Europe's first magazine for personal computers for home and business use

EXHIBITIONISM - SMALL COMPUTERS FOR SMALL ORGANISATIONS

Applevision
The Multilingual Machine
Assembly Point

PCW Review: The MSI 6800
If you buy the wrong personal computer, you can't re-program your bank account!

Buying a personal computer is not an easy task. So many people selling them neglect the little things that enable you to get the most from your computer, such as documentation, spares, add-ons and maintenance. We believe that these 'details' are essential. We are the only British company to put all our time and energy into the personal computer market and are in the best position to advise you on your initial purchase and keep you fully informed about all the new developments relevant to your computer.

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There’s never been an event like this before.

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PCW REVIEW Stuart Danton
The Midwest Scientific Instruments (MSI) 6800 35

SMALL COMPUTERS FOR SMALL ORGANISATIONS
Mervyn J. Axson
Part Two of an article useful for anybody with a small computer 43

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We welcome interesting articles written simply and clearly. You need not be a specialist to write for us. MS should not be more than 3000 words long, lines double spaced, with wide margins. Line drawings and photographs wherever possible. Enclose a stamped self-addressed envelope if you would like your article returned.

Manufacturers, suppliers and dealers are welcome to contribute technical articles, and send product information, but we are pledged to an independent viewpoint and will publish evaluations and reasoned criticism or praise, space permitting. Naturally there will be right of reply. Views expressed in articles are not necessarily those of Personal Computer World.

We may make arrangements to offer our readers products at special prices, for a limited period, in line with the policy outlined above.

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Editorial

This really should be headed "appeal". I am receiving a flood of articles, a lot of them publishable, but many handwritten. It goes against the grain to reject an article because it is not neatly typewritten or does not have a printed listing; but, really, some submissions are a typesetter's nightmare. If you do have to write, please use block letters. Don't let what I've just said discourage you from submitting articles. Only, remember the poor typesetter at our end.

SUBSCRIPTIONS

When PCW started publication, we had a special six-issue offer. When these subscriptions expired, we sent out reminders. The renewal rate was 70%!

PCW reader loyalty is becoming a byword in publishing. If you're having difficulty in obtaining PCW at your newsagent, take our subscription. You can find the details at the foot of P.S.

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Publisher's Letter

Dear Reader,

I am glad to announce that Computer Trader, our new publication, has had a good reception. It deals mainly with "trade" news, of the kind found in PCW's Tidbits, and is packed with information such as the full details of the MAPCON Scheme, and a monthly updated list of exhibitions. As such, it is increasingly in demand from those who have to or want to keep tuned to the micro business. If you're interested in seeing a sample copy, simply write in and ask for one.

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Second PCW

Microprocessor

Chess Tournament

Following the success of the first PCW Chess Tournament last year, we are pleased to announce that our second tournament will take place at the PCW show in London, November 2nd - 4th 1979.

It is hoped that some financial support may be available for private entrants from outside the U.K., to defray travelling expenses, and there will be at least one cash prize. The highest placed programs will be eligible to compete in the first World Microprocessor Championships which will be held at the 1980 PCW Show.

Detailed rules and entry forms will be available in due course. Prospective entrants are requested to write to David Levy (c/o Personal Computer World, 62A, Westbourne Grove, London W2) who will be acting as commentator and tournament manager.

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Letters

Reader's ingenuity
I am writing to you in reply to your request for letters from micro-computer owners, since I own a Pet 2001-8.

I would like to offer the following information: I have not seen the previously submitted ideas. It is widely known that if you require lower case letters on the Pet, you cannot have graphics characters simultaneously. This is not strictly true since you only lose the graphics characters which are accessed by [Shift, "any letter of the alphabet"].

Characters which do not have a lower case equivalent, e.g. numbers, punctuation marks, remain shifted graphics characters. In addition, four new graphics characters can be obtained whilst in the lower-case mode. These are:

- shift colon, which gives a "tick" character i.e. shift 1, which gives a 4 x 4 check pattern
- shift ] (close bracket), which gives a diagonally striped pattern, and finally
- shift -, which gives a similar pattern sloping the other way.

I would like to compliment you on the high standards set by your magazine, which despite the recent appearance of other rival magazines, I still regard as the best.

If I could make a few suggestions for future articles, I would like to see an article on Assembly-language programming, explaining how to put together an Assembly language program. Also some articles on ideas for games, not necessarily listings of games programs, but suggestions for games, for readers to write themselves; how about reviews of more popular machines.

I am an optimist (I expect Commodore to release a printer for the Pet in my lifetime), I hope to write a Word Processor for the Pet.

Paul Hallam
Wadham College, Oxford OX1 3PN.

Basically good
Your correspondent Mr. Greg Trice (Letters, April) condemns as cretinous the widely accepted BASIC language. Whilst this was never intended to compete with more sophisticated program- ming schemes it maintains its popularity because of the ease with which it may be implemented on small and simple computer systems.

If Mr. Trice were to own a very small computer, which is what a large proportion of PCW's readers aspire to, I should be very interested to know whether he would choose to program in BASIC or machine-code.

Mark Morgan Lloyd
Lenton Hall, University Park, Nottingham NG7 2RB.

Defender of the here and now
Sometimes, I'm really annoyed by your correspondents who make such condescending remarks about the Z80; trivial programs are for the 'earliest beginner', small programs are for 'rich hunters' etc.

Mr. Randal wants some amazing system I can't afford, but isn't going to do the work; he would help, of course. Does he have a machine at all? He's not saying.

Mr. Trice doesn't approve of "frivolous" applications, such as typing alone, unless they are absolutely certain that zero will NEVER be printed, as attempts to evaluate LOG(10) should cause argument errors. To sum up, the published coding:

```
100 IF ABS(N)<THEN 130
100 PRINT TAB T-INT (LOG (ABS (N)))/LOG(10)); N
120 GO TO 140
130 PRINT TAB T; N
``` 

May I, as a newcomer to the world of computing, say how much I am enjoying this new (hobby at the moment) interest.

I look forward to each issue of your magazine, although many items are still above my head, or of no interest due to their specialization.

My main reason for writing to you is to give you an idea of some of the types of articles I, as a beginner, would like to see in your magazine. After discussions with other friends who are also new to the field, it seems that we are in general agreement about the difficulty of finding certain techniques clarified.

Whereas some beginner articles such as you publish are good, they tend to be brief and limited, very suitable for the 'earliest beginner'. Then there is a gap, with the next stage seeming to cover much more complex programs or hardware ideas.

I know that it is probably true that you can only publish what is submitted to you, but perhaps if there is evidence of what is needed, you could ask some of your 'regulars' to provide manuscripts.

To this end, perhaps you could include a 'survey' in a future issue to see how your readers divide.

To give you an idea of the sort of problems that have puzzled me (or still are), and which could be subjects for articles:

**Software**

1. A brief resume or summary of what each step is doing where this is not obvious — certainly not needed on a 100% basis — could be restricted to short programs or those for minimum (beginners) systems.

2. A series explaining how monitor software works — I have NASBUG T2 listing for my NASCOM but I cannot at present make full use of the subroutines available as I am unable to see the 'wood for the trees'.

3. I am at present trying to write simple 'Games' software for my NASCOM. I have not yet found out (probably tied up with 2, above) how to interact with a running program, in order to, shall we say, 'wipe out' targets on screen. An article or series, on methods of changing displays, programs, etc in execution, would probably be of considerable interest.

4. Where programs listings are given using routines, commands or functions that are not common, could the authors be asked, where practicable, to give alternative commands, so that the program may be 'translated' to less powerful versions of the language.

5. General articles on 'Basic' are usually rather limited in their treatment of some of the more specialised commands. It would be nice to see a series where a particular command

---

Chris Blackmore
31 Hersey Rise, Ilminster, Somerset, TA19 0HH.

PCW Intel, Zilog, Motorola and other companies deserve our thanks for being in the forefront of the microprocessor revolu- tion. And they are bringing out more advanced products PCW
A program naught can cross
In reply to the correspondence about the 3D Noughts and
Croses program published in the December '78 edition: I would
like to add my ideas for the arrays N0 and N1.

\[
\begin{array}{ccc}
N1 & \text{N0} \\
C & V & C & V \\
0 & 0 & 0 & 0 \\
1 & 1 & 2 & 3 \\
3 & 49 & 3 & 16 \\
\end{array}
\]

The original values were "aggressive" but were easily foiled. So
the new values were defensive blocking every attempt at a line
by the human, then eventually, 3 x's will be unnoticed and even
if there is another point which would block 3 rows with 3 o's
(3 x 16), it will make the move to make 4 x's. (49)

I wrote this program in machine-code for a MIKBUG com-
patible M8080 system which has only 1k of store (plus about 20
bytes remaining from the stack), luckily all the variables, con-
stants and data are always less than 255 (and integers) so 1 byte
suffices. After about 10 or 20 games I have not been able to beat
it, the best results being a draw (after about 1/2 hour).

I then altered the program so that it reversed the o's and x's
after each move and jumped over the input routine, thus the
machine took on itself! The result being a draw after 11 seconds
(this must be much faster than a similar BASIC program).

I would be glad to hear from anyone who manages to beat a
machine to the values given. If anyone is interested in having
a copy of the two programs send 50p and a SAE to my address.
B. Grainger

219 Kingsbury Road, Erdington, Birmingham, B24 8RD.

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Basic Basic (An introduction to computer programming in Basic language) J.S.Cohan £5.40 .50 pp
Practical Microcomputer Programming(6800) Weller £17.56 1.00 pp
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New Company
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Further information from:
Micro Gems,
32 Buckingham Avenue, Hucknall, Nottingham NG15 8ET.

Staggeringly Dynamic
The first 64K bytes memory card for Cromemco systems has been introduced in the UK by MicroCentre, the Edinburgh Cromemco distributor.
Priced at £1026 the new card replaces four 16K byte cards previously costing up to £450 each, a saving of £774 for 64K bytes which "represents a staggering 43 per cent price drop".
Details from:
MicroCentre,
132 St. Stephen Street, Edinburgh EH3 5AA.
Tel: 031 225 2022 Telex: 72165 Ref: W502

RAIR have added the Decwriter IV to the range of DEC terminals they supply. The Decwriter is under £900, a 300 baud desk-top terminal printing at burst speeds up to 45 cps, employing a 9 x 7 dot matrix to produce the complete 128 character ASCII set. It can be firmware configured from the keyboard or the host computer. Character width, vertical spacing, tab stops and left and right margins are all adjustable.
RAIR Ltd., is at:
30-32 Neal Street, London WC2H 9PS.
Tel: 01-836 4663

Giving Viewdata a Fillip
After four years of development, Philips Data Systems have announced a private Viewdata system designed specially for the business market. It is a new, inexpensive method of recording, storing and accessing business information, and is expected to make the benefits of electronic data handling available to everyone in user companies from boardroom to shop-floor. The system is very comprehensive and is designed for medium to large companies.
Details from:
Adrian Wheeler, 01-589 3422

The MK8.01 miniature alphanumeric keyboard from Apex Microsystems is available in chassis or stand-alone versions. Measuring 165 x 93 x 14mm, it is "particularly suited to applications where size is vital", such as portable or mobile data entry systems, or as an alternative to conventional keyboards in small computer systems. Tactile response miniature keyswitches are spaced at 12.5mm centres.
Apex Microsystems,
27 Cowbridge Road, Pontyclun, Mid-Glamorgan.
Tel: Llantrisant (0443) 225578.

The new ADDS Regent 20, an "economy class VDU", has many standard options, claimed to be unusual in the dumb terminal market. It's a conversational device, with half duplex and local echo or full duplex and no echo working. The display is 24 x 80 on a 5 x 8 matrix with lower case descenders.
For full details contact:
Roger Crumpton, TDS Ltd., at (0254) 662244.

The Melody Eight door chime from Chromatronics, illustrating the bubble pack designed for the retail market. Price is £9.95.
Details obtainable from:
Robin Palmer, Chromatronics.
Tel: Harlow 418611

Small Systems, Big Ideas
Small Systems Engineering have brought off a coup. They are now marketing the famous Pickles and Trout P & T-488, which interfaces S100 bus computers to the IEEE-488 instrumentation bus; functions as a 488 controller, talker or listener; and has three software packages available: North Star DOS/BASIC interface; CP/M interface, and a custom systems interface package.
Small Systems are at:
62 New Cavendish Street, London W1.
Tel: 01-637 0777
Filling the Gap

Mutek, microprocessor systems specialists, have come forward with a system close to OSI Superboard capabilities by using readily available OSI products. The package consists of 1) The 500 CPU board with 4K user RAM, 8K Basic, several user ports 2) The 640 interface board with a 64 x 32 video display capability modified to European TV Standards; cassette interface and keyboard ports. 3) Encoded ASCII keyboards. 4) An 8-slot backplane assembly with 6 free slots for expansion.

Details from:
Dave Graham at The Studio, Quarrey Hill, Box, Corham, Wiltshire SN14 9HT.

The Winter of Content

Scarborough House, Scarborough Road, Bridlington.

The Thinker's Disc Drive

The Computhink Disc Drive offers up to 800K Bytes of online mass storage, is for the PET, and has "a wide and ever-extending range" of professional software such as a disc operating system, assembler, a linking loader, assembler-editor, Fortran Compiler, PLM compiler. Software under development includes an accounting package and a data base.

Details:
John Chew, Kingston Computers Ltd., Scarborough House, Scarborough Road, Bridlington.

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The 4D1OB Dual Trace Oscilloscope features full XY operation and Z modulation, an accuracy of ±3%, DC-10 MHz bandwidth and incorporates CMOS technology.

The development by Petsoft -- (micro software subsidiary of bureau group Applied Computer Techniques) -- "of versatile, low price business programs"--, has made personal computers such as the Commodore PET shown here, an increasingly popular accounting tool for small businessmen. Programs range in price from £5 for a telephone charge monitoring program to £49.50 for a powerful Percentage Costing Package.

Details from:
ACT Ltd., Petsoft Division, 5/6 Vicarage Road, Edgbaston, Birmingham B15 3ES. Tel: 021 454 5348 Telex: 339396
High Bred product from Vero: The Hybrid Board AB082

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Signing the Centronics/ITT contract are, from left to right:
Keith Williams, Divisional Manager, ITT Electronic Services;
Chris Gill, Systems Manager, ITT Electronic Services; Mike Boyle, Distributor Sales Manager, Centronics Data Computer (UK) Limited.

Further information from:
Marilyn Holmes. Telephone: Bracknell (0344) 54471

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the Faces Behind the Places
Photographs by Yoshi Iinamura

Peter Norman of Computer Centre. He's a very competitive man—and his customers can thank that instinct in him, because it's reflected in his prices. It will be no surprise to PCW if Peter Norman becomes a major figure in the small computer world. In the photograph is Computer Centre's own system, of which Peter Norman is immensely proud. Address: 9 De la Beche Street, Swansea, West Glamorgan.

Barbara Hall of American Data, the marketing company for Ohio Scientific Instruments. OSI is a very cost-conscious company, and the C2-4P that readers see advertised is proof of that. The Challenger 1P in the photograph is a packaged version of the OSI Superboard—a computer-on-a-board with outstanding specifications. The Superboard is not yet available in quantity in Britain.

Roland Perry (standing), Nigel Day and Karen Duerden of Sintrom Microshop. While some of the flamboyant figures of the small computer world appear and disappear across the scene in nanoseconds, Roland Perry is hard at work building a solid image of dependability for Sintrom. The Vector M2 (see PCW, April 79) is its stock-in-trade. Sintrom is at 14, Arkwright Road, Reading, Berks RG2 0LS. Tel: (0734) 84322. Telex: 847395. Cables: Sintrom Reading.

David Bannister and Vanessa Blackburn Kiddle of PCW. David claims to help the editor and Vanessa claims to manage them both. If you look very closely you can also see Phreakstein. And if you don't know PCW's address by now you must be even more bemused than its editor.
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The Great British Electronics Bazaar Alexandra Palace. Contact: The Evan Steadman Communications Group 34-36 High St., Saffron Walden, Essex. JUNE 28 – 30

1979 Microcomputer Show (Incorporating the DIY Computer Fair) Bromleybury Centre Hotel. Contact: Online Conferences Ltd., Cleveland Road, Uxbridge JULY 5 – 7


European Conference on Applied Information Technology. Contact: 13 Mansfield Street, London W1. AUG 28 – 30

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Semicom (Japan); Tokyo, Golden Gate Enterprises Inc., De Anza Office Center, 1307 So. Mary Ave., Suite 210, Sunnyvale, CA 94087. NOV 28 – 30


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Summer Consumer Electronics Show, McCormick Place, Chicago, IL. Contact: Consumer Electronics Two Illinois Center, Suit 1607, 233 N. Michigan Ave., Chicago, IL 60601. JUNE 3 – 6


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COMPUTER LANGUAGES

The Multilingual Machine

G. J. Marshall
(Department of Electronic and Communications Engineering,
The Polytechnic of North London)

The developments and improvements that have occurred during the evolution of programming languages can be interpreted as responses to the needs of the programmer. Increasingly sophisticated languages have provided him with much needed tools and techniques for the solution of ever more difficult and complex problems. The aims of this article are to describe the development of computer languages, to give the flavour of some of them and to examine the effects of language developments on personal computing.

Introduction

The process of solving a problem with the aid of a computer can be divided into three parts, they are:-

i) specify the problem,
ii) find a method to solve the problem, and
iii) communicate the method to the computer.

The first step seems obvious. However, on occasion, superb programs have been written to provide the solution to a problem which, on further investigation, turned out to be the wrong problem. The second step is to find or devise a suitable algorithm. In a business environment, the first two steps are, essentially, what is known as systems analysis. Step three relates to the subject of this article, for the way to communicate a solution method to a computer is to express it in a language that the computer can understand. This is, in essence, what a computer programmer does (he may, of course, carry out the work involved in steps one and two as well).

The aims of this article are, then, to review the development of computer languages, to illustrate features of some of the languages and their applications, and, finally, to examine the impact of computer languages on personal computing.

From Machine Code to High-Level Languages

All computers, whether large mainframe computers or microcomputers, can only store, and operate on, binary digits. Data and instructions are stored and understood by the computer as patterns of binary digits.

Also, each computer has its own set of instructions, with one instruction for each action that the computer can perform. Thus, a computer, fundamentally, can only obey an instruction that belongs to its instruction set, and it can only understand an instruction when it is expressed as a binary pattern. Another way of expressing the same ideas is to say that a computer can only understand its own machine code. A segment of a machine code program for an eight-bit computer is listed as Program 1. (See p. 22)

It is clear that, while machine code is suitable for computers, it is far from ideal for people. We will return to the machine code program to consider its meaning shortly.

![Fig. 1. Action of an assembler.](image-url)
Programmers who had to write machine code programs naturally found it impossible to develop their programs from scratch as sequences of binary patterns, since mistakes were easy to make but hard to detect. They soon developed the habit of assigning each instruction a short mnemonic, such as LDA for Load a number into the Accumulator and STA for Store the contents of the Accumulator. Only at the final stage of loading the programs into the machine were the mnemonics replaced by their binary codes. In due course, it was realized that this coding chore could be undertaken by the computer itself and so assembly codes originated. A short assembly code program is given as Program 2.

This program finds the sum of three numbers, previously stored in the locations with addresses 12, 15 and 7, by loading the contents of location 12 into the accumulator, adding the contents of location 15 to it and adding the contents of location 7 to that: the sum is stored in location 20 so that it is preserved and the accumulator is available for other computations. The program has a degree of generality, for it can compute the sum of any three numbers that are stored in locations 12, 15 and 7.

The assembly code instructions of Program 2 are each equivalent to one machine code instruction. This is true of most of the instructions in any assembly code, although facilities available with some assembly codes, most notably macro processors, make certain instructions equivalent to several machine code instructions. Assembly code instructions cannot be executed directly, but must first be translated to machine code. This translation is performed by a special program called an assembler: its operation is represented diagrammatically in Figure 1. To illustrate the basic principles of operation of an assembler, Program 2 can be assembled manually to provide the equivalent machine code program with the aid of the code in Table 1. To translate the instruction LDA 12, the machine code mnemonic LDA is replaced by its code 000 and the decimal address 12 is replaced by its (five digit) binary equivalent 01100 to give the eight (binary) digit pattern 00011000. The same process applied to the other instructions converts Program 2 to Program 1.

<table>
<thead>
<tr>
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<th>code</th>
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<td>000</td>
</tr>
<tr>
<td>ADD</td>
<td>001</td>
</tr>
<tr>
<td>SUB</td>
<td>010</td>
</tr>
<tr>
<td>STA</td>
<td>011</td>
</tr>
<tr>
<td>JUN</td>
<td>100</td>
</tr>
<tr>
<td>JEQ</td>
<td>101</td>
</tr>
<tr>
<td>EOR</td>
<td>110</td>
</tr>
<tr>
<td>STOP</td>
<td>111</td>
</tr>
</tbody>
</table>

Table 1. Three digit code for eight operations.

Trade Off

When machine code instructions are represented by patterns of eight binary digits, there is a trade-off between the number of operations that can be represented and the number of locations that can be addressed. In the example just discussed, assigning three digits for the operation code allows $2^3 = 8$ operations and $2^5 = 32$ different addresses to be represented. If two digit operation codes are allocated then only $2^2 = 4$ operations can be represented (see, for example, Table 2) but $2^6 = 64$ addresses can be accessed. It should be clear that representing instructions by patterns of eight binary digits imposes considerable restrictions. These restrictions do not apply to computers with longer word lengths. It is probably necessary to use two (8-bit) words to represent instructions in an eight-bit machine.

<table>
<thead>
<tr>
<th>mnemonic</th>
<th>code</th>
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<tbody>
<tr>
<td>LDA</td>
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<tr>
<td>ADD</td>
<td>01</td>
</tr>
<tr>
<td>SUB</td>
<td>10</td>
</tr>
<tr>
<td>STA</td>
<td>11</td>
</tr>
</tbody>
</table>

Table 2. Two digit code for four operations.

A typical instruction set, that of the MOS Technology 6502 microprocessor (which is used in KIM and PET), is listed in Table 3. It is worth stressing that only two of the 56 instructions are arithmetic, implying quite clearly that the microprocessor is not primarily intended for 'number crunching'.

Auto Codes

The next development in computer languages was the emergence of auto-codes. The early, relatively primitive, auto-codes have instructions of the form

$$A = A + B$$

$$X = A + C$$

These two instructions cause the values of the variables A, B, and C to be added and assigned to the variable X. The introduction of variable names relieves the programmer of address management chores by passing this task to the translation program. Primitive auto-code instructions of this type are equivalent to three assembly code instructions — a load instruction and a store instruction — so that the programmer now handles a larger amount of computation per instruction than with an assembly code.

However, the task of adding three numbers still cannot be achieved with a single instruction. More sophisticated auto-codes were developed, including Mercury Autocode, Extend- ed Mercury Autocode and Atlas Autocode. Each of these languages is specific to a particular machine, but the latter, at least, deserves to be classified as a high-level language, in the sense that its instructions can describe a large amount of computation, being, in appearance, very similar to those of Algol. The development of autocodes overlaps the emergence of the so-called high-level languages. The most widely used ones, in scientific applications, are FORTRAN, Basic and Algol 60. In each of these languages three numbers can be added together by executing a single instruction. The instructions are:

in FORTRAN: $X = A + B + C$

in Basic: LET $X = A + B + C$

and in Algol: $x := a + b + c$

The trend of these developments was to throw an increasing amount of the mundane management chores onto the translation program, thereby relieving the programmer and absolving him from the need to understand the detailed workings of the computer he was using. Also, single instructions

| HIGH-LEVEL | MACHINE |
| PROGRAM   | CODE    |

Fig. 2. Action of a compiler.
describe increasingly large amounts of computation, implying that they are equivalent to increasing numbers of machine code instructions. This gives the programmer a better chance of machine code instructions. This are equivalent to increasing numbers describe increasingly large amounts.

PERSONAL COMPUTER WORLD

The FORTRAN instruction reads a number from the input device assigned to channel 1. The 100 refers to the format which specifies the form of the number and its precise location, on, for example, a data card if the input device is a card reader. The Basic instruction is for interactive input from a keyboard and is obviously much easier to use. The Algol instruction is from ICL Algol and is probably unique to that implementation. The one language feature not defined in the Algol 60 report was input/output, so that the form of these instructions is left to the discretion of the language implementer and almost certainly varies from implementation to implementation. Output instruction in these languages resemble input instructions and illustrations are given below.

FORTRAN was the first of the high-level languages, emerging from IBM in 1957. Algol 60 was formally defined by a report dated 1960, and implementations followed that date. These two languages were intended for scientific and engineering applications. Basic, which was intended as a teaching language that would be easy to learn and to use, was devised at Dartmouth College, USA, in the early 1960s. Meanwhile, COBOL had arrived as a high-level language for business applications.

The widespread use of high-level languages, and, of course, their compilers, gave rise to the 'virtual machine concept'. Broadly, this is the idea that a computer can seem to understand FORTRAN (or, indeed, any other language) when the appropriate compiler is stored in its memory. Programs written in a high-level language can then be automatically translated to machine code and run by the computer in a way that need not concern the high-level language programmer at all. Thus, by using the stored program facility to store a translation program, a computer appears to be something it really is not.

These languages, while by no means the only ones, are typical of the early high-level languages. The remainder of this section is devoted to an account and comparison of some of their features.

The features to be considered are:

i) Input and output

Input, in the form of a value for a variable, A, can be obtained by the following instructions in FORTRAN, Basic and Algol, respectively:

```
READ (1,100) A (Fortran)
100 FORMAT (F10.2)
```

The shorthand for repetition in Fortran and Basic is similar, although the need in FORTRAN to identify the end of the loop with a number can be irksome. The arrangement in Algol is perfectly explicit and easily readable.

```
DO 50 I = 1, 20
50 CONTINUE Fortran
```

The instructions all have the general form: 'IF condition THEN conditional instruction', but with variations. During program execution, the conditional instruction is executed only when the condition is true. The FORTRAN instruction is clumsy and the use of the same symbol as a separator and a decimal point is confusing. The Basic form is more readable and the inclusion of THEN is very helpful. However, the Algol instruction with the 'else' at the end is much more powerful.

ii) Conditionals

The forms of the conditional instructions in the respective languages are illustrated by:

```
IF (A.GT.2.5) S = A + B ... Fortran
IF A > 2.5 THEN S = A + B ... Basic
IF a > 2.5 then s = a + b else s = a - b ... Algol
```

The instructions in the respective languages for the handling of vectors and matrices.

```
DIM V(10) Fortran
DIM V(10) Basic
REAL array v [1:10] Algol
```

The FORTRAN instruction reserves ten locations for variables named V(1) to V(10); while, in most dialects, the Basic instruction reserves eleven locations for V(0) to V(10). The Algol instruction is explicit. Cobol, which is intended for use in commercial applications, has instruc-

Fig. 3. Cobol Structure.
Only simple arithmetic facilities are necessary, the major facilities are provided for reading and updating file records and filling in forms. The language is intended to be readable.

The Cobol instruction:

\[
\text{MOVE } X \text{ TO } Y
\]

is equivalent to the FORTRAN instruction \(Y = X\), while

\[
\text{ADD BALANCE TO OLDTOTAL is equivalent to NEWTOTAL = OLDTOTAL + BALANCE.}
\]

Cobol has more sophisticated data structures than the scientific languages and can support structures such as the one illustrated in Figure 3. Selection of an item in such a structure is achieved by: \((\text{LAST NAME IN EMPLOYEE})\).

Arrays of such structures can also be used, for example

\[
\text{EMPLOYEE (1:25).}
\]

Structured Programming and Languages for it

The next stage in language development was the emergence of languages to permit structured programming. The need for such languages emerged because programmers were experiencing intense difficulty in the development of long programs. The difficulties arose largely because language facilities were not available to permit the management of a natural flow of control in large programs, so that programmers were forced to use clumsy and unsuitable constructs.

The fundamental concepts of structured programming follow from the idea that the structure of a program should reflect the structure of the problem solution method. If programs can be written in this way they are automatically readable. Thus, there is no real need to add comments to a program to make it readable.

More importantly, programs are made more easy to debug because the logical flow of the solution method is preserved directly by the program itself. Properly structured programs are also easier to develop and test because, as illustrated in Figure 4, they can be divided into modules, each of which has only one entry and exit point, that can be developed and tested independently.

The shortcomings of the early high-level languages arise from the fact that they do not provide features to make possible the writing of large, properly structured programs. The languages that are intended for structured programming include Pascal and Algol 68, PL/1 also has facilities for structured programming, although it was conceived as a general purpose language, combining the features of both FORTRAN and Cobol while showing the influence of Algol 60. Pascal was intended as a teaching language that would demonstrate programming as a systematic discipline and that could be efficiently implemented in a compact manner.

The first operations compiler became available in 1970. Algol 68 was defined by a formal report dated 1968; it is a general purpose language developed from and updating Algol 60.

It is rather difficult to properly illustrate structured programming without examining long programs. However, the examples and programs discussed in the remainder of this section may give some flavour of it. The Basic program listed as Program 3 can be said to be a very bad one!

![Fig. 4. Good (a) and bad (b) program structures.](image-url)
Fig. 5. Lists and their representations.

```
read ff
if stay
  then
else if stay

if age <3
  then fare: =
else if age <14
  then fare: = 0.5*af
else fare: = af
```

Program 7. Pascal program for problem 2.

```
I = 0
repeat read (n); I = I + 1 until n < 0
writeln (fare);
```

Program 5. Pascal program for problem 1.

Reductions on the full rail fare for a journey are given according to both the length of stay and the age of the passenger as shown in the following tables:

<table>
<thead>
<tr>
<th>Length of stay (days)</th>
<th>Discount on full fare</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>50%</td>
</tr>
<tr>
<td>2 - 14</td>
<td>30%</td>
</tr>
<tr>
<td>15 or more</td>
<td>0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>Actual Fare</th>
</tr>
</thead>
<tbody>
<tr>
<td>under 3</td>
<td>free</td>
</tr>
<tr>
<td>3 - 13</td>
<td>half discounted fare</td>
</tr>
<tr>
<td>over 14</td>
<td>discounted fare</td>
</tr>
</tbody>
</table>

Given the full fare, length of stay and age of the passenger, compute the actual fare to be paid.

A Basic program to do the same thing is given as Program 6 and is a little contrived.

```
10 I = 0
20 INPUT N
30 I = I + 1
40 IF N < 0 GOTO 60
50 GOTO 20
60 PRINT I
```


Now consider a second problem which concerns the calculation of rail fares:

A Pascal program for this which captures the natural solution method is given as Program 7. The variables ff, af, and fare are used to hold the values of the full fare, adult fare and the fare to be paid, respectively. It is left as an exercise for the reader to attempt the same thing in Basic or FORTRAN.

Special Purpose Languages

All the languages mentioned to this point are intended for either scientific or commercial application. However, other languages have been developed for particular special purposes. These include languages designed for manipulating particular data structures, most notably for manipulating strings and for processing lists. Snobol is the major language designed principally for string manipulation. It has facilities that include pattern matching and pattern replacement.

A typical Snobol instruction is

```
STR "ED" : S(FOUND)
```

The effect of this instruction is to scan the string named STR for the pattern ED and if the search is successful to jump to the instruction labelled FOUND. The original string manipulation language is LISP. A typical LISP instruction is

```
(EQ (CAR LAT) A) (CDR LAT))
```

The applications of string manipulation and list processing include linguistic analysis, compiler writing, computer assisted instruction and artificial intelligence.

Two examples may show, in a limited way, how list processing can be used, but first the meaning of a list must be explained.

A list of the four elements A, B, C and D can be represented by (A, B, C, D) and the way in which it is stored is represented in Figure 5a. The figure shows that each element of the list is stored with a pointer to the next element, and this is the way that the elements of a list are linked. A more complex list is represented in Figure 5b. The first example is drawn from a system developed by Terry Winograd for the machine comprehension of natural language.

The system manipulates a representation of a set of coloured blocks,
such as the one illustrated in Figure 6. The system can understand and obey instructions expressed in natural language such as "put the small red block on the large green block". We consider only how the machine can determine what is meant by "the small red block". Given a list of all the blocks, (A, B, C, D), a list of the red blocks, (A, C), a list of the green blocks, (B, D), a list of the small blocks, (A, B), and a list of the large blocks, (C, D), then the small red block must be a block that is in both the list of small blocks and the list of red blocks. Thus, the small red block is block A.

It is worth noting that operations on sets are being implemented by using lists, for if the list of blocks is regarded as a description of a set, the lists of blocks with a particular property are subsets and the problem of determining what is meant by the small red block becomes that of finding the intersection of two subsets.

The next example illustrates how lists and list processing can be of value in enabling a robot to automatically determine the actions necessary for it to achieve a specified objective. Consider a robot in the rather simple situation illustrated in Figure 7 which is set the task of filling the bucket. The situation in the diagram can be represented by a list (known as the world list) thus:

\[(\text{ROBOT, IN, ROOM 2}) (\text{TAP, IN, ROOM 2}) (\text{BUCKET, IN, ROOM 1}) (\text{BUCKET, EMPTY})\]

The situation on successful completion of the task is represented by this world list:

\[(\text{ROBOT, IN, ROOM 2}) (\text{TAP, IN, ROOM 2}) (\text{BUCKET, IN, ROOM 2}) (\text{BUCKET, FULL})\]

Now, each action that the robot can take alters the situation in some way and can be represented by a corresponding change in the world list. To achieve its task, the robot must determine an appropriate sequence of actions. This can be done by determining a valid sequence of changes to the initial world list which alters it to the world list representing the situation on completion of the task.

Pascal is structured and capable of compact implementation. For both languages, interpreters seem to be more suitable than compilers for personal computing because the ability to interact with a program seems, in general, to be more desirable than attaining the shortest possible times for program execution.

As for the future, the possibility of natural language input, at least in a restricted form, has been touched on. Since a speech recognition unit is currently available for the Apple, perhaps programming will soon be possible by addressing the computer in almost ordinary English.

---

**Impact on Personal Computing**

Figure 8 shows, in the form of a tree, the lines of development connecting the languages mentioned in this article. With regard to the languages that have made an impact on personal computing, assembly codes are not really in the running, since an assembly code is specific to a particular micro-processor making it difficult for one to achieve any general impact. The language that has made the greatest impact to date is Basic, and the most likely language to achieve general acceptance in the near future is Pascal.

It is interesting that both were designed as teaching languages. Their general acceptance probably stems from the fact that their principal aims fit the requirements of personal computing almost perfectly. In particular, Basic is easy to learn and Pascal is structured and capable of compact implementation. For both languages, interpreters seem to be more suitable than compilers for personal computing because the ability to interact with a program seems, in general, to be more desirable than attaining the shortest possible times for program execution.

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**are...software... software... software... software... sof**
The purpose of this article is threefold. Firstly to speculate about the future, secondly to describe the Leicester Polytechnic’s present computers and show how they are used, thirdly to mention two favourite programs.

A Speculation

First a personal speculation about the future. A new computer laboratory consisting of 20 personal computers will be available with mainly BASIC, perhaps some PASCAL, FORTRAN, ALGOL, APL and other languages. It may be situated in the library, be open from 8 a.m. until 9 p.m. and be supervised by computer centre staff. Interactive computer programs with associated information for learning and calculation purposes will be available from the tutor on duty, these programs would be pre-recorded on cassettes, floppy discs or ROM’s. Printers, graph plotters and recorders will be available to plug into any computer when required. In addition a few intelligent terminals will be on-line to a national/international network.

Personal computers will be available in the present laboratories for simulations and for processing the results of experiments. They will be available for use in lecture theatres with the present closed circuit television system, and for use at home.

Finally, equipment will be available to prepare demonstrations of the use of programs in problem solving; for example, 35mm camera, tape recorder, video recorder, data recorder, printer, plotter, along with the appropriate replay equipment.

The Present Set-Up

Now a description of our present computers. The central system, located in the Computer Centre, is based on a Burroughs B6700 computer with a memory of 224K words (1 word is 48 + 4 bits, 1 byte is 8 bits), 2 line printers, plus the usual collection of discs, tapes, card readers, modems and terminal lines. Connected to the computer are 28 visual display units (with edit facilities), 3 graphic terminals (2 storage, 1 refresh), 1 on-line digital graph plotter and numerous envoys and teletypes. From the user’s view point the main features of the central system are that:— the visual display units (vdus) operate at 600 baud (60 characters a second) — the graphic terminals operate at 9600 baud — 6 languages are normally available — all the terminals are on-line to edit and modify programs —
only 6 to 16 terminals share the data processor to run user programs at any time. In addition, a Honeywell H516 computer is available with a disc, graphics terminal, teleprinter, high quality graph plotter, high speed paper tape reader and punch.

The above equipment is distributed between a computer room, a terminal laboratory (16 vdis + 3 printers), a graphics laboratory, and various other rooms. It is available for general use between 10 a.m. and 9 p.m. and can be reserved by teachers for supervised student use.

In addition to the central system various Polytechnic Schools have their own computers; namely, Data General, Membrain, DEC, SWTPC's, PET's, and various microprocessor kits.

All these computers are used in two main ways, either to practice a programming language or to use an existing program. A disc based library of 250 programs for teaching and research purposes has been developed during the past 10 years. These programs are described in a software catalogue which is published by the information section of the computer centre. In addition to the description in the catalogue, demonstrations of the on-line use of some of the interactive programs have been recorded by means of slide/tape, video cassette, and audio cassette where the left channel is used for data and the right channel for speech. The audio cassette is replayed via a vdu to a television monitor or direct to a television set as illustrated in the photograph.

The Polytechnic was a member of the Engineering Science Project of the National Development Programme in Computer Assisted Learning (1972-77) along with many other Polytechnics and Universities. The results of this Development and the lists of programs available for transfer can be obtained from the Council of Educational Technology.

Two favourites

Now a mention of two favourite programs. These are Interactive Simulation Language (ISL) and Impedance and Complex Number Calculations (AC).

ISL consists of 30 mathematical routines which can be interconnected in order to simulate dynamic problems. The program is interactive and the results can be displayed graphically. The main routine is integration, other routines include summation, sine function, pulse, square waves, non-linear, unit delay, counters.

A favourite demonstration is illustrated in figures 1 and 2. Figure 1 shows a square wave synthesised from the first fifteen harmonics, whilst figure 2 shows an exponential decay synthesised from the results of the harmonics after each as "passed through" a capacitor-resistor circuit (or mathematically equivalent system). The ratio of periodic time to time constant is 10 to 1.

AC consists of 6 mathematical routines (add, subtract, divide, multiply, parallel, square root) involving complex numbers. These routines can be linked together using standard electrical equations in order to analyse simple electrical circuits. It is used as an introduction to computer aided circuit design.

ISL is introduced to students by means of a problem investigating a laboratory class whereas "The Learn Machine, PCW Vol. 1, No. 12".
The author eagerly supports the concept of the Mobile Computing Laboratory for Schools proposed by Mick Coleman in a PCW article and which is already available in Pennsylvania.

One of the disappointments of the present situation is that local schools have not been able to take advantage of Computer Centre facilities because of the cost of a terminal and an acoustic coupler, and the telephone charges. But the Open University is doing an excellent job with its online computer system; also Prestel, Oracle & Ceefax are here to use, and given sufficient demand their cost might remain steady in spite of inflation.

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In both cases the use of computer programs enables more experience and knowledge to be gained in the same time relative to the situation a few years ago.

AC has been used to solve problems by a weekly tutorial class. In both cases the use of computer programs enables more experience and knowledge to be gained in the same time relative to the situation a few years ago.

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A PCW Conversation

THE EVERRISS EXPRESS

The above quotes are from a PCW conversation with Bruce Everiss of Microdigital, Liverpool. The conversation ranged from his plans for expansion, to the market outlook, especially for retailing to the small business.

Bruce Everiss has a background in accountancy, a flair for promotion, and plenty of what advertisements for salesmen call "self-motivation". At first glance he seems young and diffident — but as he talks you can see how each phrase satisfies him with its aptness, to become the fuel for following phrases of increasing confidence and authority. Here is another sample of Everiss exposition: "We've been hiring new staff at the rate of one a fortnight. Microdigital has expanded to two suites of offices — we can give a red-hot service".

He seems particularly proud of his stock of books and the turnaround of his mail order service.

But Everiss, speaking from what he regards as a position of strength, doesn't skate over the problems. "We get a manufacturer's delivery date and then advertise in good faith, but there are delays sometimes. Then we get people wondering what's going on. We explain and inform. We are extremely patient because we are extremely patient because we are proud of our goodwill".

The Evangelist

Everiss is a great fan of the PASCAL language. In fact, while talking he was transformed from fan to evangelist. "PASCAL is totally portable. A PASCAL program written for the APPLE can be run on a super-machine like the CRAY with absolutely no trouble".

In most people's mouths that would sound like bombast, but it's plain that Everiss lives for what he believes in — the spread of microcomputers. In his opinion, Government is well intentioned but bumbling, with a reaction time to events which is slow because of built-in inertia. So Government can — against its will, perhaps — be insensitive. He thinks that programs like TV's "Blake Seven" are doing more to popularise computers and educate people about them than anything any Government agency does. Government support goes to the bigger companies. "It totally ignores retailers who are doing the groundwork — and taking the risks".

And as for Liverpool, with its University — there's no place like home. "Liverpool University's microcomputer laboratory is the leading centre for microcomputer education".

Later in the conversation, Everiss reverts to PASCAL. Already, he says, PASCAL is the second language of Apple, and may be put on the Sorcerer. Its time is now dawning and the Age of Pascal will be the Age of People's Programming. "Basic is an abomination. Basic is the language of Babel".

PCW person hastily lights another cigarette. PCW is full of BASIC.

And talking of PCW, Everiss says its layout is terrible. Its contents great.

Micro Business

When asked about the requirements for setting up in dealing in micros, Everiss says, "The technology is so new that a person's background is irrelevant... yesterday's window cleaner is today's authority". If the man is intelligent enough, and interested enough, and can get proper backing.

Who's buying? "A lot of businesses, government departments, educational establishments and even multinational companies".

The small business market is there, all right — even the business owned and run by one person or partners. The potential can be realised, and people come to Microdigital looking for a job to be done; but Everiss says that small business applications need micros with at least one disk and file handling routines.

For him, a minimum configuration would be a system with a Disc Operating System of 10K and user memory of 32K. A printer would be needed, depending on the application. Microdigital is well placed to sell to the small business, as it's situated in the commercial centre of Liverpool — the equivalent of London's "square mile". And Microdigital's company secretary is also a senior partner in a firm of accountants. On his full-time staff there will be a commercial programmer, who's now looking at writing small business software for the Apple. The Apple, says Everiss, is "the premier machine in the market today". He cites the Trade Counter program for the Apple (at £25) as just one small example of the usefulness of the small computer in business. And people haven't yet looked closely at the practical possibilities of voice input/output, which the Apple has had for some time.
Everiss went on to describe Microdigital's set-up, in the process giving clues to what makes a successful micro retailing enterprise tick.

"This is a new industry. We find that the prime requirement for staff is intelligence rather than experience — in a totally new situation, what experience can be valid? If we took a top systems analyst and let him loose in this line of country, the man would be lost. We need intelligent, adaptable people, with no preconceptions. That is why no big company has succeeded in retailing personal and small business systems. "The prime requirement is being fast on your feet — and a certain amount of prescience helps".

"I give my staff machines to take home at weekends. I ask them to put together kits like the NASCOM 1." You can't get hands-on experience sitting in an armchair and dozing over a book.

Professionalism

"I have no problems with staff discipline. I can do practically anything they can — that is, I can speak their language — so we're in touch. Everybody at Microdigital is so bright, anyhow. They need very little directing. Our staff find us, and not vice versa.

"I know it's easy to ramble on about customer goodwill and customer satisfaction — it looks good in print. But I believe in it. Our repair service has so far managed to wind around in a week, except", and Everiss winced, "when there's a shortage of a particular component.

"We're more professional than most. We don't believe in exploiting the keenness of an electronics hobbyist to do our repair work for us — the 'repair facilities' of some retailers are just a part-timer who's paid what his employers think he's worth; they get what they pay for, some don't pay very much. If I do anything I do it properly — that means using engineers in digital electronics; and they don't come cheap.

"We cheerfully hire out computers. A sale may be delayed while people are making friends with a computer, but we believe in the future. Then when someone buys a system, we tune it for him before he goes home. I'm not selling cars or fridges or take-away food. I don't regard people as consumers but as customers. Now I'm setting up a genuine technical consultancy service for really practical advice".

'Take the money and run' may be a cute caption for a cartoon, but it is a malevolent motto for microcomputer retailing.

Everiss sees the market mainly in terms of its now classic categories: hobbyist, home computers, education and research, and data processing for the small business. He points out, however, that there is a vast market for small computers as adjuncts to bigger systems, in distributed data processing and scientific applications. Then, of course, there is proper electronics control using the dedicated microprocessor. There is a burglar alarm system by Chubb with a 6802 sitting in it. He is certain that the biggest single application affecting the public will be the microprocessor in cars. He has absolutely no doubt that ignition, fuel, readouts will all be controlled or implemented using the microprocessor.

He has one customer who's used the NASCOM to replace the hard-wired logic in fruit machines, another using the SC/MP to control two separate machine tools. The micro is in some washing machines, radios and hi-fi, and will be in anything that can be controlled in discrete steps. It will be sitting there, a swift slave.

And Everiss more believes than hopes that the silicon slave will be exploited mercilessly to benefit all of us.

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The computer today comes in all shapes and sizes, from the largest mainframe or D.A.P. to the most modest of micro-computers. The SYSTEM ONE is a microcomputer but it is by no means a modest one. It boasts an MC6800 microprocessor, up to 56K bytes of RAM and built-in backing storage provided by mini-floppy discs.

Even in its minimum configuration the SYSTEM ONE costs a bit more than the average British amateur would wish to pay for a personal computer; however, SYSTEM ONE falls naturally into a niche at the lower cost end of the professional market.

SYSTEM ONE is in fact a complete computer system available with single or dual disc drives and all the necessary support software. Although there are at present no standard application packages supplied specifically for the SYSTEM ONE, there is a wealth of such software that with the minimum of adaptation can be run on SYSTEM ONE to advantage due to two very good versions of BASIC available from S.E.E.D., the suppliers of SYSTEM ONE.

The evaluation kit was the dual disc version with a 2MHz MC6800 and 32K of RAM. The terminal used was the SOROC IQ120 which is also available from S.E.E.D.

The Hardware

SYSTEM ONE is a well engineered product in a pleasant, sturdy, non ostentatious box. It is not particularly small, being about 21" x 15½" x 7", but this reflects the fact that the hardware is well laid out on a solid chassis.

The box houses two Shugart SA400 mini-floppy disc drives, an
The power supply is rated to give +8 Volts at 15 Amps and +15 & -15 Volts each at 3 Amps. These rails are further regulated at each board.

The motherboard uses the SWTP S5-50 bus and each board is held firmly in position by the connectors only.

The CPU board is the MSI CP-1 and is based on a 2MHz MG6800. The 6800 can address up to 64K bytes of memory, but having no input or output ports it uses some memory addresses for I/O leaving 56K bytes as a practical limitation. The board provides for up to 4K bytes of 2708 EPROM and uses an MC6810A 128 byte static RAM. Clocks are provided for the serial interfaces as well as for the CPU. There are bi-directional bus drivers and address buffers and an MC6875 provides memory timing and DMA control.

On the 32K RAM system, two MSI RAM-16 boards are provided. These use TMS4044 4K x 1 static RAMs. Address selection is by on board DIL switches. On the 32K SYSTEM ONE the first 32K of storage is RAM. The disc drives are controlled by a powerful single board, the SSB BFD-68, which uses the FD1771B-01 single chip disc controller. This leaves enough room on the board for the disc control firmware in on-board ROM (disc bootstrap and all the disc I/O routines). Communication with the CPU is via an MG6820 PLA. The other board in the SYSTEM ONE is the MSIA-1 interface adapter which is capable of providing eight serial channels although on the SYSTEM ONE only one is required to connect to the terminal. The terminal governs the data rate and in the case of the SOROC IQ120 used on the evaluation SYSTEM ONE a zippy 19,200 BAUD.

Memory Organisation

The first 32K of memory in the 32K SYSTEM ONE is contiguous RAM. The locations from 0000H to 67FFH are available as user memory, locations 6800H to 7FFFH being used by the disc operating system. Locations 8000H to 83FFH are occupied by the disc firmware.

The SMARTBUG EPROM is on the CPU board and is located from E000H to E3FFH. The MC6810A RAM is located from A000H to A07FFH and is mainly used by SMARTBUG.

There are two other EPROMS on the CPU board. The first, located from E000H, is an extension to SMARTBUG provided by S.E.E.D., giving built in diagnostic aids including confidence tests, memory tests. The second is for interrupt vectors.

Controls

One expects a computer to be a mass of flashing lights and a complicated array of switches — that is if you watch T.V.! On the modern computer these functions are performed by monitors and operating systems so on SYSTEM ONE there are just three controls.

The first is the ON/OFF switch. On power up SMARTBUG is automatically started so that SYSTEM ONE is ready for use. The second control is the RESET switch which when used restarts SMARTBUG. The third initiates the disc bootstrap and providing that a DOS68 system disc is in DRIVE 0, the disc operating system is loaded to RAM and becomes operational.

System Software

At the “lowest” level is the elegant SMARTBUG intelligent monitor which provides the SYSTEM ONE programmer with several features including all the “front panel” controls and displays and is a very capable de-bugging aid. Having created a program, the user can use SMARTBUG throughout its development.

The assembly level program may be created using the editor and assembler package (discussed in more detail later), or, for small programs, with the aid of pencil and paper and SMARTBUG itself.

On start up SMARTBUG displays the prompt character (*) on the terminal indicating that it is ready for a command. Commands are recognised on the keying of a single character in response to the prompt.
The Operating System

The SYSTEM ONE operating system is DOS68. It is a fairly typical microcomputer operating system offering most of the system facilities the user should ever require at console operation and programming levels.

DOS68 is first loaded into SYSTEM ONE by placing a system disc in DRIVE 0 and pressing the DOS switch. After a few moments of disc activity DOS68 "signs on" by displaying on the terminal its name and version number followed by the DOS68 prompt character (&) on the next line. Once loaded to RAM the facilities of DOS68 are available. DOS68 may be warm started using the RDM bootstrap controller.

DOS68 is well supported by the BFD-68 System Manual supplied with the BFD-68 disc controller. It provides comprehensive information about the hardware as well as the DOS68 operating system itself. Operators and programmers guides are included in the manual.

To minimise RAM requirements only a few of DOS68 commands are actually resident in RAM all the time, the other commands, known as transient commands, are loaded only when requested. It should be remembered that the disc I/O routines are in ROM. This is a great plus to the system — many a frustrated programmer has ruined a valuable disc due to inadvertent corruption of RAM resident disc I/O routines!

System commands are run by just typing their name (plus any required parameters) in response to the monitor prompt:

<table>
<thead>
<tr>
<th>COMMAND</th>
<th>FUNCTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>LIST</td>
<td>Lists all the program and data files on the disc nominated. System files are listed using a switch parameter. Other information about disc status is also listed.</td>
</tr>
<tr>
<td>SAVE</td>
<td>Is used to save selected areas of memory content to a nominated (new) disc file.</td>
</tr>
<tr>
<td>GET</td>
<td>Loads a binary object file to RAM without executing it.</td>
</tr>
<tr>
<td>GETH</td>
<td>As GET for a hexadecimal file.</td>
</tr>
<tr>
<td>RUN</td>
<td>Loads a binary object file to RAM and then executes it.</td>
</tr>
</tbody>
</table>

The evaluation SYSTEM ONE was supplied with various support software packages including the SE/A-1 Super Editor/Assembler and two different BASIC packages — one an interpreter — the other a compiler! S.E.E.D. will also have available, in the very near future, a FORTRAN compiler which will further widen the scope of SYSTEM ONE into scientific applications. Also for release in the very near future is another compiler known as STRUBAL (an acronym for STRuctured Basic Language) which is in fact a hybrid language containing elements of PL/M, assembler and BASIC.

The Super Editor is very well conceived, being very simple to use and easy to learn to operate. Note-worthy is the fact that the editing capabilities are not just restricted to the preparation of program source, but are equally useful for simple word processing.

During the edit process each line of text is numbered by the editor, so keeping track of position within the text is easy at all times. Using this editor cuts down the risk of making the type of mistakes that can cost hours to correct.

Facilities include adjustable tab settings, multiple string replacement, block text transfer, insertion and deletion of text, an overlaying facility as well as many other functions; some not to be found on other editors. The documentation provided is simple to understand taking the first time user through the features in a simple and informative manner.

The Assembler too is simple to use, yet it offers a selection of features including multi-level conditional assembly, as well as being fast due to a hashing technique used for symbol table access. If there is an error diagnosis is easy, there is an error summary at the end of the assembly. Used together the

Support Software

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Super Editor/Assembler package earns its name. BASIC is still the most popular high level language available for microcomputers. RANDOM BASIC is an interpreter designed in close conformity to the ANSI standard. RANDOM refers to the ability to access records in a disc file by key as well as just sequentially. This makes RANDOM BASIC ideal for applications such as stock control where a sequential search through a disc file could be too slow; and being written to the ANSI standard most BASIC programs can be run using RANDOM BASIC, on the SYSTEM ONE, to great advantage.

RANDOM BASIC has amongst its repertoire the usual mathematical functions, array and string handling, disc control and housekeeping functions, program loop, branch and subroutine handling, terminal accept and display, memory peek and poke and program chaining. From the console, commands provide for the saving and retrieval of BASIC programs and file management. Program debugging is greatly facilitated by a trace feature that displays the line number of each instruction of the BASIC program as it is executed. When a syntax error is encountered the erring instruction line is displayed with the error clearly marked.

The second BASIC package, SDBASIC, being a compiler is very unusual. Programs written with SDBASIC are prepared in a similar way to assembly language programs using the Super Editor. The program is then compiled using system program, SDBAS. As a result an intermediate object file is created. This is translated into an executable file by a further system program SDRUN. This file is run by loading it using system program SDRM. Each time the program is required.

The big advantage of this is that the object program runs several times faster than if it were interpreted. SDBASIC is fairly close to the ANSI standard and has a repertoire similar, but not identical, to RANDOM BASIC.

**Application Packages**

SYSTEM ONE is not directly associated with specific application packages, but this does not detract from what this microcomputer offers. There is a vast amount of applications written in BASIC that are ideal for SYSTEM ONE.

**Prices**

The SYSTEM ONE is available from Strumech Engineering Electronics Division (S.E.E.D.). The following prices serve as examples of various builds of SYSTEM ONE, but the price of a 16K single disc system complete with ACT-1 terminal and Sanyo 9" monitor is only £1674.

**System One Hardware**

<table>
<thead>
<tr>
<th>DISCS</th>
<th>32K RAM</th>
</tr>
</thead>
<tbody>
<tr>
<td>SINGLE</td>
<td>£1510</td>
</tr>
<tr>
<td>DUAL</td>
<td>£1790</td>
</tr>
<tr>
<td>Pack 10 mini discs</td>
<td>£35</td>
</tr>
</tbody>
</table>

**Suitable Terminals**

| ACT-1A Keyboard + Video monitor | £385 |
| SOROC IQ120 Visual Display Unit | £699 |
| ELBIT DS1920 Visual Display Unit | £950 |

**Software for System One**

| R BASIC Random Access BASIC Interpreter | £65 |
| 6800BC BASIC Compiler (SDBASIC) | £185 |
| SE/A-1 Super Editor/Assembler | £36 |
| STRUBAL Structured BASIC Language | £170 |
| FORTAN Fortran Compiler | £T.B.A. |
| TP-1 Text processor | £30 |
| TD-1 Trace Disassembler | £14.25 |
| SG-1 Source Generator | £17.70 |

All prices are exclusive of delivery and V.A.T.

**Maintenance**

In keeping with the professional approach they have taken to the production of SYSTEM ONE, S.E.E.D. have organised servicing of this product through one of the national maintenance organisations and the rates for this service, although not known at the time of writing, are likely to be competitive.

**Conclusions**

SYSTEM ONE is a well composed piece of hardware. It is well constructed, generously laid out and should give the potential owner reliable service. It is supported by good software that can be used to develop programs for all sorts of applications be they educational, scientific, business or pleasure. Furthermore SYSTEM ONE is an ideal computer to run many of the wealth of BASIC programs that have been developed over the past few years. The BASIC compiler overcomes many of the weaknesses of some BASIC interpreters and should make some BASIC programs very competitive.

SYSTEM ONE was not without some quirks. Hi-Fi lovers who are also home computing enthusiasts may find it disturbing that during disc accesses some breakthrough on VHF radio was detectable on stereo signals. The cooling fan was quite noisy and could be annoying in an office environment; however, as the cooling is more than adequate, a slower speed fan would probably suffice; the boards were cool even after several hours running. The system will lock up when trying to access a disc that is not there — SYSTEM ONE is not alone in this situation.

Nevertheless SYSTEM ONE is a very fine microcomputer which, with prices starting at £1674 for a computer with a mini-floppy disc, keyboard and monitor, must be amongst the most competitive on the British market today.
THE RESEARCH MACHINES 380Z COMPUTER SYSTEM

Microcomputers are extremely good value. The outright purchase price of a 380Z installation with dual mini floppy disk drives, digital I/O and a real-time clock, is about the same as the annual maintenance cost of a typical laboratory minicomputer. It is worth thinking about!

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What about Schools and Colleges? You can purchase a 380Z for your Computer Science or Computer Studies department at about the same cost as a terminal. A 380Z has a performance equal to many minicomputers and is ideal for teaching BASIC and Cesi. For A Level machine language instruction, the 380Z has the best software front panel of any computer. This enables a teacher to single-step through programs and observe the effects on registers and memory, using a single keystroke.

WHAT OTHER FEATURES SET THE 380Z APART?
The 380Z with its professional keyboard is a robust, hardwearing piece of equipment that will endure continual handling for years. It has an integral VDU interface — you only have to plug a black and white television into the system in order to provide a display unit — you do not need to buy a separate terminal. The integral VDU interface gives you upper and lower case characters and low resolution graphics. Text and graphics can be mixed anywhere on the screen. The 380Z has an integral cassette interface, software and hardware, which uses named cassette files for both program and data storage. This means that it is easy to store more than one program per cassette.

Owners of a 380Z microcomputer can upgrade their system to include floppy (standard or mini) disk storage and take full advantage of a unique occurrence in the history of computing — the CP/MTM industry standard disk operating system. The 380Z uses an 8080 family microprocessor — the Z80 — and this has enabled us to use CP/M. This means that the 380Z user has access to a growing body of CP/M based software, supplied from many independent sources.

380Z mini floppy disk systems are available with the drives mounted in the computer case itself, presenting a compact and tidy installation. The FDS-2 standard floppy disk system uses double-sided disk drives, providing 1 Megabyte of on-line storage.

*Trademark, Digital Research.

Versions of BASIC are available with the 380Z which automatically provide controlled cassette data files, allow programs to be loaded from paper tape, mark sense card readers or from a mainframe. A disk BASIC is also available with serial and random access to disk files. Most BASICs are available in erasable ROM which will allow for periodic updating.

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We now come to the “nitty-gritty”. How do we make PET operate our paper system? This is done firstly by entering our membership data onto a cassette tape. A program is entered into PET’s internal memory and then ‘Run’ so writing the data tape. A program consists of a series of numbered Statements, each of which tells the computer to perform a simple operation. It does not matter in what order they are entered for the computer will always go through them in numerical sequence; e.g. if they are entered in the order 3, 2, 1 they will still be executed in sequence 1, 2, 3. If they are labelled 10, 20, 30 the same procedure will result, but with the advantage that if you later want to add something between the first and second statements i.e. 10 and 20, then a statement labelled 15 will do this. This fact is very useful in our system.

Now for the first program, which we will call “Write Membership”. This completes the data for the first member, so we go on to the second member.

```
0101 PRINT #1, MRS
```

and so on, until the data for all the members has been entered.

This may seem to be a laborious task and it is! But it only has to be done once and it can be tackled a bit at a time and the program so far saved on a cassette. When convenient this can be loaded into PET and the next batch of data entered. This can be repeated as often as required until “Write membership” is completed. Moreover, a similar process of entering the initial data has to be performed whatever the system, whether it be a large computer or a simple register, so it is not a defect caused by using PET.

The rather strange method of line numbering shown is to help in verifying the data. The first item of data for each member is entered in a line ending in 1, the second in line 2, etc. If you find that you are entering the last data item in line 9 then obviously one data item has been missed out.

Leading zeros are given to the line numbers so as to ensure that each type of input appears exactly under the previous one no matter whether the line number is 20 or 9000. This helps to pinpoint missing characters e.g.

```
0021 PRINT #1, MR
0022 PRINT #1, DJ
0023 PRINT #1, ALLEN
```

shows up an error in line 0023. The large gaps in the sequence of line numbers between members allows for later insertion of data for new members in correct alphabetical sequence.

“Write membership” can now be run to create the data file on the cassette tape. All fairly simple, but there is one awful snag, which at first sight would appear to invalidate the whole procedure. To test both this and the various operating programs I had set up a dummy membership file of thirty members which was sufficient for this purpose. All went well and odd snags were easily ironed out, but deep down there was a nagging thought that something had been overlooked. But what? Suddenly the thought emerged. Everytime PET is switched on it displays:—

```
***COMMODORE BASIC***
7167 BYTES FREE
READY
```

Simply, a “byte” is a storage space in the computer’s internal memory, and the horrible thought was “How many bytes are needed to write the data for each member?” A few rapid tests and calculations
showed that it was 160 give or take a few, and that 7167 divided by 160 is approximately 44. This would mean that the longest "write membership" program could only deal with 44 members, and if spaces were to be left to insert future members, perhaps 28 to 30 would be better. This would result in having something like twenty separate data tapes which would have to be put into the cassette player one after the other for the computer to read, so defeating the object of the exercise, automatic operation.

At first this seemed a major stumbling block, but a little thought showed a possible solution. We know that we can produce the program for 25 members, so let us do so for the first 25. Then first, save the program on a cassette tape and then run the program to record file 1 on another cassette. Don't rewind either cassette. Clear PET's internal memory and then repeat the operation to create file 2 which will hold the data for the next 25 members. The only change in the "Write" program will be that it now refers to file 2 e.g.

0010 OPEN 2,1,1
0021 PRINT #2, MR
9999 CLOSE 2

When the new write program has been run file 2 will be stored on the data tape immediately following file 1 and 2. Write mem will follow 1. Write mem on its own tape. Repeat for file 3 and so on until the file for the 430th member has been dealt with. This is only a form of batch entry, and is no more or less tedious than the original method.

Obviously, we now have files 1 to 18 successively recorded on the data tape. All that we now have to do is to ensure that the operating programs tell PET to process the data for file 1 and then proceed to file 2 and so on until the processing of file 18 has been completed. This is very simple, as you will see.

Before we finish with the creation of the data tape, there is one other operational point to be mentioned. PET needs to know how many members' data is recorded in each file. If it is not then it will try to read beyond the end of the file. All this requires is an additional data item after the file is opened and before the data for the first member i.e. in the Write program:

0015 PRINT #1,125
Note that if you later add or delete a member or members, this initial data value must be amended. Obviously, since 17 files will cover 425 members, this value will be 5 in file 18.

None of this may be very elegant, but it works, and we now have the membership data stored on a cassette tape, so how do we use it?

We now come to the operating programs, and these are very simple. All that is required is to read the data for a member and then write out those parts that give the required answer. Then go on and read the data for the next member and so on. This is the working part of the program and it must be preceded and followed by some general instructions to PET, such as which file to read. These instructions will be the same for every operating program and we will look at them first.

That concludes the opening to each program. Note the use of A $, etc. for the first eight data items which are either letters or letters & numbers, whereas just I & J are used for the last two since they are simple

500 NEXT Z go back to line 50 and repeats program for next member
510 CLOSE R Reaches when all members in file have been dealt with
520 LET R = R + 1 Gives number of next file
530 IF R = 19 all files have been processed
GOTO 550
540 GOTO 20 Starts on next file
550 PRINT "FINISHED" End of program.

These opening and closing lines can be entered into PET and then recorded on a cassette tape. Then when ever an operating program has to be written, they can be loaded into PET in a few seconds, and lines 51 to 499 are available for the entry of the working part of the program. Consider the list for the steward. We want a print name (A $, B $, C $, H $) for each member followed by 'phone number (H $). We must then also

print JUNIOR in the appropriate cases.

The program will be:

60 IF I = 13 OR I = 14 GOTO 90 (Sorts out Junior)
70 PRINT A $, B $, C $, TAB (20), H $ (Prints data for other categories)
80 GOTO 500 (Transfers to NEXT Z (next member in file))
90 PRINT A $, B $, C $, TAB(20); H $; TAB(01); "JUNIOR": (Prints data for Junior. Will then go next line i.e. 500.)

Typical output from this program would be:

MR M J A JXSON 2916
MR O A J A JXSON 2916 JUNIOR
MR J E BROWN NO PHONE

Address labels for playing members would be catered for by:

60 IF I = 5 OR I = 6 GOTO 500
70 IF I = 11 OR I = 12 GOTO 500
80 PRINT A $, B $, C $
90 PRINT D $
100 PRINT E $
110 PRINT F $
120 PRINT G $

Lines 60 and 70 omit social mem-
bers and lines 80 to 120 print names and addresses of playing members. Even simpler for the list of lady members. Since their categories are 7 to 12, only one line is needed to select them, followed by another line to print their names.

60 IF I< 7 OR I >12 GOTO 500
70 PRINT A $, B $, C $

The "horror" task even has a very simple program. It requires more lines but the operations are routine. This task could have been tackled in many ways, but the Hon. Sec. has de-
cided that an individual letter should be produced for each member, which suitably folded may be put in a window envelope, so obviating the need to address envelopes and ensure that each has the correct letter inserted.

The program could be:

60 PRINT A $, B $, C $
70 PRINT D $
80 PRINT E $
90 PRINT F $
100 PRINT G $
101 PRINT
102 PRINT
110 PRINT "DEAR": A $, C $
111 PRINT
112 PRINT
120 PRINT "YOUR SUBSCRIPTION IS NOW DUE FOR NEXT YEAR"
121 PRINT "PLEASE SEND IT TO THE HON. TREASURER AS SOON"
122 PRINT "AS POSSIBLE"
130 IF I= 1 GOTO 150
131 IF I= 2 GOTO 152
132 IF I= 3 GOTO 154
133 IF I= 4 GOTO 156
134 IF I= 5 GOTO 158

44
The Hon. Sec. will of course record the program and the annual chore will be virtually eliminated. Finally, to show the flexibility of the system let us see how data item J can be used to produce address labels for families. J has the following values:—

- No other family members: 1
- Wife only: 2
- Wife & children only: 3
- Child/children only: 4
- Husband is a member: 5
- Parent is a member: 6

The simple address label program is:

```
100 IF J = 5 OR J = 6 GOTO 500
110 PRINT A$; "& MRS"; BS; "AND FAMILY"
120 PRINT A$; B$; C$; "AND FAMILY"
130 PRINT A$; B$; C$; "AND FAMILY"
131 GOTO 201
```

Now we must omit the family members, those for whom J = 5 or 6.

```
100 IF J = 5 OR J = 6 GOTO 500
```

The objective has been achieved. Many of the routine tasks associated with Membership have been transferred to the small computer. No experts have been required. Great knowledge of programming has been needed. The system is simple and it works. It is flexible and can easily be made to give other outputs if wanted. It may be fairly slow, but that does not matter in this context. Depending on the speed of the printer used, an hour or less will see many of these programs completed.

Let us conclude with an example of the sort of thing that happens in real life. The Hon. Sec. has spent many hours recently carrying out his duties, including preparing the list of lady members. It is a lovely evening and he decides that he will relax and actually play some golf himself. He arrives at the club, only to be greeted by the youngest and most attractive member of the ladies' committee—they always choose her for this type of task—who thanks him for the list and then goes on to say "but you haven't given their 'phone numbers'—they hadn't asked for them—"so could you please add them to the list, and if it is not too much trouble leave it with the steward before you go home to-night?"

In pre-PET days he could have acted in several ways e.g. resigned on the spot, committed murder, or even, possibly, have given up the idea of playing golf and settled down to some more tedious work. Now, he merely smiles and says "No trouble at all, my dear", goes into the office, loads "PRINT LADIES", changes line 70 to PRINT A$; BS; TAB(20); H$ and sets PET to run. Sometime later, he comes in after an enjoyable game and picks up the revised list from the office; on his way to the mens' bar.
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PERSONAL COMPUTER WORLD JUNE 1979
A FORTRAN COLORING BOOK
By Roger Emanuel Kaufman
The MIT Press
Cambridge, Massachusetts
and
London, England

Here is a book that makes programming sound like fun. It even makes programming in Fortran sound like fun! It more than lives up to its motto on the cover: "Learn COMPUTER PROGRAMING the Painfully Funny way!".

Fortran is not presented in terms of magical formulae; the author puts forward a clear computational model of the Language. Mommy's bureau drawers may seem a frivolous way to describe a computer's memory, but Kaufman's model is consistent and effective.

The topics covered in this book include:
- Names and Values (Integers and Reals)
- Assignment (Arithmetic Expressions and Built-in Functions)
- Branching
- Input and Output (Formats)
- Loops
- Arrays (and implied Do Loops)
- Data Types (Explicit, Logical and Complex)
- End statement
- Subprograms (Functions and Subroutines)
- Dummy Arrays
- Function Statement
- Storage Organisation (Common and Equivalence)
- External statement
- Data statement

The above list of topics reflects the order of presentation in the book. The text includes as well a complete set of sample problems and exercises. The emphasis is on numerical methods and the reader is encouraged to use these critically.

There are two! The handwritten script and illustrations in the text deserve a mention; only a movie of the book could be more entertaining.

On the whole I liked the way Kaufman related the "piddling puny petty paltry particulars" of Fortran. Even his awful puns are endearing. This is an ideal book for people who want to get used to, this book is recommended for the libraries of all enthusiasts with interests in hardware.

Paul M. Jessop

Error Message: "Evolutionary Programming" (PCW April 79) in the list of steps on page 46 an extra step should be inserted between steps (iv) and (v). This step reads: "This input will generate a single digit output -- for the sake of the example suppose this is 9."

The Bit Pad computer digitizer converts graphic information into digital form for direct entry into a computer. By touching a pen like stylus or a cursor, to any position on a drawing, diagram, photograph or other graphic presentation, the position co-ordinates are converted to digital equivalents.

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THE CHEAP VIDEO COOKBOOK
By Don Lancaster,
Howard W. Sams and Co., Inc., $5.95

Another masterpiece in clear and interesting electronics from the Lancaster stable, this sequel to the "TV Typewriter Cookbook" should be of interest to any computer hobbyist whether or not they have any intention of building a video display. In contrast to the designs in the previous book, the techniques used are predominantly software orientated, with the resulting reduction in the complexity which gives rise to very low hardware costs. This does of course mean that the software is much more complicated since it carries the burden of much of the timing. For users of the 6502 and the KIM 1 in particular, complete debugged software is provided, and this is said to be easily translatable for the 6800.

As with all books of this type of American origin, it is necessary to remember the differences between the British and American TV standards. However, despite the difference between the 50Hz and 60Hz field rates, the line rates is quite small so only small changes will be needed to the software.

This book sets out by setting a problem: to build a TV display device with minimum cost, and solves it in a way which most hobbyists will be able to understand. It also raises some very interesting possibilities, for instance the possibility of building an intelligent (i.e. with onboard dedicated microprocessor) visual display unit at a cost apparently below that of a unit using the so-called super-chip controller.

Despite the relatively high cost, which hobbyists must be getting used to, this book is recommended for the libraries of all enthusiasts with interests in hardware.

Paul M. Jessop
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NEWS FROM THE CLUBS
Students at the University College of Swansea are forming a local amateur computer club for the Swansea/South-West Wales area; Peter Skan of 6D7 Vivian House, Roman Bridge Close, Blackpill, Swansea, would like to hear from anyone interested in joining.

The recently formed Grampian Amateur Computer Society meets on the second Monday of each month; details of their meetings may be obtained from their president Michael Brown at 282 Queens Rd., Aberdeen AB1 8DR. Having recruited several new members as a result of publicity in the local press and radio, they suggest that other groups try the local media; which will usually cost the club nothing.

The Amateur Computer Club is now in its seventh year, making it the oldest existing amateur computing organisation in the world and — with around 2000 members — one of the largest. For those who are not aware of it, the ACC is essentially a national club, supported by a bi-monthly newsletter, whose main function is to help enthusiasts get in touch with one another, and to pass ideas, programs and hardware tips between members. Several libraries and user groups exist within the Club, usually based around particular processors. Although the membership fee has risen this year it is still a bargain and can be recouped many times by taking advantage of discounts available to ACC members. For more details and a (computerised) membership application form, send a sae to Mr. D.J. Ellis 82 St. Albans Rd., Kingston, Surrey.

A computer Club catering for both amateurs and professionals has been started at Southgate Technical College, High St., London N14. Anyone interested in computers (especially microcomputers) is welcome and can ring Paul Woolley at the college (01-886 6521) for further information.

David James of 5 Ox Lane, Harpenden, Herts asks if anyone is interested in forming a group in his area. If you are, then don’t hesitate to write to him or telephone him at Harpenden 6366.

The Bristol Computing Club is now well under way, and holds regular meetings on the third Wednesday of each month. Details of future meetings may be obtained by sending a sae to the Chairman: Mr. L. Wallace at 6 Kilbernie Rd., Bridge Farm Estate, Bristol BS14 0HY.

AND FROM GLOUCESTER
Heathkit’s new ‘Computer Systems’ catalogue makes fascinating reading for DIY enthusiasts, for as well as the H8 and H11 computers, Heath are now producing a useful range of peripherals, including the H10A paper tape reader/punch; which can read 8 hole tape at 50 characters per second and punch at 10 cps; and the H9 ASCII VDU terminal. But perhaps the most interesting item is the H14 line printer. At £396 for the kit, or £554 assembled, this is a dot matrix printer with a maximum instantaneous speed of 135 upper/lower case characters per second. It uses sprocket feed edge punched paper up to 9½” wide and interfaces via a RS232C or 20mA current loop serial interface at 110 to 4800 baud. Given Heathkit’s reputation for a quality of design and documentation, this printer must be attractive to any amateur looking for a decent hard-copy peripheral.

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THE AMATEUR VIEW

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FOR SALE
The South Yorkshire Personal Computing Group meets on the second Wednesday of every month, and details can be had from Tony Rycroft, SYPCG Secretary, 88 Spineyfield, Moorgate, Rotherham, S. Yorks. Tel: Rotherham 74889 (Evenings).

The Merseyside Nascom Users Group meets on the first Wednesday of each month at 7.30 pm at the Mona Hotel, James Street, Liverpool 2. Contact: Graham Myers at 051-677 9340 (after 7pm).

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FOR SALE

FOR SALE
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FOR SALE — 8K PET with cover, plus 5 programmed game cassettes (Startrek, Wartrek etc.). 13 blank cassettes, games book, basic programming book + selection of computer mags. Less than 2 months old. £800 one J. Penton, 7 Sutton Road, New Ranges, Sheebury, Essex, SS3 9SS.

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Is the Sorcerer magic? S. Gimblett, F & CPO Mess, HMS Neptune, Farlane, Helensburgh, Dunbartonshire, GB4 8HL, thinks so and wants to start a magicians' circle (users' group). Get in touch with him if you're interested.

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Michael Brown, president of The Grampian Amateur Computer Society invites canny computer loving Scots to contact him at 282 Queen's Road, Aberdeen, AB1 8DR. Meetings usually on 2nd Monday of each month, locations vary according to event. SAE for details, please.

Ian Prece and friends are endeavouring to begin a Personal Computer Club in the Bournemouth/Poole Area. Interested? Contact him at 246 Stewart Road, Charminster, Bournemouth.

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A computer club, for amateurs and professionals, has started at Southgate Technical College. The groups welcome anyone interested in computers, especially micro-computers. Please ring Paul Woolley on 01-886 6521 for further information.
Many small system users have the problem of balancing hardware and software costs within a fixed budget. Every penny saved on software means better hardware facilities. The D.I.Y. enthusiast is at a big advantage in this situation, since not only are his software costs minimised, but with a little extra effort the software can be designed to use the available hardware to the best advantage. With these thoughts in mind, the author has written a Z80 Editor/Assembler to run on a NASCOM 1 system. The design objectives and general principles should be of interest to anyone developing systems software for a small system. (The Assembler itself should eventually be available through the INMC.

**Design Objectives**

1. **Target Hardware**
   This was the NASCOM 1 with 4K of expansion RAM, and dual cassettes. (A version of the Assembler has in fact run on the basic NASCOM, although this version had numbered instead of named labels). For those unfamiliar with the NASCOM, its basic form has 1K of RAM dedicated to the VDU, plus 1K of user RAM. However, the VDU RAM can be used for programs if desired.

2. **Memory Required**
   An important objective was to leave as much RAM as possible for user programs, the aim being 5K out the total of 6K including VDU RAM. This was achieved by using separate Editor, Assembler, and Linker programs.

Development of a user program proceeds as follows. The source code is first saved on cassette using the Editor. This cassette is then input to the Assembler, which outputs an object code cassette containing unassembled labels, but having all code translations completed. Finally, the executable program is linked direct into RAM by feeding the object code into the Linker program. Some other advantages of this arrangement are the potential for creating libraries of object code routines which can be linked with other programs, and the ability to relocate programs easily.

3. **Flexibility**
   The Assembler was written with later expansion in mind, in particular the inclusion of instructions which decode to more than one machine code instruction, and of improved assembler directives. These objectives were met by using a single data table to define both instruction syntax and the actions required to generate the machine code or handle directives. This approach is efficient in memory requirements, easily debugged, and recommended to anyone thinking of writing an Assembler. Further details are discussed below.

**Syntax Decoding**

All syntax decoding problems are similar in the sense that they specify legal combinations of some basic alphabet or character set, and the context within which these combinations are valid. The legal combinations can themselves be combined into sequences, thus making 'sentences' from the 'words'. Repeating the process generates 'paragraphs' from the 'sentences' etc.

**Figure 1. Syntax tree**

As a simple example, consider the problem of specifying the syntax for an assembler having only four possible instructions, ADD B, ADD C; SUB A, SUB B. (See Fig. 1). At the highest level of combination, all these instructions are arithmetic types. At the next level down, level 2, the SUB instruction can be followed by A or B, while the ADD instruction can be followed by B or C. The tree diagram of Fig. 1 therefore defines the complete syntax for this assembler.

In a practical assembler, the full tree diagram would be subdivided into a number of sub-trees, each containing only a few levels.

All that remains is to translate tree diagrams into software. Let us attach a unique number, the syntax code, to each syntax element in the tree, where a syntax element can be
any single character, group of characters or word, or any higher level of combination.

In our example, the highest level is all arithmetic instructions, and this is allocated code 1 in Fig. 1.

The problem is now solved, bar the hard work!

Characters from the actual instruction are first converted into the equivalent syntax codes.

A preset table (SYNTAB) is created containing the syntax codes defined in the tree diagram, and an indication of the sequence in which these must occur.

The instruction codes are then checked against those defined in SYNTAB.

If we now take a stroll through the process of verifying the syntax of an instruction, the structure required in the SYNTAB table will become apparent. We enter the table at the highest level, which contains code 1. On its own, this number is not very informative, since we do not know whether it represents a single character, or higher grouping. Consequently, a control bit is needed in each entry to indicate this. In addition, an address word, or means of indicating the start of the next level, is required. Armed with this data, we can proceed to the next level down.

At this point, it is instructive to view the above process in a different way. Let us think of the code (1) at the first level, and its associated control bit, as a "call" to a 'subchain' defined elsewhere in the table, i.e. at the address defined by the address word mentioned above. Instead of level 2, therefore, we shall change the nomenclature to sub-chain 1. The parallel between subchains and subroutines in a program is obvious, and for most people it is easier to think in terms of subchains rather than syntax levels.

Having reached subchain 1, we see that this can be either of two elements, code 2 or code 3, and that both of these are themselves subchains. (See Fig. 1). Subchain 2 is accessed first, and this is seen to have only one possible sequence of letters (SUB) and no subchain calls, and can therefore be checked against the syntax codes from the actual instruction. If the codes match, then we may return to the call to subchain 2 with success.

However, this creates a problem, since where do we go next? If the match had failed, we would have checked subchain 3, and if that had failed to match also, we would exit with a syntax error. When a match is obtained, however, another address word is required to indicate where to find the next SYNTAB entry, assuming that the syntax is not complete. Every SYNTAB entry is therefore like a conditional jump, since a failed match always goes to the adjacent table entry, while a successful match branches to a non-consecutive entry.

Most of the SYNTAB entry structure is now apparent, and may be summarised as follows:--

<table>
<thead>
<tr>
<th>ENTRY</th>
</tr>
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<tbody>
<tr>
<td>INITIALISE CHP, SYNP, OUTP AND ERR</td>
</tr>
<tr>
<td>YES</td>
</tr>
<tr>
<td>NO</td>
</tr>
</tbody>
</table>

| COMPARE SYNTAB CODE WITH NEXT CODE |
| YES |
| NO |

| FIND NEXT CODE IN SYNTAB |
| NO |

<table>
<thead>
<tr>
<th>ADDRESS</th>
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<tbody>
<tr>
<td>L1</td>
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<td>L2</td>
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<tr>
<td>X</td>
</tr>
</tbody>
</table>

<table>
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</tr>
</thead>
<tbody>
<tr>
<td>X</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ADDRESS</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
</tr>
</tbody>
</table>

1. Define syntax code values for all syntax elements.
2. Equate all code values which are not single characters with the corresponding subchain.
3. Use a syntax table with the following minimum format for entries:
   a) Control word bits defining subchain calls, end of syntax, and end of a set of consecutive alternative codes.
   b) Syntax code value, and address of subchain if needed.
   c) Address of next entry if this code was found successfully.

Figure 2 shows a syntax table for the above example, constructed along the lines indicated. The first word of each entry is a control word (CW) with the following bit allocations:

<table>
<thead>
<tr>
<th>CW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bit 0. End of syntax, or of subchain.</td>
</tr>
<tr>
<td>Bit 1. End of set of alternative codes.</td>
</tr>
<tr>
<td>Bit 2. Sub-chain call indicator.</td>
</tr>
<tr>
<td>Bit 3. Save sub-chain code if set.</td>
</tr>
</tbody>
</table>

Two more control bits have been used in addition to those mentioned earlier. These control the storage of syntax codes in an output buffer.

Figure 2. The SYNTAB Table
All numbers are in HEX.
X means unused address

Figure 3. SYNTAX DECODER

52
Also note that the syntax codes for single characters in Figure 2 are the same as the ASCII code without parity.

Figure 3 is a flow diagram for a routine which can be used as a syntax decoder in conjunction with the table. The input to this routine is the current instruction, and the output is a list of checked syntax codes plus an indicator for legal syntax. Note the use of a special software controlled stack (SYNSTK) which is used in calling subchains. The following is a brief description of the main variables used:

1. **CHP.** This is used to point to the current position in the input list.
2. **OUTP.** This points to the next free entry in output list of syntax codes.
3. **SYNP.** Points to the current SYNTAB entry.
4. **ERR.** This is cleared to indicate a syntax error.
5. **SYNSTK.** This is a FIFO stack, used to save and restore the first three variables above on entry to or exit from a sub-chain.

So far, no mention has been made of how the actual machine instructions are generated. This is done simply by defining a set of routines which, in conjunction with code definition tables, are capable of generating the required machine code. These routines constitute the code generator, and may be identified by numbers which can be inserted at appropriate points in the syntax table, together with any required parameters. The appropriate routine can then be executed when the associated syntax code has been successfully matched in SYNTAB. A simple modification of the flow diagram of Figure 3 will allow this to be done.

Typical routines for a Z80 code generator might be:

1. Get instruction from code defining list.
2. Modify instruction (e.g. to insert register reference).
3. Insert byte to instruction (e.g. for IX and IY references).
4. Write instruction to output device.

This is not intended to be an exhaustive list, but gives an idea of the routines needed. Assembler directives can be handled by a second set of routines.

In conclusion, Figure 4 illustrates all of the main elements of this type of Assembler. Once an Assembler has been written within this general framework, it is relatively easy to generate assemblers with different syntax, or cross assemblers, or even simple high level languages such as BASIC. It is hoped that this article will encourage budding Assembler writers to take the Bit firmly between the teeth!
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Continued from Vol. 2 No. 1

Note: The author has forwarded some corrections which will be published in Vol. 2 No. 3.

D. W. Parkinson

EADDR: 0002
OPCADR: DS
HXYFLG: 0001
LABELA: 0000
BUFFER: 0002

0001 DD: 0003
0002 DD: 0002
0003 DD: 0006
0004 DD: 12-08-78
0005 DD: 2.1
0006 DD: Version 2.1
0007 DD: THE PROGRAM IS IN THE FORM OF A SUBROUTINE
0008 DD: (HL),$20
0009 DD: THE CONTROL PROGRAM MUST HAVE PLACED THE OBJECT
0010 DD: (ACTUAL LOCATION OF CODE TO BE REVERSE ASSEMBLED)
0011 DD: (DE) WITH THE "PROGRAM" ADDRESS
0012 DD: (STARTING ADDRESS USED IN THE LISTING)
0013 DD: (LD DC WITH THE 578 RT MEMORY ADDRESS)
0014 DD: (ACTUAL LOCATION OF CODE TO BE REVERSE ASSEMBLED)
0015 DD: (LD HL, WITH THE EXO ADDRESS)
0016 DD: (REVAS RETURNS WHEN THIS ADDRESS IS PASSED)
0017 DD: CALL REVAS
0018 DD: VARIABLE STORAGE
0019 DD: $1000 WORKSPACE
0020 DD: ORG$1000
0021 DD: DS 3 ;RAM PATCH TO ROUTINE
0022 DD: DS 2 ;PROGRAM COUNTER
0023 DD: DS 2 ;CURRENT MEMORY ADDRESS
0024 DD: DS 2 ;WHERE TO STOP
0025 DD: DS 2 ;POINTER IN BUFFER
0026 DD: DS 2 ;POINTER TO POS. IN BUFFER
0027 DD: DS 52 ;OUTPUT BUFFER
0028 DD: DS 52 ;LABEL VALUE
0029 DD: DS 52 ;LABEL VALUES
0030 DD: DS 52 ;NEXT LINE OF OUTPUT
0031 DD: DS 52 ;CHECK FOR END
0032 DD: DS 52 ;CLEAR BUFFER
0033 DD: DS 52 ;CLEAR BUFFER
0034 DD: DS 52 ;CLEAR BUFFER
0035 DD: DS 52 ;CLEAR BUFFER
0036 DD: DS 52 ;CLEAR BUFFER
0037 DD: DS 52 ;CLEAR BUFFER
0038 DD: DS 52 ;CLEAR BUFFER

THE PROGRAM IS IN THE FORM OF A SUBROUTINE
IT IS CALLED BY A CONTROL PROGRAM WHICH
THE TRANSLATION OF AN EXISTING PROGRAM IN MEMORY
AND EXECUTE

D.W. Parkinson
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Some months ago now, in the November 78 issue of PCW, there was a letter from David Broughton posing an interesting little programming problem for the 8080 which went something like this: *Imagine you possess an 8080 with 64K of read/write memory which you want to clear. Write a program that sets all 65536 bytes to zero.*

At David's suggestion this turned into a competition the object of which was to write the above program in either the fewest number of bytes or the shortest execution time. Spurred on by a two pound (increased to five pound) prize solutions were saved by loading HL direct rather than using the accumulator. Execution time to clear memory is 10+5+32768 \( \times 11+32767 \times 5 = 524298 \) cycles or 0.262149 seconds at 2MHz.

### The two remaining six byte solutions are equally 'correct' since they both take the same time to execute.

<table>
<thead>
<tr>
<th>Address</th>
<th>Code</th>
<th>Mnemonic</th>
<th>number of clock cycles</th>
</tr>
</thead>
<tbody>
<tr>
<td>FFFC</td>
<td>21 00 00</td>
<td>LXI HL,0000</td>
<td>10</td>
</tr>
<tr>
<td>FFFF</td>
<td>F9</td>
<td>SPHL</td>
<td>5</td>
</tr>
<tr>
<td>0000</td>
<td>E5</td>
<td>PUSH H</td>
<td>11</td>
</tr>
<tr>
<td>0001</td>
<td>E9</td>
<td>PCHL</td>
<td>5</td>
</tr>
</tbody>
</table>

This program is very similar to the previous solution and works in exactly the same way. Four clock cycles (2 micro-seconds) are saved by loading HL direct rather than using the accumulator. Execution time to clear memory is 10+5+32768 \( \times 11+32767 \times 5 = 524298 \) cycles or 0.262149 seconds at 2MHz.

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Neil Harrison
The PCW competitions seem to have gathered momentum now. The number of entries is staggering. This competition attracted over 200 entries. The age ranges and areas were diverse, but yet I received only one female entry.

This competition was to write a BASIC program to print four Bridge hands. There were two categories for entries. These were:

(i) write the Fastest program, and
(ii) write the program with the fewest number of statements. Each run should produce different hands of the form North, East, South, and West followed by the cards.

I deliberately left the layout undefined. Each entry required the inclusion of a stamped addressed envelope; amazing how many people ignored this request. I always reply personally to each entry, and hence the need for an SAE.

The winner of category (i) was J. Yale of Wimborne, Dorset; who provided a program that ran 20 times in 2½ seconds. This program was a clear winner over the next entries. Creditable entries were received from Chris Why, Paul Shirley, John Steggals, P. J. Andrews, and D. C. Broughton.

The winner of category (ii) was J. T. Steggals, whose program was only 8 statements long. Creditable entries that were only nine statements long were received from A. H. MacDonald-Smith, H. O. Roberts, J. Yale, G. M. Tennant, B. Bloomfield, J. A. L. Clark, and H. N. Dobbs; so as you can see, the winner only won by one statement, but even then he only won because I did not specify the layout.

Here are the two winning programs:

FASTEST

```
10 DIM P(51)
20 P$=";AC, 2C, 3C, 4C, 5C, 6C, 7C, 8C, 9C, 10C, JC, QC, KC"
```

BIRMINGHAM

<table>
<thead>
<tr>
<th>Order</th>
<th>Description</th>
</tr>
</thead>
<tbody>
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<td>£470.00</td>
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<td>PET 2001 16K &amp; 32K</td>
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</tr>
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</table>

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This competition has been very difficult to judge because of the number of entries; as I have said, over 200 entries. It was necessary to run all of the entries. Some people submitted two or three programs making the task even longer. Judging this competition was aided by the fact that Research Machines supplied me with their "real-time clock board" for the 380Z. I modified the BASIC interpreter so that it could access the clock, and also allowing BASIC to scan the keyboard in a similar way to PET's GET command. Because of Research Machines' kindness I was able to time the programs much more accurately than I could otherwise have done. As users of the PET will know, there are a great many applications and games that require a clock and to users of the 380Z I can recommend its purchase. Advice on the above interpreter and on applications for the board can be obtained by including an SAE to my address at the end of this article.

While on the subject of the 380Z and also considering that I wrote an article on how to make BASIC programs run faster, users of the 380Z might like to note that 8K/9K BASIC allows you to finish a loop with NEXT with no parameter, this results in a 25% increase in speed. Also NEXT X,Y works.

Back to the subject of judging the competition. I had a great many people who asked, "How are you going to time category (i)." Some people even suggested that I would not be able to judge the competition fairly because of the difference in times between a teletypewriter and a VDU, or even a lineprinter. Well, the scheme devised, hopefully, overcomes the problem, and should have occurred to those who posed the question. Each program was run as submitted to see if it worked. If it worked it went through to the next round. I only received three that didn't work, surprisingly when you consider how many entrants admitted to having no computer on which to test their programs. Round two consisted of dividing the programs into two categories, category two being put aside for judging later. Category one (the fastest program) proved to be the most time consuming because each of the programs had to be modified in the following ways:

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There is no need, in fact it is wrong, to print the buffer lines. There was a great range of times for the programs; from the winning one which ran 20 times in 2½ seconds to one which took over 200 seconds for 20 runs. The average was around 30 seconds. Some of the output layouts were poor, but as the output format was defined this made no difference to their final positions.

As an example of programming techniques, and the ability to make a program faster I would like to show a program submitted by Mr. R. Ross which took 50 seconds for 20 runs. After applying some of the techniques outlined in my previous article on faster BASIC programs, it took only 24 seconds, over 100% improvement.

10 DIM A$(1,53)  
30 FOR X=1 TO 53  
32 READ AS(X)  
34 NEXT X  
40 FOR Z=1 TO 25  
50 LET Y=INT(51.9999*RND+1)  
60 LET X=INT(52*RND+1)  
70 LET A$(11,53)=A$(11,X)  
80 LET A$(11,Y)=A$(11,53)  
95 NEXT Z

I have no idea at all why a 2-dimensional array is used, but it certainly takes longer to reference an element in a 2-D array than it does for a 1-D array, so these were all changed. A$(1,53) is only used to hold a temporary numeric constant held as a variable. Consult John Coll’s benchmark tests to see whether your machine would benefit from that alteration. (The benchmark tests were given in Vol. 1 No. 1, and the timings again in the November 1978 issue).

10 DIM A$(52)  
30 FOR X=1 TO 52  
32 READ A$(X)  
34 NEXT X  
40 FOR Z=1 TO 25  
50 LET X=INT(52*RND+1)  
60 LET Y=INT(52*RND+1)  
70 LET AS(Y)=AS(X)  
80 LET A$(X)=A$(Y)  
90 LET A$(Y)=T$  
95 NEXT Z

Note also that some interpreters work faster with each numeric constant held as a variable. Consult John Coll’s benchmark tests to see whether your machine would benefit from that alteration. (The benchmark tests were given in Vol. 1 No. 1, and the timings again in the November 1978 issue).
In order to restrict the entries to future competitions, I shall be setting harder problems to solve.

**Competition – Magic Squares**

We have all met the magic square

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>2</td>
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<td>4</td>
<td>3</td>
<td>8</td>
</tr>
</tbody>
</table>

where each row, column, and diagonal add up to the same number. The magic constant (a fundamental property of a magic square) is 15. There are magic squares of other orders than $3 \times 3$, but I will concentrate on these. These are perhaps the best known. The next is the $4 \times 4$ square.

Let's examine the $4 \times 4$ square.

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<table>
<thead>
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<tr>
<td>7</td>
<td>1</td>
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<td>3</td>
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<td>2</td>
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<tr>
<td>8</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

The row, column, and diagonal total (which I shall call the 'magic constant') is 201. There is something even more 'magic' about this square - when the digits are reversed the square is still magic.

4. The sum of the magic constants is less than 200.

5. When the digits are reversed, another magic square is satisfied.

6. The row, column, and diagonal total (which I shall call the 'magic constant') is 201. There is something even more 'magic' about this square - when the digits are reversed the square is still magic.

MC = 228. Unfortunately four of the original numbers (66, 67, 76, 77) occur again in the reversed square.

The competition is to find a magic square that satisfies the following conditions:

1. The square is comprised of 2 digit numbers (zeroes not allowed)
2. It is a $3 \times 3$ square
3. When the digits are reversed, another magic square is produced with none of the original numbers reappearing.

Entries to Sheridan Williams, 114, Beech Road, St. Albans, Herts AL3 5AU. Enclose an SAE if you require the program returned.

---

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<td>£875.00</td>
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<td>£45.00</td>
</tr>
<tr>
<td>Memory Expansion Kit</td>
<td>£76.60</td>
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<tr>
<td>Electric Pencil</td>
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Micro computers can be used in education in various ways, most usually by means of an interactive program. A particular skill is taught by question and answer. However, another use to which the computer can be put is to simulate processes, not for the purpose of solving problems but for a visual impact which cannot really be achieved in any other way. Cine film is useful but it always presents a mere picture whilst the computer can present a close analogue of the physical process.

For this purpose random processes are the ideal choice. A random number generator is used here; a sequence is obtained by adding together seven hexadecimal bytes to get the next byte. In the machine code of an eight-bit processor such as the 6502 in the Apple II which I used for these programs, this is easy to do modulo 256. However, the cycle length in this modulus is too short so we convert to modulo 255. This is done by an easy trick. You just keep adding the high and low bytes together until the high byte is zero. The result is a number mod. 255 - which means the remainder obtained by dividing the original number by 255.

You can check this process by using the mod. command in integer BASIC.

The programs are written in machine code (they take all night in BASIC!) and the random number generator resides in locations 11ED to 122A. You can experiment with your own subroutine. If you have an Apple, or access to one, and haven't tried machine programming, then the resident mini assembler is the thing to start on. You'll learn by talking to the machine with it just as I did. But mind, it spits back at you. A tip about the mini. You are bound to discover you've missed out some instruction and there doesn't seem to be a way of getting it back in. However, you'll find a simple routine for shifting the whole block of instructions from the missing one downward out of the way; inserting the instruction, and then putting the block back. The routine is in the red book. You've probably got a bit of tidying up to do with branch instructions but it is better than retyping the whole thing. And, by the way, get a book on touch typing and practise right from the start. Nothing looks more ridiculous than a computer wizard sitting at a sophisticated machine with fists partially clenched and a pair of index fingers poking away!

The programs listed here make use of the machine subroutines of the HIRES demo tape produced by Apple. You need to load this tape, list it, and alter the instruction in location 0C08 to LDA 052 to give a full screen of graphics.

Now for the demonstrations. The first is illustrated in fig. 1. Bins from zero to 254 are loaded with random numbers as they come up. Some 50,000 numbers are involved. The X axis represents the random number X and the Y axis the incidence of that number. You can see the sort of scatter obtained in 50000 trials. Repetitions, by hitting key R, produce different pictures showing that the generator is not in a short loop.
small or large number of trials (the fair die assumption).

Assume two things. The six must come up eventually i.e. the probability that it comes up in an infinite number of trials is unity.

1) The six must come up eventually and simultaneously to put an electron (a white dot) at a fixed height above a hole in the valence band (i.e. to put a black dot amongst the white) and simultaneously to put an electron temperature is electron temperature is low. (Counting the first bin as bin zero). It is consistently low. This is due to the fact that seven numbers are added to produce the random number. It is as if you were using a die for which it was unlikely to score a six last came up! However for most applications this error is unimportant and its consistency permits it to be allowed for. A fourth-order additive system would here put this error in an awkward place.

The next demo is a Poisson distribution. This occurs in the case of a very large number of trials and a very low probability of success. When all the probable causes of human death, including old age, have finally been conquered you are pretty sure to die of something unlikely! The classic poisson distribution concerns the incidence of death among officers of the Prussian army by being kicked by their horses, for which actual records were kept (I am told the converse was a common occurrence).

The Rapid Fall-Off

In this demo 765 trials are made of the occurrence of a random number which has a probability of 1/255 of coming up. This gives an expectation value of three successes. The first bin represents the number of times that no success occurred in a succession of groups of 765 trials. Nearly 3/4 of a million random numbers are used here.

A characteristic of this distribution is the extremely rapid fall-off. With an expectation value of 3 successes the probability of 10 successes is negligibly small. The formula for this distribution is

\[ f_n = \frac{\lambda^n \exp(-\lambda)}{n!} \]

where \( f_n \) is the probability of \( n \) successes and \( \lambda \) is the expectation number. You can test the distribution shown against this formula. Notice it should give equal answers for 2 and 3 successes. They are nearly equal on the histogram shown. The ratio of two consecutive values of \( f_n \) comes out as \( 3/(n+1) \) which checks up reasonably with the values in fig. 4.

Fig. 5 shows the histogram in its early stages. Better results still can be obtained by using, say, sets of 3000 trials with a 1/1000 probability of success. This would take at least 15 minutes to display.

Finally fig. 6 shows a simulation with random numbers. A close-spaced set of dots in parallel lines represents the value of an Axiom page (this is for physics students). A random number is used to punch a hole in the valence band (i.e. to put a black dot amongst the white) and simultaneously to put an electron (a white dot) at a fixed height above it. This represents absorption of a photon. A yes-no random number decides whether this or the reverse will happen. The reverse represents stimulated photon emission.

However, the reverse process does nothing at all unless there is an excited state (white up — black down) to de-excite. If this was the only process (excitation and equally probable de-excitation) then the population of white dots up and white dots down would quickly equalise. We would say that the electron temperature was infinite. This is shown in fig. 6. However, in practice the electron temperature is kept down, unless the photon irradiation is very intense, by being cooled by the atoms of the substance. This is called photon induced recombination and a variable recombination rate (again on a random basis) is fed in during the program. Fig. 7 shows the case of a very high recombination rate.

In concluding this article I should like to thank the "Lion House" of Tottenham Court Road, London, who kindly, on a couple of occasions gave me a print-out of the programs, without which editing would have been difficult. The final print-out which you see in this article was provided by my friends at Personal Computers Ltd., and was done on an Axiom printer. I must have one of these. It is the best thing I have seen for the home user.
Appledern

1 NUMBERS=4186:POISSON=4096:PHOT=4335
2 NEGEX=4226
3 FOR I=1 TO 7
4 PPOKE
5 NEXT I
9 POKE 106,0
10 CALL -935
20 VTAB 10
30 PRINT "HISTOGRAM OF RANDOM NUMBERS."
40 PRINT : PRINT
50 PRINT "HIT ANY KEY TO START."
60 X=PEEK (-16384)
70 IF X<127 THEN 60
80 POKE 12 CALL NUMBERS
90 FOR I=1 TO 1000: NEXT I
100 CALL -936
110 POKE -16383,0
120 VTAB 10
130 PRINT "HIT R TO REPEAT OR ANY OTHER KEY"
140 PRINT "TO CONTINUE."
150 X=PEEK (-16384)
160 IF X<127 THEN 150
170 IF X=210 THEN 80
180 POKE -16368,0
190 CALL -936
200 PRINT "BOLTZMANN DISTRIBUTION.
210 PRINT : PRINT
220 PRINT "IF A SUCCESS NEEDS 5 ON THE AVERAGE "A"
230 PRINT "TRIES, WHAT IS THE CHANCE THAT IT WILL"
240 PRINT "OCURR ON EXACTLY THE N'TH TRY?"
250 PRINT "THE NO. OF TRIALS FOR SUCCESS IS PLOTTED HORIZONTALLY AND THE SUCCESS FREQUENCY VERTICALLY."
260 PRINT "THE RESULT OBTAINED WHEN THE NUMBER OF TRIALS IS SMALL IS SHOWN 5 TIMES IN"
270 PRINT "SUCCESSION, THEN THE IMPROVEMENT WHICH RESULTS FROM 500 TIMES THAT NUMBER IS"
280 PRINT "DISPLAYED" : PRINT
290 GOSUB 1000
300 VTAB 10: PRINT "HIT R TO REPEAT OR ANY OTHER TO CONTINUE"
310 X=PEEK (-16384)
320 IF X<127 THEN 310
330 POKE -16368,0
340 CALL POISSON
350 FOR I=1 TO 1000: NEXT I
360 CALL -936
370 POKE -16383,0
400 PRINT "NOW FOLLOWS A SIMULATION OF THE PROCESS"
410 PRINT "OF PHOTON ABSORPTION IN A SEMICONDUCTOR."
420 PRINT "THE LOWER BAND OF CLOSELY SPACED DOTS"
430 PRINT "REPRESENTS THE VALENCE BAND."
440 PRINT "ELECTRONS ARE EXCITED TO THE CONDUCTION BAND, AND EQUALLY PROBABLY DE-EXCITED"
450 PRINT "THE RESULT DESCRIBES A SIMULATION OF THE PROCESS"
460 PRINT "OF PHOTON ABSORPTION IN A SEMICONDUCTOR."
470 PRINT "THE LOWER BAND OF CLOSELY SPACED DOTS"
480 PRINT "REPRESENTS THE VALENCE BAND."
490 PRINT "ELECTRONS ARE EXCITED TO THE CONDUCTION BAND, AND EQUALLY PROBABLY DE-EXCITED"
500 PRINT "HIT ANY KEY TO CONTINUE."
510 X=PEEK (-16384)
520 IF X<127 THEN 520
530 POKE -16368,0
540 GOSUB 1000
550 VTAB 10: PRINT "HIT R TO REPEAT OR ANY OTHER TO CONTINUE"
560 PRINT "HIT ANY KEY TO CONTINUE"
To be Continued
This is a simplified form of the now well-known Roulette casino game, written in Processor Technology's Cassette Extended BASIC, tested, debugged and run on a SOL-20.

The program is, however, straightforward and will be easy to adapt to another BASIC dialect. A full listing is given.

Lines 140, 1170, 1280 and 1520 contain a PRINT "&" statement. This is a control statement for the SOL-20 which simply clears the screen and can easily be substituted or even left out if necessary. The DIM statement in line 150 is peculiar to PTC BASIC and specifies the number of digits which may be contained in the quoted string. In most BASICs such a statement would be used for subscripted string variables but that facility is not available with PTC's BASIC. There are several PAUSE statements included in the listing and, if your BASIC does not have this facility, it can very simply be replaced by a FOR...NEXT loop.

There should be nothing else in the program to cause any problems and you should be on your way to losing all your hard-earned cash within seconds of typing the program into your machine.

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STATPACK

Continued

Colin Chatfield

0005 REM STAT8
0080 LINE = 80
0090 GOSUB 9380
0100 ? "THIS PROGRAM IS SPARE FOR THE USER TO ENTER HIS PROGRAM"
0110 ? "TAB1201;" ; "STATPACK"
0120 GOTO 1200
1000 GOSUB 9600
1010 7 "YOUR ARRAY IS " ; A ; "X " ; 14 ; ; 70HRS(8) ; ; 7 "HRS. " ; A * BrITEMS.
1110 INPUT "CARRIAGE RETURN WHEN READY",A$
1120 GOSUB 5000
1200 GOSUB 9360
1210 IF LEFT4(A1,11="N"THEN I240
1220 IF LEFT4(A1,11="Y"THEN 1140
1230 INPUT "IF LINEAR REGRESSION INPUT Y'",A$
1232 IF AR="Y"THEN 1120
1234 CHAIN STAT1
1240 ? TAB(20);"STATPACK END": END
5000 REM THIS IS A SPARE PROGRAM WHICH CAN BE USED BY THE USER
5010 ? "THIS PROGRAM IS SPARE AND HAS NOT BEEN WRITTEN":RETURN
9000 REM SUB PROGRAMS
9360 INPUT "ENTER 'Y' FOR NONE, 'N FOR NONE " , A1
9370 RETURN
9380 ? CHR1(25);: ? CHR1(25);: ?CHR$(22);
9385 ? CHR1(12);: RETURN
9400 12=0: IF 8=1THEN B=1: 009430
9410 7 INPUT "COLUMN H STATISTICS REQUIRED FOR " ; A
9420 IF 02>0 THEN 7 "TOO HIGH":GOTO 9410
9430 7 1(29): RETURN
9600 OPEN NIO, STATFL1 FOR INPUT
9610 OPEN N20, STATFL2 FOR INPUT
9620 FIELD NIO,F=6
9630 FIELD N20,A=6,8=6
9640 SET 110=1: SET 120=1: GE 1120
9650 DIM C(A,B), F(140)
9660 FOR I=1 TO A: FOR J=1 TO B:
9670 GET 1110: C(I,J)=F
9680 NEXT J: NEXT I:
9690 CLOSE 010: CLOSE N20: RETURN

THE DHCP

WITBIT

David Parkinson & Graham Trott

The assembly language problem forum

The aim of this column is to set small problems, not necessarily complex or obscure, which will provide those of you who program in assembly language with an opportunity to exercise and develop your skill. The published solutions will illustrate one or more approaches to the problem and we hope that in time the pages will form a useful reference library of small subroutines.

Solutions should be in Z80 or 6800 code, and prizes of £10 and £5 will be awarded in each section. Entries for this month’s competition should be in by the end of June. Results in August issue.

Problem:

To write a short subroutine for an editor to execute a “Find string” command.

Background:

The variable SKEY points to a delimiter at the start of an ASCII character string. The string is terminated by an identical delimiter. The variable CURR points to the first character of the current line of an editor source file. The file is stored as:

```
ascii line (CR) ascii line (CR) ...
```

Required:

To search the file from CURR in an attempt to match the string pointed to by SKEY. On finding it CURR is set to point to the start of the line containing the string, otherwise CURR points to the end-of-file marker. Any ‘@’ in the search key represents a “don’t care” character.

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Ga As. Gallium Arsenide – descriptive element of some light emitting diodes and field effect transistors.

Gain. Measure of amplification in an electronic circuit, usually expressed as a direct multiplier (e.g. 1000 times) or in decibels.

Game Theory. Arithmetical process of selecting the best strategy against an opponent who has a strategy of his own. It is an inherent characteristic of game theory that decisions of one contestant alter the opportunities of others.

Ganged (controls). Physically connected so that they move together, though not necessarily in the same direction. A pair of ganged switches might close one circuit at the same instant as another circuit is opened.

Gap (1). The gap in a read/write head for some magnetic storage peripheral (for example, tape, or disc) is an unchanging physical fact built in by the manufacturer, which has been designed so that the tape, or disc) should be kept small and constant.

Gap (2). The space between a read/write head and the magnetic surface it serves. Where that surface is constantly in motion, for example, on disc, physical contact would cause undue wear and the head is, therefore, kept slightly clear. The gap should be kept small and constant.

Gated. An electronic switch, typically found in an integrated circuit and arranged to respond logically to a particular pattern of signals presented simultaneously to a number of input connections.

Gating. Electronic switching of a circuit, typically under the control either of a clock (opening and closing the gate periodically) or of logical circuits responding to specific patterns of input signals.

Generalised Routine. A computer program written to a specified structure (for example, to extract information from a magnetic tape file of customer's balances) which has been designed so that the parameters can be varied very easily. A general program for sales ledger analysis, for example, might on one occasion be set to register only slow moving accounts and on another occasion, by minor modification to the initial instructions, the same program could be used to extract only details of balances which had moved within the last few days. There is sometimes very little distinction between a general routine and a general sub-routine which has been designed to be used in a considerable variety of programs.

Generated. To compose a computer file (for data or program) semi-automatically, given a number of initial parameters.

Generated Address. An address composed out of quantities which arise in the operation of a program. A modified address or relative address can be a form of generated address, but a generated address may also be one determined without any reference to a given base or absolute address.

Giga. Prefix signifying one thousand million.


Gigo. Garbage In Garbage Out (acronym). A reminder that computers do not think and can produce nonsense on a massive scale if fed with inappropriate data.

Golf Ball. A particular design of printing head for an electric typewriter or sequential printer, so called because the type face is embossed on the surface of a metal sphere about the size of a golf ball.

Gosub. A program instruction (e.g. in BASIC) which transfers control to a subroutine, written elsewhere in the program, and afterw (as a RETURN instruction) the program can be resumed from the point of diversion. In this way a single subroutine may be invoked many times by different Gosub (Go to SUBroutine) instructions.

Goto. A program instruction (e.g. in BASIC) which transfers control to another part of the program.

Graceful Degradation. Capability in a computer on break-down, such as power failure, to close its activities in an orderly way so that minimum damage is done either to the machine or to the work being processed. Synonymous with fail soft.

Grandfather-Father-Son. An extension of the Father-Son technique of preserving a copy of the earlier record whenever a new version is prepared. As the title suggests, each tape or other record is kept for an extra generation (or updating cycle) before its data is destroyed; in the Father-Son payroll example data for week 39 would be retained until records for both weeks 40 and 41 had been completed and found free from error.

Graphics. The use, particularly on a computer’s display screen, of graphs, bar charts and other designs in place of or in addition to the usual alphanumeric character set.

Graphics Mode. The setting of an adjustable device, such as a daisy wheel type of sequential printer, so that graphs may be drawn on the paper where characters would normally be printed. ‘Graphics mode’ implies that both print head and paper will be moved by a very small distance (and in either direction) between each imprint of a dot or other chosen plotting character.

Graph Plotter. A computer output device which can draw lines (sometimes in several different colours) on paper under computer control.

Gray Code. A binary code drawn up in such a way that in going from one decimal value to the next only one binary digit changes its value, for example:

<table>
<thead>
<tr>
<th>Decimal</th>
<th>Binary</th>
<th>Gray</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>000</td>
<td>000</td>
</tr>
<tr>
<td>1</td>
<td>001</td>
<td>001</td>
</tr>
<tr>
<td>2</td>
<td>010</td>
<td>011</td>
</tr>
<tr>
<td>3</td>
<td>011</td>
<td>010</td>
</tr>
<tr>
<td>4</td>
<td>100</td>
<td>110</td>
</tr>
</tbody>
</table>

Synonymous with a cyclic code.

Ground. An Americanism for earth (as an electrical connection).

Group Mark. A code used to identify the limits of data treated as a single group.

Guard Band. An area capable of carrying information but deliberately left unused in order to prevent accidental interaction between signals carried in neighbouring bands.

Guard Signal. A signal provided in a central processor to prevent the reading of any area of store while it is in the process of change.

Guillotine. A device for cutting paper accurately, normally many sheets at a time; sometimes (instead of a burster) to separate forms printed on continuous stationery into individual documents.
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