1220 PRINT"■SUPERTANK'S FIREPOWER";SF;"■ ENGINES";SM;"■  ":RETURN
1230 FORK=1TO1500:NEXT:RETURN
1240 PRINT"■";LEFT$(DN$,20);:FORK=1TO199:PRINT" ";:NEXT
1250 PRINT"■";LEFT$(DN$,20);:RETURN
1260 GETR$:IFR$=""THEN1260
1270 RETURN
1280 GOSUB1240 :PRINT"ILLEGAL MOVE! FORFEIT TURN":J=3:GOSUB1230 :GOTO1200
1290 GOSUB1240 :PRINT"RAMMING SUPERTANK"
1300 H=INT((10+MM(I)+MF(I))*RND(1)+5):SM=SM-H:IFSM<0THENSM=0
1310 PRINT"YOU'VE DESTROYED";H;"ENGINES";:GOSUB1230 :GOSUB1220
1320 PRINT"■";LEFT$(AC$,MX(I));LEFT$(DN$,MY(I));" "
1330 IFSM<10ANDSF=0THEN1540
1340 MM(I)=0:MF(I)=0:N=N-1:J=3:GOTO1200
1350 R1=32768+X+40*Y:RETURN
1360 I=PEEK(R1)-176:IFI=0THENI=10
1370 H=INT(RND(1)*(10+MM(I)+MF(I))+5):SM=SM-H:IFSM<0THENSM=0
1380 GOSUB1240 :PRINT"SUPERTANK RAMS MOBILE #";I
1390 PRINT"LOSING";H;"ENGINES";:GOSUB1230 :GOSUB1220
1400 IFSM<10ANDSF=0THEN1540
1410 MM(I)=0:MF(I)=0:N=N-1:IFSM<10THENGOSUB1500 :L=3
1420 RETURN
1430 PRINTH;"HITS ON MISSILE LAUNCHERS-NOW";:RETURN
1440 PRINTH;"HITS ON ENGINES-NOW";:RETURN
1450 PRINT"NO HITS SCORED";:RETURN
1460 GOSUB1240 :PRINT"MOBILE #";I;"DESTROYED":N=N-1
1470 PRINT"■";LEFT$(AC$,MX(I));LEFT$(DN$,MY(I));" ":RETURN
1480 GOSUB1240 :PRINT"ARTILLERY #";I;"DESTROYED":N=N-1
1490 PRINT"■";LEFT$(AC$,AX(I));LEFT$(DN$,AY(I));" ":RETURN
1500 GOSUB1240 :PRINT"SUPERTANK CANNOT MOVE"
1510 PRINT"NOW YOU MUST DISARM IT TO WIN":T=2:GOSUB1230 :RETURN
1520 R1=0:FORK=1TOMN:IFMM(K)>4THENR1=R1+1
1530 NEXT:RETURN
1540 PRINT"■CONGRATULATIONS !! YOU HAVE BEATEN SUPERTANK":END
1550 PRINT"■SORRY!! YOU HAVE FAILED TO PREVENT A":PRINT"■NUCLEAR HOLOCAUST"
1560 PRINT"■    \    \     |   |    /    /"
1570 PRINT"     \     ▁▁▁▂▂▁▁▁▂▂▂▁▁▁▁▁▁   /"
1580 PRINT"    \   ◥                  ◤  /"
1590 PRINT"    /   ▌                  ▐  \"
1600 PRINT"    /   ◣■                ■◢   \"
1610 PRINT"       ▁▁▁▁▁▁  ◥▌    ◤  ▁▁▁▁▁"
1620 PRINT"         \ \   ▌    ▐   / /"
1630 PRINT"               ▌    ▐"
1640 PRINT"           \   ▌    ▐  /"
1650 PRINT"               ▌   ▐"
1660 PRINT"               ▌   ▐"
1670 PRINT"               ▌   ▐"
1680 PRINT"    ▁▂▁▂▁▁▁▁  \■■■■/  ▁▁▂▂▁▁▁▁▁"
1690 PRINT"■              ◣\\X//◢          ■"
1700 PRINT"■              ▀▀▀▀▀■          ■"
1710 PRINT"
READY.
```

Prospecting for new materials with microprocessor-control

A Research Machines 380-Z is being used by the Solid State Ionics Unit at the Royal School of Mines in London to help evaluate new materials for industrial applications. Martin Hayman meets the men responsible for the establishment of the project and reports on its progress.

DAN WATERS of the Royal School of Mines, London, saw the writing on the wall when a U.S. visitor examined the researches in which he and his department, headed by Dr Brian Steele, had been engaged for several years.

Steel fabrication

Dr Steele is a reader in materials science at the Solid State Ionics Unit and had been investigating new materials for industrial applications, notably for steel fabrication processes and for new, lightweight batteries; Dan Waters is something of a micro buff.

Much of the experimental work was laborious and tedious — it was necessary to determine empirically the impedances of materials under analysis at various temperatures, throughout the frequency range.

At first, it had mostly been a case of stopwatch and note pad, but the U.S. visitor, seeing the experiment was on the right track but hopelessly slow at producing results, returned home, set-up the same experiment with microprocessor-control and data logging and within a few weeks had run the whole investigation.

Beneficial warning

It was a salutary warning. Research budgets at universities are not on the increase; productivity is beginning to be invoked. Yet it is still possible to secure cash for capital investments and a change to microprocessor-control would free staff for more productive work.

In the first place, a more sophisticated data logger was required, one which could be programmed with a frequency sweep over a predetermined number of steps and would record the results in a rapidly-assimilable form. Such a machine is the Solartron 1170 FR, though its application in this instance is novel.

Stress tester

Designed and used originally as a stress tester for airframes, it was used widely on the development of the Concorde. The airframe would be twisted in a simulation of all possible foreseen conditions of flight and the strain measured by sensors at selected points. The Solartron plotted the stress, x axis, against strain, y axis, and

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Nicky Bonanos and Dan Waters. Bonanos helped Waters develop the program for the 380-Z. On the screen is a frequency analysis plot of a sample of zirconium.

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would display the resulting graph on an oscilloscope.

By a neat transformation, Dr Steele used the machine to plot voltage (x) input to the material — in this case various samples of zirconia — against the resistance (y) to yield values for the impedance. Mostly, at this stage, the unit was content to photograph the oscilloscope read-out and work by intuition. The shape of the curve was to trained eyes an indication of the usefulness of the particular sample for the purpose intended.

The purpose was at that time to develop a new form of oxygen probe for the smelting industry and, perhaps, for internal combustion engines. The oxygen probe may seem a marginal device, but in steel making it is vital to measure the presence of oxygen in the smelted metal, and to a lesser extent to monitor emissions from chimneys in all industries.

Measurement problems

That is difficult to measure by chemical means at the high temperatures involved and the traditional ceramic-type probe has a short life expectancy. Hence, it may be seen, the U.S. visitor's interest in the experiment and doubtless his surprise that the results were being photographed from the oscilloscope rather than logged and processed by a micro.

The next development, then was to interface the Solartron with an intelligent, or at least smarter, logger. Dan Waters was able to obtain two Research Machines 380-Zs and "lashed them together" with two Z-80 P10 chips — an intriguing piece of do-it-yourself which was not essential since both Solartron and, of course, Research Machines have suitable interfaces.

Time saving

The first notable effect of using the micro as a controller was the time saving. It is a platitude that the micro does not in itself increase output; it maximises the use of existing installations or, in this case, staff.

Where the micro can now process a complete run in half an hour, staff would previously have dedicated about two days' work with the stopwatch "if nothing went wrong".

It also combatted a further problem of semi-automation. As an early time-saving experiment, Dan Waters had constructed a small process controller which logged and printed out impedance results but in this case, continuous running simply provided more data than could be handled. Simply, the mind boggled at the prospect of deciphering and interpreting a continuous and smudgy print-out on a paper reel.

With the micro, all the experiments can be compared directly on the same basis, whether done yesterday or six months previously. In effect, it has freed research students to concentrate on deriving meaning from the results rather than spending hours simply logging them.

The work at the department is still expanding and three more 380-Zs are on order. The reason for continuing with the 380-Z is that the principal applications for the machine are controlling the experiments and logging and processing data; plenty of memory is required, but no more VDUs.

Waters did consider the Pet but decided against it because of the need for IEEE interfaces to the Solartron and is now wondering whether he might have done well to wait for the Winchester hard disc or double-sided 8in. discs instead of the standard 5¼in. drives.

New avenues

In the meantime, a new avenue of approach presents itself — batteries. That has been a secondary activity but with giants like Exxon and Varta seriously looking to invest in new battery technology, there would appear to be plenty of mileage in research directed towards assessing the materials required to produce a battery reliable enough to charge and discharge several hundred times.

On a giant scale the materials might be required to act as a buffer for electrical power stations, hence reducing the need for installed capacity. With the EEC, the Science Research Council, Chloride and NATO all putting in a stake, this area of materials research certainly needed to be dragged into the micro era.

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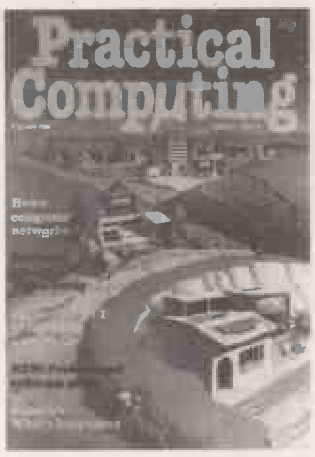

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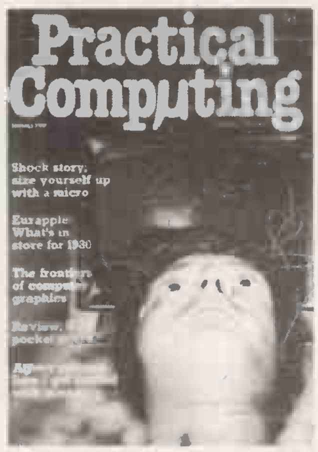

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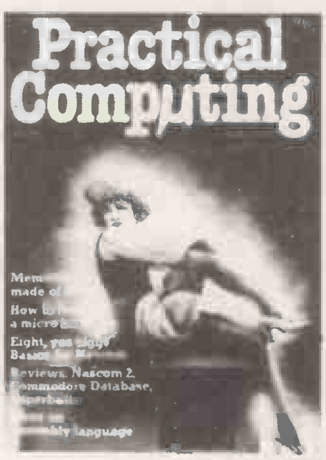

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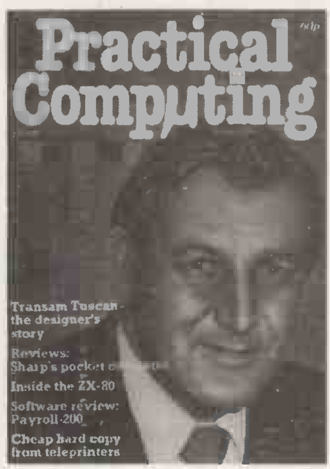

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Byte and bit manipulation

This month, David Peckett widens the scope of his discussion of machine code to take in the more complex Z-80 and deals with the intricacies of byte and bit manipulation.

SO FAR, we've been looking at the 6502 and the roughly-comparable 8080A. The 6052, of course, is used widely in personal computers such as the Pet and Apple. On the other hand, although the 8080A is probably the most widely-used micro in the world, it isn't common in personal computers.

In the early part of the series, it was appropriate to look at the 8080A, since it

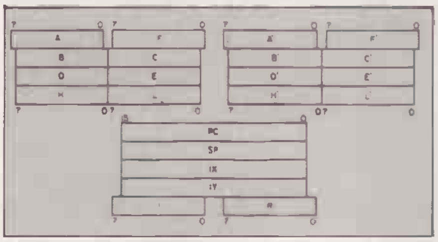


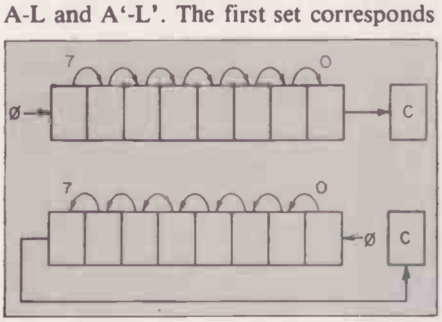
Figure 1a. Z-80 architecture.

shows an alternative approach to that taken by the 6502 designers. We are now at the stage of producing useful program segments, so I propose to change course slightly to look at the 8080A big cousin, the Zilog Z-80 — the micro used in computers such as the Nascom and the TRS-80.

As you will soon see, the Z-80 is much more complex than the 8080A, but has the significant ability to run 8080A machine code. However, it has a wide range of extra facilities which the 8080A does not begin to offer.

The Z-80 designers took the 8080A architecture as a starting point, and improved and extended it wherever they could. The result is a device with the configuration shown in figure 1a.

The first and most obvious difference is that it has two sets of working registers: A-L and A'-L'. The first set corresponds



Figures 1b and 1c.

to the 8080A registers, and are effectively identical to them. The second set provides the same facilities as the first set and may be used as an alternative to it.

The micro can perform operations in either set of registers but, and this is important, cannot swap data between the two sets. For example, you cannot load B with the contents of L'. The chip has special instructions to select which set of registers it is to work in. The double set can make the Z-80 much faster than the 8080A in areas such as servicing interrupts.

The registers labelled F and F' are the flag registers and correspond to the 8080A PSW. The Z-80 has the same flags as the Intel micro, plus extra ones — figure 2b. The S,Z and C flags are identical to their counterparts in the 8080A; the H flag is the same as the 8080 "AC".

The flag labelled "P/V" is equivalent to the 8080A "P", but it is not just a parity flag. When set by a logical operation or a shift it behaves as a parity flag. However, when it is set by an arithmetic operation, including increment and decrement, it becomes an overflow flag, equivalent to the 6502 "V". It, thus, rectifies an important weakness of the 8080A. A few of the Z-80 special instructions use "P/V" as a "pseudo-Z" flag.

The "N" flag is an internal Z-80 flag, used during BCD arithmetic.

In figure 1a, PC and SP are identical to those in the 8080A. The IX and IY registers, however, are very useful additions. They are 16-bit index registers, and give the Z-80 a true indexing capability.

The final two registers are each eight-bits

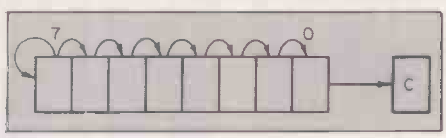


Figure 2a. Arithmetic shift right.

long. "I" is the "Interrupt-page Address" register and is used in certain types of interrupt service routine. "R" is the "Memory-Refresh" register, which primarily controls dynamic RAM. It is not normally used in programs but is left to its own devices.

In programming the Z-80, the attraction is that it can use almost any 8080A machine-code program. One possible danger lies in the change from a "P" to a "P/V" flag. Nevertheless, it is very unlikely that an 8080A program would use the "P" flag in a way which would confuse the Z-80. Instruction timings are not always identical between the two micros, so that might cause problems with critically-timed programs.

The Z-80, however, has many more programming options than the 8080A. In particular, it has a much wider choice of addressing modes. It also has a useful group of instructions to perform such operations as block transfers, and searches for a character in a block of data.

To accommodate all the extra instructions, Z-80 operations can use up to four bytes. Either a two-byte instruction and a two-byte address, or a three-byte operation with a single byte of data. The 8080A-compatible instructions, of course, use the same opcodes as that micro.

The Z-80 assembly language is rather different from that for the 8080A. That

Figure 2b. Z-80 flag register.

might be confusing at first, but remember that the mnemonics are arbitrary labels for specific opcodes.

Z-80 mnemonics are more logical, and certainly more systematic, than those of the 8080A. They follow a rigid pattern of:

operation	opcode

with all operations of a given type having the same mnemonic. For instance, all data transfers — register-register, immediate, to or from memory, etc. — are "LDS"s.

When 2 operands are needed, they are both shown:

op1	op2

As in the 8080A, data goes from op2 to op1.

The operands are well-chosen. Single registers are shown by their letters, e.g., B, D, and RPs are represented by a pair of letters, e.g., HL. References to memory, whether via a label, an RP or direct, are enclosed in brackets, and numeric labels or data are presented normally. One major difference is that "M" becomes "(HL)". Some 8080A/Z-80 equivalents are shown in table 1, and table 2 shows all the basic 8080A mnemonics we have met so far and their Z-80 counterparts.

From now on, I shall refer to the Z-80 rather than to the 8080A. However, I shall adhere to the 8080A-compatible instruc-

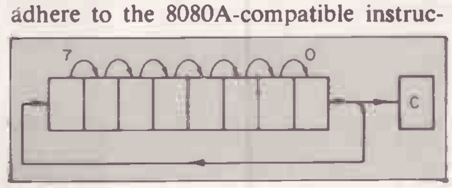


Figure 3a.

tions while I am comparing the 6502 and the Z-80.

At this stage, a few comments on specific Z-80 instruction may well be useful:

DAA. The 8080A "DAA" works properly only after addition; the instruction in the Z-80 works after subtraction as well.

DJNZ. This is a very useful instruction in loops. It decrements B, and makes a relative branch, not a jump, if the result is not zero. This speeds loops because:

```
DEC  B
JP   NZ, START ; END OF LOOP?
```

can be replaced with:

```
DJNZ START ;END OF LOOP?
```

So far in this series, we have looked at instructions which treat complete bytes of data as numbers or characters — they add and subtract them, load them and store them. That is reasonable enough — many micros are used as number-crunchers. However, it is not always the case.

For instance, we could be using the micro to control an external device, or to take-in and re-format data from, for example, a keyboard. In such cases, we must be able to manipulate individual bits in a byte.

At other times, we may need to change the position of a group of bits, while retaining their relationships, e.g., move bit 0-3 to become bits 2-5. This month, I'll describe the character- and bit-manipulation facilities which typical micros offer.

We often need to move complete groups of bits sideways, either to the right

8080A	Z-80
ADD M	ADD A,(HL)
JMP FINISH	JP FINISH
JNZ LOOP	JP NZ,LOOP
LDA $BEEF	LD A, ($BEEF)
LXI H,COUNT	LD HL,COUNT
MOV B,M	LD B, (HL)
MVI A,37	LD A,37
SHLD DATA	LD (DATA),HL
SUB C	SUB C
STAX B	LD (BC),A

Table 1. Typical 8080A and Z-80 instructions compared.

or the left, for a given number of bits. One reason for doing so is to shift a series of single bits into a position where we can read them, for instance, to test the status of a number of input lines.

Alternatively, we often use shifts during arithmetic, both during multi-byte operations and as a form of multiplication. Sometimes, after an operation has put bits into the lower nybble of a byte, they must be moved into the upper nybble to make room for more data.

Large computers often have powerful shift instructions, capable of moving, say, 64 bits through "n" positions with a single operation. In a micro, however, we must be satisfied with much more limited instructions. We can normally only move a single byte through one bit at a time. The range of possible shifts is often limited as well.

Let us look first at what might be possible and then at what we possess. Shifts fall into two main types — simple shifts and "rotates".

Simple shifts. If we want to move a byte sideways, we can use a simple shift. The

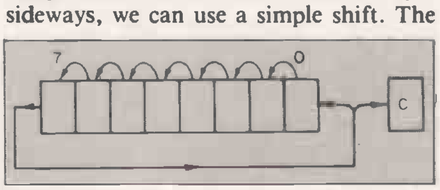


Figure 3b.

operation will move the byte one bit to the right or left, and put the bit which falls-off into the carry.

What happens to the bit at the other end depends on the type of shift. In a logical shift, the value of the bit in the hole is set to zero. Figures 1b and 1c show logical shifts to the right and left respectively.

The alternative is an arithmetic shift, in which an MSB hole is kept at its previous value, and an LSB hole is set to zero. It is particularly important in right shifts, where it means that the sign of the byte is retained. Figure 2a shows an arithmetic right shift. An arithmetic shift to the left is the same as a logical left shift — the former term is more often used because of the multiplication property of a left shift.

Simple shifts can be used to re-position a group of bits within a byte. They can also be used to read some or all of the bits in a byte, by shifting them into the carry where they can be tested.

Rotations. A rotation is exactly what the name implies. As in a simple shift, the byte is shifted one place so that a bit at one end falls from the word — normally, that bit is stored as the carry. Depending on the type of rotate, the hole which forms at the other end is filled with either what fell-off — eight-bit rotation — or with what was previously in the carry — nine-bit rotation.

The rotation could take place either to the right, i.e., the LSB falls out, or to the left, when the MSB falls out. Figures 3a and 3b show eight-bit right and left rotation, and figures 4a and 4b show nine-bit right and left rotations.

When are the two used? If, for instance, we want to test the status of each bit in a word, and leave it unchanged, we could do it with eight, eight-bit rotates. Following each rotate, the carry flag would show the status of the shifted bit, and appropriate action could be taken. After eight rotates, the word would be back where it started.

On the other hand, we may have four bytes representing a single 32-bit word to

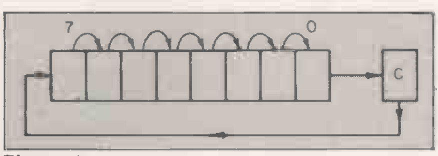


Figure 4a.

be shifted, for example, one bit left. An eight-bit left rotate, or left shift, on the least significant byte would put its MSB into the carry. A nine-bit rotate on the next byte moves this bit into the LSB, shifts the other bits up, and primes the carry with the second byte's MSB.

By doing two more nine-bit left rotates, we effectively move all 32 bits one bit to the left, leaving the MSB in the carry. This byte-to-byte carry property of the nine-bit rotation is invaluable when we do multiplication.

A point to note about shifts is that a single shift effectively multiplies or divides the shifted word by two. For example, consider the bit pattern:

00110101

That represents 53_{10}. If we logically

8080A	Z-80
ACI d	ADC A,d
ADC r	ADC A,r
ADD r	ADD A,r
ADI d	ADD A,d
CMC	CCF
CMP r	CP r
CPI d	CP d
DAA	DAA
DAD rp	ADD HL,rp
DCR r	DEC r
DCX rp	DEC rp
DI	DI
EI	EI
INR r	INC r
INX rp	INC rp
JMP a	JP a
Jcnd a	JP cnd,a
8080A	**Z-80**
LDA a	LD A,(a)
LDAX rp	LD A, (rp)
LHLD a	LD HL, (a)
LXI rp,d	LD rp,d
MOV r_1,r_2	LD r_1,r_2
MVI r,d	LD r,d
NOP	NOP
PCHL	JP (HL)
SBB r	SBC A,r
SBI d	SBC A,d
SHLD a	LD (a),HL
STA a	LD (a),A
STAX rp	LD (rp),A
STC	SCF
SUB r	SUB r
SUI d	SUB d

Notes:
"a": Address 16 bits
"d": Data eight or 16 bits
"r": Register A-L, or M, 8080A, or HL Z-80
"rp": Register pair, 8080A format is: B,C etc. Z-80 format is: BC etc.
"cnd": Controlling condition for conditional jumps; can be: C, M, NC, NZ, P, PE, PO or Z

Table 2. Equivalent 8080A/Z-80 instructions.

shift it one bit to the left, we shall obtain:

01101010

or 106_{10}. The introduction of a "0" into the LSB retained the pure multiplying nature of the operation — hence its alternative name of arithmetic left shift.

Shifting the original bit to the right gives:

0011010

or 26_{10}. This is an integer division by two, and the carry holds the remainder, one in this case.

You can see that a careful combination of shifts and adds can be used to multiply by any fixed integer, and to divide by a power of two. That can be very useful in a

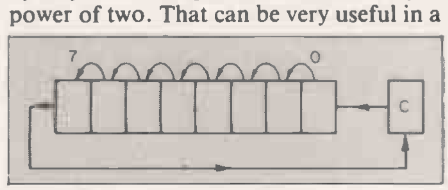


Figure 4b.

program which needs quick arithmetic with a constant.

6502 shifts. The 6502 offers only a limited choice of shifts. They are defined in table 1, and are: Nine-bit ROtate Right (ROR) and ROtate Left (ROL). Arithmetic Shift Left (ASL) and Logical Shift Right (LSR).

(continued on next page)

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These operations can shift the accumulator, or address in memory reached via a limited range of addressing modes.

Z-80 shifts. The Z-80 gives a wider choice than the 6502, and can perform eight- or nine-bit rotates, arithmetic and logical shifts right, and an arithmetic shift left: Rotate Left/Right past Carry (RLC,RRC) are eight-bit rotations. Rotate Left/Right through carry (RL, RR) are the nine-bit rotates. The arithmetic shift right has the mnemonic "SRA", and the logical shift right uses "SRL". The mnemonic for the arithmetic shift left is "SLA".

All these operations can be performed on any of the seven working registers, or on (HL), the memory location pointed to by the RP HL. They do not correspond directly to the equivalent instructions in the 8080A, which only offers rotates, and then only of A. These 8080A opcodes are preserved in the Z-80 as: Rotate Left/Right past Carry (RLCA,RRCA). Rotate Left/Right through carry (RLA, RRA).

Whenever you can, you should use these, as they operate faster than the more general Z-80 instructions.

The Z-80 also has what amounts to a 16-bit logical left shift. You will remember that "ADD HL,rp" gives a 16-bit add of an RP to HL. "ADD HL,HL" is, therefore, equivalent to multiplying HL by 2, which is the same as a left shift. Hence:

ADD HL,HL = 16-bit Left Shift

A good example of the use of shifts is a practical algorithm for multiplication. It uses shifts, both to read single bits and to multiply by powers of two.

In the third article in this series, we calculated (x*y) by adding together "x" "y"s. There is a better way. If you use long multiplication to calculate, for example:

123 * 5678

you perform repeated multiplication and addition:

(123*5*1000) + (123*6*100) + (123*7*10) + (123*8)

which you could write as:

(((123*5*10 + 123*6)*10 + 123*7)*10 + 123*8)

You can use exactly the same technique in binary arithmetic. For example, you can calculate:

10101 * 11001

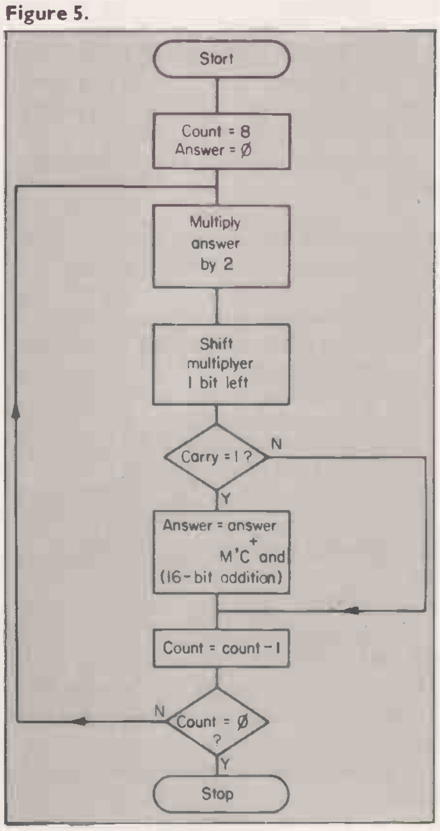
by computing:

((((10101*1*2 + 10101*1)*2 + 10101*0) *2 + 10101*0)*2 + 10101*1)

Each multiplication by two corresponds, of course, to a left shift.

We can write this procedure as a flowchart — figure 5. That shows the multiplication of two, eight-bit numbers, with the 16-bit result going into "ANSWER". You can see that it uses shifts to give each doubling, and also uses shifts to read each bit of the multiplier, starting at the MSB.

Figure 5.




```
;8X8 BIT MULTIPLICATION FOR 6502
;
;INITIALIZE REGISTERS
;
        LDA   #0          ;LOW BYTE OF RESULT
        STA   ANSWER+1    ;HIGH BYTE OF RESULT
        LDX   #8          ;USED AS COUNTER
LOOP    ASL   A           ;MULTIPLY ANSWER
        ROL   ANSWER+1    ;BY 2 USING SHIFTS
        ASL   MPLIER      ;READ MSB OF MULTIPLIER
        BCC   NOADD
;PERFORM 16-BIT ADDITION
        CLC               ;CLEAR CARRY FOR ADDITION
        ADC   MCAND
        BCC   NOADD       ;MOVE CARRY TO HIGH BYTE?
        INC   ANSWER+1    ;YES
NOADD   DEX
        BNE   LOOP        ;FINISHED YET?
        STA   ANSWER      SAVE LOW BYTES OF ANSWER
;
;FINISHED
```

Figure 6a.

6502 multiplication. Figure 6a shows the code to implement figure 5 on a 6502. In the calculation, A is used as the lower byte of "ANSWER", while the high byte is manipulated directly. X is used as the loop counter, and the lack of other suitable internal registers forces us to operate on the multiplier ("MPLIER") and multiplicand ("MCAND") directly.

The 16-bit rotation of the answer uses an "ASL" to bring a "0" into the LSB; the carry goes into the high byte via a "ROL". We then have the usual clumsy 16-bit addition of the 6502. Finally, the low byte of the answer is put into memory from A.

The routine leaves the multiplier set to zero, but does not alter the value of the multiplicand.

Z-80 multiplication. Because the Z-80 has more internal registers, it does not have to operate on the main memory during the multiplication. The routine, therefore, will not destroy "MPLIER" or "MCAND".

The program is straightforward. The multiplier is stored in A, and B is used to hold the count so that we can use "DJNZ". The answer is formed in HL, which is operated on by "ADD HL,HL" to give a 16-bit shift. I have also put "MCAND" into DE so that I can use 16-bit addition and not worry about carry.

If you are using 16-bit addition with a Z-80, and the number which you are adding has only eight bits, it should go into the low byte, e.g., E, of the RP. The high byte must be zero. You will notice that I took care of this during the initialisation; if I had forgotten to zero D, the results would have been garbage.

There are three basic logical operations which we can perform on bits: AND, OR and Exclusive-OR (XOR). They operate on pairs of bits, and also have complement forms, NAND, NOR and XOR — the last one is very unusual. Single bits can also be complemented. For reference, figures 7a, 7b and 7c show the truth tables of the three basic operations.

These are such useful functions that you'll find that a computer always offers some or all of them. In a typical micro, the operations will work only on bytes, and not isolated bits. That is no problem, because the micro actually performs the appropriate operation eight times — once for each pair of corresponding bits.

To give a few examples, using nybbles to keep the writing down:

```
;8X8 BIT ADDITION FOR Z80
;
;INITIALIZE REGISTERS
;
        LD    HL,MCAND       ;SET POINTER
        LD    E,(HL)         ;SET UP DE WITH 16-BIT
        LD    D,0            ;MULTIPLICAND FOR ADDING
        LD    A,(MPLIER)
        LD    B,8            ;B IS COUNTER
        LD    HL,0           ;ANSWER WILL FORM IN HL
;PERFORM MULTIPLICATION
LOOP    ADD   HL,HL          ;MULTIPLY ANSWER BY 2
        RLA                  ;READ MSB OF MULTIPLIER
        JP    NC,NOADD       ;BIT = "1"?
        ADD   HL,DE          ;YES, ADD MCAND TO ANSWER
NOADD   DJNZ  LOOP           ;FINISHED YET?
        LD    (ANSWER),HL  ;YES, SAVE RESULT
;
;FINISHED
```

Figure 6b.

1001 . 1010 = 1000
1001 + 1010 = 1011
1001 ⊕ 1010 = 0011
$\overline{1001}$ = 0110

Remember that a "+", in this context, means "OR".

How can we use these operations? There are many possibilities, but some of the common ones are:

Truncation. It is sometimes necessary to truncate a byte, by setting, for example, the four MSBs to zero while retaining the four LSBs. We can use the AND function for this:

abcd efgh.0000 1111 = 0000 efgh

Augmentation. That is the opposite of truncation. Sometimes, we must set specific bits to "1", while preserving the rest. The OR function is useful for this:

abcd efgh + 0000 1111 = abcd 1111

Complementing. If we need to complement a whole byte, we often have an instruction to do this. Sometimes, there is no special instruction, or we want to complement only specific bits. In this kind of case, the XOR is useful:

abcd efgh + 0000 1111 = abcd efgh

Let us look now at the logical operations we have in the 6502 and Z-80. They are shown in this month's list of instructions, table 3; as you can see, the two micros have similar facilities.

6502 bit manipulation. The 6502 provides only the three basic dyadic, i.e., working on two operands, logical operations — AND, OR and XOR. All three work on the accumulator's contents and either immediate data or a byte in memory; the result is left in the accumulator. In some cases, it would be useful to have either X or Y as the second operand, but, unfortunately, it is not possible.

The 6502 does not have a complement instruction. However, we can use the XOR instead:

```
EOR#$FF ;COMPLEMENTS THE ACC
```

Obviously, that needs two bytes, as opposed to the single byte that a true complementing instruction would require.

If we want to form the two's complement of the accumulator, it is easy:

```
EOR#$FF  ;ONES COMPLEMENT
CLC      ;ENSURE CARRY CLEAR
ADC#1    ;TWOS COMPLEMENT
```

That takes five bytes; some micros can do it using a single instruction.

There is one more useful logical operation in the 6502 instruction set — "BIT" BIt Test. It is a logical version of the "CMP" used to compare bytes, and provides a useful way of checking to see if specific bits in a word are set.

The instruction ANDs together the contents of the accumulator and the data defined by the operand. The result is not stored anywhere, but is used to control the Z flag. At the same time, "BIT" sets the N flag to the value of the MSB (bit 7) of the operand, and the V flag to the value of the operand's bit 6. These functions are summarised in figure 8.

BIT is normally, but not exclusively, used to check for a single bit's being set. The accumulator is loaded with a 1 in the appropriate position, with all the other bits set to zero. This pattern is called a mask. BIT is then executed; if the tested bit is set, the AND will be TRUE, and Z, therefore, set to zero. The converse obviously applies, as well. The Z flag thus shows whether or not the result of the AND is zero.

Since N and V are set directly by BIT, there is no point in setting a mask for

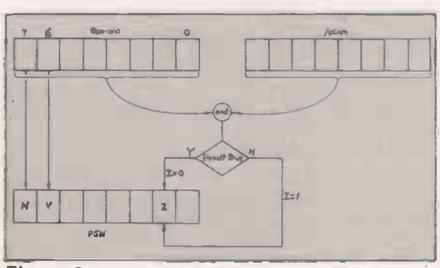


Figure 8.

either of the two MSBs; we can use whatever rubbish is in the accumulator.

BIT is very limited in the addressing modes it can use. Table 4 shows the modes available with this month's instructions — you can see that BIT uses only direct and Page-0 addressing.

Z-80 bit manipulation. As you can see from table 3, the Z-80 has the same basic bit manipulation instructions as the 6502 — AND, OR and XOR. The instructions have implied, register-based, and immediate forms.

Essentially, the instructions work exactly like their 6502 counterparts, but their detailed effects on the flags are

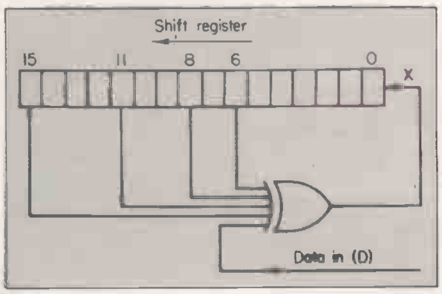


Figure 9.

different. Table 3 shows that more flags are modified by the Z-80 logical operations, and that all three logical operations set the carry flag to zero. Furthermore, the OR and XOR also clear the half-carry flag (H). The AND operation sets H to "1".

These flag manipulation properties can be useful. Data transfers in the Z-80 do not set the flags, unlike those in the 6502. However, sometimes we want to load A and test it. By ORing or ANDing A with itself, we can set the flags for testing without affecting the contents of A. For instance:

```
LD A,(HL)  ;LOAD A
OR A       ;SET FLAGS
JP Z,ZERO  ;TEST
```

We can also use "OR A" to clear the carry flag — we may well need to do this before a loop which performs multi-byte addition. The 6502, of course, has instructions to clear and set C, but the Z-80 can only set and complement it. To clear the carry with:

```
SCF ;CARRY=1
CCF ;CARRY=0
```

needs two bytes of code; "OR A" does it with one.

Another common requirement is to set the accumulator to zero. One way is obviously "LD A,O", which needs two bytes. A quicker and neater way is via "XOR A", which does the same job in a single byte.

One more trick we can perform with the Z-80 logical instructions is to test whether an RP has decremented to zero. Since the Z flag is not set when that happens, we have had to resort to clumsy constructions like:

```
LD A,0
CP L
JP NZ,NOTZRO ;LOW BYTE ZERO?
CP H
JP NZ,NOTZRO ;HIGH BYTE ZERO?
```

We can use the OR function to combine the contents of two, or more, registers:

```
LD A,L
CR H          ;A=H.OR.L
JP NZ,NOTZRO  ;ALL BITS ZERO?
```

This uses five bytes, compared to the 10 of the first method.

Like the 6502, the Z-80 has a bit-testing capability. It is, however, mechanised differently. The command "BIT b,r" tests whether bit "b" — the bits are numbered from 0-7 — of register "r" — which includes (HL) — is "1". If it is, Z is cleared, otherwise Z is set to "1".

That mechanism is less flexible than that of the 6502. Only one bit can be tested at a time, and it is not practical for the program to calculate or modify the bit to be tested. Nevertheless, it is an advance on the 8080A, which has no bit-testing capability.

The Z-80 can also set or clear specific bits in any register, via the "SET b,r" and "RES b,r" operations. Again, only one bit at a time can be set or cleared and the programmer must select the appropriate bit explicitly. It does avoid the need to fiddle with "AND"s or "OR"s.

Unlike the 6502, the Z-80 can comple-

(continued on page 113)

Figures 7a, b and c.

B \ A	0	1
0	0	1
1	1	1

B \ A	0	1
0	0	0
1	0	1

B \ A	0	1
0	0	1
1	1	0

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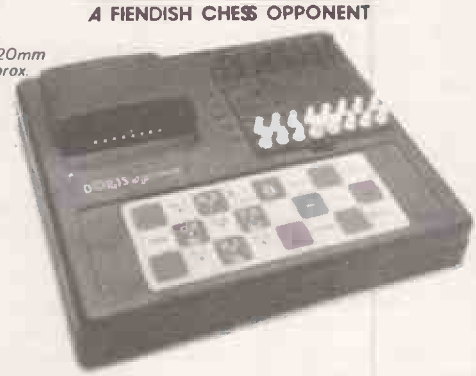

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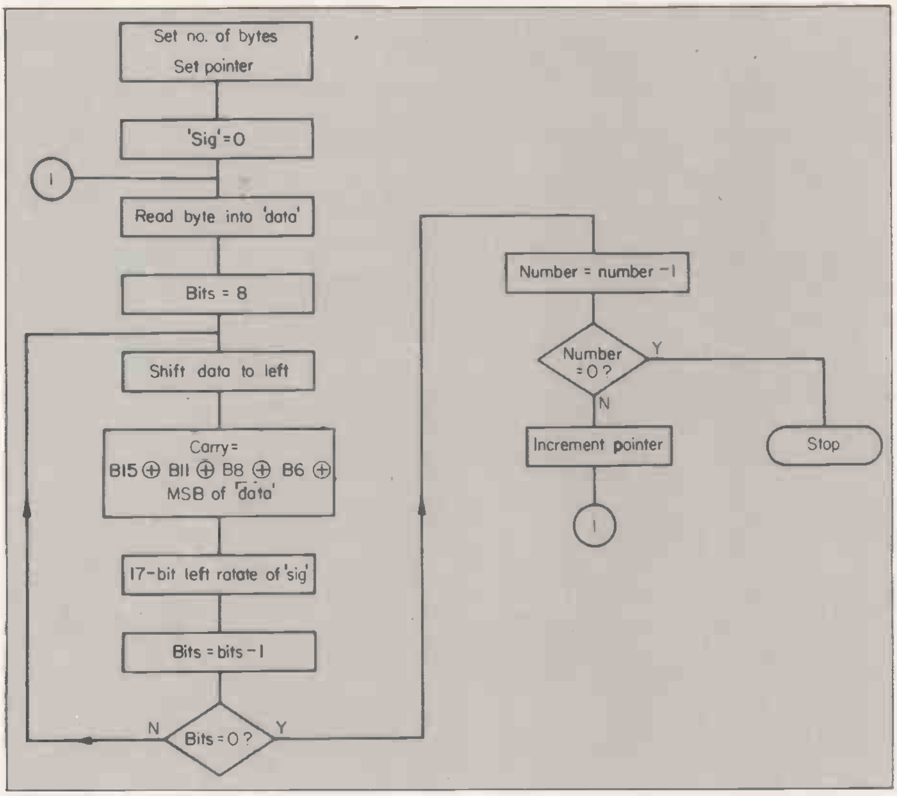

Figure 10.

(continued from page 111)

ment A with "CPL". It works on A only and gives the one's complement of the data in the accumulator. "NEG", which has no 8080A equivalent, will give the two's complement of A.

Extra Z-80 operation. There is one more Z-80 instruction that is worth describing — the "EX DE,HL" (EXchange DE and HL).

As the mnemonic suggests, it swaps the contents of the two RPs DE and HL. It is useful to be able to do that if, say, you are maintaining two pointers, and need to use them in turn to manipulate two separate "(HL)"s.

You can see a typical microprocessor compromise here. Ideally, we should be able to swap any two RPs, but the Z-80 designers could not accommodate it.

When information is sent along a data link, e.g., from a disc unit to memory, there is always a danger of its being corrupted. There are various ways of detecting errors, and in some cases correcting them; the use of parity bits is an obvious example. Another widely used technique is Cyclic Redundancy Checking (CRC).

Figure 11a.

```
;6502 CRC PROGRAM
;
;INITIALIZE THE REGISTERS
        LDY   #0           ;POINTER AND NUMBER OF BYTES
        STY   SIGHI        ;SET SIGNATURE TO
        STY   SIGLO        ;ZERO TO START
OUTLWP  LDA   (BASE),Y     ;READ A BYTE OF DATA
        STA   DATA         ;"DATA" IS WORKSTORE
        LDX   #8           ;INNER LOOP COUNTER
INLOOP  ASL   DATA         ;SHIFT MSB TO CARRY
        ROL   SCRTCH       ;LSB IS MSB FROM "DATA"
        LDA   #%00001000   ;SET MASK FOR BIT 11 OF SIG
        BIT   SIGHI
        BPL   MISS1        ;TEST MSB OF SIG
        INC   SCRTCH       ;LSB=LSB.XOR.BIT15
MISS1   BIT   SIGHI        ;MUST RESET FLAGS
        BEQ   MISS2        ;TEST BIT11 OF SIG
        INC   SCRTCH       ;LSB=LSB.XOR.BIT11
MISS2   LDA   #%00000001   ;MASK FOR BIT8 OF SIG
        BIT   SIGHI        ;TEST BIT8
        BEQ   MISS3
        INC   SCRTCH       ;LSB=LSB.XOR.BIT8
MISS3   BIT   SIGLO        ;V=BIT6 OF SIG
        BVC   MISS4
        INC   SCRTCH       ;LSB=LSB.XOR.BIT6
MISS4   ROR   SCRTCH       ;CARRY=RESULT OF XORS
        ROL   SIGLO        ;17-BIT LEFT
        ROL   SIGHI        ;ROTATE
        DEX
        BNE   INLOOP       ;READ ALL BITS OF WORD?
        INY                ;POINT TO NEXT WORD
        CPY   NUMBER       ;TEST FOR FINISH
        BNE   OUTLWP       ;IF EQUAL, FINISHED
;
;END OF ROUTINE
```

The data being transmitted along the link is also fed serially to an input of an XOR gate; the other inputs to the gate are provided by specific bit positions in a shift-register. It is common to use a 16-bit shift register, and one possible configuration is shown in figure 9. In this case, the output of the XOR gate is defined by:

$$X = D \oplus b15 \oplus b11 \oplus b8 \oplus b6$$

As each bit of the data stream arrives, the contents of the register are shifted one bit left, and X becomes the new LSB. The old MSB falls from the end and disappears.

You can see that a 16-bit code builds-up in the register, and the value of the code depends on the data stream. At the end of the data transfer, the CRC code, or signature, is compared to one sent by the data source. If they are the same, it is almost certain that the data has been received correctly.

I am not going into the maths, but single-bit errors will always be detected. The chances of missing a multi-bit error are 2^{-16}, or 0.0015 percent. I think you will agree that this is negligible.

Signatures are normally generated by hardware, as a software-based system would slow the data transfer. Nevertheless, we sometimes need to write a program to produce a CRC code, and a suitable flowchart is shown in figure 10. The routine assumes that the data to be tested is stored in memory. There are two reasons for not coding the data as it comes in: generating a signature from incoming data would slow the data transfer too much; we haven't looked at input techniques yet.

Firstly, the routine initialises itself, and sets the signature registers ("SIG") to zero. It takes each byte of the data, and reads it one bit at a time, using a shift to move the MSB into the carry. The XOR equation is applied to the incoming data and the contents of "SIG" to form "X", which becomes the new LSB of "SIG".

When all eight bits of a word have been processed, the routine moves on to the next word, until the signature for all the data has been formed. Assume, for the sake of the example, that there will never be more than 255 words to process.

At the end of the routine, the data must be left, undisturbed, in its original locations.

How do we compute the XOR equation? What the equation says is: "Count the number of "1"s on the right-hand side. If the number is odd, set X to "1", otherwise set it to "0"". We can do this by adding together the five bits on the right-hand side — the LSB of the sum is identical to the XOR answer, and we can read it directly.

Another term for this type of computation is "Modulo-2 Addition". The result is given by the remainder left over when you divide the algebraic sum of all the bits by two, i.e., shift it to the right.

```
;Z80 CRC PROGRAM
;
;INITIALIZE THE REGISTERS
;
        LD    HL,(BASE)    ;READ BASE ADDRESS
        EX    DE,HL        ;BASE IN DE
        LD    HL,(NUMBER)  ;READ NUMBER OF BYTES
        ADD   HL,DE        ;HL=NUMBER+BASE
        LD    (TEST),HL    ;SAVE FOR LATER TESTS
        LD    HL,0         ;SIG WILL BE IN HL
OUTLWP  LD    A,(DE)       ;READ DATA BYTE
        LD    B,8          ;INNER LOOP COUNTER
INLOOP  RLCA               ;READ MSB OF DATA
        RL    C            ;LSB OF C=MSB OF DATA
        BIT   7,H          ;TEST BIT 15 OF SIG
        JP    Z,MISS1
        INC   C            ;LSB=LSB.XOR.BIT15
MISS1   BIT   3,H          ;TEST BIT 11 OF SIG
        JP    Z,MISS2
        INC   C            ;LSB=LSB.XOR.BIT11
MISS2   BIT   0,H          ;TEST BIT 8 OF SIG
        JP    Z,MISS3
        INC   C            ;LSB=LSB.XOR.BIT8
MISS3   BIT   6,L          ; TEST BIT 6 OF SIG
        JP    Z,MISS4
        INC   C            ;LSB=LSB.XOR.BIT6
MISS4   ADD   HL,HL        ;SHIFT SIG (LSB NOW=0)
        BIT   0,C          ;READ XOR RESULT
        JP    Z,MISS5      ;IS IT "1"?
        SET   0,L          ;MOVE TO L
MISS5   DJNZ  INLOOP       ;FINISHED WITH BYTE?
        INC   DE           ;YES, POINT TO NEXT BYTE
;TEST TO SEE WHETHER FINISHED
        LD    A,(TEST)
        CP    E            ;LOW BYTE SAME AS TEST?
        JP    NZ,OUTLWP
        LD    A,(TEST+1)
        CP    D            ;HIGH BYTE SAME AS TEST?
        JP    NZ,OUTLWP
        LD    (SIG),HL     ;FINISHED. SAVE RESULT
;
;END OF ROUTINE
```

Figure 11b.

Enough of the theory — let us look at the programs.

6502 CRC program. Figure 11a gives a CRC program for a 6502.

The program zeros Y, which is used as a pointer to the data, and initialises the two bytes of "SIG". The program has to use indirect indexed addressing to reach the data, which could be anywhere in memory. Since the 6502 cannot use this mode in rotates, the data word is copied into a workstore, "DATA".

The MSB is read by shifting it into the

(continued on next page)

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carry, from where it is copied into the LSB of the scratchpad "SCRTCH". It does not matter what the rest of "SCRTCH" contains, as long as the LSB is set by the incoming data bit.

Each relevant bit of "SIG" is tested via a series of BITs. If the appropriate bit is set to "1", "SCRTCH" is incremented, effectively adding the value of the affected bit to the SB. The BITs make use of the instruction's property of copying the two MSBs of the tested byte into N and V; the test for bit 11 thus also tests bit 15. Unfortunately, since an increment of "SCRTCH" after the bit-15 test would re-set the zero flag, we must repeat the BIT to test bit 11. At least we do not have to re-set the mask.

When we have tested all four bits in "SIG", the LSB of "SCRTCH" is the modulo-two sum we are seeking. The rest of the byte contains rubbish, but we do not care about that. By concentrating all the manipulation on the LSB, the program is shortened, e.g., we never need to zero "SCRTCH".

The LSB of "SCRTCH" is then shifted into the carry from where, via two ROLs, it becomes the LSB of "SIG", the remainder of the bits in which are shifted to the left.

We repeat that for the next seven bits of "DATA", and increment Y to point to the next word. If Y is equal to the contents of "NUMBER" — the number of bytes t be CRC'ed — the routine finishes. We end with this kind of test because Y starts at zero, and does not reach "1" until the first byte has been processed.

Z-80 CRC program. The Z-80 program, although it follows the same flowchart, is very different in detail from that of the 6502. In particular, it makes as much use as possible of the micro's internal registers.

The program uses DE as a pointer to the word being manipulated, and initialises the RP via LD HL and an "EX DE,HL", the quickest 8080A-compatible 16-bit load of BC or DE. The address of the first byte above the block of data to be CRCed is found by an "ADD HL,DE", and saved for testing DE later.

We could use a simple loop counter to check the number of bytes, but there is no spare register, and so it is best to wait for the RP to point from the top of the list.

The final stage of initialisation is to zero HL, where the signature will form.

Operation	6502 Mnem.	6502 Flags	6502 Effect	Z-80 Mnem.	Z-80 Flags	Z-80 Effect
Logical AND	AND o	N,Z	A = A.d/(a)	AND p	All	A = A.p; C = 0 H = 1
Logical OR	ORA o	N,Z	A = A + d/(a)	OR p	All	A = A + p; C = 0 H = 0
Logical XOR	EOR o	N,Z	A = A + d/(a)	XOR p	All	A + A + p; C = 0 H = 0
One's complement	—			CPL	H = 1	$A = \overline{A}$
Two's complement	—			NEG	All	Form 2's Comp
Arithmetic shift left	ASL A/a	N,Z,C	Shift A/(a)	SLA r	All	Shift r; H = 0
Arithmetic shift right	—			SRA r	All	Shift r; H = 0
Logical shift right	LSR A/a	N,Z,C	Shift A/(a) N = 0	SRL r	All	Shift r; H = 0
Eight-bit rotate left	—			RLCA or RLC r	C / All	Rotate A / Rotate r; H = 0
Eight-bit rotate right	—			RRCA or RRC r	C / All	Rotate A / Rotate r; H = 0
Nine-bit rotate left	—			RLA or RL r	C / All	Rotate A / Rotate r; H = 0
Nine-bit rotate right	—			RRA or RR r	C / All	Rotate A / Rotate r; H = 0
Bit test	BIT a	N,V,Z	See Text	BIT b,r	Z	$Z = r_b$
Set bit	—			SET b,r	None	$r_b = 1$
Clear bit	—			RES b,r	None	$r_b = 0$
Exchange HL and DE	—			EX DE,HL	None	H = D; L = E D = H; E = L

Notes:
"a" = Address (defined by the program)
"d" = Data (defined by the program)
"o" = Operand — can be an address or data
"p" = Z-80 operand — a register or data
"r" = Any Z-80 register, including (HL)
"r_b" = Bit "b" of register "r"
"." = AND
"+" = OR
"⊕" = XOR
"/" = Either/or
Brackets: "Data at the address defined between the brackets"

Table 3. This month's instructions.

B is used, with a DJNZ, to count the eight iterations of the inner loop which read each bit of a word. The data word is stored in the accumulator; on each pass through the inner loop, A is shifted left to read the next bit into the CRC calculation.

As in the 6502 program, the Modulo-two addition concerns itself only with the LSB of the byte where the sum is being formed. In this case, it forms in C, and we are not worried what is in the seven MSBs of the register.

The data bit is positioned in the LSB of C by rotating C; each relevant bit of "SIG" is taken into account by a BIT. In that kind of application, where the mask changes every time, the Z-80 "BIT" is faster than that of the 6502.

Finally, at the end of each XOR addition, HL is shifted left by an "ADD HL,LH", and the LSB of L is set with the value of the LSB of C the Modulo-two sum.

After each word has been processed, the pointer DE is incremented, and compared to the previously-calculated "top of the list" value. Unfortunately, it has to be done in two bytes.

The program's final act is to save the signature in "SIG".

In program segments in earlier parts of this series, the 8080A routine was usually shorter and faster than that for the 6502 — generally because of the power of the former micro's six registers. Similarly, in this case the Z-80 program is shorter.

This month, I have looked at the ways in which a micro can manipulate data as a pattern of bits, rather than as numbers or characters.

For example, the bits in a word may be completely unrelated, and show the status of a number of peripherals. That pattern manipulation facility is also very useful during multiplication and division.

If you want something to think about during the next month, how about considering the value of subroutines, which are segments of code, doing defined tasks, to which the program can jump? Is it useful to build a library of routines?

Table 4. 6502 addressing modes this month.

Mnem	Accum	Direct	Page-0	Immed	Index,X	Index,Y	Indir,X	Indir,Y	P-*, Index,X
AND		•	•	•	•	•	•	•	•
ORA		•	•	•	•	•	•	•	•
EOR		•	•	•	•	•	•	•	•
ASL	•	•	•		•				•
LSR	•	•	•		•				•
ROL	•	•	•		•				•
ROR	•	•	•		•				•
BIT		•	•						

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THE 6502 SPECIAL is dedicated exclusively to the exchange of information between 6502 users. It is up to you, the reader, to help establish this page with your ideas, problems and guidance for other 6502 users. Please mark your letters 6502 Special. We pay £5 for each contribution published.

Clear-screen routine

ONE OF the more irritating features of the Standard Compukit UK101 is the lack of a clear-screen routine complains L Rickwood of Norwich. To solve that, I have written a simple machine-code routine to do the job via the USR(X) function.

The routine is short — 20 bytes as opposed to 25 to 30 bytes of other routines I have seen — and very fast. The interesting feature however is that when loaded, it occupies no user workspace. That is achieved by placing it in the otherwise unused RAM at $Ø222_{16}$ to $Ø2FA_{16}$, specifically at $Ø222_{16}$ to $Ø235_{16}$.

The advantages are, firstly, that no tedious partitioning of the workspace into Basic and machine-code area is required. Secondly, the program is unaffected by commands such as cold-start. In fact, once loaded it is available for use until deliberately wiped or the machine is switched-off — the vector must be re-set after cold-start.

The routine will operate in any RAM location since it uses only relative addressing.

Mnemonic*	Address Hex	Operator code Hex		
LDA #32	Ø222	A9	2Ø	
LDX #ØØ	Ø224	A2	ØØ	
STA D3ØØ,X	Ø226	9D	ØØ	D3
STA D2ØØ,X	Ø229	9D	ØØ	D2
STA D1ØØ,X	Ø22C	9D	ØØ	D1
STA DØØØ,X	Ø22F	9D	ØØ	DØ
DEX	Ø232	CA		
BNE# —15	Ø233	DØ	F1	
RTS	Ø235	6Ø		

* Numbers preceded by # are decimal, others are Hex.
Either: load using the 'M' function of D/C/W/M?
Or: load from Basic using:

```
For X = 546 to 565 : Read S : Poke X, S : Next
Data 169,32,162,Ø,211,157,Ø,210
Data 157,Ø,209,157,Ø,208,202,208,241,96
```

If located at 0222_{16} (546_{10}) to 0235_{16} (565_{10}), the routine can be accessed by X = USR(X) with USR(X) vector set at:

Poke 12,02
Poke 11,34

On the UK101, the USR(X) vector is located in 11 and 12 (Dec). 12-high byte; 11-low byte.

To fill the screen with a character whose CHR$ code is N, use POKE 547,N after the program is loaded. Alternatively, replace the second data item (32) with N.

Video display

THE only disappointing feature of the Superboard II seems to be its video display, but I have discovered that Mutek has introduced an enhanced Superboard with a true 32 × 48 display writes P A Hague of Stockton, Cleveland. It is selling upgrading kit for normal Superboards at £40 which also allows the computer to run at 2MHz instead of 1MHz.

Morse and RTTY

I RUN a UK101 and have been developing both hardware and software to enable me to run Morse code and RTTY Baudot writes Michael Taylor of Peterborough, Cambridgeshire. The hardware interface enables not only serial-to-parallel conversion but also software control of serial format and six output ports which can control the tranciever functions.

My software is in 6502 machine code and my most useful package is a 1K program which reads RTTY using a full screen display, sends RTTY and sends CW: Transmission can be direct from the keys, or from either one of seven memories, six of which are pre-loaded station information and the last being a loadable message store.

I also have a useful Basic note for UK101 users, a way of preventing the display of INPUT information. Normally on the UK101, all INPUT information is displayed on the VDU screen. The following allows INPUT without VDU display or line scrolling — even the prompt "?" is not displayed.

It is done by placing POKE 538, 138 before the INPUT, disabling all output operation.

After the INPUT the statement POKE 538, 105 will restore output operations. The action of the first POKE is to change the output vector (FF69 at 021a/b) to vector all output to a RTS, return from subroutine. The second POKE restores the original value.

An example is a code access to a program.

```
1 PRINT" Enter your code word"
2 Poke 538,138
3 INPUT A$
4 POKE 538,105
5 IF A$ = "CODE WORD" THEN GOTO 7
6 PRINT" WRONNG": GOTO2
7 program protected by entry code word.
```

After RUN, the VDU remains locked-out following the "ENTER..." message until the correct word is entered, break/warm-start is made, or blind "return" "return" RUN 7 typed.

Terminal width

IN THE June 6502 Special, there was a note to Superboard II users saying that POKE 15,Ø causes the output of two line feeds instead of one writes Paul Morton of Stockton, Cleveland. I would like to point out that this location holds the terminal width, so that any other number can be Poked there to give you a variable-size terminal width — which gives rise to many interesting possibilities.

Also, location 14 holds the amount of characters the cursor has moved since the last carriage return. By continually Poking 14,Ø during a program, carriage returns will be prohibited, e.g., you can have a screen full of pattern without any carriage returns spoiling it.

One very interesting point is that when you want to scan the keyboard during a program for a letter, instead of turning off Control C and Peeking and Poking, you can use one of the subroutines already present:

```
1Ø POKE 11,Ø : POKE 12,253
2Ø x = USR (x)
3Ø A$ = CHR$ (PEEK (531))
```

By changing 3Ø to read:

```
3Ø A = PEEK (531)
```

you can input numbers.

Cassette-output program

FOLLOWING the recent programs to save data for the Compukit 101, writes Paul Chapman of Diss in Norfolk, here is a program which, when stored in the unused RAM (0222 → 02FF), will activate output to cassette if 'CHR$(1)' is printed. All the following prints will go to the cassette until a 'CHR$(3)' is printed, then all input is from the cassette until a 'CHR$(4)' is printed. After loading the machine code program, type in Basic:

POKE 538,34: POKE 539,02

That initialises the routine by changing the output vector — that is necessary after every re-set, e.g.,

```
1Ø INPUT "DATA TO BE SETN"; A$
2Ø Print CHR$(1); : REM to switch-on cassette
3Ø Print A$       : REM SEND DATA
4Ø Print CHR$(2)  : switch-off cassette
5Ø END
```

the opposite:

```
1Ø Print CHR$(3); : REM switch to load
2Ø Input A$       : REM get DATA
3Ø Print CHR$(4)
4Ø Print A$       : REM switch-off cassette
                    input
5Ø END              and print data.
```

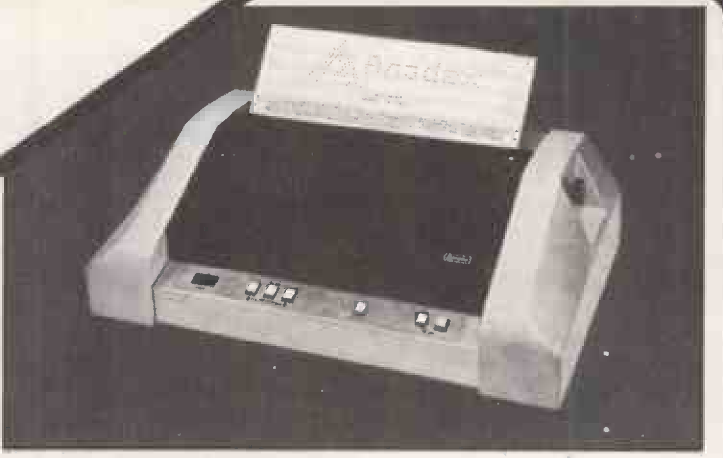
If data is longer than the line length A,

POKE 15,72

is needed during or before the program. The program can be enhanced to give all the graphic characters special functions. It should be noted that it is not advisable to give any standard characters special functions as they will occur during lists as well.

```
Ø222  C9  Ø1        CMP  #Ø1
Ø224  FØ  ØA        BEQ  Ø23Ø
Ø226  C9  Ø2        CMP  #Ø2
Ø228  DØ  ØC        BNE  Ø236
Ø22A  A9  ØØ        LDA  #ØØ
Ø22C  8D  Ø5  Ø2    STA  Ø2Ø5
Ø22F  6Ø            RTS
Ø23Ø  A9  Ø1        LDA  #Ø1
Ø232  8D  Ø5  Ø2    STA  0205
Ø235  6Ø            RTS
Ø236  C9  Ø3        CMP  #Ø3
Ø238  FØ  ØA        BEQ  Ø244
Ø23A  C9  Ø4        CMP  #Ø4
Ø23C  DØ  ØC        BNE  Ø24A
Ø23E  A9  ØØ        LDA  #ØØ
Ø24Ø  8D  Ø2        STA  Ø2Ø3
Ø243  6Ø            RTS
Ø244  A9  FF        LDA  #FF
Ø246  8D  Ø3  Ø2    STA  Ø2Ø3
Ø249  6Ø            RTS
Ø24A  2Ø  69  FF    JSR  FF69
Ø24D  6Ø            RTS
```

NEW



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

Input check

AS MOST people have probably discovered, the ZX-80 1K RAM can hold programs of reasonable size, but problems occur if a large amount of screen output is required. Thus text must be kept to a minimum in print statements writes Bob Maunder.

Sophisticated input checking routines are also out of the question at present since little space would remain for the main program. Hence program robustness and good technique often has to be sacrificed to obtain something which works.

However, when memory expansion arrives we will all be busy re-hashing our programs. The following routine is a suggestion for checking numerical data entry — it only allows for positive numbers and any other modifications or contributions will be welcomed. N$ = the number on entry and the routine puts it in, N.

```
500 LET N=0
510 IF N$="" THEN RETURN
520 LET C=CODE(N$)-28
530 LET Q=C>-1 AND C<10 AND
    N<3277 AND (NOT N=3276 OR NOT
    C>7)
540 IF NOT Q THEN RETURN
550 LET N=10*N+C
560 LET N$=TL$(N$)
570 GO TO 510
```

On exit from the routine, Q indicates whether the number is valid — Q=-1 or true — or in error — Q=0 or false.

There are reports of several ZX-80 owners starting to untangle the ROM monitor and interpreter; any useful entry points which anyone encounters would also be gratefully received.

Heated discussion

THE ZX-80 cassette interface seems to be drawing conflicting comments. Personally, I have had several problems with LOADing and SAVEing which appear to happen particularly when the system, or rather the tiny heatsink, becomes hot.

Science or Cambridge states that it has been unable to reproduce the fault on the testbench. I have found that using the ZX-80 with the top of the case removed and with a larger heatsink on the 5V regulator gives improved results.

Alternatively, if you want to keep the system tidy, try fitting a thicker insulator between the heatsink and the PCB.

DIN connections at the cassette recorder end are proving generally unsatisfactory for LOADing: that is because the output signal level is too low since it comes from the recorder's pre-amp rather than from the loudspeaker output.

Symbol Simon

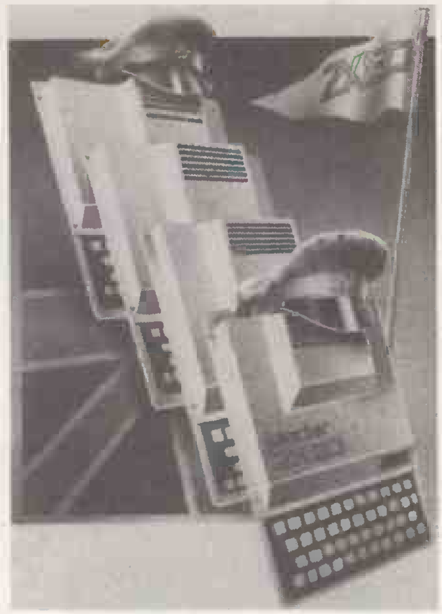
The following game, Simon, continues Bob Maunder of Middlesborough, displays an increasing number of symbols on the ZX-80 screen which must be copied correctly. The limit is 21 symbols and an option includes graphics characters accessible from the keyboard.

```
10 RANDOMISE
20 DIM P(20)
30 PRINT "SIMON"
40 PRINT "YOU ATTEMPT TO COPY
   SYMBOL"
50 PRINT "PATTERNS"
60 PRINT
70 PRINT "DO YOU WANT"
80 PRINT "1. NUMBERS"
90 PRINT "2. LETTERS"
100 PRINT "3. GRAPHICS"
110 PRINT "4. NUMBERS + LETTERS"
120 PRINT
130 PRINT "1 2 3 OR 4?"
140 INPUT C$
150 CLS
160 LET C = CODE(C$)-28
170 IF C>4 OR C<1 THEN GO TO 70
180 LET L = -27*(C=1 OR C=4)-37*(C=2)-
    (C=3)
190 LET M = -10*(C=1 OR C=3)-26*(C=2)
    -36*(C=4)
200 FOR N=2 TO 20
210 PRINT "PATTERN IS"
220 FOR I=0 TO N
230 LET P(I) = RND(M) + L
240 PRINT CHR$(P(I));
250 NEXT I
260 PRINT
270 PRINT "PRESS NEWLINE"
280 GO SUB 500
290 PRINT "NOW COPY IT"
300 INPUT G$
305 PRINT G$
310 FOR J=0 TO N
320 IF G$="" THEN GO TO 420
330 IF NOT CODE(G$)=P(J) THEN GO TO
    420
340 LET G$=TL$(G$)
350 NEXT J
360 PRINT "CORRECT"
370 PRINT "PRESS NEWLINE FOR
    NEXT"
380 GO SUB 500
390 NEXT N
400 PRINT "CONGRATULATIONS —
    YOU WIN"
410 STOP
420 PRINT "WRONG — IT WAS";
430 FOR K=0 TO N
440 PRINT CHR$(P(K)—(NOT K<J AND
    NOT C=3)*128)
450 NEXT K
460 PRINT
470 PRINT "YOUR LIMIT WAS ";N+
    (N = 2)*2;"SYMBOLS"
480 STOP
500 INPUT Z$
510 CLS
520 RETURN
```

If a symbol sequence is entered incorrectly the program highlights where the mistake was made using inverse video, except in the case of graphics characters as this would be confusing.

Inverse video

THIS item is for readers still baffled by the ZX-80 operating manual's mysterious



references in the ZX-80 operating manual to the USR function.

The first obvious requirement is at least a brush-acquaintance with Z-80 opcodes. The USR function assumes you have already stored a machine-code routine in memory. The easiest way of doing that is to set-up a dummy REM statement as the first line of the program, containing a large number of dummy characters, say, fullstops.

Having made a list of the machine-code routine, POKE the decimal values into memory starting at address 16427 — the address of the first fullstop in the REM statement. The last value should be a return instruction, e.g., decimal 201 — RET on the Z-80.

The USR function is unlike GO SUB in that it must be used within an instruction, e.g., LET X=USR(16427). Its effect is to cause control to be transferred to the routine at the address in brackets and to return — providing you include a return statement — with the value held in the HL register pair, or, if that has not changed, with the original address value.

The following routine is not machine code but uses system variables to convert the first PRINT statement in a program to appear in the listing with text in inverse video — useful for highlighting titles.

```
10 PRINT " ANY TEXT "
 ..........
499 STOP
500 LET Q=0
510 FOR A=16424 TO 16499
520 LET C=PEEK(A)
530 IF C=1 AND Q THEN STOP
540 IF Q THEN POKE A, C + 128
550 IF C=1 THEN LET Q=-1
560 NEXT A
```

Lines 10 to 499 represent the main program and the routine at line 500 does the inversion. Start the routine by RUN 500 and afterwards the listing will reveal the text in line 10 as being in inverse video. Lines 500 onwards may then be erased and the program SAVEd normally on cassette.

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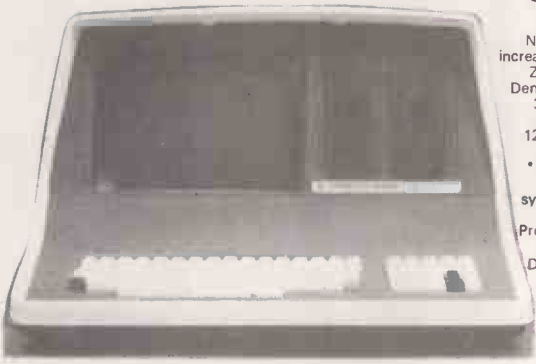

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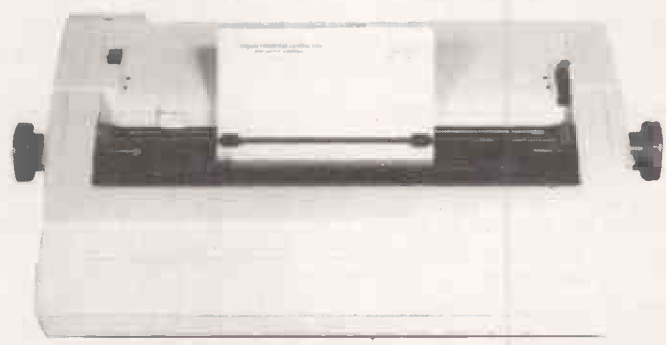

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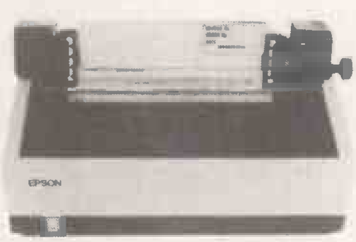

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Powerful graphics

WHEN I first acquired my TRS-80, my initial impression was one of awe, particularly at the flexibility and speed of the VDU display compared to the printers of my previous experience, writes Ken Smith of Linton on Ouse in Yorkshire.

Once I started to program in earnest however, my initial joy turned to dismay. Efforts to produce pictures on the screen seemed futile. Graphics were a bind — a disaster — time-consuming and headache-making.

I spent the next two months regretting my decision to find an easier way into graphics. However, that period has passed and I now have a powerful set of routines and ideas to pass on.

Let us first look at definition. The screen is divided into a 128 × 48 element display for raw graphics and 64 × 16 locations for ASCII characters and pre-defined graphic symbols. If that is not clear, examine the video worksheet in the manual.

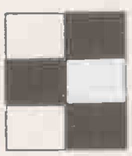
Raw graphics are used with the set and re-set function, by defining the 'X' and 'Y' axis [(0—127) and (0—47)]; whereas the pre-defined graphics are used with the PRINT @' (0—1023) or the 'POKE' (15360 to 16363) functions.

Set and re-set give the finest definition. A set of pre-defined symbols which will cover any combination of set re-set within a print or Poke location are provided on the TRS-80. Each 'Print location contains six set Pixels.

Figure 1.

1	2
4	8
16	32

Figure 2.



Each is numbered as in figure 1. That is the easy way to identify them. Add the values of the lit Pixels to 128, and you obtain the graphic code for that shape. Thus figure 2 becomes 2 + 4 + 32 + 128 = 166. An easier way to see them is to use the routine on page C/2 of your manual.

We can now draw our picture by 'Print 0 X, CHR$(Y); and so on. The technique uses 1/6 of the program statements but the grey matter involved in identifying the correct positioning and numbers is beyond me — and I suspect you. A quicker way to do the same thing is POKE (location) + 15360, graphic number.

For the weak of mind or faint at heart there is help. A J Harding (Molimerx) has a program which allows you to draw your picture using the cursor arrows and resolves the screen into location and graphics code.

It then pushes the information into several data lines. Erase the program lines, CSAVE, and all the work has been done. A quick restore, read and Poke enters your drawing into any program you write on top.

Of course, you can Poke anything you like on to the screen, all the ASCII character set, in fact. You can also Peek

the screen to see what is there. Very useful for games or specials — try:

```
10 CLS: INPUT A$ (Input your message here)
20 A = LEN(A$):DIMA$(A)
30 FOR X = 1 TO A : A$(x) = MID$(A$,X,1):
   NEXT
40 FOR X = 1 TO A : ?@127,A$(x);
50 FOR Y = 64 to 126: POKE 15360 + Y,
   PEEK(15360 + Y + 1):NEXT
60 NEXT: FOR X = 1 TO 3 : GO TO 50;
   NEXT : GO TO 40
```

On my machine, a prompt appears and any message I enter up to 255 characters moves across the screen, albeit slowly. It is rather slow to show the structure and to use most of the important graphic routines.

If we need to repeat a set of graphics continually or make a symbol or symbols move, we can make our graphics into a string.

```
10 A$ = CHR$(179) + CHR$(157) + CHR$
   (140):CLS
20 ?@12, A$;
```

My screen shows a little rocket ship. If we rub it out we can move it. Add the following to your program

```
30 B$ = CHR$(32) + CHR$(32) + CHR$(32)
40 ?@12,B$;
50 For X = 1To 1023 step 3
60 ?@X,A$;:?@x,B$;:NEXT
10 CLS
20?PEEK(14426) 8;:GO TO 20
```

Run it, and you will be looking at a screen full of Øs. Press a cursor arrow — magic. Each cursor and combination has a different number. What a useful thing. That is not a one shot effect like "INKEY$' and you obtain a continuous result for as long as the key is held down.

Although this short routine loads in Basic, it has a machine-code routine which, combined with efficient use of Basic, makes it fast. Before typing-in, do the following: pull the plug from the auxiliary socket on the recorder, push back the lever in the top-left of the cassette tray; press record and play. Now type in:

```
10 Clear 50:FORX = 32000 TO 32009:READY
   POKE X,Y:
NEXT : POKE 16526,O:POKE 16526,125:XX
   = 15360:DEFINTZ:CLS
20Q = USR(Ø):Z = PEEK(XX):PRINT@Z*4,
   STRING$(Z/4,Z),
GO TO 2Ø
30 DATA 2Ø5,18,2,1Ø5,53,2,5Ø,Ø,6Ø,2Ø1
```

Now run. Try talking — a little louder perhaps. Is the LED on the recorder flickering? Play some music. The frequency response is best suited to voice or pop music, although anything with a beat works well.

Data file method

I HAVE seen a number of items in Tandy Forum concerning the problems involved in using the cassette recorder for data files with the PRINT # statement writes John Heap, of Leeds. As many people have discovered, it is very slow and wearing on the cassette motor.

In January Tandy Forum, Martin Evans gave a method of using the same data file — held as a series of data statements — with a number of programs. What I have developed is a method of updating and saving the data file in its updated form. The program which follows serves as an example — it is a simple update of a file which consists of records made up of record number, reference number, quantity.

The method is based on the fact that the TRS-80 stores the program in terms of codes for reserved words and ASCII representations of the characters involved in program lines. To check that, try PEEKing at locations above 17129 on the 16K machine while referring to the new improved manual which contains a list of codes for the reserved words.

The program is loaded in the normal way and then RUN. Lines up to 100 tell the machine to accept another program — the data file, which is a set of DATA statements created beforehand and stored on cassette. That data file should consist of statements numbered higher than any line in the main program and with fields

(continued on next page)

(continued from previous page)

corresponding to the largest expected value, e.g., 5000 DATA 1,A001,01250 — if the maximum quantity to be stored is 99999. The last DATA statement should be an end of file record consisting of a record number of 99 which can be recognised by the program as an end-marker, e.g., 5100 DATA 99,9999,99999

The instructions printed on the screen by the program must now be followed:

1. CLOAD the data file.
2. POKE the values suggested into the locations given.
3. RUN 100 to start the main program.

The subroutine starting at line 1000 amends the data file. It is done by searching each program line in turn to see if it contains the code 136 for the reserved word DATA. If it does not, the program goes to the next program line by computing its start address from the values in the first two bytes of the line.

In the program, those are P1 and (P1 + 1) — the address of the next program line is given by (P1 + 1)*256 + P1. The updated quantity is converted into a string, split into characters and the ASCII values for those characters are POKEd into the appropriate locations.

Lines 500-end save the updated data file to tape with a simple CSAVE instruction. Further experimentation should enable readers to construct quite sophisticated update programs using only one CLOAD and CSAVE for data input/output.

```
10 CLS
20 E=17129
30 S=E: E=PEEK(S+1)*256+PEEK(S):
   IF E<>0 GO TO 30
40 POKE 16549, INT(S/256):POKE 16548,
   S-INT(S/256)*256
50 PRINT"POSITION DATA TAPE AND
   CLOAD"
60 PRINT"THEN POKE 16548,233 AND
   POKE 16549,66"
70 PRINT"THEN RUN 100"
80 STOP
100 READ X$,Y$,Z$
110 IF X$="99" THEN 500
120 PRINT X$,Y$,Z$:PRINT
130 INPUT"ADDITION TO Z =";Z1
140 IF Z1 =0 THEN 100
150 Z=VAL (Z$):Z=Z+Z1:Z$=STR$(Z)
160 GOSUB 1000
170 GO TO 100
500 REM**END ROUTINE TO SAVE
    UPDATED DATA TO TAPE**
510 POKE 16549,INT(S/256):POKE 16548,
    S-INT(S/256)*256
520 PRINT"POSITION DATA TAPE AND
    CSAVE"
530 PRINT"THEN POKE 16548,233 AND
    POKE 16549,66"
540 END
1000 P1=17129
1010 IF PEEK(P1+4)=136 THEN 1030
1020 P1=PEEK(P1+1)*256+PEEK(P1):GO
     TO 1010
1030 A=6:V$=""
1040 V=PEEK(P1+A)
1050 IF V=44 THEN 1200
1060 V$=V$+CHR$ (V)
1070 A=A+1:GO TO 1040
1200 IF V$=X$ THEN 1300
1210 GO TO 1020
1300 FOR K=1 TO LEN(Z$)
1310 T$=MID$(Z$,K,1)
1320 T=VAL(T$)
1330 Q=T+48
1340 POKE P1 + A + 5 + K,Q
1350 NEXT K
1360 RETURN
```

Example Data File

```
5000 DATA 1,A001,0025
5010 DATA 2,A002,0150
5020 DATA 3,A115,3250
5030 DATA 4,B106,0000
5040 DATA 5,A007,0785
5050 DATA 6,B200,1265
5060 DATA 99,9999,9999
```

Passing variable data

A PROGRAM of interest to TRS-80 programmers who need to chain programs together and pass variable data between them has been submitted by G Reeves of Walsall, West Midlands. Of course, that can be accomplished by writing the data to disc or tape, but it tends to be impractical for many applications. An alternative method is to Poke the data into protected memory. This small assembler program makes it very easy to do this from your Basic program.

The program uses all memory above its own end-point as a buffer in which to store data. You tell the program to store data by executing a USR call with an argument of 1. Then call it again for every variable you wish to store, using as an argument the VARPTR of the required variable. Having done that, you can link off to your next program.

To retrieve your data, execute a USR call with an argument of 2, do another call for each variable you wish to retrieve, using as an argument the VARPTR of the receiving variable.

```
               00100 ; PROGRAM TO PASS VARIABLES BETWEEN BASIC PROGRAMS
BE00           00110        ORG     0BE00H
BE00 CD7F0A    00120        CALL    0A7FH             ;GET USR ARGUMENT
BE03 3E00      00130        LD      A,0               ;IS IT A
BE05 BC        00140        CP      H                 ;VARPTR
BE06 2009      00150        JR      NZ,GOTVAR         ;IF NOT 0 IT IS
BE08 7D        00160        LD      A,L               ;GET REQUEST
BE09 3262BE    00170        LD      (REQUST),A        ;AND SAVE IT
BE0C 2A60BE    00180        LD      HL,(BUFBEG)       ;INITIALISE BUFPOS
BE0F 1849      00190        JR      FINISH            ;ALL DONE-END
BE11 E5        00200 GOTVAR PUSH    HL                ;PUT HL
BE12 DDE1      00210        POP     IX                ;INTO IX
BE14 DD4EFD    00220        LD      C,(IX+253)        ;GET TYPE/LENGTH
BE17 0600      00230        LD      B,0               ;CLEAR FOR LDIR
BE19 ED5B63BE  00240        LD      DE,(BUFPOS)       ;GET NEXT POSITION
BE1D 3A62BE    00250        LD      A,(REQUST)        ;GET REQUEST CODE
BE20 FE01      00260        CP      01                ;IS IT A SAVE REQUEST
BE22 2813      00270        JR      Z,SAVE            ;YES
BE24 EB        00280        EX      DE,HL             ;ELSE SWAP MOVE REG'S
BE25 EDB0      00290        LDIR                      ;AND MOVE DATA(RETRIEVE)
BE27 DD7EFD    00300        LD      A,(IX+253)        ;GET TYPE BYTE
BE2A FE03      00310        CP      03                ;IS IT A STRING
BE2C 202C      00320        JR      NZ,FINISH         ;NO
BE2E E5        00330        PUSH    HL                ;PUT HL
BE2F FDE1      00340        POP     IY                ;IN IY
BE31 FD4EFD    00350        LD      C,(IY+253)        ;GET TEXT LENGTH
BE34 09        00360        ADD     HL,BC             ;ADD TO HL
BE35 1823      00370        JR      FINISH            ;AND END
BE37 DD7EFD    00380 SAVE   LD      A,(IX+253)        ;SAVE REQ,GET VAR TYPE
BE3A FE03      00390        CP      03                ;IS IT A STRING
BE3C 2019      00400        JR      NZ,NOTSTR         ;NO
BE3E EDA0      00410        LDI                       ;STORE LENGTH BYTE
BE40 D5        00420        PUSH    DE                ;PUT DE
BE41 FDE1      00430        POP     IY                ;INTO IY
BE43 13        00440        INC     DE                ;POINT TO
BE44 13        00450        INC     DE                ;BUFFER TEXT POSITION
BE45 FD7300    00460        LD      (IY+0),E          ;MODIFY
BE48 FD7201    00470        LD      (IY+1),D          ;TEXT POINTER
BE4B E5        00480        PUSH    HL                ;NOW LOAD UP HL
BE4C FDE1      00490        POP     IY                ;WITH
BE4E FD6601    00500        LD      H,(IY+1)          ;ACTUAL TEXT
BE51 FD6E00    00510        LD      L,(IY+0)          ;ADDRESS
BE54 DD4E00    00520        LD      C,(IX+0)          ;GET LENGTH
BE57 EDB0      00530 NOTSTR LDIR                      ;MOVE VARIABLE OR TEXT
BE59 EB        00540        EX      DE,HL             ;FOR COMMON FINISH
BE5A 2263BE    00550 FINISH LD      (BUFPOS),HL       ;SAVE FOR NEXT TIME
BE5D C39A0A    00560        JP      0A9AH             ;RETURN TO BASIC
BE60 65BE      00570 BUFBEG DEFW    BUFTXT            ;BUFFER START
0001           00580 REQUST DEFS    1                 ;REQUEST CODE
BE63 65BE      00590 BUFPOS DEFW    BUFTXT            ;BUFFER-256 BYTES
0100           00600 BUFTXT DEFS    256
0000           00610        END
00000 TOTAL ERRORS
BUFBEG BE60 00570    00180
BUFPOS BE63 00590    00240 00550
BUFTXT BE65 00600    00570 00590
FINISH BE5A 00550    00190 00320 00370
GOTVAR BE11 00200    00150
NOTSTR BE57 00530    00400
REQUST BE62 00580    00170 00250
SAVE   BE37 00380    00270
```

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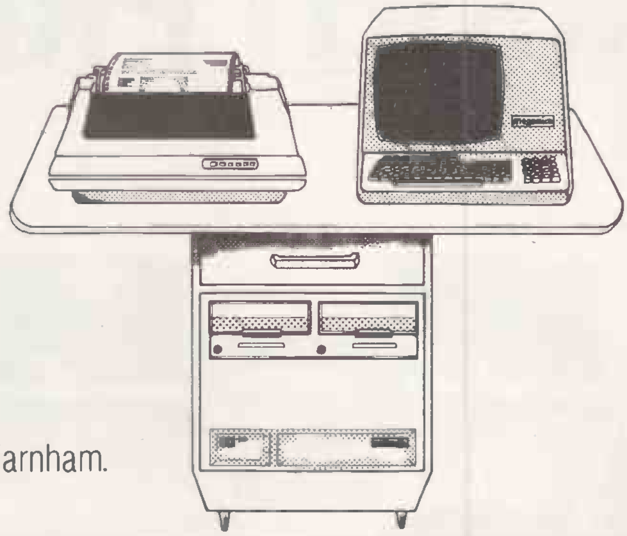

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Art of simplicity

HERE ARE two methods of having more than one input on one line, which looks good and makes long data inputs easy to read, writes Kevin Jones of Lytham St Annes, Lancashire. A Pet will not accept something like:

```
10 INPUT "ACCOUNT NO.";N;
"AMOUNT";A
```

To overcome that problem, I originally experimented both with machine code and the Get instruction. However, these two solutions are the art of simplicity:

```
10 INPUT "ACCOUNT NO";N
20 INPUT "cursor up and 20 cursor lefts
AMOUNT";A
```

The third method uses three program lines but fewer bytes. It is:

```
10 INPUT "ACCOUNT NO";N
20 PRINT TAB(20)
30 INPUT "cursor up AMOUNT";A
```

which, of course, eliminates the cursor-rights. With different spacing the method has been used successfully for three inputs on one line.

Reclaiming bytes

A PROGRAM written for the Pet with new ROMs which suppresses all unnecessary blanks in a program which has been loaded in core has been submitted by S P Folmer, Grantham, Lincolnshire.

Load the program to be modified and, if you have a "toolkit", append the program, type 'RUN 63000'. After a few seconds, relative to the size of your program, the program will display the line on which it is working. When the run is

```
63000 PØKE144,49:REM $.P. FØLMER APRIL 1980
      (c)
63001 DEFFNA(X)=PEEK(X):DEFFNB(X)=PEEK(X+1):
      DEFFNC(X)=FNA(X)+256*FNB(X):FI=-1
63002 LP=1025:BL=0:PRINT"CLR";TAB(7);"*** BL
      ANK $UPPRE$$IØN ***↓↓↓↓↓↓↓↓"
63003 L1=FNA(LP+2):L2=FNB(LP+2):LN=FNC(LP+2):
      QU=0:L5=LP-BL:L6=FNC(LP)
63004 IFFIANDLN=63000THENL5=40:GØTØ63011
63005 IFFIGØTØ63011
63006 IFLN=63000THENL3=0:L4=L3:L7=L5+2:GØTØ63
      012
63007 PØKELP+2-BL,L1:PØKELP+3-BL,L2:TP=LP+3:
      PRINT"PRØCE$$ING LINE";LN;"↑"
63008 TP=TP+1:CH=PEEK(TP):IFCH=34ØRCH=143THEN
      QU=NØTQU
63009 IFCH=32ANDNØTQUTHENBL=BL+1:GØTØ63008
63010 PØKETP=BL,CH:IFCH<>0GØTØ63008
63011 LP=L6:L3=INT((LP-BL)/256):L4=LP-BL-L3*
      256:IFFIANDL5<>40GØTØ63003
63012 PØKEL5,L4:PØKEL5+1,L3:IFFITHENFI=NØTFI
      :GØTØ63002
63013 IFL3<>0GØTØ63003
63014 PRINTBL;"←BLANK$ $UPPRE$$ED     ":PØKE
      40,1:PØKE41,4:PØKE144,46
63015 L3=INT(L7/256):PØKE623,L3:L4=L7-L3*256:
      PØKE42,L4:PØKE43,PEEK(623):CLR
"CLR"=CLEAR $CREEN ; "↑"=CUR$ØR UP ;
"↓"=CUR$ØR DØWN ; "←"= CUR$ØR LEFT.
```

completed, all you have to do is save your program as usual. At end of run, my program will display the number of blanks it has suppressed.

Notice that the program deletes itself after execution. Also I have disabled the interrupt key as an abnormal termination would leave all linkage addresses in mid air.

The interrupt key is disabled by Poking location 144 with 49. The program finds the linkage address of line 6300 which is the cause of the apparent pause before execution and sets the start-of-text pointer to the value — locations 40 and 41.

That is done to fool the system into thinking that your program no longer exists thus enabling the program to shuffle

linkage pointers. If it did not do this, the system would hang during execution as some linkage pointers would be temporarily pointing to somewhere inside a line of program text instead of to the next linkage pointer. The program starts examining each line sequentially from the start of text.

If a non-blank value is found — blank = 32 — it is poked back into memory at address TP-BL, where TP is the text pointer and BL is the number of blanks found so far.

The same applies to a blank found between quotes or after a remark statement. If, however, a blank is found, no character is poked back into memory and B2 is incremented by one.

When it reaches line 63000 — LN = 63000 — it pokes a zero value in the last linkage pointer signifying end of text. It then re-sets the start of text pointer back to 1025, the normal value, and finally sets the start of variables pointer to two bytes after end of the text and clears all variable space, deleting itself.

I realise that all that sounds rather involved, but for those who wish to know still more about the subtleties, I suggest reading the Principal Pointers Into Pet RAM chapter in your CBM user manual. That is where I found all the information I required to write the program. For the others, I simply suggest you copy the program very carefully and enjoy the lovely extra bytes you can now claim back from your programs.

When I am developing and testing a program, I always put the emphasis on legibility which saves a good deal of time at this stage. Once satisfied with a program, its execution can be optimised significantly by squeezing out any unnecessary blanks. With small programs that will not pose much of a problem as the Pet has superb editing facilities.

With a large one, however, you could waste a whole frustrating evening doing that, which was my incentive for creating the program. It has saved me many hours and thousands of bytes.

Readability improved

HERE ARE two ideas I have written for the Pet writes Mark Atherton of Liverpool. The first is to improve the readability of program listings.

As has been mentioned in previous Pet corners, FOR loops should be indented. However, the Pet deletes any spaces after a line number and so colons have to be used. If you enclose the required spaces in shifted ampersands, the spaces are left:

```
10 FOR I = 1 TO 10
20 (&) (5 SPACES) (&)
30NEXT
```

When line 20 is LISTed the &s have gone. That also allows blank lines to be left e.g., type:

```
25 (&) (SPACE) (&)
```

and when LISTed the line is just a blank.

The other routine is used most effectively in games for added effect. Usually in a game when you are destroyed/eaten/killed/beaten a message such as BOOM!!, or some equivalent, is printed. That is slow and messy. This routine is very fast — it is machine code.

When called by a SYS (826), it will scan the screen instantly and make anything in ordinary field reverse field and vice versa. It can be very effective if called repeatedly with a small delay.

```
10 DATA A2,00,86,01,A2,7F,86,02,CA,AO,
   00,B1,01,49,80,91,01,C8
20 DATA D0,F7,E6,O2,E0,7A,D0,EE,60,
   END
30 FOR I = 1 TO127 : READ A$:IFA$ =
   "END" THEN 90
40 B$ = LEFT$(A$ ,1) : C$ = RIGHT$
   (A$,1)
50 T = t + VAL(C$) + 16*VAL(B$)
60 IF VAL(C$) = 0 AND C$ < >
   "O" THEN T = T + ASC(C$)—55
70 IF VAL(B$) = 0 AND B$ < > "0" THEN
   T = T + 16*(ASC(B$)—55)
80 POKE 825 + I,T: T = 0:NEXT
90 REM YOUR PROGAM STARTS HERE
   AND ROUTINE IS CALLED WITH
   SYS 826
```

If there is too much snow, as on an old ROM Pet, POKE the screen off before use and off again after the SYS.

Program security

TO STOP others loading your disc programs or using your files on the Commodore disc drives, include control characters in the file name writes Jonathan Dick of Bristol. They do not show in the directory providing the file name starts with a quote character.

Because of that, a program which looks as if the file name is TEST might, as far as the disc is concerned, have several control characters embedded in it. For example, to save a program called HELLO so that nobody else can load it you might type:

```
A$ = CHR$ (34) + CHR$ (1) + "H" + CHR$
(2) + "E" + CHR$ (9) + "LL" + CHR$
(3) + CHR$ (5) + "0"
```

Followed by a carriage-return. You would then type:

'SAVE"0:" + A$,8.'

That would save the program to disc with the control characters embedded in the filename. When a directory is called subsequently, you see double quotes, the program name, without control characters visible, and the file type indented further left than usually.

Because of the vast possible combinations of control characters and ordinary characters, you can put a 16-character file

(continued on next page)

(continued from previous page)

name which is almost impossible for anyone to load unless they know what characters it contains.

To load the program, you do the same as when you save it apart from substituting the command LOAD for SAVE. The reason why control characters appear as reverse-field characters unless you put the CHR$(34) at the start of the file name is that the file name appears in quotes in the directory.

The quote you insert closes the quotes before the file name is typed. You must always insert at least one other control character before the file name, otherwise someone might load it using the '*' for pattern-matching, e.g., 'LOAD"0:" + CHR$(34) + "H*",8' for a file name which starts with an 'H'.

Something you must not do is put a protected program at the start of a disc otherwise it can be loaded by typing 'LOAD"*",8'.

Load problems

A SIMPLE method to avoid the successive LOAD problem on the CBM disc has been sent by G Thomas of Liverpool.

One problem with the CBM 3040 disc unit relates to the calling of one program from another via the LOAD statement. It will work only if the called program is of the same size, or smaller, than the calling program.

If it is not, the LOAD is executed, but the called program is truncated or corrupted and will not run. That is a nuisance if a user wishes to swap programs back and forth from a master routine or chain a large program.

The difficulty can be overcome, however, by fooling the Basic into thinking that it has more program in memory than is there. There are no pointers to the end of Basic but the pointers to the start of the variable table, which follows the Basic, serve the purpose. Take the case where the largest program in a suite is 10K.

Assuming that the Basic starts at location 1025, a 10K program will lift the top of Basic to 1025 + 10 * 1024, or location 11265. By poking the low and high bytes of that adress + 3 into locations 43 and 42, the pointers to the start of the variable table, the Basic space is expanded. Thus, the statement POKE 42,4: POKE 43, 44 added to all programs in the suite will accommodate free loading of any of them.

It is important that the statement should immediately precede the LOAD statement, for if it does not, the variables generated in the calling program can be corrupted. A typical application will look something like:

```
1000 POKE 42,4: POKE 43,44
1010 LOAD"1:PROGRAMA",8: END
```

The procedure does not reduce the memory space available for variables and arrays in the calling program because the instruction is not executed until the program has effectively ended. Thus, the calling program determines its own top of Basic in the usual way, to have it expanded only at its end. It is for that reason that the POKEs must immediately precede the LOAD.

Banner maker

HERE is a little program from Compshop (Ireland) for making banners on your Pet or Epson printers.

```
1 OPEN1,4
2 CMD1
3 LIST
4 REM'B A N N E R (C) COMPSHOP [IRELAND] 1980
5 PRINT""
6 RESTORE
10 INPUT"HORIZONTAL";X
20 INPUT"VERTICAL";Y
30 INPUT"CENTRED";L$
31 G1=0:IFL$ >"P"THENG1=1
33 INPUT"STATEMENT";A$
40 A=ASC(LEFT$(A$,1))
70 FORT=1TOLEN(A$)
80 P$=MID$(A$,T,1)
85 FORO=1TO50
95 READS$,S(1),S(2),S(3),S(4),S(5),S(6),S(7)
100 IFP$=" "THEN812
101 IFP$=S$THEN200
120 NEXT
200 RESTORE
210 X$=S$
215 FORU=1TO7
218 FORK=8TO0STEP-1
230 IF2^K<S(U)THEN270
240 J(9-K)=0
250 GOTO280
270 J(9-K)=1:S(U)=S(U)-2^K
272 IFS(U)=1THEN815
280 NEXT
445 FORT1=1TOX
447 PRINT#1,TAB((63-4.5*Y)*G1/(LEN(X$))+1);
450 FORB=1TOF(U)
460 IFJ(B)=0THEN500
465 FORI=1TOY:PRINT#1,X$;:NEXT
470 GOTO600
500 FORI=1TOY
510 FORI1=1TOLEN(X$)
520 PRINT#1," ";:NEXTI1
530 NEXTI
600 NEXTB
620 PRINT#1,"
630 NEXTT1
700 NEXTU
750 FORH=1TO2*X:PRINT#1,"":NEXT
800 NEXTT
806 FORH=1TO75:PRINT#1,"":NEXT
810 PRINT"MORE(YES/NO)?"
811 INPUTR$:IFR$="YES"THEN5:IFR$="NO"THEN820:GOTO810
812 FORH=1TO7*X:PRINT:NEXT
813 GOTO800
815 F(U)=9-K:GOTO445
820 END
899 DATA"",0,0,0,0,0,0,0
900 DATA"A",505,37,35,34,35,37,505
901 DATA"G",125,131,258,258,290,163,101
902 DATA"E",512,274,274,274,274,258,258
903 DATA"T",2,2,2,512,2,2,2
904 DATA"W",256,257,129,65,129,257,256
905 DATA"L",512,257,257,257,257,257,257
906 DATA"S",69,139,274,274,274,163,69
907 DATA"O",125,131,258,258,258,131,125
908 DATA"N",512,7,9,17,33,193,512
909 DATA"F",512,18,18,18,18,2,2
910 DATA"K",512,17,17,41,69,131,258
911 DATA"B",512,274,274,274,274,274,239
912 DATA"D",512,258,258,258,258,131,125
913 DATA"H",512,17,17,17,17,17,512
914 DATA"M",512,7,13,25,13,7,512
915 DATA"?",5,3,2,354,18,11,5
916 DATA"U",128,129,257,257,257,129,128
917 DATA"R",512,18,18,50,82,146,271
918 DATA"P",512,18,18,18,18,18,15
919 DATA"Q",125,131,258,258,322,131,381
920 DATA"Y",8,9,17,481,17,9,8
921 DATA"V",64,65,129,257,129,65,64
922 DATA"X",388,69,41,17,41,69,388
923 DATA"Z",386,322,290,274,266,262,260
924 DATA"I",258,258,258,512,258,258,258
925 DATA"C",125,131,258,258,258,131,69
926 DATA"J",65,129,257,257,257,129,128
927 DATA"1",0,0,261,259,512,257,257
928 DATA"2",261,387,322,290,274,267,261
929 DATA"3",66,130,258,274,266,150,100
930 DATA"*",69,41,17,512,17,41,69
931 DATA"4",33,49,41,37,35,512,33
932 DATA"5",160,274,274,274,274,274,226
933 DATA"6",194,291,293,297,305,289,193
934 DATA"7",258,130,66,34,18,10,8
935 DATA"8",69,171,274,274,274,171,69
936 DATA"9",263,138,74,42,26,10,7
937 DATA"=",41,41,41,41,41,41,41
938 DATA"!",1,1,1,384,1,1,1
939 DATA"0",57,69,131,258,131,69,57
940 DATA".",1,1,129,449,129,1,1
1000 STOP
1002 END
1003 CLOSE1,4
READY.
```

Pet news

ABOUT two years ago Channel Data Systems in Goleta, California, published the Pet Data Book. It started life as a ring binder, listing under various cross headings the software, peripherals and information sources for the Pet writes Julian Allason of Petsoft.

Channel Data could not have known that support for the Pet system would grow so rapidly. At the last time count, there were more than 200 companies supplying goods for the Pet in the U.K. alone. That number is still growing which suggests whatever plans Commodore may have to market the Pet as a purely business system, there will always be a substantial number of users whose interest lies elsewhere.

The pure computing aspect of the Pet received a major shot in the arm with the release of a Pascal compiler written by T C L Software. T C L are part of Transam which manufactures the Triton and Tuscan microcomputers, and it is interesting that a British firm has succeeded where several U.S. software houses had failed.

Unlike most micro Pascal implementations, it is supplied on disc with no necessity for additional firmware. A 32K Pet is needed. There are two modes of operation. In the simplest, the Pascal compiler co-resides in RAM with your own program. Obviously, the program size is limited in that mode and users will probably find that better for learning the language.

Using the disc-based compiler, one has access to disc file handling and the full power of the language. Pet Pascal is available through Commodore dealers, price £420 inclusive of diskette and 105-page manual. Information from Transam on 01-402 8137.

The absence of the £ sign in the Pet character set has infuriated U.K. users since the system was launched. At last a solution is in sight. Petsoft and HB Computers are marketing a low-cost, high-resolution graphics board which allows up to 128 additional characters to be programmed.

Of course, it does a great deal more than that, allowing one quarter of the screen to be reserved for high-resolution graphics operations. The rest of the screen can be used in the normal text mode, a combination which will be welcomed by anyone who has attempted to wrestle with the problem of the low-density Pet plotting. It is available from most Pet dealers priced £99.50 plus VAT. Information from 021-455 8585.

It emerges from a recent survey of prospective microcomputer purchasers, that the single most popular application was electronic filing. Dataview, the Colchester-based Wordcraft experts has produced a disc-based package called Micro Clerk, specifically for the filing and retrieval of information. In fact, it can be used with the Wordcraft word processor or on its own.

The first part consists of a display editor for creating and correcting natural English records of notes, reports and letters. Part two is a program to extract from a text all paragraphs containing key words chosen by the user. They are highlighted to permit rapid identification of the information being retrieved.

Micro Clerk costs £159 plus VAT. Information from Dataview on 0206-78811.

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• Circle No. 194

This section is open to the Apple user. In every issue we hope to print ideas, hints and comments about the Apple and its suppliers. They must come from you, so write and tell us what you know.

Binary-file finder

TO COPY a binary file, whether program, data or high-resolution graphics picture from one disc to another, you need to know its address and length parameters, writes D Leedham of Enfield, Middlesex.

The program Bloads the requested file, displays the start address and length in decimal and Hexadecimal and, if required, copies the file on to another disc.

The program is in Applesoft/Palsoft and as written is for a 48K machine. For a 32K machine, subtract 16,384 from each of the PEEK addresses in lines 60 and 70. For a 16K system, subtract 32,768.

The program will crash if the binary file is Bloaded into the area of memory occupied by the BFIND program ($800-$AD6). You can still find the start address and length parameters, although without the copy facility, by using the following procedure:

```
BLOAD (filename)
LOAD BFIND
RUN 60
```

A useful addition to the program would be an On Err Goto statement and routines for dealing with Disc Full, I/O Error, File Not Found and so on.

```
]LOAD BFIND

LIST
 10 REM ** BINARY FILE FINDER **
 20 TEXT : HOME
 30 VTAB 10: INPUT "ENTER NAME OF
    BINARY FILE: ";NAME$
 40 D$ = CHR$(4)
 50 PRINT D$;"BLOAD";NAME$
 60 A = PEEK (43634) + PEEK (43635) * 256
 70 L = PEEK (43616) + PEEK (43617) * 256
 80 HOME
 90 VTAB 5: PRINT "FILENAME:
    ";NAME$
100 VTAB 10: PRINT TAB (19);"DEC";
    TAB (27);"HEX"
110 D = A: GOSUB 270
120 PRINT : PRINT "START ADDRESS:";
    TAB (19);A; TAB (27);H$
130 D = L: GOSUB 270
140 PRINT : PRINT "LENGTH:"; TAB
    (19);L; TAB (27);H$
150 VTAB 22: PRINT "DO YOU WISH TO
    SAVE THIS FILE ON ANOT HER
    DISK? (Y OR N)"
160 GET R$
170 IF R$ = "Y" THEN 200
180 IF R$ = "N" THEN END
190 GOTO 150
200 HOME
210 VTAB 10: PRINT "INSERT NEW DISK
    AND PRESS RETURN."
220 GET R$: IF R$ <   > CHR$ (13) THEN
    210
230 PRINT: PRINT
240 PRINT D$;"BSAVE";NAME$;",A";A;
    ",L";L
250 PRINT D$;"VERIFY";NAME$
260 END
270 REM ** DEC TO HEX ROUTINE **
280 H$ = ""
290 FOR I = 1 TO 4
300 T = INT (D/16):S = D-16*T + 48
310 IF S > 57 THEN S = S + 7
320 H$ = CHR$ (S) + H$:D = T: NEXT I
330 RETURN
```

Re-locating assembler

OWNERS of Euro Apples and ITT 2020s with Applesoft or Palsoft in ROM may be disappointed as I was that the mini-assembler facility is not available to them,

writes Malcolm Banthorpe of Northolt, Middlesex. However all is not lost as the assembler is listed in full in the Apple II reference manual.

It resides from F500 to F668 as listed. Re-location to any other address is a simple matter — apart from the tedium of typing 360 bytes of machine code — requiring that the destinations of JMP and JSR instructions within the 360 bytes be changed as appropriate.

I have an ITT 2020 with 48K of RAM and decided to re-locate the assembler to start at B500. The details of the necessary changes given serve as a guide to relocation to other addresses. Choosing a starting address of the form X500 minimises the number of changes required.

Assuming you are typing in the assembler starting at B500, the changes are as follows:

```
B535 becomes 4C 95 B5
B559 becomes 4C 95 B5
B5BD becomes 20 34 B6
B5DB becomes 20 34 B6
B5E5 becomes 20 34 B6
B631 becomes 4C 5C B5
B666 becomes 4C 92 B5
```

That is all there is to it. Providing you have not typed any errors, B666G will take you into the assembler which will function exactly as described in the book.

Having ascertained that all is well, it is wise to save the assembler on tape for future use before doing anything else. Presumably the Sweet 16 Interpreter could be re-located in a similar manner. I would be interested to hear from anyone who has attempted that.

Last-variable printer

SIMON Goodwin of Hereford has contributed the polished version of his assembler routine to print the last variable used by Applesoft Basic.

In essence, the routine could be written as a single line of immediate execution Basic, but when working with large programs, e.g., the tangled Chelsea College Epics, I have found it useful. It is easy to play with, unlike most assembler routines, so it should stimulate a little healthy experimentation.

There may be a string output routine somewhere in the monitor, but I can't find it so I have written my own which is the main part of the listing — it is a kind of combination 6502 For.Next loop and computed Goto, and may have other uses.

The routine can be used from any Applesoft program to find the name of the last variable handled by the computer, for example, before, an error has occured. It is accessed by a call 800 from Applesoft, and can be either Bloaded or Poked into memory. It has no use with integer Basic programs, but could probably be modified to suit.

Use it to debug: next without for, illegal quantity, overflow, division by zero, errors in complex programs. The routine from £0320-£0333 can be used as a general-purpose machine-language routine to output up to 30 text characters in memory from 0300 onwards. Remember to end with CR and code (00).

Simon Goodwin's last-variable printer.

```
0300.0311
0300-  8D 87 AA AA AA A0 CC C1                   HEX DUMP OF MESSAGE CODES
0308-  D3 D4 A0 D6 C1 D2 A0 BA
0310-  A0 00
*
0320L
0320-     AD 00 03     LDA    £0300              GET MESSAGE CODE
0323-     D0 03        BNE    £0328              JUMP OUT IF BREAK CODE
0325-     4C 31 03     JMP    £0331              JUMP OUT
0328-     20 ED FD     JSR    £FDED              OUTPUT CHARACTER
032B-     EE 21 03     INC    £0321              INCREMENT POINTER
032E-     4C 20 03     JMP    £0320              DO IT AGAIN
0331-     8D 21 03     STA    £0321              RESET POINTER
0334-     A5 81        LDA    £81                GET FIRST VAR CODE
0336-     69 7F        ADC    #£7F               CONVERT TO ASCII
0338-     20 ED FD     JSR    £FDED              OUTPUT CHARACTER
033B-     A5 82        LDA    £82                GET SECOND VAR CODE
033D-     69 7F        ADC    #£7F               CONVERT TO ASCII
033F-     20 ED FD     JSR    £FDED              OUTPUT CHARACTER
0342-     A9 8D        LDA    #£8D               LOAD CR CODE
0344-     20 ED FD     JSR    £FDED              OUTPUT CHARACTER
0347-     60           RTS                       BACK TO BASIC
0348-     EA           NOP
0349-     EA           NOP
034A-     EA           NOP                       (CR=CARRIAGE RETURN)
034B-     EA           NOP
```

How automation may affect our lives

In the final part of his series, Mark Witkowski examines the sizeable impact robots will make on industrial processes.

OF THE many forms a robot may take, the standard industrial robot is, and will continue to be for the foreseeable future, the most numerous and the type which will most affect our lives.

New uses being found continuously for such machines and the range of uses and the number of manufacturers which employ them must surely increase. They represent a bridge between the high initial cost of full 'hard' automation, with its lower running costs and the high overheads of employing people to make things.

Low initial cost

Because of its flexibility, relatively low initial cost and re-usability, the robot is slowly finding a wider acceptance with the industrialists of the world, whereas full automation becomes expensive junk when a production run ceases.

Robots open to a much wider range of smaller industries the gains to be made from mechanisation and automation — automation closer to the cottage industry.

Robots are used in a wide range of processes and industries, anywhere where heavy items must be lifted, transported, placed accurately or where a job needs to trace a consistant, repeatable path. They are used in an increasing number of light assembly tasks and for packaging goods.

Reasons vary why a robot may be introduced on to a production line. It may simply be that the introduction of soft-automation to a particular point in a production line is justified easily on economic grounds — it does the job adequately at the lowest cost. In a highly-competitive field, that will be sufficient in itself.

However, in some trades, the number of skilled people may be insufficient and the robot represents a way of allowing manufacturing to continue. In some cases, extra consistency is brought by the introduction of robots allowing improved output quality, with fewer reject items and so increased customer satisfaction.

A note of caution is that in many cases, robots have little or no integral quality-control checking, so if things start to go wrong, they could go unnoticed for a significant period.

In other situations, the work a person is being asked to do may be in some way intolerable. There is physical danger when a man must work close to moving machinery or presses — robots may be used to feed these machines and take finished work from them.

Some jobs are dirty or involve hazardous chemicals, excessive dust or noise, in which case the individuals involved and their unions will expect higher pay. At the same time, the law dictates that working conditions be within certain bounds, which involve increasingly the installation of expensive environmental conditioning. Robots will function in a wider range of hostile situations and hence require less protection and can be cheaper overall.

New techniques

It is possible that the new manufacturing processes could be introduced using robots from the outset, because previously they would have involved people in conditions too hazardous to contemplate. Robots may be regarded like any other

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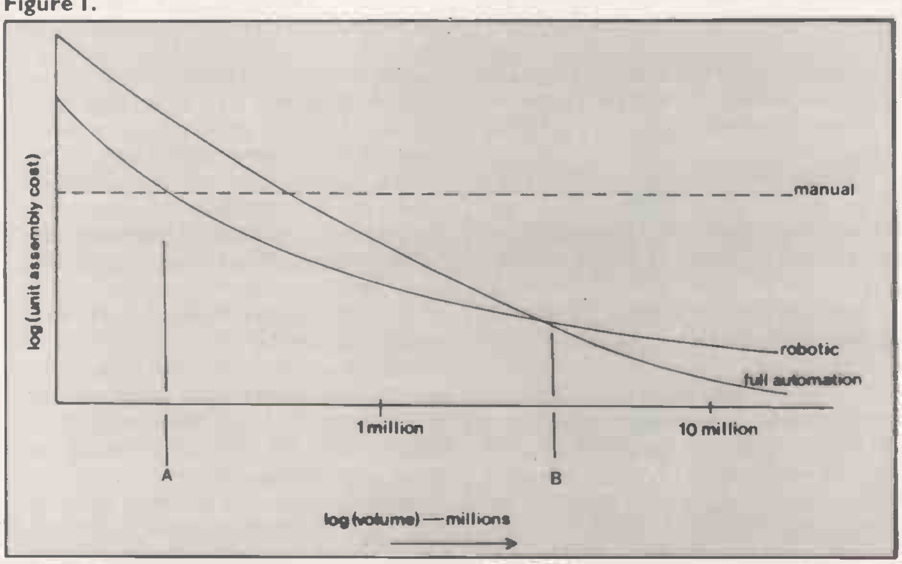
Figure 1.



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item of moving machinery and provision must be made to safeguard people who work close to them.

There are several economic factors in the use of industrial robots, both in the cost of their introduction, and the potential savings which should be made. The major initial outlay is the purchase of the robot or robots, though it may be advantageous from a cashflow or tax point of view to hire or lease equipment.

Coupled to that initial cost might be structural alterations to buildings, although that is seldom needed, installation charges, a stock of spares, staff training and programming costs. If the robot is being introduced at the expense of already existing jobs then re-training, re-location or redundancy payments may well be in order.

Production line

On the other hand, the setting-up of a new production line or construction of a new factory must be a good time to consider the introduction of robotic devices. Running costs will include maintenance contracts and service costs, various staff costs, such as overseers and programmers.

There is always, of course, the possibility of mechanical failure and down-time with consequent loss of production, though robot manufacturers insist that their machines have a good reliability record and long mean times between failures.

Against those outlays, the major saving in expense is the manpower which would have to be employed to do the same job, including any fringe benefit — administrative and employment contributions have to be made. Remembering also that there may be less need for environmental control.

The formula is complicated by the fact that a robot is unlikely to do exactly the work of one man. Whatever the relative work rates, the robot should have to stop less frequently and it could be kept working over one, two or even three shifts per day.

In many cases, the robot cycle can be optimised to use the minimum energy and materials, which over many years of operation could represent a considerable saving.

Obviously before deciding to introduce robots on economic grounds all those factors, and any specific to a given industry, must be carefully weighed. In the majority of cases, the major expense will be the initial cost, the investment being spread over the life of the robot — perhaps five to eight years.

The major saving is the cost of equivalent human labour. In those countries where 'blue-collar' workers are paid relatively well, the use of robots will seem more attractive. Figure 1 shows the increasing advantages of robotics to the U.S. automotive industry in the face of rapidly-rising labour costs — Engelburger 1979a for details of costings.

It is the responsibility of individual managers and production engineers to assess the merits of robotics in relation to manual methods or hard automation. Most robot manufacturers are only too willing to discuss the possibilities for the introduction of their machines.

Kusmierski (1979) discusses the relative merits of manual, robotic and the use of multi-axis, numerically-controlled machine tools in the drilling of bolt holes in the skin panels of a military fighter aircraft. He concludes that although such aircraft are made in relatively small quantities, around 3,000 in this case, the number of panels and the number of holes in each panel justifies the use of automation over manual drilling of the holes through templates. Because of their lower cost, and as they were capable of the accuracy called for, robots were appropriate to the task.

Figure 2 is a graphic representation of the cost per unit for the three possibilities, the curves being typical for a number of different examples. Point A on the figure will often be quoted as being around the 20,000 to 50,000 mark, point B at one to three million units produced.

Presumably relative costs will change as labour becomes more expensive and robots become relatively cheaper as a result of improved fabrication techniques. As robots become usable in the manufacture of more valuable items, their useful range will expand.

Future well-being

The introduction of robots and other forms of modern technology is seen in many quarters as being essential to the future industrial well-being of the U.K. With that change is an inevitable disruption to the labour force.

In the past, the response by both management and unions to the problem has been, to say the least, unpredictable. At least one union, the Association of Scientific, Technical and Managerial Staffs (ASTMS) has considered this problem in some depth (ASTMS 1979), though with so few robots in the U.K. and so little experience with them, their comments are in the most part directed at other forms of "new technology".

The general tone of the document agrees that the introduction is needed for the long-term well-being of the nation, that this will, indeed, cause severe employment disruption, but that the unions should be involved in discussions at all levels as to how it may best be borne.

There is a good chance that most robots will not be used to replace directly people in jobs, but that the robot will be introduced into the production line as and where it is appropriate.

General Motors, for instance, are looking at the Programmable Universal Machine for Assembly (Beecher 1979),

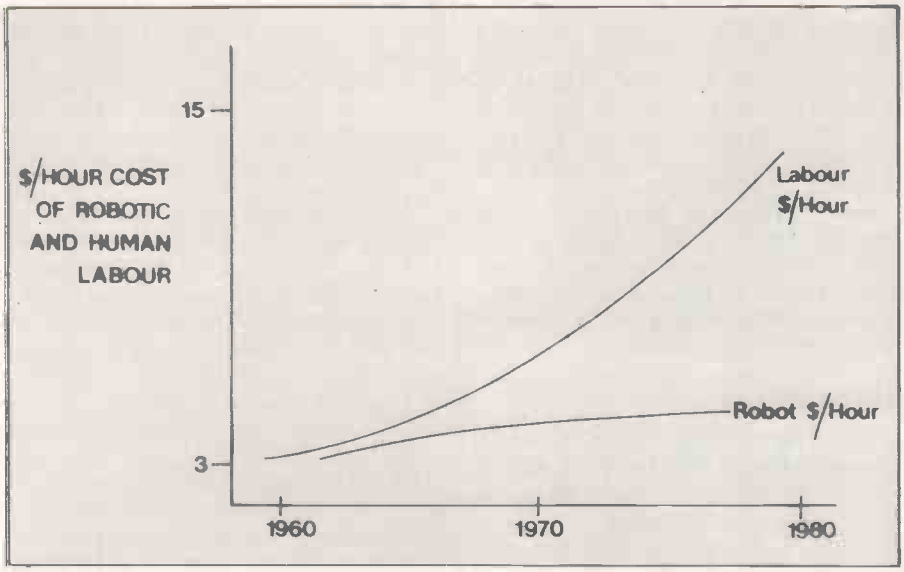

Figure 2.

Puma, as an assembly unit comprising robots, fixed automation, transfer devices, parts feeders and people in the assembly of some of the medium sized sub-assemblies to be found in cars.

Tele-operators are a second example of a robotic device in which a person plays an essential role. There are many examples of tasks where the skill and dexterity required is well in excess of that available with robot automation, yet the individual must remain at a distance from the job to be done.

Typical examples would be work in munitions factories, work with radioactive materials, undersea mining and space, where conditions are so dangerous, unpleasant, or where life-support systems are prohibitively expensive that a directly-controlled robot is an attractive proposition.

The army have a caterpillar-tracked vehicle 'wheelbarrow' to assist in bomb disposal operations. The high-energy neutrons generated by fusion reactors, such as the projected Joint European Torus (JET) leave high levels of residual radiation in the structure of the Torus so that remote manipulators will have to be used for all service operations, — Raimondi (1976).

Remote manipulation

Those working with fission reactors and radioactive materials are no strangers to remote manipulation either. Apart from the familiar master-slave manipulators used in that industry, there is some interest in remotely-controlled mobile vehicles, equipped with manipulators and television cameras — Constant and Hill (1976).

Although the U.K. is somewhat timorous at the introduction of robots, a certain amount of action has occurred in the last few months. Hall automation has been bought by the giant GEC group. British Robot Systems Limited (BRSL), a new robot manufacturing company, has been set-up between the engineering firm Remek Micro Electronic Ltd and the software house SPL International.

Its intention is both to manufacture robots and to sell complete robot systems to their customers. Unimation is opening a new factory at Telford, Shropshire, to manufacture its electric assembly robot, the Puma. British Leyland is introducing 36 welding robots to the new Mini Metro assembly line. There are, in any case, a number of other U.K. firms with robots under evaluation.

Scientific research

The Science Research Council is to take new steps to support scientific research into industrial robotics, following the publication of the Roberts report (SRC 2979). This advisory panel reported that the SRC should take a 'major initiative' in industrial robotics.

That includes the appointment of a robotics program director who is to study the situation for 12 to 18 months. A report should be prepared in collaboration with the Department of Industry to determine research priorities. It also proposed that a professorship should be established in robotics.

In addition to the technical aspects of robotics, the Social Sciences Research Council (SSRC) should investigate the social aspects of robotics, a previously neglected area. The Roberts panel saw potential for the U.K. as a manufacturer of total robot systems and expertise.

To date, the SSRC has earmarked a sum of money to a programme of University/Industry research and development collaborations. The panel seemed uncertain how to fund the artificial intelligence end of robot research, whose contribution to industry is certainly on a longer time scale.

Artificial intelligence is reckoned generally to have suffered something of a blow after a rather discouraging report to the SRC in the early seventies (SRC 1973).

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Paradoxically, the new report comes at a time when industrial robotics is feeling the effects of work done at artificial intelligence laboratories between five and 10 years ago, with more in the pipe-line, particularly as industrial robotics had been somewhat stagnant for some years.

Notwithstanding the SSRC 1973 Lighthill report, the SRC did continue to support artificial intelligence and the computing aspects of robotics as part of its general scientific funding policy, although without undue enthusiasm.

Areas of interest

The Roberts report identified several areas of industrial robotics which need attention; the list seems to cover all known apsects of industrial robotics.

Advances in robot control and programming techniques are called for, and at all levels. There are many possibilities for improvements to the low-level servo- and dynamic-control problems, which are essentially in the control engineering domain.

How industrial robots should be programmed, both to maximum effect and with a certain regard to the poor soul who has to do it is more in the computer scientists preserve. Until recently, the only practicable industrial robot programming technique was 'teaching' it by leading it through the motions it was to make, either directly or using a joystick.

Now many robots are complete with a programming language for the mini or microcomputer which is integral with the robot system. Some of the robot programming languages were discussed in part four, along with the more direct teaching modes. Major differences between robot languages and conventional programming languages arise due to the need to handle vast quantities of largely-unpredictable data conditions.

Assembly robots must servo at multiple levels — internally about proprioceptive sensors to perform the basic actions, externally about the various sensors which must guide the work.

They must also recover from errors outside the bounds of the servo-loop parameters. When that happens, the control program must detect it and evoke an appropriate routine to restore the work sequence and re-synchronise the flow of the control program at ther appropriate place.

In attempting to repair one fault, more can easily be caused and error recovery may have to be highly-sophisticated and robust — far more so than the main control program. Unfortunately, standard programming languages are based on the premise that the problem has a logical, structured solution. Few programmers are prepared for the deluge of sensory information that will be encountered in controlling a robot.

Most of it should be ignored as currently correct, although it has to be checked because sooner or later it will herald something nasty. There is always the possibility of spurious data, or a spurious interpretation of the data. There are several adoptable strategies; one is to ignore errors and to sort the environment so it 'never' happens.

The whole thing can be abandoned at the first sign of trouble and started again from a predictable point. Limited checks can be made on the progress of the task, warnings and error messages generated if they fail, but generally with little attempt at repair. That represents the current level of industrial robot programming.

Even when the 'problem-solving' techniques described in part five are perfected and applied to manipulator control, and the robot can deduce which actions are likely to achieve a given goal, the chances are that a human will still have to lay down the options.

Before a robot can have any serious degree of manipulative skill, the capability for those programs to learn will have to be incorporated. Computer learning varies upwards from simple adaption, in which the overall flow of control is predefined and only various parameters are 'tweaked' to give the final behaviour.

That is done normally by having the machine make an action — either totally at random at first, or under some sub-optimal algorithm — and a second 'system' usually a person, corrects any mistakes he thinks the machine has made.

Any actions the robot makes are a reflection of the sensor values which arrive and the current, but changeable, state of the program's adaptation parameters. Each time the robot makes an incorrect movement, the adaptive parameters are adjusted so that the response is closer to the ideal set by the observer.

The machine will eventually always make exactly the correct response — the human and the machine have 'converged'. Such programs are clearly disrupted by the trainer being inconsistent in his response, doing things differently in equivalent situations. That may occur by accident if the person knows or can see something that the robot cannot sense.

Learning algorithms

There are several such 'convergent' learning algorithms — Nilsson, 1965 — one of which has more recently been championed by Albus — Albus and Evans, 1976 — for the control of a multi-degree-of-freedom manipulator.

That is clearly a less direct and more sophisticated form of the robot training process than leading it through a sequence of actions. Adaptive learning relies almost totally on the sensor values to determine the next robot action. As we have seen in part four it is very difficult to include sensor information in the conventional training sequence.

While it is possible to justify 'training' as the word for what the robot programmer does in a conventional training sequence, there is no reason to call what the robot does 'learning'. We would no more say a tape-recorder learned what it recorded.

The problem with adaptive training is that the robot must be led through the sequence many times, until it has it right. Even then, there is no real guarantee that a novel set of sensory inputs will not cause a totally spurious output to occur. Furthermore, each novel response corrected may affect other responses adversely, but that depends on the exact form of the algorithm.

Adaption is still far less sophisticated than the other forms of learning used by both humans and animals to develop manipulative and other skills. Learning proper is only part of a multi-stage process. Initially, the robot must observe through its sensors the effects its actions have in any number of different situations.

It makes the action, either as part of some behaviour pattern or of a learning process of discovery by experimentation, and observes the effects. It may then generalise, determine which of those things are universal or frequent, or which are specific to particular instances.

Course of action

That information may be used by the other algorithms to effect a reasonable course of action. A moment's thought will reveal further complications and possibilities for refining the algorithms needed. They must be 'teachable' as well as learn on their own account. These techniques of learning programming have been discussed in more detail in *Practical Computing*, November 1979.

Apart from Albus, who in part bases his control model on the observations of Tinbergen about hierarchical control structure in some animal behaviour and in part on enurological observations — Albus 1979 — there are several other attempts to control robots with systems based on biological observations.

Sutro and Kilmer (1969) did work for NASA modelled on the visual process in the frog retina and an overall control structure based on a theory of the vertebrate brain. Their work was much influenced by the neurologist, physiologist and psychologist, Warren McCulloch. Friedman (1969) based the control strategies of his simulated robot ADROIT on theories from ethological studies of instinctive behaviour.

Whatever the desirability or value of having robots with more than a little intelligence of their own may be, the advantages of knowing how robots may be made intelligent are clear.

To design robots to do things adult people find straightforward, such as recognising and picking up objects, discovering what is going wrong, predicting the effects of what they do and what will happen generally and communicating their skill and knowledge is beyond our understanding.

Yet it is those problems that are the block to many advances in robotics. We should study how the unco-ordinated graspings of a baby become the skilled and precise actions of a master craftsman.

With a worldwide robot population numbering thousands rather than millions, their potential is only just beginning to be felt. The answer is a research and development program with both the breadth to use and apply what knowledge we already have to our advantage and the depth to ensure a supply of new understanding to maintain and increase whatever benefits these technologies may bring.

Advice and information should be available to those who may need robots and we should investigate and discuss the social implications of the widespread introduction of robotics.

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BUYERS' GUIDE

Software

The Software Buyers' Guide is bigger and more comprehensive this month. The successful presentation used in the last guide has been retained but for easy reference, suppliers, applications and machine types are listed in alphabetical order. Application packages are listed by machine type, giving machine, company name, price and capacity.

The usual criteria have been applied. The minimum configuration is 32K of RAM, a disc and a printer; the price of the package must lie between £50 and £1,000; the companies listed are the source of the software or the main dealers in the U.K., and the capacity quoted is per disc or drive.

Machine types by main applications

Combined-Ledger/Stock/Invoicing

Machine type	Supplier Name	Price	Capacity
Commodore 3032	G W Computers Ltd	£275 - £575	1,000
Z-80/8080	Great Northern C S Ltd	£995	varies
Ohio Scientific	Microcomputer B M	£656	
Tandy TRS-80	Microcomputer Applications	£90 each	
Tandy TRS-80	T & V Johnson Ltd	£110	750 trans/disc
Commodore 3032	Bristol Software Factory	£300	1,000 A/Cs 6,000 trans
Apple II	Vlasak Electronics Ltd	£855	
CP/M North Star	Benchmark CS Ltd	£950	200 A/Cs 500 trans 300 ITM
Commodore 3032	Stage One Computers		
Commodore 3032	Commodore B M (U.K.) Ltd	£650	650 A/C/ledger
CP/M	Computastore Ltd	£1,000	
Tandy TRS-80	Mode Microcomputer Applications	£350	
Commodore 3032	Analog Electronics	£550	
Commodore 3032	Logma Systems Design	£600	1-6 shops
CP/M North Star	Instar Business Systems	£999	600-2,900
Z-80/8080	Graffcom Systems Ltd	£995	

General Ledger

Machine Type	Supplier Name	Price	Capacity
Z-80/8080	Great Northern C S Ltd	£275	varies
Tandy TRS-80	Tridata Micros Ltd	P.O.A.	to be linked to S/L P/L
Apple II	Computech Systems	£295	500 A/Cs 1,600 trans
Commodore 3032	HB Computers Ltd	£200	linked to S/L & P/L
Apple II	Vlasak Electronics Ltd	£225	200 A/Cs 1,000 trans
CP/M	Computastore Ltd	£500	999 A/Cs 99 centres 9 companies
CP/M	Comput-A-Crop	£400	
CP/M North Star	Benchmark CS Ltd	£250	500 A/Cs 5,700 trans
Apple II	Microdigital Ltd	£295	
Commodore 3032	Analog Electronics	£450	
Commodore 3032	Bristol Software Factory	£300	1,000 A/Cs, 6,000 trans
Z-80/8080	Graffcom Systems Ltd	£390	

Incomplete Records

Machine type	Supplier Name	Price	Capacity
CP/M	Profcomp Ltd	P.O.A.	2,000 entries
Commodore 3032	Micro Computation	£555	120 A/Cs 5,000 trans
Apple II/ITT 2	Padmede Computer Services	£450	900 A/Cs 2,000 trans/disc
Exidy Sorcerer	Basic Computing	£350	incl. Vasee also Micropute
Apple II	Personal Computers Ltd	£250	1,000 trans 2,600 A/Cs
Commodore 3032	Stage One Computers		

Job Costing/Billing

Machine type	Supplier Name	Price	Capacity
CP/M	Graffcom Systems Ltd		100 activity codes
Z-80/8080	Great Northern C S Ltd	£330	varies
Apple II/ITT2	Padmede Computer Services	£300	1,000 A/Cs 99 centres
Apple II/ITT 2	Padmede Computer Services	£300	150 A/Cs
Commodore 3032	Stage One Computers		
Commodore 3032	CSM Ltd	£600	1,000 jobs, 100 people

Mailing Systems

Machine type	Supplier Name	Price	Capacity
CP/M	Structured Systems Group	£50	varies
Apple II	Keen Computers Ltd	£300	500 addresses
Tandy TRS-80	T & V Johnson Ltd	P.O.A.	3,000 names/addresses
Z-80/8080	Micro Focus	£90	varies
CP/M	Graffcom Systems Ltd	£250	varies
Apple II/ITT 2	The Software House	£57	
Commodore 3032	Stage One Computers		
Apple/ITT 2020	Systematics Intl Ltd	£300	500 addresses
Apple II/ITT	Guestel Ltd	£190	400 addresses
Commodore 3032	MMS Computer Systems	£250	3,000 records
CP/M Horizon	Microtek Computer Services	£500	varies
Tandy TRS-80	Cleartone ADP	£50	660 entries

Payroll

Machine type	Supplier Name	Price	Capacity
Apple	Algobel Computers Ltd	£295	500 employees
Commodore 3032	Computastore Ltd	£200	275 employees
		£350	500 employees
CP/M	Graffcom Systems Ltd	£500	250 employees
Tandy TRS-80	Tridata Micros Ltd	£218	400 employees
Apple II/ITT 2	Computech Systems	£379	
Apple II/ITT 2	T W Computers Ltd	£145	
Commodore	Petsoft Ltd	£50	200 employees
Commodore 3032	Landsler Software	£95	250 employees
Commodore 3032	L & J Computers	£220	
Tandy TRS-80	3-Line Computing	£140	
Apple II/ITT 2	Hewport Ltd	£400-£500	100 month 50 weekly
Apple II/ITT 2	Vlasak Electronics Ltd	£360	

CP/M	Comput-A-Crop	£450	
Apple II	Microdigital Ltd	£375	
Commodore 3032	Commodore B M (U.K.) Ltd	£150	200 employees
Apple/ITT 2020	Systematics International Ltd	£295	350 employees
Commodore 3032	Analog Electronics	£90	
Commodore 3032	Intex Datalog Ltd	£195	200 employees
CP/M Horizon	Microtek Computer Services	Lease	varies
Tandy TRS-80	AJ Harding (Molimerx)	£95-£200	
Z-80/8080	Graffcom Systems Ltd	£490	250 employees

Property Management

Machine type	Supplier Name	Price	Capacity
Z-80/8080	Graham Dorian Software	£325	varies
Apple II/ITT 2	Algobel Computers Ltd	£650	400 buildings 250 own 2,000 trans
CP/M	Algobel Computers Ltd	£650	2,000 trans

Purchase Ledger

Machine type	Supplier Name	Price	Capacity
CP/M	Structured Systems Group	£460	varies
Commodore 3032	Microact Ltd	£350	2,000 A/Cs 7,000 trans
Z-80/8080	Great Northern C S Ltd	£275	varies
Tandy TRS-80	Tridata Micros Ltd	£225	175 A/Cs 1,350 trans
Apple II	Vlasak Electronics Ltd	£315	200 A/Cs 1,000 trans
Apple II	Computech Systems	£295	500 A/Cs 1,600 trans
Commodore 3032	HB Computers Ltd	£350	800 A/Cs 4,000 trans
CP/M	Computastore Ltd	£400	500 A/Cs 3,100 trans
Apple II/ITT 2	Padmede Computer services	£300	900 A/Cs 4,500 trans/disc
Exidy Sorcerer	Basic Computing	£125	incl. Vasee also Micropute
CP/M	Comput-A-Crop	£400	500 A/Cs
CP/M North Star	Benchmark CS Ltd	£250	500 A/Cs 2,000 trans
Apple II	Microdigital Ltd	£295	
Commodore 3032	Act (Petsoft) Ltd	£120	200 A/Cs 700 trans
Tandy TRS-80	AJ Harding (Molimerx)	£225	1,100 entries
Z-80/8080	Graffcom Systems Ltd	£440	

Records Management (DBMS)

Machine type	Supplier Name	Price	Capacity
Commodore 3032	Commodore B M (U.K.) Ltd	£150	650
Commodore Pet	Stage One Computers	£120 & £180	165K
Apple II/ITT 2	T & V Johnson Ltd	£95	112K per drive
Ohio Scientific	Microcomputer B M	£175	
Commodore 3032	Amplicon M S Ltd	£140	1,500 records
Tandy TRS-80	T & V Johnson Ltd	£200	
Z-80/8080	Structures Systems Group	£135	varies
Commodore 3032	Compsoft Ltd	£95 ea	170,600-5,000 records
Apple/ITT	The Software House	£140	
Commodore 3032	Microact Ltd		400K - 800K
Apple/ITT 2020	Systematics International Ltd	£72 & £175	
Apple/ITT 2020	Systematics International Ltd	£125	1,000 references
Apple II	Courtman Micro Systems	£106	100K Characters
Apple II/ITT	Diskdean Ltd	£120	varies
CP/M SWTPC	Verwood Systems		
Ohio Challenger	U-Microcomputers Ltd	£175+	
Z-80/Cromemco	Xitan Systems Ltd	£850	4,000 records/disc

Sales Ledger

Machine type	Supplier Name	Price	Capacity
Commodore 3032	Microact Ltd	£350	2,000 A/Cs 7,000 trans
Z-80/8080	Great Northern C S Ltd	£275	varies
Tandy TRS-80	Tridata Micros Ltd	£225	175 A/Cs 1,350 trans
Apple II	Vlasak Electronics Ltd	£315	200 A/Cs 1,000 trans

Apple II	Computech Systems	£295	500 A/Cs 1,600 trans
Commodore 3032	HB Computers Ltd	£350	800 A/Cs 4,000 trans
CP/M	Computastore Ltd	£400	500 A/Cs 3,500 trans
Apple II/ITT 2	Padmede Computer Services	£300	900 A/Cs 4,500 trans/disc
Exidy Sorcerer	Basic Computing	£125	incl. Vasee also Micropute
CP/M North Star	Benchmark CS Ltd	£250	500 A/Cs 2,000 trans
Apple II	Microdigital Ltd	£295	
Commodore 3032	Act (Petsoft) Ltd	£120	200 A/Cs 700 trans
Tandy TRS-80	AJ Harding (Molimerx)	£225	1,350 entries
Z-80/8080	Graffcom Systems Ltd	£440	

Stock Systems

Machine type	Supplier Name	Price	Capacity
Apple II/ITT 2	Microdigital Ltd	£225	625 items
CP/M	Graffcom Systems Ltd	£350	520 - 6,000 items
Z-80/8080	Great Northern C S Ltd	£275	varies
Tandy TRS-80	Tridata Micros Ltd	£200	630 items/disc
Commodore 3032	Commodore B M (U.K.) Ltd	£150	650
Commodore 3032	Bristol Software Factory	£300 £360	2,300
Z-80/8080	Graham Dorian Software	£325	varies
Apple II/ITT 2	Vlasak Electronics Ltd	£285	
Commodore 3032	Petsoft Ltd	£50	2,000
Commodore 3032	L & J Computers	£120	3,400 items
Commodore 3032	Microact Ltd	£350	2,500 items 1,000 A/Cs
Tandy TRS-80	T & V Johnson Ltd	£115	1,000 items
Tandy TRS-80	T & V Johnson Ltd	£145	1,000 items/invoices
Commodore 3032	Aplicon M S Ltd	£750	500-600 items 255 A/Cs
Exidy Sorcerer	Basic Computing	£125	incl. Vasee also Micropute
Apple/ITT	The Software House	£80	
CP/M North Star	Benchmark CS Ltd	£450	1,000 items 750 trans
Commodore 3032	Stage One Computers		
Commodore 3032	Anagram Systems	£750	500-600 items 255 A/Cs
Commodore 3032	Logma Systems Design	£600	1-6 shops
Commodore 3032	Rockliff Brothers Ltd	£120	3,900 items
Commodore 3032	SA Systems	£650	300 records/disc
Commodore 3032	SMG Microcomputers	£395-£495	2,450-7,000 items
CP/M Horizon	Microtek Computer Services	£1,000	varies
Tandy TRS-80	Microgems Software	£150	1,000-2,000 itesm
Tandy TRS-80	AJ Harding (Molimerx)	£225	630 items
Tandy TRS-80	Cleartone ADP	POA	
Tandy TRS-80	SA Systems	£650	300 stock records
Z-80/8080	Graffcom Systems Ltd	£340	
Z-80/8080	Graffcom Systems Ltd	£580	
Z-80/MCZ	Software Architects Ltd	£600	varies
Commodore 3032	Act (Petsoft) Ltd	£75	
Apple/ITT 2020	Systematics International Ltd	£500	200-2,500 items
Z-80/8080	Rogis Systems Ltd	£500	900 - 3,500 items

Word Processing

Machine type	Supplier Name	Price	Capacity
Commodore 3032	Commodore B M (U.K.) Ltd	£75 & £150	170 pages
Tandy TRS-80	T & V Johnson Ltd	£109	10,000 words
Ohio Scientific	Microcomputer B M	£116	
Apple II/ITT 2	Algobel Computers Ltd	£75	800 lines
Commodore 3032	Dataview Ltd	£159	
Commodore 3032	HB Computers Ltd	£70	39 A4 pages
Apple II/ITT 2	Vlasak Electronics Ltd	£120	
Z-80/8080	Structured Systems Group	£120	varies
Apple II	Personal Computers Ltd	£150	17 A4 pages
Commodore 3032	Stage One Computers		
Commodore 3032	Act (Petsoft) Ltd	£325	
CP/M	Computastore Ltd	£400	
Apple/ITT 2020	Systematics International Ltd	£75	
Apple II/ITT	Guestel Ltd	£190	100K characters

Applications by machine

Apple II/ITT 2020

Application	Supplier Name	Price	Capacity
Cash-flow/bank	Vlasak Electronics Ltd	£80	
Credit control	Microdigital Ltd	£130	
DBMS	The Software House	£140	
DBMS	T&V Johnson Ltd	£95	112K per drive
DBMS I & II	Systematics International Ltd	£75 & £175	
DBMS text files	Systematics International Ltd	£125	1,000 references
Estate agents' register	Vlasak Electronics Ltd	£120	
Estate agents' system	Systematics International Ltd	£850	
Financial planning	Systematics International Ltd	£295	
Incomplete records	Personal Computers Ltd	£250	1,000 trans 2,600 A/Cs
Incomplete records/ nominal ledger	Padmede Computer Services	£450	900 A/Cs 2,000 trans/D
Job costing	Padmede Computer Services	£300	1,000 A/Cs 99 centres
Job-T&M cost recording	Padmede Computer Services	£300	APCs
Ledger general	Computech Systems	£295	500 A/Cs 1,600 trans
Ledger general	Microdigital Ltd	£295	
Ledger general	Vlasak Electronics Ltd	£225	200 A/Cs 1,000 trans
Ledgers/general sales purchase	Vlasak Electronics Ltd	£855	
Ledger purchase	Computech Systems	£295	500 A/Cs 1,600 trans
Ledger purchase	Microdigital Ltd	£295	
Ledger purchase	Padmede Computer Services	£300	900 A/Cs 4,500 trans
Ledger purchase	Vlasak Electronics Ltd	£315	200 A/Cs 1,000 trans
Ledger sales	Computech Systems	£295	500 A/Cs 1,600 trans
Ledger sales	Microdigital Ltd	£295	
Ledger sales	Padmede Computer Services	£300	900 A/Cs 4,500 trans
Ledger sales	Vlasak Electronics Ltd	£315	200 A/Cs 1,000 trans
Letter writer	Vlasak Electronics Ltd	£80	
Mail system	The Software House	£57	
Mailing and letter writer	Keen Computers Ltd	£300	500 addresses
Mailing system	Systematics International Ltd	£300	500 addresses
Modelling (VisiCalc)	Microsense Computers Ltd	£95	
Payroll	Algobel Computers Ltd	£295	500 employees
Payroll	Computech Systems	£379	
Payroll	Hewport Ltd	£400 £500	100 months 50 weekly
Payroll	Microdigital Ltd	£375	
Payroll	Systematics International Ltd	£295	350 employees
Payroll	TW Computers Ltd	£145	
Payroll	Vlasak Electronics Ltd	£360	
Property management	Algobel Computers Ltd	£650	400 buildings 250 own 20
Sales analysis	Microdigital Ltd	£200	500 A/Cs
Stock control	Microdigital Ltd	£225	625 items
Stock control	Systematics International Ltd	£500	200-2,500 items
Stock control	The Software House	£80	
Stock/purchase/order invoicing	Vlasak Electronics Ltd	£285	
Structural engineering design	James C Steadman	£200	
Word processing	Vlasak Electronics Ltd	£120	
Word processing	Algobel Computers Ltd	£75	800 lines
Word processing	Personal Computers Ltd	£150	17 A4 pages
Word processing	Systematics International Ltd	£75	
3-D graphics package	Blackpool & Fylde Coll	£150	
DBMS	Courtman Micro Systems	£106	100K characters
DBMS	Diskdean Ltd	£120	varies
Mailing/word processor	Guestel Ltd	£190	400 addresses
Word processor	Guestel Ltd	£190	100K characters

Commodore 3032

Application	Supplier Name	Price	Capacity
Appointments planner	Commodore B M (U.K.) Ltd	£50	200 entries
Building conversion	Micro Computation	£300 £400	320 clauses
DBMS	Amplicon M S Ltd	£140	1500 records
DBMS	Commodore B M (U.K.) Ltd	£150	650
DBMS	Microact Ltd		400K-800K
DBMS MK I & II	Compsoft Ltd	£95 ea	17,600-5,000 records
DBMS sequential & random	Stage One Computers	£120 & £180	165K 165K
Estate agents' package	Stage One Computers	£250	325 properties
Hotel room system (INTG)	Landsler Software	£275	8X99 rooms for 400
Hotel system (+billing)	Landsler Software	£450	130 rooms
Incomplete records A/C	Micro Computation	£555	120 A/Cs 5,000 trans
Incomplete records	Stage One Computers		
Insurance brokers' system	Stage One Computers		
Insurance renewals	Stage One Computers		650 policies
Job/apartments planner	Stage One Computers		
Job-time record costing	CSM Ltd	£600	1,000 jobs, 100 people
Ledger general	Analog Electronics	£450	
Ledger general	HB Computers Ltd	£200	Linked to S/L & P/L
Ledger/general & purchase	Bristol Software Factory	£300	1,000 A/Cs 6,000 trans
Ledgers/general/sales/purchase	Analog Electronics	£550	
Ledger purchase	ACT (Petsoft) Ltd	£120	200 A/Cs 700 trans
Ledger purchase	HB Computers Ltd	£350	800 A/Cs 4,000 trans
Ledger purchase	Microact Ltd	£350	2,000 A/Cs 7,000 trans
Ledger sales	ACT (Petsoft) Ltd	£120	200 A/Cs 700 trans
Ledger sales	HB Computers Ltd	£350	800 A/Cs 4,000 trans
Ledger sales	Microact Ltd	£350	2,000 A/Cs 7,000 trans
Ledger/sales, purchase & general	Commodore BM (U.K.) Ltd	£650	650 A/C ledgers
Ledgers/sales, purchase & general	Stage One Computers		
Ledgers/stock/invoicing	GW Computers Ltd	£275 £575	1,000
Mailing system	Stage One Computers		
Ordercontrol	MMS Computer Systems	£250	3,600 orders
Payroll	Commodore BM (U.K.) Ltd	£150	200 employees
Payroll I & II	Computastore Ltd	£200 & £350	275 & 500 employees
Payroll	Landsler Software	£95	250 employees
Payroll	Petsoft Ltd	£50	200 employees
Payroll/invoicing	L&J Computers	£220	
Printers quote system	Microland	£175	
Stock control	Act (Petsoft) Ltd	£75	
Stock control	Amplicon MS Ltd	£750	500-600 items 255 A/Cs
Stock control	Commodore BM (U.K.) Ltd	£150	650 items
Stock control	Microact Ltd	£350	2,500 items 1,000 A/Cs
Stock control	Petsoft Ltd	£50	2,000 items
Stock control	Stage One Computers		
Stock control	Bristol Software Factory	£300 £360	2,300 items
Stock control	L&J Computers	£120	3,400 items
Window replacement	CSM Ltd	£500	
Word processing	Act (Petsoft) Ltd	£325	
Word processing	Dataview Ltd	£159	
Word processing	Stage One Computers		
Word processing	Commodore BM (U.K.) Ltd	£75 £150	170 pages
Word processing	HB Computers	£70	70
Work measurement	The Alphabet Company	£150	

Ledgers/jewellers	Logma Systems Design	£600	1-6 shops
Payroll	Analog Electronics	£90	
Payroll	Intex Datalog Ltd	£195	200 employees
Printers' job control	Stage One Computers	£450	130 jobs/disc
Sales analysis	Logma Systems Design	£600	1-6 shops
Stock control	Anagram Systems	£750	500-600 items, 255 A/Cs
Stock control	Rockliff Brothers Ltd	£120	3,900 items
Stock/farming livestock	SA Systems	£650	300 records/disc
Stock/invoicing	SMG Microcomputers	£395-£495	2,450-7,000 items
Stock/jewellers	Logma Systems Design	£600	1-6 shops

CP/M

Application	Supplier Name	Price	Capacity
DBMS	Verwood Systems		
Hire purchase system	Graffcom Systems Ltd		varies
Incomplete records	Profcomp Ltd	P.O.A.	2,000 entries
Job-time recording	Graffcom Systems Ltd		100 activity codes
Ledger general	Benchmark CS Ltd	£250	500 A/Cs 5,700 trans
Ledger general	Comput-A-Crop	£400	
Ledger general	Computastore Ltd	£500	999 A/Cs 99 centres
Ledgers integrated stock	Instar Business Systems	£999	600-2,900
Ledger purchase	Benchmark CS Ltd	£250	500 A/Cs 2,000 trans
Ledger purchase	Comput-A-Crop	£400	500 A/Cs
Ledger purchase	Computastore Ltd	£400	500 A/Cs 3,100 trans
Ledger purchase	Structured Systems Group	£460	varies
Ledger sales	Benchmark CS Ltd	£250	500 A/Cs 2,000 trans
Ledger sales	Computastore Ltd	£400	500 A/Cs 3,500 trans
Ledger/sales, & general	Computastore Ltd	£1,000	
Ledger/stock/invoicing	Benchmark CS Ltd	£950	200 A/Cs 500 trans
Mail list system	Graffcom Systems Ltd	£250	varies
Mailing DBMS	Microtek Computer Services	£500	varies
Mailing system	Structured Systems Group	£50	varies
Order entry & invoicing	Benchmark CS Ltd		
Order entry & invoicing	Graffcom Systems Ltd	£350	500-5,000 orders
Payroll	Comput-A-Crop	£450	
Payroll	Graffcom Systems Ltd	£500	250 employees
Payroll	Microtek Computer Services	Lease	varies
Property management	Algobel Computers Ltd	£650	2,000 trans
Purchasing system	Graffcom Systems Ltd	£450	540-7,000 invoices
Stock control	Graffcom Systems Ltd	£350	520-6,000 items
Stock control	Microtek Computer Services	£1,000	varies
Stock/inventory control	Benchmark CS Ltd	£450	1,000 items 750 trans
Word processing	Computastore	£400	

Exidy Sorcerer

Application	Supplier Name	Price
Incomplete records	Basic Computing	£350
Ledger purcahse	Basic Computing	£125
Ledger sales	Basic Computing	£125
Stock recording	Basic Computing	£125

Ohio Scientific

Application	Supplier Name	Price
DBMS	Microcomputer BM	£175
DBMS	U-Microcomputers Ltd	£175+
Ledgers/stock/invoicing	Microcomputer BM	£656
Word processing	Microcomputer BM	£116

Tandy TRS-80

Application	Supplier Name	Price	Capacity
DBMS	T&V Johnson Ltd	£200	
Financial analysis	AJ Harding (Molimerx)	£55	N/A
Invoicing	Tridata Micros Ltd	£75	Linked to stock SA
Ledger general	Tridata Micros Ltd	P.O.A.	Linked to S/L P/L
Ledgers/payroll various	Microcomputer Applications	£90 each	
Ledger purchase	Tridata Micros Ltd	£225	175 A/Cs 1,350 trans
Ledger Purchase	AJ Harding (Molimerx)	£225	1,100 entries
Ledger sales	AJ Harding (Molimerx)	£225	1,350 entries
Ledger sales	Tridata Micros Ltd	£225	175 A/Cs 1,350 trans
Ledgers/sales, purchase, general & invoice	Microcomputer Applications	£350	
Mailing system	Cleartone ADP	£50	660 entries
Payroll	AJ Harding (Molimerx)	£95-£200	
Stock control	AJ Harding (Molimerx)	£225	630 items
Stock control	Microgems Software	£150	1,000-2,000 items
Stock/farming livestock	SA Systems	£650	300 stock records
Stock/invoicing/ order entry	Cleartone ADP	POA	

Z-80/8080

Application	Supplier Name	Price	Capacity
Appointments system	Great Northern CS Ltd	£220 £275	varies
DBMS	Structured Systems Group	£135	varies
DBMS medical records	Xitan Systems Ltd	£850	4,000 records/disc
Job/client	Great Northern CS Ltd	£330	varies
Ledger general	Great Northern CS Ltd	£275	varies
Ledger general	Graffcom Systems Ltd	£390	
Ledgers general/ sales/purchase	Graffcom Systems Ltd	£995	
Ledgers/payroll	Great Northern CS Ltd	£995	varies
Ledger purchase	Great Northern CS Ltd	£275	varies
Ledger purchase	Great Northern CS Ltd	£275	varies
Ledger purchase	Graffcom Systems Ltd	£440	
Ledger sales	Graffcom Systems Ltd	£440	
Ledger sales	Great Northern CS Ltd	£275	varies
Ledgers/stock invoicing	T&V Johnson Ltd	£110	750 trans/disc
Mailing system	T&V Johnson Ltd	P.O.A.	3,000 names/addresses
Mail list system	Micro Focus	£90	varies
Payroll	3-Line Computing	£140	
Payroll	Tridata Micros Ltd	£218	400 employees
Payroll	Graffcom Systems Ltd	£490	250 employees
Property management	Graham Dorian Software	£325	varies
Purchasing system (job)	Great Northern CS Ltd	£275	varies
Order entry/ invoicing	Graffcom Systems Ltd	£340	
Order entry/ invoicing	Software Architects Ltd	£600	varies
Sales analysis (retail)	Great Northern CS Ltd	£325	varies
Stock control	Graham Dorian Software	£325	varies
Stock control	Rogis Systems Ltd	£500	varies
Stock control (retail)	Great Northern CS Ltd	£275	varies
Stock control	Graffcom Systems Ltd	£340	
Stock control	Software Architects Ltd	£600	varies
Stock control	T&V Johnson Ltd	£115	1,000 items
Stock control/ invoicing	T&V Johnson Ltd	£145	1,000 items/Invoices
Stock control	Tridata Micros	£200	630 items/disc
Stock/order entry/ invoice	Graffcom Systems Ltd	£580	
Word processor (EP)	T&V Johnson Ltd	£109	10,000 words
Word processing	Structured Systems Group	£120	varies

Alphabetical list of suppliers

Supplier	Address	Sales contact
Act (Petsoft) Ltd 021-455-8585	Radclyffe House, 66-68 Hagley Road, Birmingham.	Sales
AJ Harding (Molimerx) 0424-22039	28 Collington Avenue, Bexhill-on-Sea, East Sussex.	John Harding
Algobel Computers Ltd 021-233-2407	33 Cornwall Buildings, Newhall St. Birmingham B3 3QR	Steven Linden
Amplicon M S Ltd 0273-562163	143A Ditchling Road, Brighton, Sussex BN1 6JA.	Jim Hicks
Anagram Systems 0403-68601	9 Michell Close, Horsham, West Sussex RH12 1JT.	John Quigley
Analog Electronics 0203-417761	47 Ridgeway Avenue, Coventry.	
Basic Computing 0535-65094	Oakworth Road, Keighley, West Yorkshire BD22 7LA.	Mike Collier
Benchmark CS Ltd 0726-61000	Tremena Manor, Tremena Road, St Austell, Cornwall PL25 5QG.	S Willmott
Blackpool & Fylde Coll.	Palatine Road, Blackpool.	Joe Swift
Bristol Software Factory 0272-20801	Micro House, St Michael's Hill, Bristol BS2 8BS.	W J Kyle-Price
Cleartone ADP 0495-244555	Prince of Wales Industrial Estate, Abercarn, Gwent NP1 5RJ.	
Commodore B M (U.K.) Ltd 0753-74111	818 Leigh Road Trading Estate, Slough, Berkshire.	Nick Green
Compsoft Ltd 2483-39665	Old Manor Lane, Chilworth, Guildford, Surrey.	Nick Horgan
Comput-A-Crop 01-771 0867	32 Whitworth Road, London SE25 6XH.	Jenny Wilson
Computastore Ltd 061-832-4761	16 John Dalton Street, Manchester M2 6HG.	David Nicholson
Computech Systems 01-794 0202	168 Finchley Road, London NW3.	Laurence Payne
Courtman Micro Systems 0222-495257	48 Melrose Avenue, Penylan, Cardiff.	G Stuckey
CSM Ltd 021-382-4171	Refuge Assurance House, Sutton New Road, Erdington, Birmingham.	Peter Mart
Dataview Ltd Colchester 78811	Colchester, Essex.	P Handover
Diskdean Ltd 01-242 7394	23 Bedford Row, London WC1R 4EB.	
G W Computers Ltd 01-636 8210	89 Bedford Court Mansions, Bedford Avenue, London WC1.	Tony Winter
Graffcom Systems Ltd 01-734 8862	52 Shaftesbury Avenue, London W1V 6DE.	Barbara Castledine
Graham Dorian Software 01-379 7931	C/O Lifeboat Associates, 32 Neal Street, London WC2H 9PS.	John Clifford
Great Northern C S Ltd 0532-450667	15 Wellington Street, Leeds LS1 4DL.	P Clark
Guestel Ltd 0225-65379	Refuge House, 2-4 Henry Street, Bath BA1 1J.	Allen Timpany
Instar Business Systems 01-680 5330	61 High Street, Croydon.	
Intex Datalog Ltd 0642-781193	Eaglescliffe Industrial Estate, Eaglescliffe, Cleveland TS16 0PN.	
James C Steadman 0903-814923	18 Manor Road, Upper Beeding, Steyning, Sussex BN4 3TJ.	James Steadman
Keen Computers Ltd 0602-583254	5B The Poultry, Nottingham.	Bob Ellis
L & J Computers 01-204 7525	3 Crundale Avenue, Kingsbury, London NW9 9PJ.	J Goodman
Landsler Software 01-399 2476/7	29A Tolworth Park Road, Surbiton, Surrey KT6 7RL.	E Landsler
3-Line Computing 0482-445496	36 Slough Road, Hull HUS 1QL.	Tim Hill
Logma Systems Design Bolton 389854	2-10 Bradshawgate, Bolton, Lancashire.	
HB Computers Ltd 0536-83922 & 520910	22 Newland Street Kettering, Northamptonshire	Stuart Whittaker

Hewport Ltd 04254-77352	20 Cunningham Close, Ringwood, Hampshire BH24 1XW	D N Rogers
Micro Computation 01-882 5104	8 Station Parade, Southgate, London N14.	Graham Dicker
Micro Focus 01-379 7931	C/O Lifeboat Associates, 32 Neal Street, London WC2H 9PS.	Chris Barnes
Microact Ltd 021-455-8585	Radclyffe House, 66-68 Hagley Road, Edgbaston, Birmingham B16 8PF.	John Farthing
Microgems Software 0602-275559	32 Buckingham Avenue, Hucknall, Nottinghamshire.	
Microtek Computer Services 0689-26803	50 Chislehurst Road, Orpington, Kent BR5 0DJ.	
Microcomputer Applications 0734-470425	11 Riverside Court, Caversham, Reading RG4 8AL.	W S Jupp
Microdigital Ltd 051-227-2535	25 Brunswick Street, Liverpool, L2 0BJ.	Graham Jones
Microland 0723-70715	17 Victoria Road, Scarborough, N Yorks YO11 1SB.	Rick Holland
Micropute 0625-612818	Communique Place, 9 Presbury Place, Macclesfield, Cheshire.	Don Cooper
Microsense Computers Ltd 0442-41191/48151	Finway Road, Hemel Hempstead, Hertfordshire HP2 7PS.	D Page
MMS Computer Systems 0234-40601	26 Mill Street, Bedford.	D Nicholls
Padmede Computer Services 025-671 2434	112/116 High Street, Odiham, Basingstoke, Hampshire.	John Packwood
Personal Computers Ltd 01-626 8121/2/3	194-200 Bishopsgate London, EC4M 4NR.	Steve Derrick
Petsoft Ltd 021-455-8585	Radclyffe House, 66-68 Hagley Road, Edgbaston, Birmingham B16 8PF.	Julian Allason
Profcomp Ltd 01-989 8177	107 George Lane, South Woodford, London E18 1AN.	Brian Whitcomb
Rockliff Brothers Ltd 051-521 5830	2 Rumford Street, Liverpool L2.	
Rogis Systems Ltd 0580-80310	Keeper's Lodge, Frittenden, Cranbrook, Kent.	Welby Everard
SA Systems Newbury 45813	Allington Lodge, Round End, Newbury, Berkshire RG14 6PL.	
SMG Microcomputers Gravesend 55813	39 Windmill Street, Gravesend, Kent.	
Software Architects Ltd 01-734 9402	34-35 Dean Street, London W1V 5AP.	
Stage One Computers 0202-23570	6 Criterion Arcade, Old Christchurch Road, Bournemouth, Hants.	N Hewitt
Structured Systems Group 01-379 7931	C/O Lifeboat Associates 32 Neal Street, London WC2H 9PS.	John Clifford
Systematics International Ltd 0268-284601	Essex House, Cherrydown, Basildon, Essex.	R Young
T & V Johnson Ltd 0276-62506	165 London Road, Camberley, Surrey GU15 3JS.	T Johnson
T W Computers Ltd 061-456-8187	293 London Road, Hazel Grove, Stockport, Cheshire.	G Thompson
The Alphabet Company 0304 617209	2 Whitefriars Way, Sandwich, Kent, CT13 9AD.	A L Minter
The Software House 01-637 1587	146 Oxford Street, London, W1.	Keith Jones
Tridata Micros Ltd 021-622-6085	Smithfield House, Digbeth, Birmingham B5 6BS.	A Plackowski
U-Microcomputers Ltd Warrington 54117	Winstanly Industrial Estate, Long Lane, Warrington.	
Verwood Systems 0788-87629	Verwood House, High Street, West Haddon, Northamptonshire.	
Vlasak Electronics Ltd 06284-74789	Thames Building, Dedmere Road, Marlow, Buckinghamshire SL7 1PB.	Paul Vlasak
Xitan Systems Ltd 0703-38740	23 Cumberland Place, Southampton.	

SHOPWINDOW

MICRO ADS

are accepted from private readers only, pre-paid and in writing, 20p per word, minimum charge £2.

Make the most of your 380Z (low resolution) graphics. Machine-code PIC makes picture drawing easy. Cassette. Listing. £2. P.G. Lewis, 29, Brownhill Road, Chandlers Ford, Eastleigh, hants.

COMPUKIT SOFTWARE: Startrek, Zombie, X-wing fighter(R), Life, 5k. Anti-aircraft, Computer Pirate(R), Hangman, NoughtVCross, Digiclock (HMS), Random Number (you-v-UK101), 4k. (R = real-time.) Most use good graphics. £3.50p. each from K.A. Spencer (PC), 33 Alpine Gdns., Bath.

UK101. 8K Ram, Beige case, 12" TV/VDU. New monitor. Plus 610 Expansion board, with 12K Ram and own 5V/3A PSU. Many programs. £500 or will split. Tel. Stevenage (0438) 68624. Anytime.

Sixteen MK4108 used Pet one year £25 o.n.o. (0272) 684688.

Pet 16K little used, perfect condition, CBM 3016, plus extra cassette deck. £650 o.n.o. Phone 01-979 2815 anytime.

TI59, PC1000C printer, plus Navigation module and much more software. £245 for lot. Possibly split. P. Curran 051-494-0408.

5WTC CT64 VDU terminal, RS232 Interface, switchable baud rates, £100. Ring V. Yelland, 01-531 0716 after 6PM. (Walthamstow).

EXPANDOR IMPACT PRINTER (not dot matrix), parallel interface, service manual, spares list, electrical diagrams, tractor and friction feed, ASCII coded. £195. Bewdley (Worcs) 402885 — weekends only.

SHARP MZ-80 Star Trek with full sound. For 22K or larger. £6 to T. Garden, 23, Whitehill Court, Berkhamsted, Herts.

MICRO 99 CPU Board £100. Many more Kit systems see advert in last month's issue. Small items too numerous to mention. Phone Bedford 46032 for list.

SHARP MZ 80K, as new. £420.00 inc VAT. Over £130 below list. Telephone 0624 822463.
Large selection of APPLE programs at bargain prices. T.W. Kerruish, Quinton Lodge, Silverburn, Ballasalla, Isle of Man.

IBM 1131 computer, with golfball printer, paper tape reader and punch. Software and Operating/Field Maintenance manuals. Good condition. Buyer collects. £550. Tel: Maidstone 677120 Evenings.

TRS-80 32K with Dual Disks. New October. £1,350 o.n.o. for Quick Sale. Phone 0273-23020.

ITT 2020 (Apple) 16K, Palsoft, Colour Modulator, 4 months old, perfect. Includes tapes. £720. 051-334 2405 Evenings.

Play Space Invaders on your Nascom. Full feature, 3K object code. Many options. SAE for full details. J. Atkins, 37 Wellington Road, Maidenhead, Berks. Telephone 0628 35145.

Powertran Comp80, 5K RAM, 2K BASIC, Monitor, with Graphics and Graph Plotting. Includes 64 x 32 TV Monitor and Tape Recorder, Metal Case. Stafford 850 244.

NASCOM PROGRAMS in machine code. 20 useful, assorted programs to run under T2, B-Bug, T4 or Nas-sys. £3 or send SAE for further details. R. Sargent, 134 Stockham Park, Wantage, Oxon.

NASCOM, built, working, with T2. Offers over £100. 01-992 8418 Evenings.

Quality written Basic Software for most Micros, silly prices. SAE for details stating Micro to Howard Kirkland, 38 Melrose Gardens, Arborfield, Berkshire RG2 9PZ.

Nascom 1 (not working), 2K Basic 8K Ram, Memory Board, Buffer Board & Bug, Power supply £150. Phone Farnborough (Kent) 53085.

PET SCREEN'S Green perspex easy fitting £3.75. Contact R. Wilmot, 1 Retreat Cottages, Broadbridge Heath, Horsham, Sussex.

NASCOM II with 16K RAM board. Graphics, 8K BASIC. Professionally built and fully tested. You can try it before you buy it. £435. Tel: 01-953 9545.

ANADEX Printer for Sale. Complete with Pet Interface. Surplus to requirements and absolutely good as new. £375. Tel: 01-952 8955.

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A 13 digit Key pad (0-9, -, ., ENTER) to run in parallel with the numeric section of the APPLE Keyboard. Supplied with connecting cable, plugs and sockets.

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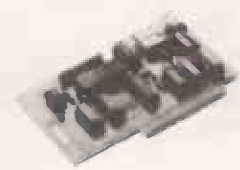

California Computer System Cards for the Apple.

Synch Serial Card	£106.37 + VAT
Asynch Serial Card	£106.37 + VAT
Para-lel Card	£ 79.77 + VAT
Arithmetic Proc. Unit	£265.97 + VAT
Programmable Timer	£106.37 + VAT
IEEE GPIB	£199.50 + VAT
A/D Converter	£ 99.72 + VAT
ROM/PROM Mod	£ 70.89 + VAT

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ARRAY Processing from Silicon Glen on the West Coast of Scotland

VIDEO VECTOR DYNAMICS Ltd. announces what will be one of the most significant innovations in microcomputing during the 1980s — the VP-9500 vector processor. The VP-9500 is a British-designed and manufactured vector processor consisting of a two to 16 long vector of pipe-lined floating point processors with individual data stacks, optimised to operate on arrays of floating point numbers of up to 16,384 elements. The VP-9500 provides floating point processing at up to 200 times faster than ordinary 4 MHz Z-80A microcomputers and 20-30 times faster than a PDP-11/34. The benchmarks on which these figures are based may be obtained on request.

The VP-9500 is constructed on one (up to 8 elements) or two (9 to 16 elements) glass fibre PCBs with full solder masking and silk-screened component locations. The precision board lay-out was generated on a CAD facility and etching was performed for us by the U.K.'s leading PCB manufacturer. The VP-9500 has its own on-board crystal clock and DIP switches allow it to be placed anywhere in the I/O space of any S-100 microcomputer running at any clock speed.

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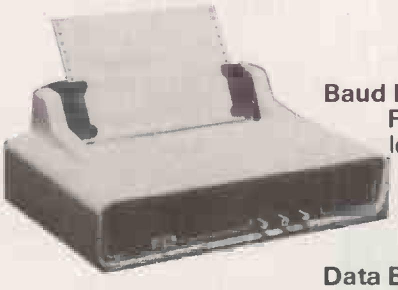

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Outline P

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Processors and Memory
memory chips – special purpose chips – bit slicing – new systems architecture – Motorola 6809 – Intel 8086 – Zilog Z8000 – 16 bit micros

Storage Systems
diskettes – single/double density – single/double sided – hard disks – 8" Winchester technology – fixed/changeable – costs and reliability

Communications
modem technology – PO facilities – data link controls – high level protocols – local area networks – Prestel – personal computer network

Systems Review
survey of micro systems – Texas Instruments TI 99/4 – Apple III – Triumph Adler Alphatronic – Sinclair ZX80 – other new releases

Technology Stream II

Monitors and Operating Systems
CP/M – MP/M – low level monitors – multi-tasking – multi-user operating systems – utility programs

Languages
BASIC – Business BASIC – Pascal – PL/1 – APL – language developments

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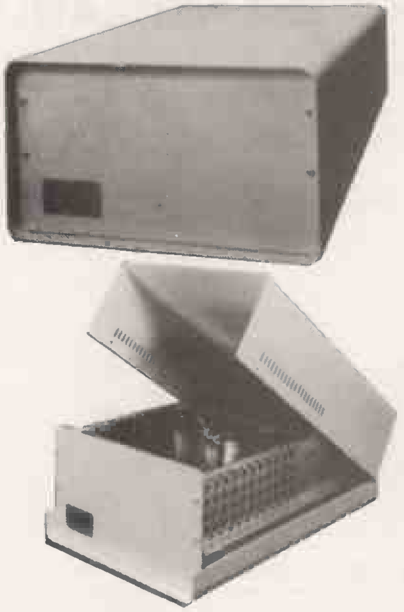

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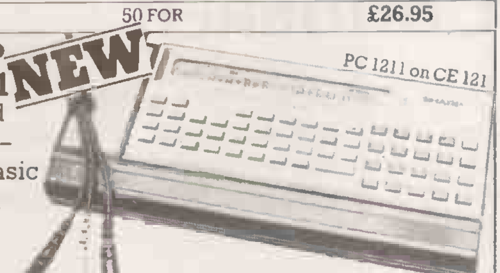

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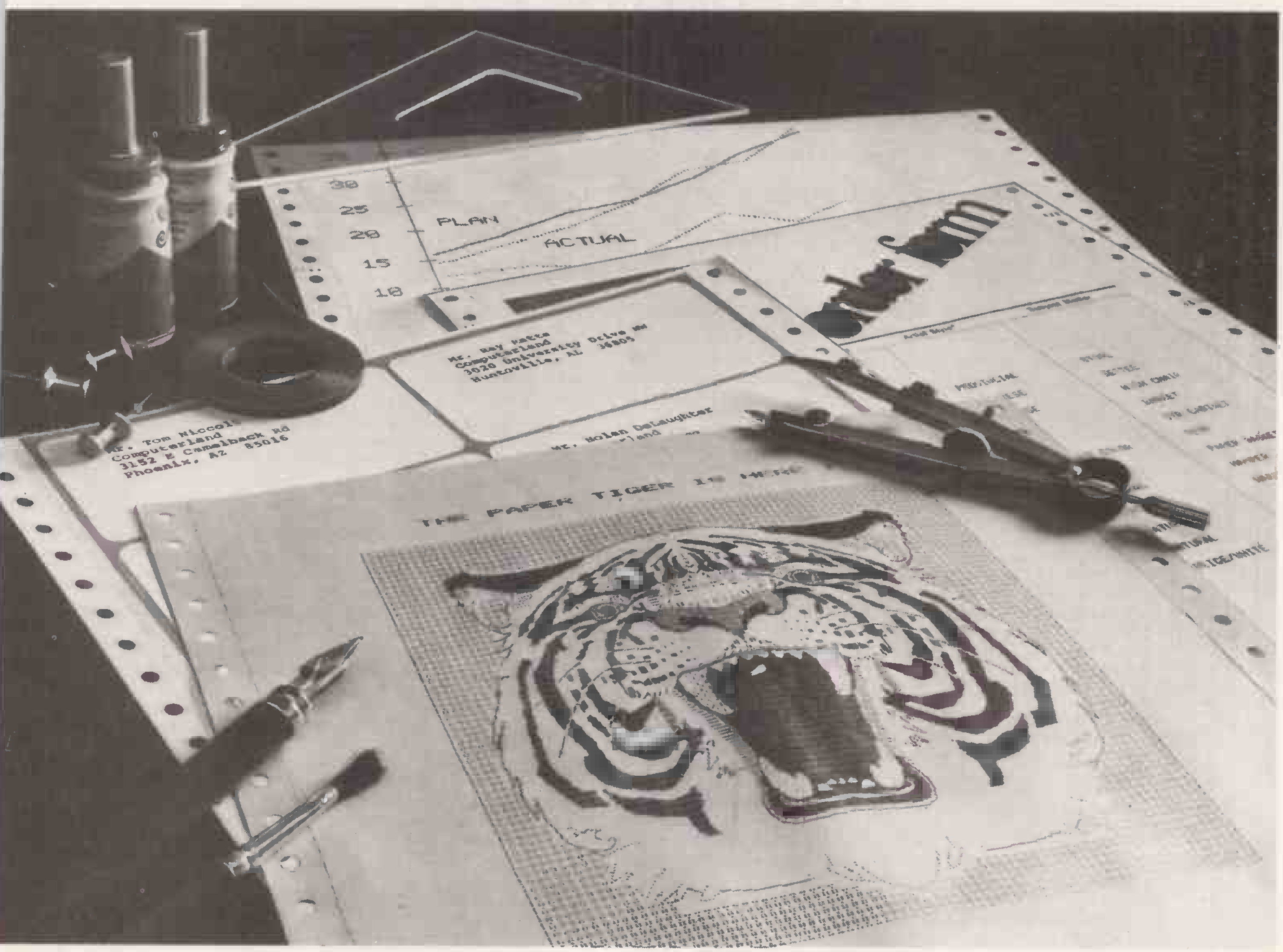

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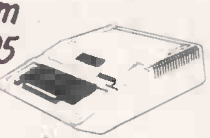

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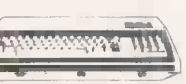

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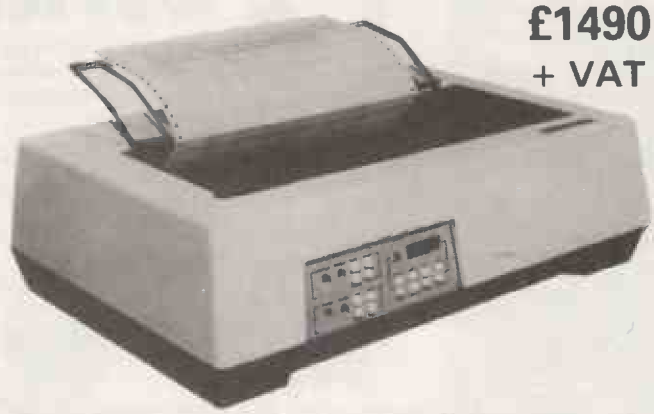

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USER PROGRAMMABLE

The DS180 offers a large number of user programmable features, yet is easy to operate. A unique programming keypad with a non-volatile memory makes printer set-up quick and simple. Top of form, horizontal and vertical tabs, perforation skip-over and auto line feed are just a few of the features the user may select. Communications status may also be programmed and monitored using the indicator panel lights and LED display.

ATTRACTIVE DESIGN

Compact, desk-top packaging allows the DS180 to fit into almost any installation. Its noise dampening cover makes it suitable for use in a quiet office environment. The cartridge ribbon makes routine changes clean, fast and convenient.

MICROPROCESSOR ELECTRONICS

Through the use of state-of-the-art microprocessor electronics, reliability and maintainability have been greatly improved. The simple modular design of the DS180 provides easy access to all major components. A single printed circuit board contains both the power supply electronics and digital controller for the printer. A self-test feature and diagnostic display panel help the user verify proper operation of the unit and isolate problems should they occur.

COMMUNICATIONS

Interfaces on the DS180 include RS232 and 20mA current loop serial interfaces, and a Centronics compatible parallel interface. Baud rates from 110-9600 and parity selection may be keyed in by the user for his specific application.

FORMS HANDLING

Adjustable tractors accomodate forms from 3-15 inches wide. A head-to-platen gap adjustment ensures optimum print quality on up to 6-part forms. Fanfold paper may be fed from the front or bottom of the DS180. A paper out sensor may be programmed to send a stop transmission character and sound an audible alarm.

QUALITY MANUFACTURING

Reliable performance is ensured by a stringent quality control program. Datasouth uses pretested, high reliability parts from leading manufacturers. Multiple tests are performed on subassemblies during each stage of production, with each completed unit undergoing a final 24 hour print test and burn-in. The DS180 carries a 90 day warranty on materials and workmanship.

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'The picture shown demonstrates mixed graphics and characters in three shades of grey provided by the Standard Atom.

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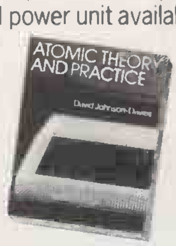

The ATOM concept
Adding chips into sockets on the PCB allows you to progress in affordable steps to large-scale expansion. You can see from the specifications that the RAM can be increased to 12K allowing high resolution (256 x 192) graphics. Two further ROM chips, e.g. maths functions, can be added directly to the board giving a 16K capacity. In addition to 5 I/O lines partly used by the cassette interface, an optional VIA device can provide varied I/O and timer functions and via a buffer device allow direct printer drive. An optional module provides red, green and blue signals for colour. An in-board connector strip takes the ATOM communications loop interface. Any number of ATOMs may be linked to each other – or to a master system with mass storage/hard copy facility. Interface with other ACORN cards is simplicity itself. Any one ACORN card may be fitted internally.
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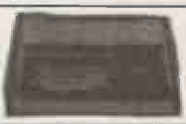

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●28-29 **Introduction to microprocessing.** Venue: Bedford. Introductory course using the TMS 9900 minimum system. Fee: £95 + VAT. Contact: Mike Hughes, Microprocessor Training Centre, Texas Instruments Ltd, Manton Lane, Bedford, MK1 7PA. Tel: (0234) 67466.

●28-29 **Structured walk-throughs.** Venue: London. Examines the use of the walk-through technique in monitoring and reviewing written output. Fee: £310. Contact: The Registrar, Infotech, Nicholson House, Maidenhead, Berkshire SL6 1LD. (0628) 39101.

●29-31 **Practical Basic programming.** Venue: Manchester University. A weekend residential course for those with little or no computing background and who would like a thorough introduction to writing programs in Basic for microcomputers. About half of the course will consist of practical programming exercises on the Pet. Fee: £57.50. Contact: Sue Eden, University of Manchester, Department of Extra-mural Studies, Manchester M13 9PL. Tel: (061) 273 3333 ext. 3076.

Basic computing science: system software.

By P J Barker, published by Blackie and Son, (1980), 64 pages paperback £2.30 ISBN 0 216 90854 X.

SOFTWARE is divided traditionally into two classes: applications software, which is designed to serve some useful purpose; system software, which is designed to make applications software easier to write and run.

The book aims to provide A level computer science students with an insight into system software. It succeeds admirably, establishing the principles with examples, yet avoiding the trap of discussing a particular system to the exclusion of all others.

By assuming a basic understanding of computing, and software, the author has managed to pack information on a wide range of topics into 64 pages. He describes all the essentials of a general-purpose operating system; loader, peripheral handling and interrupts, memory management, multi-tasking and scheduling, multi-access and virtual machines.

He also describes the superstructure software; linkers, assemblers, compilers and interpreters, editors, utilities, file structure and job-control.

The book is likely to provide useful insights even for an experienced mainframe programmer. At the other extreme, it is useful for the novice microprocessor user to understand the range of facilities provided as standard on larger, general-purpose systems.

Conclusions

- **Although intended primarily for A level students, the book can be recommended to anyone who would like to understand operating systems and other system software.**

Program design and construction.

By David A Higgins, published by Prentice-Hall International, 200 pages, paperback, £6.45.

THERE IS a tendency in many programming books to assume we know exactly what we want to do and how to do it and that

the major difficulties are the peculiarities of a particular Basic dialect or the nightmarish architecture of a new microprocessor. David Higgins' book provides a counterbalance, concentrating on the process of program design.

Most of the book is a step-by-step introduction to program design using the Warnier-Orr design methodology. Warner-Orr diagrams were developed by an American, Ken Orr, from earlier work by a Frenchman, J D Warnier.

In essence, the methodology is functional decomposition where an abstract high-level specification, such as play Startrek, is broken down, step-by-step into progressively more detail, until at the most detailed level, each step is a statement or two in your favourite programming language.

Warnier-Orr extends this method by using some of the ideas of sets and subsets, and by providing guidance on database design, physical program design, and how to handle particular problems.

The examples in the book are games programs and programs for the small business user. The programming language used in all cases is a structured Basic.

The book contains a good deal of very sound advice on program design and on programming in general. It can be thoroughly recommended as an introduction to Warnier-Orr diagramming, for microcomputer, minicomputer and mainframe programmers. However, the Warnier-Orr methodology may seem unnecessarily artificial to some readers and not very helpful to others.

Conclusions

- **Most of the early benefits of any design method derive from concentrating on some method.**
- **It makes sense to start with a design method which feels comfortable.**
- **Prospective purchasers of this book might like to consider the alternative methodologies available — Jackson, SADT, PSL, Mascot, etc. — before investing the time needed to master Warnier-Orr.**

Martyn Thomas

The computerisation of society

By Simon Nora and Alain Minc, MIT Press £7.75.

This book, by French mandarins Simon Nora and Alain Minc, addresses itself squarely to the question: what difference will computers really make? Commissioned originally by President Giscard d'Estaing in 1976, it became an immediate best-seller in France and now appears in an English translation for the first time.

It is easy to see why it is so popular and provoked such widespread discussion. Essentially, the authors believe that *télématiques* — data processing diffused through networks accessed easily by the public at large — will transform society.

That much is clear to most readers of newspapers in the western world. Yet few attempts have been made to imagine how that transformation will affect our society's way of life, and fewer still to devise practical strategies to work towards the kind of society which we might want; I discount, of course, the science fiction apocalypse ramblings of the wilder would-be prophets of the information society.

What is vital about Nora and Minc's report is it turns an analysis of data processing for all into a debate on the nature of French society and provokes the reader to think about the kind of society in which he wishes to live.

For they see the changes as not merely technological and élitist, but of vital concern to everybody and will be as great as the industrial revolution or even of the use of papyrus by the Egyptians. Taking as its starting point that information equals power — an urgent point, and one that bears repetition — the authors do not fail to remark that the British were quicker off the mark in seizing hold of communications media in 1926. The book quickly makes the point that common availability of data networks will loosen the power of existing hierarchies, i.e., governments, but will not necessarily remove control from the centre.

Rather, the centre of influence will move progressively towards those who hold the key to the production and utilisation of such systems — notably the mammoth producers such as IBM and NASA, responsible respectively for the terminals and the satellite links.

That warning of cultural imperialism is not a moment too soon, for as the authors point out, many professional users in Europe already rely on U.S. data banks for both cheapness and convenience and will continue to do so until presented with a cheaper and better option.

The report goes on to argue in favour of a "communications international", bizarre though this may seem in a report to the President. It also makes some useful caveats on the potentially rigidifying effect of data processing, suggesting that stronger departments of government such as finance, police and armed forces will, under present conditions, always secure enough capability to increase their own influence while continuing to deny those resources to departments which serve the public such as education, health, justice and the local community, leading finally to the *Tout État* in which the strong become stonger and the weak weaker, leading to increasing centralisation.

Conclusions

- **The optimum solution, suggest Minc and Nora in the concluding pages of a book, which is essential reading for anyone who can be bothered to look up from the keyboard for a moment, is one where governments will plan effectively their own demise by handing over power to their own people.** *Martin Hayman*

A PRACTICAL GLOSSARY

The final part of the terminological gamut with W-Z

WAIT
A condition where the processor has suspended program execution, usually while waiting for data from memory or a peripheral.

Wand
Or optical wand. It is a hand-held device for reading coded labels or tags, typically in a supermarket. Most work by detecting bars across the label, but some non-optical wands pick up other encoded data such as magnetic dots.

Watson
Thomas J Watson died in 1956 but deserves a mention here because he invented IBM — he fostered its growth through the war years, epitomised the hard-sell go-getting U.S. salesman, and filled the company offices with THINK, a distinctly overrated and somewhat ridiculous slogan.

His son, Tom Watson Jr, became president of IBM in 1952 and guided the company solidly into its current dominance of the computer business. He stepped down two years ago and started an ambassadorial career for the U.S.A.

WCS
Writable Control Store.

Winchester
The Winchester has, if you excuse the expression, more firepower than any other form of memory available, in a smaller space and in a more convenient package.

A Winchester disc drive measures 4.5 x 9 x 18in., which caused it to be dubbed the lunchbox, and holds 11MByte. That is a good deal of memory, and you pay for it — about £3,500 at today's prices.

Its principal disadvantage is that discs are not exchangeable. Like many of the ground-breaking technologies, the Winchester was pioneered by IBM, who were looking to pack more memory into a smaller area. The obvious way to increase recording density is to fly the recording head closer to the disc.

To achieve the fine tolerances to re-play the signal reliably, IBM found that it was indispensable to minimise the mechanical play in normal exchangeable discs and rigorously exclude dust and other atmospheric contaminants.

Those considerations led to the adoption of the sealed chamber and non-exchangeable discs. Further features of the Winchester are dedicated areas of the disc on which the record/replay head should land, thereby eliminating instability at start-up and shut-down, much improved aerodynamics of the head and lighter contact pressures — typically around 8gm.

One curious aspect of the Winchester is that discs are expected to last longer than their associated drives and circuitry.

The device has some snags, particularly associated with interfacing suitable back-up storage, but an incredible 250MB storage capacity on a single 8in. drive is predicted for 1984.

Word
The word is the basic storage element in a computer. More literal stabs at definition include: a set of characters which have one addressable location and are treated as one unit; and: the basic entitles of a language with defined meaning and possible relationships.

A word may have any number of bits, but is usually eight or 16 for micros and minis.

In practice, one word generally contains a number, a letter, or a coded program instruction.

WPM
Words per minute — not a measure encountered frequently.

Workspace
An area of memory set aside for short-term working storage but otherwise without predetermined use.

Write
To put information into memory or on to disc or tape.

Writable Control Store
A special type of fast-access memory into which the user can put specialised instructions or repetitive routines written in microcode.

WCS is expensive and difficult to use; it is generally provided only on the more sophisticated minicomputers. Most of us do not need this capability — and few of us can afford it.

Word processing
The buzzword of the late 1970s is likely to be surpassed in the 1980s by terms like office automation and the electronic office. For the moment, however, word processing is still an important concept.

The phrase covers the processing of text — which in practice equates to alpha-numeric information organised in variable-length files. Those are two important contrasts in data processing, where most information is numeric and most files contain groups of records of the same length — you know exactly how many characters you need for an invoice, a zap-the-Klingons game or an inventory record.

Yet you do not really know how long a letter, an article or a whole book is going to be. That has major implications for the type of software used to manipulate the records and that is why special WP software has appeared.

You can now buy a word-processor package for most micros. As we explained in the June, 1979 article, there are two parts to WP — the text editor, which edits text and an output program, which formats and prints it.

Purpose-built word processors still dominate the scene, of course. The screenless IBM typewriter-plus-memory systems had a head start — they appeared in the 1960s with text being stored on a tape unit connected to the typewriter.

Later, IBM produced a kind of magnetically-sensitive card with a reader unit also connected by cable to the typewriter.

Most of the world's WP installations still use that kind of equipment and IBM still sells it, but in the 1970s, screen-based word processors and floppy disc storage became available which heralded radical change.

Those screen/keyboard/printer/disc combinations are really dedicated microcomputers in a purpose-built package; most are software-driven, which means you load the WP program from floppy disc at the start of the day, but very few can also be programmed by the user.

That is partly because the WP systems are programmed only in assembler, partly because the vendors do not want to have to provide any user-support other than operator training, and partly because the typical end-user — a secretary or converted typist — will not want to program.

The counter-argument is that you might as well make the most of the small computer. So more and more systems are appearing in the middle ground between dp and WP — microcomputers are acquiring WP packages, word processors appearing with Basic interpreters.

Zilog
Interesting would-be success story. Three of the designers of the 8080 left Intel in 1974 to form their own company with funds from the oil giant Exxon. Their company is reportedly only just starting to make money, but their micro, the Z-80, is definitely one of the milestones in the business.

The Z-80 is faster than the 8080 and the other pioneer of eight-bit microprocessing, the Motorola M6800. It has more machine instructions — 158 — and it needs a simpler power supply — just one +5V source. Programs can be shorter, execution is quicker.

Every single 8080 instruction is supported, which means if you want to upgrade to a Z-80, you can retain all those programs you write for your 8080.

Zilog is not standing still. As well as many support chips, it packages the Z-80 into a working microcomputer configuration — the MCZ line — and it is starting to deliver its 16-bit micro, the Z-8000.

It also has one of the funniest examples of industry paraphernalia in the shape of its amazing comic-strip hero Captain Zilog.

As a name, by the way, Zilog means something — 'Z' stands for the last word, 'I' denotes integrated, and 'LOG' is logic. So Zilog is the last word in integrated logic. As well, we can allow them some poetic licence.

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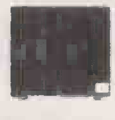

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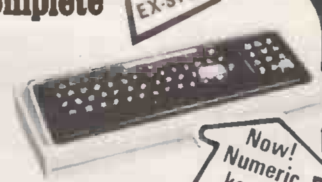

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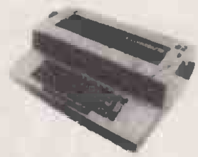

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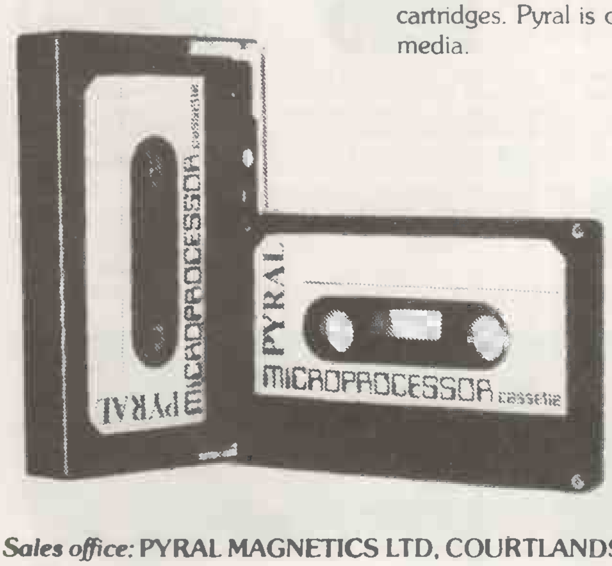

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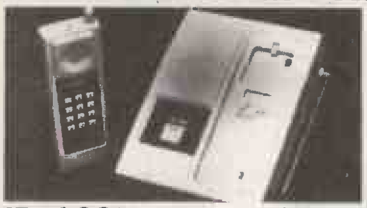

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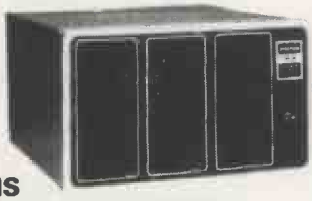

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