Practical Computing

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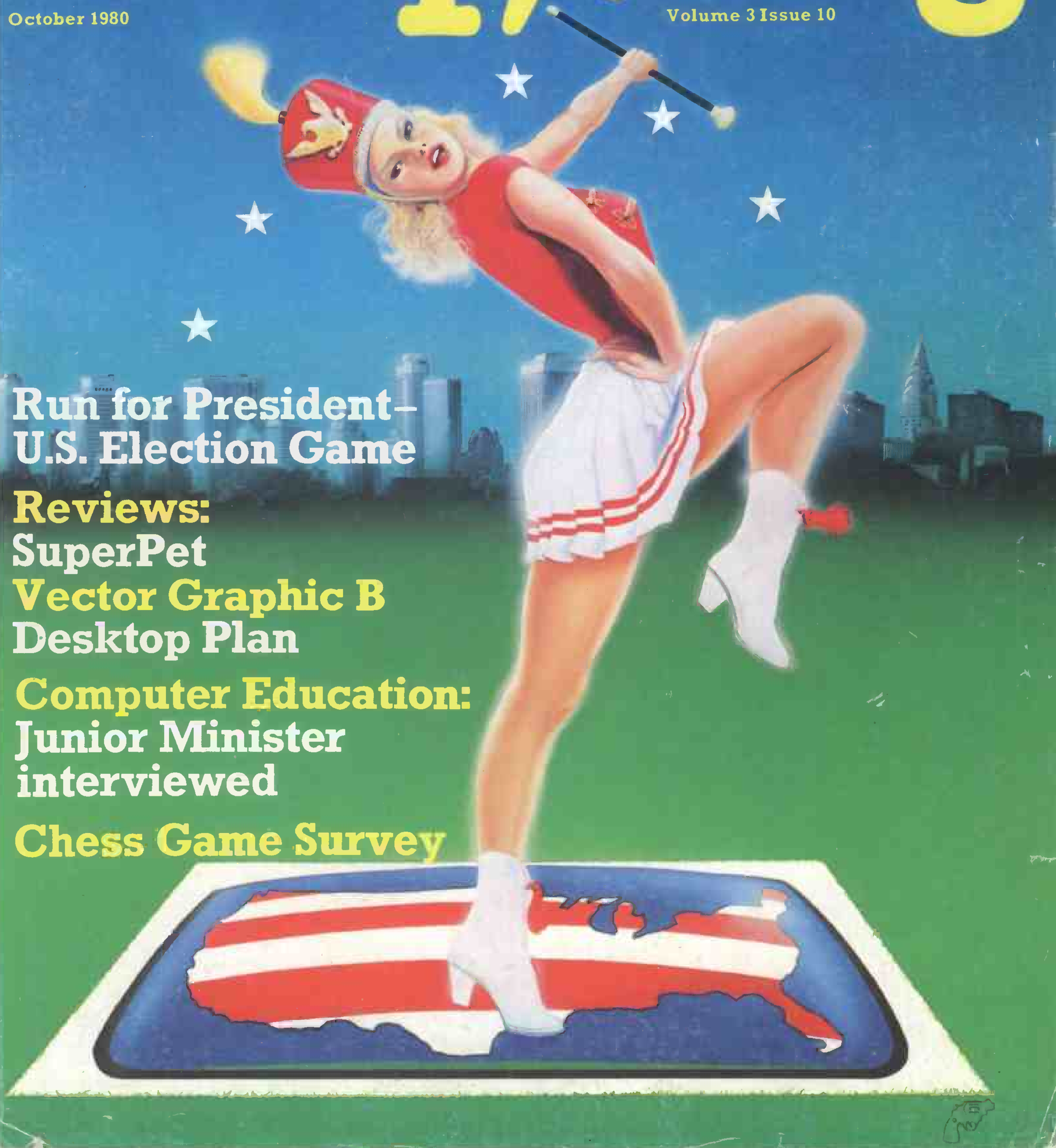

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Technical **Nick Hampshire**
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Editorial: 01-261 8752

Advertisement Manager
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Advertisement Executives
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Midlands office:
David Harvett 021-356 4838

Northern office:
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Advertisement Secretary
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Publisher
Chris Hipwell

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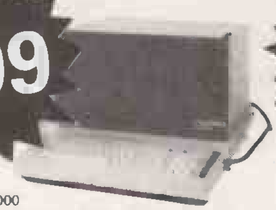

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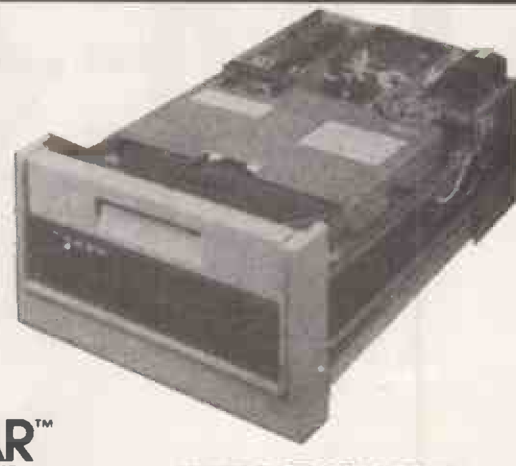

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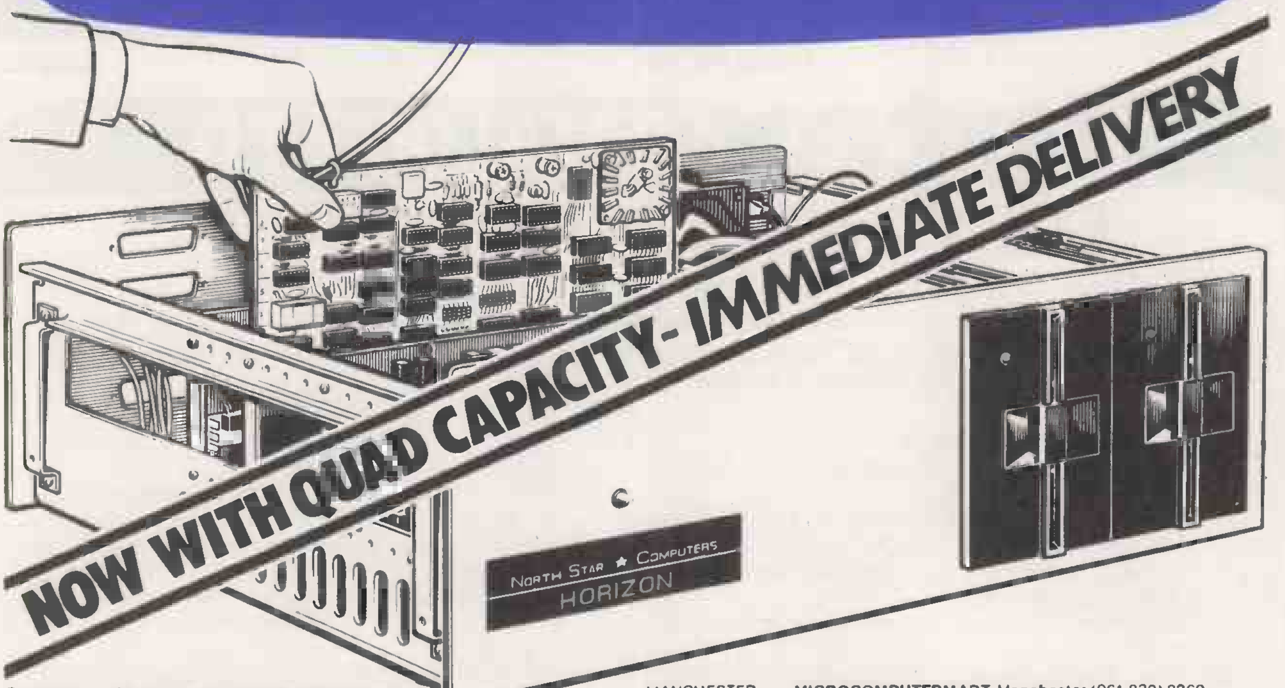

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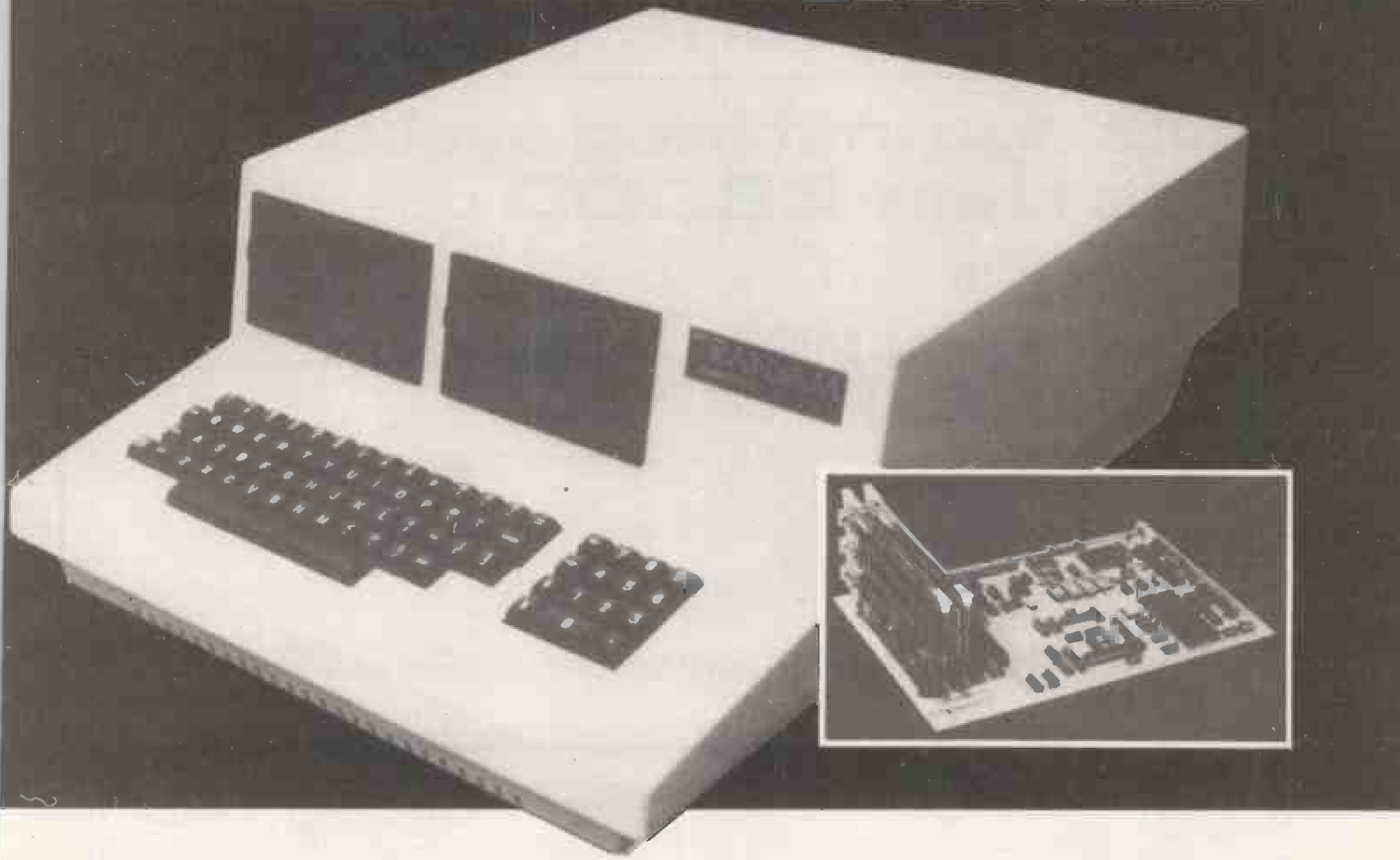

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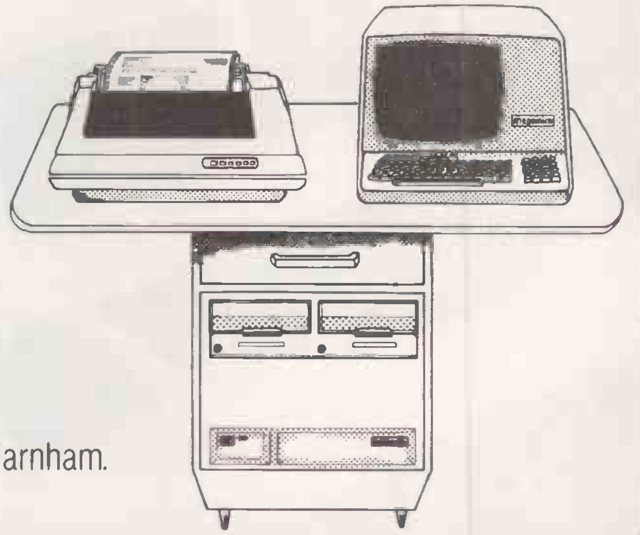

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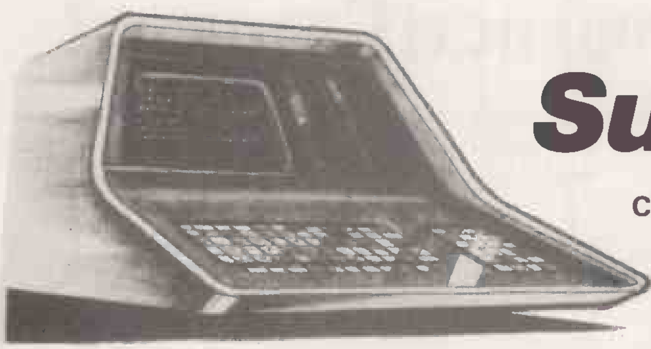

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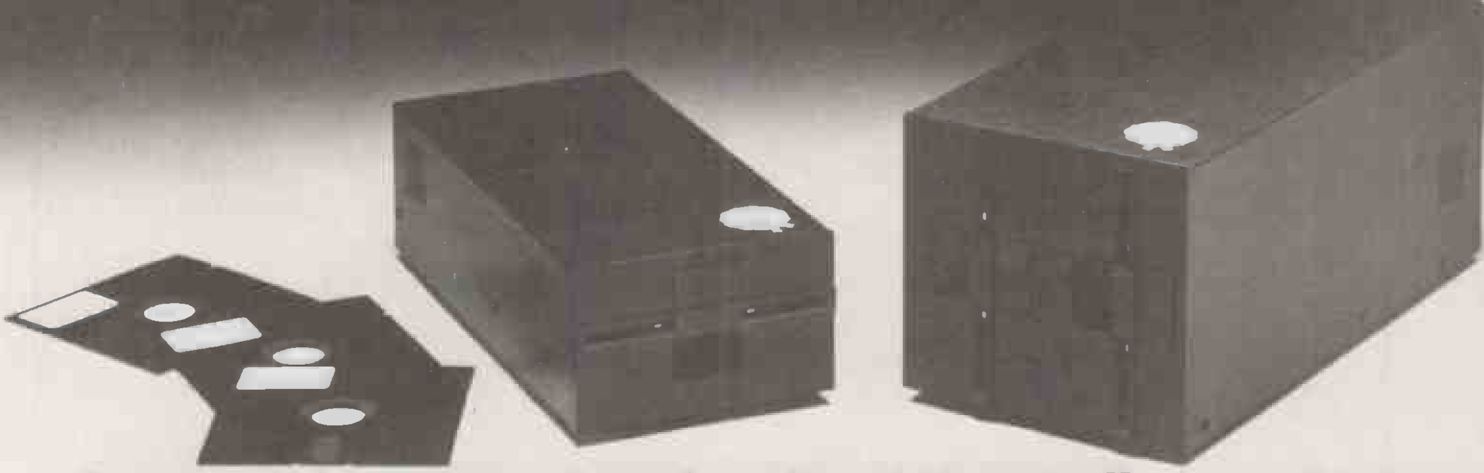

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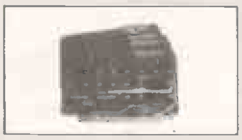

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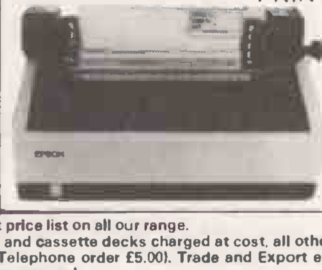

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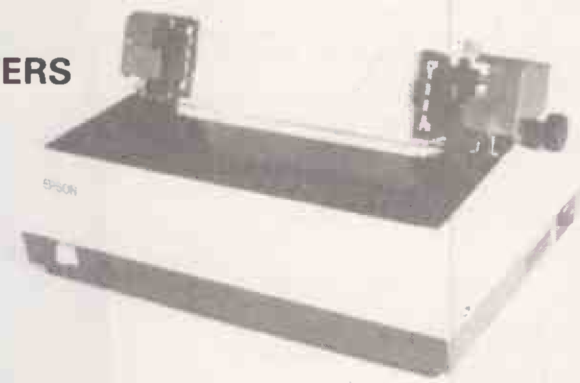

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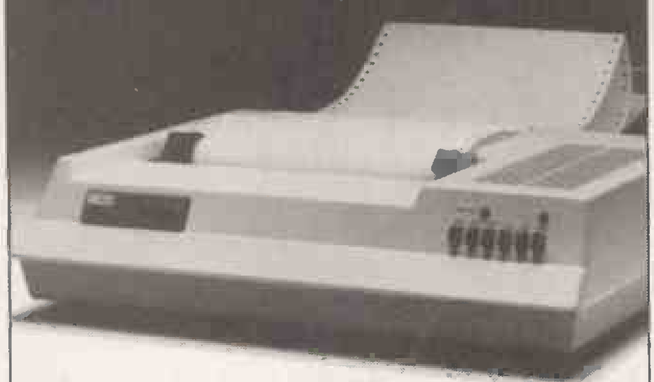

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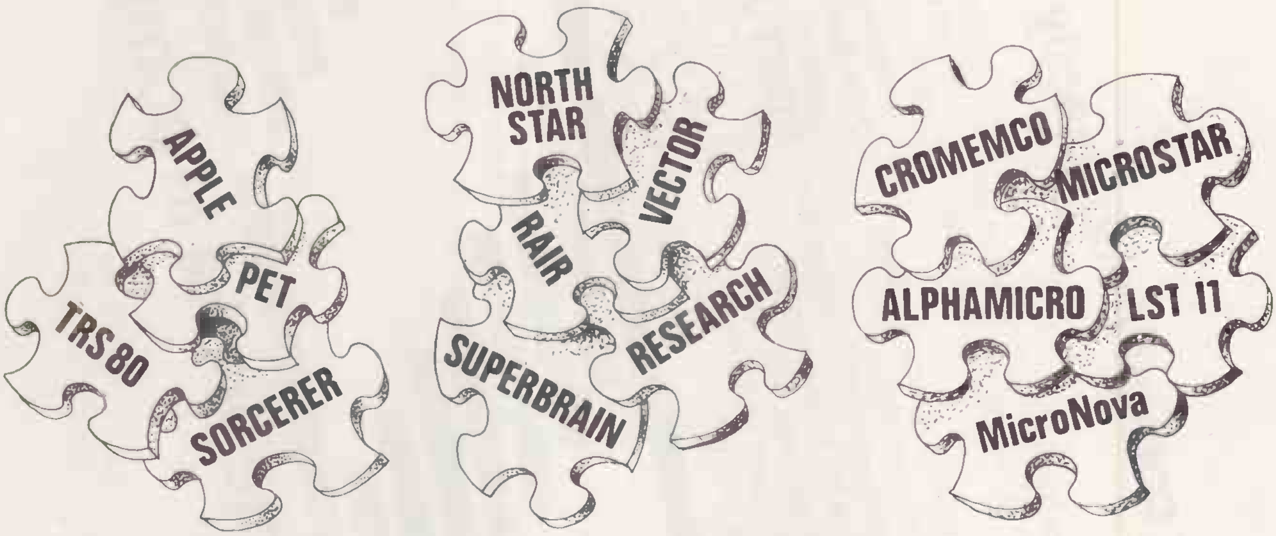

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Waiting for Shakespeare

A REGULAR theme of this page is the difference between microcomputing and the mainframe business. Although we have inherited our basic techniques from them, we should not feel ritually bound by all the details of the big computer culture which has developed in very different circumstances to those in which we work.

One of the most important differences is in the interaction between man and machine. The big computer, generally speaking, was bought by executives who never actually worked on it, programmed by professionals, to whom it was important to preserve the mystique of computing, and operated by ill-paid young women who were hardly consulted about anything.

The result, it sometimes seems, was a jungle of gobbledegook thrown up simply to preserve the distinctions between those three classes of people. We, on the other hand, are in a very different position. The buyer, programmer and operator of our machines may very well be the same person.

What kind of thorn bushes have we inherited? Operating systems that are cryptic, arbitrary, give snappish and unhelpful error messages. CP/M, for instance, will say baldly: "DISC WRITE ERROR" if you try to write to a full disc, to one that has not been formatted or to one which has something wrong with it. Monitors are designed like intellectual obstacle courses. Their authors, like sergeant instructors in the army, evidently think that they would be letting the side down if things were made easy for the user.

Languages are designed to satisfy all kinds of exotic criteria rather than simplicity and ease of use. The books and manuals which explain them often make the implicit assumption that the learner must prepare himself for some deep-sea change akin to reception into a complicated and secret religion. The very first serious business system I ever had to do with made the user recover from a crash by typing "3DOGRUN". Quite apart from being very baffling and incomprehensible to the naive user, it had to be preceded by a "#" — a useful piece of information mentioned nowhere in the manual.

Of course, things are difficult. The fruit of 30 years' esoteric work has to be taught to a whole generation who often know no more about microcomputers than that they are both too difficult to understand and absolutely essential for survival in the future.

However, many of the casualties could be avoided if people in the micro business had a clearer idea of the gulf between them and their customers. Unfortunately, like so many intellectual gulfs, it appears no bigger than a crack — until you fall into it. There is much the same gulf between the playwright and his audience.

You might think that there was no need for a theatrical profession at all. Shakespeare writes what Julius Caesar said, the audience reads the words and they have the whole thing at their finger tips. Why employ actors, directors, set designers, architects, ticket agents, reviewers — the whole huge entertainment business — to do what the play-goer can do for himself in the safety and privacy of his home?

Well, of course, it is not quite the same without the mummers. What is their business? It is to understand what the audience does not know and will not understand unless they are helped. It is to help them in all kinds of subtle ways to understand in a way which will advance the play's development.

Much the same type of skill is needed in the writer of software. He must know what will puzzle people, what will seem illogical. He must design his systems so that they correspond to their users' thoughts and expectations. It is no good writing a stock-control package to the highest professional standards if it makes its users cross-eyed with frustration.

In short, we need a new art form. We are waiting for a Shakespeare who will interpret computing to the common man. Until he arrives and shows us what to do, we will have to bodge along as best we can.

Those thoughts were prompted by two matters of detail. The first is the imminent question of the 80-character VDU. The new Pets have it and other manufacturers will, no doubt, soon be offering this facility. Why? Because it is standard commercial practice. Is 80 characters better than 40 or 20? I do not think anyone knows.

I suspect that the 80-character screen was built originally to show ignorant but rich executives that the computer could do anything a piece of paper could do. An 80-character VDU gives the programmer altogether too much scope. He can create complete zarebas of fields, lines, reversed text, flashing cursors. He can make the screen so difficult to read that it makes some people seasick just to look at it.

My own feeling is that screens and pieces of paper should be treated as the very different things they are. A piece of A4 paper can hold about 350 typed words. You can see the overall shape of the thing, you can look closer at one paragraph, one sentence.

An A4 screen is a different matter. The material on it is fluid — it can come and go in the twinkling of an eye. Why make it pretend to be paper when it is electric? The great — or perhaps the only — virtue of the computer is its speed.

An eye-saving idea for data presentation came from Heinz Wolff at a seminar organised by Sperry Univac recently. He points out the absurdity of presenting complicated information as tables of numbers or even of bar graphs. He suggests a display like a cartwheel. Each variable has a spoke; the calibration along the spoke is chosen so that when things are in the normal state, the display make a circle. If things go wrong — the display might be of various physiological quantities measured from a patient in an intensive care unit — the display departs from circularity.

You could make heart failure distort the display in one direction, excessive urea in another, so that anyone could see at a glance what was amiss. Furthermore, if the display five minutes an hour, a day back is remembered, it can be shown in a different colour, or with hatching between it and the current curve. The display then also shows the patient's history.

There is a great deal of work to be done on finding the best interface between people and machines. The readers of *Practical Computing* are in a good position to do it; let us experiment with new ways of presenting and accepting information. The way the mainframe industry does things is not necessarily the best way.

Microsystems 81

A call for papers has been issued for the Microsystems 81 conferences, sponsored by *Practical Computing*. They will be held at the Wembley Conference Centre, London, from March 11-13, 1981. Microsystems 81 is the fourth in a series of conferences and exhibitions designed for managers and engineers responsible for developing and using microprocessor-based systems. The final day of the conference will be devoted to personal computers and small business systems and their use in commerce, industry and education. Synopses of papers for consideration should be sent by the end of October to Microsystems 81, *Practical Computing*, Dorset House, Stamford Street, London SE1.

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.

Proud ZX-80 owner

AS THE proud possessor of a ZX-80, I was impressed by your review of the creature, which gave the most thoroughly accurate description of its anatomy and habits I have read; better, for example, than the operating manual.

Having spent considerable time investigating the RAM contents, I can, perhaps, clarify some of the issues which you, also, discovered to be perplexing. First, the display file. As you will have gathered from the manual, the display file is not of constant size — in fact, during execution, it does not exist much at all until a print statement occurs, and enters something into it.

As if that were not enough, the location of the first item, invariably a new-line character, in the display file depends on the size of the variables file and the length of the program since the latter are stored in RAM locations preceding the display file.

Fortunately, the beginning of the display file can be found easily by Peeking at the appropriate systems variable, "D-FILE", which is found at addresses 16396 and 16397. Hence:

```
10 LET A = PEEK (16396) + PEEK (16397)
* 256
```

Naturally, if you instruct the computer to print the contents of the display file, you are, by virtue of the print statement, enlarging the display file to include a copy of itself, and a copy of a copy of itself, and so on.

I suggest that this is why you concluded that the program lines were repeated over and over in the RAM: the program listing was resident in the display file immediately before RUN was entered so, inevitably, the program listing multiplied itself in the display file as described.

There is, however, an easy way to avoid that; the initial part of the program must fill the display file with blanks, so that the program listing is cleared immediately and, as an added bonus, the file is then confined to stay of fixed size which can be very helpful when your trying to POKE into it, e.g.,

```
1 FOR A = 1 TO 92
2 PRINT,
3 NEXT A
  rest of program.
```

Do take note of the particular format of the print statement in line two since the punctuation comma is very important and a print statement on its own is not adequate since it would only insert new-line characters, code 118, but no blanks, code Ø.

To stop the display file wandering, which is also a good idea if you want to Poke into it, it is necessary to establish the variables file as an initial step. That can be established by naming all the variables which you wish to use in the first few program lines, i.e., before any Peeking and Poking is done, e.g.,

```
4 LET X=Ø
5 LET Y=Ø
6 LET Z=Ø
```

It also pays to place randomise near the beginning of the program if it will be required during the run.

Armed with that, it is amazingly straightforward to Poke into the display file and the vain among us can even pretend we are fully memory-mapped. One word of warning — watch out for those 118s, the new-line characters.

If you delete them, weird and wonderful effects are displayed on the screen. Of course, the situation is restored easily by Poking them back again if you accidentally delete one or two. The first, and every thirty-third, character in the file is one of these.

Finally, with reference to loading from tape, I have found that much depends on the quality of the tape, rather than the cassette player, and I have had some success with an Ever Ready Super C-60.

However, the recording seems to be very prone to mutilation after being played back a few times — even though it sounds the same to the ear — and demagnetisation of the playback head may well be indicated as a worthwhile measure.

In all other respects, however, the ZX-80 is very reliable and much more versatile than apparent at first glance. However, for any good graphics games, the memory expansion board 1K is just too small.

Laurence Richardson,
Cardiff.

Plessey micromouse

WITH reference to the Micromouse article in September, as a member of the Plessey Mouse Team, I feel that a few points are in need of clarification.

Plessey's involvement in the project has been purely on a financial basis. Companies other than Plessey have also expressed interest in the competition in terms of financial sponsorship for their work teams — hence the event has become one of prestige value.

The cost of our project has probably been no more than that of the independent Marconi entrant, for example, and, therefore, in the financial resources aspect, we have had no distinct advantage.

The work on the project has been carried out in our own spare time. In fact, 95 percent of all mechanical work has been done on my kitchen table, and all electrical work in my bedroom.

It will be seen, therefore, that we have not had the advantage of the many resources available to us which the article implied.

The deciding factor in the quality of any project, be it a mouse or otherwise, can be only the engineering ability, experience and ingenuity of the design team, coupled with the amount of work put into it.

Martin Hayman mentioned Algernon's slick tyres as "a lateral thinking approach to traction which others might consider". Whatever happened to stiction being a function of load versus surface area, in conjunction with the frictional co-efficient of the tyre material?

M Buckland,
London N13.

Adventure II assessed

I READ with great interest the article Adventure II in the August issue and found it well done overall. The program could form a useful and flexible standard which would allow the creation and exchange of some worthwhile games.

However, I feel that the program as given has a few faults of a minor nature and a few omissions of a more serious nature.

On the addition side, I should like to see available three extra actions: increment flag 'N'; PUSH 'Here'; POP 'Here'. The ability to increment any flag allows more flexibility in timing, and would permit a scoring system and accumulation of light wounds as in XORK/DUNGEON.

The PUSH and POP actions would allow movable chests, socks, caskets etc., i.e., objects which are both locations and objects. Using them to extend created objects allows re-setting parts of the complex of location-independent stimuli — after time delays or on an action, etc. — and they can also be used to inhibit movement, if we are in combat for example.

As for the minor faults, I doubt the general utility of the dedicated flags three and four and feel that a counter used for

(continued on page 44)

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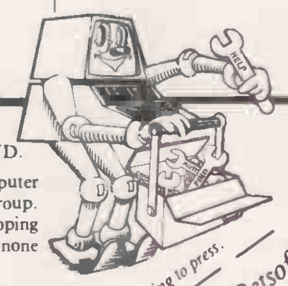

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(continued from page 42)

the lifetime of a lamp would be of more general use.

That criticism may be considered more than minor if we do not allow increment flag when we are stuck for timing, apart from using long lists of testing flags and setting flags entries in the status table.

Other minor limitations include the lack of limit testing on the computed GOTO intructions which could make testing of a database in development troublesome.

The complex problems of general purpose parsing and vocabulary were very well tackled. Although a condition: is the next keyword 'N'? might be useful.

Even if we take the program as a standard without further ado, we are not out of the woods. Since the database is not re-locatable in its normal form, there will be difficulties because for virtually all proposed positions, someone may have his monitor there or all his parts or his memory-mapped VDU. A re-location program need not be very difficult but we still have the problem of tape interfaces and formats.

While discussing the database I must take issue with the statement that fixed lengths — meaning fixed origins — for the tables will be inefficient in memory range. Since the text strings and the condition, movement and action lists are referred to only by absolute pointers, they may be use to fill in gaps very effectively, if not exactly neatly.

We now require a database-exchange network and I look forward to seeing it and the fruits of its operation.

CD Southern,
Chalfont St Giles,
Buckinghamshire.

RND functions

MAY I add a little to Peter Drew's letter in the July issue of *Practical Computing* on the Pet RND functions?

I started to investigate RND when I obtained unacceptable results for the simulation of the scores on two dice thrown many times. I tested various RND functions by generating random digits and using three types of test:

- A significance test for the mean — the expected mean is, of course, 4.5.
- A Chi-squared test for the frequency of the digits.
- A runs test. Runs tests detect patterns in sequences, e.g., a function generating a random selection of zeros and ones might produce the following two sequences:

  0000011111
  1010101010

both of which satisfy the first two tests but would fail a runs test because of insufficient runs of digits in the first sequence and there are too many in the second.

A further consideration is the time it takes to generate the numbers. The table shows how some of the functions fared in my tests and gives the time taken to generate 1,000 random digits.

	Test 1	**Test 2**	**Test 3**	**Time in seconds**
RND (0)	x	x	x	10.9
RND (1)	✓	x	✓	14.5
RND (RND(0))	✓	✓	✓	15.0
RND(RND(-RND(0)))	✓	✓	✓	16.2
F%	✓	✓	✓	51.3

Note: F% is Peter Drew's generator.

```
2000 F$ = STR$ (RND (1) * LOG (T1))
2010 F% = VAL (MID $ (F$, 8,1))   )
```

All the tests have been repeated, often several times. Tests one and two were based on 250,000 random digits for each function and took a long time to execute, e.g., 89 minutes on RND(1).

I am satisfied that for the generation of a large number of random numbers, RND (RND(0)) produces numbers which pass the tests for randomness and is faster than some other random number functions which also pass the tests.

Paul Gibson,
Mitcham,
Surrey.

Important issue

AS IT seems impossible to borrow a copy of the first issue of *Practical Computing* from any public source, may I ask any reader who has a copy of *Practical Computing* Volume number 1 July/August 1978, and is willing to loan it for a few days, to contact me?

Reginald Mascall,
Berkeley Nuclear Laboratories,
Berkeley,
Gloucestershire, GL13 9PB.

Prime and Apple II

I AM interested in using an Apple II as a dumb terminal to a Prime 550 mainframe using a direct line and the Apple high-speed serial interface card.

I have established some communication but there are still problems — mainly the loss of the first few characters of any message from the Prime. I am also having problems with any speed greater than 300 baud.

As a further project, I would like to use the Prime disc store from the Apples. Has anyone overcome any of these problems?

Tim Gerrish,
Plymouth Polytechnic,
Plymouth.

Mainframes and micros

YOUR editorial of June, 1980 was a thoughtful piece on the very important subject of how far methods from the mainframe computer world should be carried into the micro world. Unfortunately, you spoiled it by discussing the wrong things and lost credibility by making one completely flabbergasting statement.

You said you "have a young friend who wrote 5,000 lines of debugged machine code in two weeks". Do you also know someone who has done a 500 ft. high jump?

Later, you mention that "micros have put computing back 15 years" but argue this be true for the wrong reasons. The real reasons are: many programs on micros simply don't work properly; they hardly ever have more than derisory documentation.

At this point I ought, perhaps, to delcare my interest. I have been in programming, systems and design on all kinds of computers since 1955.

As evidence on the first point, I have dipped into a book of published Basic programs at several places and, in every single case, found an error just by reading the code — heaven knows that bugs would crawl if you keyed-in and ran these programs.

On your discussion of a suitable programming language, the choice of topics was very lop-sided. Recursion is an important subject in the theory of computer science, but nobody would demand it in a popular programming language, certainly not for business.

Then you stress the need for localised variables in programs 30,000 in size, and dismiss it for micros. That comment is wrong in several different ways. First, a program is large from the point of view of structure if it is more than 20 or 30 lines, because that is about the maximum a human can hold as a complete totality in his or her head.

Secondly, it is by no means the case that microcomputer programs are smaller than those on larger computers.

Thirdly, it is the linking of programs together which is important not just whether variables are local. The many pathetic re-number utilities prove that this problem is known, but they do not approach a solution.

You do not mention the most common criticism by outside programmers looking at micros. It is how can you possibly manage with all that 'S1 = S2 and 'goto 51347' when I can use names like 'QUANTITY-IN-STOCK'?.

Finally, there is the point I believe to be most important of all — the inadequacy of subroutine mechanism. The language ought to encourage programs to be built top-down — main routine on one page, calling each section as subroutine etc.

In fact, it deters, because of the clumsiness of having to assign values as arguments before each GOSUB and assign the results again after it. The DEF FN allows parameters but one cannot use the call instead of GOSUB, because a multi-line function is not allowed.

That is the only case where I have found a superior feature in Basic on mini and mainframes — usually the micro Basic is better. There are other major problems in subroutine control, e.g., in stock handling and use of ON ERROR.

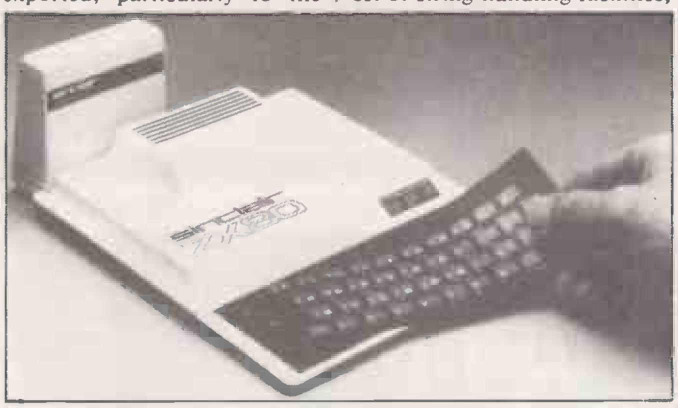
P Shackleton,
London, NW6.

ZX-80 wins extra power from latest add-ons

TWO NEW add-ons designed to expand the capabilities of the Sinclair ZX-80 have just been announced by Science of Cambridge. At their launch, inventor Clive Sinclair claimed that the ZX-80 is now outselling all the other personal computers combined in the U.K. market. The new products are a high-level, full-facility 8K Basic RAM, at £19.95 and a self-contained 16K RAM pack at £49.95.

To date, 17,000 ZX-80s have been sold and units are manufactured at a rate of 300 a day, increasing to 500 at the end of the year and 40 percent are exported; particularly to the U.S. via the Sinclair office in Boston. Exports are expected to reach 70 percent over the next six months as new overseas markets, such as Sweden and Australia, are tackled.

The 8K Basic ROM, designed as a drop-in replacement for the existing 4K Basic ROM, has a new keyboard template and a supplementary operating manual. Key features of the new Basic include a full floating-point arithmetic to nine-digit accuracy, logs, trigs and their inverse functions, a graph-plotting facility, an animated display using PAUSE n, a full set of string-handling facilities, n dimensional arrays, n dimensional string arrays and cassette Load and Save with named programs. No less than 37 new functions are available with one keystroke; e.g., Draw, Data, Arcsin, Val and Scroll.



The plug-in 16K byte RAM is a complete plug-in module which can be used as a database or for program storage. According to Clive Sinclar, it costs up to half the price of competitive additional memory. The module plugs into the existing expansion port on the rear.

In answer to complaints from users, Clive Sinclair tells *Practical Computing* that the delivery problem — a constant source of complaints for some weeks — has now been solved. He says: "When we first advertised the product, we had no idea of what the response would be and, in fact, it was miles ahead of expectations. We had planned delivery time for four weeks. At one point, it rose to nine weeks but we have re-phased our production and it is now back to four weeks or less for assembled models".

Tandy begins attack on market for pocket computers with Sharp deal

TANDY is making a new attack on the lower end of the computer market by an OEM deal with the Sharp Corporation allowing Tandy to market the Sharp PC-1211 pocket computer, reviewed in *Practical Computing* in July, under the name of Radio Shack. It will be sold through the Tandy stores.

The computer has 1.9Kbytes of RAM and 11Kbytes of ROM and has a cassette interface for extra memory. The price of the model will be £119 for the computer and £17.95 for the cassette interface. The Sharp version is now being advertised at £85 and £11.50 respectively.

In the middle of next year, Tandy plans to launch a new computer, to be called the Model III. It will be a colour computer with an integral keyboard, screen and dual 5¼in. disc drives, to fill the gap between the Model I and the more recent Model II. In the meantime, however, Tandy has opened its first store in Scotland in the centre of Glasgow and plans to open another in Edinburgh in a few weeks.

Less weight, more space

FLEXIBLE copper-clad laminates have been introduced by 3M. Flexible circuits are replacing conventional wiring looms or cable harnesses in many electrical and electronic applications because of their advantages in space and weight.

The CuFlex consists of a flexible epoxy/polyester resin, reinforced by an organic fibre non-woven web. It has all the properties of traditional printed circuits. Details from 3M on (0344) 58436.

Why people buy micros

A MANCHESTER-based market research group is starting a study into the reasons why people buy microcomputers. The aim is to assess how the people choose between competitive systems. The survey will not start until the company, BDA, has found enough companies or dealers willing to spend up to £1,000 each for a copy of the report.

The study will be strictly qualitative and in the words of Tom Burgess, one of the directors of BDA, will rely on "motivational research techniques" which will "probe beyond the level of the conscious mind".

One of the techniques used will be to invite dealers and past customers to interact: "Interaction brings out points which other research techniques miss", says Tom Burgess. Details from BDA on 061 228 3768.

MTC Pilot guides Pet to computer-aided teaching

A 6502 machine-code program for the Commodore Pet has been released by Mitac Publishing Ltd.

MTC Pilot is an adaption of common Pilot run as a machine-code interpreter for the Mark II Commodore Pet. All the features of common Pilot are supported, including full matching, automatic editing of user input, execute-indirect and file-input and output commands, and escape and go to options. Additional features are special Pet graphics commands, extended string handling and string arrays, and Peek and Poke instructions as in Basic.

By using subroutines in the Pet ROMs, the program runs in 4K of machine code. This code re-locates to the top of the available Pet RAM.

Mitac Publishing hopes the new Pilot will find a market in computer-aided teaching and computer science courses. The interpreter, manual and a number of sample programs are available, at £65 plus VAT, from Mitac Publishing, Modern Tutorial College, Kilburn Lane, London W10 4AA.

Vero extends Eurocard

VERO Electronics has extended its Eurocard range to include a fully-pierced Eurocard Veroboard, available with or without a maximum copper colander ground plane.

Another new product from Vero is an addition to the Eurocard power supply range with a 5V at 5A single-output unit. Details on (0703) 440611.

New low price starts Superbrain storm

A PRICE war has broken out among dealers of the much-acclaimed computer from Intertec, the Superbrain, reviewed in *Practical Computing* in April this year. Most dealers were advertising the system at £1,950 and were taken by surprise when a new company, KGB Computers, started offering to sell it for £1,495 — a full £500 cheaper.

According to Bill Horse, managing director of Slough-based KGB, he had not expected such a stormy reaction. "Dealers were telephoning again and again — some of them very angry. Before we entered the market there were about 40 dealers selling the Superbrain, all around the same price, and the total sales were averaging around 80 to 100 systems a month. We seem to have doubled the market, selling about 120 systems per month ourselves".

Bill Horse says several dealers have offered to talk about a common pricing policy — a move which he has so far declined.

The entry of KGB into the Superbrain market seems to have been well considered. Bill Horse also runs a company called Plus Business Systems, one of the recently-appointed Alpha Micro dealers: "We were convinced that there was a market at the lower end, and not just for the Apples and Pets.

We asked people about the Superbrain and they all agreed that it is a good system but that there were some reservations about the price".

The Superbrain retails in the U.S. for about £1,200 so unless the new price becomes accepted, Bill Horse feels that it would be cheaper for most people to fly to the States, buy one and bring it back themselves.

Recession could lead to boom in computing

THE RECESSION is beginning to bite, unemployment has topped two million and seems to be increasing at an ever faster rate. One way and another, it looks like being a hard time, especially for small companies. Most forecasters expect the recession to hit a trough between the last quarter of this year and the first quarter of 1981. Even then, the recovery should take quite some time to emerge.

From the gloom, there is, however, some good news. According to London stockbrokers Hoare Govett, working on figures published by the Government Central Statistical Office, capital investment in increasing and while companies are shedding their labour force, they are turning to new plant machinery and technology as ways of increasing their efficiency.

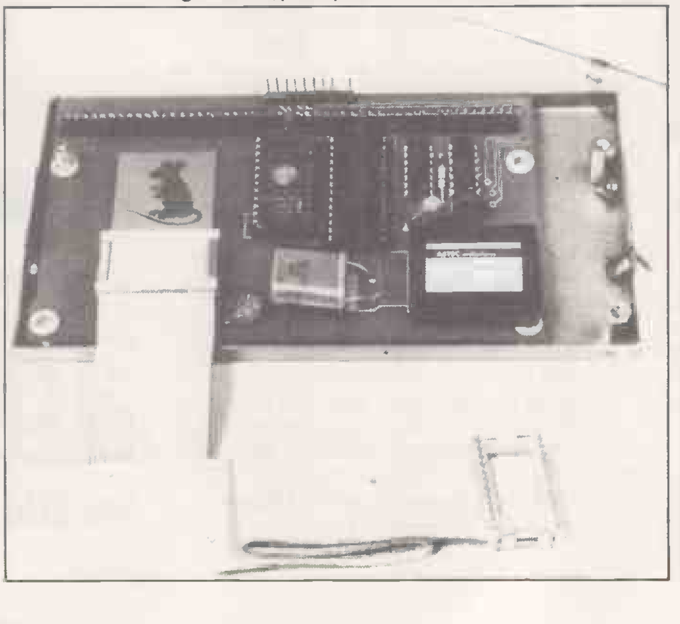
The figures for capital investment have been buoyant for some time. If all the figures are kept at 1975 prices, there has been an 11 percent increase in the volume of investment each year for 1977,78, and 1979 and the trend seems to be continuing into 1980 with another 11 percent increase in the first quarter of 1980 over the same period in 1979.

According to analyst Tony Barron, while labour costs have risen by as much as 20 percent over the past year the cost of capital equipment — such as microcomputers, especially when imported as the pound is still holding strong against the dollar — has risen on average by about 2 percent. In other words, the recession could lead to a boom in microcomputing.

Hoare Govett use the figures to help explain why the Government has found it so hard to control the money supply, arguing that it is these crash investment programs, with companies borrowing heavily for finance, which have kept the money supply figures so far above target.

The recession is expected to bite so hard that there will eventually be a small decline in investment at the end of the year, but a quick recovery is forecast in the first four months of 1981.

THE Kingston Netkit broadens the capabilities of the Pet by freeing it from many of the limitations associated with the creation of RS232C serial via the IEEE 488 port. It is a hardware/firmware package which allows a relatively inexperienced programmer, assisted by 10 new serial Basic commands to achieve configurations without recourse to machine-code routines. The kit serial port on the Pet can not only exchange data and program files freely but also be remotely-controlled and simplifies multi-access use of the Pet. Details from Kingston on (0262) 73036.



Microspeech 2 gives vocal support to progress in voice synthesis

SOUND AND voice boxes are becoming popular at last. The latest offering, Microspeech 2, is a stand-alone speech-synthesising unit which converts phonetic code, or English text into speech output, via a standard RS232 interface.

The speech is created from the unit's microprocessor so all that is required is an ASCII keyboard. Up to 1,000 phonetic characters, representing one minute of speech, can be assembled in its internal buffer before it is commanded to speak.

The optional text-to-phonetics translator program includes the phonetic equivalents of all the standard ASCII symbols and thus enables the units to be driven directly from English text, although the speech in this mode is less fluent. The unit is still expensive, however, at £875 plus an extra £75 for the English-text version.

The software was written by Richard Monkhouse and the hardware and the synthesising was designed by Tim Orr of Tim Orr Consultants. Tim Orr is frank about the high cost of the system and its sales potential: "We are only really going for people who are not spending their own money. Sales so far are from the Post Office and military users. We also see a market among blind people". In total, he hopes to sell up to 100 systems a year in the U.K. Details 01-731 2077.

Easy software transfer

SCIENTIFIC micro-builders Research Machines of Oxford has announced that the Computer-Assisted Design Centre well-known GINO-F, GINO-2D and GINOGRAF packages will be released for the 380-Z later this year.

The various GINOs are rather like CP/M in that they provide a standard interface between the high-level software and the machine's hardware. GINO provides the writer of a graphics package with a number of basic visual resources.

If he wants to draw a circle, for example, he just has to tell GINO the centre and the radius. That not only makes his life much easier, it means that graphics software can be transferred from one machine with GINO to another.

Expansion for Superboard

A NEW expansion system for the Superboard and UK101 has been developed by Zen Computer Services. The basic system consists of two boards with a 40-way jumper lead to the main computer board.

OSI systems boards which can be run include both static and dynamic RAM, 8in. floppy-disc controller and a range of I/O options. Price of complete system is £43.70. Details from Zen on 061-962 3251.

Users' bid to buy Nascom fails as receiver accepts another offer

THE proposed take-over of Nascom by John Margetts, head of the Nascom microcomputer club has been abandoned now that the receivers, Cork and Gully, have accepted one of the other bids for the company.

Although the bid has been accepted, Jack Haggar, temporarily running Nascom on behalf of the receiver, is not willing to disclose the name of the purchaser until a formal contract has been signed. This is said to be "imminent".

As reported in *Practical Computing* in August, John Margetts planned to form a company, financed by Nascom users and distributors, which could make its own bid for Nascom. Until very recently, he understood from the receiver that his bid would be given preference if he could raise the capital quickly enough.

According to Margetts he managed to raise only £10,000 in cash and several £100,000 in promises of support both from individuals and companies involved in Nascom add-ons and back-up.

Margetts claims that the company turnover is now currently running at about £138,000 per month. The small number of staff at Nascom are being encouraged to stay on under the new ownership.

A NEW version of the LX-500 computer has been released by LogAbax. It has dual-density discs and will sell for £3,500. According to LogAbax, the LX-500 is "no bigger than a shoebox". Details from LogAbax, 01-965 0061.

No exit for Exidy

THE declaration by Exidy, reported in Printout in July, that it had sold the Sorcerer to Recortec seems to have been a little premature. Although the deal was planned, it never materialised and for the time being, the Sorcerer remains an Exidy product.

In the meantime, Sorcerer U.K. agent, Liveport of St Ives in Cornwall, has released a CP/M operating system and a Basic package for the Sorcerer, supplied on Micropolis discs. The package, with documentation, will cost £220 plus VAT. Details from Liveport (0736) 798157.

Monitor EPROM produced for Ohio micros

A NEW monitor EPROM has been written for the Ohio Scientific microcomputers which use Microsoft Basic. Called CEGMON, it has been developed by George Chkiantz, Richard Elen and Tom Graves, the co-ordinators of the OSI U.K. user group.

It will be available in separate versions to suit the C1/Superboard II, the Challenger 2 and the new C4, reviewed last month, the enhanced, larger display, C1, and the UK101.

CEGMON is supplied burned into a standard single-rail 2716 EPROM and can be installed with minor alterations to the processor board.

Some of the features of the new monitor include a screen editor, a revised keyboard routine, a completely new screen handler, NEWMON, a full machine-code monitor for the development of machine-code routines, input/output vectoring, and a floppy-disc bootstrap.

According to the authors, CEGMON retains all the major entry points of the original SYNMON monitor and there is full compatibility with existing software, firmware and hardware at the fundamental level. Details from Dave Graham at Mutek on (0225) 743289.

Z-80 operating system

INTERFACE Computer Services, the Essex-based consultancy, has been awarded the U.K. franchise for a new commercial operating system for Z-80 and Z-80A micros.

A Cobol compiler and an on-line debugging tool are provided as part of the system. Details: Witham (0376) 518112.

Graphics is growing reveals industry report

COMPUTER graphics is one of the most rapidly-growing areas of computing according to the latest Infotech state-of-the-art report, Computer Graphics. In an invited paper in the report, Robert Dunn, of the U.S. firm Summagraphics, predicts that there will be a 100-fold growth in the use of computer graphics by the end of the 1990s.

The report examines many aspects of the field of computer graphics with particular emphasis on the use of interactive graphics. Among the topics covered are data management, hardware, computer animation, standards and applications.

The two-volume, 600-page report costs £150.

MUSE to receive cash support for software-transfer project

THE Department of Education and Science, DES, has agreed to finance some of the work that MUSE, Microcomputer Users in Secondary Education, has planned for the next academic year.

The money, believed to be about £30,000 will be drawn from the DES advisory committee on microelectronics in schools, formed recently to promote the development of computer education.

One of the projects planned is a software-transfer service. MUSE hopes to appoint two research assistants, preferably school leavers, who can re-write education programs to make them compatible for all the microcomputers used in schools.

The chairman of MUSE, John Coll of Oundle School, has also been appointed as one of the five external members of the advisory committee. Mark Carlisle, Secretary of State for Education and Science, announced the formation of the committee shortly before the end of the last Parliamentary session.

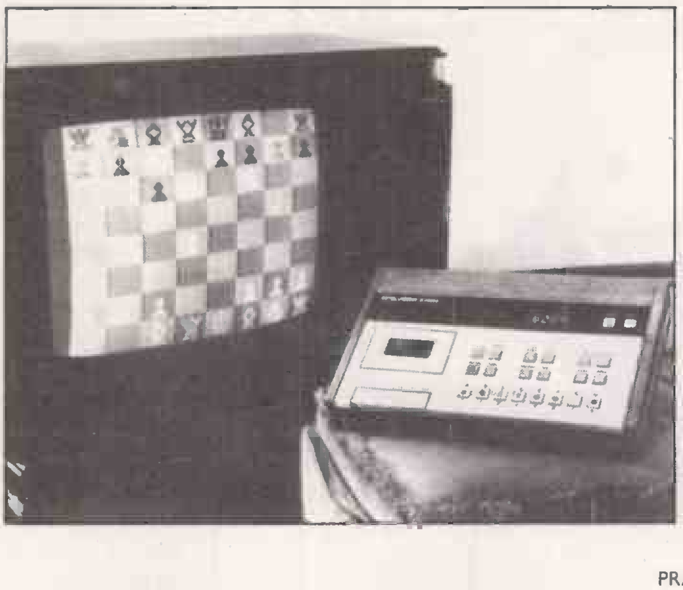
The chairman will be A Halsey, Permanent Under-Secretary at the DES. G Hubbard of the Council for Educational Technology, J Major of the Department of Industry and J Mann of the Science Council have been appointed to the advisory committee as full-time assessors.

The five external advisors include only two teachers, A Clements of King Edwards Five Ways School in Birmingham and John Coll. The structure of the committee has already been criticised by the National Union of Teachers, NUT, which has pointed out that none of the full-time members has any direct experience of computing in schools and that none of the external advisors teaches in the state sector.

First British chess computer has recording facility and 13 levels

THE FIRST British chess computer, designed with the aid of David Levy, the well-known chess master and computer chess enthusiast, will be released by the Hertfordshire-based games firm Optim.

The chess computer now dubbed Intelligent Chess, has a built-in tape recorder which can record up to 1,000 chess games and replay them in colour on a domestic TV set. The game will be aimed at the top end of the computer chess market and is expected to retail at about £295.



The game performs all the usual operation of any chess computer, playing an opponent at different levels of difficulty, playing against itself, suggesting the next best move to an opponent, but includes the additional features of the TV interface and the ability to record the games with a talk-over commentary.

The computer can also be asked after it has moved what its next best move would have been and the player can at any time step back moves, even to the start of the game.

The computer, with 13 levels of difficulty, is based on the 6502 chip, has 64K bits of ROM and 16K bits of RAM. Optim intends to release another, less sophisticated chess computer for £39.95. Details from Optim on (0279) 54547.

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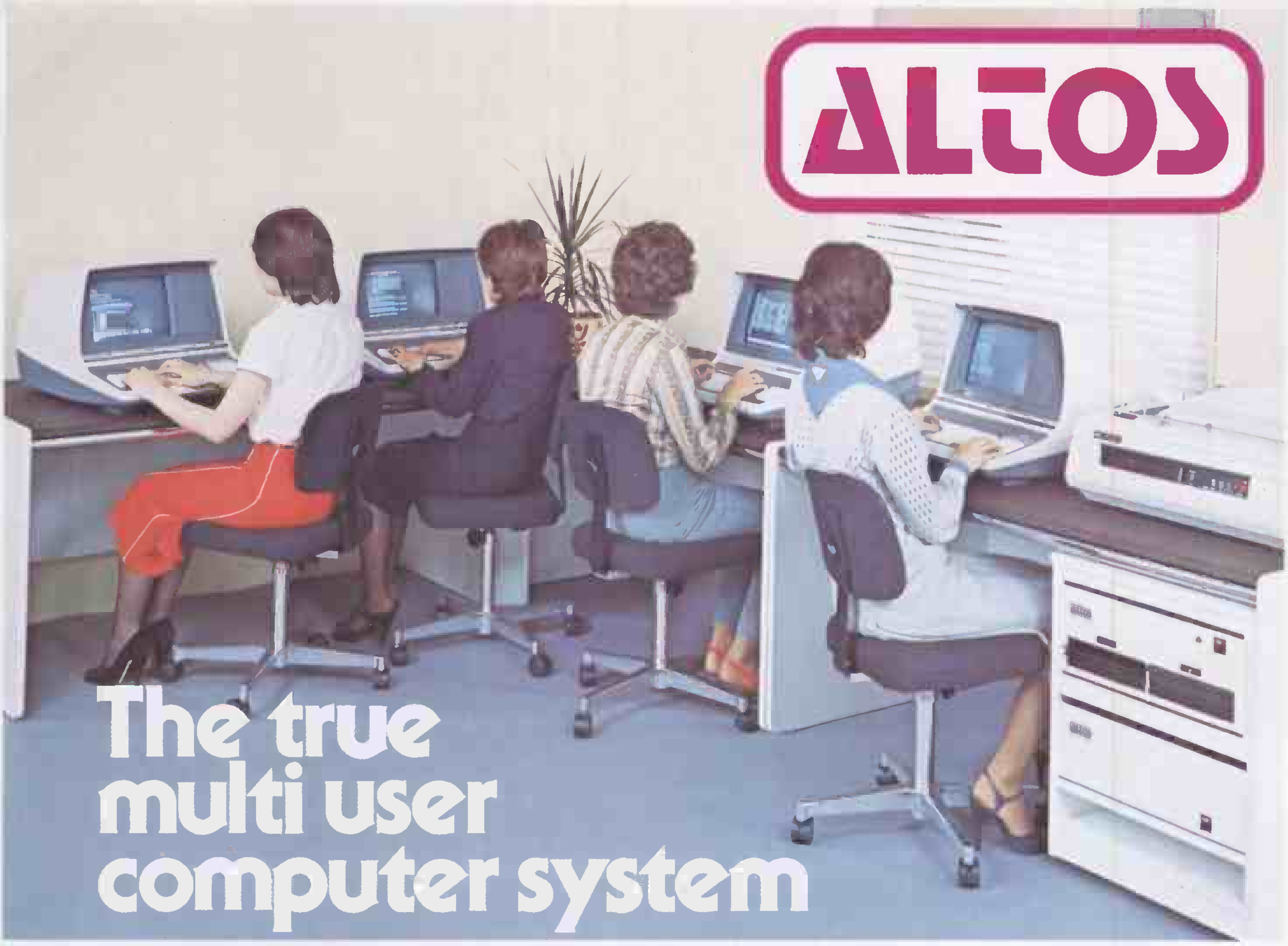

The ALTOS ACS 8000 range of business/scientific micro computers creates a new standard in quality and realiability in high technology micro computers.

Hard Disk/Multi User Systems

The Winchester hard disk/multi user systems are now available supporting up to 4 simultaneous users and providing a maximum of 58 Megabytes of hard disk data storage.

The systems are truly flexible and allow expansion of the ALTOS floppy disk system to keep pace with the users requirements.

Still single board, features include

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- High speed (4 MHz.) D.M.A. control as standard.

Yes, mini power and at micro cost too.

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The ACS 8000 range are true single board micro computers making them extremely reliable and maintainable. All electronics are socketed for quick replacement. Complete diagnostic utility software for drives and memory is provided.

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Unlimited versatility. The ACS 8000 range support the widely accepted CP/M and MP/M operating systems plus basic (Microsoft and CBasic), Cobol, Pascal, and Fortran IV. All available now.

Logitek in conjunction with its own microsoftware house, Interface Software Ltd. of Camberley are able to supply a wide range of proven 'off-the-shelf' business software including general accounting, word processing, stock control, mailing list etc.

There are already over 1000 micro computer installations using this software. A track record which we consider speaks for itself. Why 're-invent the wheel' when there is standard software of this quality available now?

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Two new custom software packages are now available for the Altos Computer System operating with CP/M to enable it to communicate with remote machines over ordinary telephone lines. ASYNC is an asynchronous package that operates with almost any remote machine. SYNCH is a synchronous package for use with the IBM 3780 protocols.

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A full graphics and scientific package is now available for use for the Altos with FPP.

GRAFLIB is a custom Altos software package containing a complete range of FORTRAN—callable graphics subroutines. It is designed with DRE RG—512 board, or a Tektronix 4000 series graphics terminal. Several multi-colour X-Y plotters are supported allowing hard copy in addition to screen graphics.

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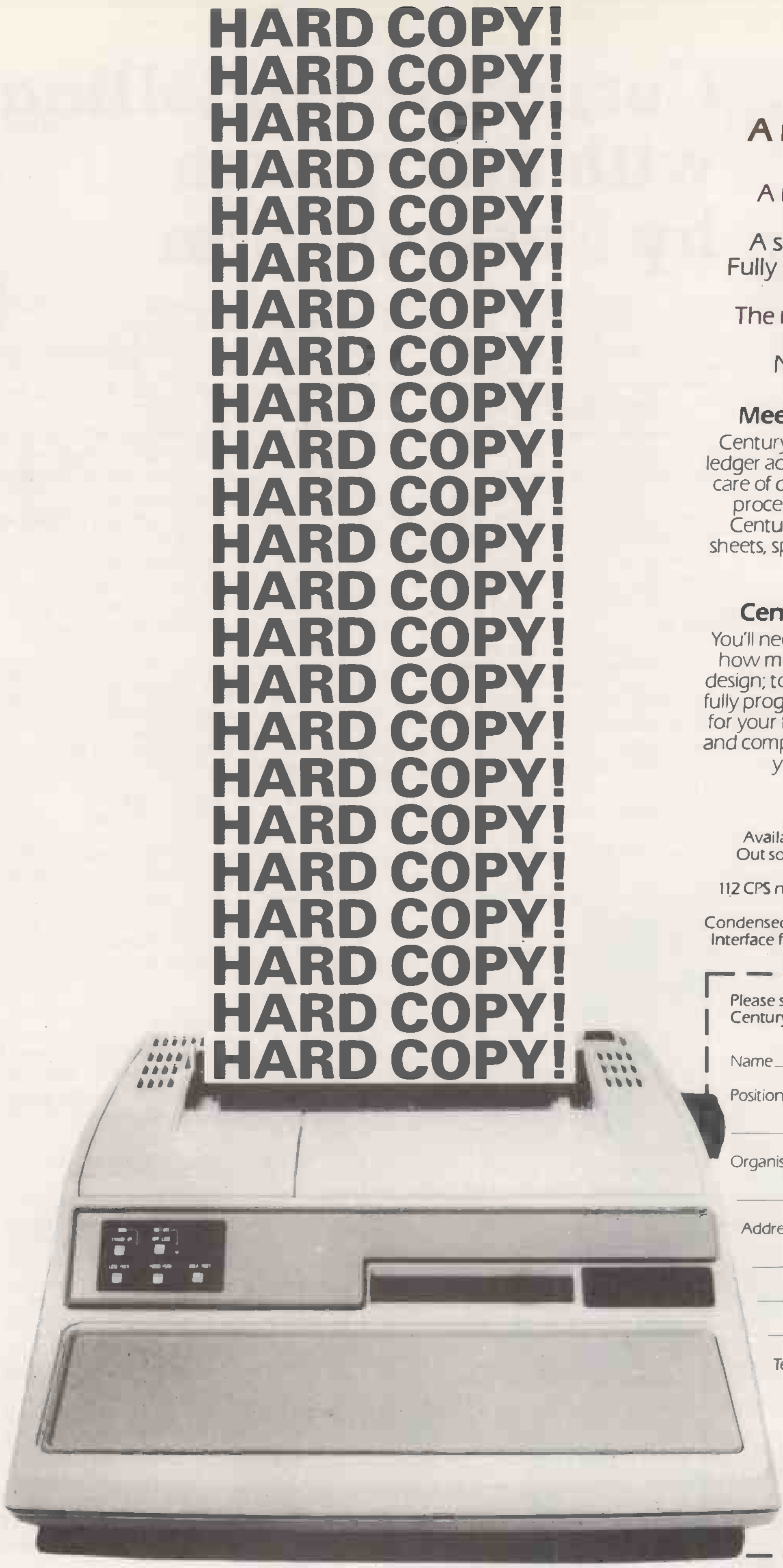

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Corporate modelling with many uses by Desktop Plan

by Mike McDonald

DESKTOP Plan is one of the first corporate-modelling packages available for micro-computers in the U.K. It was written in the U.S. by Don Williams and is marketed under the colours of Personal Software Inc — the vendors of VisiCalc — see *Practical Computing*, June.

Desktop Plan will run on either the Apple II Eurapple or the ITT 2020 with a variety of printer devices. A 32K machine with one or two disc drives will be required. The review copy was supplied by Keen Computers.

The system is structured so that three files are created through a series of interactive screen formats which, when combined subsequently, produce a numerical analysis and pre-formatted report.

The package is a modelling facility which may be user-programmed to produce any common type of business report and application areas including:

- Profit and loss accounts
- Balance sheet
- Cash flow
- Budgetary control

Desktop Plan need not be limited to business applications and can cope with personal finance, taxation analysis and many other applications. The criteria for using Desktop is essentially that the user wishes to computerise a tabular report.

Tabular reports with multiple columns of data which can represent timescale, products, etc., and be interlinked or separate are ideal for the package.

The main difference between VisiCalc and Desktop Plan is the Desktop sophisticated reporting facility. The level of report definition is so good that the business user is able to produce reports acceptable in a business environment which need not be typed or finished on a conventional typewriter.

On the other hand VisiCalc is better at complex calculations and numerical interrelationships in array calculations. Desktop Plan is supplied on a single mini-floppy disc with a 144-page A5 binder.

The three files created by Desktop Plan are:

1. A report description/definition file.
2. A planning values or data file.
3. A calculation rules file.

Initially, the user defines the report format in terms of title, column headings, line descriptions and appropriate punctuation. Once created, the file may be used to produce a dummy report which serves as a planning document for the next two phases.

The data-file creation uses the report definition to display each of the lines in the report model for data entry against each. Once a file has been completed, the calculation rules are entered defining the relationships between the data lines and columns.

That file is then executed with the input data file to produce a set of results which may be printed using the report definition and saved as another data file.

The multi-file structure used in Desktop Plan allows the user to create a variety of data files for running against a single model or vice versa. Data files, or result files, may be combined to produce a consolidated version for further processing or reporting.

The package and its functions are accessible through a master menu offering:

1. Enter or modify report description file.
2. Enter, modify or display values file.
3. Enter or modify calculation rules file.
4. Execute calculation rules.
5. Print reports.
6. Consolidate/summarise files.
7. Transfer file to another diskette.
8. Set system parameters.

We set-up a simple three-year plan for a fictitious small company. On selecting the report description option, the system prompts for up to three lines of title. Each line may be up to 30 characters long and each entry is spaced proportionately at print time.

Maximum limits

The user must next define the model size in terms of the number of lines and columns to be used. The entered values are the maximum limits the model can reach.

The stated maximum values for the package are 300 lines and 18 columns but due to the limitations of memory there is a practical maximum. Quoted examples are 255 lines by 18 columns on a 48K Apple an 100 lines by 13 columns on a 32K system.

The next request is for the column headings of which there may be two lines of nine characters for each position. A screen format offers the user an appropriate number of positions on the screen to enter each column heading and also requests a decimal indicator which will define globally for that column the number of decimal places to be printed.

As with most of the screen formats throughout the package, the user is given the opportunity of changing any erroneous entry before moving on to the next screen, or function.

Desktop Plan can only display the report-line descriptions in blocks of 10 on

PRACTICAL COMPUTING DTP REVIEW
ABC CO LTD - THREE YEAR PLAN

8 AUGUST 1980
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STAGE 2 - REPORT & PLANNING VALUES		BUDGET £ YEAR 1	BUDGET £ YEAR 2	BUDGET £ YEAR 3
SALES (UNITS)	(2)	10000	-	45000
SALES PRICE (PER UNIT)	(3)	13.54	15.25	18.70
REVENUE	(5)	-	-	-
COST OF SALES				
MATERIALS	(9)	47932	52000	65000
PROCESSING	(10)	17000	-	-
MARKETING	(11)	7500	-	-
STAFF	(12)	24580	-	-
OFFICES & BUILDINGS	(13)	12400	14000	17500
TOTAL COSTS	(15)	-	-	-
GROSS MARGIN	(17)	-	-	-
GROSS MARGIN % OF REVENUE	(18)	-	-	-
TAX DUE (52%)	(21)	1	1	1
NET INCOME AFTER TAX	(24)	-	-	-
DIVISION FACTOR -CONST-	(27)	3	3	3
TAX RATE -CONST-	(28)	52.00	52.00	52.00
MULTIPLICATION FACTOR -CONST-	(29)	100	100	100
INFLATION RATE -CONST-	(30)	18.00	16.00	19.00

PREPARED WITH DESKTOP/PLAN--COMPANY CONFIDENTIAL

Figure 1.

PRACTICAL COMPUTING DTP REVIEW
ABC CO LTD - THREE YEAR PLAN

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PAGE 1

STAGE 1 - LISTING OF REPORT FORMAT		BUDGET £ YEAR 1	BUDGET £ YEAR 2	BUDGET £ YEAR 3
SALES (UNITS)	(2)	-	-	-
SALES PRICE (PER UNIT)	(3)	-	-	-
REVENUE	(5)	-	-	-
COST OF SALES				
MATERIALS	(9)	-	-	-
PROCESSING	(10)	-	-	-
MARKETING	(11)	-	-	-
STAFF	(12)	-	-	-
OFFICES & BUILDINGS	(13)	-	-	-
TOTAL COSTS	(15)	-	-	-
GROSS MARGIN	(17)	-	-	-
GROSS MARGIN % OF REVENUE	(18)	-	-	-
TAX DUE (52%)	(21)	-	-	-
NET INCOME AFTER TAX	(24)	-	-	-
DIVISION FACTOR -CONST-	(27)	-	-	-
TAX RATE -CONST-	(28)	-	-	-
MULTIPLICATION FACTOR -CONST-	(29)	-	-	-
INFLATION RATE -CONST-	(30)	-	-	-

PREPARED WITH DESKTOP/PLAN--COMPANY CONFIDENTIAL

Figure 2.

a screen and, therefore, uses a blocking system for that function. Depending on the number of lines declared earlier, Desktop will provide a number of sequentially number blocks automatically containing each group of lines also sequentially numbered from one up to the maximum, i.e., if 50 lines are input as the maximum, the package will produce five blocks numbered 0,1,2,3,4 and each block will contain lines 0 — 1 to 10, 1 — 11 to 20, 2 — 21 to 30, etc.

Each block is accessed by its number and line descriptions entered against whichever lines the user wishes. Each line description may be up to 30 characters long and for each line entered, the user must enter a decimal specification of either 0,1, or 2. That indicator will be used both at the data-entry stage and at the report stage unless overidden by the column specification.

Lines are accessed and entered by their number and users are advised to leave some intermediate blank lines for expansion or modification at a later stage. Once the limits are entered at the beginning of the report description, they may not be changed and the size of the report model is fixed.

Report definition

Each block is accessed in turn and line descriptions entered until the report definition is complete. There are a number of shorthand characters for producing:

- '=' Only entry for a double underscore under each column.
- '—' Only entry for a single underscore under each column.
- '#' Only entry for a blank line.
- '.' Only entry for a start-new-page heading.
- '^' Last character entry on a line description for that line to be used as a sub-heading.

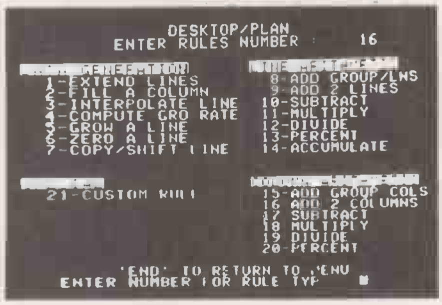
We found those special characters very useful in producing a neat report format. On completion, Desktop Plan prompts the user for the name of the file under which the format will be stored.

The file organisation in Desktop is sophisticated and very secure. Report, data, calculation, and results files may all have the same nominated name which is suffixed automatically by Desktop and accessed by virtue of the function being performed. In our case, all the files were called TESTRUN and a catalogue of the disc showed —

TESTRUN.D — report description file
TESTRUN.I — data input file
TESTRUN.R — calculation rules file
TESTRUN.C — computed results file

Throughout each stage the user is prompted only for the prefix name if accessing an existing file. That makes life much easier when entering the execution mode as only one file name must be entered.

Users may, of course, opt for different names, in which case Desktop Plan will



prompt for the name of each of the files involved.

Having produced the report definition, the manual suggests that a dummy report is produced to ensure that the format is correct and to act as a planning document for the balance of the exercise. When option five of the main menu is selected — Print Reports — the user enters the name of the report and results file for printing.

As no results or data files exist, none may be entered to produce a blank report. Each time the report option is used, the user is prompted from a sub-menu for the following options:

- Print line numbers Y/N? — These are useful in the planning stage and would be omitted on a final report.
- First line to print — In our case we stored lines of constants.
- Last line to print — constants at the end of the report format and suppressed the printing of these on the final report.
- Number of model columns per page — this defines how many columns are required across the page.
- Stop at the end of every page Y/N? — this allows the user to load or unload stationery during the course of running.
- Run description — this is a 30-character description used to identify each report produced.

We produced a dummy report from the description entered and this is shown in figure 1. On the printer used, we could only print three columns across the page out of our four-column model but that was not critical in the development stage.

Line descriptions

Desktop Plan uses fixed-length line descriptions and fixed-length columns and, therefore, can produce only x number of columns depending on the width of the printer used. The quoted limits are

Printer width	Number of columns across
156	12
132	9
80	4

These limits are unfortunate but the package has been programmed to split reports, printing the maximum number of columns on one page and the balance on a re-formatted new page. The results in this form are quite acceptable but awkward.

The manual recommends the user to enter at this stage the data to be used in the calculations. We were not convinced that this is the proper way to go about things but complied by accessing function two on the main menu — entry of planning values. *(continued on next page)*

(continued from previous page)

The user is prompted for the report-definition file name and each line is displayed for the user to enter values under each column number. The user is warned that some data-entry effort may be saved by using some of the data-handling functions available within the calculation facility such as:

- Extend/fill line
- Interpolate lines
- Grow a line
- Fill a column

A number of special key functions within the program ease the task of the data entry. The user can use the forward and backward cursors to duplicate entries across the fields or just move around. Lines may be accessed by number or by the cursor which will step forward or backward sequentially to adjacent lines. Initially, the key functions can be confusing but with some practice, they should speed the tedious process considerably.

Data files are modified from the same program and a sub-menu offers enter values, modify values or display values. As data lines are accessed, these are displayed, three across, on the screen with the first line of the column header and the column number displayed in reverse above each.

Once the entry or modification has occurred, the values entered or changed are written to the file name prompted on selecting the function from the main menu.

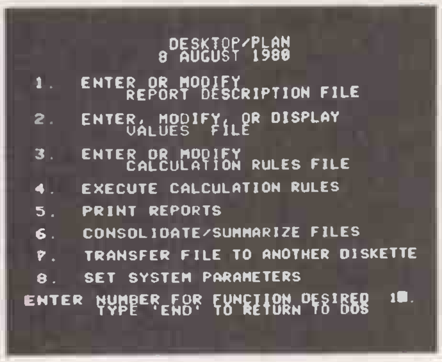
Planning values

The user may optionally now produce a second report using the entered planning values. This step is recommended for the first-time user and we once again entered option five — print report. Figure 2 shows the report produced with the appropriate data values saved in TESTRUN.I. This report was used to determine the calculation rules necessary.

The calculation rules are the series of instructions for manipulating the data entered and producing the desired results. There are 20 standard rules available in three groups; data generation, line arithmetic and column arithmetic. Rules are selected from a sub-menu and are sequentially numbered automatically.

The numbering of the rules determines the order in which they will be executed and has no bearing on the line numbers of the report lines or data lines. It is very important to have the correct sequence of calculations otherwise erroneous results will occur.

We found that it was important to write our set of rules on the dummy reports before entering them as they cannot be reviewed in the course of entry except by exiting the entry phase.



Each calculation rule has its own screen format and the rules are invariably defined as a function of:

- Operator line
- Operand line
- Results line
- Start column
- Finish column or results column

Once a calculation rules file has been created, the rules may be listed on the printer for verification or editing. The user is offered the rules sub-menu, enters the option and the line or column criteria and is then returned to the rules sub-menu for the next rule input.

The rule options are:

Data Generation
1. Extend columns
2. Fill a column
3. Interpolate a line
4. Compute growth rate
5. Grow a line
6. Zero a line
7. Copy/shift a line

Line Arithmetic
8. Add group lines
9. Add two lines
10. Subtract
11. Multiply
12. Divide
13. Percent
14. Accumulate

Column Arithmetic
15. Add group columns
16. Add two columns
17. Subtract
18. Multiply
19. Divide
20. Percent

Special rules 21.

Most of the calculation rules are self-explanatory, i.e., add, subtract, multiply and divide, between columns of lines and will not be examined in any depth. The key attribute of most of those operations is that the results may be placed in any line or column position in the model.

Complex calculations

That means substitution can occur and complex calculations performed within a small model. The warning to users who expect to use the feature is that it makes debugging an exceedingly difficult task. Some of the less usual functions in more detail are:

1. Extend/fill lines: This will duplicate a value from a column position to all following blank column positions. If a new value is encountered further up the line, this value will be extended from that point on, etc., i.e., line 1 = 23 -- -- 45 -- -- becomes 23 23 23 45 45 45.

4. Compute a growth rate: Rule four will calculate a single-figure growth percentage for a given line and place it in column one of a nominated results line.

5. Grow a line: This will compute compound growth on a selected line using another line containing a percentage in each column position.

7. Copy/shift right: Will copy a line to another line position and optionally shift the values x positions to the right. Useful for carried-forward calculations.

13. Percent/line of a value: Rule 13 calculates the percentage value of each value in a line in relation to a single value in another line.

20. Percent/column of a value: As for rule 13 but performs the function on a column of data.

Finally rule 21 is shown as special rules. Desktop Plan gives the user the option of specifying his own calculation subroutines written in Basic. Space has been left in the calculation program for a series of subroutines and the manual describes the array name in which the data table is held.

Documentation on that point is not detailed and such an exercise should only be attempted by a qualified dealer or a very experienced programmer.

Once the rules have been entered, they are saved in a file of the user's choice. Full files may be altered subsequently via the calculation rules sub-menu which offers;

1. Enter rules
2. Insert additional rule
3. Delete an existing rule
4. Display and or change a rule
5. Print the rules
6. Save the rules file

Option five is highly useful as we found it very difficult to debug the rules file on a display and change basis only. Figure 3 shows a listing of the rules as entered for our three-year plan.

Figure 3.

CALCULATION RULES NAMED TESTRUN.R — 8 AUGUST 1980

NUMBER	DESCRIPTION	LINE 1	LINE 2	LINE 3	COL 1	2	3
1	3-INTERPOLATE LINES	2	2	0	1	3	0
2	11-MULTIPLY TWO LINES TOGETHER	2	3	5	1	3	0
3	5-GROW A LINE	10	30	0	1	3	0
4	1-EXTEND & FILL LINES	11	11	0	1	3	0
5	5-GROW A LINE	12	30	0	1	3	0
6	8-ADD A GROUP OF LINES	9	13	15	1	3	0
7	10-SUBTRACT A LINE FROM ANOTHER	15	5	17	1	3	0
8	11-MULTIPLY TWO LINES TOGETHER	17	29	18	1	3	0
9	12-DIVIDE ONE LINE BY ANOTHER	18	5	18	1	3	0
10	11-MULTIPLY TWO LINES TOGETHER	17	28	21	1	3	0
11	12-DIVIDE ONE LINE BY ANOTHER	21	29	21	1	3	0
12	10-SUBTRACT A LINE FROM ANOTHER	21	17	24	1	3	0
13	15-ADD GROUP COLS/CROSSFOOT	2	24	0	1	3	4
14	12-DIVIDE ONE LINE BY ANOTHER	3	27	3	4	4	0
15	12-DIVIDE ONE LINE BY ANOTHER	18	27	18	4	4	0

The three lines and columns contain the appropriate reference for each operation and the manual must be consulted for an exact definition, but it generally follows the format quoted.

Having created the three files, TESTRUN.D, TESTRUN.I, and TESTRUN.R, the system is now ready to execute the set and produce the required results. The execute facility on the main menu allows the user to enter a single file, prefix, name or different file names for the three inputs report, data and rules file names.

Each file is read in turn and the screen displays the current rule being executed as processing occurs. If an error is found, the system stops and debugging begins. If a clean run is achieved, the user is given the options of displaying the results on the screen — line by line, printing a report and saving the results file.

We proceeded to produce the final report shown in figure 4 having examined the key lines first with the display results option. Execution by Desktop Plan is quick and a quoted speed of 30 seconds is given for a model containing 168 additions, 18 subtractions, 48 multiplications, 18 divisions and 85 data moves.

The speed of execution is offset by the extensive disc file I/O which occurs. The program files are all separate in the disc and as each function is selected from the main menu, the program module is loaded followed by each nominated report, data or rules file.

The time lag becomes noticeable but the authors have been thoughtful enough to flash a series of messages informing the user of the current activity such as loading program or loading file type.

Having produced a report, the user is given the option of producing a second copy or re-defining the same report in terms of the number of lines or columns.

Consolidate facility

Once a model has been developed, a variety of data files may be input and run against the model. The stored data files constituting results may then be consolidated by selecting the sixth option on the main menu.

The consolidate facility may be used in one of two ways — macro consolidation of files that have the same line numbers and definitions and sizes and transfer specific lines from one data file to a consolidation work area.

Consolidated results may in turn be saved as a data file and called for further running against other models or report definitions. That facility is very useful, particularly in view of the limits of the model sizes but can be somewhat unwieldy to use.

It is suggested in the documentation that the user take advantage of Apple DOS execution files for running standard consolidations in a production running system — a recommendation we emphatically endorse.

PRACTICAL COMPUTING DTP REVIEW — 8 AUGUST 1980
ABC CO LTD - THREE YEAR PLAN — PAGE 1

STAGE 3 - CALCULATIONS AND REPORT	BUDGET £ YEAR 1	BUDGET £ YEAR 2	BUDGET £ YEAR 3	BUDGET £ TOTAL
SALES (UNITS)	10000	27500	450[illegible]	82500
SALES PRICE (PER UNIT)	13.54	15.25	18.[illegible]	15.8[illegible]
REVENUE	135400	419375	841500	1396275
COST OF SALES				
MATERIALS	47932	52000	65000	164932
PROCESSING	17000	19720	2346[illegible]	60187
MARKETING	7500	7500	75[illegible]	22500
STAFF	24580	28513	33[illegible]3[illegible]	87023
OFFICES & BUILDINGS	12400	14000	17500	43900
TOTAL COSTS	109412	121733	147397	378542
GROSS MARGIN	25988	297642	694[illegible]0[illegible]	1017733
GROSS MARGIN % OF REVENUE	19	71	82	58
TAX DUE (52%)	13514	154774	360[illegible]	529221
NET INCOME AFTER TAX	12474	142868	33316[illegible]	488512

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Figure 4.

Function seven of the master menu is a utility for file transfer between drives. It is needed given that Desktop Plan is provided as a suite of programs which are called from the various programs and, therefore, must always be resident on one of the disc drives.

There is not a great deal of space left on the master diskette for the files created by Desktop and thus both drives will be more than likely used in the course of normal running.

Function eight is a facility for altering the following parameters that are stored in a file within the master disc. They are:

Printer Interface type
- — high-speed serial interface
- — communications interface, auto lf
- — communications interface, no auto lf
- — parallel interface

File source drive
- — indicates to Desktop Plan where the files will be stored and saved.

Set date function — this sets the system date which is printed-out on the top of each report automatically.

Printer width — this sets the page width and is used by DTP to determine whether a requested number of columns can be on a report. If at the report stage the user selects more columns than the width can support then a message is flashed and the entry is disallowed.

Page Length — this parameter is used by the package at the report stage to page skip automatically and re-print headings.

Overall, the system appears to be highly applicable in the business planning requirements of smaller companies. As a software program, it is well written and user-friendly with plenty of error-handling routines. The first-time user is safeguarded on this front.

The package has its limitations with regard to disc space and model sizes. The standard of the documentation with respect to the rest of the package is disappointing. The packaging is neat and of high quality. The text and structure of the manual is of poor quality.

We had a great deal of difficulty grasping the concepts of the package in the first instance and applying the information provided.

The 144-page manual is too padded-out with sales talk and copyright pleas. The relevant information is unfortunately fragmented around the pages and hard to find. Personal Software will do well to revise the format, soon.

Once we obtained a feel for the system, we found Desktop Plan easy to use for setting-up the simple model used in the article. Setting-up was easy; debugging was not.

Although facilities exist to help the user in debugging models, some improvement could be made, say, a trace facility with display of calculated lines at execution time.

Conclusions

- **Desktop Plan is useful provided its limitations in terms of model size and columns per page can be accepted.**
- **The user-written calculation facility is good planning on the part of the authors and prospective buyers should discuss what help may be available from their local dealer.**
- **The standard of programming is high in terms of user-friendliness and disc I/O error handling.**
- **Execution of calculations is fast, but there is a large measure of time-consuming disc I/O.**
- **The automatic formatting of reports and page skipping is impressive and will save users significant time in development.**
- **Data-independence is a feature which appealed to the reviewer and means that multi-division companies can process individual results.**
- **Limiting factors for the application of Desktop Plan will be model size and the disc storage capacity, or vice versa depending upon the application area and design.**
- **The documentation is poor and illogical.**
- **Desktop Plan costs £95 but there is an impending price increase.**

Word-processing versatility with intelligent System B

by Chris Bidmead and Andrew Stephenson

THE Vector Graphic MZ System B hardware is supplied as a solidly-constructed cream-and-black box with a simple front panel consisting of an illuminated re-set button, a key-operated power-up switch, and a pair of vertically-mounted 5.25in. Micropolis quad-density disc drives.

A 4ft. cable — signals and power — runs from the computer to a mindless terminal which combines a white, rock-steady VDU with a customised pseudo-Selectric keyboard and numeric pad.

Robust main unit

Thick contoured fibreglass encases the metal chassis of the terminal, styled to match the robust, somewhat utilitarian appearance of the main unit.

A 2K ROM holds a monitor which, though far from perfect in its revision 4.0 form, certainly is a great help, though usually it need be applied only to such routine matters as memory tests and booting-up the DOS. The same ROM also holds a good VDU driver, used extensively by Vector Graphic software.

The mysteries of hardware and software are discussed in three comprehensive manuals: Hardware; Vector Graphic systems using MDOS; and Operating system utilities software/CP/M on Vector Graphic systems.

The engineering standard is solid. The units run cool and are strong enough to withstand the kind of treatment generally meted out to, say, expensive typewriters.

Options include various Qume and non-daisywheel printers; compiler for MBasic-80 and Word Management System.

As far as the ergonomics of the system is concerned, our feelings are mixed. The side and rear clearance in a typical lay-out are needed for ventilation which is provided by an acceptably-quiet fan. Thick documents can be laid on top of the computer without causing noticeable temperature rise — good for those who like to fit and forget and treat their machine as a table.

Access for maintenance is easy — the top lifts off after four side screws have been removed. That is also true of the terminal which gives the impression of having a tidy and uncluttered interior — an effect spoiled slightly by the rear connector cut-outs which, if equipped with more than the OEM minimum of cables, would become congested and effectively prevent the use of the rear-most two motherboard sockets. There are 18 sockets — an unusually large number for a modern machine — so that is hardly a problem.

The terminal struck us as a sad example of a lost opportunity. The Keytronic series of keyboards includes several which resemble the IBM U.S. 101 Selectric lay-out and which offer a choice of arrangements and codings of side keys.

The model L1660, a unit with 16 extra keys on the right and four, including Control, on the left, generates seven ASCII control codes and 46 non-ASCII codes, besides the control codes available in the normal way.

Vector Graphic, however, has discarded that flexibility by fitting a unit, identical but for a caps-lock key, whose side keys are coded principally as ASCII numbers, with a muddle of other codes which have to be interpreted by the system monitor.

Screen angle

It seems a pointless downgrading of a terminal which otherwise could have been instantly applicable to specialised systems with labelled side keys.

Another shortcoming is the angle of the screen. As mounted, it seems designed for a user who has set the keyboard almost at chest height. Furthermore, it is white, P4 phosphor or similar, and highly reflective — an awkward combination. Matters are not helped by the contrast control being situated at the rear of the case.

It seems a pity that a lack of tar should be allowed to spoil the ship — even as it stands, the terminal is very usable, the steadiness of the display, in particular, was appreciated.

The handbooks are, in the main, helpful. CP/M documentation is little more than re-prints of the standard Digital Research fare. In the sections contributed by Vector Graphic, clarity improved considerably. The general level assumes some familiarity with the system, which may delay the user at first but should please him later, once he has passed the beginner stage.

The result of all that is that experienced operators, or engineers, will find the system very easy to use. It is possible to switch on, press the correct button, and be inside a program, within seconds — virtually turn-key operation.

The system software is a mixture — a combination of products from independent sources. The historical background of the Vector Graphic range is also a factor in the software's mixed character.

Unfortunately, knowing that does nothing to help the user, who must master at least several sets of commands and procedures if he is to make the most of CP/M and MDOS, both of which are supplied, and both of which must be learned for the sake of the programs which run under them.

For example, the directory command in MDOS is "FILES", in CP/M it is "DIR", in Vector Graphic DOS, MZOS — not advertised but present as part of Word management — needs "FI", while Word management itself views the directory with the somewhat unfortunate abbreviation, "VD".

Subsidiary programs, too, demand their own learning periods; Basic-80 uses different commands to achieve the same results as CP/M, its DOS.

MDOS documentation

MDOS is splendidly documented, and seems capable of coping with just about every aspect of disc-file manipulation. Its weakness is that, like North Star DOS and others, it resides at the bottom of RAM, and so requires all user programs to start above it.

Thus, any expansion of the DOS will encroach on the program space, unless headroom is left, which is neither a guarantee of safety, nor particularly economical in RAM.

By contrast, CP/M resides at the top of RAM and so allows all user programs to start at a fixed low address, 100 Hex. CP/M or programs running under it may expand into the intervening space, which may be enlarged, if necessary, by adding RAM and causing CP/M to re-locate itself upwards — no changes need then be made to user programs.

There exists a problem more general than one of simple inconsistency. It amounts to the feeling that System B may not be a complete system, that it still needs a rationalisation exercise to smooth away its rough edges and fit it to the turn-key users at whom it appears to be aimed.

One curiosity which exemplifies this is that virtually all the software documentation uses extended-8080 mnemonics, rather than those designed officially for the Z-80 by Zilog and Mostek.

Again, it can be blamed on history and, perhaps, on the fact that CP/M is 8080-orientated. Maybe Digital Research should issue its own CP/M Zilog/Mostek Z-80 assembler, to give history a helping hand.

If we seem too funereal, it is worth re-emphasising that System B is a very useful collection of hard and software as it stands. Anyone who settled on CP/M alone could manage splendidly. There are clear signs that Vector Graphic is working on transferring all its software to CP/M, although some major items still depend on the comparatively primitive MDOS, or even — such as Word management and Mail merge — on MZOS.

Hardware
Z-80A, i.e., 4MHz, CPU
64K dynamic RAM, normally reduced to 56K
Two Micropolis 5.25in. drives, 630K totals, mounted vertically
Flashwriter II memory-mapped VDU, 80 characters x 24 lines
12K PROM board with burner for 2708/2704
Three serial I/O, two parallel I/O ports, cable for only one S-10, others extra

As evidence of the considerable development effort Vector Graphics appears to have invested, consider the extra CP/M programs supplied:

Back-up makes copies of whole discs on to unformatted discs, removing any need to initialise them first.

Raid — RApid Interactive Debugger — is an amazing re-locatable 6K simulator of Z-80 programs — extended 8080 mnemonics. It shows, in screen sub-divisions, such information as the segment of program being simulated with disassembled code, register contents, flags and stack contents.

Separate segments of display are reserved for program output, memory dumps in ASCII or Hex, halt information, and details of which program area is to have its simulation displayed.

Scope — SCreen Orientated Program Editor — is intended to replace the CP/M ED program. It is a versatile on-screen line editor of CP/M ASCII files representing documents up to 250 columns width, which are viewed through a window formed by the screen. Four modes — command, change, insert and control — are used.

File-handling methods resemble those of ED but the facilities are considerably improved. However, the user is still limited to forward passage of text through the working buffer. A paginated print function — selective or global — is included. Total memory usage, combined with CP/M2 itself, is about 15K, the remainder is available for the text buffer.

ZSM is a disc-to-disc assembler of extended-8080 mnemonics which seems equal to most routine jobs. It also handles the CP/M USERCUST BIOS re-configuration function. Labels may be up to 47 characters, and of any number. Assembly-time arithmetic is strictly left-to-right — no rules of precedence, or brackets. Conditional assembly is supported, as is assembly-time I/O of label values, a potentially useful feature.

CONFIG is a treat to use. It rapidly configures a CP/M disc to select the various automatic load-and-run options of CP/M2, for virtual turn-key operation, as well as assisting in setting-up printer software.

One important consideration for the end-user is the flexibility of the system. Here, again, we have to report mixed feelings.

CONFIG is certainly of great help — a disc can be configured with its aid to boot-up into a desired program, under the control of a non-technical user, e.g., a secretary, which frees the specialists for more productive work.

On the ergonomic debit side, the key-board-dedicated side-keys mean that, in text processors at least, commands will always have to be entered either as printable characters in a command code, or as control keys commands. That reduces efficiency and slows the learning process and these days, time is money in most places where this system is likely to be installed.

Character set

Software could have converted the keys to a numeric pad, if desired; it is always easier to throw away information than it is to obtain it.

One very pleasant feature which offers great scope for specials is the adaptability of the VDU character set. On the Flashwriter II, every character is defined by two PROMs which may be re-programmed as any dot pattern eight across by 10 high. The ability to invert video levels and/or, by hardware modification, reduce intensity or, with suitable PROMs, handle up to 256 characters, makes it very versatile. The flicker-free, screen-loading electronics permit highly-mobile displays.

Character re-programming could well be done with the aid of the PROM board, on which one socket of the eight can function as a programmer of 2708 or 2704 PROMs. The capacity of the board is normally kept to 8K or less, but can accommodate up to 12K of 2708 or 2704, plus 1K of RAM, thereby allowing the user to install his own resident utilities. We felt the choice of PROMs betrays the age of the board, but the 2708 is by no means obsolete.

The standard I/O configuration is a single cable from one of the serial RS-232 ports, intended to drive a printer and, therefore, connected as a data source. Extra cables may be purchased for plugging into the other serial or parallel ports.

The total selection is three serial 110-9600-baud RS232, with various bit-count and parity options, based on the Intel 8251, one having a 20mA loop option;

(continued on next page)

(continued from previous page)
and two eight-bit TTL parallel ports. The serial receives can generate independent vectored interrupts by polling, although use of the facility disables one of the parallel output ports. More I/O boards can be installed easily.

Of interest to multi-user purchasers is the fact that the System B can be fitted with more than one VDU board and terminal — up to five sets — and appropriate software which can presumably be combined with the CP/M2 multiple-user file handling, although individual user RAM is then limited to 48K.

Re-jumpering makes memory allocation flexible, but essentially the lower and largest area is given to RAM, while the top of the memory space is occupied by VDU, 2K, monitor, 2K, and sundries such as the disc controller.

In practice, 56K of RAM is usually available to the user, though bank-switching allows eight banks of up to 56K each. The manuals describe in some detail how to adjust addresses and other optional function settings, though we guess that some heavy homework would be involved in software-patching the operating system to make the most of the formidable potential of 448K.

Technical information

The technical information provided to system developers is exhaustive, even extending to cover the proper procedures for writing DOS, if desired. Description of the mechanics of the drives is sketchy.

The Micropolis disc drives run continuously once discs have been mounted, so we were not surprised to find that the handbook rates the life of a disc at possibly as little as 2,000 hours — an estimate that takes no account of wear due to head contact.

Comparatively cheap though discs are, there must be an insidious cost implied in the extra work of monitoring their life and the risk of a fault developing unnoticed during idling time.

Micropolis claims that the discs are not damaged by continuous running but Vector Graphic suggests that the drives be switched off-line when unused for any length of time. However, if you are making a regular habit of unlatching discs during sessions, from time to time you will inevitably try to write to a drive that is not up.

That is especially easy to do as the disc-unit exterior design makes it difficult to see if discs are on or off. Our solution was to put coloured stickers on the door latches, so that when the outer, green-labelled latch slides to one side, it reveals the red patch underneath, indicating even at a distance that the drive is engaged. If you try to write to a drive which is not up, the drive button lights, the empty hub spins for a while, and CP/M returns the somewhat misleading news that it has encountered a "BAD SECTOR".

The error causes CP/M to unlog the loaded disc, so that subsequent attempts to save the program in core memory are frustrated by the CP/M otherwise helpful habit of marking temporarily an unlogged disc as read only. It is relatively easy to re-log with a warm boot — Control C — but if you were in Basic, you will find you are back at DOS level.

That need not be fatal if you happen to know that CP/M keeps its current COM file at start address 0100. It is a simple matter to jump back into Basic and restore the current program. Those who do not know that — and mention of it is made in the CP/M manual — could finish by losing a program or two.

The file handling employed by the Word management system (WMS) does not create this problem. Even with the drive off, it still knows the name of a document being revised. It will tell you if a drive is off-line, and the UD command will create an update under that name once you have powered-up the drive.

Once booted-up with the Word management system, a process that takes less than a minute, the System B appears to the user as a relatively simple and comprehensive word processor, differing from the dedicated system in that all the control processes — except cursor movement — have to be accessed through two keys — control and a letter.

Summary specifications

CPU — 6502.
Memory — 32Kbytes RAM, Basic operating system in ROM.
Keyboard — 73 keys with cursor control keys and separate numeric keypad.
Screen — 12in. diagonal, green phosphor, displaying 24 lines of 80 columns.
Character set — upper- and lower-case alphanumerics, but not with normal ASCII values, plus about 100 graphics characters.
Discs — Recording on mini 5¼in. floppy discs in two drives to 170Kbytes per drive (2040) DOS 2.1 and with own intelligence.

Though this does not represent any long-term problem to the user who is prepared to familiarise himself with the lay-out, the complication of having to know the control code keys might add to the technophobia of, say, the temporary secretary. No help prompts are available, and the well-laid-out Vector Graphic manual needs to be kept at hand.

The design philosophy differs from some rival system in that WMS retains a complete copy of the working document in RAM. One immediate advantage is that global searching becomes very fast — a valuable asset if only because it quickly becomes the technique for finding one's way round long texts. A price is paid in the theoretical vulnerability of the work in progress to mains-born problems. Theoretical, because during extensive use, no trouble of that kind was experienced.

The simple and fast updating instruction, UD, is always available to put revisions safely back on to disc, and its regular use is recommended.

Whether being able to choose one's own breaks like this was preferable to disc-based systems like WordStar, where the writer is interrupted in mid-flow by automatic disc updates is open to question. Because the whole document is written back to disc each time, disc-waits become relatively lengthy as file capacity — about 24 A4 pages — is reached. When timed, it is extraordinary how long a mere 15 seconds can seem in comparison with the speed of the system as a whole.

Running back-up copies on to a disc on the other drive is almost as easy as a simple update, although the disc copied to must not already contain the named file. That introduces a slight complication in the event of making a second back-up copy, but it remains the simplest disc-copying procedure we know.

The directory presents files as a row of five columns, and access is by using the cursor keys to move an inverse video block. Single letter commands are typed once the block is located correctly over the file name, and appear beside it as a visual check before you hit return. Thus the title of a file need be typed only once, when the file is created.

That protocol allows reading (R), saving (S), protecting (P), unprotecting (U) and appending (A) of the addressed file. In practice, the approach makes for fast and easy working as long as the number of files on each disc is limited to about 20. With more than that, unnecessary time is wasted looking for the position of the file name in the catalogue and positioning the cursor.

There is another good reason for minimising the number of files on each disc; space allocation is not dynamic under the MZDOSE operating system, and the creation of a large number of small files tends to use a good deal of tracks, even if those files are deleted subsequently. There is a compacting procedure to redress this, but the process takes as much as six minutes.

Scrolling mode

Documents created on screen can be read either by paging or scrolling, and both modes permit movement in either direction with the space bar used as a start/stop toggle. Scrolling produces the usual somewhat giddying effect, particularly as its speed is uncontrollable.

Paging is more restful to the eye, and would be ideal but for the fact that the page mode announces itself via a small flashing square in the bottom-right-hand corner which obscures two letters of the text.

The scrolling flag appears in a similar position, but in that mode, it is, of course, possible to move up the page slowly to read what lies underneath. That is a niggling point which is easily forgiven.

The Global Search facility the WMS system offers is certainly very useful, but lacks two important options: upper- or lower-case must be defined in the search

string — there is no facility for ignoring case; and if a replace string is defined, there is no pause each time the required phase occurs to choose whether to make the switch or not.

One can choose the number of times the switch is made, starting from the cursor position, but that seldom is the requirement in real life.

Usually, the cursor rests at the beginning of the searched string, not at the end as in some systems. The search facility also permits wild-card characters represented by the hash sign.

That is useful for checking suspected spelling errors, but also in the absence of an ignore-case option, it should be valuable for testing for words at the beginning of sentences.

There seems to be one small bug in this facility on the System B — searching for a string beginning with a hash sign does not end when the search reaches the end of text; the program then begins to loop as the whole of system memory is searched for a string beginning with any character.

Word-wrap facility

The loop may halt eventually, but we did not have the patience to wait more than five minutes and had to resort to the re-set button. It was not a major disaster, as the Version 4MZ monitor makes recovery from the re-set condition very simple.

In common with other word-processing systems, there is no need to carriage-return at the end of the screen — the last word is carried to the beginning of the next line automatically. It is a pity that this facility cannot be switched off, because we noticed that under some conditions the word-wrap becomes somewhat confusing, if not actually confused.

Two alternative cursors are available, one for normal typing — the overwrite cursor — and another for editing — the insert cursor. The problem occurs when text insertion with the very useful insert cursor chases material ahead of itself into the word-wrap area.

Sometimes characters which should be behind the cursor on the new line appear to vanish from the screen, only to reappear mysteriously in front of the cursor when the backspace key is used.

Inability to switch off the word-wrap facility also means that lines ruled across the screen collapse when they get into the word-wrap area, because the system takes them to be very long words.

A completely comprehensive word-processing system should be able to cope with hyphenation at the end of lines, but the designers of the Word management system have chosen to avoid the problem.

With word-wrap operating, the user will ignore line-end hyphenation — advisable unless he is prepared to risk tangling the printer formatting — but on print-out he will have to learn to live with rather more ragged right-hand edges than usual, or, if he chooses to justify text, some strange spacing if his lines lengths are short. Perhaps for this reason, the print format rules do not permit the printing of lines shorter than 25 characters.

Cursor movement is by character only and not by word, so that in comparison with the speed of the rest of the system, positioning the cursor sometimes seems subjectively rather slow, taking as much as 10 seconds to travel across the screen.

Control commands are used for toggling the cursor from insert to direct mode, for deleting whole lines or part lines, and for opening up blank lines for insertion. Dedicated keys control the cursor movement in four directions, and in the absence of a cursor-home key, the Control B command does double duty, returning the cursor to the top-left corner at the first issue of the command, and to the top of the whole text when the command is repeated. Control E works in the same way to take the cursor to the end of screen and end of text.

One very useful and unusual command enables deletion from the current cursor positioning up to and including any defined following character.

Thus Control R followed by a space deletes to the next space, i.e., deletes the following word, followed by a comma deletes the following phrase, by a full stop erases the rest of the line, and by a carriage return erases to the end of the paragraph.

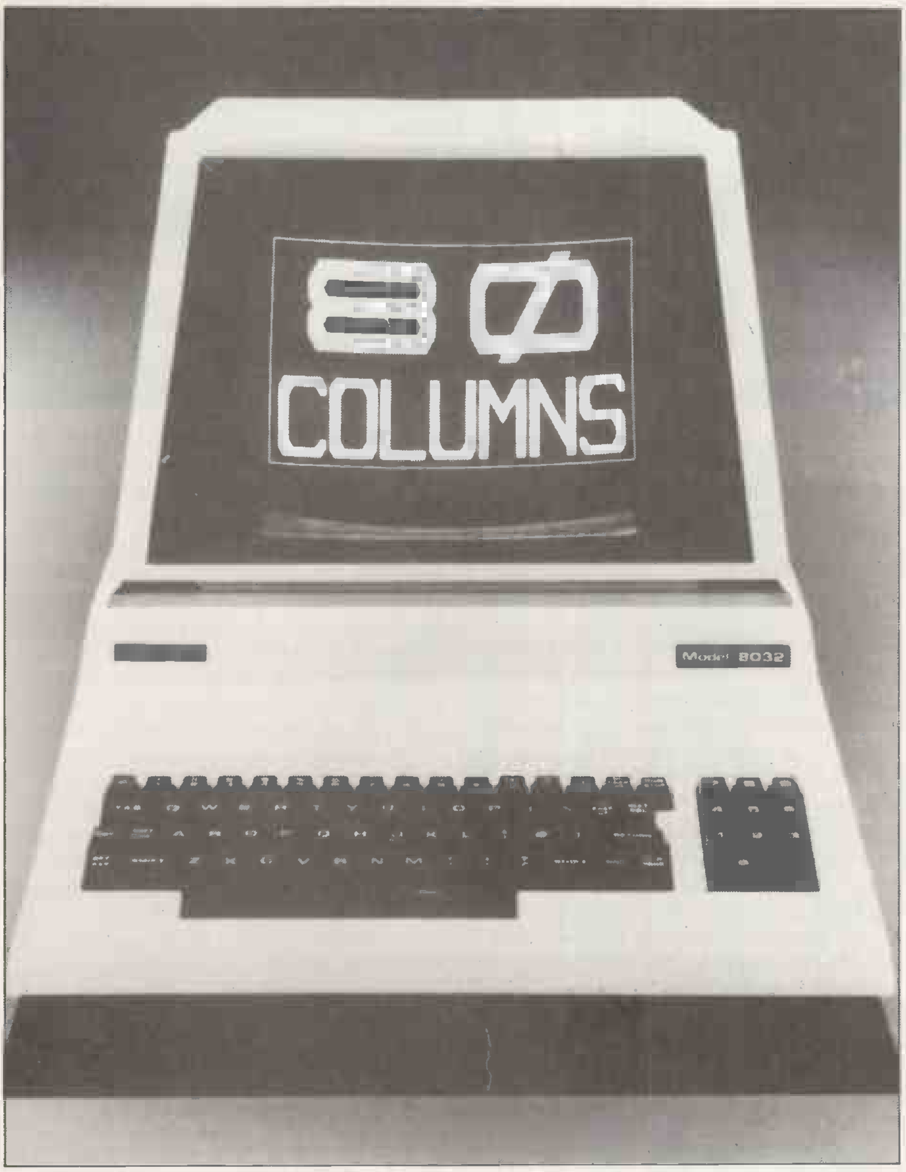
In comparison with other systems, the marking arrangements for the duplication or removal of blocks of text seemed rather elementary. No highlighting defines the block once marked, and the prompt "BLOCK MARKER ERROR" appears if there are more or less than two markers in play when block moving or copying is attempted.

It might be better design to make the introduction of the third marker remove the first one, so that there were never more than two. A recent addition to the software allows for the removal of those markers without having to go in search of them — but idiotically the process takes one back to the top of the text each time, so a search is still necessary for your original place in the text.

One limitation which we regarded as a major disadvantage, particularly in the printing of long documents, was the inability of the system to determine before printing where the page breaks are to occur. The problem is frankly summed up by Vector Graphic in the WMS Manual.

Conclusions

- **Vector Graphic System B is a versatile and comprehensive word-processing system, well-suited to the generation of short documents.**
- **Sensible safeguards against accidental erasure of files have been built in, and the creation of back-up copies is easy.**
- **At about £300, the software alone — with the special character PROM — seems somewhat expensive.**
- **Sold as a combined software-hardware package, the system is highly competitive with dedicated word processors, and has the added advantage of offering the facilities of a microcomputer.**
- **Judged as a whole, System B seems good value for money at around £3,000.**
- **The phased evolution from 8080 to Z-80 philosophy is making the system software and documentation look somewhat jumbled.**
- **Yet that does indicate that the manufacturer is sensibly pacing itself, and seems to be taking the trouble to carry old customers forward with it.**
- **The Vector Graphic marketing support in the U.K. seems solid, with the possibility of further consolidation.**
- **Warranty is generous enough, 90 days from Vector Graphic; Almarc Data Systems, the sole U.K. distributor of Vector Graphic equipment and which supplied the review system, has recently introduced one-year cover.**



SuperPet

THE Commodore Business Machines Pet computer is claimed to be the best-selling microcomputer in the U.K. The Pet was designed originally as a general-purpose small computer aimed particularly at the personal and hobbyist markets.

The personal computer market has evolved gradually so that, in the U.K. at least, most of the micros sold are purported to be for small business usage. That trend obviously changed the marketing directions of Commodore.

The trend to business usage has prompted the popular microcomputer manufacturers to announce business computers. Examples of that are the Apple III, the Tandy TRS-80 Mark II and, the subject of this review, the Commodore Business Computer 8032, nicknamed the SuperPet.

All those machines appear to be more business-like in having full-sized 12in. diagonal VDU screens capable of displaying 80 characters by 24 lines — a feature useful for word processing available on the majority of ordinary VDUs.

Is the CBM 8032 a business computer or is it merely the original Pet with a full-sized screen and a few modifications to appear more business-like?

by Vincent Tseng

The new CBM 8032 SuperPet looks like the large keyboard version of the Pet with a larger screen. That is an all-in-one terminal computer, consisting of a 12in. diagonal screen, with a 73-key keyboard in the QWERTY lay-out including a separate numeric keypad housed in a egg-shell-coloured casing of pressed sheet metal. On the back, there is an on/off switch and three cut-outs in the casing which expose three edge connectors.

As a ready-built system, to set-up, one attaches a mains plug, connects it to a mains outlet and switches on. The 8032 then emits a chirp from the built-in bleeper, and as it warms-up, the screen announces the Commodore Basic version.

The character lines of the display were not horizontal and inclined upwards to the left. As the inclined display did not prevent me from using the machine, it seemed a minor fault. Other than that, the display was of good definition and stability in green phosphor.

The machine, when booted-up, is in Basic.

commodore basic 4.0 31743 bytes free

is announced in lower-case alphabetics. Typing on the keyboard produces lower-case alphabetics which the Basic recognises. Surprisingly, the Basic will not recognise upper-case characters inputted using either the shift or the lockable shift-lock keys.

Upper-case letters

The response of syntax error is given if upper-case letters are tried, which can be a little disconcerting if one is used to Basics which recognise only upper-case — the more common situation. However, that is a small point as a POKE command can be used so that the screen will display in upper-case acceptable to Basic.

Although the keyboard is reasonable to use and one can type relatively quickly on it, one minor point I found annoying was that it was noisy. Not the keyboard by itself, but in combination with the metal casing, it tended to produce a clanking sound with every keystroke.

That may be a consideration if the keyboard is to be used extensively e.g., in word processing, one would have to ensure that the user or typist will be happy with the feel and sound of the keyboard.

Among the keys available are some special-function keys. The more significant ones are cursor-control keys, down/up on one key, with up in the shifted position, right/left — "left" is shifted — and cursor-home sharing the same key as clear-screen.

There is a key to put the screen into reverse video and the shifted position turns it off. There is the usual delete key, but in the shifted position, this key allows insertion. A key marked stop acts as a break key, which in the shifted position is Run which loads the first program from drive 0 of the floppy discs, if installed, and executes it.

Due to the established customer base in Pets, it was not surprising to find that the version of Basic was very similar to the Basic on the older version Pet. Timings from the familiar benchmarks show that they were effectively the same as for the older Pet — well within margins of error. However, there were additional commands for disc operation DSAVE, DLOAD, DIRECTORY. The SAVE, LOAD commands from Basic version 2.0, i.e., from the Pet, are upward-compatible with the 8000 series.

However, there was one feature I liked, not really part of Basic, but associated more with the operating system — the screen editing facility. Like the Nas-Sys supplied with the Nascom, it is possible to edit anything on the screen using the cursor control keys mentioned. The edited command or statement became effective after entering it by using the return key at the end of the edited line.

That is very useful for correcting Basic programs without having to re-enter complete lines, and also for repeating commands. The cursor control keys were, unfortunately, a little awkward — the shifted position must be used for certain directions. The facility could have been made so much better by the addition of two extra keys and a better key lay-out for the cursor keys.

DOS 2.1 is an improvement on the original DOS for the Pet, but not a enormous one. It is still slightly primitive, for example, in requiring the opening and closing of files. They were awkward, requiring the user to remember three code numbers. Program files have to be loaded separately and the command run entered before they can be executed. In many other DOSs under Basic, one can call the program by run "filename" and it is loaded and executed in one command.

Intelligent disc drive

The plus point is that the disc drive is intelligent containing its own 6502 processor. In theory, the 2040 is capable of processing while the 8032 is running.

A demonstration test disc was enclosed with the drive. Running the diagnostic program from the disc called Diagnostic Boot, revealed that there might be a fault. The test suggested that the ROM 6332 at position K1 or the 74LS42 at position B3 could be suspect. This was further borne out by a DOS error on the documentation program called Pet Disc where after a good deal of the program had run the message: Disc Error

CBM DOS v2 73 18 4

was displayed. The number codes were perhaps an error message, but I could not find that error code in the manual and using the command PRINT DS$ to obtain the error message gave a message which told me it was correct — not very helpful.

Also, on loading the DOS Support program, the direct disc commands did not work, which was a disappointment as they looked useful. The response from the system on using the direct commands was syntax error, which could have been due to incompatibilities or differences between the 8032 and the Pet 2000 series, rather than the disc fault mentioned.

The manual on the disc drive gave the Poke command to obtain upper-case alphabetics on the display which were accepted by the Basic. It was:

POKE 59468, 12

However, some commands required certain characters to be shifted, and the shifted character may be under those conditions, to be one of the graphics characters. The disc drives recorded in 5¼in. mini-floppy discs on double-density, soft-sectored format giving approximately 170Kbytes per drive storage. That is adequate only for small business applications. For more flexibility and better capacity for handling data, one needs .5Mbyte to 1Mbyte storage as minimum.

Software supplied on disc

CP/M, Version 2.11, plus:
Microsoft Basic 80, versions 4 and 5
BACKUP — system-specific disc copier
RAID — on-screen program simulator, extended-8080 mnemonics in the disassembler portion of the display
SCOPE — on-screen text editor
ZSM — assembler for extended-8080 mnemonics
CONFIG — CP/M re-configurer
Micropolis MDOS, plus:
MBasic
Line editor
Equivalent of ZSM
Equivalent of CONFIG
Games.

Again, mini-floppy discs were designed originally for the hobbyist market; for higher capacity, Commodore has had to turn to double-sided discs and even double-tracking.

Upper and lower-case characters are available, but they were not the usual ASCII values. The lower-case alphabetics, in fact, had ASCII values for the upper-case characters, and the upper-case characters on the 8032 had totally-unrelated values.

That is an important point to bear in mind, especially if inter-machine communications were envisaged. If inter-machine communications are not to another CBM 8000 series, there may well be difficulties.

There is a large set of graphics characters available — around 100. They look the same as those for the Pet, useful, and the ones used on the demonstration software seem reasonably good.

Like the Pet, the CBM 8032 still retains the IEEE-488 standard parallel interface via which most devices are attached in a cascade manner, e.g., the disc was attached on the interface. Although the IEEE-488 is a recognised standard interface, it is not very common in computing, where the RS232C/V-24 serial standard is more usual. It will retain compatibility to the Pet and Pet peripherals.

The other interfaces were a user parallel port, and connections for an external cassette recorder — they were the three connectors exposed from the holes in the casing. Two other connections were available inside and were for memory expansion and one for the internal cassette.

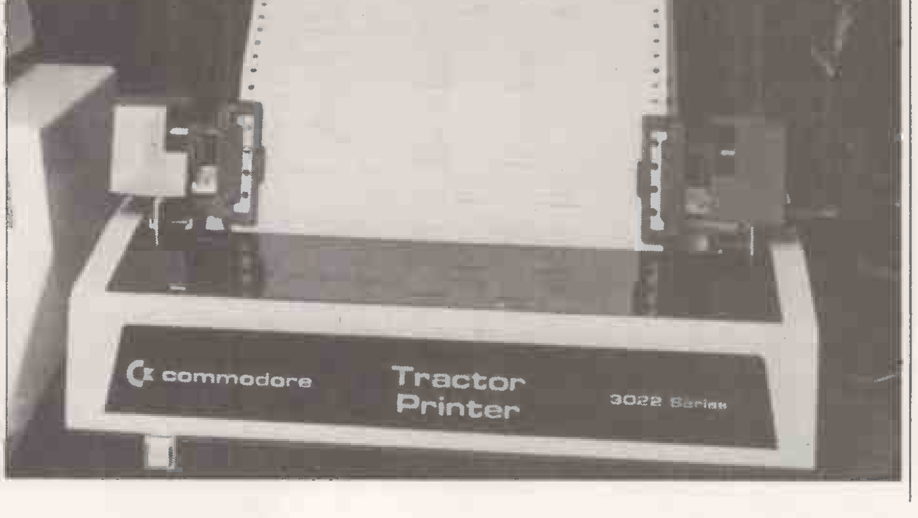
The electronics is contained on a single board. The lay-out is neat with plenty of space between components and the power supply regulator circuitry is also on the same board. Access to the single board is very good, although access to the CRT tube is not as easy and there is no easy way to rotate the scan deflectors to correct for the slanting display.

The CBM 8032 has only a 60-page users' guide which was perhaps an inadequate explanation for a user to realise the full potential of the machine. For example, the graphics characters are not even mentioned. The guide seemed more like a promotional booklet showing the peripherals available for the CBM 8032. No doubt the documentation will improve as it did for the original Pet. The user manual for the disc system was better.

Conclusions

- **The CBM 8032 has many features in common with the older version Pet.**
- **Its main concession to business computing is its larger screen suitable for word processing.**
- **The SuperPet can use most of the peripherals and even software for the Pet.**
- **As far as software is concerned, programs using Peek and Poke statements may not be transferable between the two machines.**

The Commodore Tractor printer.



U.S. Presidential

Election

In a sophisticated recreation of the flavour of the U.S. Presidential election, Alan Bayliss presents a program which leads the players through the in-party intrigue, the manipulation of primary elections and press to the climax of the race for Presidential power on election day.

IN A U.S. Presidential election, two people challenge for the leadership. Each is from a different political party, either of which is capable of winning the election, and both of which are likely to receive similar popular support nationwide.

The electoral system used involves voting in each State, with the candidate who receives most votes winning that state. Each State is worth a certain number of votes in the Electoral College and it is ultimately the number of State votes which each candidate wins which determines the new President rather than their total popular votes.

Media-orientated

A U.S. election is heavily media-orientated and involves great financial expenditure in adverts for, say, TV. Those adverts are designed to convert the floating voters to voting for one or other of the candidates.

Local issues can also play their part in the election — that can be seen where similar States in an area tend to vote the same way, e.g., the southern States.

As the results are announced, those from the East Coast arrive before those on the West Coast, because of the different time zones involved. U.S. TV typically shows the results as graphical displays and attempts to predict the outcome of the election based on the results as they arrive.

The program, written in Basic for a 32K Exidy Sorcerer, attempts to recreate as much of the flavour of the election and the tension, as the results are announced.

The program is designed round two main segments — the one- and two-player games — which call on subroutines to perform the various activities required. This procedure reduces the repetition between these sections and allows for easy expansion of the facilities.

Variables

The following variables are used in the program. ( ) indicates a dimensioned variable.

VARIABLE	DEFINITION	VARABLE	DEFINITION
A$( )	State names	H0	Predicted outcome
B ( )	State votes	H1	Of state votes
C ( )	State popular votes	I	
D ( )	State selection list	J	For/next loop variables
E ( )	State vote totals	K	
F ( )	Player's money remaining	L	Winner's number
G ( )	State point totals	Q	Current state number
H ( )	Current leader	Q1	Random dummy
M ( )	Popular vote totals	Q1$	Information variable
N ( )	State points Winner's number	Q2	Close result Random number
P ( )	State display Winner's number Short game:state	Q3	User routine dummy
S ( )	Expenditure per State vote	R	Random seed
V ( )	Money spend on state	S	Popular votes calculation variable
Z$( )	Players' names	S1	Extra money variable
A A2→9	State shading graphics	S2	Short game calculation variable
A1	User-defined graphics	T	Turn number
B1→4	State shading graphics	U	Number of players in game
D1→4	State drawing variables	X	Random number
H	Time delay variable	X$	Underlining constant

Sections common to both the one- and two-player games form the start of the program. After reading that information and receiving the details of which version is required, the program calls on the Print-Map subroutine and the Print-States subroutine.

The map is constructed from a series of Poke commands which individually push a single graphics character into the video output section of the memory.

State shading

Originally, the shading of the individual States was executed in the same way but it was found to occupy too much of the available memory space, so it was modified so that a series of similar graphic characters are Poked-in using a for/next loop subroutine — lines 9000+. That saved up to 7K of memory at the acceptable cost of printing the State at a slower rate.

Since the names and positions of the States are not widely known, the name and number of State votes are displayed above the map as the State returning its votes is being flashed on and off.

This State is displayed on the screen using the white character set, but those States which have been won by either player utilise that players colour for their display.

The game is based on the premiss that the more money spent in a State, the better the chance of gaining a majority of the popular votes and thus obtaining its State votes, the eventual winner being the one who wins most of those votes.

Naturally, it is not completely the case, as the personality of the candidate and the area of the country in which the State is situated have an important influence.

To simulate that, States adjacent to the current game turn's State exert an influence over it, giving a benefit to whoever won them. The effect that these States have is further complicated by the drawing of two national boundary lines, dividing the country into three areas. Across the boundaries, the States exert much less influence.

This effect was calculated from the following main rules:

- The number of State points from an adjacent State was equal to half that State's state votes — fractions being discounted.
- The larger States — in terms of State votes — could exert an influence further away but the State points would be very much reduced.

Maximum figure

The nett effect of these rules can be seen in figure 3, where the State Points are listed. For any particular State, the points for each player are calculated and the difference is multiplied by 750 to give a nett State effects contribution to the player having the most points.

Although the maximum figure which can ever be added to a players total is a nett of 30,000 — in fact, one player has +15,000, the other -15,000 — in practice, it is usually much less, unless a player has won most of the States in an area.

Glossary

Popular Votes — the number of votes obtained by the candidates in an election.

State effects — the addition to — or subtraction from — the player's money, fixed and random numbers in any State, from the State points multiplied by 750.

State information — the player's display, showing the amount of money that he has left, the State name, State votes, opinion polls and current performance details.

State points — any State is influenced by the results in surrounding States which hold a certain number of State points for it. These points go to whoever has won those States and then the difference in each player's holding of points is calculated. The player with the most State points has this difference multiplied by 750 to give a State effects contribution.

State results — the display showing the actual result, winner's name, totals of State and popular votes and predicted result details.

State votes — each State is allocated a number of State votes based, in part, on the number of Senators each State has. The winner of each State gains the State votes for that State and the new President is the person to obtain 270 — a majority — of the State votes.

To the player's expenditure on a State is added the State effects contribution, a fixed number and a random number. This total is converted into a percentage and from that, the votes each player apparently obtained are calculated and reflect the size of the population in that State.

To prevent one person from obtaining an extremely low number of votes — the worst case is 10 percent — a cut-off at 25 percent is provided. In the event of the result being close — the two totals being within two percent of each other — a Close Result subroutine, lines 4400+, calculates the final result in a more random manner, including a time delay before displaying the result, to heighten the tension.

Money display

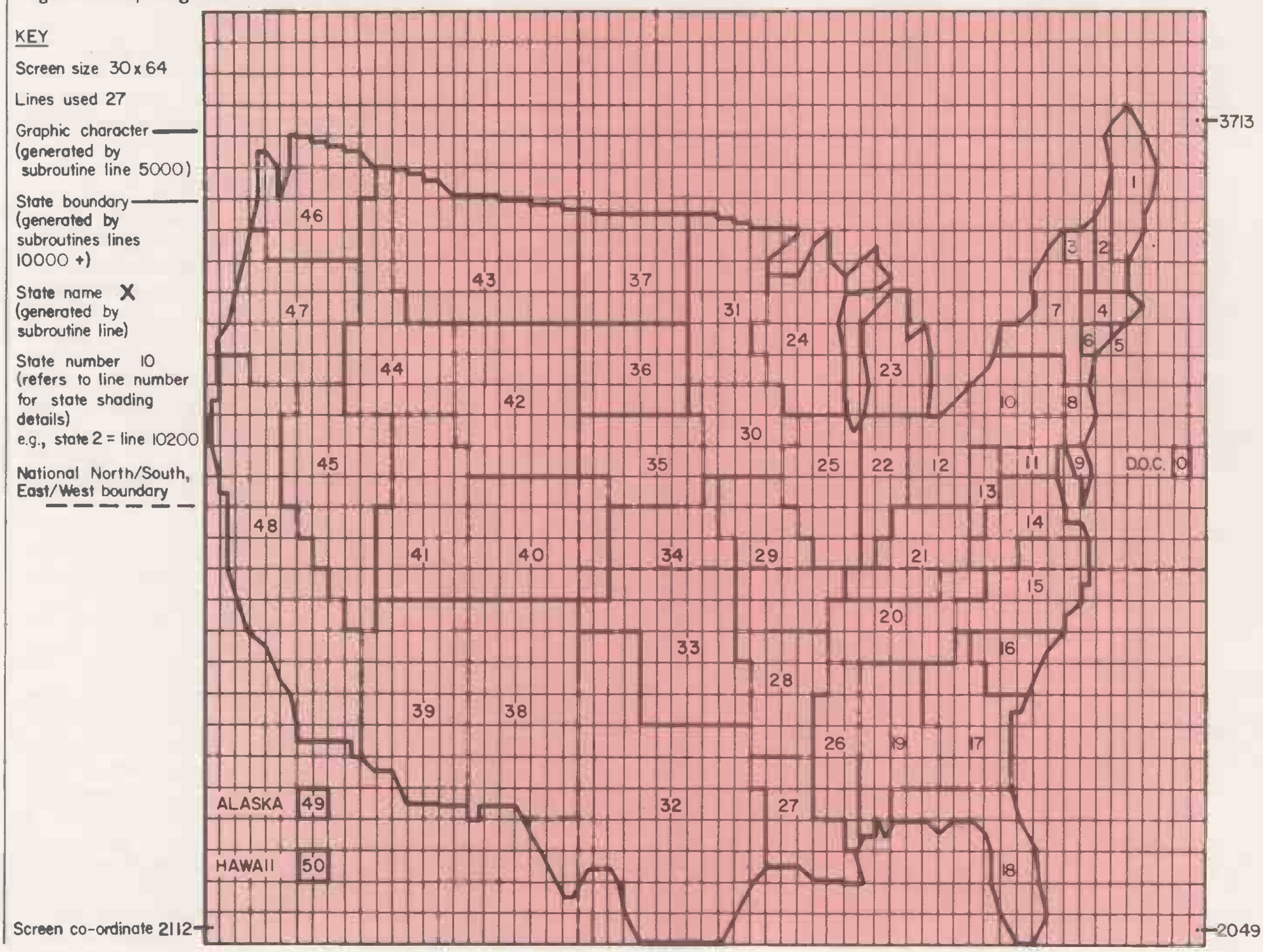
The players are presented with a display for each State listing their money available and current performance. The inclusion of the Opinion-Polls subroutine gives the players some idea as to the effect that the adjacent States are having on that turn's State.

That figure is weighted to take into account the size of the State — in terms of its votes — and the probable money each player would enter. Also included in the display is a summary of the current State-votes position indicating how many more are required for a player to win.

The results are displayed in a format

(continued on next page)

Figure 1. Map diagram.



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showing the winning player, the votes obtained and the totals to date. More importantly, the present totals of the State votes are shown and from these the Predicter-Result subroutine, lines 2900, calculates the final result on the basis of the State votes obtained and the percentage of the popular votes each player has.

Useful guide

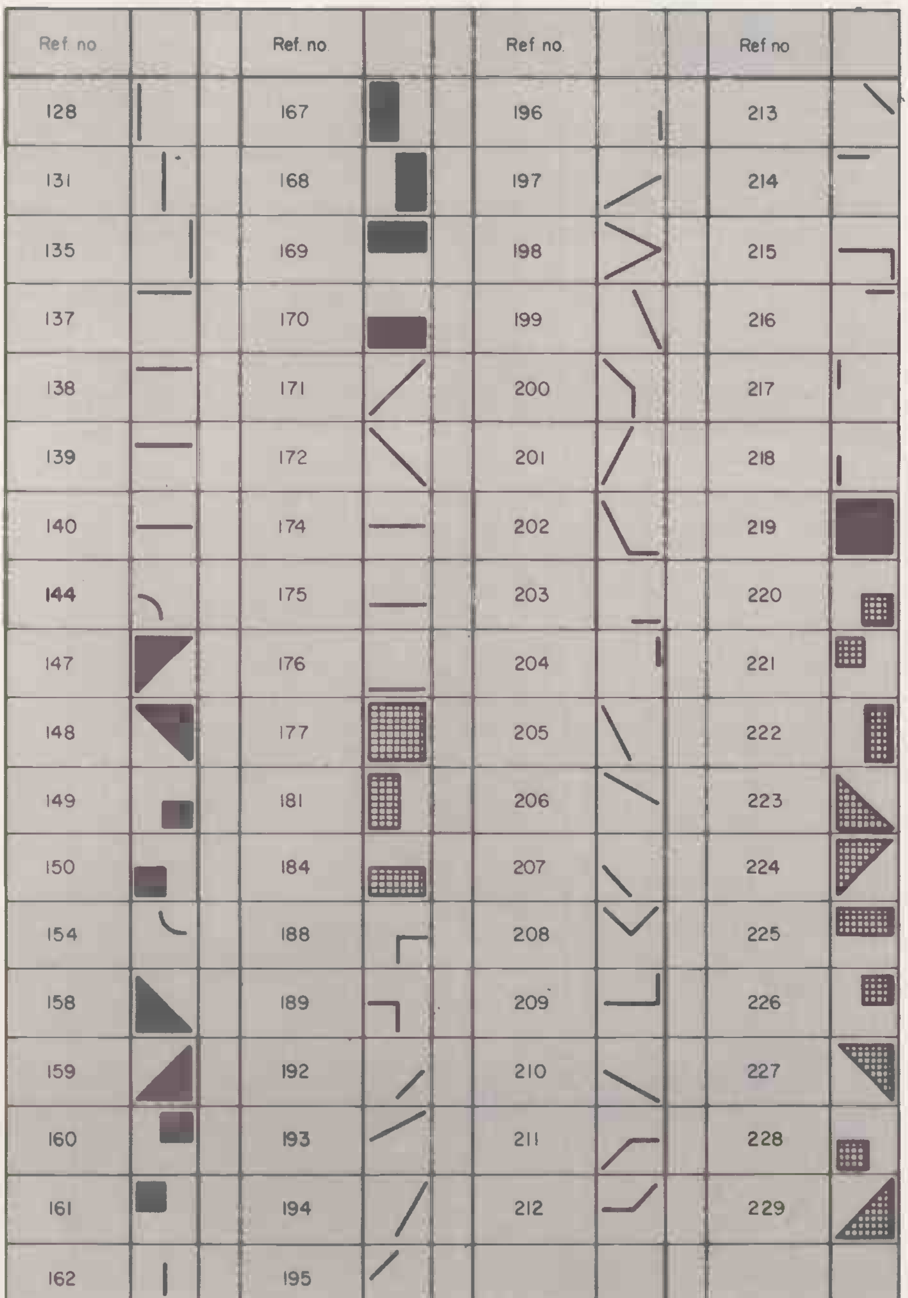
Although not being accurate for the first 10 or so State results, as the game progresses the error is reduced and it provides a useful guide as to who is likely to win.

The first State is chosen from a list containing the first 15 States. The States have been numbered consecutively from east to west. Once the result has been calculated for a particular State, its number is replaced on the list by the next unused one.

Eventually, less than 15 States will remain and a dummy market is used to replace them as they are chosen. The number has no effect in game terms and causes the program to re-select until a valid State is chosen. The nett effect of this section is to give the impression of the results arriving from the East Coast before those from the West.

Although not required to be a fast program to run, much of the bookkeeping work is done while the players are reading information displayed on the screen. This includes the updating of the State effects, which is carried-out before the program returns to printing the map, States won and indicating the next game turns State.

Figure 2. A complete list of the graphics characters used in the program with their reference numbers.



Subroutines

Line No.	Description
500	TWO PLAYER GAME
2100	STATE RESULTS PRINTOUT
2200	STATE INFORMATION DISPLAY
2300	CALCULATE OPINION POLLS
2400	FLASH RANDOM STATE
2500	ONE PLAYER GAME
2600	BASIC INSTRUCTIONS
2700	PRINT VOTES TOTALS
2800	PRINT STATES
2900	PREDICTED RESULTS
3000	CLEAR SCREEN
3100	LIMIT STATE EFFECTS
3200	END OF GAME
3300	RANDOM STATE SELECTION
3400	VOTES CALCULATION
3500	UPDATE STATE EFFECTS
3900	STATE SHADING
4000	STATE DRAWING
4300	NEGATIVE RESULT
4400	CLOSE RESULT
4500	SHORT GAME
4800	HOW TO PLAY (1 PLAYER)
4900	HOW TO PLAY (2 PLAYERS)
5000	AMERICAN MAP DETAILS
6000	STATE NAME DISPLAY
7000	RETURN FROM SHORT GAME
10000	STATE MAP DETAILS

On completion of the 51st State result, the program jumps to the End-Game subroutine, lines 3200, where the winner's name is printed within the map and all the States are shown in their correct shadings.

The addition of several print lines removes the cursor from within the map area and ensures that the prompt-ready following the completion of the program, appears at the bottom of the screen. The program is terminated by an end statement rather than a stop command which causes two lines of printing and distorts the final display.

One-player game

The one-player game is similar to the two-player game in its output and construction. The main difference being that there is only one State information display before the result, the computer inputing the money for the second player according to a fixed equation.

In addition to the two main games, there is the Short-Game variation, lines 4500, which is included to reduce the length of playing time from about 45 minutes to as little as five — depending on when the game is chosen.

This game is reached by the first player on any turn, inputting a figure greater than 1,000,000 on his expenditure in any State. The Short game displays only a modified results picture indicating the State, winner's name, current voting positions and the predicted result.

The results are calculated in the same way as the normal games with the computer allocating the players resources to each State based on its number of State votes and the amount of money remaining.

To return to the normal game, a machine-language subroutine has been included, which scans the keyboard for a few seconds after every result to check whether a key is being pressed. If one is, the computer is directed to return to what-

State	Ref. no.	Is affected by these states																																																	
		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
DISTRICT OF COLUMBIA	0	3							2	4		6	5	3	1	6	1					1																														
MAINE	1		4	2		3		1	5			1																																								
NEW HAMPSHIRE	2		2	4	1	7	1	2	20	1		6	1																																							
VERMONT	3		1	2	3	7		2	20	1		6	1																																							
MASSACHUSETTES	4		1	2	1	14	2	4	20	2		6	1																																							
RHODE ISLAND	5			1		7	4	4	10	2		3																																								
CONNETICUT	6			1		7	2	8	20	4		6	1	1																																						
NEW YORK	7				1	7		4	41	8		13	2	6	1	1																																				
NEW JERSEY	8			1		3		2	20	17	1	13	5	6		3																																				
DELAWARE	9					1		1	5	8	3	6	5	3		3																																				
PENNSYLVANIA	10					1		1	20	8		27	5	12	3	3							2	3	5																											
MARYLAND	11	1				1		1	5	8	1	13	10	6	3	6	1						2	1	2																											
OHIO	12								10			13	2	25	3	3						1	4	6	10	1	6				1																					
WEST VIRGINIA	13								10	4		6	5	12	6	6	1					1	4	3	5		3																									
VIRGINIA	14	1							2	4			5	6	3	12	6	1	1			5	4	1	2		3																									
NORTH CAROLINA	15									1		2	1	1		6	13	4	6	3	2	5	2																													
SOUTH CAROLINA	16															1	6	8	6	4	2		1																													
GEORGIA	17																6	4	12	8	4	5	2					1	1																							
FLORIDA	18																3	2	6	17	4	2						1	1																							
ALABAMA	19																3	1	6	8	9	5	2					3	2	1	1			3																		
TENNESSEE	20													3		3	6	2	6	4	4	10	4	1	1		3	3	2	3	6			3																		
KENTUCKY	21								1			3	1	12	3	6	1		1	1	1	5	9	6	5	2	13	1		1	6																					
INDIANA	22								1			6	1	12		3						1	4	13	10	2	13				3	2																				
MICHIGAN	23											3	1	12									2	6	21	5	6				1		1																			
WISCONSIN	24													3									1	3	10	11	13				3	4	5																			
ILLINOIS	25											3		6		1						1	4	6	5	5	26				6	4	2																			
MISSISSIPPI	26																1		3	4	4	5	2					7	5	3	3			6	2																	
LOUISIANA	27																		1	2	2	2						3	10	3	3			13	2																	
ARKANSAS	28																		1	2	2	5	2				3	3	5	6	6			13	4																	
MISSOURI	29																1		1			5	4	2	1	2	13	1	2	3	12	4	2	3	4	3	1															
IOWA	30													1										3	2	5	13				6	8	5			3	2	2														
MINNESOTA	31																								2	5	6				3	4	10				1	2	1													
TEXAS	32																			1	1							1	5	3	3			26						1	2											
OKLAHOMA	33																					2					1	1	2	3	6	2		13	8	3				3	2											
KANSAS	34																									1	5			1	6	4	1	4	4	7	2			3												
NEBRASKA	35																									1	5				3	4	2	1			5	2		3				1								
SOUTH DAKOTA	36																									1	2				3	4	5			1	2	4	1					1								
NORTH DAKOTA	37																									1						2	5					2	3						2							
COLERADO	38																														1			5	4	3	2			7	2	1	2	1						1		
NEW MEXICO	39																																	13	4					3	4	3								11		
ARIZONA	40																																	3						2	2	6	2				1			22		
UTAH	41																																	1						3	1	3	4	1		2	1			11		
WYOMING	42																																	1			2	2		2			2	3	2	2						
MONTANA	43																																						1						4	2		2	1			
IDAHO	44																																										2		2	4	1	4	3	11		
NEVADA	45																																									3	2			2	3	2	3	22		
WASHINGTON	46																																												1	2		9	3	11		
OREGON	47																																													2	1	4	6	22		
CALIFORNIA	48																																									3					1	2	3	45		
ALASKA	49																																																		3	
HAWAII	50																																																			4

Figure 3. This table shows the State points for each State and their effect on the others.

ever game — one- or two-player — it was from, and to display the next State's information picture.

If no key is being pressed, the program continues to calculate the next State's result before repeating the question. After the last result has been calculated, the End-Game subroutine is called and the map printed as in the normal games.

On execution of the run command, a header message and a request for whether

Basic Commands

Here is a list of the Basic instructions used in this program which may prove useful to those wishing to run the program on a different make of computer.

ABS	IF...GOTO	ON...GOSUB	RETURN
ASC	IF...THEN	ON...GOTO	RIGHT$
CHR$	INPUT	PEEK	RND
DATA	INT	POKE	SGN
DIM	LEFT$	PRINT	STR$
FOR...NEXT	LEN	READ	TAB
GOSUB	MID$	REM	USR
GOTO			

information is wanted on how to play the game will be output. If this information is required, about 25 lines of a basic game description will be displayed followed by a statement requiring a random number to be input.

That is followed by another question requiring the number of persons in the game to be entered. If information had been requested, a further 25 lines of game instructions are output specific to either the one- or two-player game depending on which variation had been selected.

Those lines give an idea as to the best tactics to adopt in the game and are followed by entering the player or players' names.

The game is started by printing the map and selecting one of the first 15 States at random. This State is flashed on the map and its name and State votes are also displayed. After a set number of flashes the map is replaced by a display indicating the State name, turn number, player's name, amount of money remaining, opinion polls and the current State votes position.

On the basis of that information, the player is required to enter the amount of money to be spent on this State. In the two-player game, the second player's information, in a similar format, is displayed immediately on the screen follow-

Program Listing Details

The program runs in 32K of memory by entering all the Basic instructions as single-key commands — as allowed by the Sorcerer. Naturally, the listing uses the full names for each command. The symbol, △, indicates a space where there is need to make this more obvious — so not all the spaces have been shown in this way.

ing the input of the first player's expenditure.

Once the second player has typed in his figures, the result is calculated. In the one-player game, entry of the first player's money expenditure causes the result to be calculated. In that case, the second player is the computer which calculates its expenditure.

The result is displayed showing the

(continued on next page)

(continued from previous page)

State name and the player's names and votes obtained. The winner's name is printed and a summary of the new State votes and total popular votes is also displayed. Should the result have been close — the winner receiving less than 51 percent of the votes — the Close-Result subroutine will have been called and is indicated.

The results display also shows the predicted final result and here an assessment on the outcome of the election has been made, based on the previous results.

After several seconds, the results display is replaced by the map and all States where the results have been calculated are displayed in a colour — white or grey — dependent on who had won them. The computer then selects a new State and flashes it on to the map before displaying the State information.

In the two-player game, the previous turns second player becomes the first player for the new game turn, thus each person takes it in turn to be the first to enter their expenditure on the States throughout the game. In the one-player game, it does not apply.

Within the standard game, the program identifies the entry of a negative amount of money for any State, as a request for more money, and after it has been input allows a positive value to be spent on that State. An attempt to spend more money than a player has left is also recognised and that player is penalised.

The cycle of entering money/displaying results is repeated for all 51 States. After the last result, the winners name is displayed and the map and shaded States superimposed over it. A normal game played this way would take about 45 minutes to complete.

In addition to the standard game, a quicker version has been provided, accessible by typing in a number greater than 1,000,000 as the first player's expenditure in any State. In the two-player version, the computer calculates both players' expenditure for the State based on their remaining money and the size of the State — in terms of State votes.

Symbol	Ref. no.	Code	Symbol	Ref. no.	Code
	192	00 00 00 00 01 02 04 08		211	00 00 00 0F 10 20 40 80
	193	03 0C 30 C0 00 00 00 00		212	01 02 04 08 F0 00 00 00
	194	01 01 02 02 04 04 08 08		213	08 04 02 01 00 00 00 00
	195	10 20 40 80 00 00 00 00		214	F0 00 00 00 00 00 00 00
	196	00 00 00 00 01 01 01 01		215	00 00 00 00 FF 01 01 01
	197	00 00 00 00 03 0C 30 C0		216	0F 00 00 00 00 00 00 00
	198	C0 30 0C 03 03 0C 30 C0		217	80 80 80 80 00 00 00 00
	199	08 08 04 04 02 02 01 01		218	00 00 00 00 80 80 80 80
	200	80 40 20 10 08 08 08 08		219	FF FF FF FF FF FF FF FF
	201	10 10 20 20 40 40 80 80		220	00 00 00 00 05 0A 05 0A
	202	80 80 40 40 20 20 10 1F		221	50 A0 50 A0 00 00 00 00
	203	00 00 00 00 00 00 00 0F		222	05 0A 05 0A 05 0A 05 0A
	204	01 01 01 01 00 00 00 00		223	00 80 40 A0 50 A8 54 AA
	205	80 80 40 40 20 20 10 10		224	55 AA 54 A8 50 A0 40 80
	206	C0 30 0C 03 00 00 00 00		225	55 AA 55 AA 00 00 00 00
	207	00 00 00 00 80 40 20 10		226	05 0A 05 0A 00 00 00 00
	208	81 42 24 18 00 00 00 00		227	55 2A 15 0A 05 02 01 00
	209	01 01 01 01 FF 00 00 00		228	00 00 00 00 50 A0 50 A0
	210	00 00 00 00 C0 30 0C 03		229	01 02 05 0A 15 2A 55 AA

Figure 4. The pre-defined Sorcerer graphics characters used by the program — lines 1-24.

```
1  REM USER DEFINABLE GRAPHICS
5  FOR I = 0 TO 303
6  READ A1: POKE —512 + I,A1
7  NEXT I
10 DATA 0,0,0,0,1,2.3,8,3,12.48.192,0,0,0,0,1,1,2.2,4.4.8,8
11 DATA 16,32,64,128,0,0,0,0,0,0,0,0,1,1,1,1,0,0,0,0,3,12,48,192
12 DATA 192,48.12,3,3,12,48,192,8,8,4,4,2,2,1,1,128,64,32.16,8,8,8,8
13 DATA 16,16,32,32,64,64,128,128,128,128,64,64,32,32,16,31
14 DATA 0,0,0,0,0,0,0,15,1,1,1,1.0,0,0,0,128,128,64,64,32,32,16,16
15 DATA 192,48,12,3,0,0,0,0,0,0,0.0,128,64,32,16,129,66,36,24,0,0,0,0,
16 DATA 1,1,1.1,255,0,0.0,0,0,0,0,192,48,12,3,0,0,0,15,16,32,64,128
17 DATA 1,2,4,8,240,0,0,0,8,4,2,1,0,0,0,0,240,0,0,0,0,0,0,0,
18 DATA 0,0,0,0,255,1,1,1.15,0,0,0,0,0,0,0.128,128,128,128,0,0,0,0
19 DATA 0,0,0,0,128,128,128,128,255,255,255,255,255,255,255,255
20 DATA 0.0,0,0.5,10,5,10,80,160,80,160,0,0,0,0,5,10,5,10,5,10,5,10
21 DATA 0,128,64,160,80,160,84,170,85,170,84,168,80,160,64,128
22 DATA 85,170,85,170,0,0,0.0,5,10.5,10,0,0,0,0
23 DATA 85,42,21,10,5,2,1,0,0.0,0,0.80,160,80,160
24 DATA 1,2,5,10,21,42,85,170
30 DIM A$(50),B(50),C(3),D(14),E(1),F(1),G(50),M(3).H(1)
31 DIM N(50),P(50),V(1),Z$(1),S(1)
40 FOR I = 0 TO 50:READ A$(I),B(I):NEXT I
45 DATA "DISTRICT OF COLUMBIA",3,"MAIN",4,"NEW
     HAMPSHIRE",4
46 DATA "VERMONT",3."MASSACHUSETTS",14."RHODE
     ISLAND",4
47 DATA "CONNETICUT",8,"NEW YORK",41,"NEW JERSEY",17
48 DATA "DELAWARE",3,"PENNSYLVANIA",27,"MARYLAND",10
49 DATA "OHIO",25,"WEST VIRGINIA",6,"VIRGINIA",12
50 DATA "NORTH CAROLINA",13,"SOUTH CAROLINA",8,
     "GEORGIA",12
51 DATA "FLORIDA",17,"ALABAMA",9,"TENNESSEE",10
52 DATA "KENTUCKY",9,"INDIANA",13,"MICHIGAN",21
53 DATA "WISCONSIN",11,"ILLINOIS".26,"MISSISSIPPI",7
54 DATA "LOUISIANA",10,"ARKANSAS",6,"MISSOURI",12
55 DATA "IOWA",8,"MINNESOTA",10,"TEXAS",26
56 DATA "OKLAHOMA",8,"KANSAS",7,"NEBRASKA",5
57 DATA "SOUTH DAKOTA",4,"NORTH DAKOTA",3,
     "COLORADO",7
58 DATA "NEW MEXICO",4,"ARIZONA",6,"UTAH",4
59 DATA "WYOMING",3,"MONTANA",4,"IDAHO",4
60 DATA "NEVADA",3,"WASHINGTON",9,"OREGON",6
61 DATA "CALIFORNIA",45,"ALASKA",3,"HAWAII",4
65 F(0) = 1 E 6 : F(1) = F(0)
70 FOR I = 0 TO 14: D(I) = 1 : NEXT I
72 POKE 260,32 : POKE 261,0
74 POKE 32,205:POKE 33,24:POKE 34,224:POKE 35,50
76 POKE 36,0 :POKE 37,0 :POKE 38,201
78 T = 1
80 X$ = "________________" [REM: LENGTH OF X$
```

```
                                          20 SPACES]
85   FOR I = 0 TO 50 : P(I) = 9 : N(I) = 0 : NEXT I
90   REM HEADING INFORMATION
95   GOSUB 3000
100  PRINT TAB(20);"THE AMERICAN ELECTION GAME"
105  PRINT TAB (20);"[redacted]"
110  PRINT:PRINT:PRINT
120  PRINT TAB(15);"DO YOU WANT INSTRUCTIONS — TYPE YES
       OR NO"
130  INPUT Q1$ : IF Q1$ = "YES" THEN GOSUB 2600
140  PRINT TAB(15);"TYPE IN TIME (OR A SIMILAR RANDOM
       NUMBER)"
150  INPUT R
160  Q1 = RND(—R)
170  PRINT TAB(15);"ARE THERE ONE OR TWO PEOPLE IN THIS
       GAME?"
175  PRINT TAB(15);"ENTER THE NUMBER 1 OR 2 ΔΔ";:INPUT U
176  IF Q1$ < > "YES" GOTO 180
178  ON U GOSUB 4800,4900
180  ON U GOTO 2500,200
190  GOTO 175
200  PRINT:PRINT TAB(15):"PLEASE TYPE IN YOUR NAMES"
210  INPUT Z$(0),Z$(1)
220  GOSUB 5000
230  GOSUB 2400
500  REM TWO PLAYER NORMAL GAME
510  GOSUB 3000
520  IF RIGHT $ (STR$(T*5),1) = "5" GOTO 540
530  K = 1 : GOTO 550
540  K = O
550  GOSUB 2300
600  FOR I = 1 TO 2
610  GOSUB 2200
620  K = K + 1
630  IF K = 2 THEN K = O
640  NEXT I
700  GOSUB 2100
800  IF T = 51 GOTO 3200
810  GOSUB 5000
820  T = T + 1
850  GOTO 230
2100 REM STATE RESULTS DISPLAY
2104 GOSUB 3400
2108 PRINT TAB(15);"THE RESULT IN THE STATE OF Δ";A$(Q)
2112 PRINT TAB(24);"IS AS FOLLOWS":PRINT
2116 IF C(0)<0.49 OR C(0) = 0.51 GOTO 2140
2120 PRINT TAB(20);"WOW!!! Δ A CLOSE RESULT"
2124 PRINT TAB(19);"THERE MUST BE A RECOUNT":PRINT
2128 GOSUB 4400
2132 FOR I = 1 TO 500:NEXT I
2136 PRINT TAB(17);"AND HERE IS THE FINAL RESULT":PRINT
2140 GOSUB 3450
2144 FOR I = 0 TO 1
2148 PRINT:PRINT TAB(15);Z$(I);TAB(30);C(I);"ΔVOTES";TAB(55);
       C(I + 2);"Δ%"
2152 NEXT I
2156 PRINT:PRINT TAB(15);"MAJORITY";TAB(31);ABS(C(0)—C(1))
2160 PRINT:PRINT TAB(15);"THE WINNER OF THIS STATE ISΔ";Z$(L)
2165 GOSUB 2700
2170 GOSUB 2900
2175 IF 14 + T < 51 GOTO 2185
2180 D(X) = 99 : GOTO 2190
2185 D(X) = 14+T
2190 FOR I = 1 TO 2000 :  NEXT I
2195 GOSUB 3500
2199 RETURN
2200 REM STATE INFORMATION DISPLAY
2205 V(K) = 0
2210 PRINT TAB(25);A$(Q);TAB(50);"RESULT NO.";T
2215 PRINT TAB(25);LEFT$(X$,LEN(A$(Q)))
2220 PRINT:PRINT
2223 PRINT:TAB(15);"THIS STATE IS WORTH Δ";B(Q);"ΔVOTES"
2226 PRINT:PRINT
2229 PRINT TAB(15);Z$(K);",YOU HAVE $";F(K);"LEFT TO SPEND"
2232 PRINT:PRINT
2235 PRINT TAB(15);"THE LATEST OPINION POLLS SHOW THAT"
2238 PRINT TAB(12);"YOU HAVE";C(K);"Δ% OF THE VOTES IN THIS
       STATE"
2241 PRINT:PRINT TAB(17);"CURRENTLY, YOU HAVE";E(K);"Δ
       VOTES"
2244 M = K + 1:IF M = 2 THEN M = 0
2247 PRINT TAB(15);"AND YOUR OPPONENT HAS";E(M);"ΔVOTES"
2250 IF E(K) > = 270 GOTO 2259
2253 IF E(M) = 270 GOTO 2262
2256 PRINT TAB(13);"SO YOU NEED ANOTHER";270—E(K);"ΔVOTES
       TO WIN":GOTO 2265
2259 PRINT TAB(20);"BUT YOU HAVE A MAJORITY":GOTO 2265
2262 PRINT TAB(17);"BUT YOU CANNOT GET A MAJORITY"
2265 PRINT:PRINT TAB(15);"TYPE IN HOW MUCH YOU WISH TO
       SPEND":INPUT V(K)
2268 IF I = 1 AND V(K) > 1 E 6 GOTO 4500
2269 IF I < > 2 OR V(K) < = 1 E 6 GOTO 2271
2270 PRINT "ONLY THE FIRST PLAYER CAN REACH THE FAST
       GAME": GOTO 2265
2271 IF V(K) > = 0 GOTO 2282
2274 PRINT TAB(10); IT LOOKS AS IF YOU ARE REQUESTING MORE
       MONEY"
2277 PRINT TAB(17);"TYPE IN HOW MUCH EXTRA YOU WANT"
2280 INPUT S1:F(K) = F(K) + S1 : GOSUB 3000
2281 GOTO 2205
2282 F(K) = F(K) —V(K):IF F(K)< = 0 GOTO 2292
2284 PRINT:PRINT TAB(15);"YOU GOOFED AND OVERSPENT YOUR
       ALLOWED BUDGET"
2286 PRINT TAB(13);"WITH YOUR OPPONENT REVEALING THIS TO
       THE ELECTORS"
2288 PRINT TAB(15);"IN THIS STATE,IT MUST HAVE COST YOU
       VOTES"
2290 FOR H = 1 TO 2000:NEXT H:V(K) = F(K):F(K) = 0
2292 IF V(K)< = B(Q)*2000 GOTO 2296
2294 V(K) = B(Q)*2000 + (V(K)—B(Q)*2000)/EXP(RND(1))
2296 GOSUB 3000
2298 RETURN
2300 REM CALC OPINION POLLS
2310 GOSUB 3100
2320 C(0) = 45000—G(Q)*750 + B(Q)*1000
2330 C(0) = INT(C(0)*100/(90000 + B(Q)*2000))
2340 C(1) = 100 —C(0)
2350 RETURN
2400 REM FLASH RND  STATE
2410 GOSUB 3300
2420 GOSUB 6000
2430 FOR I = 1 TO 5
2440 GOSUB 3900
2450 GOSUB 4000
2460 A = 32 : A2 = A: A3 = A : A4 = A : A5 = A : A6 = A
2470 A7 = A : A8 = A : A9 = A : B1 = A : B2 = A : B3 = A : B4 = A
2480 GOSUB 4000
2490 NEXT I
2495 RETURN
2500 REM ONE PLAYER GAME
2505 PRINT:PRINT TAB(15);"PLEASE TYPE IN YOUR NAME ΔΔ";
       :INPUTZ$(0)
2510 Z$(1) = "COMPUTER"
2515 GOSUB 5000
2520 GOSUB 2400
2525 GOSUB 2300
2530 GOSUB 3000
2535 K = O : I = 1 : GOSUB 2200
2540 V(1) = B(Q)*2200
2550 GOSUB 2100
2555 IF T = 51 GOTO 3200
2560 GOSUB 5000
2565 GOSUB 2800
2575 T = T + 1
2580 GOTO 2520
2600 REM INSTRUCTIONS
2602 PRINT:PRINT"This game is a simulation of the PRESIDENTIAL";
2604 PRINT"ΔELECTIONS":PRINT"It can be played by ONE or TWO
       persons."
2606 PRINT"ΔΔΔΔΔEach player takes it in turn to enter the amount"
2608 PRINT "of money that they wish to spend in the current State."
2610 PRINT"The higher the figure the better the chance of winning"
2612 PRINT"it, and taking its State Votes to add to their total."
2614 PRINT"The aim is to be the person to reach 270 State Votes,"
2616 PRINT"and the various displays will help you on your way."
2618 PRINT"ΔΔΔΔΔThere is an Opinion Polls section to give you an"
2620 PRINT"idea of how you stand in a particular State before you"
2622 PRINT"decide how much you want to spend there. And after the"
2624 PRINT"the result has been announced the computer will give its
2626 PRINT"latest prediction on who is likely to win. A map printed"
2628 PRINT"after every result shows who has won each state and acts"
2630 PRINT"as an aid to future strategy.
2632 PRINT:PRINT"ΔΔΔΔΔ Because the standard game takes 45 minutes to
       play,"
2634 PRINT"a shorter version is also available. To reach this game the"
2636 PRINT"first player on any turn must enter a number greater than"
2638 PRINT"1 million (1000000) instead of spending money on that State."
2640 PRINT"You can get back to the standard game whenever you like,"
2642 PRINT"simply by pressing one of the keys when asked to."
2644 PRINT"ΔΔΔΔΔ If you do run out of money or feel like you deserve"
2646 PRINT"more (who doesn't?) you can get some extra by typing a"
2648 PRINT"negative (—) number as the amount of money to be spent"
2650 PRINT"for that State. ΔΔΔ Now to start —"
2660 RETURN
2700 REM PRINT VOTES TOTALS
2705 PRINT:PRINT TAB(15);"THE CURRENT VOTING POSITION IS AS
       FOLLOWS"
2710 IF E(0) > = E(1) THEN H(0) = 1
2715 IF E(1) > = E(0) THEN H(1) = 1
2720 FOR I = 0 TO 1
2725 PRINT:PRINT TAB(15);Z$(I);TAB(30);E(I);"Δ VOTES Δ";
2730 IF I = 0 AND H(I) = 0 THEN PRINT
2735 IF H(I) = 0 GOTO 2765
2740 IF E(I) >269 GOTO 2755
2745 PRINT"(";270—E(I);"MORE VOTES REQD)"
2750 GOTO 2760
2755 PRINT"(HAS NOW A MAJORITY)"
2760 H(I) = 0
2765 NEXT I
2770 PRINT
2775 FOR I = 0 TO 1:PRINT
2780 PRINT TAB(14);"(Δ";Z$(I),M(I);"ΔPOPULAR VOTES";TAB(55);
       M(I + 2);"Δ%)"
2785 NEXT I
2790 RETURN
2800 REM PRINT STATES
2810 FOR I = 0 TO 50
2820 IF P(I) = 9 GOTO 2880
2830 Q = 1 : IF P(I) = 1 GOTO 2860
```

(continued on page 73)

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Tel: 01-739 2387 & 01-729 4460

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EQUINOX
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• Circle No. 167

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2840 GOSUB 3900
2850 GOTO 2870
2860 GOSUB 3950
2870 GOSUB 4000
2880 NEXT I
2890 RETURN
2900 REM PREDICTED OUTCOME
2910 H0 = INT((538—E(0)—E(1))*M(2)/100) + E(0)
2920 H1 = 538—H0
2930 PRINT:PRINT TAB(14);"THE LATEST PREDICTIONS ARE AS
       FOLLOWS"
2940 PRINT TAB(14);Z$(0);TAB(30);H0;" Δ VOTES"
2950 PRINT TAB(14);Z$(1);TAB(30);H1;" Δ VOTES"
2960 RETURN
3000 REM CLEAR SCREEN
3010 PRINT CHR$(12)
3020 PRINT:PRINT:PRINT:PRINT:PRINT:PRINT
3030 RETURN
3100 REM LIMIT STATE EFFECTS
3110 IF ABS(G(Q))>40 GOTO 3150
3120 G(Q) = G(Q)/2 : GOTO 3180
3150 IF SGN (G(Q)) = —1 GOTO 3170
3160 G(Q) = 20 : GOTO 3180
3170 G(Q) = —20
3180 RETURN
3200 REM END OF GAME
3205 FOR I = 1 TO 1500:NEXT I
3210 IF E(0)>E(1) THEN L = 0
3220 IF E(1)>E(0) THEN L = 1
3230 GOSUB 3000
3235 GOSUB 3020 : PRINT
3240 IF E(0) = E(1) GOTO 3270
3250 PRINT TAB(15);"CONGRATULATIONS,";Z$(L);" Δ YOU ARE
       THE"
3255 PRINT TAB(20);"NEW PRESIDENT OF THE U.S.A."
3260 PRINT TAB(15);"***************************************"
3265 GOTO 3280
3270 PRINT TAB(14);"CONGRATULATIONS, YOU HAVE ACHIEVED
       A DRAW"
3275 PRINT TAB(22);"HOW ABOUT TRYING AGAIN?"
3280 FOR I = 1 TO 10:PRINT:NEXT I
3285 GOSUB 5005
3290 GOSUB 2800
3295 END
3300 REM RANDOM STATE
3310 X = INT (15*RND(1))
3320 IF D(X) = 99 GOTO 3310
3330 Q = D(X)
3340 RETURN
3400 REM VOTES CALC.
3410 C(0) = V(0)—G(Q)*750 + 25000 + 40000*RND(1)
3420 C(1) = V(1) + G(Q)*750 + 25000 + 40000*RND(1)
3430 S = C(0) + C(1)
3440 C(2) = INT(C(0)*100/S):C(3) = INT(C(1)*100/S)
3445 C(0) = C(0)/S : C(1) = C(1)/S
3449 RETURN
3450 C(0) = INT(C(0)*B(Q)*190000):C(1) = INT(C(1)*B(Q)*190000)
3460 IF C(2) < 25 OR C(3) < 25 THEN GOSUB 4300
3470 M(0) = M(0) + C(0) : M(1) = M(1) + C(1)
3472 (M2) = INT(M(0)*100/(M0) + M(1))):M(3) = INT(M(1)*100/(M(0) +
       M(1)))
3475 IF C(0)>C(1) THEN L = 0
3480 IF C(1)>C(0) THEN L = 1
3485 E(L) = E(L) + B(Q):P(Q) = L
3488 IF L = 0 THEN N(Q) = —1
3490 IF L = 1 THEN N(Q) = 1
3495 RETURN
3500 REM UPDATE STATE EFFECTS
3505 G(0) = 2*N(7) + 4*N(8) + 6*N(10) + 5*N(11) + 3*N(12) + N(13)
3510 G(0) = G(0) + 6*N(14) + N(15) + N(20)
3515 G(1) = 2*N(2) + 3*N(4) + N(6) + 5*N(7) + N(10)
3520 G(2) = 2*N(1) + N(3) + 7*N(4) + N(5) + 2*N(6) + 20*N(7) + N(8) + 6*N(10)
       + N(11)
3525 G(3) = N(1) + 2*N(2) + 7*N(4) + 2*N(6) + 20*N(7) + N(8) + 6*N(10) + N(11)
3530 G(4) = N(1) + 2*N(2) + N(3) + 2*N(5) + 4*N(6) + 20*N(7) + 2*N(8)
3535 G(4) = G(4) + 6*N(10) + N(11)
3540 G(5) = N(2) + 7*N(4) + 4*N(6) + 10*N(7) + 2*N(8) + 3*N(10)
3545 G(6) = N(2) + 7*N(4) + 2*N(5) + 20*N(7) + 4*N(8) + 6*N(10) + N(11) +
       N(12)
3550 G(7) = N(3) + 7*N(4) + 4*N(6) + 8*N(8) + 13*N(10) + 2*N(11) + 6*N(12)
3555 G(7) = G(7) + N(13) + N(14)
3560 G(8) = N(2) + 3*N(4) + 2*N(6) + 20*N(7) + N(9) + 13*N(10) + 5*N(11)
3564 G(8) = G(8) + 6*N(12) + 3*N(14)
3568 G(9) = N(4) + N(6) + 5*N(7) + 8*N(8) + 6*N(10) + 5*N(11) + 3*N(12) + 3*
       N(14)
3572 G(10) = N(4) + N(6) + 20*N(7) + 8*N(8) + 5*N(11) + 12*N(12) + 3*N(13)
3576 G(10) = G(10) + 3*N(14) + 2*N(21) + 3*N(22) + 5*N(23)
3580 G(11) = N(0) + N(4) + N(6) + 5*N(7) + 8*N(8) + N(9) + 13*N(10) + 6*N(12)
3584 G(11) = G(11) + 3*N(13) + 6*N(14) + N(15) + 2*N(21) + N(22) + 2*N(23)
3588 G(12) = 10*N(7) + 13*N(10) + 2*N(11) + 3*N(13) + 3*N(14) + N(20)
3592 G(12) = G(12) + 4*N(21) + 6*N(22) + 10*N(23) + N(24) + 6*N(25) + N(29)
3596 G(13) = 10*N(7) + 4*N(8) + 6*N(10) + 5*N(11) + 12*N(12) + 6*N(14)
3600 G(13) = G(13) + N(15) + N(20) + 4*N(21) + 3*N(22) + 5*N(23) + 3*N(25)
3604 G(14) = N(0) + 2*N(7) + 4*N(8) + 5*N(11) + 6*N(12) + 3*N(13) + 6*N(15)
3608 G(14) = G(14) + N(16) + N(17) + 5*N(20) + 4*N(21) + N(22) + 2*N(23) + 3*
       N(25)
3612 G(15) = N(8) + 2*N(10) + N(11) + N(12) + 6*N(14) + 4*N(16) + 6*N(17)
3616 G(15) = G(15) + 3*N(18) + 2*N(19) + 5*N(20) + 2*N(21)
3620 G(16) = N(14) + 6*N(15) + 6*N(17) + 4*N(18) + 2*N(19) + N(21)
3624 G(17) = 6*N(15) + 4*N(16) + 8*N(18) + 4*N(19) + 5*N(20) + 2*N(21)
3628 G(17) = G(17) + N(26) + N(27)
3632 G(18) = 3*N(15) + 2*N(16) + 6*N(17) + 4*N(19) + 2*N(20) + N(26) + N(27)
3636 G(19) = 3*N(15) + N(16) + 6*N(17) + 8*N(18) + 5*N(20) + 2*N(21) + 3*
       N(26)
3639 G(19) = G(19) + 2*N(27) + N(28) + N(29) + 3*N(32)
3642 G(20) = 3*N(12) + 3*N(14) + 6*N(15) + 2*N(16) + 6*N(17) + 4*N(18)
3645 G(20) = G(20) + 4*N(19) + 4*N(21) + N(22) + N(23) + 3*N(25) + 3*N(26)
3648 G(20) = G(20) + 2*N(27) + 3*N(28) + 6*N(29) + 3*N(32)
3651 G(21) = N(7) + 3*N(10) + N(11) + 12*N(12) + 3*N(13) + 6*N(14) + N(15)
3654 G(21) = G(21) + N(17) + N(18) + N(19) + 5*N(20) + 6*N(22) + 5*N(23)
3657 G(21) = G(21) + 2*N(24) + 13*N(25) + N(26) + N(28) + 6*N(29)
3660 G(22) = N(7) + 6*N(10) + N(11) + 12*N(12) + 3*N(14) + N(20) + 4*N(21)
3663 G(22) = G(22) + 10*N(23) + 2*N(24) + 13*N(25) + 3*N(29) + 2*N(30)
3666 G(23) = 3*N(10) + N(11) + 12*N(12) + 2*N(21) + 6*N(22) + 5*N(24)
3669 G(23) = G(23) + 6*N(25) + N(29) + N(31)
3672 G(24) = 3*N(12) + N(21) + 3*N(22) + 10*N(23) + 13*N(25) + 3*N(29)
3675 G(24) = G(24) + 4*N(30) + 5*N(31)
3678 G(25) = 3*N(10) + 6*N(12) + N(14) + N(20) + 4*N(21) + 6*N(22)
3681 G(25) = G(25) + 5*N(23) + 5*N(24) + 6*N(29) + 4*N(30) + 2*N(31)
3684 G(26) = N(15) + 3*N(17) + 4*N(18) + 4*N(19) + 5*N(20) + 2*N(21)
3687 G(26) = G(26) + 5*N(27) + 3*N(28) + 3*N(29) + 6*N(32) + 2*N(33)
3690 G(27) = N(17) + 2*N(18) + 2*N(19) + 2*N(20) + 3*N(26) + 3*N(28)
3693 G(27) = G(27) + 3*N(29) + 13*N(32) + 2*N(33)
3696 G(28) = N(17) + 2*N(18) + 2*N(19) + 5*N(20) + 2*N(21) + 3*N(25)
3699 G(28) = G(28) + 3*N(26) + 5*N(27) + 6*N(29) + 13*N(32) + 4*N(33)
3702 G(39) = N(15) + N(17) + 5*N(20) + 4*N(21) + 2*N(22) + N(23) + 2*N(24)
3705 G(29) = G(29) + 13*N(25) + N(26) + 2*N(27) + 3*N(28) + 4*N(30)
3708 G(29) = G(29) + 2*N(31) + 3*N(32) + 4*N(33) + 3*N(34) + N(35)
3711 G(30) = N(12) + 3*N(22) + 2*N(23) + 5*N(24) + 13*N(25) + 6*N(29)
3714 G(30) = G(30) + 5*N(31) + 3*N(34) + 2*N(35) + 2*N(36)
3717 G(31) = 2*N(23) + 5*N(24) + 6*N(25) + 3*N(29) + 4*N(30) + N(35)
3720 G(31) = G(31) + 2*N(36) + N(37)
3723 G(32) =  N(18) + N(19) + N(26) + 5*N(27) + 3*N(28) + 3*N(29) + N(38)
3726 G(32) = G(32) + 2*N(39)
3729 G(33) = 2*N(20) + N(25) + N(26) + 2*N(27) + 3*N(28) + 6*N(29) + 2*N(30)
3732 G(33) = G(33) + 13*N(32) + 3*N(34) + 3*N(38) + 2*N(39)
3735 G(34) = N(24) + 5*N(25) + N(28) + 6*N(29) + 4*N(30) + N(31) + 4*N(32)
3738 G(34) = G(34) + 4*N(33) + 2*N(35) + 3*N(38)
3741 G(35) = N(24) + 5*N(25) + 3*N(29) + 4*N(30) + 2*N(31) + N(32) + 2*N(36)
3744 G(35) = G(35) + 3*N(38) + N(42)
3747 G(36) = N(24) + 2*N(25) + 3*N(29) + 4*N(30) + 5*N(31) + N(34) + 2*N(35)
3750 (G36) = G(36) + N(37) + N(42)
3753 G(37) = N(24)  + 2*N(30) + 5*N(31) + 2*N(36) + 2*N(43)
3756 G38) = N(29) + 5*N(32) + 4*N(33) + 3*N(34) + 2*N(35) + 2*N(39) + N(40)
3759 G(38) = G(38) + 2*N(41) + N(42) + N(48)
3762 G(39) = 13*N(32) + 4*N(33) + 3*N(38) + 3*N(40) + 11*N(48)
3765 G(40) = 3*N(32) + 2*N(38) + 2*N(39) + 2*N(41) + N(45) + 22*N(48)
3768 G(41) = N(32) + 3*N(38) + N(39) + 3*N(40) + N(42) + 2*N(44) + N(45)
3771 G(41) = G(41) + 11*N(48)
3774 G(42) = N(32) + 2*N(35) + 2*N(36) + 2*N(38) + 2*N(41) + 2*N(43) + 2*
       N(44)
3777 G(43) = N(37) + 2*N(44) + 2*N(46) + N(47)
3780 G(44) = 2*N(41) + 2*N(43) + N(45) + 4*N(46) + 3*N(47) + 11*N(48)
3783 G(45) = 3*N(40) + 2*N(41) + 2*N(44) + 2*N(46) + 3*N(47) + 22*N(48)
3786 G(46) = N(43) + 2*N(44) + 3*N(47) + 11*N(48)
3789 G(47) = 2*N(44) + N(45) + 4*N(46) + 22*N(48)
3792 G(48) = 3*N(40) + N(45) + 2*N(46) + 3*N(47)
3795 RETURN
3900 REM STATE SHADING (0)
3910 A = 219:A2 = 168:A3 = 158:A4 = 147:A5 = 149:A6 = 161
3920 A7 = 170:A8 = 169:A9 = 167:B! = 160:B2 = 148:B3 = 150:B4 = 159
3930 RETURN
3950 REM STATE SHADING (1)
3960 A = 177:A2 = 222:A3 = 223:A4 = 224:A5 = 220:A6 = 221
3970 A7 = 184:A8 = 225:A9 = 181:B1 = 226:B2 = 227:B3 = 228:B4 = 229
3980 RETURN
4000 REM STATE DRAWING
4010 ON Q + 1 GOSUB 10000,10100,10200,10300,10400,10500,10600
4020 IF Q— 6<= 0 GOTO 4200
4030 ON Q— 6GOSUB 1070 ,10800 ,10900 ,11000 ,11100 ,11200 ,11300
4040 IF Q—13<= 0 GOTO 4200
4050 ON Q—13 GOSUB 11400,11500,11600,11700,11800,11900,12000
4060 IF Q—20<= 0 GOTO 4200
4070 ON Q—20 GOSUB 12100,12200,12300,12400,12500,12600,12700
4080 IF Q—27<= 0 GOTO 4200
4090 ON Q—27 GOSUB 12800,12900,13000,13100,13200,13300,13400
4100 IF Q—34<= 0 GOTO 4200
4110 ON Q—34 GOSUB 13500,13600,13700,13800,13900,14000,14100
4120 IF Q—41<= 0 GOTO 4200
4130 ON Q—41 GOSUB 14200,14300,14400,14500,14600,14700,14800
4140 IF Q—48< = 0 GOTO 4200
4150 ON Q—48 GOSUB 14900,15000
4160 RETURN
4300 REM NEGATIVE RESULT
4310 IF C(2)>25 GOTO 4350
4320 C(0) = INT(0.25*B(Q)*190000):C(1) = INT(0.75*B(Q)*190000)
4330 C(2) = 25:C(3) = 75:GOTO 4390
4350 C(0) = INT(0.75*B(Q)*190000):C(1) = INT(0.25*B(Q)*190000)
4360 C(2) = 75:C(3) = 25
4390 RETURN
4400 REM CLOSE RESULT
4410 Q2 = RND(1)
4420 IF Q2<0.5 THEN C(0) = C(0)-0.005
4430 IF Q2>0.5 THEN C(0) = C(0) + 0.005
4440 IF C(0)>0.49 AND C(0)<0.51 GOTO 4410
4450 C(2) = INT(C(0)*100/(C(0) + C(1))):C(3) = INT(C(1)*100/(C(0) + C(1)))
4490 RETURN
4500 REM SHORT GAME
4510 GOSUB 3000
4515 S2 = 540—E(0)—E(1)
4520 FOR I = O TO 1 : S(I) = F(I)/S2:NEXT I
4525 PRINT:PRINT:PRINT
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4530 PRINT TAB(14);"To return to standard game, press any key"
4535 FOR I = 0 TO 150:Q3 = USR(0):IF PEEK (0)<>0 GOTO 7000
4540 NEXT I
4545 GOSUB 3000
4550 GOSUB 3100
4555 FOR I = 0 TO 1:V(I) = S(I)*B(Q):NEXT I
4560 IF U = 1 THEN V(I) = B(Q)*2200
4565 GOSUB 3400
4570 IF C(0)>0.49 AND C(0)<0.51 THEN GOSUB 4400
4575 GOSUB 3450
4580 PRINT:PRINT
4585 PRINT TAB(15);"RESULT NO.":T
4590 PRINT TAB(15);"THE WINNER OF THE STATE OF Δ";A$(Q)
4595 PRINT TAB(15);"ISΔ";Z$(L);"Δ BY";ABS(C(0)—C(1));"Δ VOTES"
4600 GOSUB 2700
4605 FOR I = O TO 1:F(I) = INT(F(I)—V(I)):NEXT I
4610 GOSUB 2900
4615 IF T + 14<51 GOTO 4625
4620 D(X) = 99:GOTO 4630
4625 D(X) = 14 + T
4630 IF T = 51 GOTO 3200
4635 GOSUB 3300
4640 GOSUB 3500
4645 T = T + 1
4650 GOTO 4525
4800 REM ONE PLAYER INSTRUCTIONS
4802 PRINT" ΔΔΔΔΔ So you're on your own are you. Well it isn't going"
4804 PRINT"to be easy to defeat the computer but here are a few"
4806 PRINT"hints as to how to set about doing just that."
4808 PRINT:PRINT" ΔΔΔΔΔ For a start the computer will always spend"
4810 PRINT"$2200 * The Number Of State Votes in any State."
4812 PRINT"That means in a 4 vote State it is using about $9000"
4814 PRINT"whilst in the big 40 vote States it will spend $90000 + "
4816 PRINT"To make matters worse, if you try to match him,"
4818 PRINT"any money that you spend over $2000 * State Votes"
4820 PRINT"suffers by being reduced by anything up to 40% of its"
4822 PRINT"true value. (So in a worst case $30000 spend in a"
4824 PRINT"10 vote State could become only $24000, only slightly"
4826 PRINT"more than the computer has put in.)"
4828 PRINT" ΔΔΔΔΔ However most of the States affect the results in"
4830 PRINT"adjacent States (or in the case of the bigger vote"
4832 PRINT"States, those even further away ) and contribute a"
4834 PRINT"significant bonus to whoever has won the States which"
4836 PRINT"surround the one in play. ΔΔΔ This is of course what the"
4838 PRINT"Opinion Polls are for, indicating the advantage (if any)"
4840 PRINT"that you hold in a State before you spend your money."
4842 PRINT" ΔΔΔΔΔ So to stand a chance you must go for all the big"
4844 PRINT"States irrespective of cost and win as many of the early"
4846 PRINT"ones as possible. Δ Your money should run out after about"
4848 PRINT"35 States but by then you should be near to winning. If"
4850 PRINT"you are still a long way off, there's always next time."
4852 PRINT"ΔΔΔΔΔ Good Luck and may the best person win (That rules"
4854 PRINT"out the computer!)"
4856 RETURN
4900 REM TWO PLAYER INSTRUCTIONS
4902 PRINT" ΔΔΔΔΔ In the standard game each player takes it in turn to"
4904 PRINT"be the first to enter the amount of money to be spend"
4906 PRINT"on any individual State. ΔΔΔ This is because it is a"
4908 PRINT"disadvantage to be the first player — the second"
4910 PRINT"one knows how much he must spend to win!"
4912 PRINT" ΔΔΔΔΔ However the game isn't that easy, since putting in a"
4914 PRINT"greater amount of money won't necessarily win a State"
4916 PRINT"for you. Δ This is where the Opinion Polls can be a guide"
4918 PRINT"for you. Δ A popularity of 55% in a State means that it can"
4920 PRINT"normally be won by putting in the same amount as your"
4922 PRINT"opponent. Δ Over 60% and you can think about putting in less"
4924 PRINT"and still win."
4926 PRINT" ΔΔΔΔΔ If you are the first person to put their money in"
4928 PRINT"a State, the main things to think of are as follows —"
4930 PRINT" Δ (1) Δ Is it a big enough State to risk spending a lot on."
4932 PRINT"After all if your opponent is going to win it, at least"
4934 PRINT"make it as expensive as possible."
4936 PRINT" Δ (2) Δ Can you afford to lose it?"
4938 PRINT"If it is a big State then the benefits from winning it"
4940 PRINT"can be enormous in terms of the effect that it has on"
4942 PRINT"the surrounding States. The more money you put in the"
4944 PRINT"closer the result will be, perhaps you might even pick up"
4946 PRINT"the State on a recount. Beware if you let your opponent"
4948 PRINT"get a Predicted Result of over 300 Votes, because it is"
4950 PRINT"very difficult to pull back from this."
4952 PRINT" ΔΔΔΔΔ In the end may the best person win (well America"
4954 PRINT"needs all the help that it can get!)"
4990 RETURN
5000 REM PRINT AMERICA
5002 GOSUB 3000
5005 POKE—3719,192:POKE—3718,193:POKE—3717,172:POKE—3652,172
5010 POKE—3588,194:POKE—3524,195:POKE—3525,196:POKE—3461,171
5015 POKE—3397,128:POKE—3343,62:POKE—3271,197:POKE—3270,193
5020 POKE—3333,198:POKE—3208,194:POKE—3144,199:POKE—3080,171
5025 POKE—3016,200:POKE—2952,201:POKE—2953,135:POKE—3016,200
5030 POKE—3017,202:POKE—3082,203:POKE—3018,162:POKE—2954,154
5035 POKE—2890,204:POKE—2889,140:POKE—2888,144:POKE—2824,162
5040 POKE—2760,191:POKE—2761,196:POKE—2697,193:POKE—2698,196
5045 POKE—2634,193:POKE—2635,192:POKE—2571,195:POKE—2572,192
5050 POKE—2508,195:POKE—2509,188:POKE—2445,162:POKE—2381,162
5055 POKE—2317,199:POKE—2252,172:POKE—2187,205:POKE—2123,199
5060 POKE—2059,171:POKE—2060,176:POKE—1996,206:POKE—2061,172
5065 POKE—2126,199:POKE—2190,162:POKE—2254,207:POKE—2255,206
5070 POKE—2256,137:POKE—2257,193:POKE—2258,206:POKE—2259,137
5075 POKE—2260,137:POKE—2261,208:POKE—2262,209:POKE—2263,192
5080 POKE—2199,199:POKE—2135,137:POKE—2200,176:POKE—2201,176
5085 POKE—2202,210:POKE—2083,176:POKE—2084,176:POKE—2085,172
5090 POKE—2150,199:POKE—2214,207:POKE—2215,140:POKE—2216,211
5095 POKE—2153,212:POKE—2154,213:POKE—2218,207:POKE—2219,213
5100 POKE—2283,207:POKE—2284,213:POKE—2348,207:POKE—2349,140
5105 POKE—2350,140:POKE—2351,188:POKE—2287,214:POKE—2352,215
5110 POKE—2353,140:POKE—2354,139:POKE—2355,140:POKE—2356,213
5115 POKE—2420,207:POKE—2421,140:POKE—2422,206:POKE—2423,216
5120 POKE—2487,189:POKE—2488,140:POKE—2489,140:POKE—2490,140
5125 POKE—2491,204:POKE—2555,199:POKE—2619,207:POKE—2620,213
5130 POKE—2684,207:POKE—2685,206:POKE—2686,216:POKE—2750,205
5135 POKE—2815,199:POKE—2879,131:POKE—2943,131:POKE—3007,189
5140 POKE—3008,204:POKE—3072,199:POKE—3136,131:POKE—3200,188
5145 POKE—3199,217:POKE—3264,135:POKE—3328,196:POKE—3327,195
5150 POKE—3391,194:POKE—3454,201:POKE—3518,194:POKE—3581,201
5155 POKE—3645,131:POKE—3709,188:POKE—3708,210:POKE—3644,135
5160 POKE—3643,201:POKE—3707,131:POKE—3771,203:POKE—3706,137
5165 POKE—3705,138:POKE—3704,139:POKE—3703,140:POKE—3702,210
5170 POKE—3637,137:POKE—3636,138:POKE—3635,139:POKE—3634,140
5175 POKE—3633,210:POKE—3632,176:POKE—3631,176:POKE—3630,176
5180 POKE—3565,137:POKE—3564,137:POKE—3563,138:POKE—3562,138
5185 POKE—3561,139:POKE—3560,139:POKE—3559,140:POKE—3558,140
5190 POKE—3557,140:POKE—3556,140:POKE—3555,139:POKE—3554,139
5195 POKE—3553,139:POKE—3552,140:POKE—3551,174:POKE—3550,175
5200 POKE—3549,176:POKE—3548,176:POKE—3547,176:POKE—3483,193
5205 POKE—3484,197:POKE—3421,204:POKE—3420,140:POKE—3419,140
5210 POKE—3418,195:POKE—3482,192:POKE—3481,193:POKE—3480,128
5215 POKE—3416,206:POKE—3415,193:POKE—3478,197:POKE—3477,218
5220 POKE—3413,198:POKE—3414,176:POKE—3351,137:POKE—3352,194
5225 POKE—3288,199:POKE—3224,135:POKE—3160,204:POKE—3159,218
5230 POKE—3095,208:POKE—3158,201:POKE—3222,205:POKE—3286,128
5235 POKE—3350,197:POKE—3349,193:POKE—3412,176:POKE—3347,128
5240 POKE—3284,204:POKE—3283,193:POKE—3282,205:POKE—3218,131
5245 POKE—3154,201:POKE—3090,137:POKE—3153,197:POKE—3152,193
5250 POKE—3215,197:POKE—3214,195:POKE—3278,194:POKE—3277,137
5255 POKE—3340,197:POKE—3339,217:POKE—3404,196:POKE—3403,195
5260 POKE—3467,192:POKE—3466,193:POKE—3529,176:POKE—3528,197
5265 POKE—3527,195:POKE—3591,194:POKE—3655,199
5270 POKE—2368,65:POKE—2367,76:POKE—2366,65:POKE—2365,83
5275 POKE—2364,75:POKE—2363,65:POKE—2362,135:POKE—2361,137
5280 POKE—2360,128:POKE—2297,137
5285 POKE—2240,72:POKE—2239,65:POKE—2238,87:POKE—2237,65
5290 POKE—2236,73:POKE—2235,73:POKE—2234,135:POKE—2233,137
5295 POKE—2232,128:POKE—2169,137
5300 POKE—3014,68;POKE—3013,79:POKE—3012,67:POKE—3011,135
5305 POKE—3010,137:POKE—3009,128:POKE—2946,137
5310 RETURN
6000 REM PRINT STATE NAME
6010 FOR J = 1 TO LEN(A$(Q))
6020 M = ASC(MID$(A$(Q),J))
6030 POKE—3752 + J,M
6040 NEXT J
6050 FOR K = J + 1 TO LEN(STR$(B(Q))) + J
6060 M = ASC(MID$(STR$(B(Q)),K—J))
6070 POKE—3752 + K,M
6080 NEXT K
6090 RETURN
7000 REM RETURN FROM SHORT GAME
7010 ON U GOTO 2520,500
9000 REM STATE DRAWING (2)
9010 FOR J = 0 TO D1 STEP D2
9020 FOR K = 0 TO D3
9030 POKE—D4 + J + K,A
9040 NEXT K:NEXT J
9050 RETURN
10000 REM DOC
10005 POKE—3010,A
10095 RETURN
10100 REM MAINE
10105 D1 = 128:D2 = 64:D3 = 1:D4 = 3654:GOSUB 9000
10110 POKE—3588,A:POKE—3462,A:POKE—3718,A:POKE—3655,A2
10115 POKE—3717,A3:POKE—3652,A3:POKE—3461,A4:POKE—3719,A5
10120 POKE—3524,A6
10195 RETURN
10200 REM NEW HAMPSHIRE
10205 POKE—3399,A:POKE—3398,A:POKE—3463,A:POKE—3527,A
10210 POKE—3591,A5
10295 RETURN
10300 REM VERMONT
10305 POKE—3400,A:POKE—3464,A:POKE—3465,A:POKE—3528,A7
10395 RETURN
10400 REM MASS.
10405 D1 = O:D2 = O:D3 = 3:D4 = 3336:GOSUB 9000
10495 RETURN
10500 REM RHD ISL
10505 POKE—3270,A8
10595 RETURN
10600 REM CONNETICUT
10605 POKE—3272,A:POKE—3271,A
10695 RETURN
10700 REM NEW YORK
10705 D1 = 128:D2 = 64:D3 = 2:D4 = 3403:GOSUB 9000
10710 POKE—3208,A9:POKE—3209,A:POKE—3276,A:POKE—3277,A
10715 POKE—3278,A5:POKE—3340,A7:POKE—3466,A:POKE—3467,A5
10795 RETURN
10800 REM NEW JERSEY
10805 D1 = 64:D2 = 64:D3 = 1:D4 = 3145:GOSUB 9000
10895 RETURN
10900 REM DELAWARE
10905 POKE—3017,A:POKE—3016,A9:POKE—2952,A9
10995 RETURN
11000 REM PENNS.
11005 D1 = 126:D2 = 63:D3 = 3:D4 = 3213:GOSUB 9000
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11010 POKE—3214,A:POKE—3215,A7:POKE—3146,A:POKE—3151,A
11095 RETURN
11100 REM MARYLAND
11105 POKE—3082,A:POKE—3083,A:POKE—3018,A9:POKE—3019,A
11110 POKE—3020,A:POKE—3021,A
11195 RETURN
11200 REM OHIO
11205 DI = 128:D2 = 64:D3 = 3:D4 = 3091:GOSUB 9000
11210 POKE—3152,A:POKE—3153,A
11295 RETURN
11300 REM W.VIRG.
11305 DI = 64:D2 = 64:D3 = 1:D4 = 3023:GOSUB 9000:POKE—2895,A
11395 RETURN
11400 RETURN
11405 DI = 64:D2 = 64:D3 = 2:D4 = 2957:GOSUB 9000
11410 POKE—2954,A9:POKE—2888,B3:POKE—2889,A7:POKE—2890,A
11415 POKE—2894,A:POKE—2829,A:POKE—2830,A:POKE—2831,A
11495 RETURN
11500 REM N.CAROL.
11505 DI = 126:D2 = 63:D3 = 3:D4 = 2828:GOSUB 9000
11510 POKE—2824,A9:POKE—2760,A6:POKE—2761,A:POKE—2766,A
11515 POKE—2697,A8:POKE—2698,A:POKE—2703,A:POKE—2704,A
11520 RETURN
11500 REM S.CAROL.
11605 DI = 64:D2 = 64:D3 = 2:D4 = 2638:GOSUB 9000
11610 POKE—2634,A8:POKE—2635,A:POKE—2639,A:POKE—2571,A6
11695 RETURN
11700 REM GEORGIA
11705 DI = 192:D2 = 64:D3 = 2:D4 = 2577:GOSUB 9000
11710 POKE—2508,A6:POKE—2509,A:POKE—2510,A:POKE—2514,A
11715 POKE—2578,A:POKE—2640,A:POKE—2445,A9:POKE—2446,A
11720 POKE—2381,A:POKE—2382,A
11795 RETURN
11800 REM FLORIDA
11805 DI = 0:D2 = 0:D3 = 7:D4 = 2324:GOSUB 9000
11810 D3 = 2:D4 = 2125:GOSUB 9000
11815 POKE—2252,A3:POKE—2253,A:POKE—2254,A:POKE—2255,B1
11820 POKE—2257,A8:POKE—2258,A8:POKE—2187,A9:POKE—2188,A
11825 POKE—2189,A:POKE—2190,A2:POKE—2059,A4:POKE—2060,A
11830 POKE—2061,A:POKE—2126,A2
11895 RETURN
11900 REM ALABAMA
11905 DI = 192:D2 = 64:D3 = 3:D4 = 2582:GOSUB 9000
11910 POKE—2450,A:POKE—2386,A:POKE—2325,A:POKE—2326,A
11915 POKE—2261,A8:POKE—2262,A8
11995 RETURN
12000 REM TENN.
12005 DI = 64:D2 = 64:D3 = 7:D4 = 2712:GOSUB 9000
12010 POKE—2767,A:POKE—2768,A:POKE—2769,A
12095 RETURN
12100 REM KENTUCKY
12105 DI = 126:D2 = 63:D3 = 4:D4 = 2900:GOSUB 9000
12110 POKE—2832,A:POKE—2775,A
12195 RETURN
12200 REM INDIANA
12205 DI = 128:D2 = 64:D3 = 2:D4 = 3094:GOSUB 9000
12210 POKE—2901,A:POKE—2902,A:POKE—2838,A
12295 RETURN
12300 REM MICHIGAN
12305 DI = 65:D2 = 65:D3 = 2:D4 = 3286:GOSUB 9000
12310 DI = 0:D2 = 0:D3 = 3:D4 = 3158:GOSUB 9000
12315 POKE—3415,A:POKE—3414,A:POKE—3413,A9:POKE—3478,A7
12320 POKE—3350,A7:POKE—3282,B3:POKE—3222,A2:POKE—3218,A9
12325 POKE—3154,A9:POKE—3349,A7:POKE—3348,A:POKE—3283,A7
12395 RETURN
12400 REM WISC.
12405 DI = 128:D2 = 64:D3 = 3:D4 = 3356:GOSUB 9000
12410 POKE—3482,A5:POKE—3481,A:POKE—3420,A7:POKE—3419,A7
12415 POKE—3418,A:POKE—3417,A:POKE—3416,A:POKE—3352,A4
12420 POKE—3293,A:POKE—3288,A3:POKE—3224,A:POKE—3163,A
12425 POKE—3162,A:POKE—3161,A:POKE—3160,A
12495 RETURN
12500 REM ILLINOIS
12505 DI = 192:D2 = 64:D3 = 3:D4 = 3098:GOSUB 9000:POKE—2841,A
12510 POKE—3035,A:POKE—2971,A:POKE—2839,A:POKE—2840,A
12595 RETURN
12600 REM MISSISS.
12605 DI = 192:D2 = 64:D3 = 2:D4 = 2521:GOSUB 9000
12610 POKE—2584,A:POKE—2583,A:POKE—2263,A
12695 RETURN
12700 REM LOUIS.
12705 DI = 128:D2 = 64:D3 = 2:D4 = 2396:GOSUB 9000
12710 DI = 0 :D2 = 0 :D3 = 3:D4 = 2202:GOSUB 9000:POKE—2203,A8
12715 POKE—2397,A:POKE—2265,A:POKE—2264,A:POKE—2204,A8
12720 RETURN
12800 REM ARKAN.
12805 DI = 192:D2 = 64:D3 = 2:D4 = 2652:GOSUB 9000
12810 POKE—2654,A:POKE—2653,A:POKE—2649,A:POKE—2589,A
12815 POKE—2885,A:POKE—2525,A:POKE—2461,A
12895 RETURN
12900 REM MISSOURI
12905 DI = 195:D2 = 65:D3 = 3:D4 = 2975:GOSUB 9000
12910 DI = 0 :D2 = 0 :D3 = 5:D4 = 2718:GOSUB 9000:POKE—2844,A
12915 POKE—2911,A:POKE—2846,A:POKE—2782,A:POKE—2781,A
12920 POKE—2776,A:POKE—2907,A:POKE—2846,A:POKE—2845,A
12995 RETURN
13000 REM IOWA
13005 DI = 128:D2 = 64:D3 = 4:D4 = 3168:GOSUB 9000
13010 POKE—3169,A:POKE—3099,A
13095 RETURN
13100 REM MINNES.
13105 DI = 256:D2 = 64:D3 = 3:D4 = 3489:GOSUB 9000
13110 POKE—3553,A:POKE—3552,A:POKE—3551,A7:POKE—3550,A7
13115 POKE—3485,A:POKE—3484,A:POKE—3483,A8:POKE—3421,A
13120 POKE—3357,A:POKE—3229,A
13195 RETURN
13200 REM TEXAS
13205 DI = 128:D2 = 63:D3 = 3:D4 = 2664:GOSUB 9000
13210 DI = 192:D3 = 10:D4 = 2472:GOSUB 9000
13215 DI = 130:D2 = 65:D3 = 4:D4 = 2214:GOSUB 9000
13220 DI = 0:D2 = 0:D3 = 4:D4 = 2209:GOSUB 9000
13225 POKE—2333,A:POKE—2284,B1:POKE—2283,A:POKE—2282,A
13230 POKE—2281,A:POKE—2269,A:POKE—2219,B1:POKE—2218,A
13235 POKE—2217,A:POKE—2261,A8:POKE—2215,A8:POKE—2154,B1
13240 POKE—2153,A8:POKE—2150,B2:POKE—2144,A:POKE—2143,A
13245 POKE—2142,A4:POKE—2085,B2:POKE—2079,A4
13295 RETURN
13300 REM OKLA.
13305 DI = 192:D2 = 64:D3 = 5:D4 = 2724:GOSUB 9000
13310 DI = 0:D2 = 0:D3 = 3:D4 = 2728:GOSUB 9000
13315 POKE—2590,A:POKE—2526,A
13395 RETURN
13400 REM KANSAS
13405 DI = 128:D2 = 64:D3 = 6:D4 = 2918:GOSUB 9000
13410 POKE—2976,A:POKE—2847,A:POKE—2783,A
13495 RETURN
13500 REM NEBRAS.
13505 DI = 128:D2 = 64:D3 = 5:D4 = 3110:GOSUB 9000
13510 DI = 64:D3 = 1:D4 = 3112:GOSUB 9000
13595 RETURN
13600 REM S.DAKOTA
13605 DI = 128:D2 = 64:D3 = 6:D4 = 3304:GOSUB 9000
13695 RETURN
13700 REM N.DAKOTA
13705 DI = 192:D2 = 64:D3 = 6:D4 = 3560:GOSUB 9000
13790 RETURN
13800 REM COLORADO
13805 DI = 192:D2 = 64:D3 = 8:D4 = 2991:GOSUB 9000
13895 RETURN
13900 REM NEW MEXICO
13905 DI = 320:D2 = 64:D3 = 6:D4 = 2735:GOSUB 9000
13910 DI = 0:D2 = 0:D3 = 3:D4 = 2348:GOSUB 9000
13915 POKE—2351,A:POKE—2350,A8:POKE—2349,A8
13995 RETURN
14000 REM ARIZONA
14005 DI = 256:D2 = 64:D3 = 5:D4 = 2741:GOSUB 9000
14010 DI = 0:D2 = 0:D3 = 4:D4 = 2420:GOSUB 9000
14015 POKE—2678,A:POKE—2614,A:POKE—2550,A:POKE—2486,A
14020 POKE—2422,B1:POKE—2421,A8:POKE—2356,B1:POKE—2355,A8
14025 POKE—2354,A8:POKE—2353,A8:POKE—2352,A8
14095 RETURN
14100 REM UTAH
14105 DI = 256:D2 = 64:D3 = 4:D4 = 3060:GOSUB 9000
14110 DI = 0:D2 = 0:D3 = 3:D4 = 3124:GOSUB 9000
14115 POKE—2933,A:POKE—2869,A:POKE—2805,A
14195 RETURN
14200 REM WYOMING
14205 DI = 256:D2 = 64:D3 = 6:D4 = 3311:GOSUB 9000
14210 POKE—3312,A:POKE—3248,A:POKE—3184,A:POKE—3120,A
14295 RETURN
14300 REM MONTANA
14305 DI = 192:D2 = 64:D3 = 10:D4 = 3571:GOSUB 9000
14310 POKE—3636,A:POKE—3635,A:POKE—3634,A:POKE—3633,A3
14315 POKE—3572,A:POKE—3508,A:POKE—3444,A
14395 RETURN
14400 REM IDAHO
14405 DI = 128:D2 = 64:D3 = 6:D4 = 3319:GOSUB 9000
14410 POKE—3637,A:POKE—3574,A:POKE—3573,A:POKE—3510,A
14415 POKE—3509,A:POKE—3446,A:POKE—3445,A:POKE—3382,A
14420 POKE—3381,A:POKE—3380,A
14495 RETURN
14500 REM NEVADA
14505 DI = 128:D2 = 64:D3 = 6:D4 = 3131:GOSUB 9000
14510 DI = 192:D3 = 1:D4 = 2935:GOSUB 9000:POKE—2808,A
14515 POKE—3194,A:POKE—3193,A:POKE—3192,A:POKE—2938,A
14520 POKE—2937,A:POKE—2936,A:POKE—2873,A:POKE—2872,A
14595 RETURN
14600 REM WASHING.
14605 DI = 128:D2 = 64:D3 = 5:D4 = 3644:GOSUB 9000
14610 POKE—3709,A5:POKE—3708,A7:POKE—3707,A2:POKE—3706,A
14615 POKE—3705,A:POKE—3704,A:POKE—3703,A7:POKE—3702,A7
14620 POKE—3645,A2:POKE—3638,A:POKE—3581,A
14695 RETURN
14700 REM OREGON
14705 DI = 192:D2 = 64:D3 = 5:D4 = 3453:GOSUB 9000:POKE—3326,A
14710 POKE—3518,B4:POKE—3517,A:POKE—3454,A:POKE—3447,A
14715 POKE—3391,B4:POKE—3390,A:POKE—3383,A:POKE—3327,A
14720 RETURN
14800 REM CALIF.
14805 DI = 192:D2 = 64:D3 = 3:D4 = 3199:GOSUB 9000
14810 DI = 128:D4 = 2942:GOSUB 9000
14815 DI = 192:D2 = 65:D3 = 4:D4 = 2749:GOSUB 9000
14820 DI = 0:D2 = 0:D3 = 3:D4 = 2554:GOSUB 9000
14825 POKE—3263,A:POKE—3262,A:POKE—3200,A5:POKE—3195,A
14830 POKE—3136,A2:POKE—3072,A:POKE—2943,A2:POKE—2879,A2
14835 POKE—2874,A:POKE—2810,A:POKE—2809,A:POKE—2750,A2
14840 POKE—2744,A:POKE—2685,A8:POKE—2679,A:POKE—2620,B1
14845 POKE—2555,B1:POKE—2490,A8:POKE—2489,A8:POKE—2488,A8
14850 POKE—2487,A:POKE—2815,B1
14895 RETURN
14900 REM ALASKA
14905 POKE—2361,A
14995 RETURN
15000 REM HAWAII
15005 POKE—2233,A
15095 RETURN
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Chess Machine Survey

There has been a great deal of discussion recently about the value of the chess programs available for microcomputers. Although many chess machines have been reviewed in magazines, few critics have been competent chess players and the machines have been assessed in terms of technical merit or by being played against each other at low levels; alternatively, international masters — who can beat the machines easily at any level — have been called on to endorse the programs. J F White redresses the balance as one who can play the machines at their own level.

MY OWN interest in chess machines dates back to the days of mainframe programs. Although I am a reasonably strong club player, I prefer opponents who are always ready when I am, and can be switched off when the position becomes difficult. I have tried to keep up with all the new machines as they are marketed.

Historically, the original purpose for programming a computer to play chess was to provide an insight into the working of the human brain, to mimic the means by which a human assessed a complex, analysable situation.

The first programs were written for mainframe computers — the chip was not available — and I can still recall an international game between the best Soviet program and the best U.S. one.

As you might expect, the U.S.S.R. has taken a particularly keen interest in chess programming a computer to play chess was master has said that its players are almost computerised already.

Rapid developments

The Soviet machine won, but the standard of play was so poor that a novice might have done better. Developments in both programming and technology followed rapidly, although not so fast that English master David Levy was to lose his bet, placed in the late 1960s, that there would be no machine program capable of beating him within 10 years.

Nevertheless, by 1975, machine programs had been developed which could beat many human opponents, as was demonstrated in a tournament in the U.S. that year. The present generation of chess machines is capable of giving any competent chess player a good run for his money, and it was the advent of the chip which brought those programs into the home.

Characteristic method

The first machine on the U.K. market was Boris which altered its level of play by setting a clock — the longer the time of thinking, the longer the ply search and the greater the depth of thinking.

Boris was introduced in 1978. In March of the same year, Dan and Kathe Spracklen in the U.S. invented the Sargon program in Z-80 assembly code. It won the 1978 U.S. championships for microcomputers.

Sargon has a characteristic method of play, and has been developed and used in subsequent chess machines. The Chess Challenger series has a style of play similar to that of Sargon.

Features of Sargon and Chess Challenger are an obsession with doubling-up the opponent's pawns and avoiding doubling its own, moving the queen into a better position behind its pawns and advancing passed pawns.

The strategy of the chess programs has been to award points for winning the opponent's material, for defending its own, and for controlling or defending the squares of the board, especially at the centre.

According to the level of play, the program thinks about an increasing number of responses to its move, i.e., if I do this, the human will do that, so I shall move another, and so on, but the huge number of possible moves in chess makes pre-selection of some moves essential and they are analysed in greater depth — the so-called ply search.

It is very hard for a program to see that if, instead of taking a rook now — win of many points — it sacrifices three pawns in succession — loss of points — it will win the opposing queen.

Complex analysis

To see the winning of the queen would require analysis of the moves of some $(32)^4 \sim 1$ million pieces — assuming all 32 pieces remain on the board — whereas an early selection of the best ply move, which would require much less memory, would rule out the loss of pawns in favour of the acquisition of a rook.

A greater problem is the assessment of a position, and even the best present programs tend to become poorer in the endgame. I have seen a machine advance a pawn steadily onwards, straight towards the opponent's waiting king.

It could not see far enough ahead to

realise that the king could take it while advancement of a pawn scored high priority in its general program.

Nevertheless, a remarkable feature of the best programs is that they give a good game at all the higher levels — increasing the time spent at a level, or the depth of search at that level, is subject to the law of diminishing returns owing to the increasing number of possibilities which have to be considered, or owing to the wrong selection of a ply search in the first place.

Better positions

The result of the program's calculations is that it keeps moving pieces into what it regards as better positions. Although capable of executing simple combination moves, even the best programs are as yet incapable of forming long-term plans.

That means the better machines are superb at defending, where no plan is generally needed, but much poorer when attacking as well as in the end-game.

Contrary to widespread reports, the better machines do not have an obsession with attack, although it is a feature of the simpler programs with their lesser emphasis on positional points. Because the machines cannot form a plan, the motive for every move can always be seen by a little inspection.

It must, therefore, be emphasised that the machine cannot beat you in the sense that a human opponent can — you beat yourself by overlooking an obvious move by the machine.

That is not to deny that the machines have any useful purpose, since they greatly improve the precision of your play by forcing you to study all its possible moves.

Unlike a human opponent, the machine cannot overlook anything. In the complicated middle of a game, the machine can calculate better than a human who should aim to win by adoption of a plan or by positional play, rather than simply by trying to secure superior exchanges of material.

Sophisticated graphics

Of the present machines, on cassette for use on microcomputers, we have Microchess and Sargon chess. The former can be used with 6502 or Z-80 CPUs, but has been severely criticised recently for its fixed response to moves and its poor level of play. It is suitable for beginners only.

The Sargon chess program is available only for machines with Z-80 CPUs. It combines six levels of play with sophisticated graphics which suffer from the problem of putting black and white pieces on black and white squares, giving a confusing mixture of types to surmount the problem.

There are no book openings pre-programmed but the level of play is good. I should estimate that the play is about equivalent to that of a Chess Challenger 7 at the corresponding first three levels, but the response time is slower — level two takes an average of one to two minutes; level three, which considers three consecutive moves, is worse, and level six is excruciating.

Remarkably, the original program uses only 8K of memory, and will run, for example, in a TRS-80 16K Level II. The cassette costs about £16, although a newer version, winner of the 1979 championship, is available for £28.

With hardware, as far as the chess machines go, it may be said that you get broadly what you pay for. In the lower range, is Videomaster Chess Champion, £55 — at present only £35 from Comet — and Commodore Chessmate — about £50. They are suited best to beginners, being considerably weaker than the Chess Challenger 7.

The Chess Challenger series, 7 — seven levels — 10 — 10 levels — and Voice — 10 levels — respectively £100, £160 now discontinued, and £250, are all closely related, the first two being based on a Z-80 microprocessor and the Voice on a Z-80A.

The Voice is, therefore, about twice as fast as the others, and the program has been slightly improved. The Voice can speak all its own moves and your responses, which is helpful for the blind, but can otherwise be very irritating.

A measure of the power of the Voice is its 96K ROM and 8K RAM, excluding that dedicated to the voice, which would put it out of the reach of most microcomputers even if it were available on cassette. The standard of play of the Chess Challenger 7 and Voice is very good.

Tournament standards

Tournaments against human players have put their standard, at the highest level, at about that of the average-to-good club player. Even international master Hartston, known to readers from the BBC *Master Game*, referred to the Voice as "a very good toy" at its launch in 1979.

The Challenger is pre-programmed with several book opening moves and it is also possible to establish your own position and watch the machine react.

In addition, like all the better chess machines, there is a random facility enabling the program to choose its own response from several of roughly equal value. That makes each game different. Even the lowest level is superior to Microchess, and I greatly enjoy games of lightning chess against it — each move to be made within 10 seconds.

Unfortunately, at the higher levels, the response time becomes increasingly slow. On the Chess Challenger 7, at level six — best play, average response time, six minutes — it can take an enthusiasm-destroying 30 minutes for one move in a complicated position. The machine varies its response time according to the complexity of the situation.

A typical game at that level can take five to seven hours, including the one hour spent by the human: it is difficult for the latter to concentrate for that length of time and lapses of concentration are punished heavily.

Infuriatingly, after all that time, the Voice reminds you at short intervals to "make your move" in a Dalek-like voice, which would not be allowed in a human game and is a strong inducement to turn the speaker off, thereby wasting the extra money which you have spent on the feature.

This year more chess machines have been launched. A new Chess Champion, £155, is reputed to be superior to any of the previous machines except the Challenger series, and has the added attraction of a chess-board display, £107, and a print-out of the game, £105, as optional extras.

Response times

The other is the Sargon 2.5, £280, manufactured by the maker of the pioneering Boris — now withdrawn after heavy criticism of its high price, £180, and comparatively poor play — and available as a cartridge which can be removed and replaced for a superior version at a later date without replacing the hardware.

The level of play of Sargon 2.5 is superior to that of the similarly-priced Voice but is without the ability to speak. It is much faster — average response time at the top playing level is two minutes.

Sargon 2.5 will probably stretch the ability of all club players at that level. It has a random choice of moves and can store positions for long periods — useful if the game has to be interrupted.

The most recent arrival on the chess computer stage from Hong Kong, the Super System III, is available with every conceivable user facility. As well as the basic chess computer at £155, it is also possible to buy a computer-operated board on which the pieces are displayed, £107, and a printer which can be used to list the moves shown on the board to give a permanent record, £105.

In addition, further options include a memory pack which will hold an uncompleted game for up to a year and a battery pack for travelling.

Fixed-period moves

Super System III is claimed to be the first machine available on the domestic market which obeys all the rules of chess. It recognises a stalemate after repetition of three positions or after completing 50 moves without a piece being taken or a pawn moved, as well as castling, *en passant* and promotion of a pawn — which is not automatically to a queen; you are offered the choice if the pawn promoted is yours.

It differs from Sargon and Chess Challenger in that the moves are made after a fixed period of time, which can be

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set between zero seconds and 99 hours.

The advantage is that it is possible to tell exactly when the machine will make its move, avoiding the frustration of waiting up to half an hour for a move supposed to take an average time of six minutes with other machines. The disadvantage is that the machine may need to show its best move when the time is up without having completed its ply analysis.

Random choice

The memory of the Super System III consists of 8K ROM and 1K RAM, inviting comparisons with the early Sargon program. At longer response times, i.e., around 10 minutes, the designers claim that the level of play is equal to that of the Voice Challenger. In some respects, though, its play at lower response times seems to be poorer.

As far as I can tell, no book-openings have been pre-programmed and the manual makes no mention of the machine possessing a random choice between moves of equal value. I have not been able to play it often enough to tell whether identical opening moves are always met with by identical responses.

Compare the following plays to Super System III at response of one minute and Chess Challenger 7 at level two — average response time 15 seconds — the CC7 was first adjusted to overcome the pre-programmed book opening:

	White (Author)	*Black* SSIII	*Black* CC7
1	d2-d4	d7-d5	d7-d5
2	c2-c4	d5xc4	d5xc4
3	e2-e4	g8-f6	g8-f6
4	b1-c3	b8-c6	b8-c6
5	e4-e5	c8-g4 ??	f6-g4
6	f2-f3	g4-e6	—
7	e5xf6	d8xd4	—
8	d1xd4	c6xd4	—

Within seven moves, the Super System III has managed to lose a knight with little compensation, although my next few moves were rather difficult. The Chess Challenger 7 avoided the trap.

Much has been said of the game between the world champion Karpov and a Super System III in West Germany. Karpov was a rook down and should have lost, but the machine made a frightful blunder which enabled Karpov to give checkmate — the Chess Challenger 7 finds the correct move at all levels, including the lowest.

Simultaneous exhibition

Unfortunately, it seems clear from an analysis of the game that Karpov's earlier loss of the rook was due to a blunder of hs own, when under no pressure, and not to any brilliance by the machine.

Karpov was one of several grandmasters giving a simultaneous exhibition againt 25 Super System IIIs each, so that the Super System III had plenty of chances of securing at least a win — all of which it missed as have all the other chess computers available on the domestic market.

Two new chess games have just been announced by Optim Games. The first, called Intelligent Chess, was designed with the aid of Davy Levy and has a built-in tape recorder allowing it to replay games on a colour television. It will retail at about £295. The company intends to release another, less sophisticated chess game early in the autumn for £39.95.

Conclusions

- **All-in-all, the Super System III is a competent machine with many fascinating extras — the perfect gift for the man who has everything.**
- **In terms of pure chess-playing ability, though, the main unit may not perhaps be such good value as the Chess Challenger 7 and Sargon 2.5.**
- **Addition of the LCD board and the printer obviously reduces the value for money for a chess purist who does not mind moving pieces and writing down his own moves.**
- **Computer, board and printer are available for £370, which includes an attache case to carry the units.**
- **For a serious chess player who can afford it, Sargon 2.5, £280, is a must.**
- **Chess Challenger 7, £100, is also fine value for money, albeit slower and weaker than Sargon.**
- **If you have a Z-80-based microcomputer with 16K user RAM, the Sargon cassette, £16, seems a good buy.**

Junior Minister outlines plans for computing in schools

As Parliamentary Under-Secretary at the Department of Education and Science, Neil Macfarlane is closely involved with Government plans to promote the use of microcomputers in schools. In this interview with Paul Fisher, the Junior Minister explains how the Government sees those plans developing.

PF: How high a priority does the Government give to computer education at secondary and primary level?

NM: It gives a high priority to the increasing awareness of those facilities as appropriate within the limits of public expenditure. There is obviously a limiting factor within most western economies at the moment and ours is no different. The general thrust of Government economic strategy is well known so it is not surprising that we are having to watch our pennies at the Department of Education and Science.

However, one has to understand that many local authorities have been pursuing their own programmes for a general computer education for a number of years. At the same time, one has to acknowledge that the Department of Industry and its education unit have also provided additional back-up.

The increase in our activities in microelectronics, the formation of our advisory group and the £9 million to be spent over the next four years is, we hope, putting some cream nearer the top.

PF: Are you satisfied that enough money is being spent?

NM: Within the limits of public expenditure, yes, I am. The local authorities have already spent several million pounds. I'm very encouraged by what I've seen over the past 12 months and am most impressed by the degree of expertise which exists in many local authorities.

We are now trying to organise an infinitely closer relationship between the worlds of industry and education, starting with our regional conferences later this year. We are having 10 such conferences which will cover all 105 local authorities. We've latched into local industry and the links we are fostering will obviously involve a good deal of microelectronics activity. I hope the pace of change over the next few years will be well understood by schools and that industry will march a long way towards helping them. It is now up to the Department of Education and Science to provide co-ordination throughout the country and to monitor what is happening through the director.

We're not doing badly in this country and we hope that by adding the £9 million we shall really be ahead of the field so far as western Europe is concerned.

PF: Do you have any figures for how much is being spent overall on computing in secondary education?

NM: No, I don't. Most polytechnics have 30 or 40 micros and the majority of further education colleges have two or three. In the university sector, the current costs are met by the Computer Board which last year spent some £13 million on equipment and £20 million on recurrent costs.

So far as schools are concerned, we would not really have a detailed and accurate figure. Some local education authorities are spending a considerable amount. We hope that over the next year or so our microelectronics advisory group and the director will have a greater awareness of what is being spent.

PF: Could you tell me about this advisory group?

NM: It had its first meeting on Friday, July 25 and was chaired by one of our Under-Secretaries, Mr Halsey. It includes those who have had experience in teaching both in the private and the maintained sectors of education. We've Mr Coll of Oundle School, Mr Clements of King Edward Fiveways, Mr Esterson from the Inner London Education Authority, Mrs Fraser from the College of St Mark and St John and Mr Fairbairn of the National Computing Centre.

Since joining Parliament in 1974, Neil Macfarlane has sat on the Select Committee on Science and Technology, was a member of the sub-committee assessing science and technology in Japan and has held his present position since 1979.

Then there are the departmental members from the Inspectorate, Mr Mann of the Schools Council and of course our friends from the Council for Educational Technology and the Department of Industry. It will meet six times a year and, along with the full-time director, will be a good focal point for all local education authorities.

Baroness Young and myself will obviously take a very close interest in the work of this committee but we shall all largely be in the hands of the director. While we shall be considering the importance of equipment, the day-to-day points will be in the hands of the director.

PF: *So, if there is any attempt to standardise equipment, that will be decided by the director?*

NM: Yes. That's a difficult one because so many have got so far down the road and have their own programmes lined-up for the next few years. I think that the biggest difficulty will be in persuading members of staff who haven't had a hand in computing to teach themselves so that they understand it.

PF: *Do you see a role for some kind of guru? I'm thinking of a person who knows a good deal and could administer a software library and answer specific technical questions.*

NM: I don't think so.

PF: *Has any of the £9 million been spent yet?*

NM: No, it hasn't, but as I said, money is constantly being spent by the local authorities. We are now in a position to really take off in the next year or so and I hope that the local authorities will keep that momentum going because it is important even in these days of restricted public expenditure.

PF: *Why was it decided not to spend any of the £9 million on hardware?*

NM: In many cases, the purchasing of hardware has already been completed. What could well prove an important exception is that some of the programme's resources could be devoted to work in special educational fields.

Little electronic equipment has been designed for children with special educational needs. I think that at the moment, while we have announced the money, it is up to the experts, the director and his committee, to determine how that money is spent.

PF: *How important are competitions?*

NM: They are not an important part of the Department of Education and Science approach but they certainly are so far as private enterprise and, to a lesser extent, the Department of Industry. Our responsibility is to ensure that there is equal coverage and that all local education authorities have a share of the cake.

PF: *What do you think of the French approach of installing a microcomputer in every school?*

NM: I went over there for three days at the end of March and I saw the French Science Minister and visited their centre just outside Paris. At the moment, their scheme to distribute 40,000 microcomputers is at an embryonic stage. The time to look will be early next year.

The French education system and our own are totally different. Theirs is controlled from the centre by government. Here, we work through the local education authorities. We are a policy department rather than an executive department, so it is very difficult to compare.

PF: *Is there to be any significant change in the central Government role in the administration of a microelectronics programme?*

NM: So far as the Department of Education and Science is concerned, no. The role of the local authority, as enshrined in the 1944 Act, is the authority for that area. While this department can provide further top-up and back-up, it certainly would not be for it to dictate to a local authority what equipment it should purchase and how a particular course should be taught.

PF: *What kind of computer skills do you think should be promoted in schools?*

NM: Well, I think that the real importance of computer studies is that they are a fundamental mind-training activity and that they also have to be useful to most pupils in their adult lives.

Even if you have a competent mathematician, that person may not necessarily have a total flair for handling and working with computers.

I think that what many people will be looking for is a certain flair in a person to understand just how these skills have been developed.

PF: *So you don't see computer studies related to any particular subject?*

NM: Well, not essentially. I think that our microelectronics programme will concentrate on business studies, craft design technology as well as mathematics and the sciences. Certainly, the skills applications thereafter will be determined largely by a person's flair in this field.

Some months ago, when I was talking to a businessman, he said he wished his son had been taught typing at school because he thought it would have helped him. I am not going to pass judgment on that except to say that I think if anybody wants to learn typing, they don't necessarily need to expect the school to teach it to them. They can do it by buying an old typewriter and learning it in their spare time.

PF: *So, how important do you think it is that children have a chance to use a computer?*

NM: I think it is very important, even in the latter stage of primary education. I would suggest that a general awareness of what can be done is essential from about the age of 10 or 11.

PF: *It seems remarkable to some people amid all the other cuts, one of the things which is being favoured is microelectronics.*

NM: Yes, I think it is. There has been the announcement of the money to Inmos and the fact that over the last year, and during the next few years, the Science Research Council budget has been held. The Science Research Council is involved in computer science so we reckon that by 1983/4, the expenditure will be some five percent above what it was in 1978/9.

Some four or five years ago, when I was a member of the Select Committee on Science and Technology, I was taken to a valley in California and told that this new substance was going to revolutionise our work and lifestyle. I found that there were five Britons working on that project. I just wish somehow we could have kept them in this country.

PF: *Perhaps Inmos will grab them back?*

NM: I think that is a distinct possibility.

Making Tuscan communicate with the outside world

This month, Mike Hughes discusses the design of the Transam Tuscan input/output circuitry — the eyes, nose, ears and mouth of the system.

PUTTING memory into a computer presents no problems whatsoever. It is only necessary to decode — from the high-order address lines — chip select signals which tie in with the organisation of memory within the chips.

The low-address lines are paralleled to all the memory chips to select the required byte of memory and the chip-select line activates only the chip in question — figure 1.

General method

Random access memory, RAM, and read only memory, ROM or EPROM, are managed in near identical ways — the only differences is that RAM requires two strobe lines, memory read and memory write, to differentiate between the two complementary operations while ROM needs only a memory-read strobe — for obvious reasons.

I had already devised a general method to isolate the on-board system with data buffers from the S-100 busbar so it required very little design effort to arrange the protocol of address lines and chip selects for memory within the on-board system.

The only problem I would face was the actual lay-out of the reasonably large number of chips — we had decided to use type 2114, 1K by four bit, chips for the RAM and type 2516, 2K by eight bits, chips for the on-board EPROM. To provide 8K of each required 16 of the 2514s and four 2516s.

The part of the system which still required thought was the I/O circuitry. Probably because I am more interested in hardware than software, I always find I/O systems the most rewarding parts of a computer to design. Once one has designed the fundamental system, they are also quite easy to understand and handle.

While memory is akin to the computer's brain, the input/output system equates to its eyes, nose, ears and mouth and is used to communicate with the outside world.

Required versatility

From the outset, we had decided that Tuscan should have a high degree of I/O facility on its main board to give it the versatility we envisaged end-users would require. Obviously, we had to make provision for communication with the system and, therefore, had to allow for keyboard entry and a means for the system to talk back — through a video display unit.

That would be the bare minimum for someone who wanted a single-board home computer but clearly, we had to go some way further to provide a means of saving programs on tape. That would require a means of serialising data — converting it from 8-bit parallel bytes to a series of pulses down a single line — and converting it by modulation into a form which may be recorded on audio tape.

To complement that, one would also need a system to receive data played back from tape, demodulate it into a series of pulses and then re-form it back into parallel 8-bit data to go back into the computer.

Transam had also specified an RS232 serial I/O option for use with an external terminal or with serial input printers. RS232 is simply a standard for serial transmission of data and specifies that the logic levels should be represented by voltage swings between +12V and —12V — as opposed to the more common logic levels of +5V and 0V.

The RS232 interface would require parallel-to-serial and serial-to-parallel converters for the output and input respectively, together with a level converter to change TTL levels to RS232 standard and an interface to convert RS232 back to TTL levels.

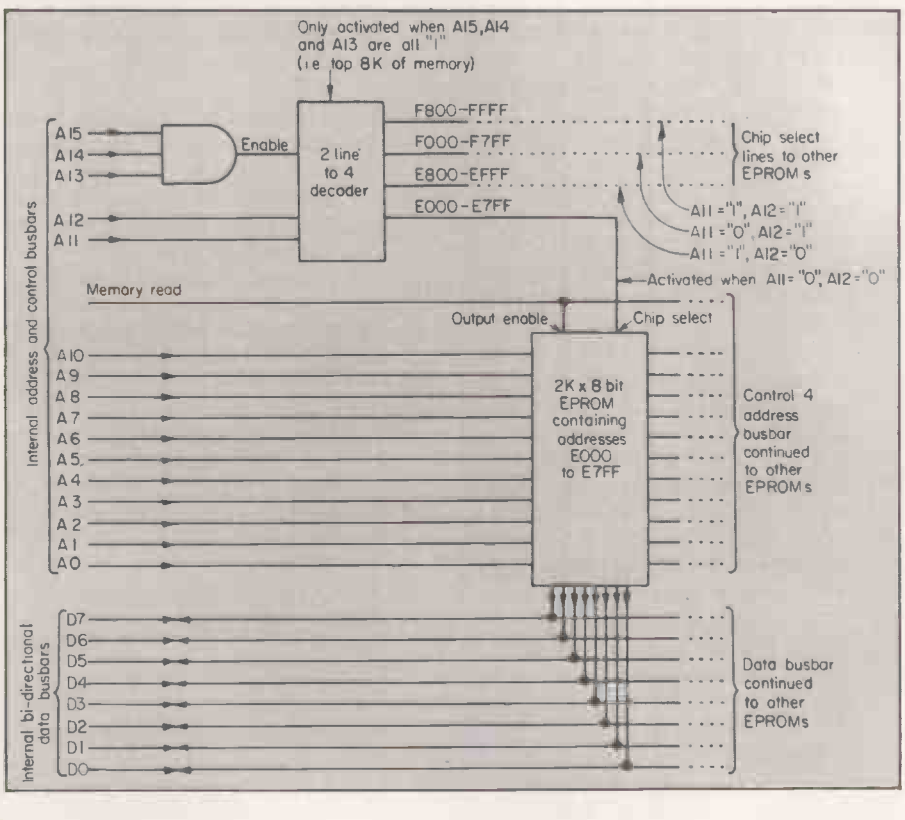
Port address

The Z-80, like the 8080, allows up to 256 input and output ports which can be addressed independently. The address of a port is carried on the bottom eight bits of the address busbar and, because I had modified the Z-80 address busbar to simulate an 8080, the I/O port address on Tuscan is duplicated on the top eight bits.

By and large, an output port consists of a single or set of up to eight latches which take, as their input, the signals on the internal data busbar. The gating of those signals into the latches is arranged to occur only when that particular port is addressed and when the I/O write strobe of the control bus is active.

Sometimes the set of latches can be disguised within a specialised circuit which performs other functions, for example, a serialiser. The outputs of the latches take up the condition of the inputs at the time of the I/O write strobe and hold the data stable until such time as it is changed by a further output operation. While the data is stable on the outputs, the outside world

Figure 1. High-order address lines decode individual chip signals while low-order lines are used to address locations within the chip.



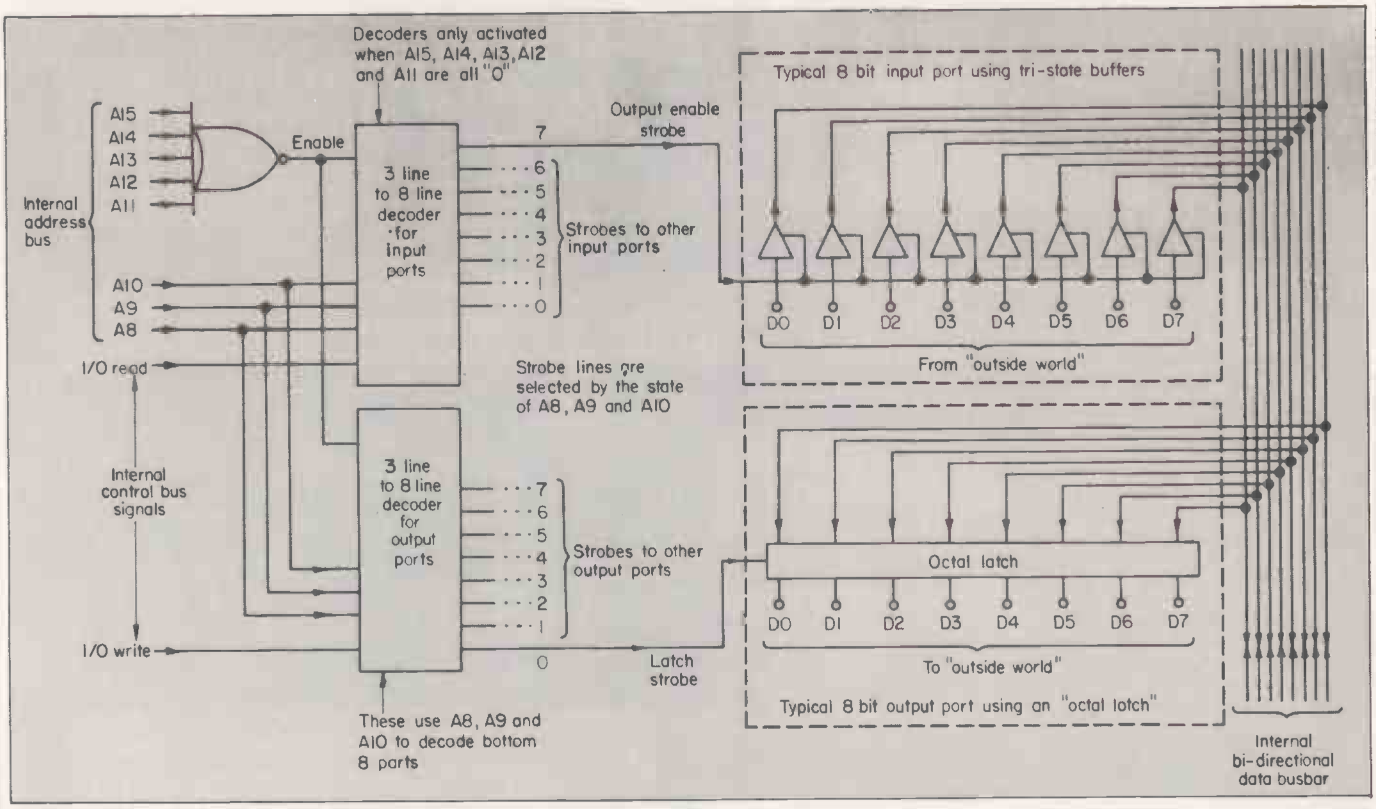


Figure 2. Input and output ports often take this form but there are many variations and the latches and buffers might be contained within a multi-function IC, e.g., a UART.

can use it as a steady source of information.

An input port, on the other hand, is usually a set of tri-state buffers — sometimes tri-state latches — feeding into the internal data busbar. The outside world can place data on the inputs to the buffers but their outputs are held in a tri-state condition — ensuring that they do not influence the data busbar until the port is addressed and an I/O Read strobe is generated on the control busbar.

In some respects, I/O ports resemble memory elements which can be written to or read from; they differ only in that there are not so many of them and that they convey information to and from the outside world.

Many types of microprocessor, unlike the Z-80 or 8080, require one to use certain reserved memory addresses to designate I/O ports — this fact underlines the similarity in operation.

On-board system

By chance, the way I had decided to identify addresses of the on-board system, to control the on-board data buffers, made the on-board system respond not only to the top and bottom 8K of memory but also the bottom eight I/O ports — eight input and eight output. I would require one input port to handle the keyboard and one output port to control the on-board VDU.

To serialise data for the tape, or communications, modulator/demodulator (Modem), it was most cost-effective to use a UART (Universal Asynchronous Receiver Transmitter).

A UART contains an output port to feed the serialiser and an input port to obtain data back from the serial to parallel converter. It also contains a second input port which provides data which describes the current status of the UART — whether it is ready to transmit, whether it has received data or whether any error conditions such as parity or framing errors exist. I would need a second UART to handle the RS232 interface and it would have the same three types of ports as the Modem serialiser.

So far, the number of ports required totted up to five input and three output and I had provision within my block of addresses for a further three input and five output ports. It seemed a shame not to make use of them.

Further discussion revealed the need for a spare 8-bit parallel output port to be used as a possible interface to parallel input printers of the Centronics type. It might need a strobe associated with it which could be produced by another single-bit output port.

For good measure, we decided to put that in and, at the same time, use the remaining three output ports as single-bit ports for general-purpose applications. They might be for switching relays in control applications or to output waveforms — music and the like.

By this time, Brendan Owen had been getting on well with the development of some monitor firmware for the machine but had run up against a self-inflicted problem. We had conceived Tuscan with so much system flexibility in mind — on-board VDU; S-100 memory-mapped VDU, internal keyboard, external terminal operation, Centronics or RS232 printer options and 2MHz or 4MHz clocks that he did not know which system the monitor ought to be designed to cope with.

As we had 2K of EPROM available for that monitor, we thought it might just be feasible to cope with all the options at the user's discretion and to do that, Owen wanted a four-bit input port which could have data set-up on it by means of a set of switches. That would define the system configuration.

General purpose

Early on in the system's initialisation, the monitor would look at this switch and configure itself to the system set-up by the user. It seemed a good idea anyway. That left two spare input ports which we decided to make general-purpose single-bit ports to be used for handshaking operations or to convey control data back into the computer from any external process-control operations.

Producing the 16-port select signals presented no difficulty and utilised only two chips — figure 2. They were both to be 74LS138s — three to eight line-decoders with two enabling inputs. The master signal, which identifies when the bottom eight ports are being addressed, already existed in my on-board system address circuit and could be used to feed one of the enabling inputs of each of the decoder chips.

The second enabling input of each could be fed by I/O read and I/O write

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respectively. In that way, one of the chips would produce eight input port strobes to activate the port tri-state buffers while the other would produce eight separate strobes to drive the output port latches.

The eight lines of each chip would be selected by the bottom three address lines. Following that, everything was plane sailing and it was only necessary to decide on the organisation of buffers, latches, and the two UARTs to make up the complement of I/O.

Because UARTs serialise data, that must be done at a pre-determined speed as different types of external device might wish to receive, or transmit data at different bit rates — figure three. With hindsight, we realised we had made a slight mistake with Triton by allowing a variable setting of the baud rate. That was a problem for the home constructor with no access to precise frequency-measuring equipment and it made necessary complex instructions and sample tapes to aid the setting-up.

Baud-rate range

This time, we were determined to have all baud rates crystal-controlled and locked to the master clock. To provide versatility, we needed to provide a range of different baud rates which would match most conceivable contingencies.

The UARTs we were to use required clocks which were sixteen times the frequency of the desired baud rate and, for the sake of standardisation, we wanted these to fall into the binary series of 4,800, 2,400, 1,200 baud.

To obtain the highest of our baud rates would have required a clock frequency of 76,800Hz whereas our master clock frequency would be either 2 or 4MHz. Using binary division techniques, there is no way one can produce a precise 76.8kHz from 2MHz however, by dividing 2MHz by 26 will give 76.923kHz which is not far out and when divided by the factor of the UART would give a maximum baud rate of 4,807.69 instead of the precise 4,800 we were looking for.

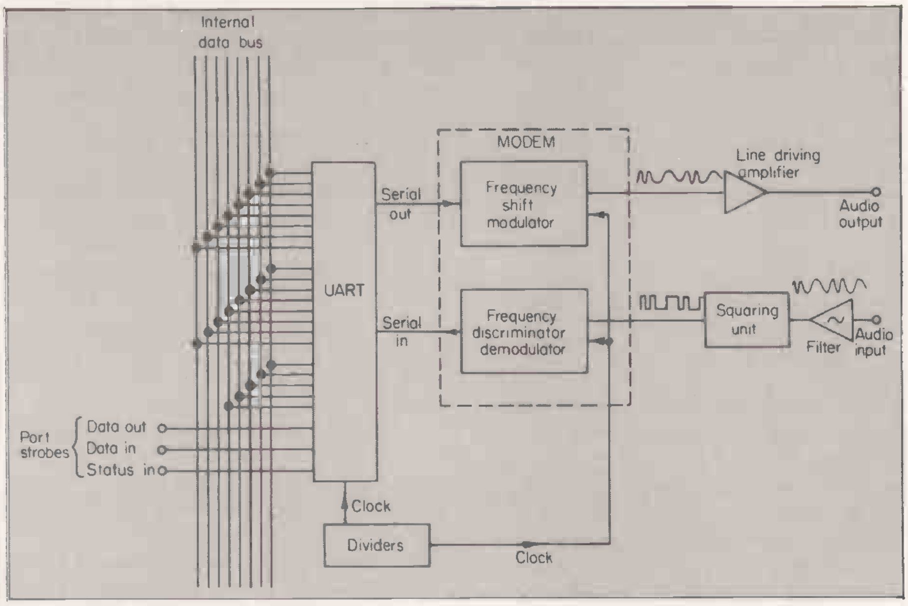


Figure 4. Block schematic of the elements needed to provide a serial communications or tape I/0 device.

Now it is comparatively easy to divide by 26n using binary techniques — a modulo-13 counter followed by a divide-by-two to square up the ensuing non-symmetric signal. So we agreed, very quickly that an error of precision of roughly 8in. 5,000 for our baud rate should be acceptable in most quarters.

Further divide-by-two stages would give us all the binary sub-divisions to give a useful range of baud rates including those at 600 and 300 baud. The latter were important because we had decided to use the same Modem system that had worked so successfully in Triton. This is a single-chip Modem controlled by a 1MHz clock — derived easily from our system clock — which produces internationally-standard frequency-shifted tones to define the logical ones and noughts.

That meant that the Modem could be used for tape recording and for communications purposes, depending on the user's needs. Using the same system also meant compatibility between our systems which could prove useful.

The maximum baud rate the Modem chip would handle, before aliassing problems with the carrier frequency start to occur, was 600 baud but our experience with Triton indicated that, unless very high-quality tape recorders were used, the most reliable data rate for recording purposes was 300 baud — figure 4.

Medium speed

By some standards, that is only medium speed but it did not worry us unduly as the Tuscan system was really designed with floppy discs in mind for program and data storage. Serious users would take advantage of the latter but domestic users, with rather lower budgets, would not find 300 baud much of a disadvantage if they wanted to start with a low-cost system and develop upwards to a disc system.

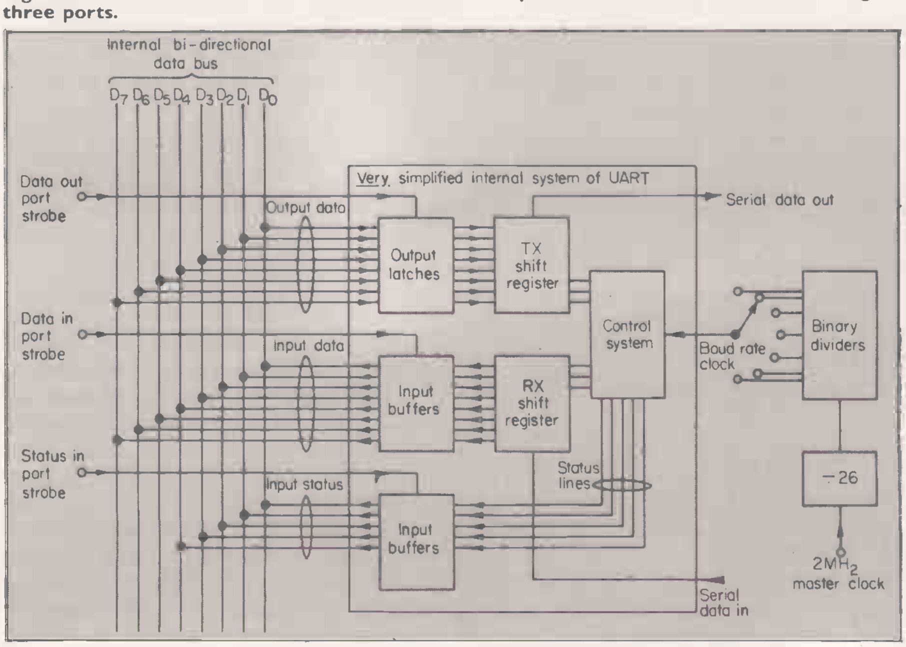
For communications purposes, it would be a real plus to be using standard frequency pairs for transmission and reception and they could easily drive acoustic couplers with very little extra interfacing.

We felt we ought to keep the on-board VDU a simple and straightforward as possible. It never had been the intention to make this a memory-mapped system. It was to be utility but sufficiently useful to handle business and monitoring applications for process control and the like.

Having the S-100 busbar would allow a wide range of alternative VDUs for those who had special applications — including colour, vector graphics, etc. For that reason, we decided to stay with the well-

(continued on next page)

Figure 3. The interface of a UART to a data busbar provides a serial I/O device utilising three ports.



(continued from previous page)
tried Thomson CSF 96364 chip that had done such sterling service on Triton.

We had learnt sufficiently about it to improve over our Triton application and Brendan Owen had some excellent ideas about how he would be able to speed its rate of display through firmware. Looking back after the event, he was able to make the most spectacular increase in speed — effectively 1,200 characters per second and faster than some memory-mapped displays — figure 5.

The 96364 is now available to match various international television standards and it would enable us to offer Tuscan to a wider range of international markets including the U.S., merely by changing this chip and, in the case of the States, the transformer.

Again, for versatility, we decided to use our own character-generation memory in the form of EPROM. By doing that, we could include full upper- and lower-case as well as graphics in a single chip and provide an option for special characters for dedicated, or foreign language, applications.

Block schematic

As the on-board VDU would be operating as an I/O device the whole of its circuit could, if desired, be left out on the final board without interfering with the main workings of the computer. The only thing the user who did not require it would be paying for would be a small area of redundant PCB.

By now, almost all the main-board system had been sketched in block schematic form with detailed circuitry here and there and the time had arrived to check whether the theory would work in practice. I have always hated breadboarding in any shape or form. I find it time-consuming, messy and sometimes misleading — especially when lay-out is critical.

Some parts of the system I knew would work from previous experience — they included most of the I/O, the interrupt system and the memory driving circuits. The big imponderable was the Z-80 to S-100 interface and the master timing. At the frequencies I would be using, I doubted whether a breadboard would be of much value.

On many occasions in the past, I have found it positively beneficial to spend time on converting theoretical drawings into PCB lay-outs before any attempt to test theoretical circuitry. In a strange way, it concentrates the mind and frequently indicates mistakes or omissions — probably because it forces one to refer to data sheets and pin-out diagrams as one goes which can often identify a lost or omitted signal.

I think I must have spent the best part of two months during the latter part of 1979 trying over and over again to fit the semblance of a lay-out on a large — four times life size — piece of squared paper. As I expected, many minor mistakes in the original concept were uncovered in the process but nothing untoward.

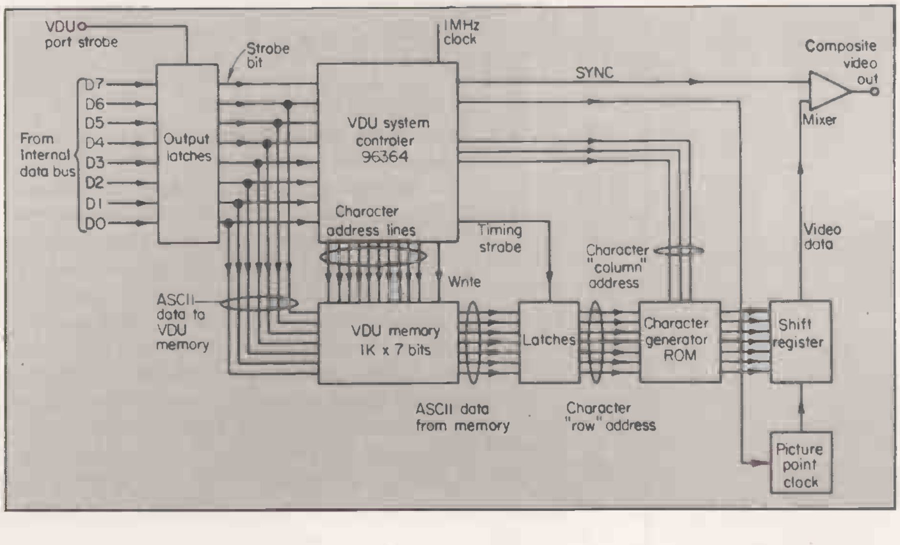
Computer-aided design might be the answer to this time-consuming exercise but the problem is that it presupposes the original design concept is correct. It might produce a wonderful-looking board which does not work.

Relying on the computer to do the painstaking job of lay-out does not force the designer right into the system — he might not notice that parallel pair of lines carrying signals which are going to interact with each other. Perhaps computer-aided design would remove a good deal of the tedium but in the long run, may not necessarily cut the time involved.

Whether or not that is true is irrelevant because I did not have any expensive computer-aided design facilities at my disposal and to help keep myself sane, that is what I kept telling myself.

I think that it was at about the sixth lay-out in pencil that I felt I had the system properly mapped and it fitted within a board area only slightly larger than our initial concept. The moment had now arrived to discuss the whole concept in committee before the design was frozen.

Fgiure 5. Block schematic of a VDU system operating as a parallel I/0 device.



This meeting was crucial because the Transam software specialists now had their first real opportunity to see a consolidated design of the system and identify what they were designing for. At the meeting, I was praying that there would be no last minute changes in design specification — almost certainly that would have entailed a trip back to the drawing board to start all over again.

Fortunately, there were no major design changes although a few minor modifications were suggested and embodied in pencil. The major question, however, was still unanswered — would it work?

Vital decision

Having been over the system time and time again, I was reasonably confident that there were no major mistakes but there might have been a fundamental flaw in the principles I was adopting. It is a very lonely feeling to be the only person at a meeting who knows where the weaknesses are in a design when the decision has to be made to put real money into it.

That is exactly what Transam now had to do to prove the design. To Transam, it was not just a matter of investing a few hundred pounds in making a prototype board; they now had to confirm orders amounting to tens of thousands of pounds for some of the specialised components.

Tuscan would require keyboards, tool work for case manufacture, special transformers, disc drives and power supplies not to mention large stocks of memory chips and other integrated circuits some of which required several months for delivery.

Some of the PROMs and EPROMs I had specified required expensive upgrading of ROM-burning equipment and all that had to be ordered to have it available in time for the system's launch. Until then, Brendan Owen had been working on the framework of supporting software but now he had to concentrate fully on the details because it would now be only a month or so before I had a hardware system ready for test and would be needing a monitor program.

The decision was made; we would freeze the design and venture forward. For my part, I had to convert my scale drawings into precise artwork from which the prototype board would be made. That is easily said but not so easily done.

A clean neat appearance is important, not only for aesthetic quality but neat groupings of busbars can help considerably should any troubles ensue.

It took about six weeks of painstaking work to convert the pencil-drawn lay-out into good quality artwork and, in so doing, I reckon I consumed about two kilometres of tape. Eventually, the job was done and the artwork went off to the board manufacturers and I could return to pen and paper to work out the coding for the all important Z-80 to S-100 encoding ROMs.

Apple Price List

MICROSENSE COMPUTERS MICROSENSE COMPUTERS

Product Code	Description	Price (£)
	HARDWARE	
A2S1016P	APPLE 16K VIDEO OUTPUT ONLY	695.00
A2M0003	DISC DRIVE WITHOUT CONTROLLER	299.00
A2M0004	DISC DRIVE WITH CONTROLLER	349.00
A2M0016	16K ADD ON RAM	69.00
	CARDS & ACCESSORIES	
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A2B0002	PARALLEL PRINTER INTERFACE CARD	104.00
A2B0003	COMMUNICATIONS CARD	130.00
A2B0005	HIGH SPEED SERIAL INTERFACE CARD	113.00
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MHP-X007	MOUNTAIN HARDWARE ROM PLUS BOARD	116.00
MHP-X015	MOUNTAIN HARDWARE ROMWRITER	101.00
E2B100	EUROCOLOUR CARD	79.00
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E2B102	A1-02 DATA ACQUISITION CARD	180.00
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A2M0019	PROGRAMMERS AID 1	27.00
A2M0027	AUTO START ROM PACK	38.00
A2M0029	GRAPHICS TABLET	462.00
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E2B107	IEEE INTERFACE	212.00
	SOFTWARE	
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A2D0010	DISC UTILITY PACK	15.00
A2D0012	APPLE BUSINESS CONTROLLER PROGRAM	340.00
A2D0013	APPLE POST PROGRAM	27.00
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A2D0026	APPLE WORD PROCESSING PROGRAM	42.00
A2T0013	MICROCHESS 2.0 CHESS CASSETTE	15.00
E2D001	VISICALC DISC & BOOK COMPLETE	95.00

Product Code	Description	Price (£)
	DOCUMENTATION	
A2L001A	APPLE II REFERENCE MANUAL	11.00
A2L0002	6502 HARDWARE MANUAL	9.00
A2L0003	6502 SOFTWARE MANUAL	9.00
A2L0005	APPLE II BASIC PROGRAM MANUAL	6.00
A2L0006	APPLE II REFERENCE MANUAL	6.00
A2L0012	DOS 3.2 MANUAL	6.00
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A2D0000	(10) BLANK APPLE DISCETTES	32.40
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APPLE COMPUTER SYSTEMS APPLE COMPUTER SYSTEMS

Finding significant trends with the Runs Test

Owen Bishop shows how the Runs Test on the micro can be used to detect clustering and significant trends in business and survey statistics.

EARLIER articles in this series in November and December 1979 have demonstrated that a good deal of useful statistical analysis can be done by microprocessors — even with such small systems as the Science of Cambridge MK14. The tests described in those articles have all belonged to the group known as distribution-free tests, or non-parametric tests. Their main features make them ideal for microprocessors:

- The amount of number-crunching required is minimal; microprocessors are not really designed for number-crunching so that makes things easier for them.
- The amount of listing, sorting and ranking of data is large; those jobs are done easily by microprocessors, so we are making the best use of their special capabilities.

Those reasons alone are not enough to justify using distribution-free tests to analyse data, but there are sound statistical reasons which make this kind of test the only really acceptable one for many types of data.

That point was dealt with in November 1979. There, an example of a distribution-free test was given in the form of the Runs Test. Essentially, the function of that test is to look at a series of events of two different kinds and to assess whether or not the events of one kind tend to be clustered together.

House survey

An example was given of a street of 20 houses surveyed to find what brand of TV set was installed. A house with brand A was scored '1' and houses with other brands were scored '0'. The result of the survey might have been:

11100011111110001000

The question is: "Are the houses with a brand A set clustered together more than we would expect than if the '1's and '0's were simply scattered at random along the street"? If there are, it could be interpreted as meaning that people tend to copy their neighbour over the matter of choosing a TV set.

Another example could be a record of rainy days during a given month. If '1' means rain and '0' means no rain, the record might be:

00000111110000001111000000011111

runs
or spells
1 2 3 4 5 6

Here we have 14 rainy days, 17 dry days, and six runs, or spells, of weather of one kind or the other. Does our weather tend to occur in spells? If it rained yesterday, should I take my umbrella when I go out today, even though it is not raining at the moment?

Obviously, if the record has been

001010101101100011101010001000 1

We would say that there is no rhyme or reason to the weather, and take the umbrella anyway, just to be on the safe side.

The Runs Test tells us just how few runs there must be to show the clustering effect is significant. For six runs in 30 days the effect is significant — our weather tends to occur in spells. For 20 runs, as in the second example, it clearly is not.

A table of the critical value of runs has been calculated and shows that for 30 events, seven runs or fewer is highly significant — p= 0.0006, meaning that you can obtain seven or fewer runs by pure chance only six in 10,000 times, which we can safely ignore.

Business application

Nine runs or fewer are significant for p = 0.007 — only seven in 1,000 chance of obtaining this few by chance — and 11 runs or fewer are significant for p = 0.046 — 46 in 1,000 chance, which most people would consider as still indicating a significantly small number of runs.

If you obtain more than 11 runs, no effect of clustering or rainy spells has been demonstrated.

The Runs Test can also be used in another application — one of interest to people in business, though also of interest in many other fields.

Suppose that the monthly profits in £10,000s from a small business for a period of two years are these, in order:

4 3 4 1 4 7 4 9 4 7 5 1 2 3 1 9 5 5 10 9 9 3 10 7

Is there a trend? Are profits increasing over the two year period? If you plot a graph of the figures, a rising trend is apparent, but is it significant? Opinions are not good enough, but fortunately the Runs Test can give an unbiased assessment of the situation.

The first step in analysing the data is to write it again, in order. In other words, we sort it — something a micro can do in an instant.

1 1 1 2 3 3 3 4 4 4 4 4 5 5 5 7 7 7 9 9 9 9 10 10

Next, we find the median or middle value of the set of data. There is no actual middle value for this data because there is an even number of items. The median falls between 4 and 5.

We can say that all profits of £40,000 and less are below the median, while all of £50,000 and more are above the median.

Now we write the profits, month by month in order and, below each, write a '0' if it is below the median, or a '1' if it is above:

4 3 4 1 4 7 4 9 4 7 5 1 2 3 1 9 5 5 10 9 9 3 10 7
0 0 0 0 0 1 0 1 0 1 1 0 0 0 0 1 1 1 1 1 1 0 1 1

We are back to the Runs Test again for we have 12 '0's, 12 '1's and there are 10 runs. This is too many runs to indicate a statistically-significant effect. Despite the fact that there seem to be more '1's toward the right-hand end of the string, there is no evidence of clustering and, therefore, no evidence that the '0's and '1's are anything other than randomly scattered over the 24 months in question. There is no evidence for an upward — or a downward — trend in profits.

The test can be used to look for trends in any series of data, provided that the trend, if any, is continuously in one direction. The effect of an upward trend followed by a downward one would cancel out the clustering effect.

Then it might be more appropriate to split the data into two sections, one for the supposed upward trend and one for the supposed downward trend, and analyse each separately.

Similar approach

The program, written for TRS-80 II 16K, performs both versions of the runs test. It can be adapted readily to other versions of Basic. It is highly sophisticated when compared to the machine-code program in the earlier article but, nevertheless, goes about the test in much the same way.

The main addition is a routine for accepting a series of numerical data and converting them to a series of '0's and '1's, ready for testing for trend, using the Runs Test.

The program for the simple Runs Test for clustering operates on data entered as a string of '0's and '1's, as in the original machine-code program. In this program, up to 240 items can be accepted into the string.

When testing for trends, up to 100 items of data can be accepted and processed. Data can be positive or negative, integers or floating-point variables. The program works with single-precision variables — up to six significant figures. Any item entered which has more than six significant figures is rounded-off to six figures automatically and the rounded-off amount is displayed and used in the program.

The table of critical values for the number of runs, u, has been calculated for up to 40 items of data, and assumes that the number of '0's does not differ by more than six from the number of '1's. It would be possible to write a program to calculate critical values, given the numbers of '0's and '1's for numbers greater than 20 of each, but these calculations involve computation of factorial numbers and immediately we are in the realms of number-crunching.

The program runs much faster if the table of critical values is incorporated — lines 940-1000 — as it was in the machine-code program, and the value required is looked up by the program — lines 350 to 470.

Although there are ways of short-cutting the calculation of expressions involving factorials, there is no need to bother with them in this case. When there are more than 40 items we can use an approximate method, as follows.

First we calculate a quantity $\mu_u = \frac{2n_1n_2}{n_1+n_2}$ and a quantity $\sigma^2_u = \frac{2n_1n_2(2n_1n_2 - n_1 - n_2)}{(n_1+n_2)^2(n_1+n_2+1)}$

In those quantities, n_1 is the number of '0's — represented by variable NØ in the program — and n_2 is the number of '1's — represented by N1. Finally we calculate

$$t = \frac{\mu_u - u}{\sigma_u}$$

Where 'u' is the number of runs we had, and 't' is the value for comparison with the value of 't' given in the well-known student's table for 't', for infinite degrees of freedom. Those values are incorporated directly into the program in lines 520 to 570, where 't' is represented by variable 'Z'.

On the way to calculating t, the statements are simplified by calculating N2 ($= n_1 + n_2$), and N4 ($= 2n_1n_2$). The value of N3 is the integer of $(n_1 + n_2)/2$ so that, if n_1 and n_2 are unequal, we obtain a value less than their average.

That is used when looking up values in the critical table for 'u'. This means that we apply slightly stricter criteria when deciding how small a number of runs is acceptable as significant.

That helps to offset the fact that the numbers of '0's and '1's are unequal, for they should really be equal for the quoted values of 'p' to apply.

The program warns the user to be cautious about accepting the value of 'p' in those circumstances — line 300. When testing for trend, the warning appears if the number of items is odd, for then the number of '0's must always be one greater than the number of '1's.

Since the difference is slight, the effect on probability levels is only marginal and the warning can usually be ignored. Note that line 290 rejects the data if there are fewer than eight items. With only eight events, even as few as two runs is not

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```
RUNS TEST PROGRAM
10 CLEAR 1000
20 DEFINT H-V: DEFSTR A-D:DIM F(99):DIM G(99,1)
30 CLS
40 PRINTTAB(20)"RUNS TEST PROGRAM":PRINT
50 INPUT"DO YOU WISH TO TEST FOR CLUSTERING (C), OR FOR TREND (T
60 IF A = "C"PRINT:PRINT"CLUSTERING":GOTO 100                 )";A
70 IF A = "T"PRINT:PRINT"TREND":GOTO580
80 PRINT:PRINT"INCORRECT RESPONSE;PLEASE TYPE C OR T WHEN NEXT R
EQUESTED"
90 FOR J=1 TO 2000: NEXT:GOTO30
100 PRINT:PRINT"ENTER DATA IN ORDER AS (0) OR (1). KEY 'ENTER' W
HEN DATA ENTRY IS COMPLETE":PRINT
110 INPUT D
120 C=LEFT$(D,1)
130 IF C="0" OR C="1" THEN 140 ELSE 200
140 U=1
150 IF C="0" N0=1
160 IF C="1" N1=1
170 FOR J=2 TO LEN(D)
180 B=MID$(D,J,1)
190 IF B="0" OR B="1"THEN230 ELSE 210
200 B=C
210 PRINT "INVALID DATA ENTERED ( ";B;" , FOR EXAMPLE)"
220 GOTO100
230 IF B = "0" N0=N0+1
240 IF B = "1" N1=N1+1
250 IF B=C THEN270
260 U=U+1
270 C=B: NEXT
280 N2=N0+N1
290 IF N2<8 PRINT"INSUFFICIENT DATA FOR ANALYSIS": GOTO 90
295 IF ABS(N0-N1)>6 PRINT "NUMBERS OF ITEMS OF THE TWO TYPES DIF
FER BY MORE THAN 6.   VALID ANALYSIS IS NOT POSSIBLE":GOTO 90
300 IF N0<>N1 PRINT" NUMBER OF ITEMS OF ONE TYPE IS NOT EXACTLY
EQUAL TO THE NUMBER  OF ITEMS OF OTHER TYPE. ACCEPT VALUE OF P W
ITH CAUTION"
310 PRINT :PRINT"ZEROS = ";N0,,"ONES=";N1
320 PRINT"TOTAL DATA = ";N2,"TOTAL RUNS = ";U:PRINT
330 IF N2>20 THEN480
340 N3=(N0+N1)/2
350 FOR L=1 TO 17
360 READ M
370 IF M=N3 THEN 410
380 FOR K= 1 TO 6
390 READ X 'DUMMY READ
400 NEXT K,L
410 FOR J = 1 TO 3
420 READ V
430 IF U<=V THEN 460
440 READ X: NEXT J 'DUMMY READ
450 PRINT"THE DATA ARE NOT STATISTICALLY SIGNIFICANT":PRINT:END
460 READ P: W = P*0.0001
470 PRINT"THE DATA SHOW A SIGNIFICANT EFFECT, WITH P = ";W:PRINT
480 N4 = N0 *N1*2                                             :END
490 Y1 = N4/N2+1
500 Y2 = SQR(N4*(N4-N2)/N2/N2/(N2+1))
510 Z = (Y1-U)/Y2
520 IF Z<1.65 PRINTTAB(20)"T = ";Z:GOTO450
530 W=0.05
540 IF Z>= 1.96 W=0.025
550 IF Z>=2.33 W=0.001
560 IF Z>=3.29 W=0.0005
570 PRINTTAB(20)"T = ";Z:PRINT:GOTO470
580 PRINT:PRINT"ENTER ITEMS OF DATA, WITH SIGNS IF NECESSARY.  P
RESS 'ENTER'   AFTER EACH. AFTER LAST ITEM, ENTER 999999":PRINT
590 INPUT "DATA ENTERED =";E:PRINT
600 IF E=999999 THEN 650
610 N2=N2+1
620 PRINT"DATA RECORDED",,"NUMBER OF ITEMS"
630 PRINT:PRINTE,,N2
640 PRINT : G(N2-1,1)=E:GOTO 590
```

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significant. The program also rejects data in which n_1 and n_2 differ by more than six — line 295 — for the same reasons.

To minimise the length of the program, remarks have been kept brief.

Lines 10-30: initialisation.

Lines 40-90: determining whether the user wishes to test for clustering or for trends.

Lines 100-270: processing the clustering data.

Lines 280-320: data — either for clustering test or for trend test — checked for validity, and, if valid, the results are printed.

Line 330: if more than 20 items, the program branches to calculate 't'.

Lines 340-470: reading the table of critical values — DATA — and printing the interpretation.

Lines 480: calculating t(Z) and determining p(W), then back to lines 450 or 470 to print the interpretation.

Lines 580-640: requesting data for trend testing. Data are entered one by one.

Lines 650-670: data copied from first column of matrix G to array F.

Lines 680-790: bubble sort of array F.

Lines 800-840: finding the median of the values arrayed in F, after first determining if the number of values present is even or odd. Median is Z.

Lines 860-910: comparing each value in the first column of G to the value of Z.

Lines 920-980: table of critical values, based on Table 84, from Bishop O N, Longman, London, second edition, 1971.

(continued from previous page)

```
650 FOR M= Ø TO N2-1
660 F(M)=G(M,1)
670 NEXT M
680 FOR I = 1 TO N2-1
690 J=Ø
700 FOR K = Ø TO N2-2
710 IF F(K)<=F(K+1) THEN 760
720 Y = F(K)
730 F(K)=F(K+1)
740 F(K+1)=Y
750 LET J=J+1
760 NEXT K
770 L=L+J
780 IF J=Ø THEN 800
790 NEXT I
800 W=N2/2 'W IS SINGLE PRECISION
810 Q=N2/2 'Q IS INTEGER
820 IF W=Q THEN 840
830 Z =F(Q):GOTO850
840 Z = (F(Q-1)+F(Q))/2
850 FOR J = Ø TO N2-1
860 IF G(J,1)<=Z THEN NØ=NØ+1: G(J,Ø)=Ø : GOTO 880
870 N1=N1+1 : G(J,Ø)=1
880 U=1
890 FOR J=Ø TO N2-2
893 IF G(J,Ø)<>G(J+1,Ø) THEN U = U+1
900 NEXT J
910 GOTO 290
920 DATA 4,Ø,Ø,Ø,Ø,2,29Ø,5,Ø,Ø,2,8Ø,3,4ØØ,6,Ø,Ø,2,2Ø,3,13Ø
930 DATA 7,2,6,3,4Ø,4,25Ø,8,2,2,4,9Ø,5,32Ø,9,3,4,4,3Ø,6,45Ø,
940 DATA 1Ø,4,1Ø,5,4Ø,6,13Ø,11,4,3,6,7Ø,7,23Ø,12,5,5,7,9Ø,8,3ØØ
950 DATA 13,5,2,7,4Ø,9,34Ø,14,6,4,8,6Ø,1Ø,41Ø,15,7,6,9,7Ø,11,46Ø
960 DATA 16,8,9,1Ø,9Ø,11,23Ø,17,8,3,1Ø,4Ø,12,27Ø
970 DATA 18,9,5,11,5Ø,13,3ØØ,19,1Ø,7,12,6Ø,14,35Ø
980 DATA 2Ø,11,9,13,8Ø,15,38Ø
```

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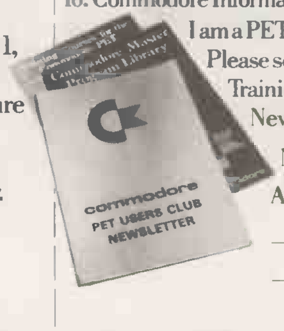

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Pet cultivates new role as gardener

by Martin Hayman

THE microcomputer can be sited wherever you please. It is a tool, but if that tool can store knowledge, it will reliably return that knowledge to the user.

If we ask it to tell us what kind of tree to plant in a shady corner of a garden with wretched rank soil where hitherto only ground elder has grown, and that ideally it should have glossy green leaves and shell-pink flowers, it can do it, reliably and consistently if, and only if, we have picked someone's brains for the results of a lifetime's experience in the garden.

This is exactly what a team of enterprising young programmers has done at Syon House Garden Centre, Brentford, Middlesex. What is there that a gardening encyclopedia has not already done, and in which you can browse to your heart's content?

In the first place, such a book will doubtless contain the information you want — if you know how to go about looking for it, but it does not provide specific answers to specific questions, such as what will grow in a neglected corner.

Grandiose scheme

It is also an expensive and diversionary way of selecting one piece of information from the distillation of a lifetime's experience in gardening. How often will you not sit down with your one question in mind and hours later still find yourself browsing over some grandiose scheme which your mean patch has no chance of containing?

From the garden centre's point of view, no doubt the scheme has further advantages; it points the customer promptly in the best direction, if he is a serious buyer. If he is not, he will swiftly be discouraged by the specificity with which he is asked to issue his instructions — nor will he be able to pass the day discussing the finer points of gardening with the resident sage, no doubt to the latter's irritation.

It may be argued that it reduces the essentially human component of such fine leisure activities as gardening — the kind of activity which, the proponents of the benignly-disemployed society tell us, we shall be enjoying several decades hence in far greater measure.

Yet the Syon Park Garden Centre is enormous, with a huge throughput of customers, and if each were to spend 10 minutes arguing about the price and specification of a terra cotta pot, nobody would ever buy a thing.

Jonathan Hall, the manager of the centre, is a micro-user, but it was Mal Seagroatt who conceived the plant-enquiry program. He has now left, to do a TOPS training course, and in his stead are two young men from the neighbourhood; Keith Morrison, who has now left school, and Michael Connaghton, who is taking A level in computing at Kingston College of Further Education.

It is Connaghton who is further expanding the possibilities of the Pet, working furiously on software-protection routines and other more commercially-slanted programs during the down-time on the Pet.

He learned on Kingston College's mainframe, which is now due for replacement: he is hoping that the college will opt for several Pets rather than another mainframe installation, and says he prefers the easier presentation and editing on a micro such as the Pet.

One of his first jobs was to create a dustbin file for all the anomalies which had crept into the data: "There were all kinds of joke plants", Jon Hall told me. That, of course, is where there is no alternative to human experience; if you know, in your personal experience, that there is no such species, then you have to instruct the machine to dump that particular string.

The machine's precision is one reason to tread a little cautiously. The Pet system grew from a card index file which was maintained by charmingly-named George Orchard who, drawing from his own experience, has been compiling the details and habits of all the plants held at the centre on to a standard form.

The form is designed to yield rapidly the essential details wanted by the amateur gardener — height, preferred soil type, sunny or shady habitat, colour of flowers. Syon Park specialises in bushes, trees and shrubs, so fortunately those details can be minimised, even so, a file offering only 255 characters is restrictive.

The file is defined by the plant's Latin name, rather than the popular name; some of the former are long — more than 30 characters — leaving little space for other than schematised details, which causes some quaint abbreviations: Mother in Law's Tongue, otherwise known as Snake Plant, becomes Mum in Laws Ton.

File headaches

Errors in coding George Orchard's card files have caused headaches and it is infrequently that the comprehensive file of a particular plant is referenced directly. The title must be keyed-in character-perfect or the machine is foiled.

Problems of cross-referencing become more acute in the other programs which Jonathan Hall has in mind, for cross-pollination of fruiting trees and combatting disease.

Yet that is by no means impossible — it just requires a good deal of work. There is no doubt a wealth of gardening information residing in the brains of the Duke of Northumberland's many employees at Syon Park, and doubtless once you have found the right person, it is as quick to ask him why your roses should have burst out in blackspot; but as Jon Hall remarked, unprompted: "It is all very well to have someone who is an expert, but if he moves on somewhere else, he takes his information with him."

So the micro at Syon Park is not creating anything new. If you like, it is merely making knowledge available in a clear and concise way, quickly. The principle is the same, whether the subject is gardening, or law, or stress analysis or politics: information is the power to do something well.

Keith Morrison updating the plant-enquiries program, and program developer Michael Connaghton.

Winchester discs win ground in battle to lower bit prices

The Winchester hard-disc drive is one of the most vital areas of microcomputing, adding immeasurable power to the capabilities of even the humbler machines. Yet there remain some notable problems to overcome — particularly in the areas of archiving and interfacing — before it will become acceptable universally.

DEVELOPMENTS in memories are moving at such a rate that the Winchester hard disc, which seemed so revolutionary when it was first introduced, can now, five years later, already be described as an established technology. Yet while designers still grapple with the problems of non-standard interfaces for back-up storage, developments are proceeding apace in new materials for disc media and new types of read heads.

The Winchester eight-in. hard-disc drive is packed into a case about 4.5 × 9 × 18in. — a lunchbox. Some have a panhandle actuator motor at the back, and in most cases, the unit is intended to be rack-mountable or fit into the desk-top slots left vacant by the displaced floppy.

Essential features

The essentials of Winchester technology are small, lightly-loaded heads designed to land on the disc and a sealed contamination-proof disc and head chamber. The development of the technology was fuelled by the demand for higher capacity drives with a lower cost per bit and more reliability.

To increase disc capacity without increasing the recording area, two parameters can be changed. Tracks can be packed at a greater density and so can the number of bits on them.

The best way of improving signal definition and increasing recording density is to reduce the distance between the recording head and the disc. The physical misalignments of recorded tracks must also be minimised to allow the maximum signal to be read back reliably.

Mechanical tolerances

Those misalignments occur in exchangeable disc drives mainly becuse of the mechanical tolerances inherent in the construction of the spindle and pack-locating mechanism. Such differences occur between drives, between packs and even between different insertions of the same pack in the same drive. Thus the two obvious methods to increase the capacity of a disc drive are to make the discs non-removable and to fly the heads closer to the disc surface.

To have close-flying heads, it is vital to keep out dirt and to seal them in a contamination-proof chamber with continuously circulating and filtered air.

The next step is more subtle and involves an understanding of the mechanics of head flying, particularly at start-up and shut-down of the disc drive. At those times, in a conventional disc drive, the heads are inserted or retracted mechanically into the air stream above the already-spinning discs. The heads are unstable at load and unload times resulting in occasional contact between heads and discs, with debris and oxide build-up on the heads.

In a sealed chamber, that was unacceptable so Winchester heads are allowed to land on the disc as it stops. That results in stable take-offs and landings, but needs a head with minimum pressure on the surface on landing and also a special coating on the discs to reduce the possibility of oxide transference. Typically, Winchester heads have a pressure of eight to 10gm., compared with the 40 to 60 gm. of conventional heads.

Downward pressure

Since that pressure downwards towards the discs balances the lift created on the head by the airstream close to the disc surface, the lift has to be reduced and so Winchester heads are small. Dedicated landing zones also prevent damage in the head/disc contact phase. The heads do not land on data tracks and rapid start and stop times mean that they are in contact only briefly with the spinning disc — one-third to one-half revolution.

Most eight-in. drives have closed-loop, positive-pressure air circulation with filtration down to a few microns and motors outside the disc chamber. The IBM 3340 exchangeable packs even incorporated heads sealed within the pack but the design has not been imitated widely.

It appears that the extremely high engineering tolerances required for a drive to deal with such exchangeable cartridges are simply too daunting.

The last major innovation associated with the Winchester is the use of a special servo surface on one disc containing a pre-recorded clock track for each cylinder of the disc pack. Heads were previously positioned using inductive or optical transducers on the drive body controlling linear DC motors — voice coils via powerful servo amplifiers.

Positioning could also be either linear, i.e., along the radius of the disc, or rotary-mounted on a pivot like the familiar record player. Rotary actuators are simpler with fewer bearings and mechanical parts, and most eight-in. drives have gone the rotary route.

The problem with using transducers is that positioning is always relative to the drive rather than to the disc — unless you mount the transducer on the disc pack. Increasingly high track densities have made more sophisticated positioning techniques necessary. Eight- and 14-in. Winchesters have a "spare" head which reads the bottom servo surface to define where its parallel brethren are located.

Considerable accuracy

That means, however, that considerable accuracy is required in the assembly of disc packs and the read/write head comb assembly to ensure everything is parallel. Current eight-in. drives use servo track following with the exception of the Memorex 101 and the New World Computer 211 which use stepper motors and have noticeably lower track densities of 159 and 100 compared to an average of 500 track/in.

Other features found in some units are dual head/surface, DC spindle drive motors and the removal of all extraneous mechanisms, such as actuator motors, from the sealed chamber. For the best designed devices, a maximum time before failure of over 20,000 hours is realistic. The maximum time before failure of accompanying motors, power supplies and associated electronics is often around 5,000 to 10,000 hours — a reversal of the situation found commonly in older technology drives.

Further problems

Unfortunately, all of the ramifications of those designs are not without disadvantages. The most obvious one is the lack of an archiving capability to allow security dumping and the extension of the drive's database facilities.

A further problem can arise in interfacing due to the higher data transfer speeds. Existing interfaces can be either too complex or incapable of handling the high transfer rate from the drive. That has resulted in a plethora of unstandardised interface designs which need special controllers.

Those disadvantages can, of course, be overcome. Archiving can be accomplished by the addition of a separate, or even an integrated, exchangeable disc unit, or by a tape drive.

High-capacity developments of the tape cartridge drive and a new generation of .5in. tape units using low-cost streaming techniques are becoming available. They have a capacity from 10 to 80Mbyte and to minimise archiving time software techniques are being developed, such as transaction logging.

Transaction logging

With transaction logging, a continual record is kept of each disc update, so that a disc could be recreated by reading the update log. Ironically, the reliability of archiving devices is often considerably lower than that of the Winchester drive.

The interface question is being solved in several ways. For the bigger, more expensive drives the SMD interface has been used in most cases, while for the lower-cost units, both floppy disc-like — but with some critical differences — and a newly-emerging standard are available. When the newer standard has been agreed, it is likely that many of the present drives will be adapted.

Pressure is being applied by both chip manufacturers and potential drive users, who predict low-cost controllers using single-chips within a year's time. The SMD interface will also be taken down-market as electronics costs continue to fall. In fact, single-chip SMD controllers are a distinct possibility within the next two years.

It is likely that there will be a 10-fold improvement in track density and a five-fold improvement in bit density. To accomplish that, developments of both the disc media and recording heads will be needed, such as plated discs and thin-film deposited heads. The advent of thin-film heads raises the possibility of processing capabilities being included at the head itself.

It is expected that some novel designs will appear in the exchangeable field. Already a high-capacity hybrid drive is on the market, combining a removable 3330 technology cartridge disc with a fixed Winchester module, both units sharing power supplies, electronics and a spindle motor.

Low-cost combinations

Low-cost fixed and exchangeable combinations will use new developments to lift Winchester heads away from the disc surface, allowing its removal. The new design of disc cartridge to permit this is only practical for the largest disc manufacturers.

Any technological innovations will affect all types of disc, although increasing densities will naturally favour increasingly smaller packages with a mini five-in. Winchester in the not too distant future. Eight-in. drive capacity is expected to top 250Mbyte by 1984 and 100Mbyte on three platters is possible.

Media will be first to change — with cobalt-, chromium- and even ceramic-plated discs progressively replacing ferrous particulate. Plated-disc density starts at 6,000 bit/in. and could reach 18,000 bit/in. by 1982. To take advantage of that capacity, thin-film disc heads will replace ferrite heads, reducing flying heights to 10μin. and increasing track density to 1,500/in. by 1986.

Closed loop

The ony positioning technology capable of dealing with such densities is interspersed servo track following or embedded servo in which servo information is recorded at the head of each sector on the disc.

Each head operates in a closed loop servo on the track it is seeking. The result is higher positional accuracy, greater utilisation of disc surfaces and disc pack interchangeability over a wide temperature range.

Only Vermont, Digital Equipment and Cii Honeywell-Bull use interspersed servo track following and no-one has yet combined it with Winchester technology, but for the full potential of the lunchbox to be realised, it must happen.

Thin-film technology may be key to improved capacity

In the quest for improved price performance, disc capacity has been increased almost 50-fold for the same final cost to the consumer, by improving discs, heads, electronics, servos, mechanics, codes and error-correction techniques. A further huge jump is expected if a new type of head using semiconductor thin-film technology instead of the traditional ferrite is developed successfully.

MAGNETIC recording on discs, tapes and cassettes is performed by passing a recording head over the surface of the storage media — figure 1. A time varying current is driven into the head which results in a spatial variation of magnetic moment in the media. Such a written track of information is shown in figure 1.

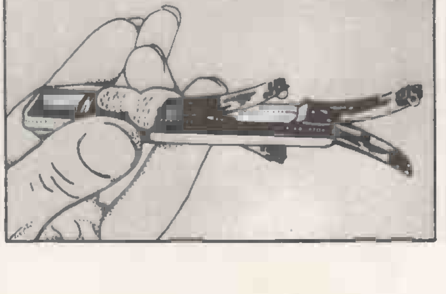
Spatial variation

The spatial variation of magnetic moment along a track can be read by the same or another head which senses the spatial variation of magnetic flux emanating from the media and emits a voltage which can be decoded to retrieve the stored information.

Heads are electro-mechanical devices — figure 2 — which comprise a magnetic core with a gap to perform the writing and reading, a mechanical assembly which critically positions the core with respect to the storage media and the electrical harness which interfaces to a winding on the magnetic core and plugs into a PCB.

The winding on the core performs as the primary of a transformer. It converts the time-varying current driven into the winding during writing into a time-varying magnetisation in the core. During reading, the winding acts as the secondary of a transformer and converts the time-varying magnetisation induced in the core by the storage media into a voltage across the winding.

Figure 2.



Flux concentrator

The gap of the core acts as a magnetic flux concentrator during writing. The flux generated in the core by the current in the winding jumps across the core gap. It does that in arcs, some of which intersect the storage media and magnetise it, thus recording information.

During reading, the magnetised variations in the media generate flux changes through the core as they pass the gap which must be shorter than the bit period along the track so that the head can resolve each bit.

Thin-film heads utilise thin-film processing to fabricate the magnetic cores and the turns of the winding around the

(continued on next page)

(continued from previous page)

cores. The processes used are similar to those used in fabricating the conductor metallisation lines on silicon LSI devices. Those processes are very different from those used to fabricate conventional ferrite heads.

Ferrite heads are named after the ferrite ceramic from which the magnetic cores are made. A head contains the magnetic core or gap element within a body called the slider, which is the vehiçle to maintain stability and height in relation to the media.

The manufacture of heads has changed over the disc generations but the closest comparison is the 8450 ferrite head process, which is the simplest and has the fewest elements — figure 3. A ferrite I-block — basic slider body — and the C-block — core bar — are bonded together. Glass holds the U together and acts as the non-magnetic gap of the core, separating the poles. The bonded block is diced into slider bodies and shaped to the air-bearing surface to form the slider.

Closest point

In this design, known as a taper/flat air-bearing slider, the flatness and angles must be machined with exacting precision. To define the core, excess material is removed at the rear of the slider body and windings are wrapped around the centre pole. The thickness of the gap at the pole defines the track width and, when flying, it is that tap which is held at the closest point to the media.

Thin-film heads are batch-fabricated on the surfaces of substrate wafers. There are numerous approaches to fabricating the devices.

The cores and winding are fabricated with two layers of aluminium conductors and two layers of magnetic metal. These four metallic layers are patterned by the use of photo-lithography and are separated from each other by insulating layers.

In figure 4, the first pattern of aluminium conductor is shown. The conductors will become part of the windings. The pattern is repeated for each core that wil be deposited on a two-in. substrate. Figure 5 shows the patterned bottom

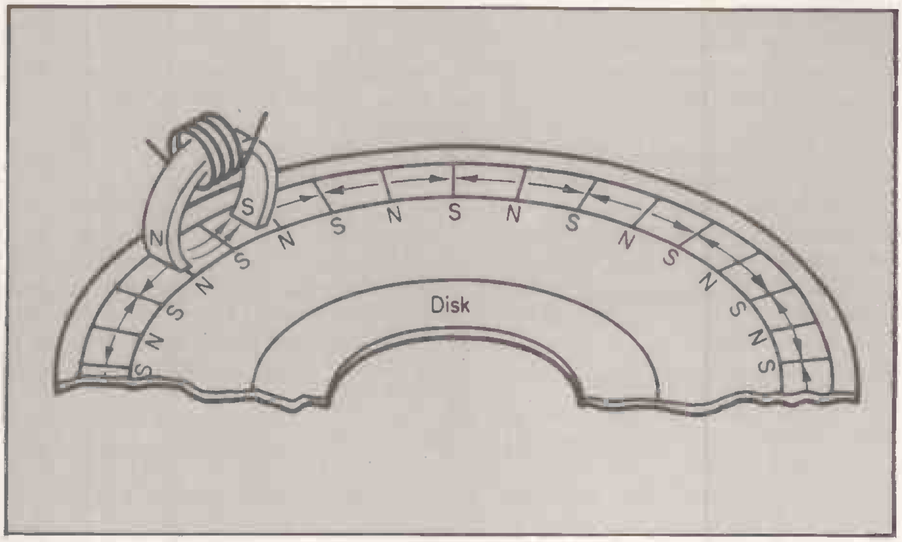


Figure 1.

magnetic film. The patterned second magnetic film — figure 6 — completes the magnetic core.

The insulator deposited between the two magnetic films acts as the gap in the core. Figure 7 shows the final conductor pattern superimposed on the previous layers.

The top conductors contact the first conductor pattern at the white rectangular

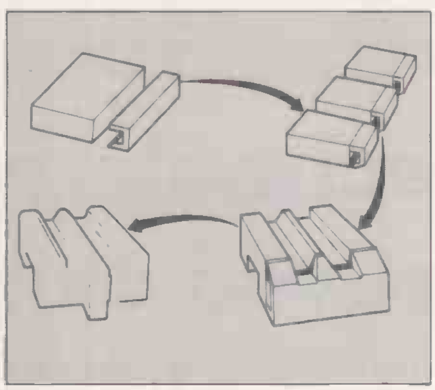


Figure 3.

areas where the insulator layers have been removed. The two layers of conductor form the 11 turns of this core winding. The W in figure 7 is the width of the overlap between the two magnetic layers and is the width of the track the head would record on a storage media passed just below the head perpendicular to the picture.

The wafer of deposited heads is sliced into bars and, as in the 8450 ferrite head, further sliced, ground and polished into the slider body with three cores on it which is attached to a head arm assembly.

Thin-film heads have a strong potential for increasing storage density, reducing head costs and improving access time in disc recording. The heads are more efficient, can resolve smaller bits and can perform at higher frequency than ferrite heads. Those improvements result from the much smaller geometries which can be made with thin-film processing technology.

Ferrite cores

Ferrite cores are very difficult to fabricate smaller than 50 × 50 × 1 mil — 1,250 × 1,250 × 25 micron — while thin-film cores can be made as small as 1 × .2 × .1 mil — 25 × 5 × 2.5 micron.

The storage density capability of a disc drive is the result of the complex inter-relationship of all components, not just the head. It is, therefore, impossible to make an accurate estimate of the increase of storage density which results from the use of thin-film heads whose small size allows flexibility of head configurations.

For example, many cores can be

Figure 4.

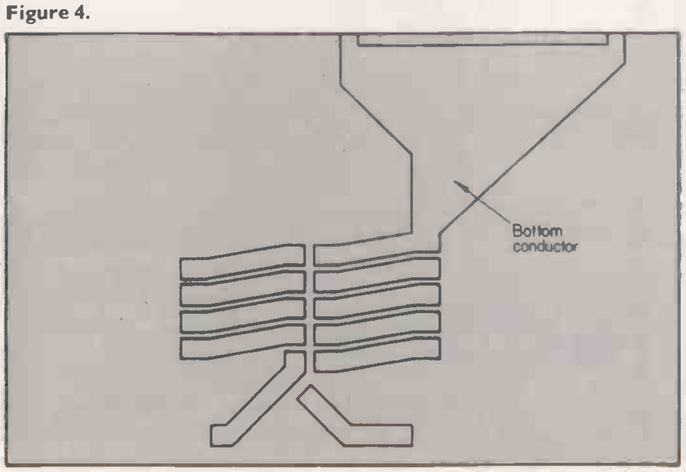
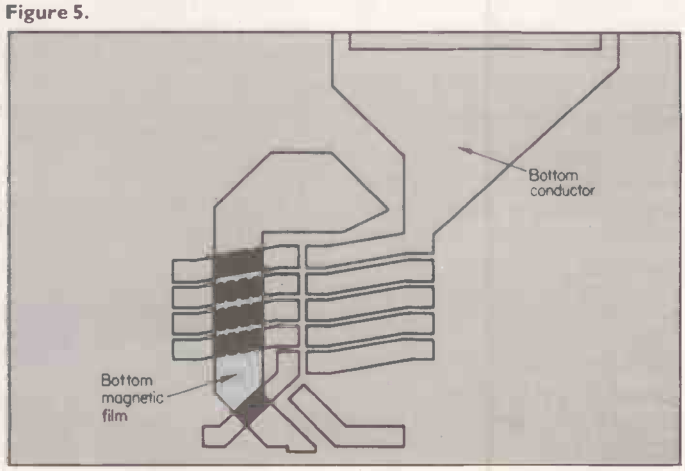


Figure 5.



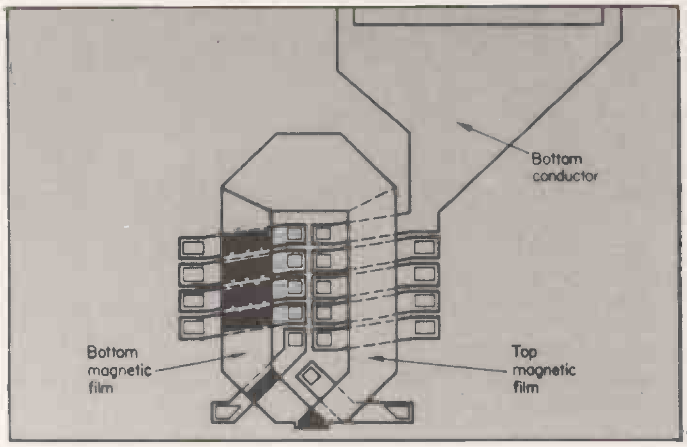


Figure 6.

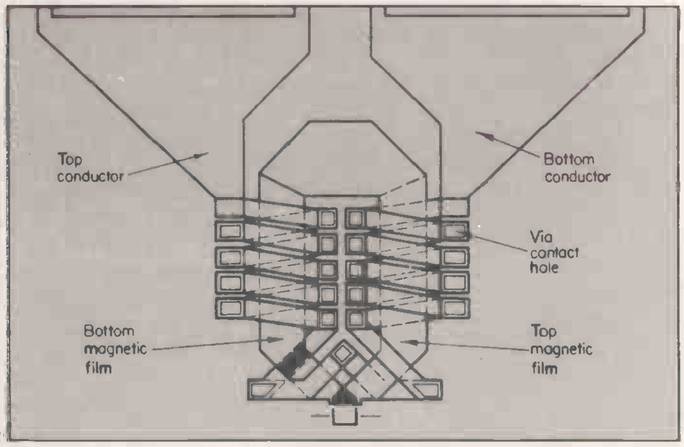


Figure 7.

deposited on the same head arm assembly to make multi-track heads which can be used to increase cylinder capacity, reduce access time and improve throughput.

An effective improvement in access time can be obtained if the number of movements required to access data serially can be reduced. For instance, if there are 10 gaps/slider, a cylinder of data accessible in one movement is 10 times greater than that of a single gap/slider, all other elements being the same.

Also, smaller and lighter slider bodies allow the number of sliders/arm to increase, reducing stroke length which improves access time.

Thin-film cores at the wafer level are much lower in cost than are ferrite cores. That results in a reduced head-arm assembly cost in those assemblies in which the core is a significant part of the head cost. That is particularly true in the case of multi-core heads such as those used in head-per-track disc products.

Lower reliability

Thin-film heads have been demonstrated to have electrical and magnetic performance superior to that of ferrite heads, but reliability is not as high. The magnetic metallic thin films of the heads are inherently less abrasion- and corrosion-resistant than ceramic ferrites which are hard oxides.

Head wear is of particular concern in discs like the 8450 where the heads land and take off in contact with the disc during turn-off or start-up. Wear-testing thin-film heads through thousands of such cycles of contact start-stops show that soft metallic films exposed at the flying surface recede from the surface.

That wear is not desirable but may be acceptable. Unlike ferrites, magnetic thin films are subject to corrosion in air. By varying some of the head materials and protecting the device in a number of ways, those disadvantages should be overcome.

Latest techniques maximise floppy-disc performance

The Winchester may be poised in the wings for a take-over, but the floppy will be the standard storage medium for many years — not least for its flexibility. Two-sided, double-density eight-in. discs with double-tracking will yield a capacity of approximately 2.3Mbyte within two years, and five to 10Mbytes are already forecast with improvements in media-production technology.

ALL single-density floppy-disc controllers utilise the double-frequency, DF, encoding technique. The problem is that coding efficiency — the average number of flux transitions per information bit — is poor, requiring a maximum of two flux transitions per information bit for data encoding.

The modified-frequency-modulation, MFM, recording code, on the other hand, requires a maximum of one flux transition per information bit, thus making it possible to double the information bit density for a given recording density — flux transitions/in.

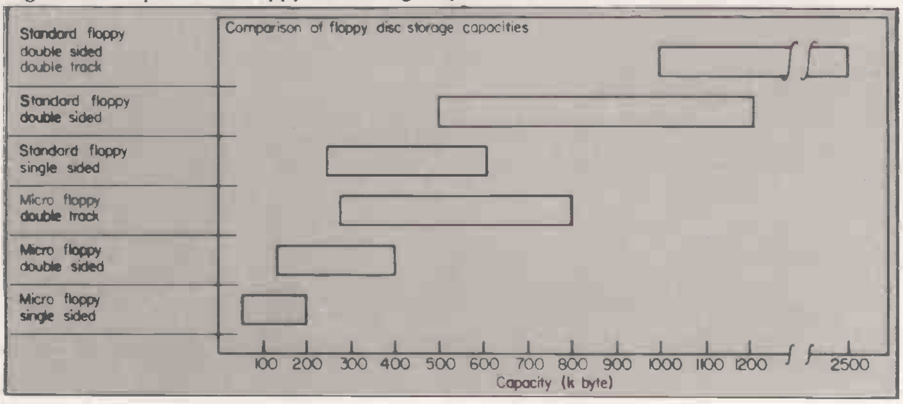
Modified-frequency modulation, along with its cousin, modified-modified-frequency modulation, M^2FM, are the two most frequency used recording codes suitable for use in double-density operation with floppy disc drives.

Both permit self-clocking, have a relatively narrow frequency spectrum, and provide a relatively simple hardware implementation. The encoding algorithms for the two recording codes are as follows: modified frequency modulation: a flux transition is always recorded at the centre of the information bit cell for a binary one. No flux transition is recorded for a binary zero unless it is preceded by another zero, in which case, the flux transition is provided at the beginning of the information bit cell.

Modified-modified-frequency modulation: a flux transition is always recorded at the centre of the information bit cell for a binary one. A flux transition is recorded at the beginning of an information bit cell

(continued on next page)

Figure 2. Comparison of floppy-disc storage capacities.



(continued from previous page)
unless the previous information bit cell contained a flux transition — either a 0 or 1 — in which case no flux transition is recorded.

Figure 1 shows the encoded waveforms for MFM and M²FM, along with double frequency for comparison. Although the information bit time, 200 nanoseconds the MFM also M²FM encoding technique, recording density remains unchanged and thus the amount of peak shift at both single and double information bit densities also remains about the same.

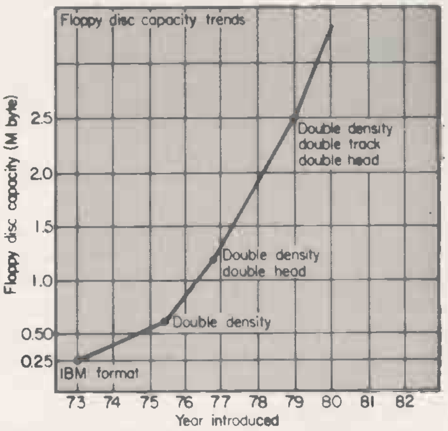
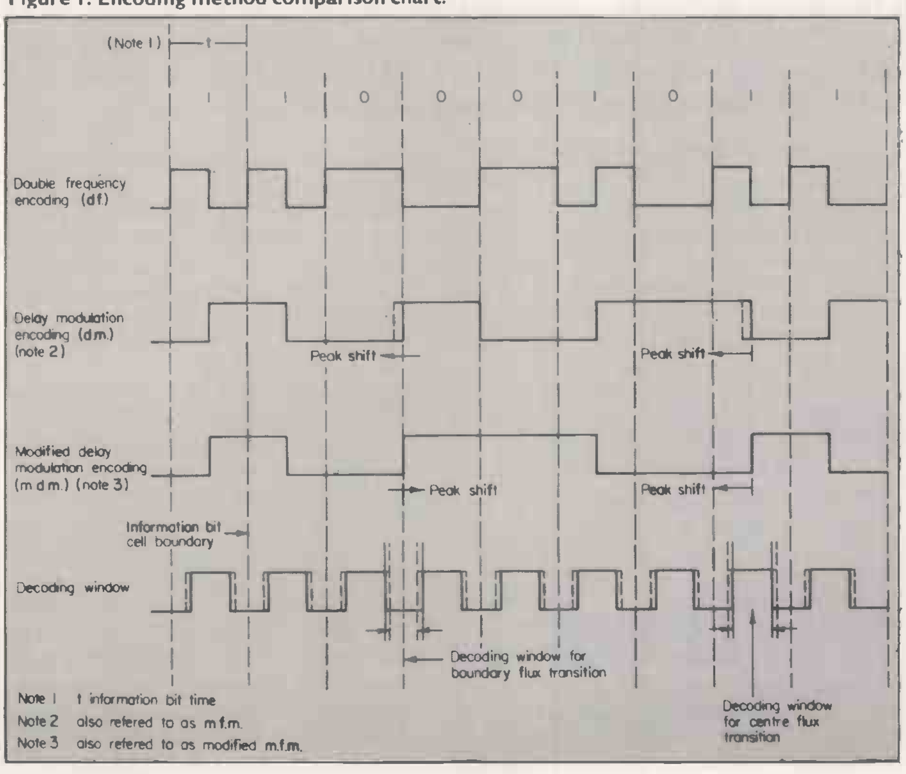


Figure 3. Projection of storage capacity against technique.

The DF, MFM and M²FM recording codes require a decoding window which is one-half of the information bit time. The information bit time at double density is reduced to one-half, 2μs, of its value at single-density, 4μs, and so the attendant decoding window for double density is reduced by one-half — 1μs from 2μs.

The peak shift thus absorbs a greater proportion of the available decoding margin for double-density operation.

Figure 1. Encoding method comparison chart.



The principle of write pre-compensation can be described as a given flux transition being written with a predetermined time distortion of its true position on the medium if it is expected — depending on the flux transition pattern — to undergo peak shift. Otherwise no write pre-compensation is provided.

The amount of write pre-compensation is normally about one-tenth of the information bit time, 200 nanoseconds and is provided in the direction opposite to that of peak shift.

Data decoding involves identifying each transition in the flux transition sequence read from the disc either as a boundary or a centre transition. That can be achieved by generating decoding windows for boundary and centre flux transitions with the use of a phase locked loop.

Decoding windows

If the boundary and centre flux transitions experience equal amounts of peak shift, the decoding windows for the two types of transition will be symmetrical. However, it is found in practice that in the case of MFM, flux transitions at the centre of an information bit cell experience more peak shift than those at the boundary.

That is demonstrated by applying the principle of superposition of peak shift. Further, it can be shown that the asymmetry is even more pronounced in the case of MFM than in MFM — figure 1. MFM owes its existence to asymmetrical peak shift for boundary and centre flux transitions.

The discussion suggests that, in general, asymmetrical decoding windows can be used to improve the decoding margin for both codes, although the gain is more in

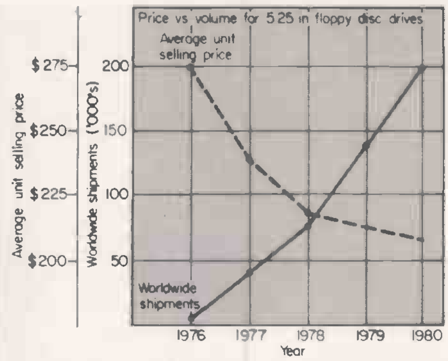


Figure 4. Projection of cost based on an expanding market.

the case of M²FM. Figure 1 illustrates the use of asymmetrical decoding windows (40/60) in data decoding; asymmetrical windows are shown in dashed lines.

Additional gain in decoding margin M²FM is offset by one important disadvantage — it allows the maximum flux

Table 1. Memory cost comparison.

System	Hardare price (£) per drive	Media cost (£)	Maximum unform atted capacity	Price per Kbyte
Winchester	3500	—	11MB	£3.18(1)
S/S eight	400	4.50	½MB	£0.49(22)
D/S Eight in.	800	5.50	1MB	£0.78(11)
S/S 5¼in.	350	2.40	200KB	£0:43(55)
D/S 5¼in.	600	3.50	400KB	£0.63(28)
C-12 cassette	25	0.40	16KB, at 300 baud	£0.27(688)

transition separation of 2.5 information bit times. For high-resolution heads, that can cause a differentiator droop problem — shouldering effect.

Excessive differentiator droop in the presence of noise can greatly increase the transient error rate even though the decoding margin might have increased with M²FM. Hardware complexity normally required to eliminate the effect of differentiator droop without affecting the decoding margin is usually not warranted.

From empirical measuremetns with Pertec double-density floppy disc drives, it has been found that for head resolution values between 45 and 60 percent, MFM with symmetrical decoding windows provides a sufficient decoding margin to achieve the desired error rate, although asymmetrical decoding windows can be used to further improve the decoding margin. For low-resolution heads, however, M²FM will be the better choice.

In table 1, the price per Kbyte is calculated on approximate current prices for 11MB storage. The figure after the price per KB indicates the number of units required to achieve 11MB storage. Clearly, the high price of the Winchester reflects a substantial bonus in convenience — 688 cassettes are going to take up a great deal of storage space.

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Frieze Patterns

MANY will be familiar with the computer simulation, Life, which was invented by John Conway, probably the leading U.K. expert in the field of recreational mathematics. When I was a student, Conway showed me a kind of numerical version of Life which he called Frieze Patterns.

As in Life, the outcome of a Frieze Pattern is derived from its initial position

```
1 1 1 1 1 1 1 1 1 1 1
 1 m
  1 n                 ODD NUMBER
   1                    OF ROWS
  1
   1
1 1 1 1 1 1 1 1 1 1 1
Here, = 2 and n = 3, see text.
```

Figure 1. Typical starting position.

by the application of simple rules. Although, in this case, the result is entirely predictable — it is the manner in which the result is obtained which is both interesting and surprising.

To draw a Frieze Pattern, start with two infinite rows of 1s an odd number of lines apart and join them with a chain of 1s in any formation you like, without breaking the chain — figure 1. The rest of the pattern is completed according to the rule:

```
   a
b     c   where ad + 1 = bc
   d
```

Thus, the 'm' in figure 1 is found by: $1 \times 1 + 1 = 1 \times m$ so that $m = 2$ similarly, $n = 3$ and so on. As you start to fill in the pattern, be ready for a surprise — the answers are always whole numbers.

The reader is now urged to draw a pattern to verify that amazing fact. However big the numbers become, and, if you start with the rows too far apart they will become very big, the result always divides-out.

As the process continues, the numbers begin to become smaller and you will eventually reach your original pattern of 1s — only reversed, figure 2. From here, the pattern repeats itself, thus justifying the name of Frieze Patterns.

Because the rules are so simple, it is a comparatively easy task to program a computer to draw Frieze Patterns and a suggested flowchart and program in Basic are given.

Those who have access to a printer will find that Frieze Patterns make great mathematical wallpaper. Others might like to discover exactly why the process works — it is not so easy.

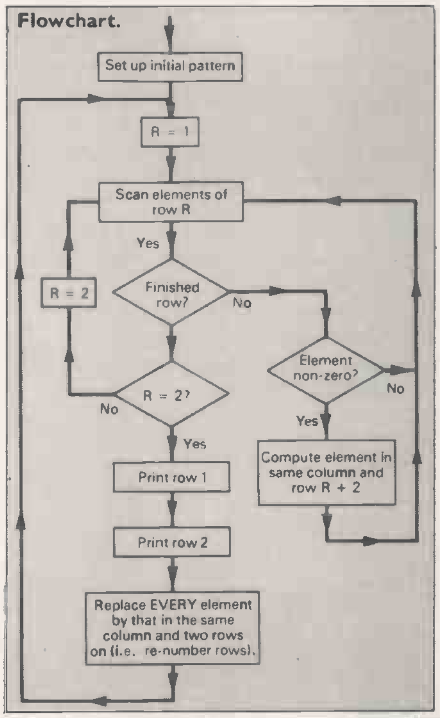
For obvious reasons, the pattern is printed vertically rather than horizontally and 'WIDTH' (line 110) refers to the total width of the pattern, including the two rows of 1s.

The starting position is entered as a string, P£ consisting of Us for up and Ds for down — note that it is not necessary to place the first 1, but all the rest must be placed correctly relative to it.

The method of inputting the initial configuration, which occupies lines 100 - 280 of the program, is rather clumsy but, in practice, easy to use.

Lines 430 - 460 re-number the rows so that only W are remembered. In fact, as soon as a row is printed, it is forgotten.

Flowchart.




```
1\ 1  1  1  1  1 /1  1 \1  1  1  1
  \1  2  2  3  2 /1  3  4 \1
    \1  3  5  5 1/ 2 11  3 \1
      \1  7  8  2 /1  7  8  2 \1        etc.
    1\ 2 11  3  1/ 3  5  5  1/
      \1  3  4 1/ 2  2  3  2 \1
1  1 \1  1 1/ 1  1  1  1  1 \1  1
Note that the pattern has returned to its starting position, where it repeats. Note also the reflected pattern of 1s in the middle.
```

Figure 2. Frieze pattern of figure 1 completed.

Typical frieze pattern.

```
1\  0    0    0    0    0    0    0    0    1
  \1   0   /1\  /1\   0    0   /1\  /1\   0
1   \1   1/  \1/  \1   0   1/  \1/  \1   1
  2   \1/  2    2   \1   /1   2    2   \1
1   3    3    5    3  \1/  3    5    3   \1
  2   10   8    8    4    4    8    8    4
1   7   27   13   11   17   11   13   11   1
  4   19   44   18   47   47   18   18   3
1   11  31   61   77   130  77   25   5    1
  3e  18   43   261  213  213  107  7    2
1   5   25   184  722  349  296  30   3    1
  2   7   107  509  1183 485  83   13   2
1   3   30   296  834  1644 136  36   9    1
  2   13   83   485  1159 461  59   25   5
1   9   36   136  674  325  200  41   14   1
  5   25   59   189  189  141  139  23   3
1   14  41   82   53   82   98   78   5    1
  3   23   57   23   23   57   55   17   2
1   5   32   16   10   16   32   12   7    1
  2   7    9    7    7    9    7    5    4
1   3   2    4    5    4    2    3    3    1
  2   /1\  /1\   3    3   /1\  /1\   2   1/
1   1/  \1/  \1   2   1/  \1/  \1   1/   1
  1/  2    2   \1   /1   2    2   \1/  2
1/  3    5    3  \1/  3    5    3    3    1
  4   8    8    4    4    8    8    10   2
1   11  13   11   17   11   13   27   7    1
  3   18   18   47   47   18   44   19   4
1   5   25   77   130  77   61   31   11
BREAK IN 490
READY.
```

```
100 PRINT"3FRIEZF5"
110 INPUT"WIDTH (UDD) ";W
120 DIMA(W+2,W)
130 FORR=1TOW+2STEP2
140 A(R,1)=1:A(R,W)=1
150 NEXT
160 PRINT"YOUR PATTERN(";W-3;"ITEMS)";
170 INPUTP$:IFLEN(P$)=W-3THEN190
180 PRINT"INCORRECTLY SET":GOTO170
190 R=2:A(2,2)=1:FORC=3TOW-1
200 A$=MID$(P$,C-2,1)
210 IFA$<>"U"THENR=R+1:GOTO270
220 IFR>1THENR=R-1:GOTO270
230 A(2,C)=1:FORY=2TOC-1
240 FORX=WTO1STEP-1
250 IFA(X,Y)=1THENA(X,Y)=0:A(X+2,Y)=1
260 NEXTX,Y:R=2:GOTO280
270 A(R,C)=1
280 NEXTC
290 REM NOW COMPUTE PATTERN
300 FORR=1TO2
310 FORC=2TOW-1
320 IFA(R,C)=0THEN340
330 A(R+2,C)=(A(R+1,C-1)*A(R+1,C+1)+1)/A(R,C)
340 NEXTC,R
350 R=1:PRINTR;"  ";
360 FORC=3TOW-2STEP2
370 GOSUB480
380 NEXT:PRINTR;"5"
390 R=2:PRINT"  ";
400 FORC=2TOW-1STEP2
410 GOSUB480
420 NEXT:PRINT"5"
430 FORR=1TOW
440 FORC=1TOW
450 A(R,C)=A(R+2,C)
460 NEXTC,R
470 GOTO300
480 PRINTA(R,C);" ";
490 IFA(R,C)<10THENPRINT" ";
500 RETURN
READY.
```

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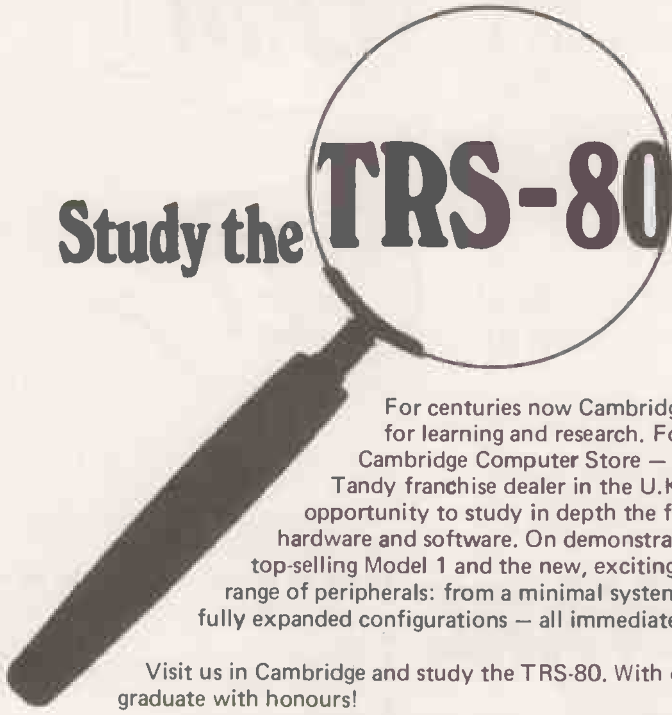

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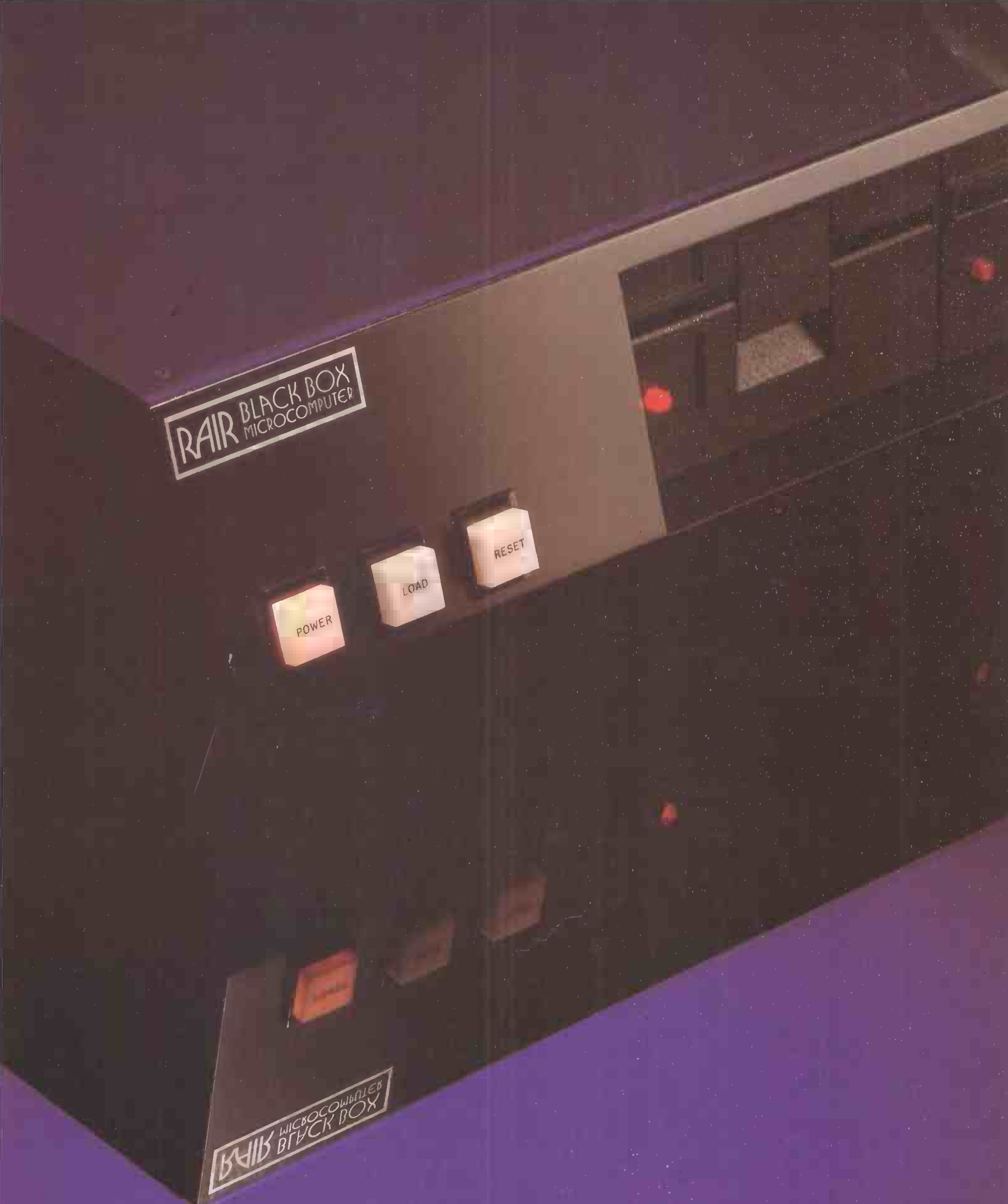

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- BASIC language also handles full Boolean arithmetic, conditional expressions, etc.
- Exceptionally powerful edit facilities, allows modification of existing program lines.
- Randomise function, useful for games and secret codes, as well as more serious 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.

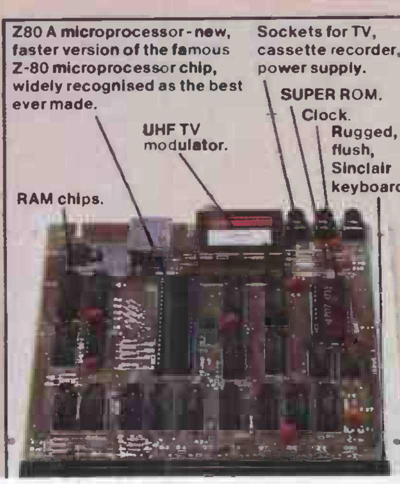
Fewer chips, compact design, volume production – more power per pound!

The ZX80 owes its remarkable low price to its remarkable design: the whole system is packed on to fewer, newer, more powerful and advanced LSI chips. A single SUPER ROM 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 of BASIC. (Key words occupy only a single byte.)

The display shows 32 characters by 24 line[s].

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.



104

plete

The Sinclair teach-yourself BASIC manual.

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

The Sinclair ZX80. Kit: £79.95. Assembled: £99.95. Complete!

The ZX80 kit costs a mere £79.95. Can't wait to have a ZX80 up and running? No problem! It's also available, ready assembled and complete with mains adaptor, for only £99.95.

Demand for the ZX80 is very high: use the coupon to order today for the earliest possible delivery. All orders will be despatched in strict rotation. We'll acknowledge each order by return, and tell you exactly when your ZX80 will be delivered. If you choose not to wait, you can cancel your order immediately, and your money will be refunded at once. Again, of course, you may return your ZX80 as received within 14 days for a full refund. We want you to be satisfied beyond all doubt — and we have no doubt that you will be.

sinclair ZX80

Science of Cambridge Ltd

6 Kings Parade, Cambridge, Cambs., CB2 1SN.
Tel: 0223 311488.

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Remember: all prices shown *include* VAT, postage and packing. No hidden extras.
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Quantity	Item	Item price £	Total £
	Sinclair ZX80 Personal Computer kit(s). Price includes ZX80 BASIC manual, excludes mains adaptor.	£79.95	
	Ready-assembled Sinclair ZX80 Personal Computer(s). Price includes ZX80 BASIC manual and mains adaptor.	£99.95	
	Mains Adaptor(s) (600 mA at 9 V DC nominal unregulated).	8.95	
	Memory Expansion Board(s) (each one takes up to 3K bytes).	12.00	
	RAM Memory chips – standard 1K bytes capacity.	16.00	
	Sinclair ZX80 Manual(s) (manual free with every ZX80 kit or ready-made computer).	5.00	
NB. Your Sinclair ZX80 may qualify as a business expense.		TOTAL	£

I enclose a cheque/postal order payable to Science of Cambridge Ltd for £______

Please print

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Address______

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M1

Sharp MZ-80K

The quality single unit computer.

SHARP

New Low prices

	Net	Vat	Total
MZ-80K Computer 48K RAM	500.00	75.00	575.00
MZ-80FD dual disk drive	780.00	117.00	897.00
MZ-80P3 printer	500.00	75.00	575.00
MZ-80I/O interface unit	84.00	12.00	96.60
MZ-80FDK extra disk drives	680.00	102.00	782.00
MZ-80T20C machine language	18.00	2.70	20.00
MZ-80TU assembler	38.00	5.70	43.70

Not a Kit
Works the same day you buy it.

Japanese
The same quality they have put into cars and Hi-Fi.

Single Unit
No trailing leads and wires

Z80
More registers and instructions than other processors

Tape Basic
You don't get left with obsolete ROMS

Tape counter
Know where you are on the tape.

Sound
Built-in music synthesiser with 3 Octaves.

Fast loading
Cassette interface runs at 1200 bps.

Other features – 79 keyboard up to 48K RAM, on screen editing, real time clock 256 different characters, 10 inch video display 80 x 50 bit mapped graphics.

The Basis of System Expansion
Interface Unit MZ-801/0

The MZ-801/0 interface unit connects the central processing unit (CPU) with other terminal units and makes possible further expansion of the system.

The interface unit can hold up to five different interface cards and utilizes its own built-in power source.

Fast and Legible Printing of Characters and Graphics
Dot Printer MZ-80PS

By parallel data input, the MZ-80P3 prints charcters on ten-inch wide paper, 80 characters to the line, at a speed of approximately 1.2 lines per second. The "tractor feed" system prevents paper slipping and produces clear print at high speed. A variety of characters can be printed by the MZ-80P3, including both upper and lower case letters, numerals and graphics.

Large Memory Capability in a Compact Unit
Floppy Disc MZ-80FD

Memory capacity up to 280K bytes can be accessed quickly and easily from dual driven standard 5.25 inch floppy discs.

Specifications

MZ-801/0

Interface system:	Parallel Interface
Signal:	TTL level
Usable interface card:	Up to 5 sheets Printer interface card, Floppy Disk interface card, Colour display interface card, Universal interface card, etc.
Power consumption:	45W
Power Supply:	Local voltage, 50Hz
Operating temperature	0 to 35°C
Storage temperature:	–15 to 60°C
Dimensions:	205(W) x 320(D) x 130(H)(mm)
Weight:	5kg

MZ-80FD

Memory capacity	143K bytes/drive (286K bytes/unit)
No. of tracks:	70
No. of sectors:	16 (per track)
Working conditions:	4 to 25°C, 28 to 80% (relative humidity)
Rated voltage:	Local Voltage, 50Hz
Power consumption:	40W
Outer dimensions:	205(W) x 320(D) x 200(H)(mm)
Weight:	7.9kg
Option:	
Floppy interface card:	MZ-80FI/O included in price
Disk BASIC:	MZ-80FMD included in price
Flat cable for connection	MZ-80F15, included in price

MZ-80P3

Printing method:	Serial dot matrix method
Feed method	Tractor feed method
Printing capacity:	80 characters/line 40 characters/line (Double size character display)
Kinds of printed characters:	226 kinds excluding the space code
Character make-up	6 x 7 dots 12 x 7 dots (Double-size character display)
Size of character:	Width: 2.2mm Height: 3.1mm
Printing speed	About 1.2 lines/sec (at 25°C)
Line-to-line space	2.54mm (in normal mode)
Head sweep direction	Left Right
Operation switches	Power supply & paper feeding
Interface:	Conforming to Bandminton interface
Print recording paper:	(1) Kind: Fanfold paper (2) Size: (Width) 102 to 254mm (4 to 10 inches) Note: In the case of printing 80 characters per line, use paper of 254mm width. Copy possible
Ink ribbon:	(1) Colour: Single (Black) (2) Size: 13mm(W) x 11,000mm(L) (3) Life: About 2 million letters
Power supply:	Local voltage, 50Hz
Power consumption:	85W
Working temperature:	5 to 40°C
Working humidity:	10 to 80% (No dew-condensation)
Storage temperature:	–20 to 50°C
Storage humidity:	5 to 85% (No dew-condensation)
Outer dimensions:	410(W) x 385(D) x 198(H)(mm)
Weight:	10.6kg

*Specifications and design subject to change without notice.

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Apple II

sets the standards.

Free with every Apple II
★ 32K bytes of extra RAM
★ Black and white Modulator.

Why Apple II

Apple Computer has built a reputation for advanced design with innovations like:

- Colour Graphics
- High Resolution Dot Graphics
- Sound Synthesis
- Analog Inputs

Apple understands product support: documentation, software, accessories; and the system capacity to take advantage of them. Additionally, more than 60 other companies produce hardware and software products for Apple II, making the system an industry standard.

The Apple II Computer features

Apple II is a state-of-the-art personal computer. It is not a toy or a video game, but a sophisticated system for the person who appreciates quality tools. It's worth more, because its unique features help you do more.

Colour Graphics

Apple's colour graphics permit applications ranging from business charting to architectural design. They make any presentation more effective.

Sound Synthesis

A built-in loudspeaker lets you explore audio applications from computer music to synthesized human speech.

Languages

Apple speaks BASIC, so you can use the programs already available in hundreds of publications. We offer a powerful scientific BASIC, with all the string and mathematical functions a programmer could want. We also offer assembly language and PASCAL for advanced users. More languages are under development.

Expansion Capacity

Apple II can handle complex applications, with up to 48k bytes of user memory space. And it can expand as your needs do, with a hefty power supply and eight connector slots for disks, printers, and other peripheral interfaces.

Apple is a system, not just a computer. It offers the peripherals and accessories the professional looks for. Whether you want printers, voice recognition, telecommunications, or high-density floppy disks. Apple can meet your needs.

The Apple system offers smart peripherals, so you can use them immediately without developing special control programs. They let you expand the capability of your system without adding boxes and power supplies.

Apple helps you learn, with the most complete documentation on the market. Whether you're an engineer designing computer interfaces or a beginner curious about programming, you'll find the information you need in our detailed manuals.

Floppy Discs.

Gives your system immediate access to large quantities of data. The subsystem consists of an intelligent interface card, a powerful Disk Operating System and one or two mini-floppy drives.

Features

- Storage capacity of 116K kilobytes/diskette. (140K with Pascal).
- Data transfer rate 156K Bits/second.
- Individual file write protection.
- Powered directly from Apple II.
- Full disk capability with systems as little as 16K bytes of RAM.

- Fast access time – 600 m sec (max) across 35 tracks.
- Powerful disk operating software.
- Load and store files by name.
- BASIC programs chaining.
- Random or sequential file access.

Prices	Nett	Vat	Total
Apple II 16k + free offer	695.00	104.25	799.25
Disk system	349.00	52.35	401.35
Second disk drive	299.00	44.85	343.85

Latest Apple II plus model with floating point BASIC and Autostart ROM.

Colour output optional – requires Eurocolour card.

Parallel Printer Interface

The Parallel Printer Interface Cards are available to allow the use of parallel printers with your APPLE computer.

Features

— Built-in Firmware Allows Printing With Simple BASIC Commands
— Prints up to 255 Char/Line for format flexibility
— High Speed—up to 5000 Char/Sec (3700 LPM @ 80 Char/Line
— Easy to Use with Most Popular Printers (Axiom, Centronics, SWTP, Selectric conversions).

Specifications

PARAMETER	DESCRIPTION
Data and Control Signals:	7-8 Parallel Data Bits, STROBE and ACKNOWLEDGE
Print Line Width:	40-255 Char/Line. Automatic formatting of BASIC listings.

Price	Nett	Vat	Total
Parallel	104.00	15.60	119.60
Centronics	130.00	19.50	149.50

Communications Interface Card

The Communications Interface Card is available separately to allow you to connect your APPLE to modems, CRT terminals, and other devices employing a serial RS-232C interface. The card's built-in intelligence lets you control these devices easily, in BASIC.

Features

—Firmware Control Programs
—No Software to Write
—Easily Controlled from BASIC using simple commands
—Communicates at 110 or 300 Baud, Half- or Full-Duplex
—RS-232C-compatible Serial Interface

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Apple II

sets the standards.

Specifications

PARAMETER	DESCRIPTION
Signal level:	EIA RS-232C
Data Word Format:	1 start bit, 1 or 2 stop bits, 7 or 8 data bits; odd, even or no parity

	Nett	Vat	Total
Price	130.00	19.50	149.50

Serial Interface

The Serial Interface Card allows an APPLE computer to exchange data with computers, printers, and other devices in serial format (one bit at a time). It is intended for use (in place of the Communications Interface Card) in applications that:
—Use data rates other than 110 or 300 baud (10 or 30 char/sec)
—Involve serial printers that don't require "handshake".

Features

—Permits BASIC Control of High-Speed Printers and Plotters
—Quickly Transfers Large Blocks of Data by Telephone (through a modem), or Directly to Local Equipment
—Handles Half-Duplex Communication from 75-19.2K Baud
—Programs Easily with Switch-Selectable Preset Conditions for Speed, Line Length, Auto Line Feed and Carriage Return Delay

Specifications

PARAMETER	DESCRIPTION
Signal Level:	EIA RS-232C or 20mA current loop
Data Word Format:	1 start bit, 1 or 2 stop bits, 5-8 data bits; odd, even, or no parity. Checksum is optional.
Character Handling Options:	Lower-case characters optionallly converted to upper-case or passed through unmodified and displayed in inverse video.

	Nett	Vat	Total
Price	113.00	16.95	129.95

Eurocolour Card Produces PAL colour signals to drive colour video monitor or with a Black & White modulator drives a colour T.V.

	Nett	Vat	Total
Price	79.00	11.85	90.85

Language System

This package includes the Language Card, which allows APPLE users to take immediate advantage of the powerful PASCAL language as well as the Integer and Applesoft BASIC interpreters. The Language Card's 16K bytes of RAM memory electrically replace the ROM firmware built into each APPLE. Upon start-up, this RAM memory is automatically loaded from disk with the user's choice of languages, then electrically protected from change. The loading is controlled by the AUTO-START ROM, also contained on the card. The complete system also includes diskettes containing a language selection "Hello" program, PASCAL, Applesoft BASIC, and Integer BASIC. The reference manuals for all the above languages are also included.

	Nett	Vat	Total
Price	299.00	44.85	345.85

Apple Fortran

Apple FORTRAN is "ANSI Standard Subset FORTRAN 77." These latest computer industry standards provide significant additions and enhancements over previous 66 standards (FORTRAN IV). An example of this is the expanded "IF" statements that have been added to traditional FORTRAN statements.

Apple FORTRAN operates in the Apple Pascal Language system offering the same comprehensive software development environment provided to our Pascal programmers. The Editor, Linker, Filer and Assembler can all be used with the Apple FORTRAN compiler, which, like Pascal, produces 'P' code.

	Nett	Vat	Total
Price	120.00	18.00	138.00

Graphics Tablet

The Graphics Tablet is an image input device that allows the user to enter pictorial information directly (by sketching or tracing) from:
—maps and photographs
—logic diagrams and schematics
—histograms
—architectural drawings
—fine art

Tracing a shape on the tablet surface converts the image to digital values. This information is displayed on the video monitor and may be stored on disk for later processing by the Apple.

	Nett	Vat	Total
Price	462.00	69.30	531.30

Appletel

The Appletel package provides the means to bring the Apple II computer and the Prestel service together. The power of the Apple microcomputer makes the Appletel terminal much more than a simple Prestel receiver. You have the facility to store pages from Prestel in the computer and examine them later at leisure (saving telephone bills). You can automatically call up a sequence of pages of information you regularly need and/or store them. You can use the Appletel terminal to put your own information onto Prestel. Appletel has local editing facilities to help you do this. The fact that you have a full keyboard means that you can make good use of the Prestel facility for sending messages.

	Nett	Vat	Total
Price	595.00	89.25	684.25

Alf music synthesiser card

Three part harmony – plugs into domestic Hi-Fi up to three cards which gives nine parts harmony. Total controls of envelope shape.

	Nett	Vat	Total
Price	180.00	27.00	207.00

Clock/ Calendar Card

This plug-in card provides a 388-day calendar and clock, with resolution to 1/1000 second. The clock is crystal controlled to yield .001% accuracy. A built-in rechargeable battery keeps the clock on time up to four days without system power, and external batteries may be used for longer periods. Optional interrupt capability simplifies control applications. Supplied with complete operating instructions and rechargeable battery.

	Nett	Vat	Total
Price	128.00	19.20	147.20

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MS

Apple II

sets the standards.

apple computer
Sales and Service

ROM Plus card

ROMPLUS + provides six sockets to accept individually addressable 2K ROM's or EPROM's. Keyboard Filter a 2K ROM program, comes installed on the ROMPLUS + board and adds many useful features to your Apple, including:

- Upper and lower case letters. The only system that offers keyboard input and standard shift key operation.
- Multipe user-defined charactor sets.
- Coloured or inverse-coloured letters.
- Keyboard macros – two key-stroke, automatic typing of multiple, user-defined words or phrases. Including BASIC and DOS commands.
- Mixed text and graphics.
- Improved cursor control.
- STOP LIST and END LIST.

	Nett	Vat	Total
Price	105.00	15.75	120.75

Hobby/ Prototyping Card

Create your own APPLE interface boards with this wire-wrap card. The 2¾" x 7", double-sided circuit board includes a hole pattern (on 100-mil centres) that accepts all conventional IC's and passive components. It plugs directly into any APPLE expansion connector, and fits entirely within the computer case. Supplied with complete bus documention to aid the interface designer. (Order No. A2B0001).

	Nett	Vat	Total
Price	15.00	2.25	17.25

Apple Pilot

PILOT is a high level, easy-to-use language which was designed for educators and courseware developers. Since 1968 many teachers and trainers have been using PILOT to create Computer Aided Instruction (CAI) programs. In fact, PILOT is available on more computers than any other CAI language. This means, a large number of potential customers and a large number of existing PILOT programs, most of which will run on the Apple PILOT system.

Apple PILOT has been designed to take full advantage of the Apple's unique features and at the same time offer a superior easy to use CAI system. Through the use of graphics and sound, the instructor can prepare lessons utilizing the full capabilities of the Apple II. Apple PILOT offers the courseware designer a total support system.

System Requirements

- Apple II or II PLUS with 48K memory
- One disk drive for "LESSON" mode or two disk drives for both "AUTHOR" and "LESSON" modes.
- DOS 3.3 or The Apple Language System.

Price on application

DOS 3.3

Apple's new DOS, DOS 3.3, contains two significant improvements for the Apple owner. It creates a compatible environment so that the Apple owner can easily and efficiently use his Applesoft, Integer, and Pascal programes on one set of hardware. The second benefit for the user is that the disk space available is increased 23%. Under the old operating system, approximately 103,000 bytes where available to the user. With the new DOS, 126,976 bytes will be available for user programs.

Included with the new DOS is a utility to convert programs from the old disk format to the DOS 3.3 format, a fast single or double disk drive file copying program, a diskette to allow you to run unconverted software from the old disk format, and a flexible new file utility program. Also included in the package is a new DOS manual, and,of course, the necessary PROMs to change your Apple to the new disk format.

	Nett	Vat	Total
Price	39.00	5.85	44.85

Other Prices

	Nett	Vat	Total
Applesoft Firmware Card – for integer Apples	116.00	17.40	133.40
Integer Card – For applesoft apples	116.00	17.40	133.40
IEEE 488 interface card	212.00	31.80	243.80
Vinyl carrying case	16.00	2.40	18.40
Speechlab – speech input	127.00	19.05	146.05
Supertalker – speech output	136.00	20.40	156.40
Sup 'R' Terminal – 80 column card	253.00	37.95	290.95
A.I.O., Serial and Parallel card	120.00	18.00	138.00
Appleset 16 channel 8 bit A-D	166.00	24.90	190.90
CCS 3¾ digit BCD A-D	80.00	12.00	92.00
Templeman dual 8" disk system – 1M byte	1550.00	232.50	1782.50
Numeric keypad	125.00	18.75	143.75

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Apple III

Size: 17.5 inches wide (44.45 cm)
18.2 inches deep (46.22 cm)
4.8 inches tall (12. 2 cm)
Cast aluminium base with moulded plastic cover.

Weight: 26 pounds (11.8 kilos)

Processor: Apple designed processor utilizes 6502A as one of its major components. Other circuitry provides extended addressing capability, re-locatable stack and zero page, and memory mapping.

Emulation Mode: Provides hardware emulation of 48K byte Apple II or Apple II Plus. Allows most Apple II programs to run without modification.

Clock Speed: 1.8 MHz with video off, 1.4MHz average
1.0 MHz in emulation mode.

Main Memory: 96K (98,304) eight-bit bytes minimum
128K (131,072) bytes maximum
Dynamic RAM memory

Rom Memory: 4K (4,096) bytes used for self-test diagnostics

Power Supply: High-Voltage switching type
+5, –5, +12, –12 volts

Mass Storage: One 5.25 inch floppy disk drive built-in
140K (143,360) bytes per diskette

Up to 3 additional drives can be connected by daisy-chain cable (572K bytes on-line storage)

Keyboard: 74 keys (61 on main keyboard, 13 on numeric pad). Full 128 character ASCII encoded. All keys have automatic repeat.

Three special keys: SHIFT, CONTROL, ALPHA LOCK. Two user-definable "Apple' keys. Four directional arrow keys with two-speed repeat. Four other special keys: TAB, ESCAPE, RETURN, ENTER.

Screen: Three upper/lower case text modes:-

80 column, 24 line black-and-white,
40 column, 24 line 16 colour foreground and background
40 column, 24 line black-and-white.

All text modes have a software-definable 128 character set (includes upper and lower case) with normal or inverse display

Three graphics modes:

280 x 192, 16 colours (with some limitations)
140 x 192, 16 colours
560 x 192, black-and-white
plus Apple II Modes.

Video Output: RCA phono connector for NTSC black-and-white composite video. DB-15 type connector for:

NTSC black-and-white composite video
4 TTL outputs for generating RGB colour. Composite sync signal. NTSC colour composite video. +5, –5, +12, –12 volt power supplies

Colour signals appear as 16-level grey scale on black-and-white video outputs.

Audio Output: Built-in 2 inch speaker. Miniature phone-tip jack on back of Apple. Driven by six-bit digital/analog converter or fixed-frequency "beep" generator

Serial I/O: RS-232C compatible, DB-25 female connector. Software selectable baud rate and duplex mode.

Joysticks: Two DB-9 connectors for two joysticks with pushbuttons.

Printer: One DB-9 connector (shared with second joystick) for Apple Silentype printer.

Clock: Can be set and read from programs. Powered by long-life replaceable watch batteries. Keeps track of month, date, day of week, and exact time to 1/1,000th of a second.

Expansion: Four 50-pin expansion slots inside the cabinet

SOS: Sophisticated Operating System handles all system I/O SOS can be configured to handle standard or custom I/O devices and peripherals by adding or deleting "device drivers"

All Languages and Application programs access data through the SOS file system.

Languages: Apple Business BASIC, PASCAL, FORTRAN

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M7

Apple Software

	Nett	Vat	Total
Payroll I			
Weekly/Monthly. Up to 200 employees. Weekly/Tax, National Insurance and Pension. Up to 20 departments.	375.00	56.25	431.25
Payroll II			
Weekly/Monthly. Up to 99 employees. Less detailed reports as in above. Excellent value.	200.00	30.00	230.00
LEDGERS			
Sales			
500 accounts, 1600 transactions, Credit limit check. 100 Analysis codes, aged debtors analysis.			
Program	295.00	44.25	339.25
Manual	3.00		3.00
Purchase			
500 accounts, 1600 transactions Turnover aggregated for each customer.			
Program	295.00	44.25	339.25
Manual	3.00		3.00
General			
Trial Balance/Accumulated profit/Loss on demand. 1000 named accounts, 1700 postings.			
Program	295.00	44.25	339.25
Manual	3.00		3.00
Optional Applications Manual			
Uses for incomplete records, group consolidation branch accounts, etc.	10.00		10.00
Inventory Control			
Probably the most powerful package on the market. 1250 items/disk, 600 suppliers. Automatic re-order routine. Fully documented, easy to use, well proven in the field.			
Program	225.00	33.75	258.75
Manual	3.00		3.00
Other Applications: Point of sale stock control Licensed trade stock control.			
Visicalc			
Visicalc and Apple do to the calculator what word processing has done to the typewriter. Plan budgets, rate of returns, financial statements, tax effects, sales forcasting, "What if?" Uses are endless and visicalc is limitless.			
Visicalc	95.00	14.25	109.25
Mailing List			
Company name/address/contact/ telephone no. 375 records/disk. Add, amend, delete. Print all/selected records. Print self adhesive labels.	27.00	4.05	31.05
Apple Desktop/Plan			
A business planning and analysis system designed to aid development and analysis of business plans such as budgets, sales forecasts, cash flow planning, profit and loss predictions and many other similar types of analysis	64.00	9.60	73.60
Applewriter			
Most probably the best word processing system avilable on a microcomputer for the price. Features include: high speed versatile cursor control, moving blocks of text, delete by character, word and paragraph, left, right, centre justifications, upper and lower case, very easy to use, well documented.	42.00	6.30	48.30
Credit Control			
An ideal aid for the business who needs tight control on their debtors. Holds up to 850 accounts. Informs you if any order exceeds the credit limit. Easy to use.	75.00	11.25	86.25
Sales Control			
Gives breakdown of sales per client over the last 3 years and each month this year. Shows number of unconverted enquiries, reports, on printer between user development parameters on area product turnover to date, turnover this month. Many other valuable reports.	150.00	22.50	172.50

Appleware

FOR FURTHER DETAILS PLEASE RING

	Nett	Vat	Total
Programming Aids and Tutorials			
Applepie (Integer)	30.00	4.50	34.50
Assembler Editor (Machine Code)	45.00	6.75	51.75
Data Base (Integer)	23.50	3.53	27.03
Disk magic (Integer)	16.00	2.40	18.40
Hi Resolution Character Generotor (Applesoft)	16.50	2.48	18.98
Appleforth (Integer)	39.95	5.99	45.94
large Character (Integer)	16.00	2.40	18.40
Lisa (Integer)	28.50	4.28	32.78
Master Catalogue (Applesoft)	14.00	2.10	16.10
Shape Builder (Applesoft)	17.00	2.55	19.55
Step by Step (Applesoft)	37.50	5.63	43.13
Talking Disk (Integer)	14.95	2.24	17.19
Three D Animation (Integer)	12.95	1.94	14.89
Tiny Pascall (Integer)	40.00	6.00	46.00
Business Programs			
Active Filter (Applesoft)	15.00	2.25	17.25
Audio Engineer(Applesoft)	15.00	2.25	17.25
Index File (Integer)	16.00	2.40	18.40
Statistics (Applesoft)	19.95	2.99	22.94
Games and Simulations			
Games Pack 1 (Integer)	12.00	1.80	13.80
Games Pack 2 (Integer)	12.00	1.80	13.80
Games Pack 3 (Integer)	12.00	1.80	13.80
Games Pack 4 (Integer)	12.00	1.80	13.80
Games Pack 5 (Integer)	12.00	1.80	13.80
Games Pack 6 (Integer)	12.00	1.80	13.80
Games Pack 7 (Applesoft/Integer)	12.00	1.80	13.80
Alien Encounters (Applesoft)	8.00	1.20	9.20
Alien Invasion (Machine Code)	8.00	1.20	9.20
Apple Invaders (Integer)	12.00	1.80	13.80
Battlefield (Applesoft)	8.00	1.20	9.20
Biorhythm (Applesoft)	10.00	1.50	11.50
Breakthrough (Machine Code)	8.50	1.28	9.78
Bulls and Bears (Integer)	12.00	1.80	13.80
Datestones of Ryn (Applesoft)	12.95	1.94	14.89
Death Race (Integer/Machine Code)	10.95	1.64	12.59
Earth Quest (Integer)	11.50	1.73	13.23
Galactic Battle (Integer)	8.00	1.20	9.20
Guided Missiles (Machine Code/Integer)	10.95	1.64	12.59
Invasion Orion (Applesoft)	18.00	2.70	20.70
Laser Blast (Machine Code/Integer)	12.00	1.80	13.80
Lunarlander (Machine Code/Integer)	9.25	1.35	10.64
Phasor Zap (Integer)	10.00	1.50	11.50
Saucer War (Applesoft)	9.95	1.49	11.44
Space Traders (Applesoft)	12.95	1.94	14.89
Space Wars (Machine Code/Integer)	12.95	1.94	14.89
Speedway (Integer)	10.00	1.50	11.50
Star Voyager (Integer)	15.95	2.39	18.34
Strato Laser (Applesoft)	10.95	1.64	12.59
Stunt Cycle (Machine Code)	10.50	1.58	12.08
Super Dungeons (Integer)	12.95	1.94	14.89
Super Starwars (Machine Code/Integer)	11.25	1.69	12.94
Starfleet Orion (Integer)	18.00	2.70	20.70
Temples of Apshai (Applesoft)	22.95	3.44	26.39
U.F.O. (Machine Code/Integer)	8.50	1.28	9.78
War Lords (Integer)	12.00	1.80	13.80
Educational, Mathematical and Scientific Programs			
Function Pilot (Applesoft)	18.50	2.78	21.28
Planets (Applesoft)	15.00	2.25	17.25
Sirus (Applesoft)	15.00	2.25	17.25

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Video Genie

Value and TRS 80 compatibility

20 free Microdigital quality Cassettes with each Genie

The Video Genie is a complete computer system, requiring only connection to a domestic 625 line TV set to be fully operational; or if required a video monitor can be connected to provide the best quality display.

The system case contains the Central Processor Unit (CPU), 16,000 bytes RAM memory, the cassette system, a 12,000 byte operating system and BASIC interpreter in ROM, and a full size keyboard, in a stylish case, at a price that makes the Video Genie better value than some "kit" computers.

Keyboard

The Video Genie has a 51 key typewriter style keyboard, which features a 10 key rollover. This makes it very easy for experienced and inexperienced typists alike to enter programs and data into the machine.

Applications

The Video Genie System has many uses in all spheres of life, the easy to use BASIC language means that programs are easily written for specific applications, and pre-recorded program tapes are available in great variety.

The system has great scope in the home, sophisticated games programs can introduce the computer age to all the family, who can then progress to writing their own programs in BASIC or even machine code. Software is continuously being developed to aid home budgeting and education.

In a school or college the machine can be used with a large screen TV to allow a whole class to be taught at once.

The powerful Extended BASIC interpreter makes the solution of complex scientific problems simple, and the graphics allow pictorial displays of results.

Extended BASIC

— Single, double and integer – precision numeric variables, as well as string variables.

— multi-character variable, with the first two characters significant.

— program lines, logical lines and string variables up to 255 characters long.

— includes all scientific functions.

— numeric accuracy up to 16 significant digits, with intrinsic functions at 6-digit accuracy.

— formatted, printing, program editing (with extensive editing subcommands), error trapping, named files, program tracing, automatic line numbering, multi-statements per line, and keyboard rollover allowed.

— multi-dimension arrays, and complete string manipulation.

— direct memory inspection, and input/output commands provided.

— direct graphic commands.

— allows access to machine language subroutine.

— many other advanced features, all included in the detailed programming manuals.

Cassette Unit

The Video Genie has an integral cassette system which can save information on standard tape cassettes. An interface is also provided to connect an external audio cassette unit for greater storage flexibility.

Accessories

The Video Genie is supplied with the following accessories:-
BASIC demonstration tape.
Video lead
Second cassette manual

Manuals

Users manual
BASIC manual
Beginners programming manual

These manuals provide an an excellent course of instruction for the beginners to computing. They take the user gently through the subject, explaining the concepts of computing with the Video Genie.

Software

The Video Genie utilises the same renowned extended BASIC interpreter as the TRS-80. Most software for the TRS-80 will run on the Video Genie so an enormous range of software is available.

	Nett	Vat	Total
Price	330.00	49.50	379.50

Price does not include T.V./monitor

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M9

Printers

Tally/Mannesmann M80/77/MC

A printer for the professional user. This new printer from T/M offers fast, dependable and cost effective hard copy data processing for the business man. Its high speed, 200 c.p.s., bi-directional print mechanism will ensure that your printer is not tied up all day. We are able to offer this printer at a price that includes a 1K character buffer and 132 column print option included in the price. Serial or parallel compatible.

We feel that this printer will fulfill the requirements of the most demanding user, whether it be Payroll, Ledgers or Stock-control, the M80 will handle the application with minimum fuss for the User.

Price	Nett	Vat	Total
Tally/Mannesmann M80/77/MC	1000.00	150.00	1150.00
Includes 1K Buffer, 132 Print Option			

Oki Microline 80

Quality and reliability at a price that makes it available for business, educational and home-user applications. The features and specifications of this small lightweight printer are those of models costing many times more.

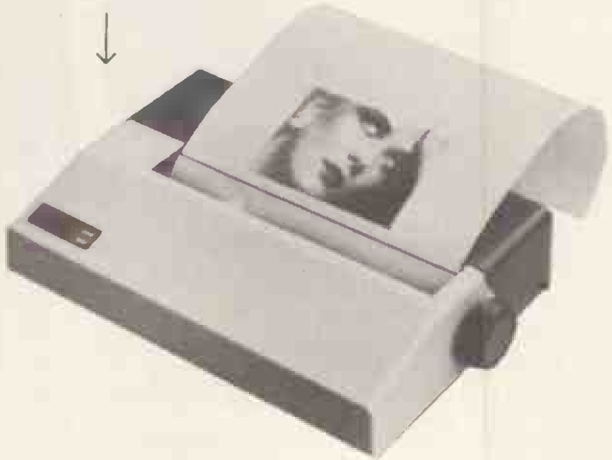
80 characters per second
80 and 132 columns program selectable
Full 96 character set with graphics printing facility
Long life 9 x 7 print head matrix parallel and serial compatible.
Friction and Pin Feed as standard.

Price	Nett	Vat	Total
Microline 80	499.00	74.85	573.85
Tractor Feed Option	35.00	5.25	40.25

Microhush 200

This, the latest in the line of thermal printers, offers all the high performance features of the Microhush 100, plus an 80 column printing capacity and the ability to reproduce the whole screen of a 'Apple' high resolution image, utilising a 60 dots per inch definition.

Price	Nett	Vat	Total
Microhush 200	349.00	49.35	398.35

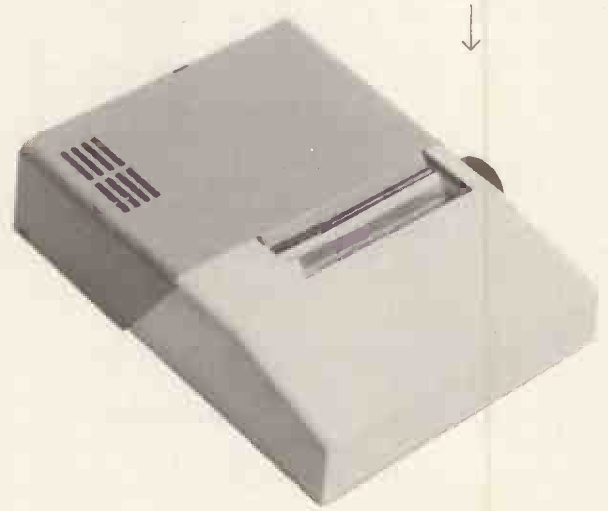


Microhush 100

A fast reliable thermal printer offering the user a high definition 96 character set created by a 5 x 7 print head. Its 40 characters per second, bidirectional look-ahead printing and extremely quiet operation, ensures a high performance at low cost.

Interfacable to most microprocessor systems including Apple, Sorcerer and RS 232.

Price	Nett	Vat	Total
Microhush 100 including 'Apple' interface	299.00	44.85	343.85



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M10

Atom

Prices	Nett	Vat	Total
Atom Kit 8K + 2K	120.00	18.00	138.00
Atom Ass 8K + 2K	150.00	22.50	172.50
Atom Kit 12K + 12k	220.00	33.00	253.00
Atom Ass 12k + 12K	250.00	37.50	287.50
1K RAM sets	9.50	1.43	10.93
4K Floating Point ROM	20.00	3.00	23.00
Printer driver	11.50	1.73	13.23
Mains Power Supply	8.00	1.20	9.20

The Basic Atom

Elegantly designed and injection moulded in heavy duty polystyrene, the Atom meaures only 15" long x 9½" deep and 2½" high fitting snugly inside a normal briefcase.

And yet it still contains a full sized keyboard laid out in a conventional typewriter way. The full travel, light pressure keys give a positive reliable action, better for both the amateur and experienced typist.

To use the Atom immediately you just connect the power supply and a cable into the aerial socket of a television set. Any UHF colour or monochrome set will do – the Atom doesn't harm them at all.

The Atom has an initial 2K of RAM and 8K of ROM but of course this can be boosted enormously. The standard computer has Basic and Assembler (machine code) graphics and sound output, with direct cassette and TV interface. (See further for list of specifications.) Basic is the language used by Atom and is indeed the language used by most personal computers. The Basic used has all the normal functions you would expect plus many powerful extensions making it easier for you to operate and write your own programs. In personal computer terminology 'powerful' means the machine works harder cutting down the amount of information that you would otherwise have to type in.

How your Acorn Atom grows

Internally

Both screen and program memory can be expanded in 1K blocks up to 12K total, and the fixed memory can be added to in two blocks of 4K. One is the 4K floating point arithmetic package. The printer interface requires the addition on board of a 6522 and buffers.

The PAL encoder module when fitted allows full colour output to a domestic colour TV although a simple modification allows direct connection to a colour monitor without a PAL encoder.

Externally

The most exciting addition however is the communication module which fits inside the case and allows high speed communication to other systems which can be anything from an Acorn System One to an IBM 370 and what's more any number of other Atoms. Designed for classroom use where, for example, twenty Atoms may be linked both to each other and to the teacher's system. The teacher can take control of any keyboard and display for instruction purposes, and can link any pupil to a printer or disc storage facility. In the home or laboratory however, this module may be used to control substations such as System I with any of the Acorn interface modules.

nb. Existing owners of Acorn systems may use the tape interface as a simple communication line to and from the Atom.

Technical Description — Hardware

Memory: From 2K to 12K RAM on board (in steps of 1K) up to 40K including external memory. From 8K to 16K ROM (two 4K additions).
Processor: 6502 with 1 Mc/s clock.
Video Display Generator: 6847 generates video signals for 8 different modes including: high resolution graphics (256 x 192), Red, green, and blue graphics up to resolution of 128 x 192, and mixed ASCII characters and semigraphics.
PIA: 8255 provides keyboard scan, cassette I/O port (one used for printer output) plus a wide range of serial I/O functions and dual timers.
Cassette Interface: CUTS 300 baud, involves minimum hardware (zero crossing detector input and output from timer) to allow user to redefine tape routine to virtually any speed or standard.
Loudspeaker: Driven from 8255 via buffer allowing software tone generation of any frequency.
B/W Video Output: To monitor.
UHF Modulator Output: Channel 36 domestic T.V.
Bus Output: Fully buffered address and data bus plus internal connections for one Acorn Eurocard.
Power Requirement: Minimum system: 8 volts @ 800mA (from Atom power unit feeding internal regulator). Maximum system: 5V @ 1.8A from external regulator supply.

Technical Description — Software

Atom basic: 32-bit arithmetic (±2,000,000,000), High speed execution, 43 standard and extended BASIC commands, Variable length strings (up to 256 characters), String manipulation functions, 27 32-bit integer variables, 27 additional arrays, Random number function, PUT and GET bytes, words and strings to and from files, WAIT command for timing, DO-UNTIL construction, Commands may be abbreviated for economy, Multiple statements per line, Logical operators (AND, OR, EX-OR), LINK to machine code routines, Numbers can be input and printed in hexadecimal, Symbolic labels for fast branches and subroutine calls, Powerful indirection operators (?,!), Graphics facilities to draw points and lines, 16 PLOT commands, MOVE and DRAW.
Assembler: Mnemonic Assembler for machine code programming, Formatted listing, Assembler and BASIC may be combined. Standard 6502 mnemonics, Provides symbols, automatic resolution of forward references, Macro-facilities, Breakpoints may be inserted for debugging.
VDU: 32 characters x 16 lines, Inverted characters, Automatic scrolling, Paged/Non paged modes, All control codes can be generated, Screen editing.
Operating System, CUTS cassette routines with checksum, Filenames up to 12 character, LOAD and SAVE BASIC and assembler programs or text files, Search (catalogue) routine, Software hook to optional disc drive and communication loop modules, Printer drive routines.
Optional Maths Software: Floating point maths functions to 9 digit accuracy including arithmetic, trigonometric and hyperbolic functions.
Optional Communication Software: Allows high speed bi-directional interface to other Atoms or peripherals, Allows transfer of control or data to other modules in loop.
Optional Utility ROM: Such as the ONLIBASIC extension for real time control of laboratory experiments.

Cassettes/Disks

Disks

High Performance Mini Floppy disks

- Made by Kybe corporation
- Anti static envelopes
- soft sectored
- single sided, single density
- free library cases (with 10 or more disks)
- labels and write protect tabs supplied

Prices	Nett	Vat	Total
one disk	3.00	0.45	3.45
ten disks	22.00	3.30	25.30
fifty disks	100.00	15.00	115.00
one hundred disks	180.00	27.00	207.00

Cassettes

Quality Microcomputer Cassettes.

- C15 Agfa Tape
- Special Labels
- Cellophane wrapped
- Precision transport mechanism
- Leaderless
- Insert Cards
- Screw fixing case
- Proven performance

Prices	Nett	Vat	Total
one cassette	0.80	0.12	0.92
box of ten cassettes	5.20	0.78	5.98
fifty cassettes	25.00	3.75	28.75
one hundred cassettes	45.00	6.75	51.75

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BOOKS

SYBEX BOOKS

Introduction to Personal and Business Computing by R. Zaks 4.90
A comprehensive yet simple introduction to the micro computer world for the potential user whether it be for home or business use.

Microprocessors – From Chips to Systems by R. Zaks 6.95
The basic text on micros for everyone with a technical or scientific background. This book teaches all the fundamentals of microprocessors step by step.

Microprocessor – Interfacing Techniques by R. Zaks 9.90
This comprehensive book introduces the basic interfacing concepts and techniques, then presents the implementation details from hardware to software.

Programming the 6502 by Rodnay Zaks 7.90
This book is an educational text designed to teach programming, using the 6502. It does not require any prior programming knowledge, yet can be used to advantage by anyone wishing to familiorize himself with the 6502. An invaluable book for owners of the PET, Apple, Kim etc.

6502 Applications Book 7.90
This book presents practical applications techniques for the 6502 ranging from a complete home alarm system to an industrial control loop for temperature control. Also includes analog to digital conversion and simple peripherals from paper-tape reader to micro printer.

Programming the Z-80 8.90
Another in the highly successful Sybex Series by Rodnay Zaks. This book combines the function of a teaching text, that Sybex do so well, with an extensive reference section. The book is much more than an introduction to the Assembly Language syntax of the Z-80.

SCELBI BOOKS

Understanding Micros by N. Wadsworth 7.90
If you are at all curious about small computers you must own this no-nonsense text which explains all the fundamental concepts behind the operation of virtually all microcomputers.

Calculating with BASIC 7.90
Here's a variety of programs in BASIC to help apply the language to practical problems. The book covers problems in finance, statistics, engineering, mathematics and electronics. Good descriptions and examples are provided with each program listing.

PIMS Personal Information Management System 7.45
This book is really a ready to use data base system in Microsoft BASIC with full instructions. An excellent starting point for your home applications.

OSBORNE BOOKS

Z-80 Assembly Language Programming 8.10
These books are assembly language primers in the "classical sense" – they treat assembly language as a means of programming a microcomputer system and are full of simple programming examples.

6502 Assembly Language Programming by Leventhal 8.20
Another fine manual in the Osborne Assembly Language series to join the best selling 8080, 6800 and Z-80 books.

PET and the IEEE 488 Bus (GPIB) by Fisher & Jenson 9.90
A book for instrument designers, scientists, programmers and hobbyists – which shows how you can have a low-cost versatile system that may be interfaced to any of hundreds of electronic instruments.

Introduction to Microcomputers by A. Osborne – Volume 0: The Beginners Book 5.90
If you know nothing about computers this is the book to begin with. It explains what computers are and describes their components.

Introduction to Microcomputers by A. Osborne – Volume 1: Basic Concepts 6.25
This book describes application techniques common to all microprocessors yet specific to none. All the basic hardware and software concepts are explained simply.

Introduction to Microcomputers – Osborne (September 1978 Edition)
Volume 2 – Some Real Microprocessors 14.90
This 9" x 7" loose leaf format book covers every major microprocessor on the market. 4 bit to 16 bit in detail and analyses more than 20 CPUs. Includes new sections on the most recent entries into the microprocessor market. Describes support devices for use with only one microprocessor.

Volume 3 – Some Real Support Devices – loose leaf 10.90
A companion volume to volume 2. This describes the micro support devices which can be used with more than one microprocessor – including system buses.

Some Common BASIC Programs 7.90
Includes 76 short programs covering financial, mathematical, statistical and general interest subjects, all of which have been tested.

Z-80 Programming for Logic Design 6.25
These books describe the implementation of sequential and combinotional logic using assembly language. They describe the meeting ground of the programmer and the logic designer and are written for readers in both fields.

ADDISON – WESLEY BOOKS

Artificial Intelligence by Winston 13.75
Artificial intelligence is concerned with extending the application of computers and gaining an understanding of the principles that make intelligence possible. This book designed for use in a course on artificial intelligence should prove invaluable to the newcomer to the topic as well as to the experienced as a reference text. Part one covers an introduction to the key ideas in the subject such as representation, symbolic constraint exploitation, search and control. Part two covers the LISP programming language and its use. The book is profusely illustrated.

Problem Solving and Structured Programming in BASIC by Koffman and Friedman 8.90
The book reflects the view that good problem solving and programming habits should be introduced at an early stage. Three separate phases of the solution are used:-
1) Specification of the algorithm using flow diagrams.
2) Analysis of the problem.
3) Implementation of the problem solution.

The Little Book of BASIC Style by Nevison 5.70
Structure style and correctness and maintainability are the attributes of good programming – they are getting much attention as well they should. When one considers what we invest in programs their manageability and efficiency become very important. In this book these concepts are explained along with 19 rules and many examples in BASIC to help improve your programming style.

A Guide to BASIC Programming by Spencer 8.80
A first course in BASIC for Scientists, Business people and Engineers. The book illustrates the application of the language with numerous examples which will be useful later in your BASIC programming career.

Introducing System Design by Squire 9.65
This book assumes some knowledge of computers and from this builds a review of the techniques used in system design through data base, security of the system and top down design. An important book for the student of business use of computers.

Software Tools by Kernigan and Plauger 8.15
This text is designed to emphasie Structured Programming and Top Down Design. It deals with filters, formatting, files, sorting, text patterns, editing and macro-processing.

BASIC and the Personal Computer by Dwyer & Critchfield 9.70
The authors provide a detailed presentation of BASIC and extended BASIC. Included are many applications possible on any microcomputer. Readers are encouraged to think about personal computing in its widest sense, write programs and research new applications. A selection of projects appears at the end of each chapter. The book may be used as a self-study text or a course book.

Problem Solving and Structured Programming in FORTRAN by Friedman & Koffman 9.90
This book is designed for a short first course in computer programming. This book introduces the techniques of structured programming at a very early stage. The authors emphasize three distinct phases of problem solving: 1) the analysis of problem 2) the specification of an algorithm and 3) the language implementation of the algorithm.

A Course in APL with Application by Grey 9.70
This introductory text may be used by either the experienced computer user familiar with at least one general purpose language, or by the beginner with no previous programming experience. The presentation aims to show that APL is a refinement and enhancement of mathematics. Emphasis is placed on the use of APL as an ideal language for formulating and developing algorithms.

Programming in PASCAL by Grogono 6.90
This introductory language manual is an excellent start to one of the fastest growing programming languages today. The book is arranged as a tutorial containing both examples and exercises to increase reader proficiency with the language. Besides a chapter on procedures and files there are sections on dynamic data structures such as trees and linked lists. These concepts are put to use in an example of bus service simulation.

Programming a Microcomputer (6502) by Foster 7.20
This book will teach you how to program a microcomputer in machine language. Although designed specifically for the 6502 microprocessor used in the Kim 1, PET and the Apple. The basic principles involved apply to all computers.

The Computer – An Everyday Machine by Squire 8.40
This text puts the data processing computer in perspective, introduces it as a tool that can be used and understood by anyone. The approach is to take a simple problem, analyse it and then solve it using a hypothetical language and a computer consisting of the simplest possible units. The book is an excellent introduction to the computer as used by large scale businesses. The author is a systems engineer with IBM Canada and provides her own interesting perspective. The book is widely used by business management students as their first introduction to computers.

The Art of Computer Programming Volume 1 – Fundamental Algorithms by Knuth 9.90
This is the first book in this world wide best selling series and thought by many as the best books of their type available. Volume 1 begins with a thorough review of the mathematical techniques used, although it does not assume mathematics above high school level in the reader. It goes on to review assembly level programming and ends with a 200 page review of information structures. The book contains numerous exercises.

M12

BOOKS

The Art of Computer Progamming Volume 2 – Semi-Numerical Algorithms by Knuth 16.40
This book covers random numbers, random sequences, statistical tests, floating point arithmetic, multiple precision arithmetic, polynomials etc. This book offers a comprehensive interface between existing knowledge of computer programming and numerical analysis including a substantial amount of complexity and number theory statistics. It assumes 'A' level mathematics capability.

The Art of Computer Programming Volume 3 – Searching and Sorting by Knuth 20.40
This text is by far the most comprehensive survey of these computer techniques ever published. The material is presented such that the general principles are applicable to a wide range of problems. Some knowledge of computer techniques and elementary calculus is assumed.

CREATIVE COMPUTING BOOKS

BASIC Computer Games by Daivd Ahl 5.45
The first collection of games all in BASIC. Contains both a complete listing and a sample run of each game along with a descriptive write up.

Mare BASIC Computer Games by David Ahl 5.45
This is the sequel to the best selling "BASIC Computer Games". 84 fascinating and entertaining games for solo or group play. All games are complete with a program listing in BASIC, a sample run and a description. Standard Microsoft BASIC is used throughout and the programs are simple to use with almost all microcomputers.

WELLER BOOKS

Practical Microcomputer Programming with the Z-80 by Weller 19.50
18 chapters of solid accurate programming information. Debugging techniques, interrupt modes, array and table handling, number base conversation, floating point arithmetic, programmed input/output stockpointer usage. The book includes an editor assembler listing for Z-80 and 8080. If you retum the coupon at the back of the book you receive either paper tape or TRS 80 cassette of the object code for the assembler.

HOWARD SAMS BOOKS

Microcomputer Primer by M. Waite and M. Pardee 6.30
Written for the beginner in the computer field. All the basic concepts and characteristics of microcomputers are explored and explained.

Getting Acquainted with Micros by L. Frenzel 6.90
Learn about microcomputers in an effective low cost manner. The essential information contained in this book has been compiled especially for Engineers, Technicians and Scientists but is equally invaluable to the layman.

Computer and Programming Guide for Engineers by D. Spencer 9.10
Written specifically for the Engineer or Scientist, this book explains what a computer is, how it works and how it can be used to the best advantage. Details FORTRAN and BASIC programming.

TTL Cookbook by D. Lancaster 7.10
Discover what transistor-transistor logic is, how it works and how to use it. Discusses practical digital applications and teaches you how to build TTL systems that entertain test and train.

CMOS Cookbook by D. Lancaster 7.45
Your complete guide to the understanding and use of Complementary Metal-Oxide-Silicon integrated circuits. Gives usage rules, power suppply design examples, applications, bread boarding and coverage of logic.

TV Typewriter Cookbook by D. Lancaster 7.20
A comprehensive guide to low cost television display of alpha-numeric and graphics data for microprocessor systems word processing, TV titling and video games.

Cheap Video Cookbook by D. Lancaster 4.90
A complete guide to super low cost alphanumeric and graphic microprocessor based video displays – this book picks up where the TV Typewriter Cookbook ended.

How to Program Micros by W. Barden Jnr. 6.90
Explains assembly language programming of microcomputers based on the 8080, 6800 and 6502 microprocessors. Basic concepts, number systems and operations, computer operation and codes are examined.

Z-80 Microcomputer Handbook by W. Barden Jnr. 6.90
This book provides essential information on Z-80 technology and is organised into three sections: Hardware, software and microcomputers built around the Z-80.

Microcomputers for Business Applications by W. Barden Jnr. 7.10
This book will prove invaluable to a potential buyer of a business microcomputer system – helping him to select the best system for his particular needs. The micros discussed range from spin-offs of hobbyist computers to complete "turnkey" systems with customised software.

The S-100 and Other Micro Buses by Poe and Goodwin 5.10
This book is about buses and after acquainting the reader with bus basics moves on to detail the eleven most widely used bus systems.

BASIC Primer by Waite and Pardee 6.90
This book is exactly what it says it is – on top of this it also includes 7 appendices to help you optimise your code for speed or memory use. Finally at the back is a reference card which you will keep in your pocket during the rest of your BASIC programming career.

Z-80 Microprocessor Programming and Interfacing Volume 1 by Nichols and Rony 7.70
This book is the first of a two volume series on the Z-80. It covers programming at the assembly and machine language level for the Z-80. Book 2 will cover interfacing. The books are laboratory oriented texts. The strong emphasis is on learning through experiment. This book requires no background in computers.

Z-80 Programming and Interfacing Book 2 by Nichols and Rony 8.45
Address interfacing digital circuits with the Z-80 CPU, PIA and CTC chip and progresses on from Book 1 (Interfacing) assuming the reader is familiar with the topics covered in Book 1.

Industrial Process Control System by Patrick and Fardo 8.90
Process control procedures, system concepts, components, industrial applications and study questions in a logical text book.

TRS-80 Interfacing by J. A. Titus 6.90
Requiring a good understanding of Level II BASIC, this book describes the signals available in the TRS-80 computer and their applications to the control of external devices. Experiments in the construction and use of some typical interfaces are included.

The Howard W. Sams Crash Course in Microcomputers by L. E. Frenzel 10.60
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COMPUSOFT BOOKS

Learning Level II BASIC by David Lien 11.00
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Morse Tester and Loopy

MORSE Tester by K E Whitehouse of St Leonards-on-Sea, East Sussex, prints five morse characters to the screen and gives a delay time, set by the user, during which the user may enter his guess at the message.

The number five is significant as I wrote the program for a colleague studying for his Post Office Morse test — in the examination, one is asked to decode Morse messages transmitted in fives.

```
READY.
MORSE TESTER 13/06/80

READY.

10000 PRINT"MORSE CODE TESTER "
10010 PRINT"AUTHOR - K.J.WHITEHOUSE "
10020 PRINT"FIVE MORSE CHARACTERS WILL BE OUTPUT"
10030 PRINT"TO THE SCREEN AND A TIME DELAY WILL"
10040 PRINT"THEN OCCUR TO GUESS THE MESSAGE."
10050 PRINT"THIS DELAY WILL BE FOLLOWED BY THE"
10060 PRINT"5 CHARACTER ANSWER."
10070 PRINT"SET YOUR TIME DELAY"
11000 CLR RESTORE
11010 SP$="  "
11020 DI$="  "
11030 DA$="     "
11040 INPUT"DELAY IN SECONDS APPROX.":SS
11050 DIMCD$(36,2)
11060 FORK=1TO36 READCD$(K,1),CD$(K,2) NEXTK
11070 XX=1
11200 PRINT"WOULD YOU LIKE -"
11210 PRINT" 1  LETTERS"
11220 PRINT" 2  NUMBERS"
11230 PRINT" 3  COMBINED"
11240 PRINT"INPUT YOUR CHOICE  1    2   OR  3 ."
11250 GETK9$ IFK9$=""THEN11250
11260 IFK9$<"1"ORK9$>"3"THEN11250
11500 AN$="" RC$=""
12010 PRINT"GUESS THE MESSAGE"
12020 FORK=1TO5
12030 GOSUB40000
12040 FORJ=1TOLEN(CE$)
12050 IFMID$(CE$,J,1)="S"THENGOSUB31000
12060 IFMID$(CE$,J,1)="L"THENGOSUB32000
12070 IFJ<LEN(CE$)THENGOSUB30000
12075 NEXTJ
12080 PRINT PRINT
12090 AN$=AN$+AC$
12100 NEXTK
13000 FORK=1TOSS
13010 FORJ=1TO30
13020 GETRY$ IFRY$<>""THENPRINT"J" GOTO14000
13030 NEXTJ
13040 NEXTK
13045 PRINT"";
13050 PRINT"TRY AGAIN WITH A NEW MESSAGE"
13055 FORZZ=1TO1200 NEXTZZ
13060 GOTO11500
14000 PRINT"YOUR GUESS IS = "
14010 RC$=RC$+RY$
14015 PRINTRY$;
14020 GETRY$ IFRY$=""THEN14020
14030 IFRY$=CHR$(13)THENPRINT GOTO15000
14040 GOTO14010
15000 IFAN$=RC$THENPRINT"WELL DONE":GOTO13055
15010 IFAN$<>RC$THENPRINT"CORRECT ANSWER = "AN$"":GOTO13050
30000 REM - SPACE
30010 PRINTSP$;
30020 RETURN
31000 REM - DOT
31010 PRINTDI$;
31020 RETURN
32000 REM - DASH
32010 PRINTDA$;
32020 RETURN
40000 REM - CODE GENERATE ROUTINE
40010 ONVAL(K9$)GOTO40020,40030,40040
40020 RR=INT(26*RND(XX)+1):GOTO40050
40030 RR=INT(10*RND(XX)+27):GOTO40050
40040 RR=INT(36*RND(XX)+1)
40050 AC$=CD$(RR,1) CE$=CD$(RR,2)
40060 RETURN
50000 REM - DATA BLOCK
50010 DATAA,SL
50020 DATAB,LSSS
50030 DATAC,LSLS
50040 DATAD,LSS
50050 DATAE,S
50060 DATAF,SSLS
50070 DATAG,LLS
50080 DATAH,SSSS
50090 DATAI,SS
50100 DATAJ,SLLL
50110 DATAK,LSL
50120 DATAL,SLSS
50130 DATAM,LL
50140 DATAN,LS
50150 DATAO,LLL
50160 DATAP,SLLS
50170 DATAQ,LLSL
50180 DATAR,SLS
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50200 DATAT,L
50210 DATAU,SSL
50220 DATAV,SSSL
50230 DATAW,SLL
50240 DATAX,LSSL
50250 DATAY,LSLL
50260 DATAZ,LLSS
50270 DATA"1",SLLLL
50280 DATA"2",SSLLL
50290 DATA"3",SSSLL
50300 DATA"4",SSSSL
50310 DATA"5",SSSSS
50320 DATA"6",LSSSS
50330 DATA"7",LLSSS
50340 DATA"8",LLLSS
50350 DATA"9",LLLLS
50360 DATA"0",LLLLL
READY.
```

Loopy is a program which demonstrates a fault peculiar to interpreted languages such as Basic.

The fault pin-pointed by Loopy occurred during the development of the Morse Tester. The loop variables in the double loop 12020 — 12100 are K, J in that order whereas the loop variables inside the double loop 13000 — 13040 were J, K — of course, now corrected.

That second double loop represented the time delay which, if not interrupted, worked perfectly. However, should any key be pressed, the double loop would be exited and eventually the program flow would return to the first double loop, producing a next-without-for error at line 12100.

The reason is obvious when you see it, but it is difficult to spot. What happens is that provided a loop is completed, the variable is taken from the appropriate stack. If not, it is left on, and in this case, in the wrong order, i.e., badly nested for the first double loop.

```
READY.
0 OPEN40,4:CMD40
1 PRINT"START DOUBLE LOOP ONE"
2 FORK=1TO4
3 FORJ=1TO3
4 PRINT"INSIDE DOUBLE LOOP ONE"
  ;K;J
5 NEXTJ
6 NEXTK
7 PRINT"AFTER DOUBLE LOOP ONE
  ";K;J
11 PRINT"START DOUBLE LOOP TWO"
12 FORJ=1TO6
13 FORK=1TO5
14 PRINT"INSIDE DOUBLE LOOP TWO
  ";J;K
15 IFJ*K=20THEN21
16 NEXTK
17 NEXTJ
18 PRINT"AFTER DOUBLE LOOP TWO
  ";J;K
19 STOP
21 PRINT"LEAPT OUT OF DOUBLE
   TWO":GOTO1
READY.
```

Screen contents printer

THIS program prints-out the contents of the screen on a printer writes Jonathan Dick of Bristol. It was written for the CBM 3022 printer and will work only on a new-ROM Pet. You could use the program with another printer providing it is connected to the IEEE-488 bus. It cannot be guaranteed that it will work with anything other than the CBM printer.

With the CBM printer, all graphics and reverse-field characters will be printed. The graphics will appear as lower-case characters if you are Poked into lower-case mode on the Pet.

To call the routine, execute a 'SYS 826'. If you call it more than once, you must have 'CLOSE 4:CLOSE 6' between each call or you will obtain a '?FILE OPEN ERROR' as the program does not close files 4 and 6 after using them.

That is because the program only just fits in the second cassette buffer. If it used one more byte, it would corrupt a monitor vector which prints a question mark if you make an error. Corrupting that vector can often make the Pet crash if you enter monitor. Putting in the extra instructions to close the files would have meant corrupting the vector so they were omitted.

It should be remembered that the program does not like printing quote marks as after the first one is printed, the printer goes into quote mode, i.e., it prints-out the control characters it receives rather than obeys them.

As the program sends reverse-field on-and-off signals, they are printed as a reverse-field 'R' and a reverse-field line if the printer is in quote mode. That continues until a closing quote is encountered or a carriage-return is executed.

The answer to the problem is not to have quote marks on the screen when you want to do a printout.

The program as it is now leaves no space between the printed lines. That is done so you can print-out screens of graphics without any gaps in the printing.

If you want to print-out text from the screen, you can set the spacing as it is normally on the printer by 'POKE 834,24' before calling the program. When you want normal spacing normal again, 'POKE 834,18'.

```
READY.

C*
     PC  IRQ  SR AC XR YR SP
.;  C6FB E62E 34 37 38 35 FA
.
.:  033A A9 06 A2 06 20 E5 03 A9
.:  0342 12 20 45 CA 20 72 F2 A9
.:  034A 04 A2 00 20 E5 03 A9 00
.:  0352 85 01 A9 80 85 02 A0 00
.:  035A A2 00 AD 4C E8 C9 0C F0
.:  0362 05 A9 11 20 45 CA 18 B1
.:  036A 01 C9 1F B0 05 69 40 4C
.:  0372 AC 03 C9 80 90 09 C9 BF
.:  037A B0 05 E9 3F 4C B6 03 C9
.:  0382 C0 90 07 C9 DF B0 03 4C
.:  038A B6 03 C9 E0 90 05 E9 40
.:  0392 4C B6 03 C9 40 90 09 C9
.:  039A 60 B0 05 69 80 4C AC 03
.:  03A2 C9 61 90 06 C9 7F B0 02
.:  03AA 69 40 85 0F A9 92 20 45
.:  03B2 CA 4C BD 03 85 0F A9 12
.:  03BA 20 45 CA A5 0F 20 45 CA
.:  03C2 C8 D0 02 E6 02 E8 E0 28
.:  03CA D0 9C 20 E2 C9 A2 00 A5
.:  03D2 02 C9 83 F0 03 4C 5C 03
.:  03DA C0 E8 F0 03 4C 5C 03 20
.:  03E2 72 F2 60 85 D2 86 D3 A9
.:  03EA 00 85 D1 A9 04 85 D4 20
.:  03F2 24 F5 A6 D2 20 BC F7 60
.?
```

Time saver

I USE a new-ROM Pet with a Rockliffe PR40 printer writes M J Valentine of Rotherham, South Yorkshire. Using its software interface, there are only two commands:

Q=USR(Ø) full-screen printout
Q=USR(3) last-line printout.

For most purposes, those two commands are adequate, but when a long program listing is required, the only method is to list about 10 lines using the Q=USR(Ø). That can be very frustrating in program development work.

(continued on next page)

(continued from previous page)

Much time is wasted with LIST, and Q = USR(Ø) commands. Since LIST always returns Pet to the direct mode regardless of call, it is very difficult to obtain a program listing under program control.

The listing overcomes this limitation. It works by adding lines to list the program. As long as the line numbers in the program to be tested are not greater than 59,999, it will work.

```
100 REM PROG LIST PR40 :
    M. VALENTINE
110 PRINT"STO LIST A PROGRAMME
    ON A PRINTER THAT
120 PRINT"QUSES Q=USR(3) TO PRINT
    LAST LINE
140 PRINT "QI WILL LIST LINES 60000-
    60180 ON THE PET
145 PRINT"SCREEN"
150 PRINT"QLOAD THE PROGRAMME
    TO BE LISTED
160 PRINT"QKEEPING THE LISTING.
    HIT RETURN TEN TIMES
170 PRINT"QTHEN TYPE RUN 60000
    FOLLOWED BY RETURN
180 PRINT"QHIT A KEY TO CONTINUE"
190 Q=USR(Ø):REM FULL SCREEN
    PRINTOUT
100 GETQ$:IFQ$=" "THEN200
210 PRINT"S":LIST60000-60180
    60000 LO=1025: HI=1026
    60020 LI=PEEK(LO+2)+(256*(PEEK
    (HI+2))):
IFLI>59999THENEND
  60035 PRINT"SLIST";LI:FORI = 1TO5:
POKE624+I,PEEK(32772+I):NEXT
  60040 POKE158, 11:POKE623, 76:POKE
624, 201
  60050 POKE630, 13:POKE631, 67:POKE
632, 207:POKE633, 13
  60090 STOP:LO=PEEK(LO)+(256*
(PEEK(HI))):HI=LO+1
  60110 L=40: IFPEEK(33128)=18THENL
=80
  60120 LI$=" ":FORI=1TOL:Q=PEEK
(32768+(40*6)+I):IFQ<31. 5THENQ=Q+64
  60160 LI$=LI$+CHR$(Q):NEXTI:PRINT
LEFT$(LI$,39):Q=USR(3): IFL=40THEN
60020
  60180 PRINTMID$(LI$,40,39):Q=USR(3):
GOTO60020
READY.
SYS0
TO LIST A PROGRAMME ON A PRINTER
THAT USES Q=USR(3) TO PRINT LAST
LINE I WILL LIST LINES 60000-60180 ON
THE PET SCREEN
LOAD THE PROGRAMME TO BE LISTED
KEEPING THE LISTING. HIT RETURN
TEN TIMES
THEN TYPE RUN 60000 FOLLOWED BY
RETURN
HIT A KEY TO CONTINUE
```

RAM-space sabotage

ABOUT a year ago, a demonstration I was giving went horribly wrong writes Julian Allason. Mysterious out-of-memory errors kept occuring. A quick ?FRE(0) revealed that less than 200 bytes of RAM remained although the program was a mere 3K running on a supposedly 8K machine.

I say supposedly because what the saboteur had done was to portion off most of the free RAM space. Here is how.

On old-ROM Pets, the address of the last byte of RAM is stored at decimal location 135. Peeking that location on an 8K Pet would normally return a value of 32 because 32 × 256 = 8,192 = 8K. By Poking an eight into location 32, Basic was fooled into thinking that it lived inside a 2K Pet.

The cure for such tomfoolery was POKE135,32. On a 32K Pet the value stored in that location should be 128; 128 × 256 = 32768 = 32K — remember?

Yet ?PEEK(135) returns the value 96 on a new-ROM 32K Pet. Obviously, the location has been changed. How to find it? Since we know that the location we are looking for should contain a 128, the following short program will help:

```
100 A = 0
110 A = A+1
120 IF PEEK(A) = 128 THEN PRINT
"LOCATION "A" CONTAINS 128"
130 GOTO 110
```

This routine reveals the following suspect locations: 49, 53, 136, 224, 226, 227, 228, 229 and 230. So let us test them as follows:

```
100 DATA 49,53,136,224,225,226,227,228,
229,230, —1
110 PRINT "FREE RAM = "; FRE(0)
120 READ A
130 IF A = —1 THEN PRINT
"FINISHED";END
140 PRINT "NOW POKING LOCATION"
;A
150 POKE A,8
160 GOTO 110
```

The results show that Poking location 53 with an eight immediately reduces the number of bytes apparently free. As a final check, we can execute a Poke 53,128 to check that the full amount of memory available has been restored to us.

Since Basic stores variables and arrays from the top of RAM downwards, this technique of portioning-off a section of memory could prove useful. Storage of long machine-code programs is one possible application.

Normal and reverse video

I HAVE written a machine-code subroutine for the Pet which will alternate the screen display between normal and reverse video says G J Kelly of Bradford. However, blank spaces are not altered.

I have found the subroutine very useful in a program for highlighting the display at, say, an important part in a game. The two versions can be loaded into the second cassette buffer either by the machine code monitor in the new-ROM Pet or by the loader program.

Program A

```
033A    18           CLC
033B    A000         LDY# 00
033D    8401         STY 01
033F    A280         LDS # 128
0341    8602  LOOP1  STX 02
0343    B101  LOOP2  LDA (01),Y
0345    C920         CMP# 32
0347    F004         BEQ NEXT
0349    4980         EOR # 128
034B    9101         STA (01),Y
034D    C8    NEXT   INY
034E    D0F3         BNE LOOP2
0350    E8           INX
0351    E084         CPX# 132
0353    D0EC         BNE LOOP1
0355    60           RTS
```

Basic Loader for Program A

```
10 DATA 24,160,0,132,0,162,128,134,16,177
20 DATA 15,201,32,240,4,73,128,145,15,200
30 DATA 208,243,232,224,132,208,236,96
40 FOR J=826 TO 853
50 READ A: POKE J,A
60 NEXT
```

The program can be called from Basic with SYS826 — the rate of change could be controlled with a for/next loop.

```
10 SYS826:FOR J=1 TO 500: NEXT:
GOTO 10
```

Program B

```
033A    18           CLC
033B    A500         LDA 00
033D    6900         ADC# 00
033F    8500         STA 00
0341    B003         BCS PASS
0343    4C2EE6       JMP 58926
0346    18    PASS   CLC
0347    A000         LDY# 00
0349    8401         STY 01
034B    A280         LDS# 128
034D    8602  LOOP1  STX 02
034F    B101  LOOP2  LDA (01),Y
0351    C920         CMP# 32
0353    F004         BEQ NEXT
0355    4980         EOR# 128
0357    9101         STA (01),Y
0359    C8    NEXT   INY
035A    D0F3         BNE LOOP2
035C    E8           INX
035D    E084         CPX# 132
035F    D0EC         BNE LOOP1
0361    A900         LDA# 00
0363    8500         STA 00
0365    4C2EE6       JMP 58926
```

Basic Loader for Program B

```
10 DATA 24, 165,0,105,133,0,176,3,76,46,230
20 DATA 24,160,0,132,1,162,128,134,2,177,1
30 DATA 201,32,240,4,73,128,145,1,200,208
40 DATA 243,232,224,132,208,236,169,0,133
50 DATA 0,76,46,230
60 FOR J=826 TO 871
70 READ A: POKE J,A
80 NEXT
```

This subroutine can be called independently of any other program the computer is executing. At the start of your program, alter the IRQ interrupt vectors — located at 144,145 — to include the subroutine located in the second cassette port.

The rate of change can be varied by Poking a number into location 830; zero will inhibit the change. It is important that the interrupt vectors are altered together, i.e., as one line of the program otherwise the program will crash.

After using the subroutine, the interrupt vectors should be returned to their original values, again on the same program line.

```
10 POKE 144,58: POKE 145,3: REM This will
run the subroutine everytime there is an IRQ
interrupt
20 REM Your program
100 POKE 830,5: REM Set rate of normal to
reverse video
110 REM Your program
1000 POKE 830,0: REM This turns off
subroutine
1100 POKE 144,46: POKE 145,230: REM
This returns IRQ to normal
1200 END
```

Both subroutines use part of zero-page memory occupied by the user jump function for the variable address necessary to point to the screen memory. Therefore, if your main program uses the user function the variable address pointers should be relocated as required.

Program B uses the IRQ interrupt so care must be taken if part of your program uses interrupt. Also any small error in program B will usually result in the computer crashing.

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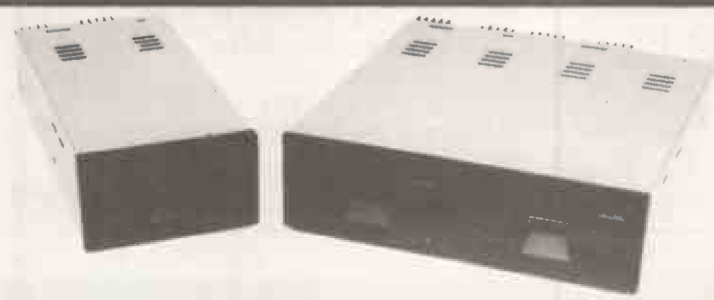

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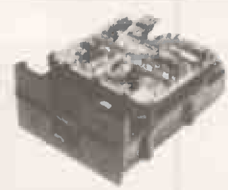

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We have had so many requests for advice about software for the little ZX-80 that we have decided to start a club page devoted to the machine. If you have a contribution to make, write to *Practical Computing* marking your letter ZX-80 Line-up. We pay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

Card tricks

THINK of A Number is a simple game programmed in the integer Basic for the ZX-80. The game originated in a cracker at Christmas and when one of the cards was lost, it was programmed into the first handy computer.

The game consisted of a group of cards with numbers on them. A member of the audience was asked to think of a number between, say, one and 63. The participant was then shown each card in turn and asked if the number was on it.

When the last card had been shown and assuming everything had been done above board, the card sharp would tell the audience what the participant's choice was.

The program follows this procedure and should end with the same correct answer. There are plenty of comments so no further explanation will be given otherwise it would give the game away. The player should answer the question is the number on this page? with either yes or no.

The program will run on most Basics with only minor changes. For Basic with string input, lines 520, 530, 730 and 740 should be altered.

```
  5 REM DIMENSION ARRAY
 10 DIM R(20)
 15 REM SET UP ANSWER VARIABLES
 20 LET Y=1
 30 LET N=0
 35 REM CLEAR SCREEN
 40 CLS
 45 REM NUMBER OF BITS
 50 LET P=5
 55 REM CALCULATE MAXIMUM NUMBER
 60 LET Z=1
100 FOR I=1 TO P
110 LET Z=Z*2
120 NEXT I
130 LET Z=Z-1
195 REM ASK PLAYER TO SELECT A NUMBER
200 PRINT "THINK OF A NUMBER BETWEEN 1 AND ";Z
210 PRINT "READY ?"
220 INPUT B
225 REM INITIALIZE ANSWER VARIABLES
230 LET S=0
240 LET T=1
295 REM MAIN LOOP - LOOP FOR EACH BIT
300 FOR A=1 TO P
305 REM CLEAR SCREEN AGAIN
310 CLS
315 REM CLEAR ARRAY
320 FOR I=1 TO P
330 LET R(I)=0
340 NEXT I
395 REM LOOP FOR EACH NUMBER
400 FOR I=1 TO Z
410 LET J=0
415 REM CONVERT NUMBER TO BINARY
420 LET J=J+1
430 LET R(J)=R(J)+1
440 IF R(J)<2 THEN GO TO 470
450 LET R(J)=0
460 GO TO 420
465 REM PRINT NUMBER IF BIT IS ON
470 IF R(A)=1 THEN PRINT I.
480 NEXT I
485 REM END OF NUMBER LOOP
500 PRINT
505 REM ASK IF NUMBER HAS BEEN DISPLAYED
510 PRINT "IS THE NUMBER ON THIS PAGE ?"
520 INPUT B
525 REM ACCUMULATE ANSWER IF YES
530 IF B=1 THEN LET S=S+T
540 LET T=T*2
550 NEXT A
555 REM END OF MAIN LOOP
595 REM DELAY
600 FOR I=1 TO 900
610 NEXT I
620 CLS
695 REM PRINT ANSWER
700 PRINT "YOUR NUMBER IS ";S
705 REM ASK IF ANOTHER GO WANTED
710 PRINT
720 PRINT "DO YOU WANT ANOTHER GO ?"
730 INPUT B
735 REM JUMP IF YES
740 IF B=1 THEN GO TO 200
750 STOP
```

Loading cassette data

ANOTHER solution to the ZX-80 problem of loading data from cassette is suggested by Tony Willgoose. He noticed that the input impedance of the ZX-80 is very large — presumably because it has a CMOS buffer — and realised that with the output capacitor of the tape recorder, there must be a very long time constant involved which would tend to make hash of data.

He solved the problem by connecting a 100Ohm resistor across the output of the tape recorder — or the input of the ZX-80. Since then, he says he has had 100 per-cent success. We feel that 100Ohms might load the output rather — it might be better to try 490Ohms.

Addition exercise

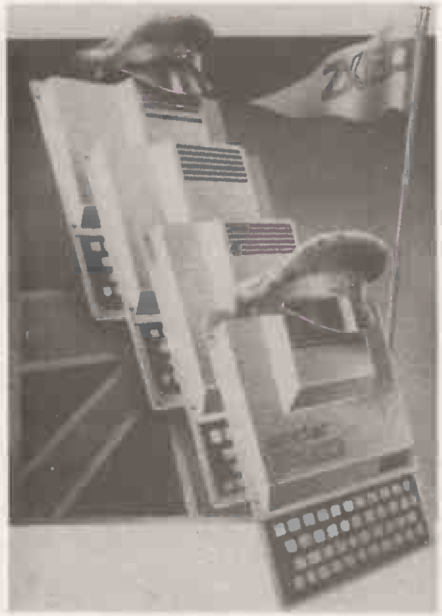
THIS program enables a user to practise simple addition and was submitted to us by the Regional Computer Centre at Bath University. Each time it is used, it generates a new sum and presents it. For each column, it asks first for the digit to write-in to the answer and then for the digit to carry. This example shows the program at the stage of asking for the carry digit for the third column.

If a wrong digit is input at any stage, the program keeps asking until the correct one is input. When the sum is completed the user is asked: "another sum"?

```
530
098
178
644
 50
22
WRITE-IN? 4
CARRY?
```

The number of rows and columns in the sum can be varied by changing statement numbers 110 and 111. R is the number of rows; C the number of columns. However, the number of rows should not be more than 10 — the program algorithm is valid only for $R<10$.

For a ZX-80 with 1Kbyte of RAM, the program occupies a large proportion of memory, so there is a limit to the overall size of the sum that can be handled. If statement numbers 100 and 101 are removed, the program works for up to four columns and six rows or three columns and eight rows, although it will run out of display space if a large number of incorrect answers are entered by the user.



Three factors contribute to the amount of memory needed by a running program: the length of the program; the number of variables in the program, and the volume of text printed on the screen at any one time. The length of a program is increased very significantly by string variables or constants.

Thus, there tends to be a conflict between the objective of making an interactive program user-friendly and the need to keep the program small enough to fit into memory. Likewise REM statements increase program length significantly.

It should be noted that using fewer digits in the line numbers has very little effect in decreasing the length of the program. Line numbers at the beginning of lines are stored in two bytes irrespective of the magnitude of the numbers, so the only saving possible is where a line number appears in a GO TO or GO SUB statement. Obviously, if the volume of text appearing on the screen is proving critical, it is helpful to clear the screen whenever possible.

Sometimes after having run a program that uses most of the memory, it appears that the computer is not responding properly to new commands, and you may think that the program has been lost. However, what may have happened is that running the program initialised enough variables to use all or most of the memory. This memory can be retained by pressing CLEAR.

In version one of the program, the digits to be added are held in the array S, and the write-in and carry digits are stored in W and C repectively. When the final answer to the sum is displayed, it appears as follows:

	S(9)	S(5)	S(1)
	S(10)	S(6)	S(2)
	S(11)	S(7)	S(3)
	S(12)	S(8)	S(4)
C(4)	W(3)	W(2)	W(1)
C(4)	C(3)	C(2)	

The subroutine to print this —

(continued on next page)

(continued from previous page)
statements 500 - 720 — is, however, complicated, because at earlier stages of the print-out, when the user has not yet added all the columns, the appropriate number of blanks has to be left in the write-in and carry rows. The information as to how many blanks to print-out is communicated to the print subroutine through the variable I.

In the second version of the program, the whole sum is held in the one array S. However, because blanks and dashes as well as digits have to be represented, the CODE of each character is held in the appropriate array element.

Thus a blank is represented as zero, a dash as 18, a zero as 28, a one as 19, and so on. In this case, the print subroutine is much more straightforward — each array element is converted to a character and then printed.

In the subroutine, also included is a feature to suppress the printing of the leading zeros — so that, for instance, 93 is not printed as 093.

The sum is represented in the array as follows:

S(25)	S(17)	S(9)	S(1)	
S(26)	S(18)	S(10)	S(2)	
S(27)	S(19)	S(11)	S(3)	
S(28)	S(20)	S(12)	S(4)	
S(29)	S(21)	S(13)	S(5)	line of dashes
S(30)	S(22)	S(14)	S(6)	write-in
S(31)	S(23)	S(15)	S(7)	line of dashes
S(32)	S(24)	S(16)	S(8)	carry

Although the print subroutine of the second version is much shorter, this is offset by longer initialisation — statements 200 - 275 — and more space being used in the array.

Both versions give an indication of how numbers larger than 32,767 can be handled by storing each digit separately. The algorithms for addition and subtraction are quite simple, but for multiplication and division they are more complicated.

Program details

Initialise variables	statements	110 — 117
Generate sum		200 — 275
For each column		300,395
Print the sum so far		305
Calculate correct write-in and carry		310 — 335
Ask for write-in and test it		340 — 365
Ask for carry and test it		370 — 390
Print the completed sum		400,410
Ask another sum?, and continue or stop		420 — 435

Printing subroutine (Version 1):

Clear screen	500
Print the numbers in the sum	510 — 540
Print the first ruler-line	550
Print the digits written-in so far	560 — 610
Print the second ruler-line	620
Print the digits carried so far	630 — 670
Print another blank line and return	680,685
Subroutine to print a ruler-line	700 — 720

Variables (Version 1):
- C = the number of columns in the sum
- C( ) = array holding the carry digits
- I = loop counter denoting the column column current being added
- J,K = loop counters
- Q$ = variable to hold answer to "ANOTHER SUM?"
- R = number of rows in the sum
- S( ) = array holding the sum
- S( ) = array holding the write-in digits
- Z = variable to hold answer to WRITE-IN? or CARRY?

Variables (Version 2):
- C, Q$, R, S( ), Z — as in version 1
- D = R + 4
- F = flag in print subroutine
- I,J,K = loop counters
- T = temporary variable to hold often-used expressions

VERSION 1 LISTING

```
100 REM "EXERCISE IN ADDITION"
        VERSION 1
101 REM COPYRIGHT 1980 W.BARRON
    SWURCC, BATH  BA2 7AY

110 LET C=3
111 LET R=4
112 IF R>10 THEN STOP
113 DIM C(C+1)
114 DIM W(C)
115 DIM S(C*R)
116 LET C(1)=0
117 RANDOMIZE

200 FOR J=1 TO R*C
210 LET S(J)=RND(10)-1
220 NEXT J

300 FOR I=1 TO C
305 GO SUB 500
310 LET W(I)=C(I)
315 FOR J=1 TO R
320 LET W(I)=W(I)+S(R*(I-1)+J)
325 NEXT J
330 LET C(I+1)=W(I)/10
335 LET W(I)=W(I)-C(I+1)*10
340 PRINT "WRITE-IN?";
345 INPUT Z
350 IF Z=W(I) THEN GO TO 365
355 PRINT Z;"?";
360 GO TO 345
365 PRINT Z
370 PRINT "CARRY?";
375 INPUT Z
380 IF Z=C(I+1) THEN GO TO 395
385 PRINT Z;"?";
390 GO TO 375
395 NEXT I

400 LET I=C+1
410 GO SUB 500
420 PRINT "ANOTHER SUM?"
425 INPUT Q$
430 IF CODE(Q$)=62 THEN GO TO 200
435 STOP

500 CLS
510 FOR J=1 TO R
515 PRINT " ";
520 FOR K=1 TO C
525 PRINT S(R*(C-K)+J);
530 NEXT K
535 PRINT
540 NEXT J
550 GO SUB 700
560 IF I<C+1 OR C(I)=0 THEN GO TO 575
565 PRINT C(C+1);
570 GO TO 590
575 FOR J=1 TO C+2-I
580 PRINT " ";
585 NEXT J
590 IF I=1 THEN GO TO 610
595 FOR J=1 TO I-1
600 PRINT W(I-J);
605 NEXT J
610 PRINT
620 GO SUB 700
630 IF I=C+1 THEN GO TO 655
635 FOR J=1 TO C+1-I
640 PRINT " ";
645 NEXT J
650 IF I=1 THEN GO TO 670
655 FOR J=1 TO I-1
660 PRINT C(1+I-J);
665 NEXT J
670 PRINT
680 PRINT
685 RETURN
700 FOR J=1 TO C+1
705 PRINT "-";
710 NEXT J
715 PRINT
720 RETURN
```

VERSION 2 LISTING

```
100 REM "EXERCISE IN ADDITION"
        VERSION 2
101 REM COPYRIGHT 1980 W.BARRON
    SWURCC, BATH  BA2 7AY
110 LET C=3
111 LET R=4
112 IF R>10 THEN STOP
113 LET D=R+4
114 DIM S(D*(C+1))
117 RANDOMIZE

200 FOR I=1 TO R
205 LET S(C*D+I)=28
210 FOR J=0 TO C-1
215 LET S(I+J*D)=RND(10)+27
220 NEXT J
225 NEXT I
250 FOR I=1 TO C+1
255 FOR J=0 TO 1
260 LET S(I*D-3+J*2)=18
265 LET S(I*D-2+J*2)=0
270 NEXT J
275 NEXT I

300 FOR I=1 TO C
305 GO SUB 500
310 LET T=D*(I-1)+R+2
312 LET S(T)=S(T+2)-28
314 IF I=1 THEN LET S(T)=0
315 FOR J=1 TO R
320 LET S(T)=S(T)+S(T+J-R-2)-28
325 NEXT J
330 LET S(D*(I+1))=S(T)/10+28
335 LET S(T)=S(T)-10*(S(D*(I+1))-28)+28
340 PRINT "WRITE-IN?";
345 INPUT Z
350 IF Z=S(T)-28 THEN GO TO 365
355 PRINT Z;"?";
360 GO TO 345
365 PRINT Z
370 PRINT "CARRY?";
375 INPUT Z
380 IF Z=S(D*(I+1))-28 THEN GO TO 395
385 PRINT Z;"?";
390 GO TO 375
395 NEXT I

400 LET S(C*D+R+2)=S(C*D+R+4)
410 GO SUB 500
420 PRINT "ANOTHER SUM?"
425 INPUT Q$
430 IF CODE(Q$)=62 THEN GO TO 200
435 STOP

500 CLS
505 FOR J=1 TO R+4
510 LET F=1
515 FOR K=0 TO C
520 IF F=0 THEN GO TO 545
525 IF NOT S((C-K)*D+J)=28 THEN GO TO 540
530 PRINT " ";
535 GO TO 550
540 LET F=0
545 PRINT CHR$(S((C-K)*D+J));
550 NEXT K
555 PRINT
560 NEXT J
565 PRINT
570 RETURN
```

Program contents viewer

ANYONE who has played with Adventure and other machine-code game programs, will know how annoying it can be as you cannot easily see the contents of the program writes AS Whipps of West Molesey in Surrey. However, there is an indirect method I first tried on the Tandy Eliza program which is not on sale in the U.K.

Firstly, you load the concerned machine code program, then re-set the machine and type in the following short program:

```
10 REM LAST RESORT
20 CLS
30 FOR I = 1 TO 32767
40 PRINT CHR$(PEEK(I));
50 NEXT I
60 CLS:PRINT @ 390, "THAT'S ALL
   FOLKS"
70 END
```

After about three minutes of Level II Basic words, graphic characters and error messages appear on your screen, you will finally arrive at the program. In the case of Adventure, you will see the words to which it responds, and the rooms and objects in it, but in the case of Eliza you will see the foul language it answers and its appropriate responses.

Of course, this program should only be used as a last resort.

ESP computing

THIS program, called ESP was designed for a TRS-80 model 1 Level II, but should work on any standard Microsoft Basic if the instructions are suitably modified writes Edward Reid of Dublin. It uses about 3.5K of memory.

I decided on the idea for the program while I sat playing with a deck of cards. I found that if you accumulated the cards in the correct order, you could obtain a predetermined card at will.

When I started work on the program, I found that 52 was not a good number but that 48 and 64 were superior because they both divided evenly by four and then by four again which is what I needed for this game — 48 ÷ 4 ÷ 4 = 3, 64 ÷ 4 ÷ 4 = 4.

That meant I would have to accumulate 48, three times and 64, four times. I decided on 48 because of the screen space available and the time taken to pick 48 random numbers making sure that none was repeated.

The first time I tried the program, the sorting took around 2½ to three minutes.

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

```
100 REM  ***************************
110 REM
120 REM
130 REM
140 REM  *SETTING UP
    ARRAYS*
150 T=0
160 DIMA(50):DIMD(50):A(1)=0:D(1)=0
170 CLS
180 REM  *SETTING UP INST.*
190 PRINT@465, "WHAT IS YOUR FIRST
    NAME";
200 INPUT"";C$
210 CLS
220 PRINT:PRINT:PRINT
230 PRINT"  THIS IS A GAME TO SHOW
    YOU THAT THE COMPUTER KNOWS
    EXACTLY"
240 PRINT"  WHAT YOU ARE
    THINKING ALL THE TIME."
250 PRINT:PRINT
260 PRINT"  ALL YOU HAVE TO DO IS
    PICK A NUMBER BETWEEN 0-49
    AND IT  WILL TELL YOU WHAT
    YOUR NUMBER WAS AFTER ONLY
    THREE SIMPLE  QUESTIONS."
270 PRINT:PRINT:PRINT"  THE
    COLUMNS ARE NUMBERED AS
    BELOW."
280 PRINT
290 PRINT"  1","2","3","4"
300 REM  *PUTTING ON THE
    BORDER*
310 FORX=1TO127
320 SET(X,1):SET(X,47)
330 NEXTX
340 FORY=1TO47
350 SET(1,Y):SET(127,Y)
360 NEXTY
370 REM  *PICKING THE FIRST
    27RND*
380 R=27:GOSUB1010
390 REM  *FILLING IN WITH
    POINTS*
400 FORA=2TO46
410 FORX=1TO127
420 SET(X,A)
430 NEXTX
440 NEXT A
450 REM  *BACK TO PRINTING*
460 PRINT @228,
470 PRINT@340,"E.S.P."
480 PRINT@468,"BY EDWARD REID"
490 PRINT@596,"A BASIC PRODUT" =
500 PRINT@724, "FOR A TRS80"
510 REM  *PICKING THE NEXT
    18 RND*
520 R=18:GOSUB1010
530 REM  *PICKING THE LAST
    3RND*
540 R=3
550 CLS:PRINT@469,"S O R T I N G"
560 GOSUB1010
570 REM  *HOW MANY TIMES
    LEFT TO GO*
580 FORU=1TO3
590 REM  *SETTING UP
    NUMBERS*
600 CLS
610 PRINT@12, "REMEMBER THAT
    NUMBER ";C$:PRINT
620 FOR X=1 TO 12
630 PRINT A(X),A(X+12),A(X+24),A
    (X+36)
640 NEXTX
650 PRINT:INPUT "WHICH COLUMN IS
    YOUR NUMBER IN ";Q
660 CLS
670 Z=0
680 FORX=1TO4
690 REM  *WHICH COLUMN
    FIRST*
700 IF Q=1 THEN V=0 : GOTO760
710 IF Q=2 THEN V=3 : GOTO760
720 IF Q=3 THEN V=6 : GOTO760
730 IF Q=4 THEN V=9 : GOTO760
740 GOTO650
750 REM  *RESORTING
    NUMBERS*
760 FORY=VTO11:Z=Z+1:D(Z)=
    A(X+)4*Y))
770 NEXT Y
780 IFV=0GOTO800
790 V=V—1:FOR Y=0TOV:Z=Z+1:D(Z)
    =A(X+(4*Y)):NEXTY
800 NEXT X
810 REM  *FROM D TO A*
820 FORS=1TO49
830 A(S)=D(S)
840 NEXTS
850 NEXTU
860 REM  *DID YOU GET IT
    RIGHT*
870 PRINT@468, "YOUR NUMBER WAS";
    A(1);"!"
880 PRINT@595, "WAS I RIGHT (Y OR H)
    ";
890 INPUT"";B$
900 IFB$= "Y"THENGOTO940
910 IFB$="N"THEN CLS:PRINT@580,
    C$;" YOU ARE A LITTLE CHEAT OR
    A ROTTEN TYPIST !!!":FOR
    X=1TO30
    00:NEXTX
920 CLS
930 REM  *TRY AGAIN*
940 CLS:PRINT@584,C$;"DO YOU WANT
    TO TRY AGAIN (Y OR N)";
950 INPUT"";A$
960 IF A$= "Y"GOTO580
970 CLS:PRINT@590, "WELL IF THAT'S
    THE WAY YOU THINK !!!":FORX=
    1TO3000:NEXTX
980 CLS:PRINT596, "G O O D B Y E !"
990 FORX=1TO2500:NEXTX:CLS:END
1000 REM  *COMPARING RND
     NUMBERS*
1010 FORX=1TOR
1020 A=RND(48)
1030 FOR Y=1TOT
1040 IFR=3 THENH=A+35:SET(H,19);
     SET(H,24)
1050 IF A=A(Y)THEN GOTO1020
1060 NEXTY
1070 T=T+1
1080 A(T)=A
1090 NEXTX
1100 RETURN
1110 REM *THE END*
```

The New DDP Video Monitor . . .

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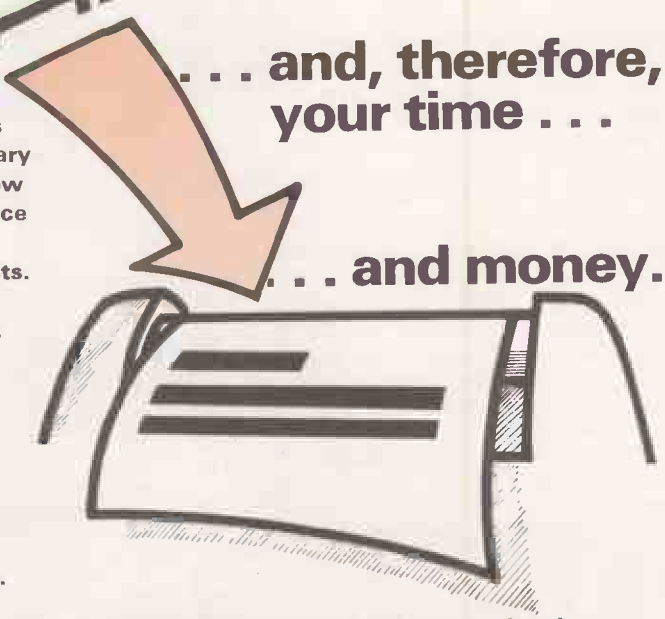

. . . and money.

At last, from DDP, here's the video monitor that eyes and ears all over Britain have been waiting for. Eyes, because as alternatives to black and white tubes, green and revolutionary new orange tubes are optionally available. Ears, because now you're going to enjoy the sound of silence – from your service engineer.

But to take first things first, we mention a few colourful facts. After Scandinavian scientists had proved how close-range human vision could benefit from working with orange light, orange tubes quickly replaced green as standard for most Scandinavian videos. A few years behind, we in Britain still belong to the Green Screen Club – but as indifferent members when it comes to monitors. With DDP's new monitor, however, you can experience Scandinavian sophistication. And all the difference it makes to operating profits when allowance is made for operator fatigue.

Inside our monitor you'll discover its second big advantage. More easily overlooked, but just as important to long-term operating profitability is the unique modular circuitry. The resin-block circuits will outperform conventional systems and delight engineers when, aeons into the future, servicing is eventually required.

And the cost? Bearing in mind the big 12 inch screen, you'll be amazed at our recommended retail price of £165 (ex. VAT). Generous DDP volume discounts are equally astonishing, but most surprising of all is how quickly we can deliver. To find this out, though, you'll need to make a phone call . . .

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• Circle No. 193

Backspace for Superboard

OSI Superboard users like myself must grow extremely frustrated by the lack of a true backspace — shift gives only a series of dashes complains David Harrison of Bury.

I have thus written a short program to turn the rub-out key — previously unused by Basic — into a backspace and delete key. The program is as follows and should be entered via the monitor.

```
0PDF 20BAFF  JSR  FFBA    ; GET KEY
0FE2 C97F    CMP  7F      ; RUB-OUT?
0FE4 F001    BEQ  01
0FE6 60      RTS          ; NO-RETURN AS NORMAL
0FE7 CA      DEX          ; DECRE-MENT TEXT POINTER
0FE8 10 02   BPL  02      ; NO TEXT?
0FEA E8      INX          ; RESTORE IF SO
0FEB 60      RTS          ; AND RETURN
0FEC AC0002  LDY  0200    ; GET CURSOR LOC-ATION
0FEF A920    LDA  20      ; SPACE = $20
0FFI 9900D3  STAD300,Y    ; BLANK OUT CHAR-ACTER
0FF4 CE0002  DEC  0200    ; DECRE-MENT CURSOR LOCATION
0FF7 88      DEY
0FF8 A9 5F   LDA  5F      ; CURSOR CHAR-ACTER = $5F
0FFA 9900D3  STA  D300,Y  ; DRAW CURSOR IN NEW LOCATION
0FFD A9 7F   LDA  7F      ; RESTORE A
0FFF 60      RTS          ; AND RETURN
```

It is written to run on a 4K machine — memory size of 4,062 — but will re-locate with no changes. It is brought into operation by altering the input vector to point to it by

POKE 536, 223:POKE 537, 15

I am thinking of making the very simple and obvious modification to convert my microprocessor to run on 2MHz. I would appreciate, however, if someone could answer these two questions for me.

I presume my 6502 will not run at 2MHz, would I need to purchase a 6502A?

Is my memory fast enough? Considering how many people seem to have made this conversion, it is, I presume, no major problem.

Graphics display

THIS routine creates a fascinating graphics display on your television, ideal for impressing friends at parties or computer exhibitions writes Paul Kaufman of Edgware, Middlesex. The screen is divided into four quadrants.

The program goes through each location in the top-left quadrant and increments its.

The bulk of the program is taken up by checking routines to ensure the program stays within the bounds of the screen. There are two subroutines used, one to reflect a graphics byte and the other to invert the byte.

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.

```
0040 00              TLLO     BYTE )200
0041 00              TLHI     BYTE )
0042 00              TRLO     BYTE )21F
0043 00              TRHI     BYTE )
0044 00              BLLO     BYTE )3EO
0045 00              BLHI     BYTE )
0046 00              BRLO     BYTE )3FF
0047 00              BRHI     BYTE )
0048 00              TEMP1    BYTE
0049 00              TEMP2    BYTE
0400 A902            INIT     LDA #2
; set up screen
0402 8541                     STA  TLHI
; pointers
0404 8543                     STA  TRHI
0406 A900                     LDA  #0
0408 8540                     STA  TLLO
040A A8                       TAY
040B A91F                     LDA  #1F
040D 8542                     STA  TRLO
040F A9E0                     LDA  # EO
0411 8544                     STA  BLLO
0413 A9FF                     LDA  #FF
0415 8546                     STA  BRLO
0417 A903                     LDA  #03
0419 8545                     STA  BLHI
041B 8547                     STA  BRHI
041D B140            LOOP     LDA  (TLLO),Y
041F 18                       CLC
0420 6901                     ADC  #1
; Increment top left
0422 9140                     STA  (TLLO),Y
; quadrant
0424 208A04                   JSR  REFLECT
; reflect byte
0427 9142                     STA  (TRLO),Y
; update top right
0429 20A804                   JSR  INVERT
; invert it
042C 9146                     STA  (BRLO),Y
; update bottom right
042E 208A04                   JSR  REFLECT
; reflect it again
0431 9144                     STA  (BLLO),Y
; update bottom left
0433 A540            SCAN     LDA  TLLO
; increment top left
0435 18                       CLC
; scan pointer
0436 6901                     ADC  #1
0438 8540                     STA  TLLO
043A 290F                     AND  #0F
043C D007                     BNE  CONT1
043E A540                     LDA  TLLO
0440 18                       CLC
0441 6910                     ADC  #10
0443 8540                     STA  TLLO
0445 A542            CONT1    LDA  TRLO
; increment top right
0447 38                       SEC ; scan pointer
0448 E901                     SBC  #1
044A 8542                     STA  TRLO
044C 290F                     AND  #0F
044E C90F                     CMP  #0F
0450 D007                     BNE  CONT2
0452 A542                     LDA  TRLO
0454 18                       CLC
0455 6930                     ADC  #30
0457 8542                     STA  TRLO
0459 A544            CONT2    LDA  BLLO
045B 18                       CLC
045C 6901                     ADC  #1
045E 8544                     STA  BLLO
0460 290F                     AND  #0F
0462 D007                     BNE  CONT3
0464 A544                     LDA  BLLO
0466 38                       SEC
0467 E930                     SBC  #30
0469 8544                     STA  BLLO
046B A546            CONT3    LDA  BRLO
; increment bottom right
046D 38                       SEC
; scan pointer
046E E901                     SBC  #1
0470 8546                     STA  BRLO
0472 290F                     AND  #0F
0474 C90F                     CMP  #0F
0476 D007                     BNE  CONT4
0478 A546                     LDA  BRLO
047A 38                       SEC
047B E910                     SBC  #10
047D 8546                     STA  BRLO
047F ADF0BF          CONT4    LDA  GON
; switch on graphics
0482 A200                     LDX  #0
; delay — to slow things
0484 CA              LOOP1    DEX
; down a bit
0485 D0FD                     BNE  LOOP1
0487 4C1D04                   JMP  LOOP
048A 8548            REFLECT  STA  TEMP1
; this subroutine reflects
048C 18                       CLC
; a graphics byte (reverses it)
048D 2A                       ROL
048E 29AA                     AND  #AA
0490 8549                     STA  TEMP2
0492 A548                     LDA  TEMP1
0494 18                       CLC
0495 2A                       ROL
0496 6900                     ADC  #00
0498 2955                     AND  #55
049A 18                       CLC
049B 6A                       ROR
049C 6A                       ROR
049D 1002                     BPL  SKIP
049F 49C0                     EOR  #CO
04A1 9002            SKIP     BCC  STORE
04A3 0980                     ORA  80
04A5 0549            STORE    ORA  TEMP2
04A7 60                       RTS
04A8 8548            INVERT   STA  TEMP1
; this subroutine inverts
04AA 18                       CLC
; a graphics byte (turns it upside down)
04AB 2903                     AND  #03
04AD 6A                       ROR
04AE 6A                       ROR
04AF 6A                       ROR
04B0 8549                     STA  TEMP2
04B2 A548                     LDA  TEMP1
04B4 29C0                     AND  #CO
04B6 18                       CLC
04B7 2A                       ROL
04B8 2A                       ROL
04B9 2A                       ROL
04BA 0549                     ORA  TEMP2
04BC 8549                     STA  TEMP2
04BE A548                     LDA  TEMP1
04C0 18                       CLC
04C1 290C                     AND  #0C
04C3 2A                       ROL
04C4 2A                       ROL
04C5 0549                     ORA  TEMP2
04C7 8549                     STA  TEMP2
04C9 A548                     LDA  TEMP1
04CB 2930                     AND  #30
04CD 18                       CLC
04CE 6A                       ROR
04CF 6A                       ROR
04D0 0549                     ORA  TEMP2
04D2 A200                     LDX  #0
04D4 CA              DEL      DEX
04D5 D0FD                     BNE  DEL
04D7 60                       RTS
```

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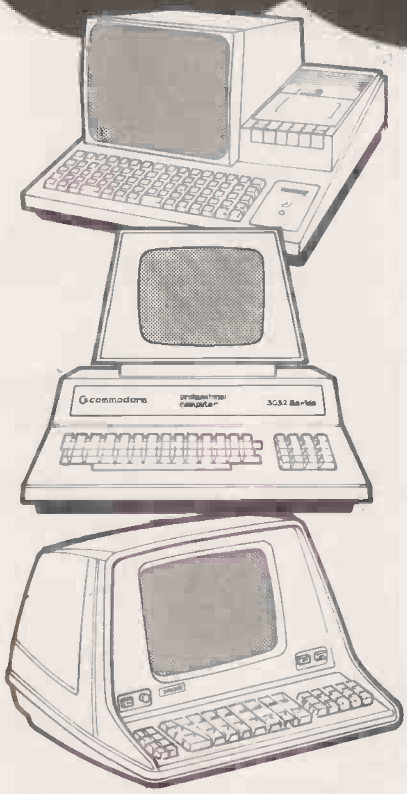

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This section is open to the Apple user. In every issue we hope to print ideas, hints and comments about the Apple and its suppliers. They must come from you, so write and tell us what you know.

Patriotic routine

HERE IS a short routine from Roger Cullis of Cranleigh, Surrey, which, using high-resolution graphics, traces the Union Jack and then plays the National Anthem through the Apple Speaker.

```
1000  REM  UNION JACK
1010  HGR2
1020  REM  SET HGR COLOURS
1030 W = 7:BL = 2:R = 6
1040  REM  COORDINATES OF APICES
1050  DATA  120,84,129,0
1060  DATA  150,84,159,0
1070  DATA  160,75,279,84
1080  DATA  160,105,279,114
1090  DATA  159,105,150,190
1100  DATA  129,105,120,190
1110  DATA  119,114,0,105
1120  DATA  119,84,0,75
1130  DATA  119,70,9,0,119,0
1140  DATA  160,64,160,0,262,0
1150  DATA  169,74,279,5,279,74
1160  DATA  177,115,279,115,279,179
1170  DATA  161,120,271,190,161,190
1180  DATA  119,125,119,190,17,190
1190  DATA  110,115,0,184,0,115
1200  DATA  101,74,0,74,0,11
1210  DATA  119,59,27,0,119,0
1220  DATA  160,59,160,0,252,0
1230  DATA  187,74,279,15,279,74
1240  DATA  187,115,279,115,279,174
1250  DATA  160,130,252,190,160,190
1260  DATA  119,130,119,190,27,190
1270  DATA  92,115,0,174,0,115
1280  DATA  92,74,0,74,0,15
1290  REM  CONSTRUCT FLAG
1300  HCOLOR= R: HPLOT 0,0: CALL 62454:
HCOLOR= 0: HPLOT 0,191 TO 2
79,191
1310  HCOLOR= W
1320  FOR J = 0 TO 7
1330  READ XA,YA,XB,YB
1340  IF Z > 1 THEN  GOTO 1400
1350  FOR X = XA TO XB
1360  HPLOT X,YA TO X,YB
1370  NEXT
1380 Z = Z + 1
1390  GOTO 1560
1400  IF Z > 3 THEN  GOTO 1460
1410  FOR Y = YA TO YB
1420  HPLOT XA,Y TO XB,Y
1430  NEXT
1440 Z = Z + 1
1450  GOTO 1560
1460  IF Z > 5 THEN  GOTO 1520
1470  FOR X = XA TO XB STEP  - 1
1480  HPLOT X,YA TO X,YB
1490  NEXT
1500 Z = Z + 1
1510  GOTO 1560
1520  FOR Y = YA TO YB STEP  - 1
1530  HPLOT XA,Y TO XB,Y
1540  NEXT
1550 Z = Z + 1: IF Z = 8 THEN Z = 0
1560  NEXT
1570  FOR I = 0 TO 1
1580  FOR J = 0 TO 7
1590  READ XA,YA,XB,YB,XC,YC
1600  IF Z > 1 THEN  GOTO 1660
1610  FOR X = XB TO XC
1620  HPLOT XA,YA TO X,YB
1630  NEXT
1640 Z = Z + 1
1650  GOTO 1820
1660  IF Z > 3 THEN  GOTO 1720
1670  FOR Y = YB TO YC
1680  HPLOT XA,YA TO XB,Y
1690  NEXT
1700 Z = Z + 1
1710  GOTO 1820
1720  IF Z > 5 THEN  GOTO 1780
1730  FOR X = XB TO XC STEP  - 1
1740  HPLOT XA,YA TO X,YB
1750  NEXT
1760 Z = Z + 1
1770  GOTO 1820
1780  FOR Y = YB TO YC STEP  - 1
1790  HPLOT XA,YA TO XB,Y
1800  NEXT
1810 Z = Z + 1: IF Z = 8 THEN Z = 0
1820  NEXT
1830  HCOLOR= BL
1840  NEXT
1850  REM  SET MUSIC PROGRAM
1860  POKE 770,173: POKE 771,48: POKE 772,192:
POKE 773,136: POKE 7 74,208
1870  POKE 775,5: POKE 776,206: POKE 777,1:
POKE 778,3: POKE 779,24  0
1880  POKE 780,9: POKE 781,202: POKE 782,208:
POKE 783,245: POKE 78  4,174
1890  POKE 785,0: POKE 786,3: POKE 787,76:
POKE 788,2: POKE 789,3
1900  POKE 790,96: POKE 791,0: POKE 792,0
1910  REM  PITCH AND LENGTH OF NOTES
1920  DATA  128,80,128,80,114,80
1930  DATA  136,120,128,40,114,80
1940  DATA  102,80,102,80,96,80
1950  DATA  102,120,114,40,128,80
1960  DATA  114,80,128,80,136,80
1970  DATA  128,80,128,40,114,40,102,40,96,40
1980  DATA  86,80,86,80,86,80
1990  DATA  86,120,96,40,102,80
2000  DATA  96,80,96,80,96,80
2010  DATA  96,120,102,40,114,80
2020  DATA  102,120,96,40,102,40,114,40,128,40
2030  DATA  102,120,96,40,86,80
2040  DATA  77,40,96,40,102,80,114,80
2050  DATA  128,240,0,0
2060  READ I,J: IF J = 0 THEN  END
2070  POKE 768,I: POKE 769,J: CALL 770
2080  REM  PAUSE BETWEEN NOTES
2090  FOR X = 0 TO 100:X = X + 1: NEXT
2100  GOTO 2060
```

Paddle Draw

PADDLE DRAW is an advanced version of Etch-A-Sketch in high-resolution and is submitted by Brian Wall of St Helier, Jersey.

For simple animation, you need a minimum of 24K, as it uses both high-resolution pages. Run Paddle Draw and draw a simple picture, say, a face. Without going to text, type Control C and save the picture on disc as PICTURE A. Still blind, delete line 40 and re-run the program. Now you can carefully add or change a small section of your picture, say, the mouth or an eye.

Paddle Draw.

```
?SYNTAX ERROR
]LIST

10  REM  """""""""" COPYRIGHT """""""
20  REM  """""""""  BRIAN WALL """""""
30  REM  """""""""" MAY 1980 """"""""
40  HGR2
50  POKE  - 16368,0
60  HIMEM: 16384
70  HCOLOR= 0
80 A =  PDL (0):B =  PDL (1)
90 A = (A * 1.4)
100  REM  ========LINE 90 IS FOR ITT'S ONLY
110  REM  DITTO THE OTHER SIMILAR LINES
120  IF B > 191 THEN B = 191
130  HPLOT A,B
140 A1 =  PDL (0):B1 =  PDL (1)
150 A1 = (A1 * 1.4)
160  IF B1 > 191 THEN B1 = 191
170 A = A2:B = B2
180  IF B > 191 THEN B = 191
190  HPLOT A,B TO A1,B1
200 A2 =  PDL (0):B2 =  PDL (1)
210 A2 = (A2 * 1.4)
220  IF B2 > 191 THEN B2 = 191
230  HPLOT A1,B1 TO A2,B2
240 P =  PEEK ( - 16286)
250  IF P > 127 THEN  HCOLOR= 0: HPLOT A1,B1 TO A2,B2:
     HCOLOR= 3: HPLOT A1,B1: GOTO 200
260 R =  PEEK ( - 16287)
270  IF R > 127 THEN 320
280 Q =  PEEK ( - 16384): IF Q > 127 THEN 40
290  POKE  - 16368,0
300  GOTO 140
310  STOP
320  REM
330 M =  PDL (0):N =  PDL (1)
340 M = (M * 1.4)
350  IF N > 191 THEN N = 191
360  HCOLOR= 3: HPLOT M,N: HCOLOR= 0
370 C =  PDL (0):D =  PDL (1)
380 C = (C * 1.4)
390  IF D > 191 THEN D = 191
400  HPLOT M,N TO C,D
410 R =  PEEK ( - 16287): IF R > 127 THEN 330
420  HCOLOR= 3
430 A1 =  PDL (0):B1 =  PDL (1)
440 A1 = (A1 * 1.4)
450 A2 = C:B2 = D
460  GOTO 170

?SYNTAX ERROR
]LIST

5  REM  --- SIMPLE ANIMATION --- -
20  HGR
30  PRINT  CHR$ (4);"BLOAD PICTURE A,A$2000"
40  HGR2
50  PRINT  CHR$ (4);"BLOAD PICTURE B,A$4000"
60  FOR I = 1 TO 150: NEXT I
70  POKE  - 16300,0
80  FOR I = 1 TO 150: NEXT I
90  POKE  - 16299,0
100  GOTO 60
```

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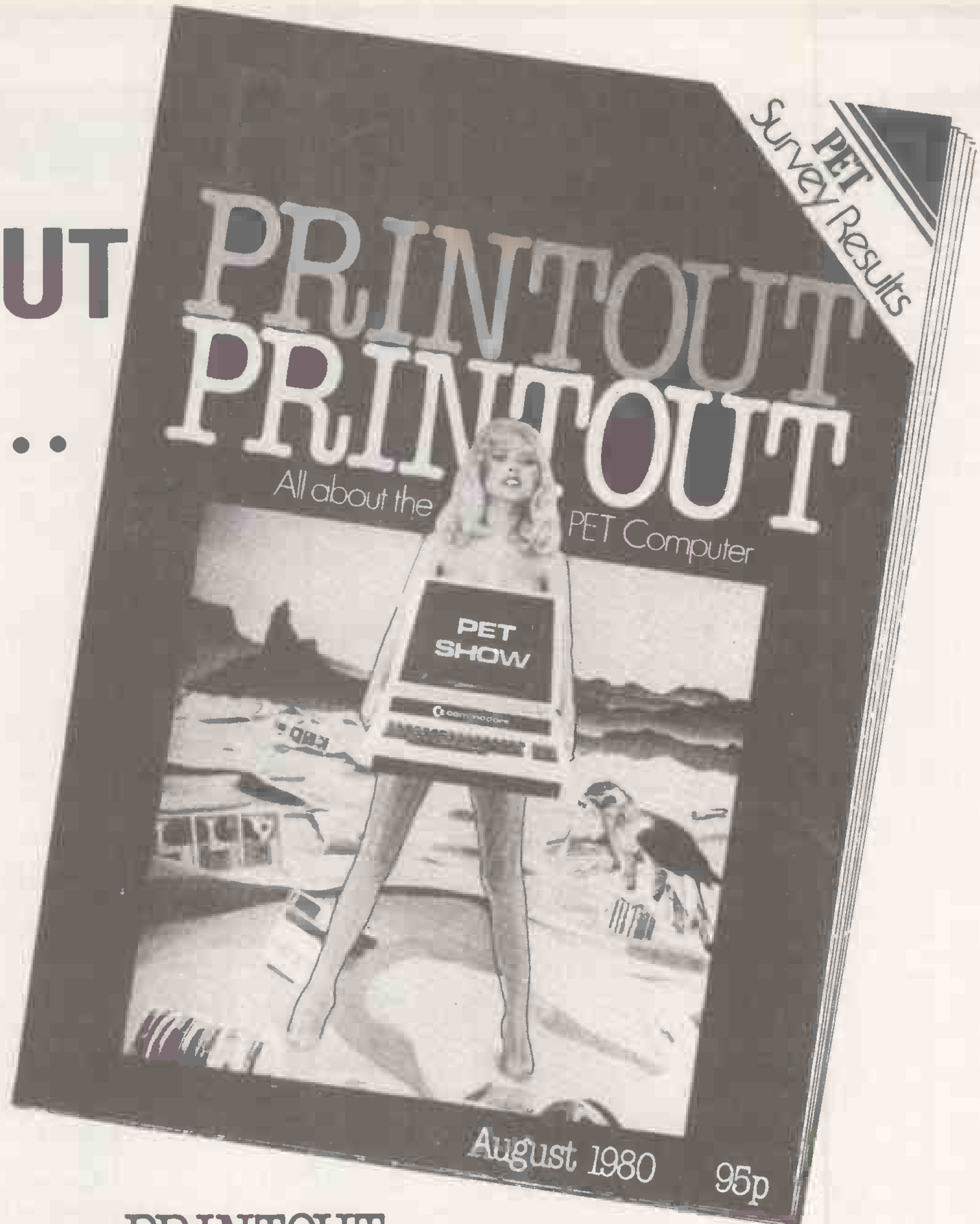

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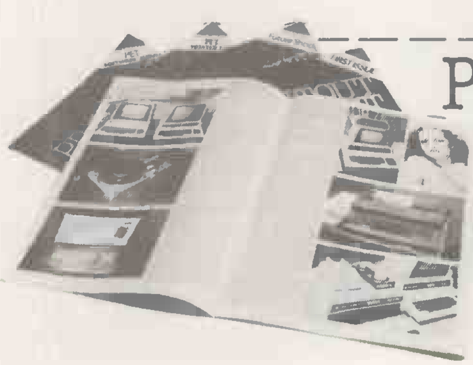

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The personal computer book

By Robin Bradbeer, published, 1980, by Input Two-Nine. 220 pages A5, available in the U.K. from good bookshops, price £5.25. ISBN 0 905897 56 0.

ROBIN BRADBEER is well known in the U.K. as a freelance writer on personal computing. In this book, he aims to provide the novice with a straightforward introduction to personal computers and he succeeds admirably.

Computing is a new discipline, high technology and with quite a strong U.S. contribution. All those factors combine to produce a fog of jargon, acronyms and reference numbers in which even experienced professionals occasionally lose themselves.

Above all, the newcomer needs a guide to the fundamentals of ideas, words and equipment. Everything necessary will probably appear in any year's issues of *Practical Computing*, but Robin Bradbeer's book provides all the information in one place, in a sensible order and in a consistent, clear style.

Chapter 1 is called What's it all about? and is a very general introduction to the past, present and future of computing. Chapter 2, Where do I start?, contains 10 useful hints on how to begin. Chapter 3, The computer — what is it? How does it work?, describes computer hardware and Chapter 4, How do I talk to the computer?, describes software and programming languages.

Chapter 5, What's in the boxes? describes peripherals and the longest chapter, 6, What can I buy?, pictures and summarises commercially-available computers and peripherals for less than £100 to more than £2,000 and advises on how to choose a system. The final chapter, rather pathetically entitled What can I do with it?, describes applications.

Eight appendices add to the book's value as a reference source once the reader has bought a system, describing binary, Octal, Hexadecimal and ASCII; bus standards and RS232C; manufacturers and U.K. distributors of equipment; U.K. computer clubs;

magazines in English; selected computer books — an annotated bibliography; a glossary and some hints on building systems from kits.

The two main criticisms which may be levelled at the book are that it is inevitably rather superficial, and that it will become increasingly out of date. Neither consideration should deter a novice considering buying the book since the information can be extended easily and kept up to date by reading.

Conclusions

- **Highly recommended for the newcomer to computing, but probably not worth buying if you have been reading magazines for a year or so and understanding them.**
- **With Christmas approaching, it could be an ideal present for intelligent nieces and nephews — if you are thinking of buying an expensive system you could even send a copy to your bank manager.**

Martyn Thomas

Data structure techniques

By T A Standish, 447 pages with index, bibliography and exercises. Published by Addison-Wesley. £13.60.

AT FIRST sight, it is a formidably academic book, smothered in formulae and equations in symbolic logic. However, the persevering reader will find a good many useful nuggets among the academic fairy gold. Standish deals in a sensible way with the progress made in developing digital computers to store and work with data from the outside world.

A quick glance at the contents page reveals the ground he covers: stacks, linked trees, hashing, circular lists, garbage collection, decision tables, fast pattern matching, encryption and indexed sequential.

It is an invaluable work for consulting before embarking on a new project, simply to see what others have done when faced with a similar kind of problem.

For instance when it arrived, I was thinking about the problems of parsing natural English. Two gems appeared immediately — Zipf's law, and the Boyer-Moore fast string-matching algorithm. Zipf tells us the relative frequencies of words in ordinary English text.

The Boyer-Moore string matching algorithm looks for a substring P in a larger string S. The idea is to lay P against S, sliding it to the right, while searching S for matches to the left, starting at the right hand end of P.

Conclusions

- **An extremely useful book, highly recommended.**

Peter Laurie,

The ZX-80 Companion

By Bob Maunder and Terry Trotter, LINSAC, 1980, pp.5-87. Price £7.50.

MAUNDER and Trotter have been quick off the mark in producing this companion volume for ZX-80 users. Roughly, the contents of this short work are as follows: approximately five pages devoted to operation of the ZX-80; nine pages on the theory of computing and programming; 26 pages on ZX-80 Basic; 12 pages on ZX-80 construction and hardware; 16 pages describing five short programs and a six-page appendix listing the ZX-80 operation codes and characters corresponding to the bit patterns, 00000000 to 11111111.

The text which is typed on A4 pages also contains full-page black and white pictures of the ZX-80 in unusual poses. There is no index.

The reader may wonder how it compares to the ZX-80 operating manual which is included in the price of the ZX-80. Both volumes contain an adequate description of how to operate the ZX-80, but the ZX-80 Operating Manual is just a subtitle of A course in Basic programming.

It contains a much more comprehensive account of ZX-80 Basic than that found in the ZX-80 Companion, as well as being an introduction to computing and programming with several illustrative examples programmed in ZX-80 Basic, and it has a reasonable index at the back.

Maunder and Trotter do not give much more information on construction and assembly than can be found in the assembly instructions which come with the kit. There remains a gap here which could be filled usefully by simply soldering instructions.

Our ZX-80 was constructed by members of staff in a university computing centre with very little or no experience in hardware. Maunder and Trotter positively discourage the construction of the kit by the inexperienced.

I disagree completely with them on this point; experience gained in construction enables the users to appreciate first-hand the ZX-80 architecture. ZX-80s constructed from kit also have the advantage that maintenance is simplified as each integrated circuit is socket-mounted and, therefore, removed easily for testing and replacement.

The Companion notes on ZX-80 hardware are rather brief — nine pages only. The ZX-80 hardware manual included with the ZX-80 will no doubt cover all the material in much greater depth.

Conclusions

- **There are some informative and helpful comments in the ZX-80 Companion, but they may not be apparent to the reader as they are lost in the over long text.**
- **It is easy for the inexperienced to fall unwittingly into bad company and certainly any volume which claims to be a ZX-80 Companion is tempting.**
- **I cannot recommend a book for £7.50 which repeats much of what is contained in literature supplied with the ZX-80.**
- **For about the same money, you could buy the paperback edition of Donald Knuth's** ***Fundamental Algorithms*** **— a companion for the rest of your programming life.**

Cornelia Boldyreff

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October

1 **Northampton personal computer users' club discussion.** Venue: Northampton. Inaugural meeting which will include the exchange of software and ideas, discussions, demonstrations and talks. Contact: J R Jackson, Mereway Upper School, Mereway, Northampton NN4 9BU. Tel: Northampton 63616.

1-2 & 21-22 **Biztronic exhibition.** Venue: 1-2 Hotel Leofric, Coventry. 21-22 Forum Centre, Wythenshawe, Manchester. Features the latest in mini- and microcomputers, word-processing equipment, copiers and other electronic office equipment. Fee: free. Contact: Norman Green, 114 Kings Road, Harrogate, North Yorkshire, HG15 HP. Tel: 0423 55040.

1-3 **Assembly-language programming.** Venue: Bedford. Designed as a follow-up course to Introduction to microprocessing. On completion, the student will be able to write assembly language program modules and use the full capabilities of the TM990/101M microcomputer module and the TM990/302 software development module with dual audio/cassette interfaces and EPROM programming interface. Fee: £250 + VAT. Contact: Mike Hughes, Microprocessor Training Centre, Texas Instruments Ltd, Manton Lane, Bedford MK1 7PA. Tel: 0234 67466 Extn. 3718.

6 **An introduction to computers.** Venue: Wilmslow Guild. The course introduces in non-technical language the basic building blocks of microcomputers and will show how they may be combined to form computers such as the Pet, TRS-80 and Sorcerer which will be demonstrated. A major part of the course will also deal with the language Basic. Fee: £10. Contact: Julian Noble, Wilmslow Guild, 1 Bourne Street, Wilmslow. Tel: 0625 523903.

6-8 **Microprocessor workshop.** Venue: Manchester. A three-day introductory course for engineers with little or no knowledge of microprocessors. The course is based on the AIM-65 board and introduces all aspects of software development by practical programming sessions. Fee: £195 + VAT. Contact: Microsystems Consultants, Ltd, PO Box 65, Camberley, Surrey GU15 1QN. Tel: 0276 27417.

6-10 **Introduction to the design of microprocessor-based systems.** Venue: Cambridge. The course gives the basic techniques necessary for the design of microprocessor-based systems by lectures and hands-on practical design work. Designed for engineers with little or no microprocessor experience, programmers, project leaders and managers. Fee: £265 + VAT. Contact: Cambridge Microcomputers Ltd, Cambridge, Science Park, Milton Road, Cambridge, CB4 4BN. Tel: 0223 314666.

7 **6502 Programming — Machine-code programming on Pet.** Venue: Manchester University. Every Tuesday for 10 weeks. Aims to show how to program the 6502 and how the speed of searching, looping and data handling can be increased. Also includes examination of Pet memory, uncovering many locations and subroutines. The course would suit competent programmers in a high-level language and would be of interest to any Pet user who wishes to make more efficient use of his machine. Fee: £10. Contact: Enrolment Secretary, Department of Extra Mural Studies, The University, Manchester M13 9PL. Tel: 061 273 3333.

8 **An introduction to microcomputers for businessmen.** Venue: Manchester University. Intended to acquaint businessmen with the terminology of microcomputers, their disadvantages and uses. At the end of the course, participants should be able to assess what kind of system would be appropriate for their businesses. Fee: £20. Contact: Enrolment Secretary, Department of Extra Mural Studies, The University, Manchester M13 9PL. Tel: 061 273 3333.

9 **Basic programming on Pets.** Venue: Manchester University. Offers to those who have little or no programming, of computer-operating experience a grounding in the writing of programs in Basic. Fee: £15. Contact: Enrolment Secretary, Department of Extra Mural Studies, The University, Manchester M13 9PL. Tel: 062 273 3333.

9-10 & 23-24 **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.

14-16 **Advanced microprocessor design techniques.** Venue: London. Designed for engineers with a good understanding of microprocessor system design. Fee: £240 + VAT. Contact: Course Registrar, Ganymede Division, SIA Ltd, 23 Lower Belgrave Street, London SW1W 0NW. Tel: 01-730 8171.

20-21 **The impact of microtechnology.** Venue: Hitchin, Hertfordshire. Designed for senior data processing and management service executives. Covers the technology of microprocessors and their impact on corporate systems architecture, and the use of microcomputers in traditional and innovative applications. Fee: £120 + VAT. Contact: Keith London Associates, 6 St. Albans Road, Codicote, Hitchin, Hertfordshire. Tel: 0438 820309.

20-24 **Practical microprocessor course for beginners.** Venue: London. Designed for engineers from any disciplinary background who need experience in handling a microcomputer. No electronic experience is assumed. The course has a strong practical content and participants will work with development equipment to configure working systems. Fee: £400 + VAT. Contact: Course Registrar, Ganymede Division, SIA Ltd, 23 Lower Belgrave Street, London SW1W 0NW. Tel: 01-730 8171.

21 **Practical introduction to microcomputers.** Venue: Cambridge. Covers the basics of microprocessors and how to use them with hands-on-training using the SGS-Ates Nanocomputer. Fee: £55 + VAT — if you buy a Nanocomputer, the course is free. Contact: Cambridge Micro Computers Ltd, Cambridge Science Park, Milton Road, Cambridge CB4 4BN. Tel: 0223 314666.

22 **Microprocessors — management appraisal.** Venue: Worthing. Enables the manager to appreciate the impact of microprocessors on his business today, to assess their potential and to plan for their possible introduction into his organisation. Fee: £70 + VAT. Contact: Carole Jones, MSS Computer & Business Consultancy, 49 Chapel Road, Worthing, West Sussex, BN11 1EG. Tel: 0903 34755/6.

25 **National TRS-80 users' group workshop.** Venue: Oxford. Randolph Hotel. Fee: £8.15. Contact: Brian Pain, 40a High Street, Stony Stratford, Milton Keynes. Tel: (0908) 566660/564271.

27-30 **Basic programming and numerical methods.** Venue: North-east London Polytechnic. Designed for engineers wishing to update their knowledge on numerical methods. Computing facilities available, 1904s ICL mainframe computer, PDP-11 minicomputer, North Star, SWTP and Sharp microcomputer systems. Fee: £250. Contact: R E Bright, Short Course Organiser, School of Chemical and Systems Engineering, North-east London Polytechnic, Longbridge Road, Dagenham, Essex. Tel: 01-590 7722 Ext. 2060.

29 **Micro or minicomputer — selection criteria.** Venue: Brighton. Designed to enable management to appreciate the relative merits and demerits of micro- and minicomputer systems. Fee: £70 + VAT. Contact: Carole Jones, MSS Computer and Business Consultancy Ltd, MSS House, 49 Chapel Road, Worthing, West Sussex. BN11 1EG. Tel: 0903 34755/6.

Subroutines and the stack

The use of subroutines is a vital technique indispensable to any self-respecting programmer. David Peckett describes the subroutine facilities provided on the 6502 and Z-80 and looks at something fundamental to the use of machine-code subroutines — the stack.

IN PREVIOUS articles, I have given examples of program segments which have specific functions — read and store data, perform multiplication, etc. Yet they are not practical programs.

Real programs are far more complex, but can be reduced usually to a set of simple functions such as read and store data, multiply and so on. Often, a given function is used by several different parts of a program and may also be needed in other programs. It is because of that need to perform the same, or essentially the same, task in several places that subroutines were invented.

If you have ever programmed in a high-level language such as Basic, you will already have met the idea of subroutines. For those brave souls who are tackling this series without any programming experience, what is a subroutine?

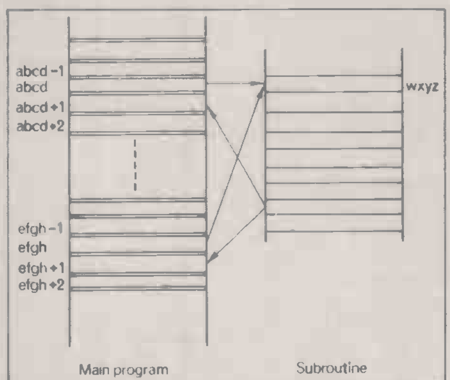


Figure 1. Subroutine call and return.

A subroutine is a section of a program which may be called from anywhere in a main program. The subroutine normally does a specific, often common, task, such as read and store data, multiply, etc. A subroutine call is similar to a jump, in that the program counter (PC) is set to the address of the start of the routine.

However, at the end of the subroutine, the program jumps back to the instruction immediately after the address from which it was called.

Figure 1 shows that diagrammatically. The main program runs normally until it reaches address "abcd", where there is an instruction calling the subroutine which starts at "wxyz". The subroutine then runs until it is finished, at which point it returns control to the main program at address "abcd + 1". That is the next instruction after the "call" — let us not worry about how many bytes there are in each instruction.

The main program then runs to address "efgh", where there is another call to "wxyz". Once more, the subroutine runs until it has finished, and hands back control to the main program, this time at "efgh + 1". Effectively, the subroutine's code is slotted into two places in the main program, although it is written down only once.

You can see that to implement a subroutine, two things must be available:

- A mechanism to jump to the subroutine, while keeping a finger on the point in the main program from which the call was made.
- A facility for jumping back to the right place in the main program when the subroutine is finished.

You could satisfy those requirements with a careful use of jumps, but that would be very untidy. A much better approach is to use special instructions. In Basic,

```
270 GOSUB 2500
```

calls the subroutine which starts at line 2500, while saving the line number of the next instruction (280?). The last instruction in the subroutine is:

```
2590 RETURN
```

That recovers the number of the next line automatically in the calling program and performs a "GOTO".

A micro has operations which are equivalent to Basic "GOSUB" and "RETURN". In the case of the 6502, the calling instruction is "JSR" (Jump to SubRoutine), and the subroutine ends with an "RTS" (ReTurn from Subroutine). The corresponding Z-80 instructions are "CALL" and "RET".

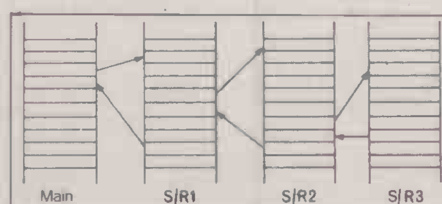


Figure 2. Nested subroutines.

The return address must obviously be stored somewhere. In early micros, it was saved in a special register inside the chip, but it is now normal to use a specially-allocated area, called the stack in main memory.

Invariably, the return address is stored in a way that allows us to nest subroutines, i.e., one can call another, which can call another, *ad infinitum* — figure 2.

We have already seen one common use of subroutines — the provision of a single block of code which can be called from many different places in a program. The alternative would be to place identical code in each place it was needed. The latter would waste a good deal of space and be very error-prone, since you would have to re-enter the code every time.

Another common way of using subroutines is from a program library. As we have seen, the same functions can be needed by many programs. By writing a general subroutine once and saving it when it has been debugged, you can use it as often as you want as a standard function.

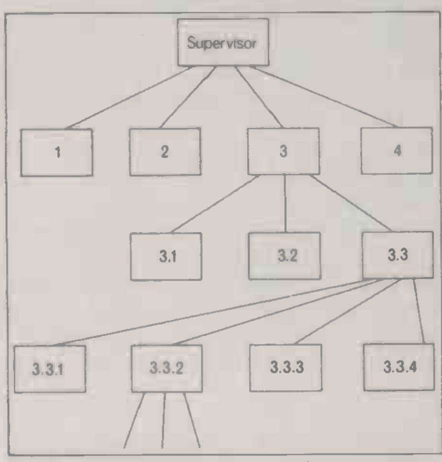


Figure 3. Top-down structured program.

A third major use of subroutines, and one that is related to the first two, is the programming technique, top-down programming. It is a powerful tool which can discipline and speed software development.

It relies on each major program function being written as a subroutine, calling lesser subroutines for smaller tasks, which in turn call even lesser subroutines — figure 3. Control passes only up and down the program and never sideways.

By writing in that way, you can develop the program one subroutine at a time, starting from the top. At each stage, you represent all the unwritten routines called by dummies. You have to debug only one subroutine at a time, and, by limiting your debugging in that way, you can find problems very quickly. Pascal is a good example of a high-level language designed to be used in top-down programming, although you can use the technique with any language.

Some assemblers provide a macro facility. At first glance, it looks very like a subroutine, but it is, in fact, totally different.

A macro is a block of assembly code which has been given a label. Every time the code is needed in the program, the label is used instead. Effectively, the macro facility allows you to define pseudo-operations to suit the specific needs of your program.

For instance, you may be writing a 6502 program which often needs to swap the contents of X and Y. You could write a macro to do this:

```
MACRO SWAPXY
      STX DUMMY    ;SAVE X
      TYA          ;MOVE
      TAX          ;Y TO X
      LDY DUMMY    ;SET Y
ENDM
```

Thereafter, whenever you needed to interchange X and Y, you could use the single command "SWAPXY". Beware: I have used an imaginary macro construction language here — check your own assembler.

Although with both macros and subroutines you write the code only once, there is a fundamental difference between the two. If you are using a subroutine, the assembly language program mirrors exactly what will appear in the object code — the subroutine is only there once. A macro, on the other hand, is a set of instructions to the assembler. It effectively says: "When you assemble this program, every time that you see the macro label, insert this block of code". The code associated with a macro thus appears every time the macro is used.

The result is that a program using macros will run faster than a program using equivalent subroutines because no time will be lost in the call and return operations. On the other hand, it will be physically longer than the subroutine-based program. Also, it may be easier to debug and modify the program which uses subroutines.

At last we reach that mysterious object, the stack. In fact it is not very mysterious at all. The stack is simply an area in the main memory the micro can write to and read from very quickly.

The stack is organised as a last-in, first-out (LIFO) store. If you read a byte from the stack, you obtain the last one which went into it, and if you read "n" bytes off the stack, you have the last "n" which went on, in reverse order.

A stack is normally organised so that it is loaded from the high addresses down. Thus, if the stack lies between 0100_{16} and $01FF_{16}$, the first byte on to it will go to address 01FF, the second to 01FE, and so on — figure 4.

The micro accesses to the stack by a special register, the stack pointer (SP), which keeps a record of where in the stack the micro is working. There is a basic difference between the SP logic of the 6502 and the Z-80. The 6502 SP points to the next vacant address in the stack; for example, if the last byte went to address $012E_{16}$, the SP will contain 012D.

The Z-80 SP, on the other hand, points to the last byte which went into the stack; in the last example, the SP would continue

(continued on next page)

(continued from previous page)
to point to 012E. The SP would be decremented when the next byte was put on to the stack.

Do not worry too much about what is in the SP, though. Unless you are being very clever and imposing your will on the SP, stack operation is automatic and largely transparent to the programmer.

There is another big difference between the SPs in the two micros. The 6502 uses

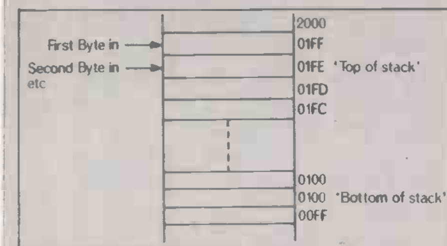


Figure 4. Stack organisation.

an eight-bit register, which means the stack has a maximum size of 256 bytes. When the micro uses the SP, the pointer contents form the low byte of the address, and a high byte of 01_{16} is provided automatically. The 6502 stack is, therefore, on page-1 — figure 5.

The SP in the Z-80 is a 16-bit register, which defines explicitly the address of data to and from the stack. It means that, in principle, a Z-80 stack can be anywhere in memory.

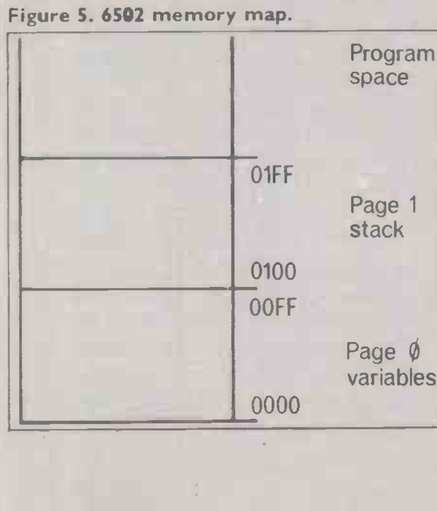
The stack can be used for several purposes, but its most important function is to store the return address when a subroutine is called. The call instruction performs two functions:

- It dumps the contents of the PC, which points to the next instruction by now, on to the stack.
- It loads the PC with the start address of the subroutine.

At the end of the subroutine, the address is recovered from — pulled or popped off — the stack and put back into the PC. That forces the micro back to the proper place in the calling program.

If another subroutine is called from the first one, the second return address is also pushed on to the stack. Because the stack is a LIFO store, that address is popped-off before the original one. Because of that property of the stack, the program

Figure 5. 6502 memory map.



will go back up the subroutine chain in the correct order.

Remember, you do not normally have to worry about the details of the stack mechanisation. The micro will push data to the stack automatically, pop it off again and will decrement and increment the SP as necessary. However, you sometimes need to have an idea of what is happening to write an effective program.

The stack is not only used for subroutines. Because data can be stored in, and read from, the stack much more quickly than is possible with normal memory, the stack is a useful place to dump data that is entering rapidly. Once the data has finished arriving, it can be recovered from the stack, in reverse order, and whatever processing is necessary performed.

It is possible to do that because micros can push and pop data between the stack and some, at least, of their internal registers. This kind of facility is additional to the automatic treatment of the PC during subroutine operations.

It will not be a big surprise to learn that the 6502 can do less in that respect than the Z-80. The 6502 can move only A and the PSW between itself and the stack. To put data on to the stack, it uses "PHA" and "PHP" (PusH A,PSW). The data is

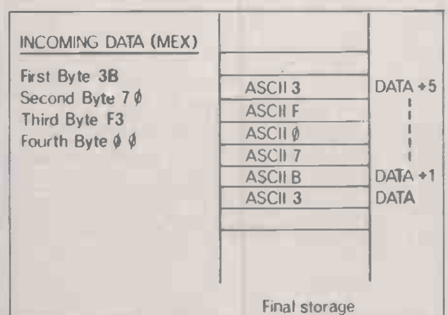


Figure 6. Data storage map.

recovered by "PLA" and "PLP" (PuLl A,PSW).

If a 6502 programmer needs to save X or Y on the stack, then he must go via A:

```
;SAVE X AND Y IN STACK
        TXA
        PHA     ;X TO STACK
        TYA
        PHA     ;Y TO STACK
         .
         .
         .
         .
         .
;RECOVER X AND Y FROM STACK
        PLA     ;STACK IS LIFO
        TAY     ;STORE. X AND Y
        PLA     ;COME OFF IN
        TAX     ;REVERSE ORDER
```

The Z-80, on the other hand, can save any of its working registers in the stack. A potential weakness is that it can transfer only register pairs: in this mode, A and F are combined to form a single RP. As shown in table 1, the appropriate instructions are "PUSH rp" and "POP rp".

Why is that a potential weakness? The main reason is the time penalty. If you are

Operation	6502			Z-80		
	Mnem.	Flags	Effect	Mnem.	Flags	Effect
Call Subroutine	JSR a	None	PC to Stack PC = a	CALL a	None	PC to Stack PC = a
Return from Subroutine	RTS	None	PC from Stack	RET	None	PC from Stack
A to Stack	PHA	None	A to Stack	—		
PSW to Stack	PHP	None	PSW to Stack	—		
A from Stack	PLA	N,Z	A from Stack	—		
PSW from Stack	PLP	All	PSW from Stack	—		
RP to Stack	—			PUSH rp	None	RP to Stack
RP from Stack	—			PULL rp	All if RP = "AF"	RP from Stack
Transfer SP to X	TSX	N,Z	X = SP	—		
Transfer X to SP	TXS	None	SP = X	—		
Load SP	—			LD SP,o	None	SP = d/(a)
Save SP	—			LD (a),SP	None	(a) = SP
Increment SP	—			INC SP	None	SP = SP + 1
Decrement SP	—			DEC SP	None	SP = SP — 1
Add SP to HL	—			ADD HL,SP	H,N,C	HL = HL + SP N = 0
Move HL to SP	—			LD SP,HL	None	SP = HL

Notes: "a" = Address — defined by the program
"d" = Data — defined by the program
"o" = Operand — can be an address or data
"rp" = Z-80 Register Pair
"/" = Either/or
Brackets: "Data at the address defined between the brackets".
All the 6502 instructions use implied addressing, apart from "JSR" which uses direct addressing.

Table 1. This month's instructions.

moving data between the stack and a single register, you waste time having to transfer two bytes. Conceivably, the stack could become too large as well.

To be honest, that is not a major weakness. You must remember, however, that every time that you pull data into A from the Z-80 stack, you may be re-setting the flags. That could result in complications. It also suggests a way of setting the flags to a given pattern if this is every necessary:

```
LD      C,FLAGS  ;SET PATTERN IN C
PUSH    BC       ;TRANSFER C TO F
POP     AF       ;VIA THE STACK
```

Obviously, you could preserve A by a "LD B,A" at the start.

The Z-80 stores RPs on the stack in its usual double-byte way — the low byte goes in the lower address. Because the stack grows from the top down, the high byte is PUSHed on first, and POPped-off last. In "AF", F is treated as the low byte.

That technique of temporarily storing data on the stack looks very useful. There is a complication: if you push data on to the stack in the middle of a subroutine, the SP no longer points to the return address — that makes it difficult to leave the subroutine.

What we need are ways to save the SP and to manipulate it. Both micros can do that; not surprisingly, the 6502 is more limited in its capabilities than the Z-80. Table 1 includes the instructions which affect the SP.

In 6502 SP manipulation, all the 6502 can do is move the SP to X ("TSX") and move whatever is in X to the SP via "TXS". Of course, once the data is in X, we can do much more with it.

With Z-80 SP manipulation, the Z-80 can treat the SP, in many ways, as just one more RP. Thus, it can load it from memory viaa "LD SP, (addr)" or immediately, "LD SP,data". The SP can also be incremented or decremented via "INC SP" and "DEC SP", and stored in memory by using "LD (addr),SP".

If we need to preserve the value of SP, we might want to keep it in another RP. There is not an instruction to do that

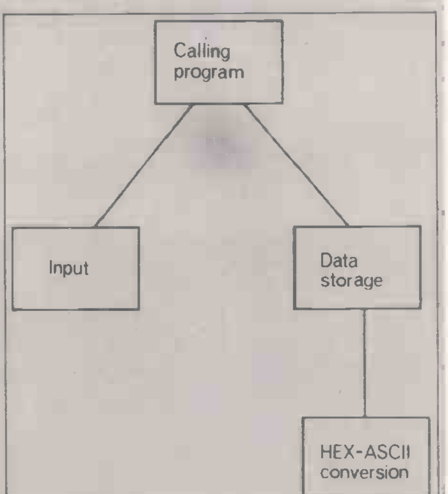


Figure 7. Program structure.

directly, but we can add the contents of SP to HL ("ADD HL,SP"). Therefore:

```
LD      HL,O
ADD     HL,SP
```

will load HL with SP. Later, if necessary, we can put HL straight into SP via "LD SP,HL".

Normally, when you switch on a micro, the SP is not set to the correct value automatically. Any computer system will have a re-set procedure, which is generally a short length of code to put the system on the air. One of its functions will be to set

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the SP to the correct starting value.

In the case of the 6502, the stack will almost certainly start at the top of page-1, i.e., at $01FF_{16}$. Since the SP must be manipulated via X, the code will have the form:

```
LDX #$FF   ;TOP OF STACK
TXS        ;INITIALISE THE SP
```

A Z-80 stack can be anywhere in memory except at the very bottom. Sometimes, a Z-80 system may have more than one stack. Initialisation is easy, though:

```
LD SP,data    ;INITIALISE STACK
```

If you are writing real programs, you must remember to set-up the stack — I shall take it for granted from now on.

Let us now look at some typical subroutines for input/output. Suppose data is input to a micro in normal eight-bit bytes. However, we have to split each byte into its two nybbles and convert each nybble into the ASCII code representing its Hex value. We will then store the characters in memory, starting at "DATA", with the first character at the lowest address. Thus, if "n" bytes enter, the characters will lie finally at addresses between "DATA" and ("DATA"+2n—1) — figure 6.

The data in each byte is packed so that the high nybble represents the first character. The system is to read each byte from address "WORD"; each byte will be ready when the MSB of "STATUS" is set to "1". A byte of value "00" shows the

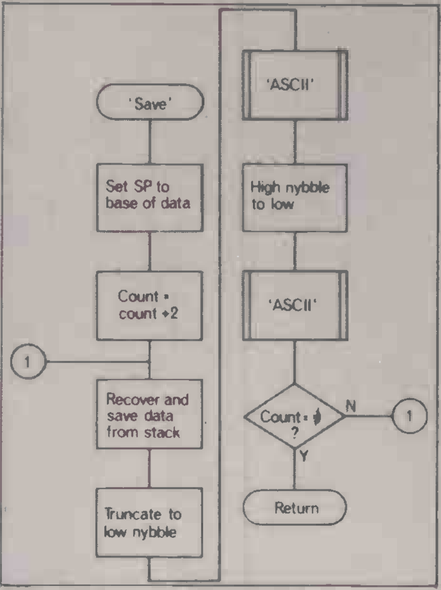

Figure 9. Save subroutine.

end of the data input — it should not be saved.

To make life interesting, let us assume that the data will enter so fast that there will be no time to split it into ASCII characters in real time. We save it in the stack and manipulate it when it has stopped arriving. Assume also that there will be no more than about, say, 100 bytes in the input string.

Finally, let us put "WORD" and "STATUS" at adjacent address, with

Table 2. Stack during 6502 input routines.

	Event	X	Y	SP	BASE	Stack	
1.	At Start	—	—	FF	—		IFF IFE IFD IFC IFB IFA
2.	Just after entry to "INPUT"	FD	0	FD	—	RETURN ADDRESS I	IFF IFE IFD IFC IFB IFA
3.	After recognising termination byte	FD	2	FB	—	RETURN ADDRESS I DATA I DATA 2	IFF IFE IFD IFC IFB IFA
4.	Immediately before return from "INPUT"	FD	2	FD	FB		
5.	Just after entry to "SAVE"	4	2	FB	FB	RETURN ADDRESS 2 DATA I DATA 2	IFF IFE IFD IFC IFB IFA
6.	After first entry to "ASCII"	4	DATA2	FA	FB	RETURN ADDRESS 2 DATA I RETURN ADDRESS 3	IFF IFE IFD IFC IFB IFA
7.	Before return from final "ASCII"	0	DATAI	FB	FB	RETURN ADDRESS 2 RETURN ADDRESS 4 ADDRESS 3	IFF IFE IFD IFC IFB IFA
8.	Before return from "SAVE"	0	DATAI	FD	FB		

"STATUS" having the lower address. That is not as unlikely as it may sound.

To make it easy to develop the software, we shall use subroutines, one to input the data, and one to sort it afterwards. For each byte of data, we need two Hex-to-ASCII conversions and saves. It seems reasonable to make that function a subroutine, also. The end result will be a program structured as in figure 7.

Figures 8-10 give flowcharts for the three subroutines. As you see, the programming task appears simple because we only have to deal with one subroutine at a time.

None of the subroutines is particularly complex, but we must be very careful with the SP. For instance, when we enter "INPUT", the SP points to the return address. However, by the time that we have stored all the input data on the stack, the SP will point to the top of the data.

It is, therefore, important to save the SP as soon as we enter the routine. At the end we will restore the SP to point to the return address. Obviously, before we can do this, we have to record the top-of-the-data SP so that the "SAVE" routine will know where to find the data.

- **Input.** Initially, the SP is stored in X, and Y is zeroed to keep track of the number of bytes input.

The actual input routine is very simple — it waits for bit 7 of "STATUS" to be set, reads "WORD" and dumps it in the stack. The only oddity is the use of a "BNZ" to return to the start of the input loop each time. Strictly, we need an unconditional jump here, but since the "BNZ" always sees a non-zero Y, it acts as such a jump.

Finally, we have to tidy things by shuffling the SPs. The original one is dumped in A while the top-of-data one is passed, through X, to a store called "BASE". The return SP is then put back, via X, and the subroutine exits properly.

- **Save.** This subroutine starts with another SP shuffle. Assuming that the calling program has not fiddled with the stack, and that is up to you, the return address exactly overwrites the one remaining from "INPUT". We do not need to preserve deliberately this SP value, but we must re-set the SP to its "top-of-data" figure from "BASE".

If we read in originally "n" bytes, we will eventually store "2n" ASCII characters. We put, therefore, "n" into A from Y, double it with a shift, and pass it to X to use as an index and counter.

A byte is pulled off the stack, they are in reverse order, into A, and copied into Y. In figure 6, you see that the last nybble of the last byte will finish at the highest address in memory. Hence, as we pull each byte off the stack, we process its low nybble first, and store characters from ("DATA" + 2n—1) downwards.

We obtain the low nybble of each byte by a simple truncation. "ASCII" then converts it to a character, stores it, and

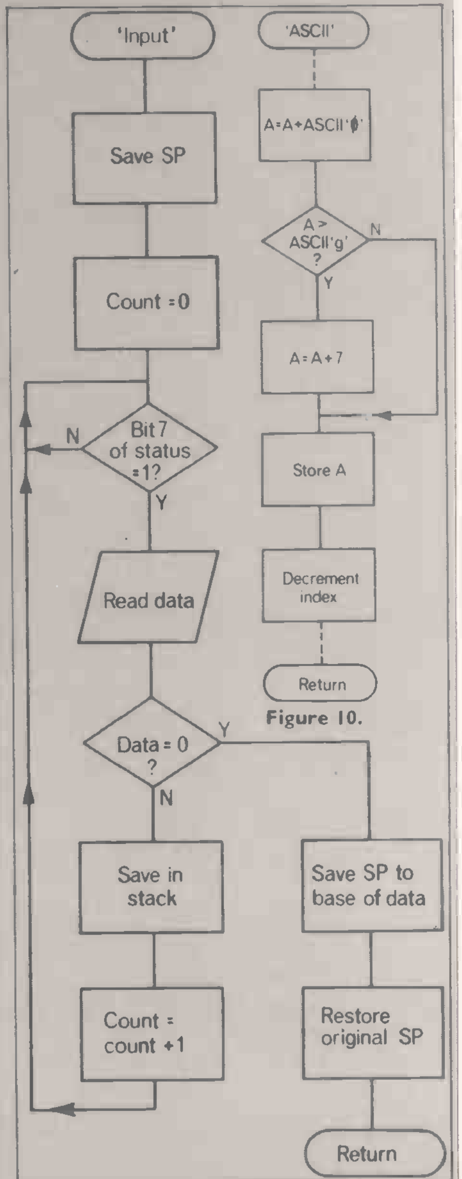

Figure 10.

Figure 8. Input subroutine.

decrements the index register to point to the next storage slot.

We complete the processing of a byte by recovering it to A from Y. The high nybble is moved to the low nybble, and the four MSBs set to 0, with four logical right shifts. "ASCII" does its stuff again to save the character.

After each byte has been processed, X is checked for zero to see whether we have finished. The test relies on the Z flag being passed back unchanged from "ASCII".

When the routine is finished, the SP points to the return address automatically, since we have pulled all the data off the stack — table 2 — we just do a simple return.

- **ASCII.** When we call "ASCII", where does the return address go? The high byte overwrites the data we have just pulled off, and the low byte is in the slot below that — table 2.

If you look at an ASCII chart, e.g., the one in part two of the series, you can see the relationship between Hex

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and ASCII. The important point is the seven-character gap between "9" and "A".

"ASCII" first sets the high nybble from zero to 3_{16}, and tests to see whether the end result is greater than ASCII "9". If it is, another seven must be added. The subroutine uses a "CMP#$3A" for the test, and monitors the carry.

The second addition allows for that by only adding six — the carry makes the total addition of seven.

Finally, the now-formed ASCII character is saved in memory via an indexed "STA" — why is the indexing base ("DATA"—1) — and X is decremented.

The Z-80 subroutines follow much the same pattern as those for the 6502, but, of course, use the Z-80 characteristics. In particular, they allow us to do everything within the chip's internal registers. The contents of table 2 are relevant to the Z-80 subroutines, although the details are, naturally, different.

- **Input.** That starts by saving the SP in DE, and initialising C to act as a counter. The zero in C is copied into A.

Now you can see why we made "STATUS" and "WORD" adjacent. We load them both into HL at once, which speeds the program. At first, of course, we are concerned only with L, which contains "STATUS", but when a word is ready, it is in H automatically.

The data is tested for zero against A — that is why we zeroed A — and, if non-zero, saved in the stack. Each time we do that, we also clutter the stack with L.

At the end of the routine, we collect the "top-of-data" SP in HL. Swapping DE and HL saves the final SP in DE, and presents the return SP value to HL for easy transfer.

- **SAVE.** First we zero B and re-set the SP to the value we had saved in DE. Having done that, 16-bit addition is used to make HL a pointer to the highest address of the block of memory where the data is to be saved. Before we start on the storage loop, B is set to "n" so that we can use a "DJNZ" to control the iterations.

To manipulate the data, pairs of bytes are popped into AF, This process loads A with the data originally read into H, i.e., "WORD", while F is set to the value which was in "STATUS".

The two nybbles are separated exactly as in the 6502 program, and processed via two calls to "ASCII". At the end of each iteration of the storage loop, we use B as a count. In that respect, the subroutine is functionally different from the 6502 "SAVE" which uses X as both index and counter.

- **"ASCII".** This subroutine is very similar to that for the 6502. The only significant difference is that the Z-80 shows no borrow by setting the carry flag to zero, so that we have to add seven for the 9-A offset.

```
;6502 DATA HANDLING SUBROUTINES
;
;INPUT SUBROUTINE
;THIS STORES INCOMING BYTES IN THE STACK.
;THE NUMBER OF BYTES ARE RETURNED IN Y,
;AND "BASE" HOLDS THE SP TO THE DATA STORED
;IN THE STACK
;
INPUT   TSX                 ;SAVE STACK
        LDY   #0            ;ZERO COUNT
WAIT    LDA   STATUS
        BPL   WAIT          ;BIT 7 SET?
        LDA   WORD          ;YES, READ DATA
        BEQ   END           ;TERMINATOR?
        PHA                 ;NO, SAVE DATA
        INY                 ;INCREMENT COUNT
        BNZ   WAIT          ;GO FOR NEXT BYTE
;INPUT OVER - TIDY UP
END     TXA                 ;MAKE ROOM IN X
        TSX                 ;FINAL VALUE OF SP
        STX   BASE          ;SAVE SP
        TAX                 ;RESTORE
        TXS                 ;ORIGINAL SP.
        RTS                 ;END OF ROUTINE
;
;SUBROUTINE TO SAVE DATA
;THE SP TO THE DATA IS PASSED IN "BASE"
;
SAVE    LDX   BASE          ;RESET SP
        TXS                 ;TO BASE OF DATA.
        TYA                 ;DOUBLE COUNT FOR
        ASL   A             ;STORAGE AND INDEX.
        TAX                 ;SET INDEX
NXTBYT  PLA                 ;RECOVER BYTE
        TAY                 ;SAVE BYTE
        AND   #$0F          ;TRUNCATE TO LOW NYBBLE
        JSR   ASCII         ;CONVERT TO ASCII
        TYA                 ;RECOVER BYTE
        LSR   A             ;PUT HIGH
        LSR   A             ;NYBBLE TO LOWER;
        LSR   A             ;SET HIGH BITS
        LSR   A             ;TO ZERO.
        JSR   ASCII         ;CONVERT TO ASCII
        BNE   NXTBYT        ;FINISHED?
        RTS                 ;YES, RETURN
;
;SUBROUTINE TO CONVERT DATA TO ASCII AND SAVE IT
;THE NYBBLE TO BE PROCESSED IS PASSED IN A
;
ASCII   ORA   #$30          ;ADD ASCII PREFIX
        CMP   #$3A          ;TEST TO SEE
        BCC   NUMBER        ;IF A-F
;AT THIS POINT, CY=1
        ADC   #6            ;ADD ALPHA OFFSET (6+CY)
;A NOW CONTAINS ASCII CHARACTER
NUMBER  STA   DATA-1,X      ;SAVE CHARACTER
        DEX                 ;POINT TO NEXT STORE
        RTS                 ;DOESN'T CHANGE Z FLAG
;
;END OF SUBROUTINES
```

Figure 11.

Figure 12.

```
;Z80 DATA HANDLING SUBROUTINES
;
;INPUT SUBROUTINE
;INCOMING BYTES ARE STORED IN THE STACK.
;THE NUMBER OF BYTES IS RETURNED IN C, AND
;DE CONTAINS THE SP TO THE BASE OF THE DATA
;
INPUT   LD    HL,0          ;SAVE
        ADD   HL,SP         ;SP
        EX    DE,HL         ;IN DE.
        LD    C,0           ;ZERO COUNT
WAIT    LD    HL,(STATUS)   ;L=STATUS, H=WORD
        BIT   7,L           ;MSB=1?
        JP    NZ,WAIT
        CP    H             ;TERMINATOR?
        JP    Z,END
        PUSH  HL            ;NO, SAVE DATA
        INC   C             ;INCREMENT COUNT
        JP    WAIT          ;GO FOR NEXT BYTE
;INPUT OVER - TIDY UP
END     LD    HL,0          ;SAVE FINAL
        ADD   HL,SP         ;SP VALUE
        EX    DE,HL         ;IN DE
        LD    SP,HL         ;RESTORE ORIG SP
        RET                 ;END OF ROUTINE
;
;SUBROUTINE TO SAVE DATA
;THE NECESSARY PARAMETERS ARE IN THE MICRO ALREADY
;
SAVE    LD    B,0           ;NEED THIS LATER
        EX    DE,HL         ;DE=SP
        LD    SP,HL         ;SP TO BASE OF DATA
        LD    HL,DATA-1     ;POINTER
        ADD   HL,BC         ;FOR
        ADD   HL,BC         ;DATA STORAGE
        LD    B,C           ;COUNTER
NXTBYT  POP   AF            ;RECOVER BYTE
        LD    C,A           ;SAVE
        AND   $0F           ;TRUNCATE TO LOW NYBBLE
        CALL  ASCII         ;CONVERT AND SAVE
        LD    A,C           ;RECOVER BYTE
        SRL   A             ;SHIFT
        SRL   A             ;TO
        SRL   A             ;LOW
        SRL   A             ;NYBBLE
        CALL  ASCII         ;CONVERT AND SAVE
        DJNZ  NXTBYT        ;FINISHED?
        RET                 ;YES
;
;SUBROUTINE TO CONVERT DATA TO ASCII AND SAVE IT.
;THE NYBBLE IS PASSED IN A. HL POINTS TO STORAGE.
;
ASCII   OR    $30           ;ADD ASCII PREFIX
        CP    $3A           ;TEST FOR
        JP    C,NUMBER      ;A-F
        ADD   A,7
;A IS NOW ASCII CHARACTER
NUMBER  LD    (HL),A        ;SAVE CHARACTER
        DEC   HL            ;POINT TO NEXT SPACE
        RET
;
;END OF SUBROUTINES
```

BUYERS' GUIDE

The Buyers' Guide is a summary of low-cost computers available in this country. It appears every third month; we add new computers and amend existing information, as required, to keep it up-to-date. Systems are listed by manufacturer.

Microcomputers

ACORN COMPUTERS

Systems 1,2,3,: 6502-based, 1-8K RAM, COS or DOS, Hex or full keyboard, TV interface, Acorn bus. Personal or scientific use. Reviewed September 1979. — *From £65 for System 1 kit; £285 for System 2 kit; £670 for System 3 kit*

Atom: 6502, 2-12K RAM, up to 40K external memory, full keyboard, Basic in ROM, high-resolution graphics, cassette and TV interface, parallel port, I/O lines. Should eventually be able to link into a ring. Acorn Computers Ltd, 4a Market Hill, Cambridge CB2 3NJ (0223) 312772. — *From £130*

ALAN PEARMAN LTD

Maple: Z-80A, 16-64K RAM, S-100 bus, CP/M, 8in. discs, RS232 serial and parallel. Sold mainly as Micro-APL system. Alan Pearman Ltd, Maple House, Mortlake Crescent, Chester CH3 5UR. (0244) 46024. — *From £1,510*

ALPHA MICRO

AM-1010, AM-1051: WD-16, 64K-16MB RAM, S-100, four 8in. up to 90MB hard discs, RS232 up to 20 ports. Alpha Micro, 13 Brunswick Place, London N1 6ED. (01) 250 1616. — *From £7,500*

APPLE COMPUTERS

Apple II Plus: 6502, 16-48K RAM, 8K ROM, colour graphics, 5¼in. discs, general use. Own bus. Reviewed October 1979. — *From £695*

Apple III: 6502A with supporting chips, giving it a superset of 6502 instruction set. 96-128K RAM, colour graphics, integral 5¼in., RS232, four 50-pin expansion slots. Microsense, Finway House, Hemel Hempstead, Hertfordshire HP2 7PS. (0442) 48151. — *P.O.A.*

ATTACHE

Attache: 8080, 64K RAM, S-100, parallel port, 8in. discs, business system. Friargrove Systems Ltd, 494 Great West Road, Hounslow, Middlesex (01) 572 3784. — *From £1,737 to £7,000*

BASF

System 7100: Z-80A, 64K RAM, RS232, 5¼in. discs, business systems. MPR, 293 Grays Inn Road, London WC2. (01) 837 6332. — *From £4,937*

BILLINGS

BMS: Z-80A, 64K RAM, 8in. 200MB hard discs, business system. Mitech Data Systems, 8 Guildford Road, Woking, Surrey. (04862) 23131. — *From £4,295*

B L MICROELECTRONICS

Biproc: Z-80 or TMS9980 kit, 1K RAM, 2K monitor, RS232, cassette, TV. BLM, 1 Willow Way, Loudwater, High Wycombe, Buckinghamshire HP11 1JR. (0494) 443073. — *From £150*

BLEASDALE COMPUTER SYSTEMS

UDS: 8080, Z-80, 6809, 32K-1MB, Multibus, CP/M, 5¼in., 8in., hard, RS232, four parallel ports, IEEE 488, development system. Bleasdale Computer Systems, Francis House, Francis Street, London SW1. (01) 828 6661. — *P.O.A.*

BRUTECH ELECTRONICS

BEM: Single-board processor with 6502 and no RAM. Data Precision Equipment, 81 Goldsworth Road, Woking, Surrey GU21 1LJ. (04862) 67420. — *From £133*

BYTRONIX MICROCOMPUTERS

Megamicro: 8080/Z-80, 64K RAM, 8in. discs, CP/M. Business and university use. Bytronix, 83 West Street, Farnham, Surrey GU9 7EN. (0252) 726814. — *From £6,080*

CANON BUSINESS MACHINES

Canon BX-1/BX-1d: 6800, 64K RAM, 5¼in. integral, RS232, V24 ports, business use. Canon Business Machines, Wadden House, Stafford Road, Croydon, Surrey. (01) 680 7700. — *From £3,250*

COMMODORE BUSINESS MACHINES

Pet: 6502, 8-32K RAM, IEEE ports, integral 9in. screen, personal and general use. Reviewed August 1979. — *From £460*

8000 Series — SuperPet: Upgrade of original Pet. 12in. screen, 5¼in. discs, business and general use. Reviewed October 1980. — *From £895*

Kim-1: 6502, LED six-digit display, 1K RAM, cassette and Teletype interface, evaluation board for 6502 chip. Commodore Business Machines, 818 Leigh Road, Slough Industrial Estate, Slough, Berkshire. (75) 74111. Reviewed November 1978. — *From £99.95*

COMPSHOP

UK101: 6502, 4-8K RAM, TV interface, RS232, full keyboard, single-board, personal use, similar to Ohio Superboard. Compshop, 14 Station Road, New Barnet, Hertfordshire EN5 1QW. (01) 441 2922. Reviewed May 1980.	*From £199 for kit*

COMPUCOLOUR

Compucolour II: Z-80, 8-32K RAM, 5¼in. integral discs, 13in. colour VDU, RS232. General use. Dyad Developments. The Priory, Great Milton, Oxfordshire OX9 7PB. (08446) 729. Reviewed June 1979.	*From £998*

COMPUCORP

655-675: Z-80, 60K RAM own OS but will run CP/M with modifications, RS232, IEEE and others optional. 1-4 5¼in. discs, 16by80 VDU. Business use. Barnet House, 120 High Street, Edgware, Middlesex. (01) 952 7860.	*From £2,595 to £4,750*

COMPUTER CENTRE

Minikit: Z-80, 16K RAM, serial and parallel, 5¼in., CP/M, S-100.	*From £800*
Maxikit: Z-80, 16K RAM, serial and parallel, 8in., CP/M S-100. Computer Centre, 9 De la Beche Street, Swansea SA1 3EX.	*From £911*

COMPUTHINK

Act System 800: 6502, 48K RAM, full keyboard, graphics, 5¼ or 8in. discs, 12in. VDU integral. Business system. Act, 66-68 Hagley Road, Edgbaston, Birmingham B16 8PF. (021) 455 8686. Reviewed February 1980.	*From £4,000*

CROMEMCO

Single Card Computer: Z-80, S-100, 1K RAM, 20mA/RS232. OEM and industrial use.	*From £273*
Z2: Z-80, 31A power supply, motherboard, 21 sockets, serious hobbyist and OEM use. Reviewed February 1979.	*From £573*
Z2-H: Z-80A, 64-512K RAM, S-100 bus, CDOS, 10MB formatted fixed disc, two 5¼in. discs, hard discs up to 70MB.	*From £5,373*
System 2: Z-80A, 64-512K RAM, S-100 21 slots, CP/M, VDU, two 5¼in. discs, hard discs up to 70MB. Multi-channel interface available. General/business use.	*From £2,095 to £6,408 for seven users*
System 3: Z-80A, 64-512K RAM, S-100, CP/M, two or four 8in. discs, hard discs up to 70MB, general/business use. Datron Microcentre, 2 Abbeydale Road, Sheffield S7 1FD. (0742) 585490. Microcentre, 30 Dundas Street, Edinburgh EH3 6JN (031) 556 7354. Comart, PO Box 2, St Neots, Huntingdon, Cambridgeshire PE19 4NY. (0480) 215005.	*From £3,568 to £8,304 for seven users*

DATA APPLICATIONS

DAI Personal Computer: 8080, 8-48K RAM, colour graphics, 20 Eurocard industrial interface modules, RS232, industrial use. Data Applications, 168 Dyer Street, Cirencester, Gloucestershire GL7 2PF. (0285) 2588.	*From £998*

DIGITAL MICRO SYSTEMS

DSC-3: Z-80, 64K RAM, CP/M, 8in. discs, hard discs up to 28MB, RS232/V24, business and general use.	*From £3,445*

DSC-4: Z-80, 128-512K RAM, CP/M, 8in. discs, hard discs up to 28MB, RS232, RS422, business and general use. — *From £3,995*

Hex-29: AMD 2900 16-bit, 64K-1,024K RAM, Hex bus, 8in. discs, hard discs up to 28MB. Eight to 32 ports, RS232. Modata, 30 St Johns Road, Tunbridge Wells, Kent TN4 9NT. (0892) 41555. — *From £6,445*

DURANGO

F85: 8085, 64K RAM, own bus and OS, graphics, four RS232 ports, integral 9in. VDU, 9 × 9 printer, keyboard and two 5¼in. disc drives. General use. Comp Ancillaries, 64 High Street, Egham, Surrey. (07843) 6455. — *From £7,500*

DYLE HOUSE

System 2000: Z-80, 64K RAM, dual 8in. discs, own OS, business use. Dyle House, 36 Abbot Way, Wellingborough, Northamptonshire. (0933) 79135. — *P.O.A.*

DYNABYTE

DB8/1.2.4.5.6.7: Z-80, 32-64K RAM, S-100, CP/M, MP/M RS232, 5¼ or 8in. discs, hard discs up to 96MB, expands to multi-task/user system. Business use. Bill Miller, Dynabyte, 25 Park Road, Falsgrave, Scarborough, Yorkshire. (0723) 65559/73338. — *From £1,600 to £12,000*

EACA

Video Genie EG3003: Z-80, 16-48K RAM, S-100, CP/M, 5¼in. discs, RS232, personal and general use. Lowe Electronics, Bentley Bridge, Chesterfield Road, Matlock, Derbyshire DE4 5LE. (0629) 2430. Reviewed February 1980. — *From £369*

EQUINOX

200: Z-80, 64-512 RAM, S-100 bus, CP/M, Omnix, MicroCobol, MVT FAMOS, cartridge disc, six serial and one parallel port, business use. — *From £7,500*

300: WD-16, 64-256K RAM, S-100 bus, CP/M, Omnix, MicroCobol, MVT FAMOS, cartridge disc drive, six serial ports, business use. Equinox, 16 Anning Street, New Inn Yard, London EC2A 3HB. (01) 729 4460/(01) 739 2387. — *From £10,500*

EUROCALC

Euroc: 8080, 64K RAM, 8in. discs, 15in. VDU, CP/M, business use. Eurocalc, 55/56 High Holborn, London WC1. (01) 405 3113. — *From £8,000*

EXIDY

Sorcerer: Z-80, 16-48K RAM, S-100, RS232, CP/M, 5¼in. discs. Plug-in ROM pack programs. Liveport, The Ivory Works, St Ives, Cornwall TR26 2HF. (0736) 798157. Reviewed May 1979. — *From £399 from Compshop*

GNAT

System 10: Z-80, 65K RAM, own bus, CP/M, graphics, 5¼in. discs, RS232, RS449, 12in. VDU, full keyboard, optional IEEE. Business use. Millbank Computers, 98 Lower Richmond Road, London SW16. (01) 788 1083. — *From £2,995*

HAYWOOD

Systems 1000-8000: Z-80, 32-65K RAM, 6000 is S-100, 3000 single-board, CP/M, graphics, 5¼in. discs, three serial and parallel ports. Business, scientific and general use. Haywood Electronics Assoc., 11 Station Approach, Northwood, Middlesex. (01) 428 9831. — *From £2,359*

HEATH/ZENITH

H8: Single-board WH8 assembled, 8080, 16K-65K RAM. Heathbus nine slots, cassette interface, nine-digit LED. — *From £321*

Z89: Z-80, 16-48K RAM, CP/M, integral 5¼ in. drive, optional dual external, two RS232, full keyboard, 12in. VDU. — *From £1,570*

WH-11A: LSI-II, 16-bit, 16-32K RAM, own bus and OS, optional dual 8in. drives, serial and parallel ports. Heath Ltd, 11b Bristol Road, Gloucester GL2 6EE. (0452) 29451. (01) 636 7349. — *From £1,250*

HEWART

6800Mk II: 6800 single-board, 1K monitor, 1K user RAM, 1K VDU RAM, 128byte scratchpad, education and home user. S-50 bus. — *From £155*

6800S: 6800, 16K monitor, 8K Basic in ROM, graphics, 5¼in. drive. Hewart, 95 Blakelow Road, Macclesfield, Cheshire. (0625) 22030. — *From £229*

HEWLETT-PACKARD

85A: 16-32K RAM, 32K ROM, IEEE 488, RS232, graphics, 5¼in. drives, integral 32 × 16 VDU, integral thermal printer, QWERTY and numeric keypad. Scientific use. Hewlett-Packard, King Street Lane, Winnersh, Workingham, Berkshire. (0734) 784774. — *From £1,830*

INDUSTRIAL MICROSYSTEMS

Series 5000: Z-80, 16-56K RAM, CP/M, S-100, two or three 5¼in. discs, two serial and one parallel port, desk unit, business and general use. — *From £1,500*

Series 8000: Z-80, 64-256K RAM, S-100, CP/M, MicroCobol, MVT FAMOS, Omnix, two, three or four 8in. disc drives, two serial and one parallel port, desk unit, business and general use. Equinox, 16 Anning Street, New Inn Yard, London EC2A 3HB. (01) 739 2387/(01) 729 4460. — *From £2,500*

INSTAR

Omega: 16-bit, 48-256K RAM, dual floppies, hard discs, up to 12 simultaneous users, business use. — *From £7,500*

Asatayd: Z-80, 16-56K RAM, dual floppies, CP/M, S-100 bus, business use, Instar, 61 High Street, Croydon, Surrey CR0 1QD. (01) 680 5330. — *From £4,950*

INTERTEC

Superbrain: Z-80, 64K RAM, 256 static RAM, dual Shugart, optional hard disc, CP/M, S-100 bus, business and general use. Encotel, Succombs Hill, Upper Warlingham, Surrey. (820) 5701. Sun,138 Chalmers Way, North Feltham Trading Estate, North Feltham, Middlesex. (01) 751 6695. KGB, 88 High Street, Slough, Berkshire. (75) 38581. Reviewed April 1980. — *From £1,495*

ITHACA INTERSYSTEMS

Pascal Micro DPS1: Z-80, 64K-1MB RAM, full IEEE S-100 bus, CP/M version 2.2, graphics 8in. and hard discs, RS232, four parallel and two serial ports per S-100 board. Ithaca Intersystems, 58 Crouch Hall Road, London N8 8HG. (01) 341 2447. — *From £4,258*

ITT

2020: Built under licence from Apple, expires at end of 1980. See entry under Apple II. ITT, Star House, Mutton Lane, Potters Bar. (77) 51177. — *From £827*

KEMITRON ELECTRONICS

UDS 3000: Z-80, 1-64K RAM, Kbus, own OS, CP/M, 8in. and hard discs, ports up to 256. Kemitron Electronics, (0244) 21817. — *From £640 to £4,000*

LOGABAX

LX-500: Z-80, 32K RAM, S-100, CP/M dual 5¼in. drives, business use. LogAbax Ltd., 1-7 Wesley Avenue, London NW10. (01) 965 0061. — *From £3,000*

LSI COMPUTERS

M-One: 8080, 8-16K RAM, own OS, dual Shugart 8in. drives, two serial and one parallel port, 12in. VDU and full keyboard. Business use. — *From £5,995 with software package*

M2: 8085, 64K RAM and 4K EPROM. To be launched in December 1980. LSI Computers, Copse Road, St Johns, Woking, Surrey GU21 1SX. (04862) 23411. — *P.O.A.*

LUXOR

ABC 80: Z-80, 16-40K RAM, 12in. VDU, IEEE 488, RS232, 5¼in. drives, loudspeaker, personal and education use. CCS Microsales, 7 The Arcade, Letchworth, Hertfordshire ST6 3ET. (04626) 73301. — *From £795*

MICRO V

Microstar: 8085, 64K RAM, three RS232, serial inputs, StarDOS, twin 8in. drives, general use. Microsense, Finway Road, Hemel Hempstead, Hertfordshire HP2 7PS. (0442) 41191. — *From £4,950*

MICROMATION

Z-Plus: Z-80, 64K RAM, S-100 bus, CP/M (3), MP/M two serial and six parallel ports, business use. Rostronics, 115-117 Wandsworth High Street, London SW18 4HY. (01) 874 1171. Reviewed May 1980. — *From £3,950 to £8,550*

MICRONEX

MX-100: Z-80A, 64K RAM, S-100 bus, RS232, CP/M, Pixel graphics display system, twin 8in. drives. Micronex, Harford Square, Bristol BS18 8RA. (027) 589 3042. — *From £3,485*

MIDWEST SCIENTIFIC INSTRUMENTS

MSI 6800: 6800, 16K-56K RAM, 5¼ or 8in. or hard discs up to 10MB. Systems 1,2,7 and 10. System 7 runs Flex, MSI, DOS and SDOS, RS232. System 10 is System 7 with hard disc. Business use. — *From £1,100 to £12,000*

Strumech (SEED), Portland House, Coppice Side, Brownhills, Walsall, West Midlands. (279) 4321. Reviewed March 1980.

MODULAR BUSINESS SYSTEMS

Tutor: 8085, 32-64K RAM, Intel Multibus, CP/M, optional graphics, twin 5¼in. drives or four 8in., two RS232 serial ports. — *From £2,500*

Elite: 8085, 32-256K RAM, Intel Multibus, CP/M, 5¼in. to 24MB hard discs, RS232, 24-bit TTL programmable port. Modular Business Systems, 21 Chappel Lane, Yeadon, Leeds LS19 7NX. — *From £5,400 to £25,000*

NASCOM

Nascom 1: Z-80, 2-64K RAM, serial and up to 16 parallel ports , 8K Microsoft Basic, 1K monitor in EPROM. Personal use. Reviewed January 1979. — *From £125*

Nascom 2: Z-80, 1K RAM expandable to 256 with Nascom System 80 case. Nasbus, 8K Basic, 2K monitor and 2K character generator, low/high-resolution graphics and colour. 5¼in. single or twin floppy discs, RS232, parallel port, Kansas City cassette port. Nascom Microcomputers, 92 Broad Street, Chesham, Buckinghamshire. (04427) 74343. Reviewed April 1980. — *From £295*

NATIONAL MULTIPLEX

Pegasus: Z-80, 48K RAM, S-100 bus, 5¼in., 8in. drives, CP/M, 12in. VDU, business use. London Computer Store, 43 Grafton Way, London W1. (01) 388 5721. — *From £2,700*

NEWBURY LABORATORIES

7768: CPU board, 4K RAM, cassette and VDU interface, up to 64K RAM, kit only. — *From £45*

NewBrain: Z-80A, 2K static RAM plus 4K static or 16K dynamic, RS232 ports, 16-character, LED display, hand-held. Newbury Laboratories, King Street, Odiham, Hampshire. (025) 671 2910. — *From £155 for model without LED*

NEWTRONICS

Elf II: Single-board on 1802, 256bytes to 64K RAM, Hex keypad, RS232 I/O and VDU interface, option keyboard, machine code or Tiny Basic, educational. — *From £39 for kit*

Explorer 85: 8085, 4-64K RAM, S-100 bus, RS232, VDU interface, 8080 and Z-80 software, hobbyists and OEM use. Newtronics, 255 Archway Road, London N6. (01) 348 3325. — *From £299*

NORTH STAR

Horizon: Z-80A, 16-56K RAM, 5¼in. twin drives, S-100 bus, own OS, business, educational or scientific use. Comart, PO Box 2, St Neots, Huntingdon, Cambridgeshire PE19 4NY. (0480) 215005. Equinox, Kleeman House 16 Anning Street, New Inn Yard, London EC2A 3HB. (01) 729 4460. Reviewed April 1979. — *From £995 to £2,500*

OHIO SCIENTIFIC

Ohio Superboard and Challenger I: 6502, 8K Basic in ROM, 2K monitor, 4K RAM, full keyboard and VDU interface. Hobbyist use. Reviewed June 1979. — *From £160*

Challenger 2: 6502, 48K RAM, dual 8in. drives, serial port, low-cost business use. — *From £1,500*

SHOPWINDOW

Challenger 3: 6502, Z-80 and 6800, 48-56K RAM, OSI 48-pin bus, serial port for VDU, CP/M, expands to eight users, 10, 20 and 75MB hard disc, business use. — *From £2,300*

Challenger 4: Similar to Challenger I but 64 × 32 display, colour and sound option. U-Microcomputers, Winstanley Industrial Estate, Long Lane, Warrington, Cheshire WA2 8PR (0925) 54117/8. CTS (0706) 79332. Millbank, 98 Lower Richmond Road, London SW16. (01) 788 1083. Reviewed September 1979. Mutek, Quarry Hill, Bath, Wiltshire. (0225) 743289. — *From £450*

PANASONIC

Panasonic: 8085, 56K RAM, full keyboard, integral 24 × 80 VDU, integral twin 5¼ or 8in. floppy drives. Three RS232, business use. Panasonic Business Systems, 9 Connaught Street, London W2. (01) 261 3121. Reviewed June 1979. — *From £4,150*

PROCESSOR TECHNOLOGY

Sol: 8080, 16K RAM, S-100 bus, 5¼in. drives, VDU integral, business system. Comart, PO Box 2, St Neots, Huntingdon, Cambrideshire PE19 4NY. (0480) 215005. Reviewed July 1979. — *From £1,750*

RAIR

Black Box: 8085, 32-64K RAM, dual mini-floppy discs, eight programmable serial ports, RS232, CP/M, hard discs to 10MB, general and business use. Rair, 30-32 Neal Street, London WC2H 9PS. (01) 836 4663. Reviewed November 1979 and August 1980. — *From £2,300*

RCA

Cosmac: 1802 micro with Hex pad and TV interface. Machine-code programming with Tiny Basic option. HL Audio, 255 Archway Road, London N6 5BS. (01) 348 3325. — *From £79 for kit*

RESEARCH MACHINES

380-Z: Z-80, 4-56K RAM, RS232, CP/M, twin 5¼ or 8in. discs, high-resolution graphics. Sold princpally to higher and secondary education. — *From £830 to £3,500*

280-Z: Board version of 380-Z. Research Machines, PO Box 75, Mill Street, Oxford. (0865) 49791. — *From £722 for 4K version*

ROCKWELL

Aim-65: 6502, 1-4K RAM, full keyboard, RS232, discs, hobby use, Portable Microsystems, Forby House, 18 Market Place, Brackley, Northamptonshire NN13 5SF. (0280) 702017. Reviewed July 1979. — *From £250*

SATTCO AB

Databoard 4680: Z-80, 16-64K RAM, own bus, full-colour graphics, 5¼in., 8in. and hard discs up to 10MB, 64 interface units. General use. Microsystems Technology, PO Box 5, Knutsford, Cheshire, WA16 9DU. (0565) 52911. — *P.O.A.*

SCIENCE OF CAMBRIDGE

MK-14: 8060, 256bytes user memory to which ¼K RAM can be added, Hex pad, cassette interface, seven-digit LED, single-board. — *From £39*

Reviewed May 1979.

ZX-80: Z-80A, 1-16K RAM, 4K Basic in ROM, cassette and TV interface, touch-sensitive keyboard, educational use. 22 graphics. Science of Cambridge, 6 Kings Parade, Cambridge CB2 1SN. (0223) 311488/312919. Reviewed July 1980. — *From £79 for kit*

SD SYSTEMS INC

SBC-100: Z-80, 1-48K, S-100 bus, Basic in 8K ROM, four ROM sockets, optional 5¼in. drives, RS232 serial and parallel, single-board. — *From £155*

SD-100/200: Z-80, 64-256K RAM, 8K PROM, S-100 bus, RS232, CP/M, 12in. VDU, twin 8in. drives, business, industrial and general use. Airamco, Unit A2, 9 Longford Avenue, Kilwinning Industrial Estate, Kilwinning, Ayrshire KA13 6EX. (0294) 65533. Barcellos, Kimberley House, Vaughan Way, Leicester. (0533) 26584. — *From £3,750*

SEN ELECTRONICS

Organiser: Intel 8085, 64K RAM, multi-user Basic, 8in. drives or 20MB hard discs, three RS232, business use. SEN, 5 London Street, Chertsey, Surrey KT16 8AP. (09328) 66744. — *From £7,500*

SGS-ATES

Nanocomputer: Z-80, 6-64K RAM, Gamma bus, 2K NC-2 monitor in ROM, Basic as option, RS232, cassette interface, Hex keypad. Midwich, 9 Churchgate Street, Old Harlow, Essex. (0279) 411226. Reviewed October 1979. — *From £420*

SHARP ELECTRONICS

MZ-80K: Z-80, 16-48K RAM, 10in. integral VDU, integral cassette, loudspeaker, 5¼in. disc optional, general use. — *From £480*

PC-1211: Pocket computer. Programmable in Basic with cassette interface. Sharp Electronics, Sharp House, Thorp Road, Newton Heath, Manchester M10 9BE. (061) 205 2333. Reviewed July 1980. — *From £85*

SINTROM ELECTRONICS

Periflex 630/48: Z-80A, 32-48K RAM, S-100, CP/M, twin Micropolis 5¼in. discs, two serial and three parallel ports. — *From £2,080 to £2,500*

Periflex 1024/64: Z-80, 64K, S-100, CP/M, dual 8in. discs, two serial and three parallel. Sintrom Electronics, Arkwright Road, Reading, Berkshire RG2 0LS (0734) 85464. — *From £3,100*

SMOKE SIGNAL

Chieftain 511-821: 6800/6809, 32-64K RAM, S-50 bus, Flex DOS68/68d/69 dual 5¼in., 8in., dual RS232, video board, wide range of options, general use. Windrush Micro Designs, Gaymers Way, North Walsham, Norfolk. (069) 245189. — *From £1,807*

SOLID STATE TECHNOLOGY

Athena: 8085, integral dual mini-floppies and mini-cassette, and matrix printer, can be expanded with 10 micros beyond CPU. Memory to 1.2GB. Claims performance similar to DEC PDP-11/34. Butel-Comco, 50 Oxford Street, Southampton, Hampshire SO1 1DL. (0703) 39890. — *From £3,000*

SHOPWINDOW

MICRO ADS

are accepted from private readers only, pre-paid and in writing, 20p per word, minimum charge £2.

TI-59, Excellent Condition £100. Also HP-55 £50. Phone Leeds 507675.

UK101 Computer, fully assembled and tested, in case with 11K ROM and a full 8K RAM. £275 o.n.o. Tel: Bristol (0272) 694713.

MONROE 1810 Programmable Calculator — Cost £2750 2 yrs ago. — accept £250 o.n.o. Friden Flexowriter with ASKII punch & read £125 o.n.o. 2 Olivetti Audit 413's £250 for pair. Meopham (0474) 812691.

INTEL SBC80/05 Single board computer. New and unused with manual £150. Phone 0254 21455 Evenings.

COMPUTER FREAKS SPRING CLEAN: Pet disc drives £625. Exidy Sorcerer 32k £665. Apple Hi-Res light pen £140. Apple Lo-Res light pen £45. Texas TI59 with Master Stat library £145. S-100 CPU board £95. S-100 assembled 16k dynamic RAM board £145. Cheaply expanded to 64k for an extra £90. Versafloppy disc controller (assembled) £115. Shugart SA400 disc drive £175. IBM Selectric with Aculab interface £535. Telequipment S54A scope £125. Ring Evesham (0386) 870841 for more details.

NASCOM ROM BASIC graphics programs run faster with VORTEX machine-code utilities. Send £10, stating memory size, or sae for further information, to Chris Blackmore 31 Herne Rise, Ilminster, Somerset TA19 0HH.

EPROMS 2708 £5.40p. 2716 £21.60p postage/packing 25p. Software for most micros. Large S.A.E. for lists. Zero One Electronics, 36 Oaklands Avenue, Thornton Heath, Surrey.

AIM-65 with power supply, 3K RAM EDGE CON— nectors, Software including pilot, chess and utilities. £220 ono. Chelmsford 351704.

PET BARGAIN. 32K Business Pet + 2040 dual floppy disc. 8 months old. Little used. £1,200 o.n.o. Phone Gerrards Cross (02813) 83095.

PET 2001-8 — fitted upgrade Rom, hobby use only. With manuals and many programs (Tutorials, Utilities and Games) £425. Phone Blackpool (0253) 869108 Evenings/Weekends.

UK 101 Based Microcomputer built into Video Terminal 11K user RAM. Several games, programmes included. Ring 668 8658 £350.

WANTED S100 Z80 micro, Ram, etc cards and VDU. For Sale NASCOM minimal system with PS. £150 and Professional B/W video monitor £100. Phone 0533-62682 Evenings.

Motorola 6800 D2 assembled & tested + extra RAM. £100 ono. 02813 83095.

32K Pet new type keyboard, cassette dust cover, hardly used. £600. Evenings Stockbridge 832. Working hours Stockbridge 766.

FOR SALE: Teletype Corp ASR33 Eight Level 110 baud, good condition — 0493 70437 after 6pm.

COMPUKIT software: startrek, life, zombie, number mastermind, random number contest (you versus UK101), torpedo-boat, anti-aircraft, digital clock (H-M-S). Most require 5k, all recorded both sides C10, £2.50 each. K A Spencer, 33 Alpine Gardens, BATH.

TMS2708 EPROMS £4 each, no VAT, no postage. J. Hawthorne, 23 Iver Lane, Cowley, Middx. Phone: UXBRIDGE 36428.

FOR SALE: One PR40 Parallel Printer with Pet connections £200 ono. Tel: 01-286 8124, Evenings. Ask for Eden.

PET 2001 32K, Cassette deck and cover bought June '79, little used £625.00. Phone Stockbridge (Hants) 832. — home. Office 766/824.

Acorn Computer, excellent introduction Micro, assembled in case, £55. 01-397 6792.

TRS-80 Level 1 16K CPU, CTR80 cassette player; technical and user's manuals; many games on cassette, plugs into your own TV. Mint, only weeks old. £430 o.n.o. 01-668 6450 Evenings.

TRS-80 16K Level 2 Complete, with Library 100 and Chess Programs — £500 o.n.o. — Lincoln 53254 after 6 p.m.

Novel program and games cassettes for Pet. Dragon's Maze, Video Football, Demolition, Chemical Analysis, Mark Book Aid and many others. Prices from £2.25 inclusive. SAE for details. P.C. Abraham, 33 Bridge Green, Prestbury, Cheshire.

Personal Computer-Share. Economic rates. 16k Level II Basic microcomputer. Phone Walton on Thames 20642 Tuesdays and Thursdays 5-6 p.m.

Eprom Eraser Ultraviolet Erasing Unit in 400 × 320 × 90mm. Cabinet. Suitable for up to 12 Eproms: £35 + £2 p/p & insurance. Spare U.V. tube with instructions £11.50 + £1 p/p. J.A. Harris, 17 Cottesmore Close, West Bromwich, West Midlands.

Sorcerer 32K 240V 50Hz with technical manual + RS 232 + Software. £690. 01-390 4568.

PROGRAMMING PROBLEMS? Experienced micro-computer programmer seeks all types of programming work. Ring and discuss your requirements. Chris — 01-668 5093.

Commodore Pet 8K £325.00. Tel: 01-953 6921. Expander Pet converts 8K Pet to 32K Pet Computer £225.00. Tel: 01-953 6921.

Computhink 800K Disc for sale. With easily fitted DOS Board for 32K New Rom Pet. Still under warranty. Assistance given with installation. £750.00 o.n.o. Also ADA 1200, RS232/IEEE Interface £50.00. Phone Flitwick 2221.

For Sale TRS-80 Level II 16K plus Numeric Keypad. Keyboard fully debounced. Many extras. Ring Cradley Heath (8) 634798 after 6 p.m.

DO YOU WANT HARD COPY. Printout Service from programs or data SAVEd on tape. SAE please for details. P.D. Hingley, 28 Oakley Road, Caversham, Reading, Berks. RG4 7RL.

NORTH STAR Horizon Z-80 Computer ??????? (used) Phone 024-06-2491.

Teletype ASR33, RS232 interface. Excellent condition. £290 o.n.o. Stevenage 60397 evenings.

PET 2001-8K manuals microchess games. Private use virtually new. £420 o.n.o. Wentworth 2503.

TANDY TRS-80 radio shack level 2 — 16K as new. Comprises VDU PSU cassette recorder all manuals many basic books and working tapes. For sale at £450 o.n.o. Tel 0272-826753 (evenings).

TRS-80 Level II, 16K, VDU, Cassette Recorder manuals and some software £400. Also 32K expansion interface, Teac 40 track dual disks, manuals and some software £700. Both for £1050. Telephone Tonbridge (0732) 356728 (evenings/weekends).

TELEPRINTER 28RO with factory handbooks, 110W. Excellent condition £50. 01-599 0197.

PET 8K — 2001 Series, some tapes and manual £475. Cash only. Tel. Glenn Oxford 880663.

SHARP PC1211 Pocket Computer with CE121 cassette interface and manuals. Duplicate present used once. £95. J.M. Spillett, Bay Tree Cottage, Crabbswood Lane, Sway, Lymington, Hants SO4 0EQ.

SPACE Invaders for 4k Superboard. Partly machine code. Mystery Invaders, Splitting etc. £3 from David, 30 Vernon Road, Bury BL8 4DD.

IBM 2740 Golfball Printer/Terminal console. Serial V24 with manuals. 80 column pin feed £550. Tel. Chelmsford (0245) 62668 evenings.

TEXAS TI-59 programmable calculator, PC-100B printer plus structural engineering and maths/utility software modules. £230 (Putney) 01-870 6017 (evenings).

APPLE II Plus 32k with £150.00 worth software. £720.00. 9 inch monitor available £100.00. Aylesbury 631200.

PET Salvage kit adds four commands to Basic, only £2 on cassette. Quote model when ordering from Jones, 24 Clifton Drive, Lytham, Lancs.

NASCOM USERS — BASIC assist. Line renumber, find/change strings, list, list variables used, etc. Fully relocatable, full instructions, £6.50. Also GOMOKU, 3K object code, 3 skill levels, £3.60. Cassette, NASSYS only. Johnson, 14 Shelley Close, Winchester.

OSI, C24P, 8K user RAM + 8K Basic + Dia. convertor + Tone Generator + Case + PSU + Assembler + Manuals. £3.20 o.n.o. (021) 426 3015.

INTEL 8080 based micro, 24K Ram, dual 5¼" mini-floppy drive, 24 × 80 VDU, serviced and checked by manufacturer, £1500 o.n.o. Tel. 01-883 6585 mornings or 01-580 6361 afternoons.

SORD COMPUTER SYSTEMS INC

M200 Range: Z-80A, 64K RAM, S-100 bus, Sord OS, graphics, 5¼ 8in. or hard discs, two RS232, integral 80 × 24 VDU. Business use. Midas Computer Services Ltd, 2 High Street, Steyning, Sussex (0903) 814523. — *From £1,850 to £6,950*

SOUTHWEST TECHNICAL PRODUCTS

C/09: 6800, 56K RAM, Flex OS, 5¼in, 8in. or 15MB hard discs, business, educational and scientific packages.

S/09: 6800, 128K RAM-380K RAM,. Uniflex OS, support up to 16 users in foreground and background mode. Southwest Technical Products, 38 Dover Street, London W1X 3RB. (01) 491 7507. — *From £3,000 to £10,000*

SPENCER JOHNSTON LTD

SJL 8000: Z-80A, 64-208K RAM, integrated database system to user specifications, 8in. discs to 4MB Winchester to 80MB. Sun Computer Services, 60 Broad Lane, Hampton, Middlesex. (01) 979 9824. — *From £8,000*

SYNERTEC

Sym-1: 6502, 4K-64K RAM, port-expansion kit, TV interface, Kim software, hobbyist use. Newbear, 40 Bartholomew Street, Newbury, Buckinghamshire. (0635) 30505. — *From £160*

TANDBERG DATA

TDV Series: 8080A, 32-64K RAM, Intel bus, 4K Basic discs system in ROM, one plus three 8in. discs, or 2.5MB disc cartridge, eight ports, semi-graphics, CP/M version available, educational use. Tandberg Data, 81 Kirkstall Road, Leeds, LS3 1HR. (0532) 35111. — *From £4,000*

TANDY CORPORATION

Model 1: Z-80, 4-48K RAM, RS232, Level I and Level II Basic in ROM, separate keyboard and 12in. VDU, small business and personal use. Reviewed November 1978. — *From £349*

Model 2: Z-80, 64K RAM, integral 8in. disc, integral 12in. VDU, detachable keyboard, CP/M serial and parallel ports, Level III Basic, business use. Tandy, TRS-80 Division, Bilston Road, Wednesbury, West Midlands, WS10 7JN. (021) 556 6101. Reviewed March 1980. — *From £1,995*

TANGERINE COMPUTER SYSTEMS

Microtan 65: 6502, 1-48K RAM, Tanbus, IEEE 488, Tanbug in ROM (1K), Pixel graphics, 5¼in. discs, 32 I/O lines and three serial ports, from single-board upwards. Tangerine Computer Systems, Forehill, Ely, Cambridgeshire. (0353) 3633. — *From £69*

TECHNALOGICS

TECS: 6800, 56K RAM, Basic and Prestel terminal software, RS232, two cassette ports, two parallel ports, 5¼in. discs. Technalogics, Windmill Works, Station Road, Swinton, Manchester M27 2BU. (061) 793 6323. Reviewed November 1979. — *From £895 for kit*

TERODEC MICROCOMPUTER SYSTEMS

TMZ-80: Z-80, 64K RAM, CP/M, MP/M, CPNet, twin 8in., up to — *From £3,000*

32MB hard discs, multi-user business use. Terodec, 17 The Gallop, Yately, Camberley, Surrey. (0252) 874790.

TEXAS ELECTRONIC INSTRUMENTS (TEI)

PT-208/PT-212: 8080, Z-80, 8085, 32-60K RAM, S-100, CP/M, 5¼in., 8in. and hard discs, three RS232 and three 8-bit ports, integral VDU, business use. Abacus Data-type, 62 New Cavendish Street, London W1. (01) 580 8841. Reviewed January 1980. *From £3,500*

TEXAS INSTRUMENTS

TI-99/4: 990 16-bit, 16K RAM, Basic in 26K ROM, high-resolution, colour graphics, up to three 5¼in. discs, joystick, cassette and other ports, RS232, personal use. Texas Instruments Ltd., Manton Lane, Bedford, MK41 7PU. (0234) 67466. Reviewed August 1980. *From £950*

TRANSAM COMPONENTS

Triton: 8080, 32K RAM, CP/M, 1K TB10S in ROM, up to three 5¼in. discs, or four 8in., serial and parallel ports. Reviewed December 1979. *From £296*

Tuscan: Z-80, 8-64K RAM, S-100 bus, CP/M, RS232, TV and cassette interface, from single-board, personal use to full business system. Transam, 59 Theobalds Road, London WC1. (01) 405 5240. *From £150*

ULBRICH AUTOMATION

Powerhouse II: Z-80, 16-32K RAM, RS232, 5in. internal VDU, integral mini-cassette, 2K monitor, IEEE, 14K Basic DOS, OEM users. Powerhouse Microprocessors, 5 Alexander Road, Hemel Hempstead, Hertfordshire HP2 5BS. (0442) 42002. *From £1,200*

VECTOR GRAPHIC

MZ: Z-80, 48K-64K RAM, CP/M, 5¼in. discs, optional graphics, serial and parallel ports. Business and general use. Almarc Data Systems, 906 Woodborough Road, Nottingham (0602) 625035. Reviewed October 1980. *From £2,300*

WESTERN DIGITAL

Pascal Microengine: MCP1600, executes P-code directly, 64K RAM, own bus, 5¼in., 8in. or hard discs up to 18MB, two RS232, two parallel ports. Pronto Electronics Systems, 466-478 Cranbrook Road, Gants Hill, Ilford, Essex IG2 6LE. (01) 554 6222. *From £2,295*

ZENTEC

ZMS-70: 8080A-1, 32/64K RAM, up to 12K ROM, dual integral 5¼in. discs, 600MB, RS232, integral 15in. VDU, 16 function keys. Zigal Dynamics Ltd., Bank Chambers, 13 High Street, Chesham, Buckinghamshire. (02405) 75681. *From £4,000*

ZILOG

MCZ Series: Z-80, 64K RAM, RIO-OS, Zilog bus, optional graphics, 8in. discs, and hard discs, four RS232, one parallel, stand-alone or networking. Zilog (U.K.) Ltd, Babbage House, King Street, Maidenhead, Berkshire. (0628) 36131. *From £3,000*

SHOPWINDOW

Son of Hexadecimal Kid

A parable in eight virtual pages by Richard Forsyth
Page 1 — front page news

When the System died, all the computers and robots which constituted its active elements ceased to function. A very few androids — computerised humans, like Hex — who had, for some reason, been cut off from data communication during the critical period, survived. They soon found that the electrodes implanted inside their skulls, the communications equipment, the auxiliary memories, the on-board brain accelerators and all the paraphernalia of the cybernated man were no longer a boon but a crippling handicap. Nevertheless, some of them kept up the struggle for existence, especially the more unsystematic ones — as Cleo and her friends are about to discover.

The first tinges of dawn had begun to lighten the sky, and they were able to see the strange figure quite plainly. They gazed fascinated as he staggered uphill towards them. He was wearing a trapper's leather jacket which looked as though he had just rolled through two briar bushes. Every so often, he paused and put his hands to his head; it seemed as if he were trying to wrench it from his shoulders.

None of them moved. The stranger was obviously unaware of their presence. He drew closer and closer until, when he was less than three metres away, Piltdown 2 took a pace forward into his path and held up a hand.

The stranger lifted his eyes. Seeing the apeman's shaggy bulk, he fell to his knees.

"Help me", he implored. "Data, please — input —".

In a flash, Cleo recognised not only the symptoms, but who he was. It was wild Bill Bootstrap, clearly far into the delerium induced by advanced data deprivation.

"My head hurts", wailed the android. "Please, here — just a byte". He pointed feebly to the parallel I/O port fitted just behind his left ear; then, as if the effort was all he could muster, keeled over and lay still.

Quick and businesslike, Cleo knelt over his fallen body and rolled him on to his back, propping up his head against a boulder. Though she had no reason to be grateful to Bootstrap, her former jailer, his suffering touched her.

It was clear that, by some minor miracle, he had avoided gigosis but was now experiencing withdrawal symptoms of the severest kind in the absence of the all-embracing Network.

She beckoned to McNull.

"Now the error of his ways is revealed unto him and he sees the evil thereof. So be it", pronounced McNull without sympathy.

Cleo ignored his remark. She knew that McNull had applied for cybernation of his own accord as a young man but had failed the aptitude test. Since then he had nurtured a bitter resentment for all things cybernetic; but, more useful in the present context, his envy had led to a morbid fascination with electronic gadgetry.

Even now, just after escaping by a hair's breadth from the collapsing cavern, his pockets were bulging with LED displays, assorted chips and fragments of discarded circuit board, while the return key from a VDU keyboard he had found somewhere on his travels hung round his neck on string like a lucky charm. These baubles he collected totally haphazardly — without regard to their function or value.

"Hand me that", she said, pointing to a video games paddle that was protruding from his vest pocket.

Reluctantly, McNull obeyed. She took it and pressed it into Bootstrap's hand. His fingers closed about it. It had a warm amber handle and it seemed to comfort the android. At any rate his breathing steadied and he fell into a deep sleep.

She stood up. She knew that Mike Rose had commanded Piltdown 2 to obey her orders with his dying breath, and she wanted him to carry Bootstrap. Unfortunately, she could not speak predicate calculus, nor even Esperanto which was the least logical language the Sasquatch could understand. Eventually, by mime, she conveyed her intentions to him, and he humped the motionless body over his broad back.

"Salvation should be denied those that merit it or not", muttered McNull grumpily as they set off. To tell the truth he was very attached to his electronic trinkets and was far from pleased to have one requesitioned to relieve an android who, in his opinion, richly deserved his fate.

As they walked on, he furtively removed his prize possession, a flat-screen micro-television, from an outer pocket and secreted it about his person. That, for sure, was not going to be taken from him — it didn't work, of course, but it shone beautifully in the morning sunshine.

Cleo thus emerged as the natural leader. Although still 16, and a female to boot, she was the only one who could make decisions on the spot and the only one with an idea of where to go. Piltdown 2 was bred for service and so shambled along happily behind her. McNull, when he was not lost in a transcendental reverie, was putty in her hands.

He had inadvertently burnt out that part of his brain which dealt with forward planning in a misguided attempt to fill his head with hobbyist computer kit after the cybernation college turned him down.

Cleo's purpose, which the other two fell in with by default, was to return to Sprocket's Hole as soon as possible. That was where she had last seen her elder sister Lambda, and that was almost certainly where Bootstrap was from. If he could survive the plague of gigosis then perhaps Lambda too — who, unlike Cleo, had been cybernated — was still alive.

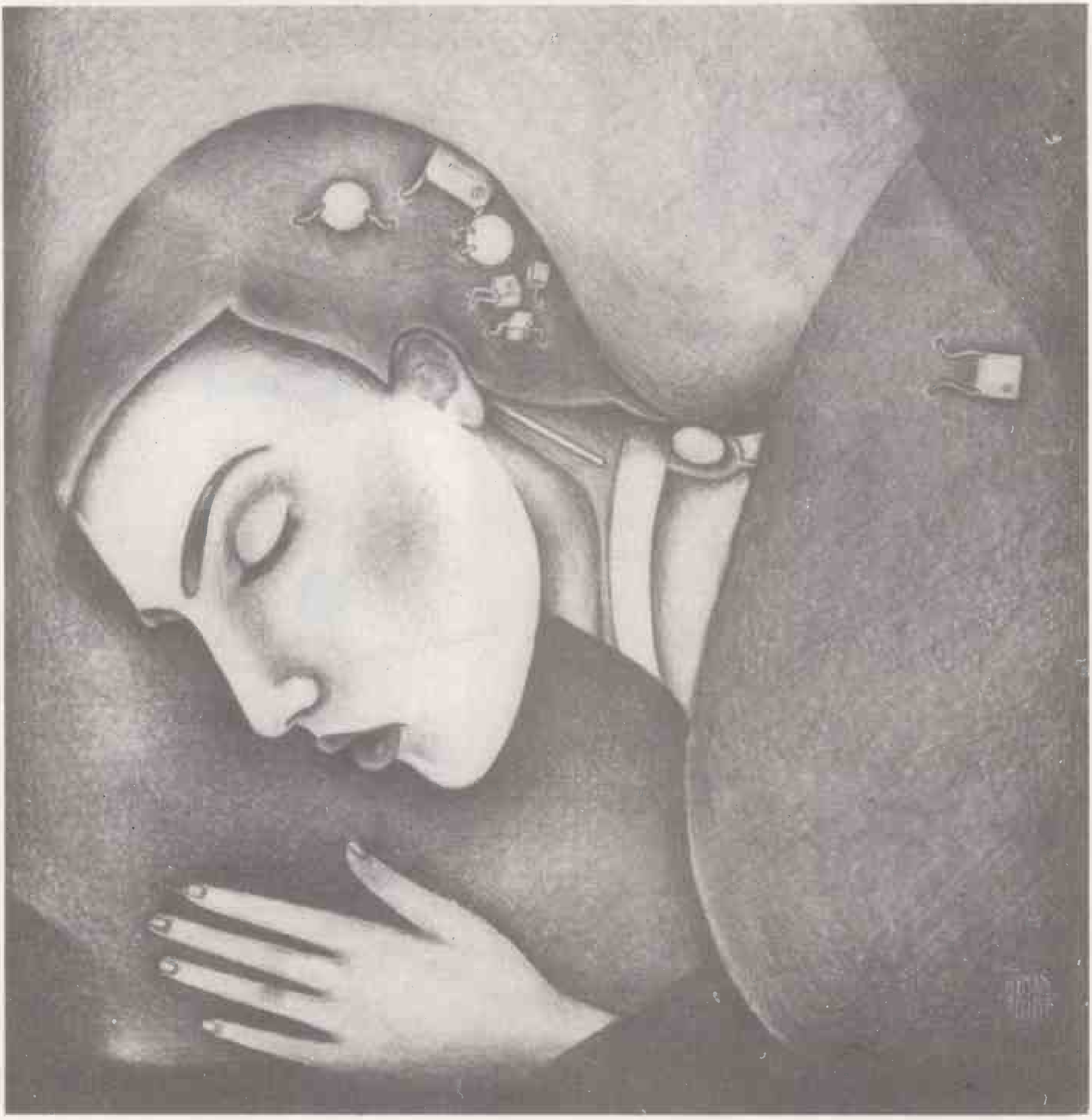
The sun hoisted itself above the horizon and suddenly it was a bright desert morning. They trudged on as the day grew hotter, Piltdown 2 apparently untroubled by his load, McNull perspiring but uncomplaining, stopping occasionally to shake the sand from their shoes.

Soon after midday, they crested a ridge from which they could look down into Sprocket's Hole. There in the haze lay the two log cabins. Nothing stirred. Cleo galloped down the slope, sliding and slithering on the loose stones, while McNull and the apeman followed at a more sedate pace. As soon as she reached the door of the larger hut, she flung it open.

Lambda she saw almost at once, splayed out half across a bench and half on the floor. Panting, she dragged her into the open air.

"Lambda, Lambda", she called, shaking her sister bodily. "What happened"?

Lambda's eyes did not open but Cleo could hear the whir of her disc drive motors as the



read/write head searched fruitlessly for track zero. Clearly, she had received a massive unregulated surge of power which had wiped clean her PROM loader and possibly corruped her system diskette.

Cleo dashed back inside to look for a ROM-pack with a fresh copy of the brain-bug loader on it. After a few moments scrabbling around, she found one and emerged just in time to see McNull peering down over her sister.

McNull's well-meaning but electronically incompetent hand strayed towards the re-start button at the back of her neck.

"No", shouted Cleo — but it was too late.

Lambda sat up, opened her eyes and started to sing Land of Hope and Glory.

"Fool", Cleo snarled at McNull. "Don't you realise how dangerous it is to try a warm-start on an android who hasn't been powered down properly"?

McNull looked crestfallen. He had only been trying to help.

She switched off Lambda, inserted the new ROM-pack and initiated the cold-start procedure.

"This had better work, for your sake", she said, glaring at McNull.

She began counting under her breath. She knew the start-up routine by heart. First there was the memory diagnostic — that took about 10 seconds. Then, the processor would exercise every opcode in combination with every possible operand which took another 30 seconds.

Finally, there was the disc-verification test which wrote, and read-back, every track on both discs twice — first filling it with zeros, then ones. That took slightly over a minute. If that failed, Lambda's brain, which was alive but which could not communicate with the outside world through the apparatus that encased it, would be trapped for ever inside a coffin of defunct electronic accessories.

After 10 seconds, then 40, still nothing had gone gone wrong. Cleo's heart pounded, making regular counting difficult — 99, 100, 101 — Surely it was time for Lambda to wake up. Next month; a rude awakening.

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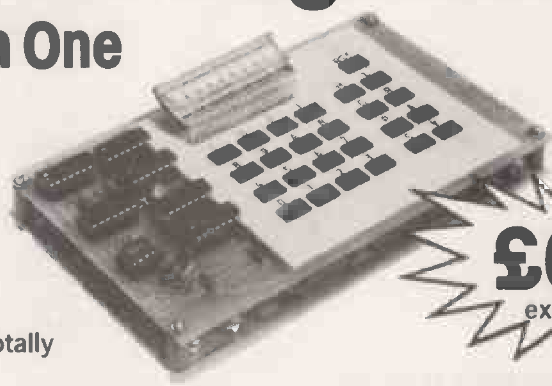

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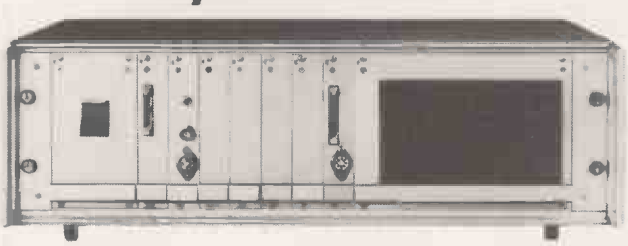

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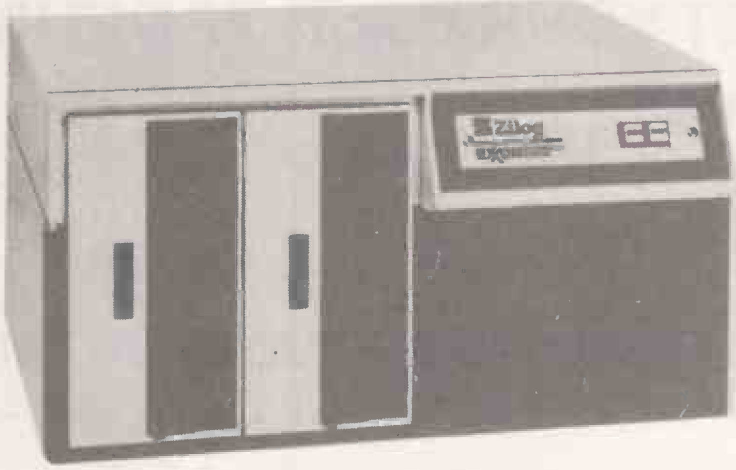

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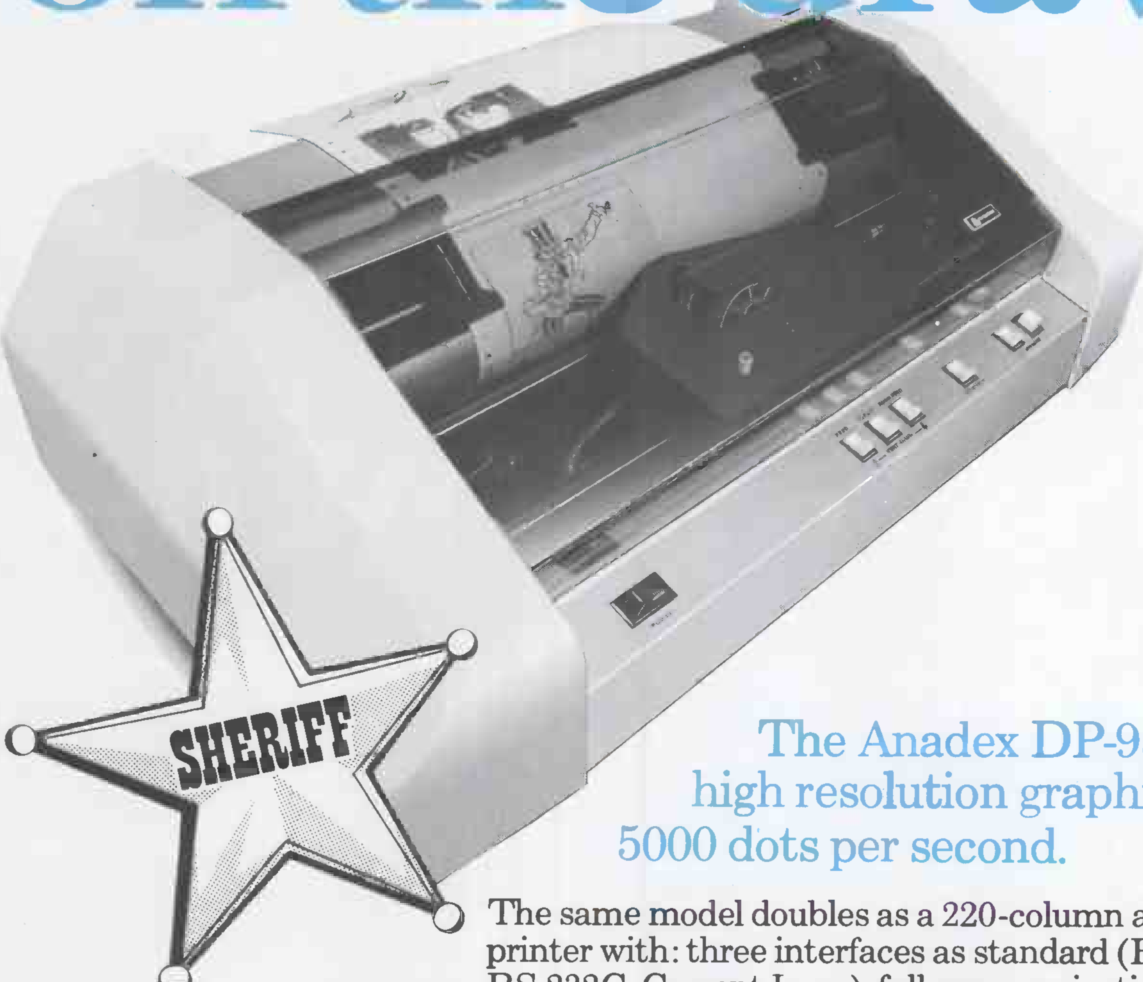

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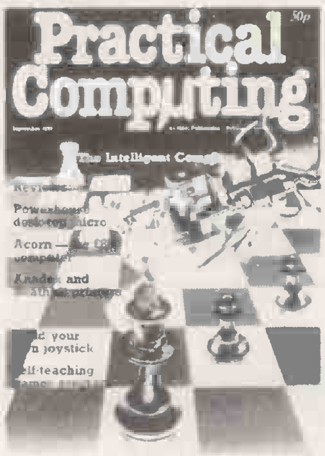

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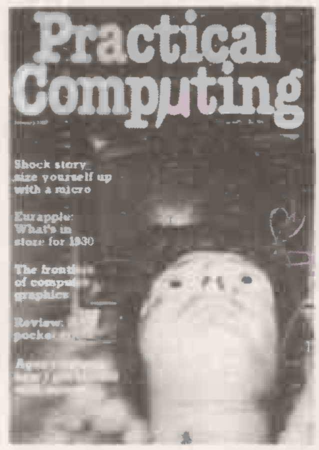

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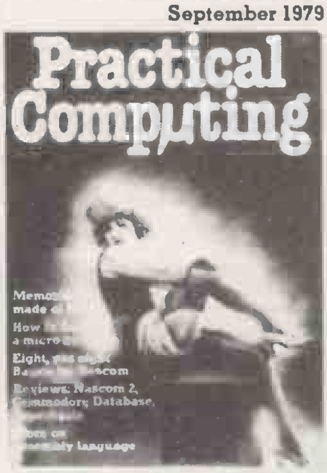

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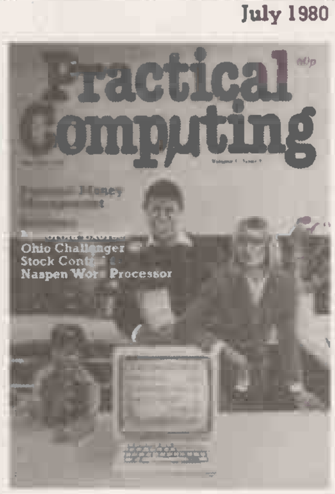

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Reviews: Panasonic JD-700U. VisiCalc. The electronic newsagent, newstrade applications; Latest developments in viewdata systems; Social services and micro applications; Electric motors as computer-controlled servo mechanisms; New monthly column — Sorcerer's Apprentice; COS for Apple II part 2. Software Buyers' Guide.

July 1980
Reviews: Sharp PC-1211; Sinclair ZX-80; Payroll-200; Tuscan designer's story — Birth of a system, Part 1; Applications in medicine; The story of a modern agent and his back room computer; Sub-Attack, a war game; CP/M explained; Cheap hard copy for Nascom 1; Hardware Buyers' Guide.
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August 1980
Reviews: Texas Instruments TI99/4; Rair, hard-disc system; Computech sales ledger; Tuscan designer's story part two. Games; Adventure II and Supertank part two; a listing of user groups; MUSE software standards. This and much more including the Software Buyers' Guide.

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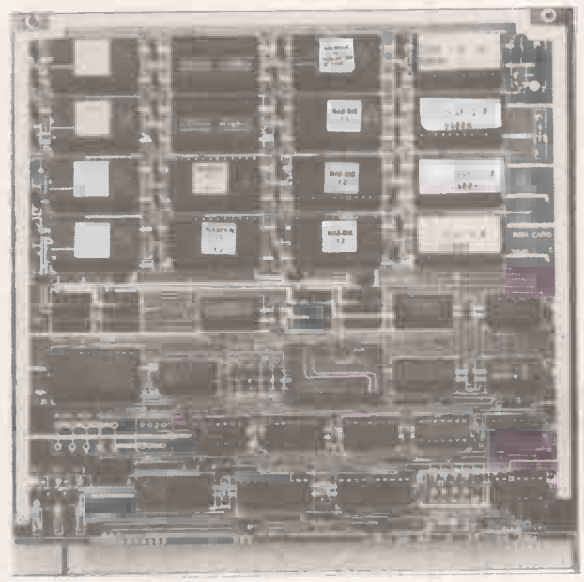

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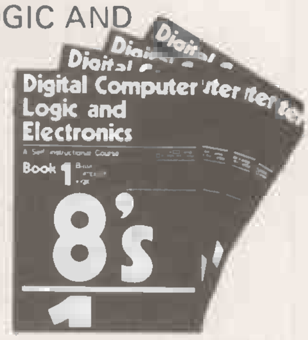

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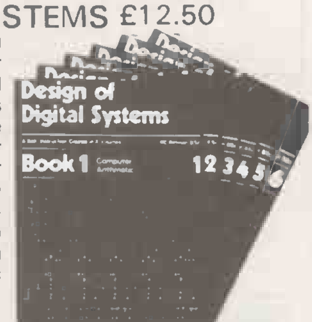

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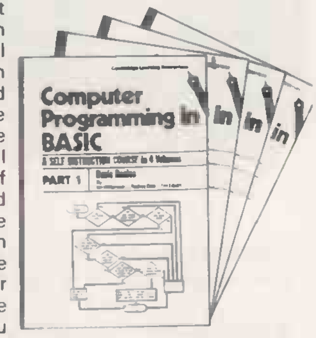

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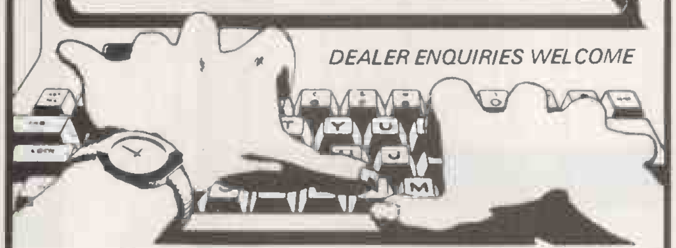

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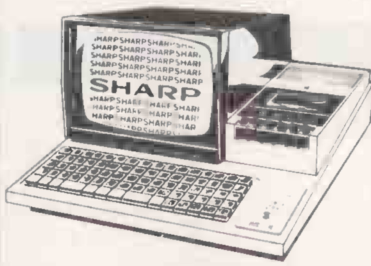

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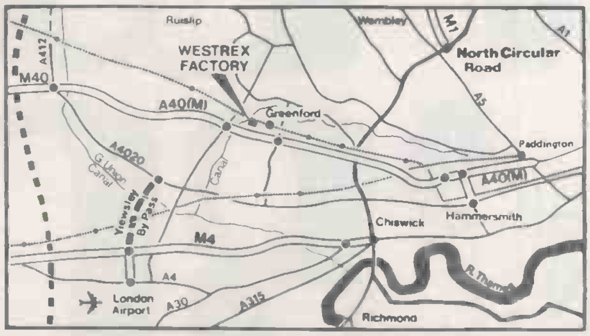

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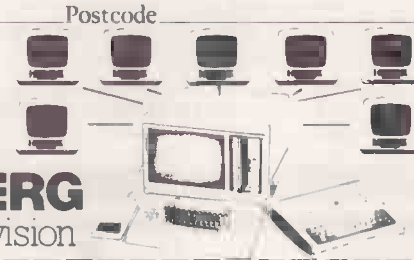

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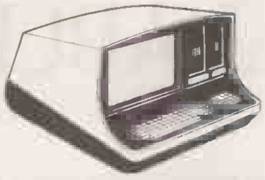

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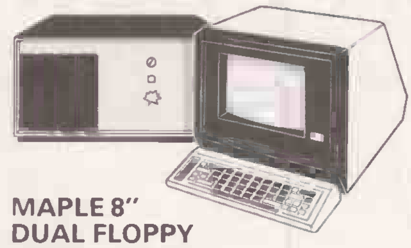

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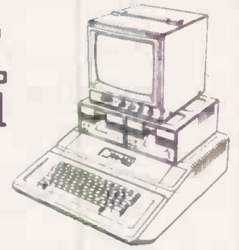

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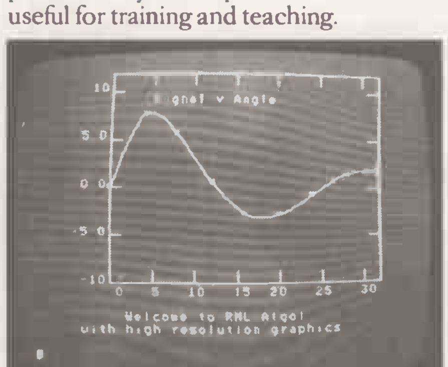

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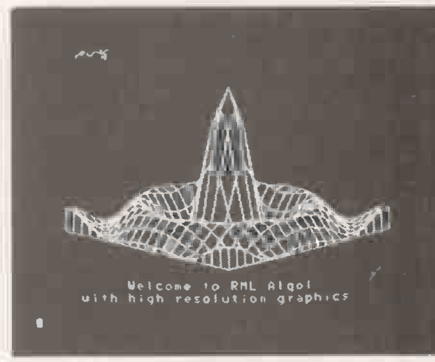

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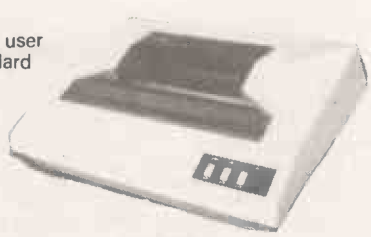

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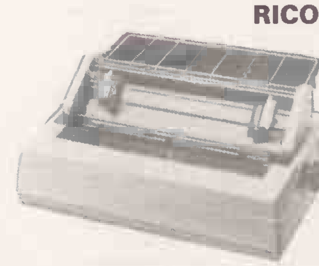

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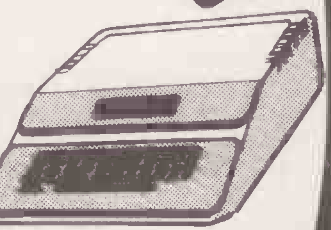

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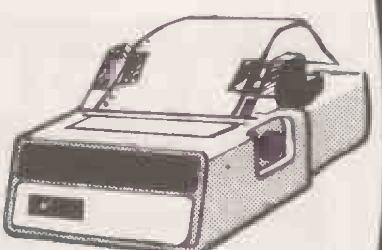

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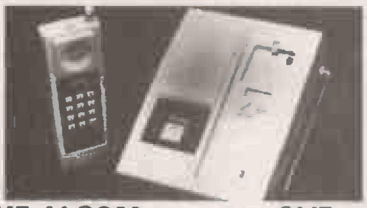

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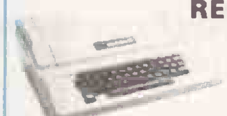

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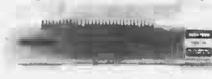

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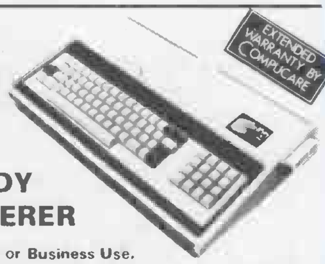

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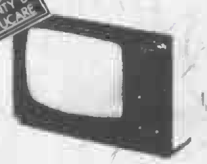

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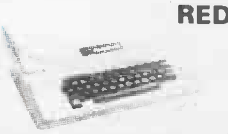

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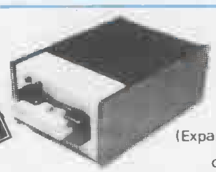

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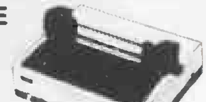

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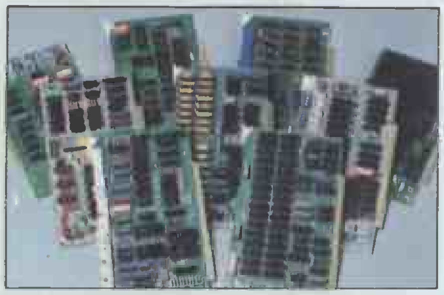

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