60p

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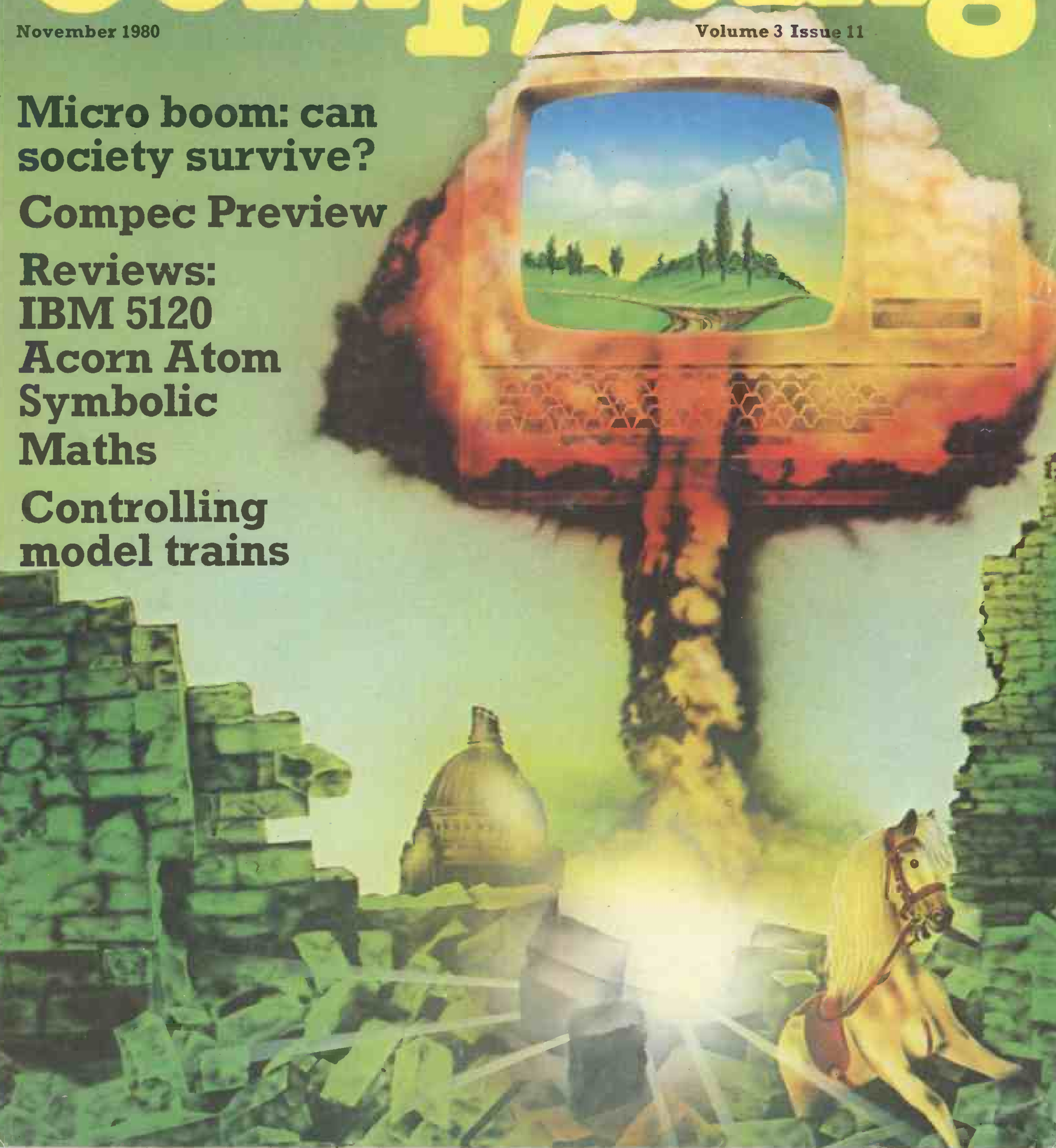

Micro boom: can society survive?

Compec Preview

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Controlling model trains

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A view of society after the micro revolution — page 70.

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CONTENTS

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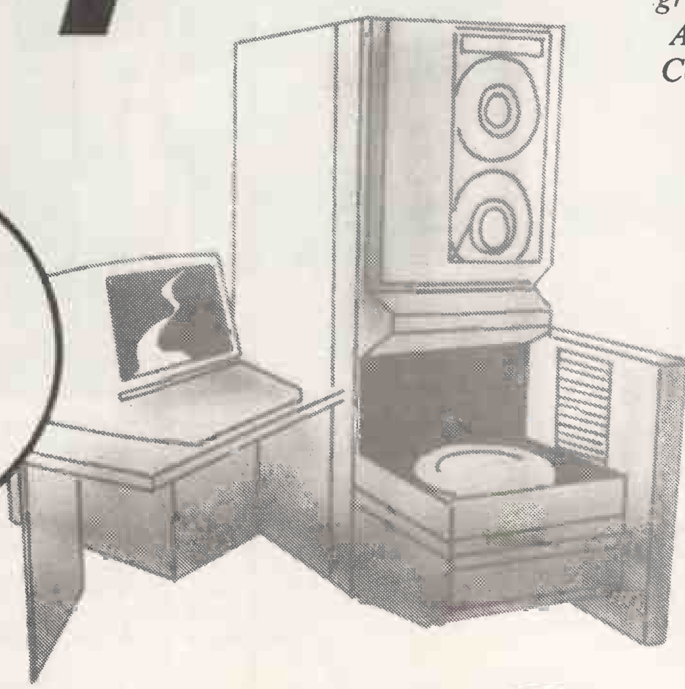

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The NANOCOMPUTER, based on the powerful Z80 microprocessor produced by SGS-ATES, is not just a microcomputer but rather a complete, modular educational system designed to grow with the student.

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08 = *ENTER 'UPDATE BANKS
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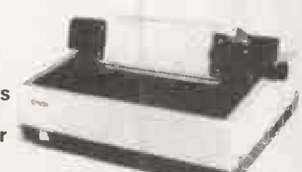

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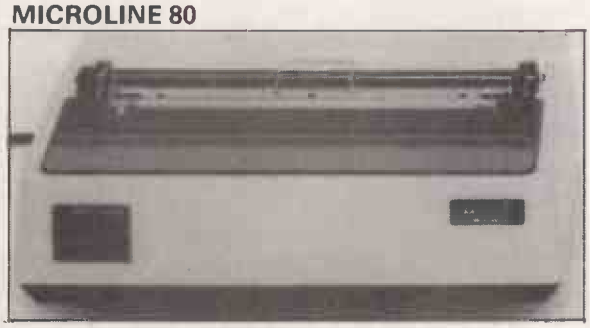

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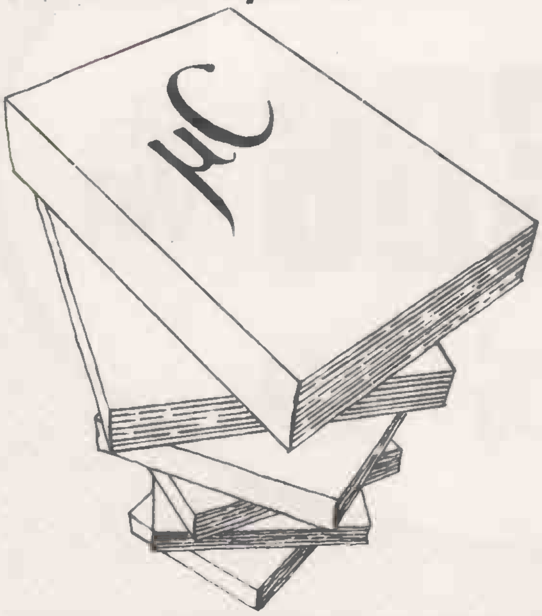

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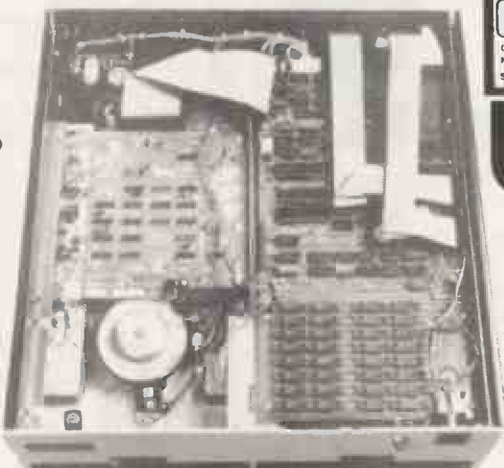

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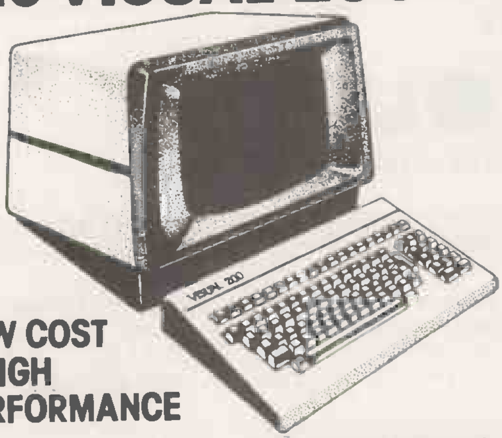

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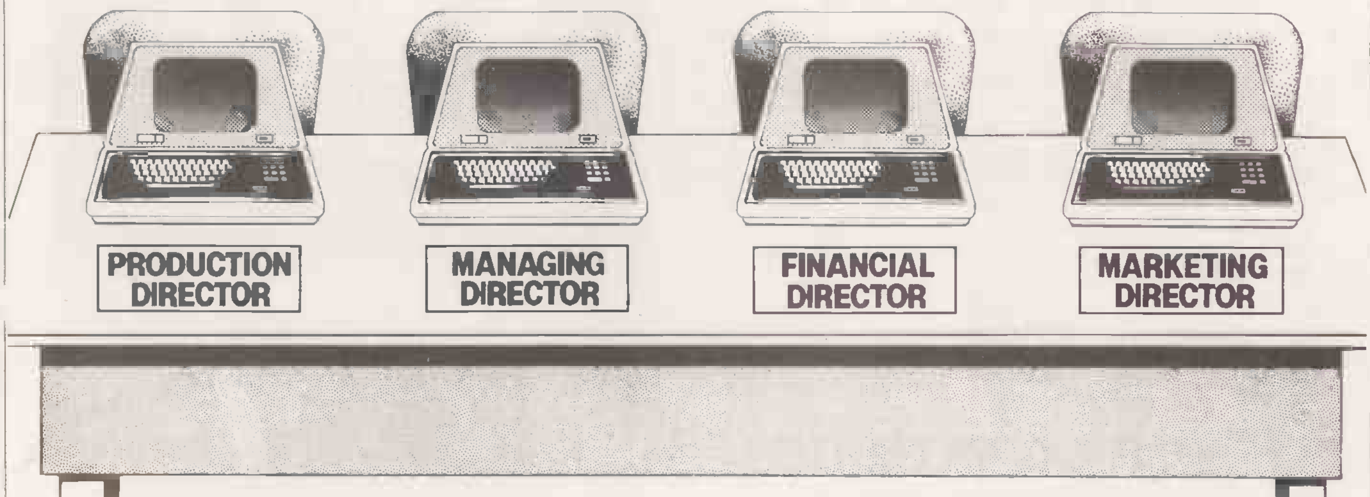

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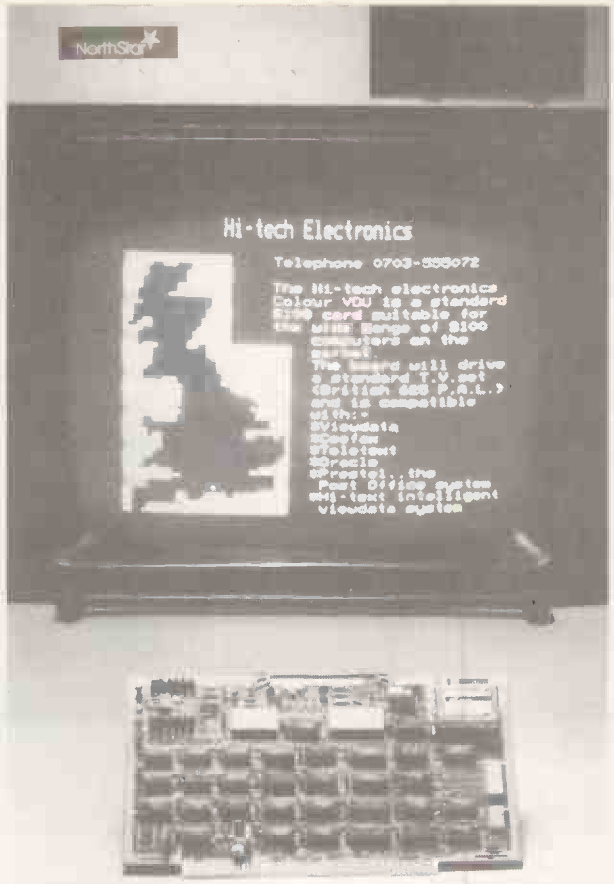

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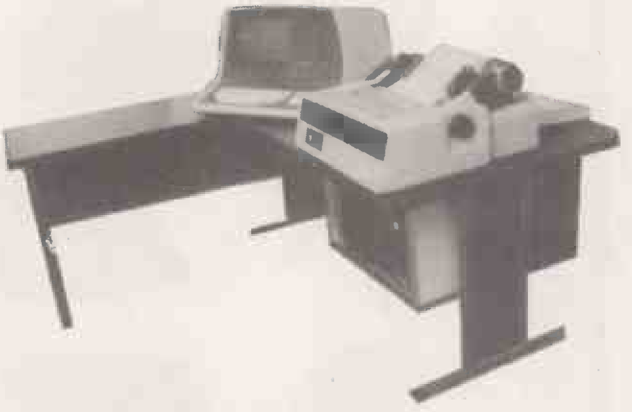

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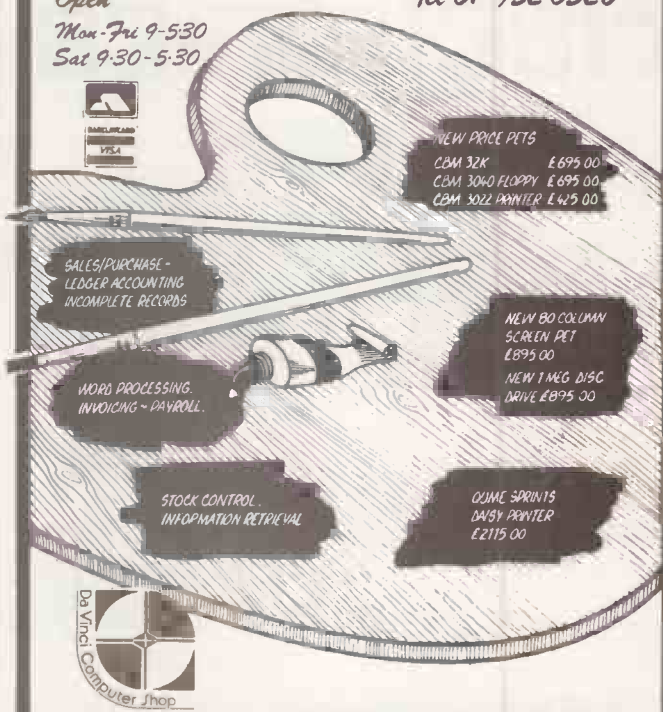

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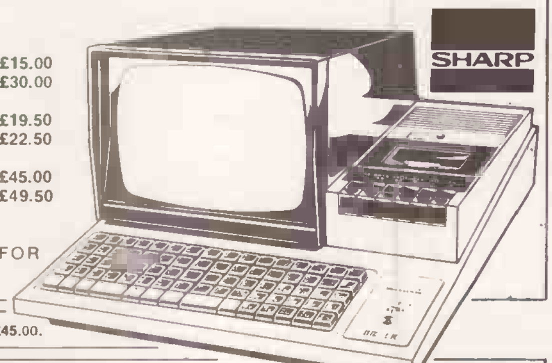

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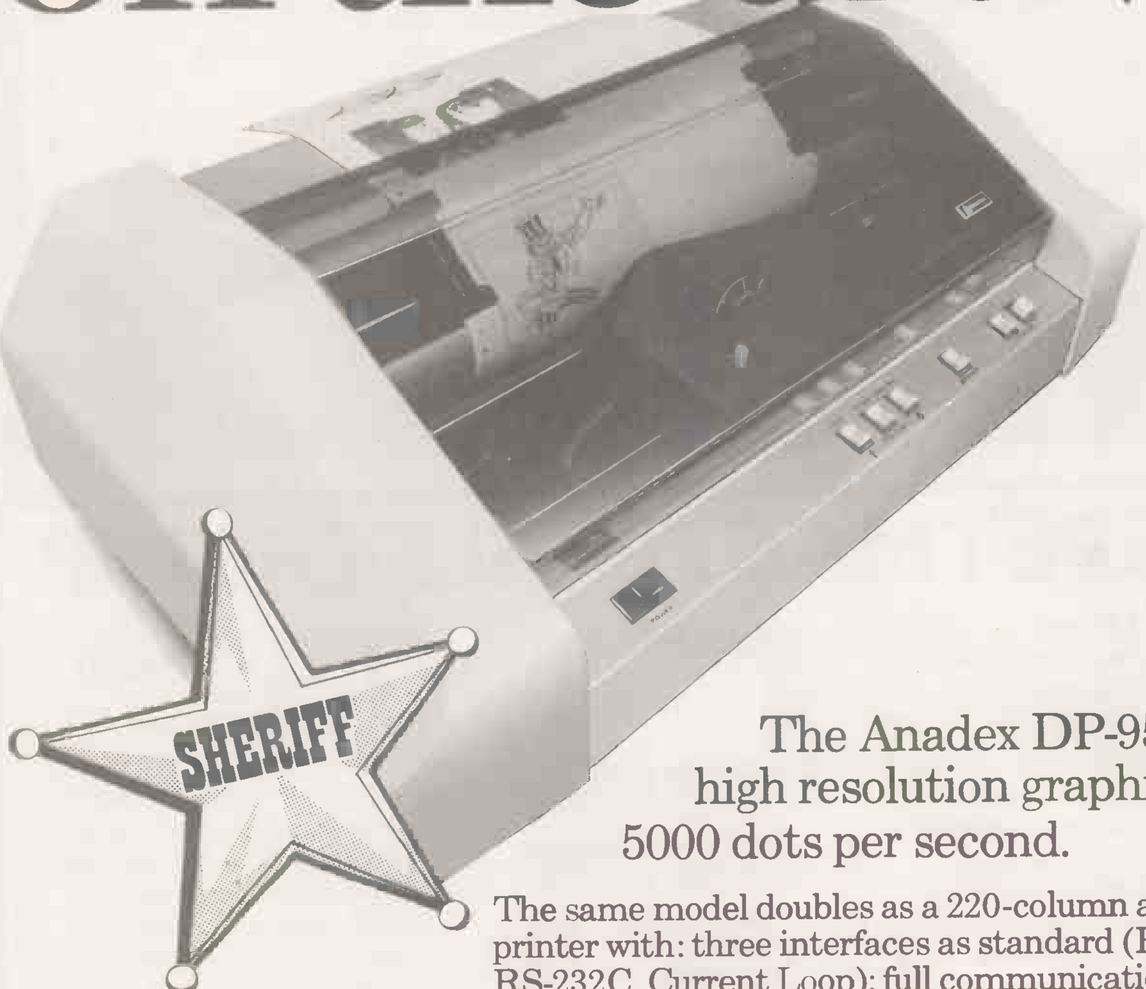

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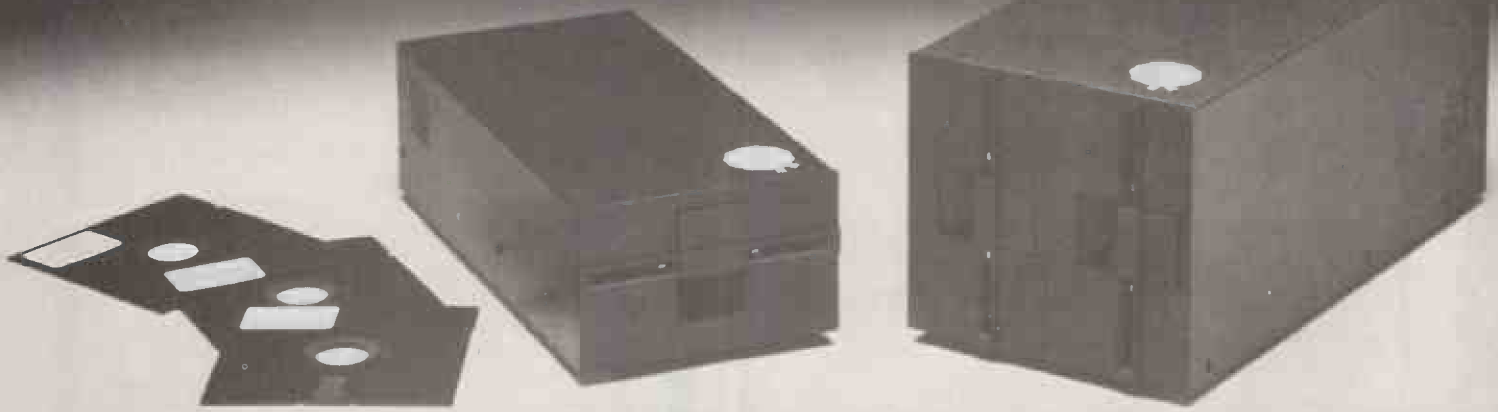

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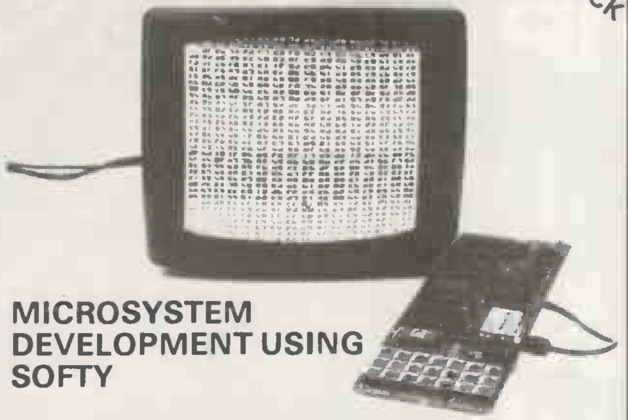

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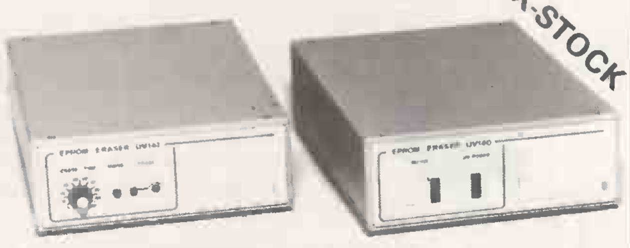

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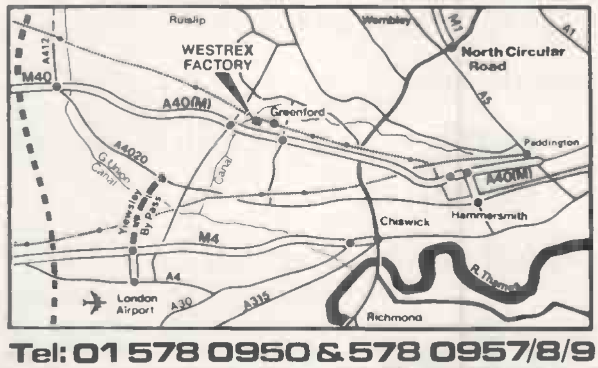

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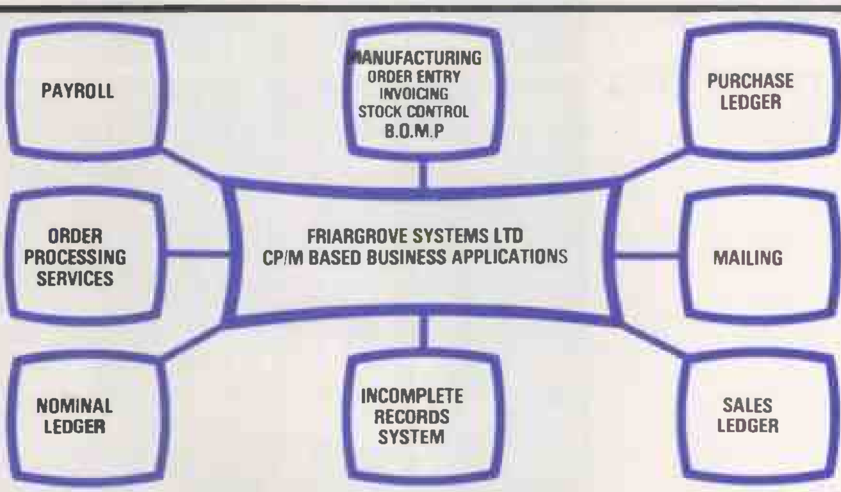

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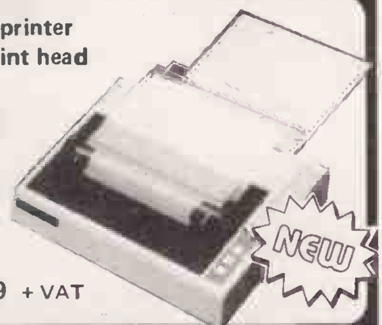

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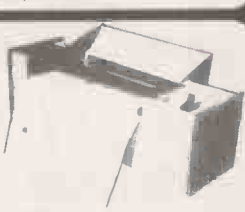

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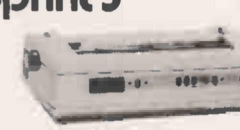

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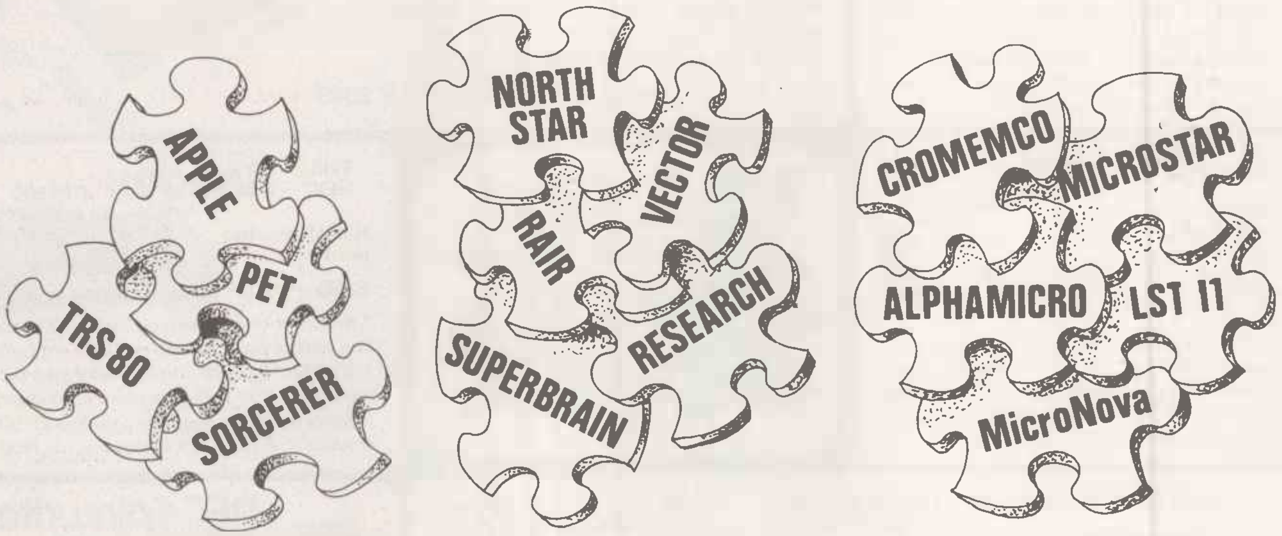

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A lurch in the right direction

THE LONG struggle to make the world with problems on its mind take micros seriously took another lurch forward recently with the publication by the British Medical Association of its report, *Computing in General Practice.* This substantial tome was prepared by Scicon with the guidance of a joint BMA-Scicon steering committee.

It seems to us that this report is newsworthy and commendable for one simple reason: it is the first time that any Establishment body has accepted that microcomputers — as distinct from microprocessors in industrial-control applications — are now a serious tool for professional people. One must add that the report does not go overboard. It is sensible and conservative — indeed, in our opinion rather too conservative at one point — and plots an achievable program to apply micros in the doctor's surgery.

The GP's surgery is in many ways an admirable exemplar of the amorphous small-business application. The doctor has a good deal of data to record; a practice with 15,000 patients would need about 2.5MB. He has to record the salient facts about his patients, their medical problems and to keep track of visits.

He also needs to monitor patients for recall with problems which need regular treatment. He needs to control the issue of repeat prescriptions. He is paid in rather odd ways by the NHS — a visit by a lady over 65 with a wooden leg earns him a set figure. Many GPs do not claim all the income to which they are entitled because of the difficulty of going back through the patient notes. He has staff to pay and books to keep, just like any other small business. He has to arrange appointments and record the results of consultations with patients.

That data could lead to useful statistical surveys of clinical problems in the practice. He needs timely data from outside the practice; information on new drugs and, in particular, notice of undesirable side-effects, particularly if prescribed with certain other drugs. He needs to know about vaccination regulations which can change suddenly.

If he supplies medicines to his patients, he needs to know his drug stock levels. He could usefully have a computer interview patients so that when they arrive in his surgery, he has at least the main facts of their problems with perhaps a tentative diagnosis. He probably could use word processing for reports, form letters and the like.

There is hardly a feature of any small business or professional system which one will not find needed in the GP's surgery. Here, there is need for the storage and quick manipulation of a large database. Security is important. There are routine calculations to do, and free-ranging ones. External databases need to be accessed through Prestel or by Post Office line to specialist mainframes. There ought to be standard protocols for intercommunication with other computers so that GPs can deliver and obtain information electronically.

The BMA is proposing a £1 million trial of microcomputers in 100 practices. The trial will not only be important to the medical profession, it will also allow, for the first time, a well-organised study of the impact of microcomputing in a standard type of business. It is in the national interest that everything which can be done to improve GP service is done, so that it is not a question of giving the doctors toys.

The target population is important too. The GP is, one may presume, a reasonably well-educated person. He or she is not necessarily a technical genius, not necessarily or even likely to be interested in machinery for its own sake. GPs are also probably not very interested in the managerial problems of running a practice. What they are interested in is looking after their patients and anything which helps them to do that better is good. So the trial will not just be about the hardware and whether it can store the bytes and retrieve them fast enough. It is also about the software designer's art: making the machines work in a sufficiently amiable way so that they do not frighten and confuse the ordinary people who will have to work with them.

Odd though it may seem to most programmers, real people in the real world do not like peering at VDUs, they hate having to type things like /46*aQj when they do not know why, they do not want to have to wonder why the printer is being sent an extra form-feed. In fact, they do not really want to have anything to do with a microcomputer at all, if they can help it.

So, if the trial can be made to work, if it shows an acceptance of the new technology by doctors and their staffs, if it promises a real national benefit in terms of patient-care per pound spent, it will be of importance to far more than just the medical profession. It will be a solid vindication of the whole micro-computing business which is, at the moment, staggering along by fits and starts, driven by the enthusiasms of pioneers and by snagging on the resistance of unconverted lay bystanders.

How will the trial work? Happily, it is too soon to say yet, and that means there is a chance it may be structured in a way which might produce some useful results.

There are, of course, two separate elements — hardware and software. The BMA report identifies four possible options rising from a simple financial housekeeping system and an age/sex register of patients up to a full-blown system with several terminals interacting with external computers and storing plenty of information on hard discs. Since by the time the study gets under way, there will be several microcomputer systems offering 20MB on hard disc with, say, four distributed-processing workstations for about £11,000, the Scicon upper estimate of some £200,000 seems a little extravagant.

Yet, we think the problem is much more in the software. If the competition is limited in hardware to a few machines — and there is not really a vast amount of choice — it should be open to all the talents in software. It would be sensible for a list of machines, protocols and targets to be published as soon and in as general a form as possible so that the maximum of software suppliers can submit proposals. Obviously, systems which do not show some chance of doing a reasonable job will not be wished on the 100 guinea-pig practices so some vetting is necessary.

On the other hand, to restrict software entrants simply to those companies which are invited would exclude a great pool of talent and ingenuity. As the U.S. shows so well, there is nothing like a free market to stimulate performance, and while hardware provision for so large a potential market needs substantial resources, the best software can be from any head or pair of heads.

The BMA report is to be welcomed as a sensible appraisal of the new technology and a workable way of testing it. It is important not only to general practice but perhaps more so for what it implies for the whole microcomputing industry.

New address for *Practical Computing*

Practical Computing moves into new offices on November 10, 1980. From that date, our new address is: Quadrant House, The Quadrant, Sutton, Surrey, SM2 5AS. Telephone: 01-661 3500 Telex: 892084 BISPRSG.

Our Feedback columns offer readers the opportunity of bringing their computing experience and problems to the attention of others, as well as to seek our advice or to make suggestions, which we are always happy to receive. Make sure you use Feedback—it is your chance to keep in touch.

Z-80 page appeal

I REALLY have no gripes with your August 1980 issue at all — although perhaps the Adventure program was not quite as well explained as it could have been. Nonetheless, a very useful program — although, I for one would like to have seen a complete small database.

The articles on machine code, contrasting 6502 and Z-80 code must also be useful to beginners — an excellent idea, especially since those two CPUs are used in all the most popular machines — who remembers the 6800 and 8080 these days?

However, what the beginner finds when he consults your various pages for specific machines/CPUs is that the only Z-80-orientated page is the Tandy one. There is a very marked 6502 bias — 6502 Special, Apple Pie, Pet Corner, etc.

What about a Z-80 Special, and, considering the 15,000 plus kits sold in this country, a Nascom1/Nascom II page. Is this too much to ask? I think not.

Just so that you have no excuse here is a very short Z-80 routine to run on a Nascom 1 or 2 to clear memory using a rather novel method.

```
OC80   E5         PUSH HL
OC81   C3 80 OC   JP   OC80H
OC84   31 80 OC   LD   SP, OC80H
OC87   21 00 00   LD   HL, O
OC8A   C3 80 OC   JP OC80H
```

Execute @ C84. Using the entire memory as a stack, HL is pushed repeatedly also note automatic re-set.

J Sifton,
Bridgewater,
Somerset.

Naspen editing

MAY I POINT to an inaccuracy in the September issue of *Practical Computing*, in the Naspen review. Naspen was written by a friend of mine, and I wrote the documentation. We are both heartened to see such a fair and objective review. One always has doubts about the bias of reviewers; and this has restored my faith in reviewers in general.

However, to be specific, Nick Laurie mentions that insertion of a block text can take place only at the end of the existing text, and then the block has to be moved using the M command to the place where the insertion is required.

That is most inconvenient and slow, and in any case, not so. The L command allows insertion of text directly to the position of the cursor.

To use it, simply move the cursor to the place where an insert is required, and type L. Text may then be inserted until such time as an ESC is typed. Laurie mentions the use of the X command to aid the re-formatting of text. It is simpler to edit out any hyphens which may have been included, then use the S command to re-format. That calls the X command automatically and then calls the "s" command. It is implied that blocks of text can only be deleted if they are to the right of the cursor by using the K command. True, but the D command will remove a block to the left of the cursor, a line at a time.

D R Hunt,
North Harrow,
Middlesex.

Exorset opinions

WE READ with interest your review of the Exorset 30 in the September issue, and agree with most of its conclusions. We bought an Exorset early this year and delivered it to a customer who wanted a one-off industrial-control system; we found its hardware an excellent vehicle for our software.

The quality control on our first machine. The clearly-visible offending PROM, not properly inserted in its socket, caused the XDOS system disc to be destroyed on first powering-up the machine. The clearly -visible offending pin was less than 2in. from a sticker saying: "final inspection OK". Four days later, the very impressive-looking PSU destroyed itself.

The machine was very promptly replaced and produced no more trouble. A design problem was that powering-up the machine with discs inserted sometimes loaded the heads, destroying disc format.

We found, like your reviewer, that the software was not up to standard. The assembler, editor and Basicm cannot handle disc-to-disc operations, and our programs had to be arbitrarily and clumsily subdivided to make them fit. That was a real problem.

Similarly limiting was the fact that assembler listings could not be directed to the RS232 port, but only to a Centronics parallel interface. Among several bugs we discovered was the rather fundamental one of Basicm sometimes making mistakes with the unary-minus operator.

We did, however, eventually deliver a system which used compiled Basic, 4K of assembler, XDOS disc I/O and high-resolution graphics simultaneously.

It seems that the software has been put together piecemeal from extant modules, producing unnecessary limitations. It is definitely not up to the quality of the system hardware design. However, having learned to pick our way round its problems, we found the machine highly versatile and usable.

We look forward to similarly accurate reviews from your magazine in the future.

E J Williams,
D A Fielder,
Milton Keynes,
Buckinghamshire.

Acorn Atom group

I AM writing to announce the existence of the Acorn Atom user group. It is intended to give Atom users a forum in which to air their views, and to provide an opportunity to exchange software and hardware tips and programs.

Membership is open to all, private, educational and commercial users. Membership costs £4 p.a., and includes access to the library and free newsletter.

R G Meredith,
Newton Ferrers,
Devon.

Two-speed enquiry

I AM enquiring about the two-speed modification you published for the TRS-80, Model 1, Level II in the September issue. Do you know if it is possible to install something similar, but allowing the speed to be changed with a program in memory?

I would like to be able to Cload programs at the old speed, and then switch to the faster speed before RUNing or re-saving the program. I have a reasonably large number of programs, both in Basic and System format and would like to be able to run them at the faster speed without having to re-type them and Csave them again.

R Huntley,
Gosport,
Hampshire.

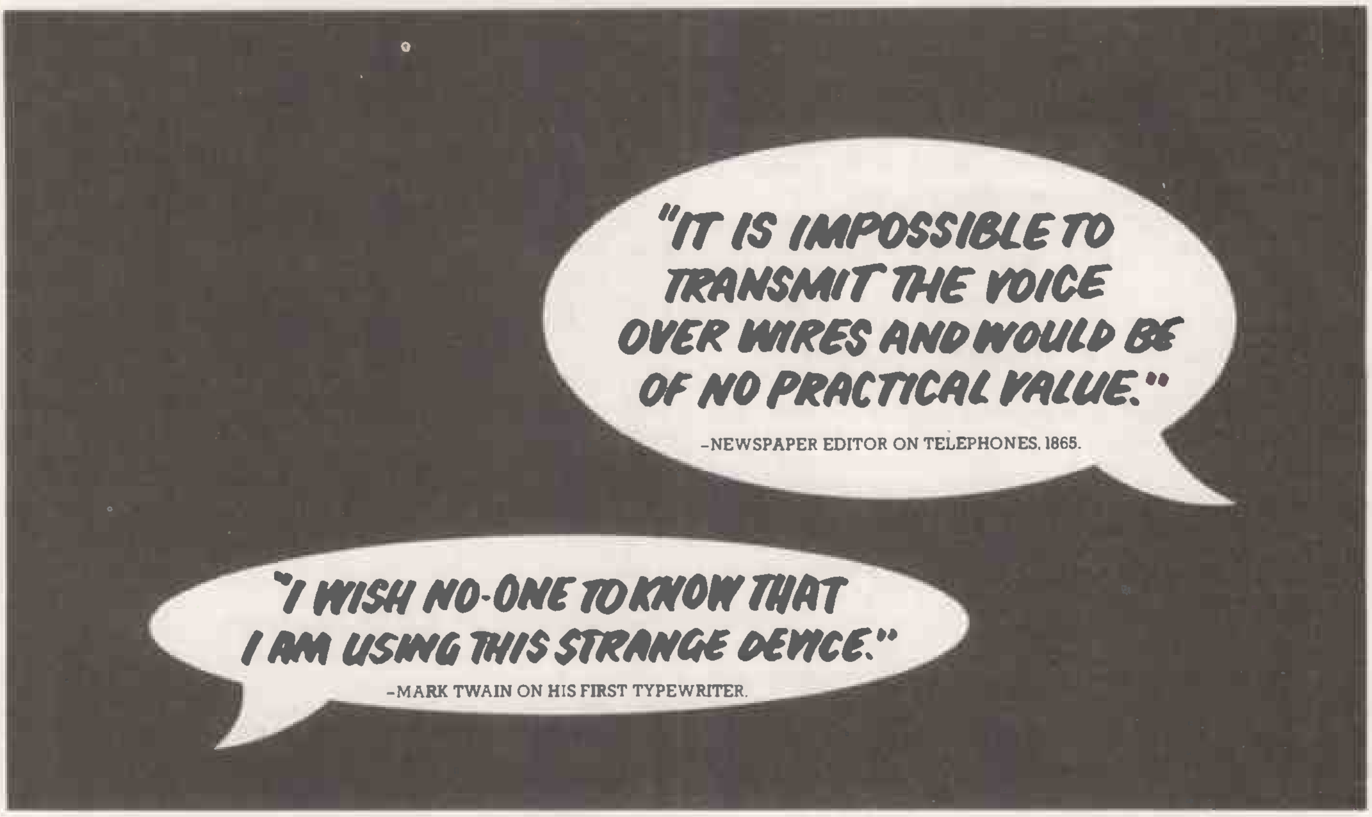
Upgrading Pet

HAVING been a reader of your excellent magazine since the first edition, I would like to say that I think it goes from strength to strength, and is now much improved.

I have, however, a problem which someone might be able to solve. I have a 16K Pet, with discs and printer which I want to upgrade to 32K. However, I cannot discover what changes are needed in the address decoding to enable me to unplug the 4108 RAM chips, and replace them with 4116 chips.

I understand that all that is required is to change the links on the link chip to the back on the right, but I cannot work out

(continued on page 44)



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Tel: Basingstoke (0256) 56144.

IBM

• Circle No. 156

(continued from page 42)

what the changes should be. If anyone can help, I am sure there are other readers who would be interested to know about it.

I admit I was wrong when I bought the Pet. I thought that when I exchanged my 8K for 16K plenty of space would be available for anything I would write; that is not so. Let me advise anyone who is contemplating a 16K to buy a 32K — you never know what you may need in the future.

Peter Dolphin,
Petersfield,
Hampshire.

• According to Nick Hampshire, you need to set the links thus: "C" for closed, "O" for open:

H	**Closed**	**A**	**Open**
I	**Closed**	**B**	**Open**
J	**Closed**	**C**	**Closed**
K	**Closed**	**D**	**Closed**
L	**Open**	**E**	**Open**
M	**Open**	**F**	**Closed**
N	**Open**		
P	**Closed**		
R	**Open**		
S	**Closed**		

Basic support

IT WAS with pleasure that I read your editorial in the June issue. Over the past year there appears to have been a growing attack on Basic.

Micros are for the small user — the less technical — and, as you state, most programs written for micros are far shorter than the number of lines limit imposed by the computer. Even a 2,000-line program is a long one and are nearly always written by one person.

We should divorce our thinking away from mainframe and remember that the reasons microcomputers caught on were that they were available comparatively cheaply and, more important, that the computing language Basic was understood easily and usable even by the inexperienced.

In short, Basic and its improvements suit the majority, who are happy with it and find that it does all that they want it to do; it is the majority who have made microcomputing take off. All strength to your support for Basic.

R F Cox.
Leicester.

Software availability

YOUR VERY readable editorial in the September edition draws attention to the disappointing state of software availability for micros so far. I agree but am not sure that it is as surprising as you infer. I belive the missing link may be the production of general-purpose software modules, which would give us, in effect, a higher-level language.

It is hard for the novice to see what they might consist of, but it does seem to me that one reason why software is not forthcoming for a wider range of applications is simply because the people who have the know-how on the application side find, when they try their hand at producing programs, that they spend a good deal of time re-inventing the wheel — and probably producing square ones at that.

Although programming is basically easy, my limited experience has been that one spends a good deal of time learning tricks of the trade which could, in fact, be incorporated into more sophisticated software.

I suppose the fact is that the hardware is still not quite cheap enough to provide the programming tools I am envisaging which would, if truly versatile, necessarily be inefficient. Until that state is reached, I would suggest that we probably will not find much good-quality software covering a broad spectrum of activities.

Meanwhile, perhaps the mainframe experts should direct some energy towards the production of some singing and dancing multi-purpose modules for when the 32K ROM costs only a pound or two — including programmers' royalties, of course.

M H Hudson,
Goudhurst,
Kent.

Apple user's advice

I HOPE you will forgive the presumption of an Apple user writing about a Pet column, Pet Corner, September, but I feel that the letter from Robert Acraman may give people problems because I suspect that the addresses at the start of lines in Pet Basic would be used when a Goto or Gosub is encountered. If that is the case, pointing a line at itself will give a Hang at the first Goto.

Why are people so psychotic about having their programs listed? What if Goya, Cezanne and Picasso had felt the same and made their works unviewable? Perhaps it is only the less competent programmer who wants to hide his dim light under a bushel.

Thanks, anyway, for an interesting column, although you must find it very difficult to find anything interesting to say about the Pet.

A quick tip to finish off which should work for the Pet. Less organised programmers than you or I possibly find themselves knee-deep in Gosubs when the user presses the key which indicates that he wants to go back to the main screen/menu. Working out how many POPs to do or putting in code at each return point can be time-consuming. An alternative is to handle it with ONERR such:

```
10 ONERR GOTO 1000: REM LINE
   NUMBER OF MAIN SCREEN
20 GOTO 1000: JUMP AROUND
   SUBROUTINES
100 POP: GOTO 100
```

Any time you want to return to the menu, GOTO 100 will put you in a loop which will clear the GOSUB stack and end with an error which will send you off to line 100. That should work in most Basics with POP and ONERR.

Bill Skipton,
Tamworth,
Staffordshire.

Cassette levy protest

I HAVE read in the National Press, *Guardian*, August 21, that a £1 levy is to be imposed, by the Government, on blank cassette tapes for the benefit of the British Phonographic Industry to offset the costs of record piracy.

Perhaps those who agree with me that this more than constitutes an intolerable imposition on users such as computer hobbyists will write to their MPs to that effect.

J R Handford,
Gosport,
Hampshire.

ZX-80 heatsink

I WAS most interested in the Heated Discussion in your August ZX-80 page. My son and I had a very similar discussion with our ZX-80. We built our ZX-80 from a Sinclair kit and from switch-on, it operated perfectly.

After three days of intensive use, it began, however, to switch off for no apparent reason. At first, we decided a possible reason was overheating and so we checked that the operating load current was within specification and steady as a rock regardless of operating mode. We found that two small pieces of Meccano enabled the effective CSM of heatsink to be increased within the confines of the cover. The fault persisted.

A systematic examination of all soldered joints was made to check the supply voltage from the power unit. That voltage on load was out of specification, hence, we now assumed that the regulator was being asked to control excessive power and the heatsink was being overworked.

We did not have a suitable supply dropper to hand, so the examination of the soldered joints continued. Two or three joints were re-soldered. Since the supply dropper was wired in live, the ZX-80 has given no trouble in any mode.

Our fault may have been a soldered joint or overheating or both. The dropper was housed in a tobacco tin, and it is a comfort to feel a relatively cool ZX-80 and a hot tobacco tin.

The only reason I bought a ready-made power supply was to have at least one set-up without a tobacco tin being involved at any stage.

My only disappointment is the lack of capability in the mathematics function, otherwise I think the ZX-80 is a very good buy.

G Winterburn,
Lytham,
Lancashire.

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• Circle No. 157

Sinclair reveals plans for ZX-80 expansion

CLIVE SINCLAIR, designer and entrepreneur behind the popular ZX-80 microcomputer, has released details of some of his future plans for the ZX-80. Last month, Printout reported that he had announced a new 8K ROM Basic and a new 16K memory expansion for the ZX-80.

The latest plans include an RS232 port with a translation ROM which is already in an advanced stage of design. It will be released to the market as soon as possible and will enable users to attach printers to their ZX-80s.

Other plans include a teletext adaptor which could be announced towards the middle of next year. It is understood that an independent television company, in the U.K., is interested in broadcasting software for the ZX-80 on standard teletext channels and intends to make money by selling advertising space on the same pages.

Clive Sinclair.

The adaptor will also be compatible with Prestel, allowing users to write programs which could select information automatically from the Prestel computer.

Sinclair has also been talking about his plans for the U.S. market in which he hopes the ZX-80 will become the top-selling microcomputer by the beginning of 1981. The U.S. software house, Image Products, has already been appointed as the main world-wide agent for ZX-80 software and the first manual of ZX-80 software will be published shortly.

It will include details of programming standards should any users like to submit their own work. A copy of the specifications should be available from Science of Cambridge, 6 Kings Parade, Cambridge (0223) 311488/312919.

Music with TRS-80

ALL THE interesting add-ons for the Tandy still seem to be from the U.S. — the latest is Orchestra-80, a TRS-80 music synthesis system. It requires a 16K Level II TRS-80, some software and a PC board which plugs into the expansion connector of the TRS-80 keyboard.

The software is a five-part machine language program; a digital synthesiser which produces four simultaneous voices in a six-octave range; a music language compiler, which allows users to enter their favourite music in any key or time signature; a full-function text editor with blinking cursor; and a file manager, which stores and retrieves named program files on tape or disc. Details from Software Affair Ltd, 473 Sapena Court, Santa Clara, California. A demonstration of the music is available on 0101-408 727 8194.

Home study of Z-8000

SEMICONDUCTOR company and manufacturer of the Z-8000 16-bit microprocessor, Zilog, has introduced a five-lesson, home-study course on Z-8000 architecture for systems engineers.

The course teaches the details of the Z-8000s 16-bit architecture, techniques of memory management, methods of interfacing memory and peripherals, proper handling of interrupts and traps and use of the Z-8000s instruction set.

Each lesson includes a test consisting of 10 questions which is individually graded by Zilog prior to the next lesson. The first lesson introduces the Z-8000 architecture, starting with a description of the function of each signal pin on the Z-80001 and Z-80002 processors. The second lesson concentrates on memory and peripheral interfacing; lesson three discusses interrupts and traps. The final two lessons study memory and peripheral management and an overview of the instruction set. The course costs £19.50 and details are available from Zilog on Maidenhead (0628) 36131.

Hard-disc controller eases back-up and maintenance

THE BEST ideas are always blindingly obvious — when they have been pointed out. We have been growing very excited about Winchester discs, wishing they would arrive, wishing they would cost less, trying not to think about the problem of back-up — without ever asking ourselves what the mainframe world has been doing about backing storage.

The simple answer is that they use an absolutely standard hard-disc system which has been available for years, is easy to repair, has five or 10MB on-line and five or 10MB in a removable pack for back-up. Only now has someone had the wit to adapt it for micros.

Various versions of discs to the IBM-5540 standard are made by Ampex, CDC, IBM, Western Dynex. There are nearly 250,000 in service and they do not need air-conditioning. Access time averages 35 milliseconds — about six times faster than 8in. floppies — and data leaves the disc at 2.5MB a second.

The hard-disc controller for the S-100 bus.

Newtons Laboratories of Wandsworth has produced a hard-disc controller for the S-100 bus.

Its controller board makes the hard disc run CP/M 2.2 so you can add them to your existing floppies. Up to four hard discs can be daisy-chained together, and Newtons promises a 20MB version in a few months.

The advantages over the Winchester system are back-up with the removable pack — most important — and easier maintenance.

The disadvantage is of considerably larger size — about six cubic ft. as against the legendary shoebox; but for the same price £3,500. Telephone 01-874 6511.

Director chosen for State scheme to develop schools computing

THE director of the £9 million Government-funded national development programme in microelectronics in schools and colleges has finally been announced as Richard Fothergill, currently head of Petras at Newcastle Polytechnic.

Fothergill established Petras, the educational development unit at Newcastle Polytechnic, which has become a centre of advice about educational technology in the north of England. In the past two years, he has prepared a number of learning materials on microelectronic subjects.

The small staff of the Directorate will, under the arrangements with the Department of Education and Science for the administration of the program, formally be employees of the Council for Educational Technology. Although the Director will be based in Newcastle, his office will have a direct telecommunications link with the Council for Educational Technology offices in London.

In October Printout, we reported the names of the Government-appointed Advisory Committee — the scheme which has already been criticised by the National Union of Teachers for including no teachers from the State sector on either the main committee or the group of external advisors.

Delay for Pet disc drive

IN THE September issue we carried a story about the new ACT 2MB Computhink disc drive for the Pet. The equipment is immediately available for the 32K Pet, but there is some difficulty about adapting it for the new 80-column Pet. ACT estimates delivery at six to eight weeks.

The problem seems to be that in the big-screen Pet, the ROM area where the disc controller used to sit is used for another purpose.

Anadex solves printer error

ANADEX has announced that some earlier models of their DP-9500 and DP-9501 printers may exhibit an operating error when used in a serial mode at high baud rates, resulting in loss of characters or incorrect horizontal tabulations.

A change in the printer software to eliminate the error has now been incorporated and is effective from serial number D006670 for the DP-9500 and serial number D00311 for the DP-9501.

First wave of business programs launched for Pet 8000 series

IN THE four months since the formal U.K. launch of the new Pet 8000 series, Commodore has been busy trying to encourage its approved dealers to produce some serious and suitable business software.

To win the mark of approval, dealers have had to follow the specifications and standards laid down by Commodore. The first series of business programs has now been launched through the Commodore-approved product dealers' network including packages such as payroll, sales, purchase and nominal ledgers, word-processing and communicators.

The Wordcraft package on the Pet 8000.

The Essex-based Commodore dealer, Dataview, has been one of the first to unveil the latest version of Wordcraft, Wordcraft 80, for the 8000 series. It is a development of the established Wordcraft program adapted for use on the 8000 series and making full use of the improved screen facilties.

It will be sold for £375. A typical complete system, with an 80-column screen Pet, twin floppy disc drives and a good quality daisywheel printer will cost about £4,200.

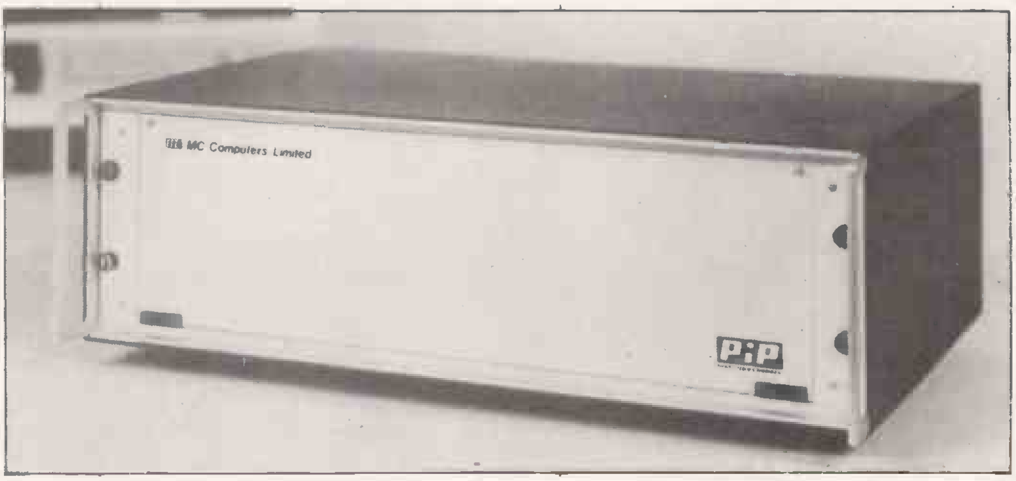
Industrial measurements from I/O subsystem which works with all types of micro

A MICROPROCESSOR-controlled input/output subsystem for use with all types of microcomputers has been introduced by M C Computers Ltd, of Newbury. Essentially a simple connection interface, providing either local or remote operation, PIP — Plant Interface Peripheral — will make a variety of industrial measurements and transmit them on a standard communications link.

Designed around a conventional 19 in. Industrial Eurorack, PIP uses front-loading, plug-in circuit cards. A number of plug-in options such as analogue output, digital input/output, dual counter card and battery back-up and memory cards are available.

PIP will accept up to 128 single-ended or 64 differential multi-plexed inputs and can both analogue and digital outputs.

A built-in, high-speed analogue-to-digital converter gives 12-bit resolutions and 11 binary ranges. M C Computers can be found on Newbury (0635) 44967.



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New share market may help micro firms raise capital

THE STOCK Exchange looks set to create an entirely new market in shares — an Unlisted Securities' Market (USM) — specifically for young high technology companies unable or unwilling to meet the Stock Exchange stringent membership requirements. The USM could provide an easy way for many of the emerging U.K. microcomputer companies to finance their rapid growth without selling all of their shares.

Companies which enter the new market will have to offer only 10 percent of their equity to the public as opposed to 25 percent on the main market.

Companies applying for the market will only have to provide three-year records of their trading although even these requirements will be lifted if a company wants to turn to the market to finance the production of new products. The market has been approved and should start work by the end of the month.

The concept of limited liability companies was invented in the U.K. at the start of the industrial revolution as a way of allowing people to invest in new ventures, such as canals and railways, without risking their entire fortunes should the venture collapse.

Over the years, the idea has become increasingly embroiled in new regulations to try and safeguard even the limited investment of the investor so that now only well-established and safe companies are willing to comply with the strict rules and conditions about trading and reporting practices which enables them to join the select club the Stock Exchange now represents.

As a medium for raising capital for new, risky but potentially money-spinning and job-creating ventures, the Stock Exchange has been in decline for many years.

One way in which it has been possible to break into the Stock Exchange without meeting the traditional requirements has been through the Market Rule 163(2), designed originally for special categories but which has been used increasingly as a backdoor for young high-risk companies.

The Stock Exchange has been worried about the number of companies entering the market through this rule, that they could not be regulated effectively and that scandals or collapses in the sector could damage the reputation of the rest of the market.

Software at W H Smith

W H SMITH, the large newspaper and magazine distribution chain, is toying with the idea of selling software games on cassette through its high street branches. An experimental display, entitled "The Computer Know-how" has been built in the Brent Cross branch in north London where "there is a young customer profile" according to John Rowland, the W H Smith marketing development manager.

"We do not think there are enough personal computers in the market to justify selling software through all our stores but in the longer term this is obviously a market we shall be in", says John Rowland.

The programs on sale have been supplied by ACT and the new software company Microtrend.

U.K. machines for Compec

TWO NEW U.K.-designed and built microcomputers are about to be introduced by Haywood Electronics Associates, of Northwood Middlesex, just in time to be shown at the *Practical Computing*-sponsored Compec Exhibition in Olympia.

The smaller of the two is the 3000, a single-board microcomputer with many of the features now almost standard requirements. Based on the Z-80A running at 4MHz, RAM is expandable from 32K to 64K.

The Haywood 7000 is another 'standard' microcomputer with 8in. discs drives to provide more than 2.5Mbytes of storage on two floppy discs. The 7000 is a complete system with a VDU, keyboard and printers matched together with software and an integrated business systems. Details are available from Haywood Electronics Associates Ltd, Northwood 28301.

Increased computer thefts lead to more security devices

REPORTS of computers being stolen are becoming increasingly frequent. We have heard stories of microcomputers being stolen from exhibitions, from shop displays and from people's homes. The latest incident occurred when Jill Hebditch, a director of the software company Microtrend, parked her car on the rear access road of the Cunard International Hotel in west London on September 3.

She returned to find that a Commodore disc drive and a Hazeltine VDU had been stolen.

The Commodore 3040 Dual Diskette Drive has a serial number 608041; the Hazeltine 1520 VDU a serial number 300596-022. If you encounter either of the items, telephone Detective Sergeant Ball of Hammersmith CID on 01-741 6071.

A product which would help prevent the theft of such easily transportable items as microcomputers and their peripherals has been introduced by NASA — Noise and Security Appliances. The company is starting to market an anti-snatch alarm which can be fitted out of general view inside the back of a machine.

The basic model is wired into the mains with the power supply for the system. While still plugged-in, the anti-snatch will not operate but once the connection is broken and the machine moved even the slightest amount, a trembler switch triggers an alarm.

The alarm has a starting price of £40. Details from NASA on Uxbridge 59575

The NASA anti-theft device.

New ROM for Level II

TANDY HAS started to introduce a TRS-80 Level II microcomputer with a new ROM, possibly creating for Tandy owners some of the problems which Pet owners already face with the confusion between the new-and old-ROM Pets.

The majority of Tandy programs should run normally although it seems somewhat unfortunate that the very few which do not are some of Tandy's own games. Other features of the new ROM are the CLOAD and CLOAD? can only be performed through the number-one tape drive and DOS users can now specify a file name.

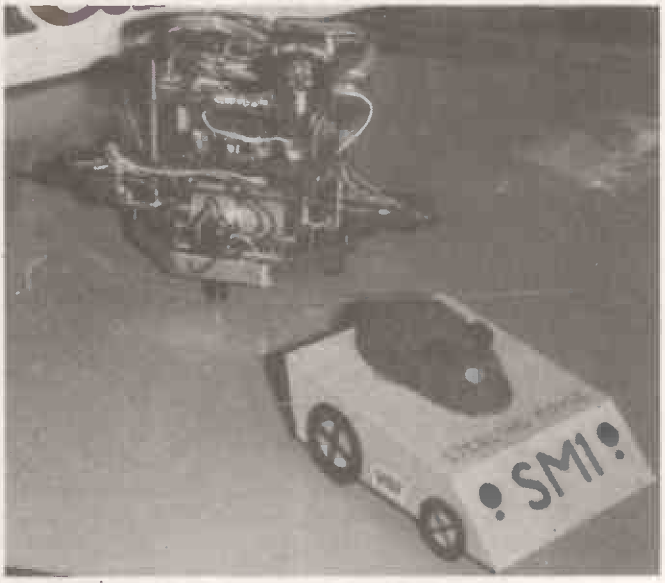
• Circle No. 158

Micromouse

THE long-awaited Micromouse contest, part of the Euromicro '80 conference held at Imperial College, has produced a worthy champion. The winner of the first and most important of the three contests — fastest time through the maze — was Sterling Mouse, built by Nick Smith and P T Crow from Ruislip, Middlesex, one a systems analyst with British Gas and the other a sparks.

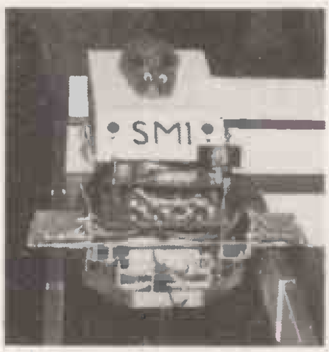
They both claim to have started knowing nothing about the mechanics of mouse-building — Smith had to teach himself how a transistor worked to build the motor control circuits.

Of the eight competitors, Sterling Mouse was the only one to find the centre. Smith and Crow collected the $1,000 first prize from Euromicro.



Sterling Mouse, the fastest mouse through the maze.

Curiously, it turned out that the real difficulty in maze running is not the writing of a computer program to explore the maze. Sterling did that in just 29 machine-code instructions; Brainy Bricks, the mouse made of Leggo, held its whole program in 200 bytes.



The champion in action.

Almost all the competitors agreed that what at first seemed the major obstacle posed no real problems. The difficulty was navigation in the maze. In planning, it was too easy to assume that the mouse moved from the centre of one maze cell to the next. In practice, it was far less simple.

Mice often became jammed and disorientated in the opening between one cell and the other, or wedged in a corner, making ineffective rightangle turns to left and right.

Navigation systems based on summing left and right wheel rotations tended to fail because of wheel slip on the taped-over joints in the baseboard. The simple matter of turning left or right into a new maze corridor involved detecting the opening, stopping the motors, allowing for forward motion between issuing the stop command, the mouse stopping, measuring the mouse's position in relation to the opening and adjusting any error. It turned out to be a far from trivial task.

Technically, the most interesting machine was the Swiss Lami. This device was square in plan, with a large wheel in the middle of each side. To allow it to move at all, each wheel had 24 tiny wheels mounted round its rim with their axes tangential to it. A big wheel driving used the small wheels like coarse tread tires; a large wheel idling ran forward on the small wheels.


Brainy Bricks, the mouse made of Leggo, negotiates a difficult corner of the maze.

A mouse either needed a very clever sensor system designed for the maze, or a very elaborate one that would position it anywhere. The Plessey unofficial entry, Fred, positioned itself by blasting out infra-red pulses front and rear.

The designers said they would, next year, rotate the pattern by 45° so that two sensors would detect a side wall instead of just one. Given an all round set of detectors like that, a mouse might have a chance of disengaging itself from corners.

It was interesting that the winning entry had the simplest sensor system. It had one bendy wire at the front connected to a microswitch to detect a barrier in front, and an ingenious wing on each side which ran along the top of the maze walls.


Fred delighted the crowd with his singing and dancing in the free-style event.

If the mouse moved too close to the wall, the wing rode up on an extra bump in its armpit. If it met an opening, the wing on that side dropped. The problem of timing the stop was solved by giving the wings upward-angled trailing edges so that the amount of drop signalled the distance forward from the start of the opening.

Although Sterling Mouse had no real competition, it moved intelligently and fast and would no doubt give the Americans some aggravation.

• Circle No. 159

We are now entering our fourth financial year of dealing solely in the personal computer market — in fact, we started it! Over this period, Personal Computers Limited have formed a group of graduate specialists who will help you in the fields of word processing, financial planning, statistics, economic modelling, forecasting, accounting systems, foreign exchange, banking and oil exploration.

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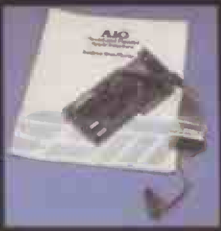

8" Disk Drive *(above left)*
Our 8" disks are still as popular as ever — 2 drives give you 1.2MB with all the reliable security of Shugart Technology. Easily interfaced to Apple, uses the same D.O.S.

A.I.O. Serial and Parallel Card *(above centre)*
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A much sought after product which we introduced to the U.K.

80 Character Card *(below left)*
. . . opens up the real commercial world for all Apple owners.

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Centronics 730 *(Below right)*
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Items pictured

Sharp MZ — 80K
A new generation of personal computer, self contained, versatile and starting at only £570 (excl. VAT). Explore the Zilog Z80 now the easy way. Disks and printer available shortly.

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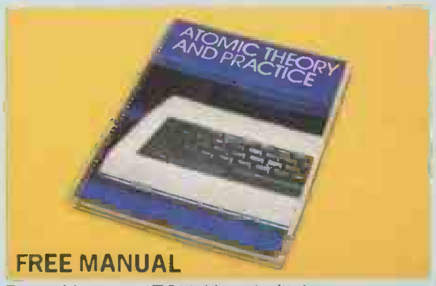

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Compec Preview

In this preview of the Compec Exhibition, held in the Grand Hall of London's Olympia from November 4-6, *Practical Computing* looks at some of the products which are on show in the U.K. for the first time.

SPONSORED by *Practical Computing,* and some of its sister publications, Compec is already Britain's biggest and most successful computer exhibition. Visitors and exhibitors attend from all over the world to see and to launch new products on to the U.K. and European computer markets.

This year, more than 350 stands have already been booked by exhibitors ranging from the mainframe companies, mini- and microcomputer manufacturers, dealers, suppliers, service companies and peripherals and software companies.

Compec represents a rare opportunity to find so much of the industry under one roof, to hear the very latest plans and announcements, to talk to the Trade and to find the solution to your computing problem whether it lies in industry, business, education or your home.

Well-known companies

Almost all the well-known companies which *Practical Computing* readers hear about each month are well represented: the list includes Commodore, Sharp, Microsense for the Apple, Nascom — under a new owner, Acorn with the Atom, the printer manufacturers, software suppliers and a selection of the smaller companies in the market.

On the home front, one of the key attractions could prove to be Sharp, on stand 2155, which is using the show to announce some interesting enhancements to the MZ-80K microcomputer and launching a brand-new machine for the small business market.

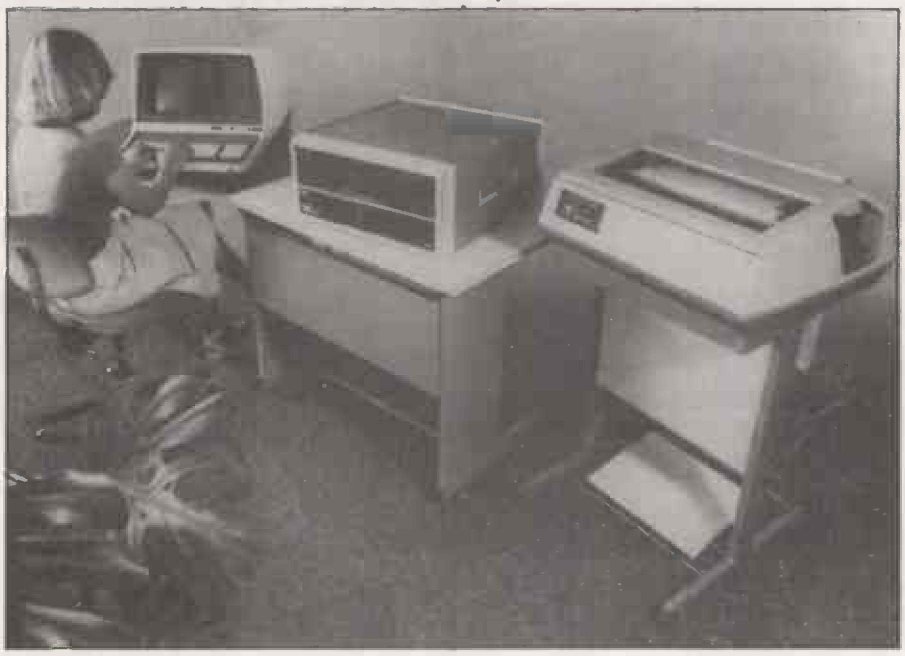
The enhancements to the MZ-80K include the first demonstration of the system running CP/M, developed for Sharp by Crystal Electronics of Torquay which will perform the necessary modifications. It broadens significantly the range of software MZ-80 owners can run.

Sharp is also introducing, or at least demonstrating, the MZ-80K colour monitor for the first time. It has a 14in.screen and four modes of colour variations — eight colours at 256x192 dots,24 colours at 128x192 dots, eight colours with eight graduations with 128x192 dots, and black and white with four graduations with 256x192 dots.

The monitor will not, however, be available until the spring of 1981.

The Elbit Micropact microcomputer.

The General Automation Boss I is launched at Compec.



The new Sharp business computer will be ready for sale early next year. The PC-3200 consists of a QWERTY keyboard with a numeric keypad, user-definable keys and cursor control keys, an 80x25 green screen, dual-density, double-sided 5¼in. discs and printer which is selectable between 80 or 132 characters per line.

The maximum RAM capacity will be 64K bytes and the disc capacity at ½MB per twin disc. The printer and disc interfaces are built-in and include RS232. The screen is capable of reverse video and selected blinking and scrolling. Basic for the PC-3200 is in ROM, unlike the MZ-80K.

Down the aisle and round the corner on stand 8131 is Microsense, which is the U.K.Apple dealer despite rumours of Apple plans to start its own organisation. Microsense is making the formal U.K. announcement of the Apple III, providing most with their first opportunity to cast their eyes over the real thing.

Apple has added extra circuitry to extend the addressing capability of the 6502 allowing it to offer RAM options ranging from 96 to 128Kbytes. A 5¼in. floppy disc is built into the case and there is an option of daisy-chaining three or more on to the system.

Latest accessories

Most Apple II programs will run on the Apple III without modifications, Microsense is also showing the Apple II again with some of its latest accessories and software.

Since most of the software on the market is now available and being written under CP/M, any move which makes CP/M software available for microcomputers based on the 6502 is not only innovatory but also very useful. Apple users, and many others, will know that earlier this year Microsoft produced a Z-80 plug-in card for the Apple which allows users to switch between using the 6502 and the Z-80 and thereby run CP/M.

That is now available in the U.K. and is shown on the Personal Computers stand 2197 at Compec along with a CP/M disc. The Z-80 Softcard, priced at £250, also has a feature which allows a Z-80 program to pass control to a 6502 subroutine and then return to the main Z-80 program.

Other products which have received wide attention in the computer press, but which few people have had the opportunity to see or try for themselves until Compec will include the Transam

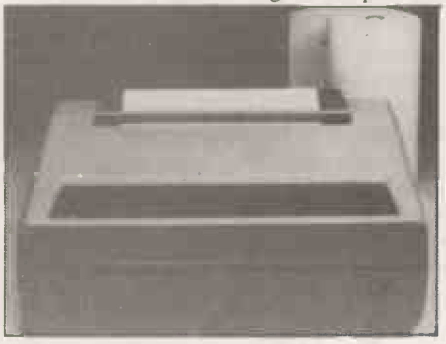
(continued on next page)

◄ • Circle No. 162

(continued from previous page)

Tuscan, on stand 7179. The Tuscan has been the subject of our series on computer design by Tuscan designer Mike Hughes. Transam is also demonstrating its version of Pascal which has been accepted by Commodore for the Pet computer.

Research Machines, Oxford-based purveyor and manufacturer of the successful 380-Z microcomputers, is showing its networking system for the 380-Z for the first time on stand 3185 with three or four distributed processors running from its new IEEE board under MP/M. It is also showing its adaptation of the Computer-Aided Design Centre's GINO graphics packages.



The Facit 4520 9x7 matrix printer will sell for £580.

As reported in *Practical Computing*, Printout in October, GINOs perform a similar function for graphics as CP/M does for discs in that they provide a standard interface between the high-level software and the machine hardware and means that graphics software can be transferred from one machine with GINO to another.

If you think that the latest thing in small business systems is a microcomputer with a multiple-processor sharing centralised and expensive goodies like hard discs and printer, wander down to stand 9088 where Computer Centre Swansea is showing its OEM3, Z-80-based system running a DRI hard disc with multiple processors under MP/M.

Apple II peripheral

Yet another peripheral for the Apple II microcomputer can be found on the Keen Computers stand 3115 where the Keenstar 14in. Super Colour Monitor is on show. It was developed for the Apple from the Keen Sony Super Colour TV. The Keen stand is also featuring the Keenstar microsystem, a 64K RAM S-100 bus microcomputer which is expandable to up to 64 terminals.

The DPSI front panel IEEE S-100 computers, from Ithaca Intersystems on stand 2186, shows some new features including a hard-disc subsystem and a colour graphics board. Also on show is its Pascal/2 native code compiler for Z-80/CP/M system which is useful when re-locatable object codes for ROM are required.

Mini-manufacturer General Automation has had a turbulent 12 months since the last Compec, with dramatic boardroom battles in the U.S. and many changes in the management hierarchy in both Europe and the U.K. including a newly-appointed boss of the U.K. operation. None of those wrangles seems to have affected its products and the U.K. team from Burgess Hill, Sussex are planning to launch a new range of micro- and minicomputers on stand 1145.

The range is for the U.K. market only and was designed and built by General Automation in the U.K. although the systems are based on its own chips. Of the three systems in the new range, the Boss 1, 2 and 3, only the Boss can be called a microcomputer. It is a single-screen, floppy-disc-based micro featuring a 128Kbyte memory and is intended for the small business first time user at a price of £6,000.

It will be sold through General Automation existing dealer network which will be expanded over the next few months. The General Automation sales talk will centre around the fact that it should be possible to start at the bottom of the Boss range and as required, upgrade to the Boss 3 and thereafter on to the rest of the General Automation range of minicomputers.

New micro range

Another new range of microcomputers, due for launch at Compec, is from the Israeli firm, Elbit, whose terminals are already used by a number of manufacturers and are recognised easily. On stand 5172, it is introducing a microcomputer under the title of Micropact, a title not chosen to confuse you with Microact but a natural development of its existing Pact range which include Medpact, a medical software package, Keypact and Datapact.

The basic configuration of the Micropact will be the now familiar Z-80, 64K RAM, 5¼in. or 8in. discs, and S-100 bus and CP/M with four ports and a 15in. screen. The starting price of £1,800 for a system with dual 5¼in. drives seems about par for this type of equipment although Arthur Kennedy, managing director of the Elbit U.K. subsidiary, stresses that there will be an attractive discount structure for dealers, systems houses and quantity buyers.

As a public company, Elbit has some good names behind it. At least 30 percent of the shares are owned by the massive Control Data Corporation of the U.S. and CDC executives play a key role on the Elbit board. Elbit aims to sell between 700 and 800 systems in the first year.

Dedicated readers of the *Practical Computing* pages will remember that in February this year, we introduced a computer system which can be programmed in plain English, or as close to plain English as most computer people can approximate. Called Tina, the system is marketed by Unilever through its office equipment distribution chain Beam which will be at Compec on stand 8166.

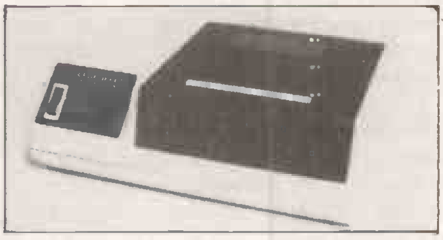
Tina has a limited vocabulary of about 40 verbs to which the user can add his own list of nouns. According to Beam, anyone can learn to program the system in a relatively short time. If nothing else, the demonstration at the exhibition should prove a useful opportunity to try the much trumpeted idea of query language programming.

If you find Tina the wrong size, you can always talk to her big and little brothers Abel, David, Adam and Goliath. Beam is also showing the Pertec PCC2000 Z-80-based micro with CP/M and the MT2 multi-user system linked through IBM protocols to the UCSL mainframe.

Immediate interest

The Swedish company Facit, on stand 1110, already well-known for its stylish office furniture, quality typewriters, printers and computer peripherals is now limbering-up for an attack on the small business computer market. A look at its ergonomically-designed VDUs and keyboard will give you a foretaste of the desk-top computer it plans to introduce some time in 1981.

Of more immediate interest will be its new matrix printers which will be on show at Compec. Two 9x7 matrix printers, the 4520 and the 4521, have bi-directional printing with 60 lines of 80 columns per minute. They are controlled by a Z-80 chip and include character sets for 14 European languages as well as U.S. ASCII. Prices start at around £580.



The Screen Image printer, from Centronics, was designed for videotex.

A more expensive new printer on the Facit stand, at £3,500, is the 4542 Graphic Flex-Hammer. It prints at 250 cps, in two colours, and with a microline feed and a 14x9 matrix dots can be placed in any position of the paper. It also features scanning, semi-graphics and 10 levels of grey to red.

X-Data is making a great show of the latest additions to the Oki line of printers on stand 4197. The Oki Microline is already one of the best-selling matrix printers and a price reduction has been promised to coincide with the launch of two new printers in the range, the Oki 82 and 83.

The 82 is a bi-directional version of the 80 with the additional features including form handling, formatting and improved interfaces, although it is still at 80 cps for its 80 columns.

1.2 Giga bytes of memory is as much as the Athena, on the Butel stand, can take.

The 83 includes all the additional features of the 82 but with a 136 column width and a speed of 120 cps, also bi-directional. The anticipated end-user prices are £550 and £800 for the 82 and 83 respectively, but they still have to be confirmed. Another feature of the stand will be the full range of TEC VDUs for which X-Data has just been appointed the exclusive U.K. dealer.

Still on the printer front, on stand 7156 Centronics is showing a selection of its range of dot matrix and band line printers. The Models 737, 6080 and 703 are all being exhibited in the U.K. for the first time. The Screen Image printer, developed specially for use with videotex and teletext receivers, will also be shown.

The Model 737 is a correspondence-quality printer, the second in the Centronics family of miniprinters capable of proportional spacing, using a 9x9 matrix, and mono-spacing using a 7x8 matrix. It also incorporates three-way paper handling, right-margin justification under software control, 96 character U.S. ASCII and five European character sets. It prints at 21 lpm over 80 columns and 58 lpm over 120 columns and prints sub- and superscripts.

Print mechanism

Mannesman Tally, on stand 6152, is showing what it claims is one of the widest ranges of dot matrix printers in the world. One of its printers is the MT 1602 with a new print mechanism and a new print head with a double life, estimated at 200 million characters.

Options include a new nine-needle head which produces improvements in the print quality. The Mannesman Tally latest comb matrix printer, the T3000, has three alternative matrix formats, controllable from software or from the front-panel switches. The T3000 HR prints at 300 lpm with a 7x7 half-space matrix and can be switched to a 7x7 whole-space matrix or a 7x10 full-space matrix.

High-density graphics

Another printer company, Anadex, on stand 1121 is launching another new printer, an 80-column dot matrix. Called the DP-9000, the range will have a full high-density graphics plus alpha-numerics featuring descenders, underlining, condensed type and double-width printing. Adjustable tractor feed handles up to A4 stationery and three built-in interfaces are standard.

After-sales support in a brief-case from HAL Computers.

More than one year ago, a company called Butel-Comco appeared on the scene in Southampton with a massive desk-top computer, the Athena. It is a hybrid system which includes an integral keyboard, screen, two tape decks, two 5¼in. drives, and a printer all in one. In its fullest form, the Athena can be expanded to have a total memory capacity of a staggering 1.2 Giga bytes.

After-sales support

On stand 2228 Butel is, at last, coming on-line with some software including a suite of interactive Cobol business packages from around £550 and some sophisticated production-control packages called MAPS, both of which are claimed to be compatible with the Data General minicomputers. The Butel aim is to go for the big-machine packages in an attempt to bring good, old-fashioned serious computing to the micro.

Even those few companies interested in after-sales support will find something for them at Compec. HAL Computers, on stand 9042, is displaying the OASIS 820 portable test equipment. This is a micro test tool in a brief-case which can be configured to test virtually any computer peripheral by simply changing the application cartridge. Engineers can carry the OASIS with them, and test anything from floppy discs to displays and printers. The equipment costs around £950.

Main attraction

A continuous demonstration of what a mains voltage conditioner can do about irregular voltage supplies and transient interference will be one of the attractions on the Cetronics stand, 1180. It has a microcomputer working from a distorted mains supply with a 1,500V spike on every cycle and show how their Reguvolt voltage conditioner can prevent hardware and software destruction.

The largest stand at Compec, 2206, has been taken by Canada, 11 of whose companies have clubbed together to book nearly 3,000 sq.ft. to impress the British, especially those with a disposition towards APL.

Of the 11 Canadian companies, six are showing microcomputer systems of which no less than four seem to specialise in APL, APL VDUs, APL time-sharing and stand-alone APL systems for Z-80-based micros.

Last, but by no means least, on stand 2131 you will find the staff of *Practical Computing* ready to answer your queries, listen to your mad ideas and sell the few remaining back copies of the magazine.

Entrance to Compec costs £2 if you turn up at the door, but only £1.50 if you send a cheque.

Make cheques payable to IPC Business Press Ltd, to Compec '80, 40 Bowling Green Lane, London EC1R 0NE.

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• Circle No. 163

Tim Robinson looks at three new software packages from The Soft Warehouse of Honolulu for Z-80- and 8080-based computers using CP/M or CP/M-compatible operating systems. They are muLisp-79, an interpreter for a dialect of Lisp similar to Lisp 1.5, with some notable extensions; muSimp-79, an interpreter for a Lisp-based, high-level Structured IMPlementation language; and muMath-79, a symbolic algebra system capable of routine algebraic simplifications, equation solving, symbolic matrix manipulations, differentiation, analytic integration, and much more. muMath is supplied with muSimp — the entire muMath system is written in the Simp language.

Honolulu's innovatory packages

MOST microcomputer users write their programs in Basic. Its popularity stems partly from the small size of a typical interpreter, which allows all but the smallest system to support it, but mostly from the fact that it is very easy to learn, so that newcomers rapidly gain confidence with the computer.

Programs are developed incrementally, relying on the interpretive nature of Basic and the built-in line editing facilities. Contrast that with most other high-level languages such as Algol or Pascal which are compiler-based. Here, to make even the smallest change in the program, it is necessary to use a text-editor to change the source, followed by the compiler to translate that source into machine code, finally loading the output of the compiler for another trial run.

For a beginner, that procedure presents a significant barrier and even an experienced user would find program development tediously slow without a disc-based machine.

Expressive power

What we need is a language with the expressive power of Algol, with a simple and uniform syntax making it easy to learn, and with the programming convenience of Basic. That is a tall order, but the muSIMP system takes a big step in the right direction. muSIMP is based on the language Lisp, but its outer appearance is totally different.

Lisp has been around for about 20 years during which time it has undergone extensive development, mainly in the hands of Artificial Intelligence — AI — researchers. It has become known as the machine language of AI and, as such, has been used to implement a number of higher-level languages in just the same way that the assembly language of a conventional microprocessor is used to write a Basic interpreter.

muSimp-79 is such a high-level language, and it frees the user from the peculiar syntax of Lisp with its profusion of parentheses, while retaining all the powerful features.

Since the underlying interpreter in Simp is very similar to muLisp, a brief look at muLisp is useful. If muLisp is similar to the dialect of Lisp known as Lisp 1.5, although there are omissions and some notable extensions.

Its authors claim that muLisp will support serious research work on AI. While I think they are being overly optimistic in that claim, muLisp opens the door for the serious amateur to become involved in a very exciting field.

Here are some of the notable features of muLisp. For the benefit of those who have never encountered Lisp, I have included a few useful references at the end.

- There is no real arithmetic. In compensation, the integer arithmetic has almost unlimited precision and can be conducted in any base from two to 36. The largest number it will handle is about 10^611. Internally, arithmetic is, of course, performed in binary.
- As new names are read into muLisp, they are given the value of a self-reference automatically. That is, if the name is used as a variable before a value is assigned to it, it will return that same name as its value. As if, in Basic, when you said PRINTS A$ and A$ was null, the machine displayed 'A$'.
- The function COND is generalised to accept any number of expressions after each predicate, returning the value of the last.
- The body of a Lambda expression is an implied COND. Also, surplus Lambda variables are bound to Nil if no matching arguments are given in a function call. Together, these features obviate the need for most occurrences of COND and PROGN in Lambda expressions.
- With the exception of the PROG-GO-RETURN combination required to make iterative programming possible, Lisp was an exemplary structured language long before the term became idolised. muLisp implements none of these. Instead, there is a powerful multiple-exit LOOP which allows iteration in a pure applicative style.
- A function Condense is provided whose purpose is to permit the sharing of common sub-expressions in function bodies and properties. It can reduce storage requirements by about half, but is time-consuming.
- In all there are 83 built-in primitive Lisp functions.
- A final useful feature is that ']' is treated as a super-parenthesis which can be used to close any number of open parentheses. Surplus right parentheses at the end of an expression are ignored.

As an example of those features, consider the definition of MEMBER. (MEMBER ITEM LIST) returns T if ITEM is a member of LIST and NIL otherwise. That function is included in the muLisp interpreter but it can, of course, be re-defined.

```
(PUTD MEMBER
  (QUOTE
    (LAMBDA (ITEM LIST)
      (LOOP
        ((NULL LIST) NIL)
        ((EQUAL ITEM (CAR LIST)) T)
        (SETQ LIST (CDR LIST)) ))))
```

In conventional Lisp this might be defined as:

```
(DEFINE (QUOTE (
  (MEMBER (LAMBDA (ITEM LIST)
    (PROG ()
LOOP (COND ((NULL LIST) (RETURN NIL))
               ((EQUAL ITEM (CAR LIST))
                 (RETURN T))
               (T (SETQ LIST (CDR LIST))) )
      (GO LOOP) )))) )))
```

In the second version, DEFINE expects a QUOTEd list of functions to be defined which accounts for the extra set of parentheses. A PROG is required, with RETURN to exit from the PROG when the value has been found, and GO explicitly to transfer control back to the label LOOP at the end of the iteration.

Note that while LOOP is a function in the first example, it is merely a label in the second. The MEMBER function could be written more concisely using recursion but I wanted to display the improvement which muLisp offers with iterative programming.

If you found the above definitions difficult to follow, compare them to the following:

```
FUNCTION MEMBER (ITEM, LIST),
  LOOP
    WHEN EMPTY (LIST), FALSE EXIT,
    WHEN FIRST (LIST) = ITEM, TRUE
EXIT,
    LIST : REST (LIST),
  ENDLOOP,
ENDFUN;
```

We see the same function in the muSimp language. Although it looks totally different, it is actually stored internally in exactly the same form as the muLisp version. CAR and CDR have been re-named FIRST and REST, EQUAL and SETQ have become the infix operators '=' and ':', and the WHEN...EXIT, LOOP...ENDLOOP and FUNCTION... ENDFUN constructs have replaced the Lisp functions COND, LOOP and PUTD. There is a great improvement in readability.

In addition to the usual prefix and infix operators of, say, Basic or Algol, Simp also has postfix and matchfix operators. Some examples:

```
Prefix:    unary —      e.g. —3456
Infix:     +,*,AND      e.g. A+2*XYZ
Postfix:   !            e.g. 7! (meaning
                             factorial)
Matchfix:  LOOP...ENDLOOP, BLOCK...
           ENDBLOCK
```

The operation of the matchfix operators is as follows. FUNCTION and ENDFUN indicate a function definition as in the example. Inside a function body, the statements are executed in order up to the ENDFUN delimiter unless a conditional statement is encountered in which the predicate, i.e., the first expression after the WHEN, is not FALSE.

In that case, control is passed to the body of the WHEN and ends when EXIT is found. In either case, the value of the function is the value of the last statement evaluated. LOOP...ENDLOOP is treated as a function body except if the ENDLOOP is reached, control goes back to the statement after LOOP.

For a WHEN statement, the predicate is evaluated. If it is not FALSE, the body of the WHEN is executed up to the EXIT, whereupon control passes to the point following the next ENDLOOP, ENDBLOCK, or ENDFUN. If the predicate is FALSE, control goes immediately to the statement following the EXIT.

Means of control

The purpose of the BLOCK...ENDBLOCK pair is to give a means of controlling where to go after the EXIT if you do not want to go as far as the ENDLOOP or ENDFUN. The first statement of a BLOCK must be a WHEN.

WHEN...EXIT and BLOCK...ENDBLOCK together are a generalisation of the CASE statement of other languages, which includes IF...THEN and IF...THEN...ELSE as special cases.

Associated with every Simp variable is a properties' list, which behaves just like its Lisp counterpart. Information is stored on this list with either the Simp command:

```
PROPERTY variable, indicator, expression;
```

or, from within a function, using the statement:

```
PUT (variable, indicator, expression)
```

where <expression> is any valid Simp expression and <indicator> is a name. The information can be retrieved using:

```
GET (variable, indicator)
```

which returns <expression>. Some very powerful techniques are possible using properties' lists and extensive use of them is made in the muMath package.

The Simp system comprises the interpreter and a bootstrap file called MUSMORE — MORE of MUSimp — which is read automatically when the system is loaded. MUSMORE contains the parser which translates the SIMP language on input for storage in the Lisp internal form.

The file begins in Lisp and as more functions are defined the text gradually changes until by the end, it is in Lisp.

Because the Simp parser is written in Simp, the user can define easily syntax extensions, new operators, or even redefine the system functions to suit his individual needs. While this can be hazardous, it offers possibilities denied to users of almost all other languages.

The muMath-79 algebra system is written entirely in the Simp. However it can be used by someone with no programming experience at all. In the examples, the "?" is the muMath prompt which indicates it is ready to accept a command. The user types a command or symbolic expression terminated by a semicolon. muMath evaluates the command and prints an "@" symbol on the next line followed by the answer.

muMath manipulates rational numbers exactly:

```
? (2/5+1/10)/3;
@ 1 / 6
```

It understands the meaning of the mathematical constants e, i, and π, which are represented by E, I, and PI respectively:

```
?#E^(3*#I*#PI/2);
@ —#I
```

muMath accepts expressions involving undefined variables. Where Basic would signal an error, muMath treats undefined variables as mathematical unknowns and attempts to simplify expressions containing them:

```
? 6*X^3/(9*X);
@ 2*X^2 / 3
```

There is a special variable #ANS, which always holds the value of the previous answer. To find the value of a variable, type its name followed by the semicolon terminator:

```
? #ANS;
@ 2*X^2 / 3
```

The colon operator is used to make an assignment, as in Simp:

```
? FRED: 1/(A*X^2+B*X+C);
@ 1 / (C+X*B+X^2*A)
```

We can now refer to the expression by using its name, FRED. Note that in attempting to simplify the expression, muMath has changed the order of the terms. There are many built-in functions for performing mathematical operations on symbolic expressions. For example, to integrate FRED with respect to X, type:

```
? INT (FRED,X);
```

After a short pause, muMath asks:

```
@ Is SIGN (4*C*A—B^2) —1 $ 0 $ 1 $ ?
```

Replying with 1; to indicate positive sign, we obtain:

```
2*ATAN(2*X*A/(4*C*A—B^2)^(1/2)
+ B/(4*C*A—B^2) (1/2))/(4*C*A—B^2)^
  (1/2)
```

To simplify that, we can use the function FCTR which attempts to factorise its argument:

```
? FCTR(#ANS);
@ 2*ATAN((B+2*X*A)/(4*C*A—B^2)^
  (1/2)) / (4*C*A—B^2)^(1/2)
```

These few examples demonstrate just how easy muMath is to use, although some practice is needed when dealing with larger problems or expressions can easily become too large to handle. muMath offers interesting possibilities for computer-aided teaching of maths in schools. However, its capabilities are limited and unlike the sophisticated systems available on mainframes, it is unlikely to be of serious use to research workers with big problems to solve.

The documentation supplied with muLisp is brief. While adequate for an experienced Lisp user, it makes no attempt to help the novice. After a brief discussion of the internal organisation of muLisp, it gives a description of each of the 83 built-in Lisp functions. There is a small program library which includes a trace package to assist in debugging.

In contrast, the documentation with muSimp and muMath is voluminous, extending to more than 200 pages. It is generally clear, but a rigorous definition of the Simp language is not given. A little experimentation, however, soon clears up any misunderstandings, and 10 interactive lessons are included for beginners.

The first five illustrate the use of the major commands available in the muMath system, while the remainder form an introduction to Simp programming. Running them will start you quickly even if you have no knowledge of Lisp.

The presentation of the manual could be improved. It is reproduced from the output of a dot-matrix printer in looseleaf form in a ring binder.

Conclusions

- **I found Simp easy to learn and, on the whole, a very good language to use.**
- **Considering the limitations of 8-bit microprocessors — limited memory and slow speed compared to big machines — muSimp and muMath are most impressive.**
- **However, I have one major complaint. To conserve precious memory space, Simp does not incorporate any form of function editor.**
- **To alter a function it is necessary to retype the whole definition.**
- **Alternatively, large programs can be typed into a text editor and the file so created read into Simp: while that is adequate, many of the advantages of an interpreter are lost.**
- **Fortunately, there is an interesting solution to the problem. It is the nature of Lisp-based systems that program and data are stored internally in the same form, as lists.**
- **Hence, it is possible to write a Simp function which, by manipulating lists, allows one to edit Simp functions — including the editor itself.**
- **While such a program needs more memory space than an equivalent editor written in machine code, it need be loaded only while a program is being developed.**
- **If space is short, the completed program can be saved and run in a Simp system without the editor.**
- **My first major project with Simp was to write such an editor and it gave me great insight into the inner workings.**
- **I highly recommend muSimp and muMath.**

Numerous system services lift IBM 5120 above its competitors

NOWADAYS, the arrival of a new 64K micro on the market is almost a daily event. However, when that product bears the name IBM, one must look at it in a different light to the run-of-the-mill offerings.

IBM, of course, needs no introduction as a large computer manufacturer and supplier of typewriters. The fact that it markets a vast range of intermediate products is not so well known. In the mid seventies, IBM realised that to attack the smaller systems market, it would need a different approach to that offered by its large systems division.

It felt, and I think rightly, that this approach would be better served by establishing a part of the company to deal with not just the smaller user, but also the users of its smaller machines.

As a result, it formed the General Systems Division which is independent of the Data Processing and the Office Products Division and, in fact, can be in competition with them in some areas.

The first IBM machine to attack the micro market was the 5110, it had very little built-in software and made little

by Nick Horgan

impact on the scene. The new machine, the 5120, is a much re-designed version of the 5110, and will run most of the software from the earlier machine. It is designed to sell both to existing IBM mainframe users and to the first-time buyers.

The machine is very solid; it weighs 120lb. and, with no hand-holds, even two people would not want to carry it very far. Aesthetically, the 5120 looks rather strange with its small screen and offset keyboard.

The screen is high on the left side of the box, allowing two 1.2MB drives to be side by side on the right. The keyboard is attached to the main box on the lower-left side, and in the middle of the front panel, in descending order, are three switches. The top switch allows display of the register contents on the VDU and is mainly for engineering use but is good fun to watch.

The middle switch is for a re-start and would be used mostly when switching between APL and Basic with the third switch. A brilliance control and an on/off switch complete the controls on the front cover.

At the rear are three sockets which are used for communications, and for connecting the system printer. Two standard printers are available; the 120 cps and the 150 cps. Both are bi-directional matrix printers allowing sprocket or cut-sheet feed.

All in all, once you have grown accustomed to the initial odd look of the machine, the system feels and looks well engineered. A quick look inside the box revealed a standard IBM type lay-out. Again, the impression was one of standard and well-tried methods.

Apart from the two printers the computer has 16K, 32K or 64K. The two integral discs are 1.2MB each and a further 2.4MB may be attached externally. The user can either select a version with APL and Basic in ROM, or, if preferred, a system with Basic only. When asked to review the 5120, I was looking for something special. I was not, on the whole, disappointed.

Like most micros, the installation is simple; plug in and go. We did — it didn't. The gloom soon lifted when the problem was traced to a blown fuse in the plug. IBM plugs, by the way, are well designed; you can change fuses without taking the plug apart and the plug top has a loop in it to assist in pulling it from the socket. We never discovered why the fuse blew, and that was the only hardware fault we found.

The version of the machine I had to test was the 64K Basic/APL model. Both the Basic interpreter and the APL are in ROM and are switch-selectable from the front panel. That one fact in itself is enough to lift the 5120 above most of its competition.

The pros and cons of having Basic or APL in ROM are that it frees all the RAM for you to use, at the expense of being stuck with whatever version of the software the manufacturer thinks you need.

Depending on the position of the APL/Basic switch when you either power-up or press the re-set switch, the system will start-up in the selected mode. Changing from Basic to APL and back takes about 30 seconds. You change the Basic/APL switch, press the re-start key and wait for the system to cycle through a memory check. The memory check is also performed after the initial power-on.

Striking features

The first thing you notice after switching-on is the small size of the screen which is, without a doubt, the worst feature of 5120. At a time when, for example, Commodore is changing its 40-column screens to 80 columns, it seems very strange that IBM should produce the 5120 with 16 lines of 64 characters. The best way to look at this feature is that 5110 users will be over the moon to have such a large screen.

The second striking feature is the keyboard, which looks extremely complicated. The major reason for this is the use of APL which, for those of you who are not aware, uses all kinds of non-standard, e.g., Greek and mathematical characters.

To say that the keyboard was being used to the maximum is an understatement, almost all the keys have five functions:

Upper-case alphabetic
Lower-case alphabetic
Basic commands
APL commands
APL special symbols

You can select the function you require from the keyboard using various combinations of control keys. Most of the common commands can be entered with a single keystroke, e.g., print, run, etc., and the keyboard itself is very easy to use. In fact, I would say it has the best feel of any I have tried.

Some of the characters needed by APL have to be created using two overtyped characters from the keyboard. For example, the exclamation mark, although not an APL character, has to be created with a typed bar, followed by a back space and a fullstop.

Memory mapping

The ability of overtype characters brings us to one of the best features of the screen — it is memory-mapped. The big advantage of that is that the CPU considers the VDU to be a part of its memory which enables you to use cursor-control keys to edit information directly on the screen.

The disadvantage is that the CPU has to keep the VDU refreshed all the time. That task can take up to 30 percent of the available processing time from the CPU, with a consequent decrease in program runtime. IBM has gone some way towards solving the problem by letting the programmer turn the screen off for long, e.g., sorts, processing programs. That can be slightly annoying for the user who is confronted with a blank screen and does not notice the process light flickering.

The home position for the cursor is the bottom-left of the screen. The display is small but crisp and I found no trouble reading it in normal light conditions.

I first tried using the machine in Basic — not a very happy experience. Having used a number of Basics, did not bother to read the Basic manual before inputting:

```
10 TEXTT$ = "ABCDEF":PRINT TEXT$
```

As soon as I pressed the enter key, the screen started flashing, an error number appeared under the Basic line, and an upward arrow pointed to the part of the Basic statement the interpreter did not like.

The Basic line is syntax-checked when you press the enter key, rather than — as with most Basics — at run time. That is reasonably useful, and when coupled with the upward arrow pointing to the character Basic does not like, it provides a fast method of ensuring that the statement format is correct.

As I could not see anything wrong with the statement, I thought that the time had arrived, when all else fails, to read the documentation.

For those who complain that they are not supplied with enough documentation, the 5120 is for you — the Basic manual is 600 pages long. The standard of the documentation is very good, as one would expect from IBM. Three sections constitute most of it:

Introduction
Reference manual
Hints and advanced techniques

Those divisions are also used for the applications packages. All in all, the system is supplied with more than 1,200 pages of documentation varying from operator instructions through Basic and APL, to various back copies of IBM newsletters.

It is obvious that IBM has gone to great lengths to ensure that a user, left to his own devices, can start to use the 5120 as painlessly as possible.

It was during the reading of the documentation that my attitude to the 5120 changed. Having worked on a number of micros and on most IBM mainframes, I have always imagined the micro-user toiling by himself manual in hand, while the large mainframe user has all the in-house back-up he could need.

Larger user

The more I grew to know the 5120, the more I found myself thinking about it in terms of the larger user. Whether that was due to the familiar IBM-style documentation, or, the complexity of the system, I do not know.

That is not to say an individual could not use the 5120, but I doubt that he would have the resources to explore more than 20 percent of the machine's capabilities. Two other factors influenced my general feelings about the machine.

Firstly, its ability to communicate with most IBM mainframes, and secondly, the way all my colleagues, who have become immune to the various computers which appear in the office walked through the door with a cheery: "How's the IBM"? There is no escaping the fact that I was not just testing a microcomputer but an IBM microcomputer.

Although the 5120 does not have an operating system as such, all the software can make use of numerous system services. Those facilities, more than anything else, raise the 5120 above any comparable micros.

The CP/M user can, by buying software from various suppliers, duplicate most of the 5120 functions, but he will have all kinds of interfacing problems.

Apart from simple commands that format discs and make file copies, there are three main areas where the system helps the applications programmer.

The first is the procedure file: that allows you to set-up a batch of commands to be executed in a given sequence. A rather neat way of setting-up the file is to use Basic to create it in the same way you create a program. You tell Basic that you want the program saved as data and all the Basic sequence numbers are stripped-off prior to the file being saved.

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Procedure statements may be branched around either unconditionally or conditionally using a return code from the program. Variables may be included in the procedure, e.g., file names, etc.

Next and almost as important is the diskette sort utility. It allows data to be sorted on up to six fields with a maximum total length of 64 characters. Each field can have a different data type, being character or five types of numeric.

Either the whole file may be sorted or a tag — address out — sort can be requested.

The sort parameters are easy to understand and may be created dynamically using Basic or APL. There are four methods of data storage

Stream files
Sequential record
Direct record
Key indexed

Stream files store data in variable format; individual data items are separated by commas.

Sequential records

In sequential records, data is stored in fixed-length records and may be accessed sequentially forwards or backwards. The file is normally in sequence by key with new data being added either at the end of the file or during a file-to-file copy.

With direct record, Data is stored in fixed-length records and may be updated using the relative record number. The file may also be processed sequentially, starting at any position in the file.

Keyed indexed is the big one, as far as applications are concerned. Each record can be retrieved by up to a 28byte key. The system keeps track of indexes, overflow areas, etc. As well as access by the whole key, you can specify just the first part of a key and perform a sequential search. To speed access, the highest level index can be called into memory.

It is a pity that the system does not allow duplicate keys, although with the various facilities available, you should be able to program around the problem.

The first few pages of the Basic manual proved very disappointing, and included the following limiting features.

- Basic variable names are restricted to one character and one numeric.
- Statement numbers vary from 1 to only 9,990.
- You may have only one statement per line.

Compared to most Basics, those restrictions are unbelievable. A final disappointment was that not only do you have to initialise discs prior to use, but you have to pre-allocate any files you will need, with a utility command called MARK.

I can see the advantage of having your files pre-allocated for speeding disc searching in a production environment, but for testing, it is annoying.

At this point, had the micro not been an IBM and had the documentation not pointed out all the other options available, I would have decided that the system was overpriced at approximately £6,000 plus printer. However, from that point on, things improved dramatically.

Even if you know Basic, you should read through the Basic manual. Like all IBM products, the interpreter treads the thin line between sophistication and complication. Most of the commands have vast numbers of options, particularly in the matrix operations.

If you are a seasoned IBM user, you will appreciate the proliferation of various kinds of brackets in the MAT PRINT statement — it takes 10 pages of explanation in the manual. With those reservations, the Basic is superb with full matrix operation, and good print and screen-formatting options.

A program was shown which enabled you to obtain a cross reference of variables and commands; it is so useful that it should be part of the Basic structure.

Error trapping

Error trapping is also very good with more than 200 possible error codes, all of the ones I obtained were even in the manual. Programs may be chained, and data passed using common variables. Programs can be saved in locked mode. That prevents listing or alteration of the Basic program — a very useful facility for a commercial environment where copying of programs is a real problem.

All the normal Basic commands are available. AUTO RENUM, TRACE, etc. The ability to route all printer output to the screen using the run statement proved its worth when evaluating the applications software that was supplied with the system.

The numeric numbers on the numeric pad can be used as function keys. They are not just the normal function keys which return a code to a program — as usual, IBM has gone a few steps further. You can program any of the nine keys in one of three ways.

- To execute a system command.
- To execute a pre-defined series of Basic statements.

• To hold a character string which can then be inserted into the current line on the screen, e.g., you can set-up a function to convert between Hex and decimal, assign it to one of the numeric keys and, by supplying the argument, press one key and obtain the answer.

I am not an APL programmer, and am, therefore, unable to pass judgment on the IBM version of APL. However, having long wanted to use APL, I felt that this was a good time to devote half an hour to trying it.

Five hours later and half way through the introduction to APL, I was living proof that, for a first-time user, the documentation really works.

An interesting point that struck me was that a machine with APL — which is very strong in matrix operations — should also feature a Basic which also has the most advanced matrix operations I have encountered.

If it is IBM, the 5120 will communicate with it or emulate it. I can imagine that existing IBM users will have been made aware of the facilities available with the 5120 to communicate with their equipment. It will communicate with all the IBM mainframes and with another 5120 via bi-synchronous or synchronous ports. It will emulate a 3741 or a 2770, and can communicate with punches, etc., via a RS232C port.

As a rule, IBM does not supply commercial packages with its systems; the user is left to program or to go to a third-party software house.

Blurred distinction

The neat line between application packages and system utilities is becoming rather blurred in the case of information storage and retrieval. However, with the 5120, IBM has gone all the way and produced a comprehensive commercial package of:

- Accounts payable
- Accounts receivable
- Nominal ledger
- Stock control

They may be used on a stand-alone basis or a total system.

BRADS, or business report/application development system, is a complex program suite which can be purchased with the 5120 to store, update and retrieve all types of information. The complexity of the system is hidden completely from the user who interacts with it via a series of menus.

In a large number of data processing applications, it is required to hold, update, enquire of and report on lists of files of data. Common examples of that are:

- Personnel lists
- Stock files
- Component lists
- Registers, etc.

BRADS allows the first-time user and the experienced programmer to create those applications in a very short time. The documentation consists of an introduction and a reference manual.

The introduction is a very well laid-out book, consisting of screen lay-outs, print lay-outs and amusing cartoons. It starts with how to turn on the 5120, how to load diskettes and how to enter the computer into BRADS. It continues with two clearly-explained examples, and by the time the user has finished, say, between five to 10 hours, it should be possible to write a simple application.

To anyone used to information storage and retrieval systems, the sequence of operations is familiar. For those to whom it is a new method, there are five basic steps:

• Define the name of the file and what it is to contain to BRADS, e.g., file is stock file and data will be stock name, level, etc.

• Tell BRADS how you wish to access the file, e.g., by stock name and by supplier.

• Input information according to the first step. You will be prompted for correct information by BRADS at each point in the update.

• Calculate and tell BRADS how you will select information, e.g., all records where stock is below minimum stock and supplier is Smith & Co.

• Define the various print lay-outs you require.

All that is done using a question-and-answer session. Needless to say, BRADS makes good use of the sort and indexed sequential facilities on the 5120, allowing report sorting and complex file structures.

That only scratches the surface of BRADS which has a large number of facilities including the ability to add Basic to a BRADS application.

Most microcompanies would call BRADS a database management system. I am glad to say that IBM has not done that because powerful though it is, to write a payroll system would not really be possible without using a large amount of Basic. However, BRADS would be of such enormous help for most people that I cannot imagine many buyers going without it.

I shall not go into depth about the accounts receivable system, but try to give some idea of how IBM packages its applications software. The packages are of U.S. origin but have been changed so that they fulfil the statutory requirements in the U.K. That is satisfactory as far as it goes, but the documentation is still full of MMDDYY and ZIP codes.

The manuals are complete with two cassettes which lead you through the documentation. The instructions and examples are excellent, taking the user from the setting-up of the system through to how and when to process information. Every facet is covered, for example, among the chapter headings you will find:

- Computerise accounts receivable — a plan of action
- Training operators
- Obtain supplies
- Conduct parallel run
- Setting-up manual controls

The instructions are easy to read and are contained in handy, small-size reference books. It all fits in with the general idea of the 5120, in that you should expect to spend time reading the manuals and trying the examples before using it in earnest.

The accounts receivable package is comprehensive, containing the following reports:

- Statements
- Trial balance
- Over credit limit
- Outstanding invoices
- Past due invoices
- Customer master file print
- Account status report

Open-item or balance-forward accounting can be selected by customer. All in all, a well-constructed, excellently-documented system which should be easy for a first-time user to set-up and run.

Conclusions

• The 5120 should be assessed as a total system including the system utilities, APL and Basic, and the communication facilities.

• If the prime marketing aim of IBM is to use the machine to stop its existing users going elsewhere for their micros, they have the design and price exactly right.

• If the marketing aim is to set first-time users on the IBM path, I am not so sure of its success; where the existing user would see worthwhile facilities, the first-time user could well be put off by the complications.

• As far as the price is concerned, for a 2Mbyte system with 64K and a 120 CPS printer the approximate price would be £8,500. Application packages work out at about £1,000 a piece, and delivery is immediate.

• There is reputed to be a large amount of software available from the 5110, and there are a number of systems houses who will write software for the 5120.

• The small screen, and rather reduced Basic facilities regarding variable names, etc. were disappointing.

• The documentation was excellent and stretched to more than 1,200 pages. Switching from Basic to APL and back is very easy, and could prove a boon in mixed commercial/scientific work.

• The command structure in Basic was very comprehensive.

• Having procedures, a sort, and indexed files makes application programming very productive.

• BRADS is a good information storage and retrieval system, and should prove popular with experienced and first-time users.

• Communications with other IBM products is as good as any user could wish.

• A solid, very comprehensive micro with an integrated-systems approach. It is going to cause problems to other vendors trying to break into existing IBM users at the micro level.

• There seemed no easy way to expand beyond the 4.2M of floppies on to hard discs or indeed any other IBM machine.

• For a single-user system, the price is on the high side, but if security of supplier is what you need, obviously you cannot do much better than IBM.

The Acorn Atom

by Jim Murray

THE QUESTION uppermost in my mind when I first received Atom for review was: "At whom has Acorn aimed the machine"? I took delivery of the machine in a cardboard casing measuring 17in. by 12in. by 4in. which housed the unit supported by foam mountings plus the three necessary electrical cables and the single accompanying manual.

The computer is of the single-unit type — a formed plastic shell supporting the processor, memory, interfaces and a full-sized QWERTY keyboard. It is also small enough to pack into an average-sized briefcase. Having no built-in display or printer, the Atom uses what surely must be the best method of output for low-cost systems — direct connection to the aerial socket of a domestic TV set.

After unpacking the unit, and turning to the manual, I met the first snag; there was no indication anywhere as to what voltage should be applied to the power line. Fortunately, there was a note written on the transit box: "Needs 5V — two 2.5V batteries". So I duly connected it to my own clean 5V supply. In fairness to the manufacturer, I learned subsequently that the review machine was a pre-production model although the manual supplied was, in fact, the latest edition.

Hardware components

Establishing that with the correct power applied, the unit gave the proper prompt when connected to the TV, I turned my attention to the hardware components. The available configurations range from the minimum system which is an 8Kbyte monitor plus 12K byte RAM. The review system had the 12Kbyte monitor and 12Kbyte RAM.

The expanded system also supports a floating-point option which was included in the review machine. Without that option, the user is limited to using integer-only arithmetic. Having verified that the machine functioned correctly, it was time to look inside and examine the architecture. The nucleus of the Atom is the 6502 processor chip, now established as one of the standards, at the heart of the Apple, the Pet and the Rockwell AIM systems. For the assembler programmer, the 6502 instruction set provides some useful facilities especially in its addressing modes, and the idiomatic Basic provided with the Atom denies the Basic programmer very few of those facilities. Memory was provided using 24 2114 4K static RAMs.

Input/output other than through the built-in keyboard, TV VDU and cassette channels was through a 6522 VIA — versatile interface adaptor — which provides two parallel ports, interval timers and a serial/parallel converter. Finally, the display processor was a 6847 which allowed a range of display options, all user-selectable using the standard software provided.

Eight graphics modes are available in all but only the base level mode — mode 0 — is available on the unexpanded machine. In that mode, the screen is structured as 16 lines of 32 columns — each character is either one of the standard 64 ASCII set or one of the standard 64 special symbols created from a six-element Pixel.

The ASCII characters can be displayed either in the standard way — white on black — or in reverse video, and the special symbols can be shown as black and white or black and grey. Mode 0 allows the full range of allowed characters and symbols to be displayed simultaneously. The higher graphics modes provide progressively higher point addressing on the screen up to a maximum resolution of 256 by 192 in black and white or 128 by 192 in four colours. However, the higher-resolution and colour facility has to be paid for by the use of up to 6K of the user RAM.

I approached the user manual with some degree of trepidation. For, as many may have experienced, some manuals supplied with hardware and software products are grossly inadequate, others are little short of disgraceful — hastily-produced adjuncts to the product they describe.

Users' manual

No such criticism can be made against the Atom manual, although the title is innaccurate, or at least misleading: "Atomic theory and practice — a beginners' course in Basic and machine-code programming". It implies that, having mastered the contents of the tome, the raw beginner would have acquired a command of both the Basic and 6502 assembler languages.

I feel that to be misleading for two reasons because the version of Basic provided with this machine is highly idiomatic and there are more concepts involved in writing assembler or machine-code programs than are introduced in this manual.

The risk is, therefore, that the beginner might emerge from his thorough study of the Atom monitor as taught by the manual, under the misapprehension that he could program in a standard Basic and even start work with a standard assembler.

With those reservations, it must be said the manual, as an explanation of the Atom monitor, is a masterpiece of clarity — full marks go to David Johnson-Davies for his very readable and instructive work.

There are three sections to the book, dealing with Basic, assembler and general reference points. Each section is neatly divided into chapters, each of which addresses one concept; there are 27 chapters. In sections one and two each chapter then follows the same pattern: a friendly introduction, aimed at the less-experienced reader, explains each new point — loops, arrays, strings, etc. — then coding is defined and finally a set of examples presented.

The worked examples distributed throughout the manual are worthy of a special mention. A wide range is presented and within each chapter, they vary from the simple, which illustrate well the chapter's central theme, to those which present methods using the theme which many career programmers could usefully add to their repertoire of techniques.

A thoughtful overall introduction is provided at the beginning of the manual which suggests a reading for those of different skill levels. The 10-page index at the back of the book is comprehensive.

Important concept

The three software components of the system are the monitor, the Basic interpreter and the assembler. The assembler is accessed through Basic which in turn is accessed via the monitor.

The monitor effectively manages a dynamic area of memory called the text space which grows or shrinks as text is added to or deleted from it. Any user input line preceded by a line number goes into the text space either as a new line or to replace an existing line with the same number. The text lines are sorted on line number as generally the text space will hold the currently-active program — either Basic or assembler.

An important concept is multiple text spaces. At any point, the user can redefine the start of the text space he wishes to manipulate and can thus have resident in memory several areas all containing lines with the same range of line numbers. Those text spaces may perhaps hold programs or there may be a mixture of programs and data. Regardless of what they hold, however, only one can be active and accessible by the monitor at any time.

The monitor thus acts as the text space — program — editor, but the only facilities offered are whole-line replacement and selective lists. There are no utilities which provide string searches, string replacement of re-sequencing.

The manual provides, however, an example of a program in a secondary text space which re-numbers the main program, resident in the primary text space an the enterprising programmer may wish to equip himself with similar utilities to emulate his favourite editor before embarking on a major project.

Text spaces are saved and loaded to and from cassette tape via simple monitor commands which allow the user to assign file names to the tape files, the encoding format being CUTS — or Kansas City Standard — with a reasonably modest fixed speed of 300 baud.

I tried three different cassette recorders to test the cassette system. They varied in price from £25 to £55. Only on the most expensive recorder did I achieve consistently trouble-free data transfer.

While it might be argued that a good quality recorder is a good investment for those wishing to use it for off-line data storage, I feel one must consider the position of the purchaser of a low-cost system such as the Acorn Atom. To him, the cost of upgrading his tape recorder must represent a large proportion of the total cost of the system.

I believe, however, that the explanation of this particular fault lay once again in the fact that I was using a pre-production system — I saw another later Atom connected successfully to a low-price recorder.

The general point is obvious: the buyer of any piece of technical equipment must satisfy himself that it is fully compatible with components he already owns and wishes to use with it.

The Atom text space can contain any data the user wishes to enter. So, when the data is, in fact, a program, no syntax checking can be performed until the run command is issued. At this point the text is interpreted as Basic.

While many, if not most Basics on small machines have eccentricities and can be said to be non-standard, some are positively more non-standard than others. The Atom Basic is definitely non-standard and that, I think, is due to the strong link between it and the built-in assembler.

The user is provided with 26 simple variables, A-Z which when undimensioned can hold either a four-byte integer or four-byte floating-point number if the floating-point option is included. Note that numbers are held in binary, not as ASCII strings, which, of course, makes for higher-speed arithmetic calculation. Thus, the default precision is 32 bits but examples in the manual indicate how to manipulate numbers of arbitary precision if this is needed.

If the simple variables are dimensioned, they are assumed to be byte arrays, holding numbers of eight-bit precision or, more normally, character strings. Those arrays must either be pre-defined or assigned dynamically to unused memory above the program space at program run time. In practice, there is not much difference between the standard dimension statement and dynamic assignment.

Array variables

An additional 26 array variables, AA - ZZ, are also provided to hold word arrays. In Atom terms, a word is the four-byte unit. Arrays can have only a single dimension. That appears restrictive until the concept of indirection and word vectors is introduced.

Indirection is a concept more familiar to assembler programmers than to those who normally use Basic but all it means is that a variable contains not a value but a pointer to a value which is held elsewhere. Atom Basic allows word vectors to hold such indirection pointers to other arrays or vectors. Thus, multi-dimensioned arrays can be simply constructed as arrays of arrays.

Admittedly, the penalty is a certain lack of clarity in the program but the bonus is that the inventive programmer can construct rich data structures found usually in the more powerful langauges. Naturally, the Atom Basic provides new operators to deal with these structures.

In the same vein, string variables are handled in a way which pays little allegiance to the more traditional methods, but once again, all the regular string manipul-

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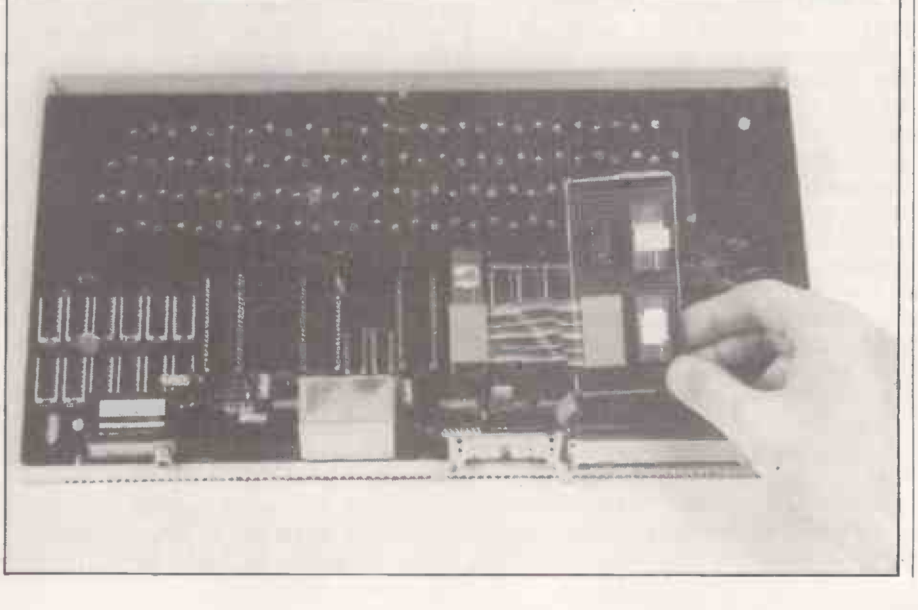

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ation functions are either present or can be very simply constructed. I must admit that initially, I found addressing the various data types rather awkward but after realising the strong association with the processor addressing modes, normally evident only when programming in assembler, all became clear.

The next point of interest was the structure of the executable program statements. Although the screen width is only 32 characters, a Basic line can in fact be 64 characters long. On the screen, the line wraps around after the 32nd character automatically.

Each line can hold as many statements — separated by semicolons — as will fit, and when one statement is an IF test, either all the remaining statements on the line are executed or none, depending on the result of the test. That, of course, helps the programmer as he can dispense with many short conditional GOTO branches whose only purpose is to include or omit a few lines of code. It also enhances the readability of the program.

Reserved words

Another feature, however, while just as valuable in other circumstances detract from the program's readability. That is that most reserved words can be reduced to one or two, sometimes three characters. A multi-statement line using the abbreviations can thus be reasonably complex, and the decision to write clear or concise code is in the hands of the user. A spin-off here is that a powerful immediate mode command can be input and can even involve more than one leve of FOR NEXT loops. Immediate mode commands are a feature of most Basics and normally allow the user to execute any single-line statement which contains no reference to another line without having to declare that single line as a program.

On the subject of loops, the FOR NEXT STEP construction naturally is present, augmented by the more recent DO UNTIL variation and FOR NEXT, DO UNTIL plus GOSUB RETURN sections can be nested to a depth of 15. GOSUBs have two interesting peculiarities. Firstly, the target line — or the target line of a GOTO — can be referenced by a label as well as by line numbers. That, of course, makes the program insensitive to line number changes and, it is claimed, results in faster execution of the program. Indeed, a simple two-line example program which produces a continuous tone on the internal loud speaker proves this, since the variation using a line number as the GOTO target produces a lower note than the variation which uses a line label.

Secondly, GOSUBs can be recursive. For those not totally familiar with recursion, it is simply the concept of a subroutine calling itself. Many classic problems can be very elegantly formulated using this concept and several useful examples are given including the Eight Queens' problem and the Tower of Hanoi, and mercifully excluding the totally useless evaluation of factorial.

Both the Eight Queens and the Tower examples show a continuous graphic display of the solution steps and it is perhaps illuminating to note that both can be run on the minimum 512-byte, user-RAM configuration.

The continuous display brings one to the graphic capabilities of the system which must be a major attraction to potential buyers. The ranges of resolution, or point addressability, mentioned and three verbs, MOVE, PLOT and DRAW, are available which produce point to point movements of the graphics cursor.

If the graphics is to be used, there are two options, one of which illustrates another neat feature of the system. If the extension ROM which processes the fourth verb — colour — is not present, the user can supply his own subroutines which process the MOVE, PLOT and DRAW verbs. That is possible by the monitor placing the default addresses for those routines in accessible RAM even though the routines themselves are in ROM. The user can, therefore, re-direct the interpreter to use his own supplied routines in preference, by adjusting the ROM pointers.

That technique is also available for other system-supplied features such as error-message processing, so for instance, in this case, the programmer might choose to try to recover from an otherwise fatal error alternatively, he might chose to produce a more specific message than the systems default.

In general, the documentation is very clear about the monitor and which memory locations can be manipulated to adjust its features and operation. Relevant to that, I was glad to note that the abominable Peek and Poke commands had been relegated to the scrap-heap and replaced by a much more elegant idea.

If a variable — holding a value which is a memory location — is preceded by a '?', the expression is interpreted either as a Peek or Poke depending on its context. Thus, for example, in the statement "?L = ?L + N", the "?L" at the left-hand side of the "=" is interpreted as a Poke while the other occurrence is interpreted as a Peek.

For the assembler programmer, access to the assembler is gained through Basic. Two special symbols, '[' and ']', are used to enclose assembler statements within a Basic program. When, during the run of the program, those statements are encountered, they are not executed, but assembled.

The location into which the machine code is placed is governed by the Basic variable P which is manipulated by the assembler just as a regular location counter or which can be adjusted by the Basic program. In fact, the variables available to the assembler programmer are identical to those available to the Basic programmer. Naturally, there is a Basic command available, LINK, which transfers control from Basic to the machine code, but there is a much more important use for writing assembler statements within a Basic framework.

Since the assembler blocks enclosed by the brackets assume the same status as an ordinary Basic statement, the higher-level language can control the selective assembly into machine code. That is, condition tests in Basic can determine whether or not a given section of assembler code will be included in or excluded from the assembly.

The systems developer who may wish to produce several versions of a machine-code program, each with its own local variations can therefore use Basic to formulate the individual options, and select those options required perhaps by a question-and-answer preamble at the beginning of the control program.

Using similar methods, macro statements, i.e., groups of assembler statements referenced by a name, can be built easily. The two utilities of user-defined macros and conditional assembly provide the developer with a powerful tool found normally in much larger machines.

Conclusions

- **The Atom is a low-cost modular and expandable system.**
- **The software provided derives from a creative approach to mixing Basic and machine code, although criticism of the dialect of Basic included would be very understandable.**
- **Most buyers will be hobbyists, educational establishments, or perhaps engineers.**
- **The machine will make less impression in the immediate future on the commercial market. Two developments in the pipeline promise, however, to change that.**
- **The mini-floppy option should be available soon. If the company sticks to the target price of less than £200, a disc-based system with colour graphics for around £450 will certainly open new markets, making the machine very attractive to the small business user.**
- **The second development is a combination of several machines into a market based on the Cambridge Ring; that concept allows a large number of units to be connected as nodes on a loop, each node controlling a particular system resource — printer, hard disc, VDU etc. — resources are shared in the total system via messages which circulate around the loop.**
- **Current opinion is that this architecture will provide an ideal base for a distributed system such as the not-so-futuristic electronic office.**
- **The Atom must, therefore, be a strong contender for inclusion on the short list of a wide range of buyers.**

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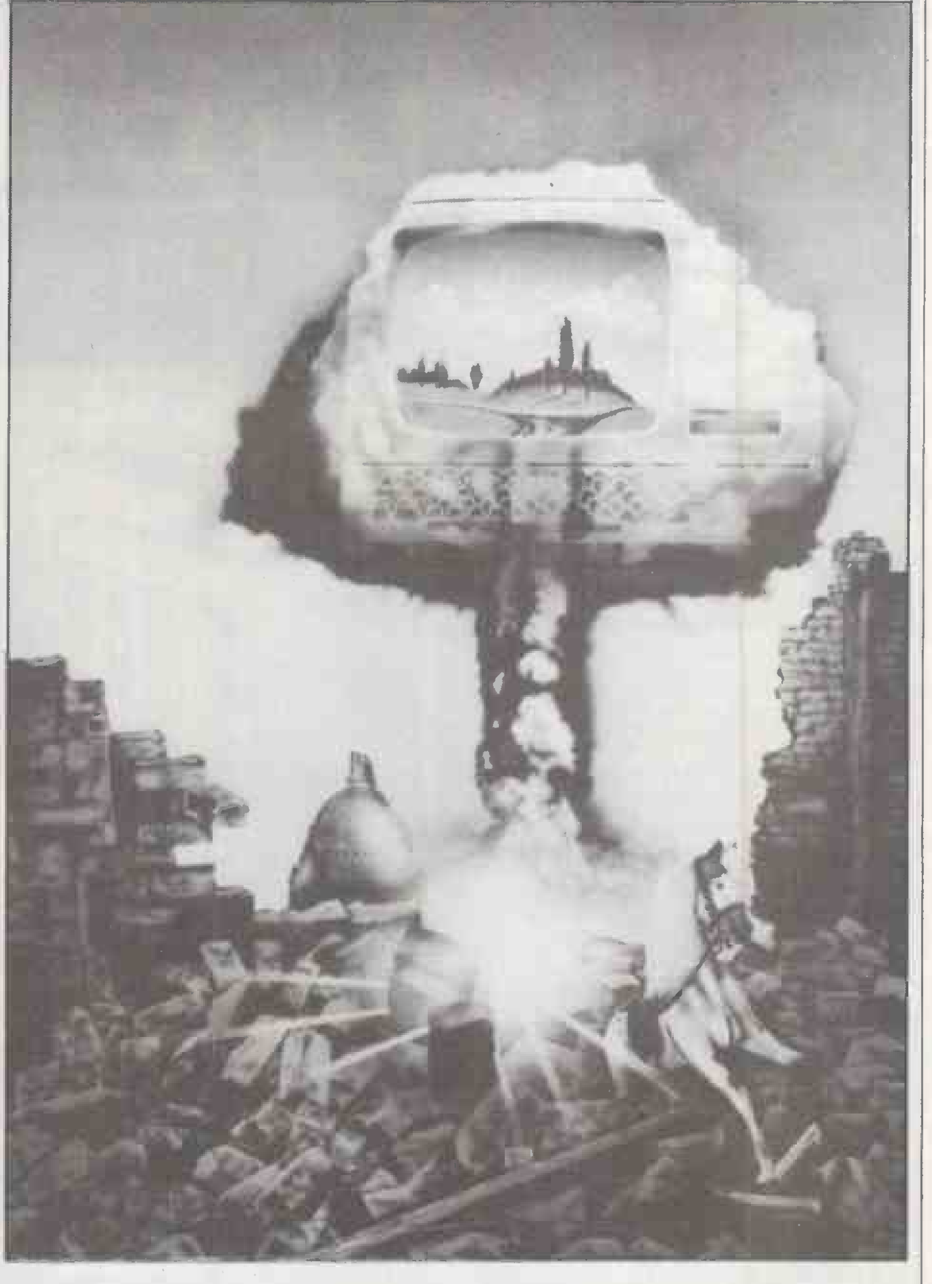
The Micro Revolution

The wonderchip promises exciting things as it infiltrates the industrial world. There are huge technical problems in applying it, but they may be dwarfed by the political and economic problems it raises. In this extract from his book *The Micro Revolution*, Futura £1.50, Peter Laurie looks at the unpleasant implications.



IT IS easy enough, in a way, to forecast what technology can do for us, and not so hard to see in isolation what it will do to change our lives. What is really difficult is to see what stands in the way of that technology being used.

To put it bluntly, there are political problems. For instance, PTTs — Post, Telephone and Telegraph administrations — in most countries have monopolies over communication. It is often forgotten, so peaceful is the tenor of our lives, that this monopoly is one of the foundations of a government's political power.

Charles II established the British Post Office simply so that he could read his enemies' letters, and thus forestall conspiracies such as those which had cost his father his head.

Politics is no different today, and an essential part in any government's power is its ability to intercept its citizens' communications. That power is not used as much as some people think — in London, Paris or New York there are probably not more than 2,000 or 3,000 telephones being tapped at a time.

Labour-intensive

In fact, telephone tapping — as opposed to recording for possible later playback — is a very labour-intensive business. It is necessary to have people listening to the lines who know the suspects and their lives and can make sense of their cryptic remarks. Yet it was no surprise when the students at Copenhagen University 10 years ago found a room full of tape recorders under their union building. It emerged, after agonised debate, that the Danish Post Office maintained seven such posts, with which they recorded all international telephone calls for NATO Intelligence. If it happens on that scale in little Denmark, can one believe it does not happen everywhere?

So security services must look on proposals for widespread broadband links with great suspicion. Even the ordinary flow of data will be very difficult to monitor, without vastly expensive artificial-intelligence installations which can sample and interpret data streams. When communications become electronic, all the normal indicators of political unrest will disappear into electronic form and may well become buried in the huge mass of trivial material which will flood the highways.

If there were not some kind of monitoring, one can see that it would be very easy to form large-scale conspiracies. With part of one's mind one scoffs but, on the other hand, would it be a good idea to let the National Front or the Ku Klux Klan go recruiting by video link? Should they show their publicity films in anybody's home? Ought one to allow them to organise encrypted conferences among their members, who may be spread anywhere in the country, unknown to their neighbours?

The first U.S. Ceefax system — in Salt Lake City — has a time-slot option which makes pages accessible only if the time at which they are transmitted is set into the receiver as well as the page number. In effect, the time setting is a simple security code. The demonstration film issued by the Salt Lake City TV station concerned shows this page being used by the local Medical Association to transmit urgent news to doctors about an outbreak of food poisoning, but one can easily foresee more sinister uses.

I, for one, am not at all sure it would be a good idea. So, for security's sake, there must be limitations on the right of free electronic communication — at least until people have got used to the new order. As James Martin pertinently observes in his book, *The Wired Society,* each major change in communications technology seems to have released the forces of revolution.

For instance, the revolutions and attempted revolutions that convulsed Europe in the middle of the last century coincided with the introduction of the telegraph — a device which reduced days of despatch riding to minutes of Morse-key clacking. Newspapers had information from the other side of the continent on the same day. So did revolutionaries. The simple stringing of wires had multiplied the pace of political life by a factor of about 100, and it is not surprising that the curbs which had worked well in the slow old days failed under the new circumstances.

The British history of civil defence records that the new invention of radio was a key weapon in the government's defeat of the General Strike in 1926. For the first time, the nation's leaders could talk, calmly, sensibly, intimately to the ordinary voter in his home. The impact was tremendous. Hitler and Stalin, in their time, both acknowledged that command of radio was a major factor in their political success.

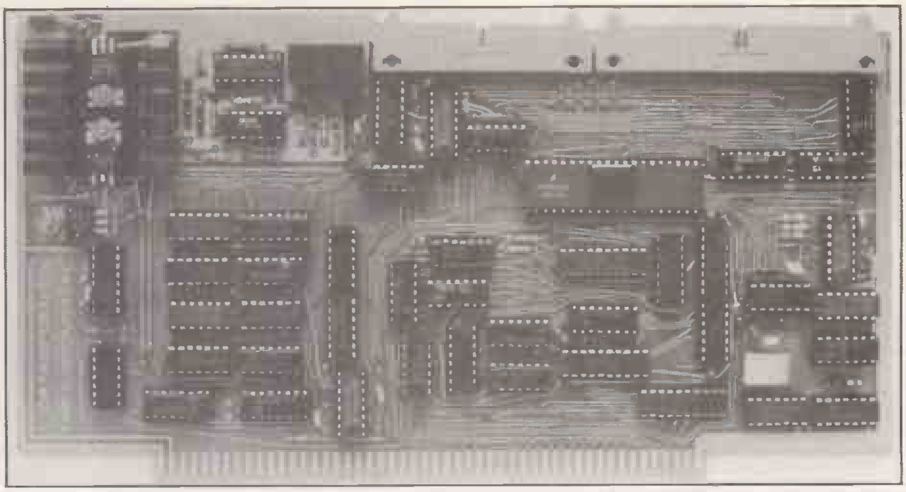
Intense student unrest in the U.S. in the sixties was perhaps triggered by the widespread enjoyment of television. For the first time, civilians could see — almost bomb by bomb and bullet by bullet — how their army spent its defence budget. Hitherto, this disturbing knowledge had been the preserve of specialist war-correspondents.

Direct contact

Direct contact with the military reality of a badly-run colonial war seems to have revolted a whole generation of young Americans, who very nearly made an end to their government. It is a testimony to the power of television that in all politically unstable countries it is the most strictly-censored medium of communication.

So, it would be foolish to expect that sudden access to great data highways will not have important political results, because politics is about co-ordinating the country's understanding and intelligence and it operates mainly in the sphere of communications. If techniques change suddenly, a whole new politics will have to be invented to cope. Since, as in technology, it is the newcomer who has the greatest incentive to master the new techniques, it is likely that, for a while anyway, the enemies of the existing order will make better use of it than the Establishment. Before things settle down, we may expect a few squalls.

On a more mundane plane, the installation of the new systems is going to



have an enormously upsetting economic effect on the old. For instance, today's audio switching network in the U.K. needs 250,000 engineers to maintain it. They are not highly-trained technicians. As the new systems arrive, few will be re-trained to cope with them. The technicians will not be in favour of a sudden switch which makes them useless.

Another problem is that natural copper ore deposits have almost been exhausted. Copper prices have risen and are rising sharply. What has happened is that the world's copper has been mined, refined, formed into wire and buried again under the cities of the West as telephone cable. The change to glass fibre or satellite radio will put millions of tons of pure copper on to the market. That will ruin countries like Zambia or Peru. Again, as a Post Office engineer told me sadly, the U.K., could have had electronic exchanges years ago if it were not that the entire city of Liverpool earns its living by building the antique mechanical sort, and seems incapable of learning to build the electronic version.

The Chief Constable of Liverpool is reported to have said recently that if the Post Office moved too fast with its electronic exchanges, he would have to introduce martial law to cope with the chaos that would result. These are not negligible problems. Technology is one thing; installing it is another matter — and perhaps just as well.

That leads to the bad news. The most obvious effect of the agricultural, *circa* 4,000 BC, and the industrial revolutions, *circa* AD 1760, was to begin rapid increases in populations. More hands meant more food which meant more hands.

The limited data-processing and distribution facilities afforded by scribes, clay tablets, horse couriers, national religions enforced a pyramidal structure on pre-electronic societies. The wider the base of peasants or factory workers, the higher the pyramid could rise and the more powerful it was in relation to other pyramids. There was consequently a driving tendency to increase populations up to the limit of the resources available, and somewhat beyond — it was found that a little peripheral famine did wonders for discipline.

According to a recent study done for the Government Central Policy Review Staff — the Think Tank — the country will need only 10 percent of today's labour force to supply all its material needs by AD 2010. Professor Tom Stonier, of Bradford University, based this prediction published in the *Guardian,* November 14, 1978, not on the unpredictable rate of technical change, but on the rate in the past at which new technology has been accepted by industry and society.

Electronic world

So the electronic world alters all that. A large population is no longer necessarily a powerful one. In fact, if it has many unproductive people in it, it may well be weaker than a sparer, better-organised society in which everyone plays a useful part. For the larger one has to waste resources supporting useless members.

When everyone — or very nearly everyone — worked at stupid machines, they could form themselves into sub-masses and make their wishes felt by striking. Because of the interlinked nature of industrial economies, a small number of determined strikers could cause a good deal of inconvenience. Consequently, all the industrial states developed either forms of democracy to remove the necessity for strong demonstrations of that kind, or heavily repressive machineries to prevent them.

However, electronics changes that, too. If you do not work, because electronics does your job more cheaply than you can, you cannot strike. Your vote, which was a precursor or symbolic exercise of your ability to cause hardship to the economic system by striking, becomes irrelevant. You are no longer necessary as a market for other people's products because the only point of selling to you was — in the eyes of the economic system — to make you labour to buy them.

The basis of today's industrial system was explicitly worked out 150 years ago. It

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was then debated whether industrial workers should be kept in their then state of serfdom or whether they should be allowed to share in the wealth which the produced. The first view seemed at first the more sensible, but as an early economist put it:

> To make men industrious, to make them shake off the lethargy which is natural to them, they must be inspired with a taste for the luxuries and enjoyments of civilised life. When this is done, artificial wants will become equally clamorous with those that are strictly necessary and they will increase exactly as the means of gratifying them increases. Whenever a taste for comforts and conveniences has been generally diffused, the wants and desires of man become altogether unlimited. The gratification of one leads directly to the formation of another. In highly-civilised societies, new products and new modes of enjoyment are constantly presenting themselves as motives to exertion and as means of rewarding it. Perseverance is, in consequence, given to all the operations of industry; and idleness, and its attendant trains of evils, almost entirely disappear.

J R McCulloch, 'Political Economy', *Encyclopaedia Britannica*, 1816 Supplement.

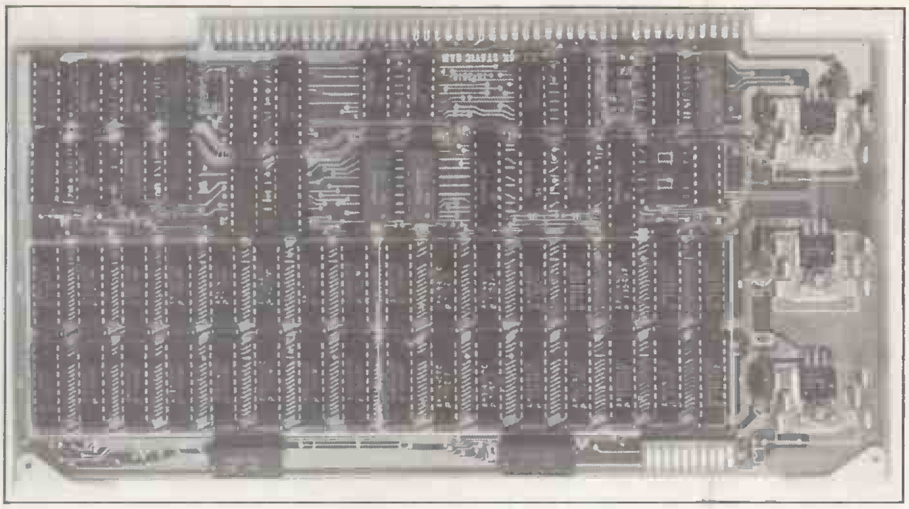
That is the system which made the industrial nations rich, but now electronics is hacking out its foundations. Since our robot at £1 an hour can work as well as the human at £3, we no longer require the services of the human. The earning power which he and his mates represented is now concentrated in the far fewer people who build and organise the robots. As long as industry continues at the same volume, they do very well. That is why computer programmers cost £100 a day.

Explosive collapse

My feeling is that a too rapid implementation of the electronic world will lead to an explosive collapse of the industrial economy, because it will make many workers unnecessary both as producers and consumers. Consequently, the people who made things for them will become unnecessary.

What happens then? Well, in theory, although the workers are not working, because they have been automated out of a job, the same amount of goods being produced, so they are better off: they do as well without having to work. Yet our system says that they cannot have the goods unless they work, since goods are distributed as a reward for work. So we have to change our economic system to reward existence rather than usefulness.

Secondly, the individual worker's political, economic and social rights were guaranteed by his ability to strike. If he were upset, he did not have to revolt; he could draw attention to his works by not working. Now, he is not required to work and so cannot strike. Since his vote was simply a symbolic precursor of his right to strike, it now becomes meaningless. Deprived of industrial and political means of drawing attention to his grievances, the workers will be forced back on violence. So we have to alter our political system to make it sensitive to nuances of unease. Or we have to make it stronger to resist the workers of the industrial disenfranchised.



Economic ills

I would argue that all this is happening now. It seems to me that the economic ills of the industrial nations are due exactly to this process. Because it is cheaper, for the moment anyway, to keep the unproductive within the system than to turn them out on the streets and have to defend oneself against them, all the industrial nations have this internal burden of an obsolete proletariat which has to seem to be treated as if it were productive.

From the realistic point of view, a worker is only worth paying £X a week if it costs more than £X a week to protect the system against him. He was to appear to be treated in line with the old ideas of equity and equality on a par with the really productive people whose earning capacity has been multiplied several times by the electronic revolution — limited as it is so far.

To put it simply: to begin with, one had an even continuum of workers from the lowest-paid lavatory cleaner to the highest-paid banker. Automation of one kind or another, rapidly rising in quantity and quality, imposes a threshold of ability below which a man is less useful than the machine.

For a while, it is simpler to keep the unemployables in the system, to make work for them, to use industry as a day prison.

As the number of unemployables grows, so the problems escalate. Because everyone has to be paid in accordance with the old steady graduation, the really productive people know very well that they are receiving nothing like their due. Because they can feel the whole system is tottering towards collapse, the unproductive take advantage rights and leap to win what they can. Hence industrial unrest, many strikes, escalating pay claims, rapid inflation.

Inflation, which increases costs and earnings in relation to historic economic rights such as capital holdings, can be seen as the inevitable accompaniment of rapid change, discounting the past in favour of the future.

After a while, the burden of he unemployable will become too heavy to carry within the industrial system, and they will be dumped.

What accompanies that? A withdrawal of political and civil rights from the unemployed — of which the practical expression is rapidly-increasing wages for the productive, and rapidly-increasing costs for essential services. Thus, in the U.S., money can buy much better medicine, policing, and social services than are offered democratically to citizens at large.

The threatened proletariat quite clearly understands what is happening — see, for instance, the bitter unrest within the National Health Service over the issue of pay-beds in State hospitals. Crime and terrorism, the expressions of discontent and organisational protection for the haves against these threats.

Not inevitable

Now, this image of a small, rich electronically productive A country within a large poor B one, having to defend its borders day and night against its hungry, miserable, despised neighbours, is not an attractive one. It is not the electronic millenium which we have been promised. But is it inevitable?

Happily not. The whole thing depends on birth, death and education. Men are born free and equal — parents, schools and jobs make us quite the opposite. We are, unfortunately, burdened with too many parents and with an educational system designed to produce large masses of docile, unimaginative industrial workers.

Even today, most jobs are part of a

game which decides who has what from heaps of wealth produced by the industrial system. Ten years ago, Schumacher, in *Small is Beautiful,* Sphere Books, London 1974, calculated that only three percent of human effort in the West was devoted to creating the necessities of life. The jobs everyone else did were only mechanisms for distributing necessities, and were irrelevant so far as supporting life went.

Acute disproportion

The electronic revolution will only make the disproportion between essential workers and the rest of us even more acute. Professor Stonier's 10 percent of useful workers will presumably include many whose function is strictly speaking unnecessary. The real core of necessary workers may fall to 0.3 percent or even 0.03 percent. However, it is not terribly important from this point of view just how many there are. What matters is that they are supporting and are surrounded by a vast majority of people in the B country, who can, if things ae mishandled, be a deadly menace to them.

The size of the unwanted, under-privileged B country depends on two things: the rate at which its inhabitants can either be retrained as members of the A country or retired so they are out of the fray; and by the rate at which the A country expands. The first is more or less fixed by the realities of human intelligence and lifespan; so the recipe for avoiding disaster is to restrain the expansion of country A.

Seen from that point of view, the reluctance of trades unions to permit new technology — such as the closure of the *Times* and *Sunday Times* as a protest by the printing unions against electronics which would make them unnecessary — is a good thing. Better to have a little industrial strife along peaceful and well understood lines now, than the desperate waging of a last-ditch battle later on, when the workers have nothing left to sell but their lives.

The difficulty of this policy of allowing the twenty-first century to happen slowly and quietly is that the U.K. is in international competition with countries which have tougher social attitudes towards the unproductive, and can, therefore, afford to expand their A countries faster than we would like. The answer, perhaps, is to make sure that our contributions to the world's A economy are more valuable than those of our tough-minded competitors.

We can do this by selling them the means of becoming an A country; that is, the hardware and software needed to transform their industrial systems. So it seems to me that the recipe for survival is heavy investment in all kinds of electronic technology, and particularly its integration into social and industrial systems, along with a gentle attitude towards our own modernisation. If we fail, what then?

Suppose, for a moment, that by some magical art the difficulties of economics and politics could be bypassed and all the electronic devices, which are now technically possible, installed overnight. The result would be a sudden, drastic social change. Hundreds of millions of people would be without job, income *raison d'être,* self-respect, occupation, entertainment. One could expect very serious civil disturbances to break out no later than the end of next week.

Essential resources

Since all the nuclear powers would find themselves in the same situation, there is no doubt that a solution would soon suggest itself to their far-sighted leaders. They would argue that all the world's essential resources are dispersed in the countryside under civil defence planning; computers and records are underground in remote places; all the best minds are employed in research centres in the more remote and attractive parts of our countries.

The major cities, on the other hand, are full of an unemployed and unemployable rabble who promise at an early date to pull the twenty-first century down around our ears. It would not take many days' brooding of that kind before fingers at the end of wrists emerging from sky-blue uniform sleeves would edge towards red buttons. The USAF would deal with Omsk while the Soviet Rocket Corps took out Pittsburg; the RAF would tidy up Hamburg while France's *Force de Frappe* removed the menace of Birmingham.

For the sake of our skins and our children, we must tread very cautiously in this electronic affair.

Gradual change will soften the technological blow

A report prepared for the government of the Netherlands puts the ravages of the chip in a less lurid light.

THE REPORT, commissioned by the Netherlands Ministry for Social Affairs from Metra Consulting Group is one of the soundest and most complete studies of the question yet published.

It consists of a general statement of the question, a summary of the evidence and conclusions, followed by extracts from specific documents which the authors studied drawn from the literature of Canada, France, Japan, Norway, Sweden, U.K., U.S.A. and West Germany.

Everything pertinent

More than 300 documents were covered and it is safe to say that anything pertinent has been considered by the authors. If they have missed something relevant, it is because of mankind's ignorance rather than theirs.

In general, they found that very few studies did not even try to quantify the effects of the chip on the labour market: "Although the concept of job and skill effects the microelectronics is a straightforward one, the estimation of those effects is complicated by the fact that they take place against a background of other technological developments and economic and market factors.

"It was not possible to arrive at any conclusions about the effects of microelectronics on the overall level of employment, i.e., over all application areas. No studies were identified which attempted such an analysis, and most informed comment was that such a study would be very difficult", maintains the Dutch chip report.

It is a simple document to understand, partly because it does not try to make pronouncements which are not supported by facts, or try to indulge in elaborate statistical fantasies in an attempt to find information which was not there in the first place. Certain numerical estimates are worth quoting:

Numerical control

It may be possible to automate 80 percent of jobs in banking.

Numerical control of machine tools in manufacturing, together with robots for moving and assembling parts might ultimately automate 25 to 80 percent of jobs, with the upper figure dependent on the in-

(continued on next page)

(continued from previous page)
stallation of integrated systems which automate a complete factory from order to delivery.

The installation of electronic devices in small machines like typewriters, cash registers, telephone exchanges should reduce the labour needed for their manufacture by 50 percent.

Word processing

Word processing can double a typist's output — or halve the number of typists needed. Ultimately, it may be possible to automate 25 percent of office jobs. Prestel-like technology will have no foreseeable impact on the print industry.

The process industries will be hardly affected because their labour forces are so small already. Even in a fully-automated plant a manual crew would still be needed for emergencies.

In materials' handling, 25 percent of labour might be saved.

In many jobs the saving of labour allowed by chip technology will be more than offset by the increase in business brought about by being able to offer better services. Thus, the U.K. Post Office — 450,000 employees — expects that current staff levels will remain constant through the next 10 years.

Decreased employment

Yet as the French Nora-Minc report warns, the introduction of automation will be led by the large companies which have capital to invest. That will lead to slight decreases in employment, so that the "only industrial jobs to be created in the future will be in small and medium-sized enterprises".

If the Metra Group report is not very precise, it is certainly reassuring. In assembling the sum of the western world's thought on the subject, it presents the readers with the many difficulties there are in applying microelectronics and makes it clear how, in the words of the U.K. Cabinet's Think Tank report, the change is likely to be: "Evolutionary rather than revolutionary and the consequent employment effects are likely to be slow to show themselves and in most areas to offer reasonable opportunities for planned adjustment".

Even though the Metra group shows how difficult it is to make quantitative judgments, we thought it might be interesting to apply some estimates to the British economy to obtain an idea of the numbers likely to be involved. It should be emphasised that our figures are based only in the crudest way on the Metra findings, and would certainly not have its blessing.

Selling proposition

The central selling proposition in the small business sector of microcomputing is that for the annual wage of a secretary — £4,000 — paid once you can buy a machine which will replace one person permanently. Suppose that the price falls to £1,000 with large volumes.

In practice, there are few jobs so stupid that a microcomputer can do them automatically. What ideally happens is that part of the work of several people is saved, and also made more efficient so that the business feels the benefit of a lump sum paid for the equipment every year until the machinery wears out or is replaced.

Still, for the sake of argument, let us say that one micro at £1,000 will replace one suitable job. How many suitable jobs are there? If we take as the roughest average of the figures assembled by Metra that 30 percent of jobs in suitable industries can be automated within the current technology horizon, and that those industries are — using the Government classifications — :

Description	Number employed Millions
Engineering	2.5
Textiles	2.2
Transport and communications	1.4
Distributive trades	2.7
Insurance and banking	1.1
Professional and scientific	3.6
Public administration and defence	1.6
Miscellaneous	2.4
30 percent of total	5.2

It seems clear that the crucial question is the speed with which this replacement takes place. On that depends the amount of social turmoil it creates.

Setting aside the questions of the availability of the software, the will of managers to introduce automation, the acquiesence of the unions in accepting the new situation — which are all very imponderable — we can make a few definite points.

Natural wastage

Firstly, natural wastage will do much to soften the blow. Curiously, no-one seems to know just how long on average people spend in a job. The best the Department of Employment can offer is turnover in manufacturing industry, which seems to be about 20 per 100 per year, giving an average time in a job of five years. Since that is averaged for all jobs, one would expect the length of stay to be shorter at the lower grades affected by computing.

Secondly, if we reckon that the hardware needed to replace a person costs £1,000, the necessary investment needed to automate those jobs is £5,200 million. That is a large sum, even at current prices. The whole of British industry spends £11,000 million a year on investment in equipment and plant.

It would be unrealistic to expect more than, say, 10 percent at the outside to be spent on automation, so that it will take at least five years to invest the necessary capital, and probably more like 15 to 20.

Thirdly, it is most unlikely that so large an investment in equipment will be spent abroad. The £1,000 worth of machinery needed to replace a worker represents three months work by someone — since ultimately all costs are labour costs.

Managable problems

Even if we imagine a new automating industry of 1,000,000 workers, it will take them at least two or three years to produce the necessary equipment, let alone the time needed to recruit, train and finance them.

So it is hard to see how, even if there were no social and technical problems at all, the chip could replace even one-third of workers in less than five to 15 years. Which really means that the problems it poses are quite managable.

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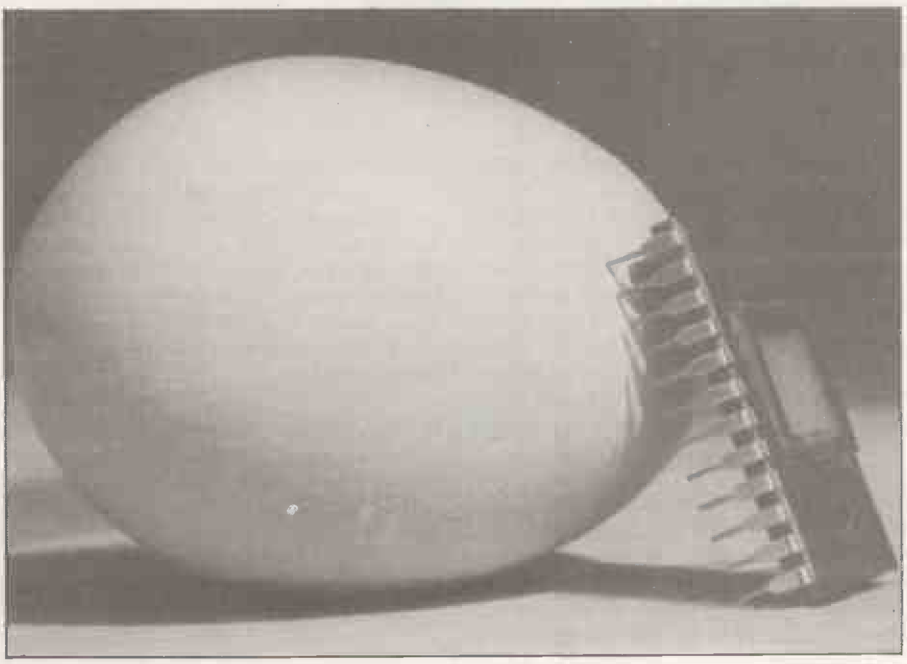

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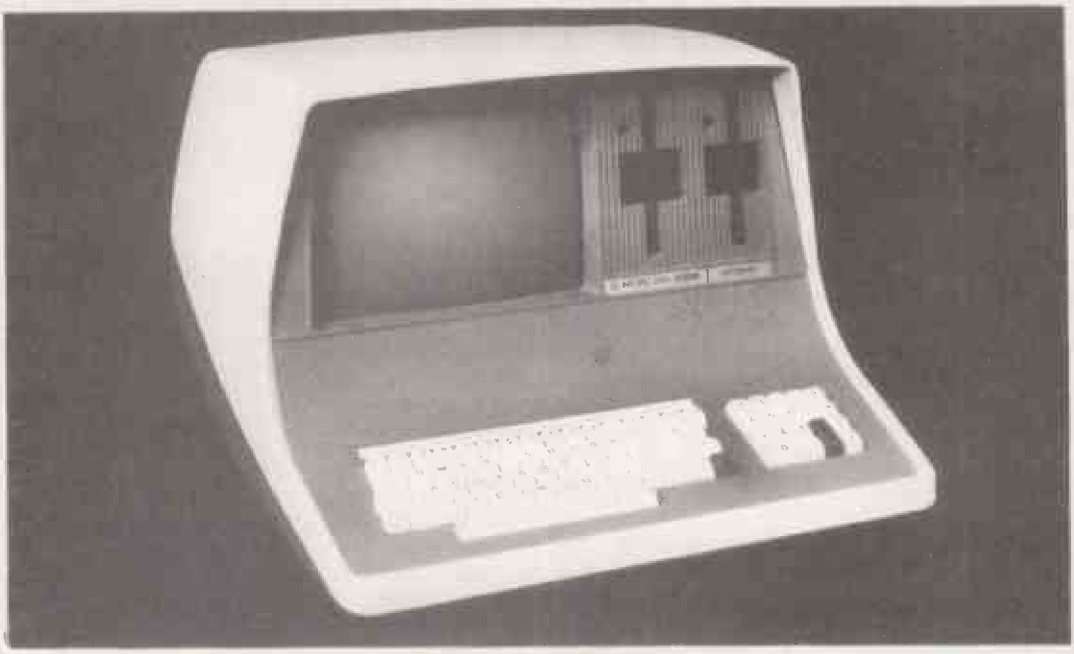

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Modelling the world's future on your microcomputer

Imminent global collapse was predicted in the famous Club of Rome *Limits to Growth* report of 1972. Now, TP Mervyn offers World Simulation, his adaptation in Basic of the programs used by the Club to arrive at those conclusions.

IN THE early 1970s, a report produced by a group of scientists, educators, humanists, industrialists and national and international civil servants known collectively as the Club of Rome caused a good deal of controversy.

The Club's report, *Limits to Growth,* predicted global disaster unless steps were taken to reduce economic growth to a fraction of the current level. The predictions of the report were produced by computer runs of a mathematical model which attempted to stimulate the behaviour of the world treated as a mathematical model using a specialised modelling technique called system dynamics.

The computer model produced by Meadows and his associates at M I T was based on an earlier model produced by

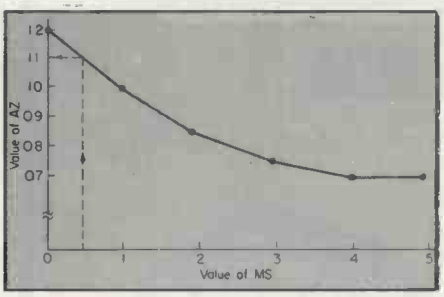

Figure 1.

system dynamics pioneer Jay W Forrester, Sloan Professor of Finance at M I T.

Forrester's earlier work was in the field of business and industrial systems and system dynamics was the formal technique devised originally for defining such systems. Any reader interested in system dynamics, rather than in its use for solving world systems, is strongly advised to consult *Principles of Systems* by Jay W Forrester.

For the not particularly technically-minded reader, here is a brief introduction to how systems dynamics is used with particular reference to Forrester's program the Basic version of which is presented.

First, various key parameters of the system, called levels are defined. They are set to known initial values which in the case of the world model described correspond to the levels at year 1900. The quantities are linked to each other in a series of loops.

Various other auxiliary quantities occur: in some cases, they occur within a connection between level variables, in other cases, they might be found in a small feedback loop from a level to itself. In all cases, though, the results from the auxiliary quantities eventually become inputs to the level parameters.

Rate quantities are also calculated from inputs which depend on both the auxiliary quantities and the level values. These rate values are incremented over a short time period — in the world model, that is conventionally one-fifth of a year — and by use of a simple tangent line approximation new rates are determined.

Auxiliary quantities

A mathematcially-inclined reader will understand that the world model is a large chain of interacting differential equations and we are using only the crudest of numerical techniques to solve them.

Having calculated auxiliary quantities, levels and rates, we now repeat this process in an iterative fashion. The former levels, auxiliary quantities and rates are used to compute the new values and so on.

The model is now stepped through as many cycles as required. A simple calculation shows for a world model covering years 1900 to 2100, we require 1,000 such iterations.

It is possible to describe the world system modelled by a system dynamics flowchart. That is a modification of the flowchart normally used in a program. Special symbols are used to denote levels, auxiliary quantities, etc

The system dynamics model is independent of any particular computer language and could presumably be solved using most high-level scientific/mathematical languages. However, Forrester chose to solve the problem using a programming language specially developed for solving problems in system dynamics.

It is the Dynamo language DYNAmic MOdelling. Dynamo is especially useful as it allows each level quantity, auxiliary, rate and initialisation to be defined in a single program statement. Here are a few statements in Dynamo to give the flavour of the language.

4.1 Line number	C shows a Constant is being defined	SWT3 = 1970 Constant SWT3 is set to 1970
37.2 Line number	R GUNK.KL = (P.K) Rate equation Rate GUNK The .KL denotes a new rate; the previous value of the rate is GUNK.JK	(CIRFT) Multiplication by CIRFT is implied

Although Forrester's original model of the world system must have taken him many months or even years to develop, its computer implementation is a reasonably simple matter. My program, which is a Basic version of Forrester's original Dynamo program, runs easily within the memory capacity of a 16K Level II TRS-80.

The listing of the program is shown in figure 4. A description of all the variables and quantities used in the program is provided within the key.

Population level

PL — the population level. The population is initialised at time 1900 to a value of 1.65 U.S. billion. The principal factor which determines the new population level is naturally the difference between the birth-rate and the death-rate. Anyone tracing through the equations of the system — see lines 4060 and 4130 — will notice that both those rate quantities are

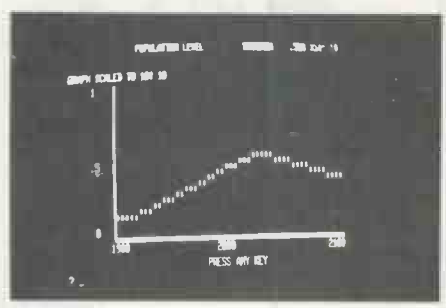

Figure 2.

given by the product of six other quantities.

One quantity is obviously the current population level and quantity CP. The remaining four quantities are auxiliary quantities. Those four quantities affect the birth rate:

- AZ — the birth-rate multiplier from material standards. It is a function of the material standard of life A more detailed explanation of how AZ is calculated is given in table look-ups and interpolation.
- GZ — the birth-rate multiplier from crowding — is one of the functions

of the crowding-ratio multiplier.

- HZ — the birth-rate multiplier from food — a function of the food-ratio multiplier.
- IZ — the birth-rate multiplier from pollution — a function of the pollution -ratio multiplier.

CP is a clip quantity and line 4050 allows it to take different values depending on the time value, TI. Thus, the birth-rate can be changed to a fraction of its initial value by making B1 a fraction of B.

That will happen at the time we allocate to S1 which is called a switch time. In the standard run program, all clip functions have the same value before and after the switch times, and all switch values are set to 1970 as befits a model published at around this date. Clip functions and

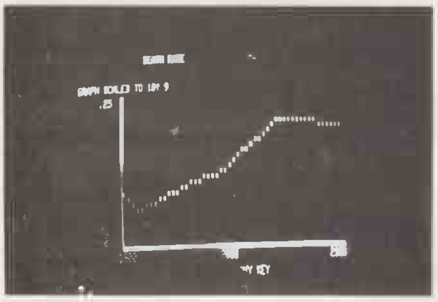

Figure 3.

switch times can be used to produce a different set of results from the program.

Without going into detail, anyone diligent may well be able to trace the connections from the program listing together with the annotations provided in the key. The other main level variables are:

CL — capital investment level
AF — fraction of capital invested in agriculture
YL — pollution level
NR — natural resources level

In the model, 22 important auxiliary quantities occur which are looked-up in a set of tables. A routine provides linear interpolation to obtain the auxiliary quantity which is being found. Let us see how this works by referring to just one example. This is AZ, which as we saw previously is the birth-rate multiplier from material standards.

Data array values

The table which is used to find AZ is contained within the array AT — line 1000. The data values for the array are found in line 630. The array AT contains set values for BRMMT — in Forrester's notation — which is the birth-rate from material multiplier table.

The values contained within AT depend on the value of another quantity, the material standard of life — MS. The graphical form of this relationship is shown in the graph — figure 3.

Notice that points on the graph are assumed to be connected by straight line segments. Thus, when we interpolate the graph we use linear interpolation. To examine how AZ is found, let us assume that MS has a current value of 0.5. The table look-up routine for AZ notes that the value of AZ depends on MS. Note that MS will range from zero to five in steps of one unit. This is why line 2100 is included.

If you look at figure 1, you see a value of MS=0.5 is interpolated to give an AZ value of 1.1. You can check that the sequence from 2100 to 2140 via subroutines at 5000 and 6000 does actually return this value.

After entering and copying the program, you should ensure that you have another clean good-quality cassette. The program generates a large amount of data which must be dumped on to tape. You should use at least a C20 tape for this as about seven or eight minutes' worth of results are collected.

Set your tape recorder to the normal level you use for recording programs. The results are output on to the screen of your VDU at the same time as they are dumped on to tape. On my system, it takes four minutes from one set of results to be output to the next set. That corresponds to a time period of four years. Thus the complete program takes about three hours 20 minutes.

Obviously, with that amount of time involved you have to treat the program as part of a batch run. For that obvious reason, I have included no interactive components to the program. After the run is complete and the last result — for year 2100 — is displayed on the screen, you may re-wind the tape containing the results. Now enter, or re-load the plotter program. — figure 5.

Plotter program

The results from the main program are fed into the plotter program by setting the cassette recorder to play — obviously not to record. As the results for each four-year period are input by the plotter program the results are flashed on the screen.

After all the results have been input, the plotter program presents you with a menu and you may plot any one of 16 quantities including all the level variables and most of the main auxiliary quantities.

Some results are displayed in figures 2 and 3, which are photographs of the results plotted on the VDU. The plotter program allows all those variables to be plotted as many times as required.

The system I used, with TRS-80 graphics, is obviously not terribly detailed; those with high-resolution and/or colour graphics should be able to obtain some striking results by simple modifications to the plotter program.

Those with printers may like to consider devising a routine which will allow them printed output instead of the output to monitor described.

Key and Annotations

Constants Forrester's names for the constants, etc., are given in parentheses.

P	Population initial (P1)
B	Birth-rate normal (BRN)
B1	Birth-rate normal number 1 (BRN1)
S1	Switch time 1 (SWT1)
E	Effective capital investment ratio normal (EC1RN)
N1	Natural resources initial (NR1)
N2	Natural resource usage normal (NRUN)
N3	Natural resource usage normal number 1 (NRUN1)
S2	Switch time 2 (SWT2)
D	Death-rate normal (DRN)
D1	Death-rate normal number 1 (DRN1)
L	Land area (LA)
P1	Population density normal (PDN)
F	Food coefficient (FC)
F1	Food coefficient number 1 (FC1)
F2	Food normal (FN)
S7	Switch time 7 (SWT7)
C	Capital investment in agriculture fraction normal (CIAFN)
C1	Capital investment initial (CII)
C2	Capital investment generation normal (CIGN)
C3	Capital investment generation normal number 1 (CIGN1)
S4	Switch time 4 (SWT4)
C4	Capital investment discard normal (CIDN)
C5	Capital investment discard normal number 1 (CIDN1)
S5	Switch time 5 (SWT5)
P2	Pollution standard (POLS)
P3	Pollution initial (POLI)
P4	Pollution normal (POLN)
P5	Pollution normal number 1 (POLN1)
S6	Switch time 6
C6	Capital investment in agriculture fraction initial (CIAFI)
C7	Capital investment in agriculture fraction adjustment time (CIAFT)
Q	Quality of life standard (QLS)
D1	Time increment (DT)
L1	Upper time limit (LENGTH)
P6	Print period number 1 (PRTP1)
P7	Print period number 2 (PRTP2)
P8	Print switch time (PRSWT)
P9	Plot period number 1 (PLTP1)
P0	Plot period number 2 (PLTP2)
PW	Plot switch time (PLSWT)
SS	Loop start time (no equivalent)
TF	Loop finish time (no equivalent)

The main program is written in a limited subset of Microsoft Basic. The only non-standard lines would seem to be those which use CLS — the TRS-80 clear-screen instruction — and those lines, 7100 and 8210, which use TRS-80 output to tape recorder. No-one should have problems finding the equivalents to those in his system's dialect.

The plotter program which uses the TRS-80 SET (X,Y) instruction will need more modifications, particularly with Pet computers where an equivalent instruction is not available.

The plotter program which uses the TRS-80 set (X,Y) instruction will need more modifications, particularly with Pet computers where an equivalent instruction is not available.

(continued on page 79)

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For anybody wishing to save time and wear on fingers when entering the program, all REMs up to, but not including, line 8000 may be deleted; all initialisations may be set numerically at the start of the program; but some work will be required to tabulate those initial values.

If you do this properly, subroutines from line 9000 onwards will not be required, neither will lines 1720 to 1900. You must however ensure that all the required initialisations have been adequately calculated by hand.

Other auxiliary quantities and rates

BR	Birth-rate (BR)
DR	Death-rate (DR)
CR	Crowding ratio (CR)
CK	Capital investment ratio (CIR)
CA	Capital investment ratio in agriculture (CIRA)
NF	Natural resource fraction remaining (NRFR)
EC	Effective capital investment ratio (ECIR)
MS	Material standard of living (MSL)
FR	Food ratio (FR)
NU	Natural resource usage rate (NRUR)
CD	Capital investment discard (CID)
CG	Capital investment generation (CIG)
PG	Pollution general (POLG)
PA	Pollution absorption (POLA)
YR	Pollution rate
QL	Quality of life (QL)

Levels

PL	Population level (P)
CL	Capital investment level (CI)
AF	Capital investment in agriculture fraction level (CIAF)
YL	Pollution level (POL)
NR	Natural resources level (NR)

Figure 4.

Variations on the standard run are:

- Pollution mode. In the standard run, the world population is reduced due to the shortfall in natural resources. In the pollution mode, we set N3 to .25. The effect of this is to reduce the rate of natural resource usage to 25 percent of its 1970 value. That leads ultimately to a drastic population crash at around year 2030 due to a crisis caused by pollution.
- Capital investment generation increase. In this model, we change C3 — the coefficient for normal capital investment generation — to 0.06, a 20 percent increase. Capital, therefore, accumulates to a 20 percent greater rate than the original model. This results in a pollution crisis, similar to that in pollution mode.
- Birth control. Reduce B1 go 0.028. That causes a decrease in the birth-rate at 1970, but as you should see produces little change in the results of the standard run.

Obviously, there is an almost infinite number of variations you can devise, each of which will produce some modification to the results of the standard model. Obviously, those interested in this model will need to refer to *World Dynamics* to try all the major variations suggested there. However, the more cynical may like to try the following change which was suggested, at least in part, by Forrester himself:

- Changing death-rate material multiplier table. Change the values in CT, line 650, to 2,1.4,1,.9,.85,.8,.77,.75,.75,.75,0,0. As Forrester admits, page 40, the effect of the multiplier may have been exaggerated in his model. Gribbin in *Future Worlds* points out that if this assumption, i.e., the change of values, is built into the model, we can obtain a more optimistic model of the future. True, there is a decline of population in the 21st century, but this is due to a decline in birth-rate rather than an increase in death-rate.

As a teacher of computer studies, I have found that some children believe in the model without reservation. If you also believe it, you may feel as certain groups did in the early 1970s, that we should now take steps to reduce economic growth before the doom-laden prognostications of the model are borne out by fact, some time in the next century.

Yet changes in the model, some of them of a minor nature, produce completely different conclusions. The model, and the successor model used in *Limits to Growth*, make gross and probably unjustified assumptions about the world system. Their model is an aggregate model; the parameters of the richer and poorer nations of the world are clumped together to give an average result. The results of the Science Policy Research Unit at Sussex University have revealed limitations in the model; the results of their researchers are ably summarised by Gribbin.

My principal reason for producing the Basic programs was just to show that large and, in their time, very important simulation programs can be reproduced on a microcomputer.

Table look-ups

The array names only are given; for array dimensions refer to the program

AT	Birth-rate from material multiplier table (BRMMT)
BT	Natural resource extraction multiplier table (NREMT)
CT	Death-rate material multiplier table (DRMMT)
DT	Death-rate from pollution multiplier table (DRPMT)
ET	Death-rate from food multiplier table (DRFMT)
FT	Death-rate from crowding multiplier table (DRCMT)
GT	Birth-rate from crowding multiplier table (BRCMT)
HT	Birth-rate from food multiplier table (BRFMT)
IT	Birth-rate from pollution multiplier table (BRPMT)
JT	Food from crowding multiplier table (FCMT)
KT	Food potential from capital investment table (FPCIT)
LT	Capital investment multiplier table (CIMT)
MT	Food from pollution multiplier table (FPMT)
NT	Pollution from capital multiplier table (POLCMT)
OT	Pollution absorption time table (POLATT)
PT	Capital fraction indicated by food ratio table (CFIFRT)
QT	Quality of life from material table (QLMT)
RT	Quality of life from crowding table (QLCT)
ST	Quality of life from food table (QLFT)
TT	Quality of life from pollution table (QLPT)
UT	Natural resource from material multiplier table (NRMMT)
VT	Capital investment from quality ratio table (CIQRT)

Auxiliaries from tables

e.g. CZ is the auxiliary from table CT, FZ is the auxiliary from table FT, etc. The auxiliary has the same name as the table it was derived from, except, of course, the word 'table' is omitted. Thus, KZ is the food potential from capital investment.

References

The Limits to Growth, Meadows et al., Pan Books 1972

World Dynamics second edition, Jay W Forrester, Wright-Allen Press 1973

Principles of Systems, Jay W Forrester, Wright-Allen

Future Worlds, John Gribbin, Abacus Press, 1979.


```
1 CLS
10 REM.*********************************************************
20 REM *  WORLD  SIMULATION (ORIGINAL BY JAY W. FORRESTER) *
30 REM *     A BASIC VERSION FOR THE TRS-80                *
40 REM *        BY T.P.MERVYN    FEB 1980                  *
50 REM *                                                   *
60 REM * FOR COMPLETE REFERENCE OF THE PROGRAM TEXT SEE    *
70 REM * 'WORLD DYNAMICS' BY JAY W. FORRESTER              *
80 REM * WRIGHT-ALLEN PRESS INC.,1971                      *
90 REM *********************************************************
100 REM
110 REM    INPUT CONSTANTS
120 REM
130 READ P,B,B1,S1,E,N1,N2,N3,S2,D,D1,S3,L,P1,F,F1,F2,S7,C,C1,C2,C3
140 READ S4,C4,C5,S5,P2,P3,P4,P5,S6,C6,C7,Q,DI,LI,P6,P7,P8,P9,P0,PW,SS,TF
150 DATA 1.65E+9,.04,.04,1970,1,9E+11,1,1,1970,.028,.028,1970
160 DATA 1.35E+8,26.5,1,1,1,1970,.3,.4E+3,.05,.05,1970,.025,.025
170 DATA 1970,3.6E+9,.2E+9,1,1,1970,.2,15,1,.2,2100,0,0,0,4,4,0
180 DATA 1900,2100
500 REM ****************************************
510 REM *  DIMENSIONS OF LOOK-UP TABLES  *
520 REM ****************************************
530 DIM AT(8),BT(7),CT(13),DT(9),ET(11),FT(8),GT(8)
540 DIM HT(7),IT(9),JT(8),KT(9),LT(8),MT(9),NT(8)
550 DIM OT(9),PT(7),QT(8),RT(13),ST(7),TT(9),UT(13)
560 DIM VT(7)
600 REM ****************************************
610 REM *  DATA VALUES FOR LOOK-UP TABLES  *
620 REM ****************************************
630 DATA 1.2,1,.85,.75,.7,.7,0,0
640 DATA 0,.15,.5,.85,1,0,0
650 DATA 3,1.8,1,.8,.7,.6,.53,.5,.5,.5,.5 ,0,0
660 DATA .92,1.3,2,3.2,4.8,6.8,9.2,0,0
670 DATA 30,3,2,1.4,1,.7,.6,.5,.5,0,0
680 DATA ,9,1,1.2,1.5,1.9,3,0,0
690 DATA 1.05,1,.9,.7,.6,.55,0,0
700 DATA 0,1,1.6,1.9,2,0,0
710 DATA 1.02,.9,.7,.4,.25,.15,.1,0,0
720 DATA 2.4,1,.6,.4,.3,.2,0,0
730 DATA .5,1,1.4,1.7,1.9,2.05,2.2,0,0
740 DATA .1,1,1.8,2.4,2.8,3,0,0
750 DATA 1.02,.9,,65,.35,.2,.1,.05,0,0
760 DATA .05,1,3,5.4,7.4,8,0,0
770 DATA .6,2.5,5,8,11.5,15.5,20,0,0
```

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```
780 DATA 1,.6,.3,.15,.1,0,0
790 DATA .2,1,1.7,2.3,2.7,2.9,0,0
800 DATA 2,1.3,1,.75,.55,.45,.38,.3,.25,.22,.2,0,0
810 DATA 0,1,1.8,2.4,2.7,0,0
820 DATA 1.04,.85,.6,.3,.15,.05,.02,0,0
830 DATA 0,1,1.8,2.4,2.9,3.3,3.6,3.8,3.9,3.95,4,0,0
840 DATA .7,.8,1,1.5,2,0,0
970 REM ************************
980 REM * INPUT TABLE LOOK-UPS *
990 REM ************************
1000 FORI=1TO8:READ AT(I):NEXT
1010 FORI=1TO7:READBT(I):NEXT
1020 FORI=1TO13:READ CT(I):NEXT
1030 FORI=1TO9:READ DT(I):NEXT
1040 FORI=1TO11:READ ET(I):NEXT
1050 FORI=1TO9:READ FT(I):NEXT
1060 FOR I=1TO8:READ GT(I):NEXT
1070 FORI=1TO7:READ HT(I):NEXT
1080 FORI=1TO9:READ IT(I):NEXT
1090 FORI=1TO8:READ JT(I):NEXT
1100 FORI=1TO9:READ KT(I):NEXT
1110 FORI=1TO8:READ LT(I):NEXT
1120 FORI=1TO9:READ MT(I):NEXT
1130 FORI=1TO8:READ NT(I):NEXT
1140 FORI=1TO9:READOT(I):NEXT
1150 FORI=1TO7:READ PT(I):NEXT
1160 FORI=1TO8:READ QT(I):NEXT
1170 FORI=1TO13:READ RT(I):NEXT
1180 FORI=1TO7:READ ST(I):NEXT
1190 FORI=1TO9:READ TT(I):NEXT
1200 FORI=1TO13:READ UT(I):NEXT
1210 FORI=1TO7:READ VT(I):NEXT
1480 REM  ********************************
1490 REM  * INITIALISE LEVEL VARIABLES *
1500 REM  ********************************
1510 PL=P
1520 NL=N1
1530 CL=C1
1540 YL=P3
1550 AF=C6
1570 REM  ****************************
1580 REM  *  OTHER INITIALISATIONS  *
1590 REM  ****************************
1600 REM
1610 CR=PL/(L*P1)
1620 CK=CL/PL
1630 CA=(CK*AF)/C
1640 NF=(NL/N1)
1650 EC=(CK*(1-AF))/(1-C)
1660 MS=EC/E
1720 REM ***********************
1730 REM * FOOD RATIO LOOK UP *
1740 REM ***********************
1750 DV=CA:I=0:J=6:K=1
1760 GOSUB 5000
1770 JJ=KT(IV):KK=KT(IV+1):LL=KT(1):MM=KT(7)
1780 GOSUB6000
1790 KZ=RV
1800 DV=CR:I=0:J=5:K=1
1810 GOSUB5000
1820 JJ=JT(IV):KK=JT(IV+1):LL=JT(1):MM=JT(6)
1830 GOSUB6000
1840 JZ=RV
1850 DV=YR:I=0:J=60:K=10
1860 GOSUB5000
1870 JJ=MT(IV):KK=MT(IV+1):LL=MT(1):MM=MT(7)
1880 GOSUB6000
1890 MZ=RV
1900 FR=(KZ*JZ*MZ)/F2
1910 GOSUB 9000  'GET INITIAL QUALITY OF LIFE.
1920 GOSUB 10000   'GET INITIAL RESOURCES USAGE RATE.
1930 GOSUB 11000      'GET INITIAL BIRTH-RATE
1940 GOSUB12000       'GET INITIAL DEATHRATE
1950 GOSUB 7000       'INITIAL O/P ROUTINE
1980 REM ****************************
1990 REM * TABLE LOOK UP SEQUENCE *
2000 REM ****************************
2030 REM
2050 REM *************************
2060 REM * GET TIME LOOPS GOING *
2070 REM *************************
2080 FOR TI=SS TO (TF-4) STEP 4
2090 FOR TS=1 TO20
2100 DV=MS:I=0:J=5:K=1
2110 GOSUB5000
2120 JJ=AT(IV):KK=AT(IV+1):LL=AT(1):MM=AT(6)
2130 GOSUB6000
2140 AZ=RV
2150 DV=NF:I=0:J=1:K=.25
2160 GOSUB5000
2170 JJ=BT(IV):KK=BT(IV+1):LL=BT(1):MM=BT(5)
2180 GOSUB6000
2190 BZ=RV
2200 DV=MS:I=0:J=5:K=.5
2210 GOSUB5000
2220 JJ=CT(IV):KK=CT(IV+1):LL=CT(1):MM=CT(11)
2230 GOSUB6000
2240 CZ=RV
2250 DV=YR:I=0:J=60:K=10
2260 GOSUB5000
2270 JJ=DT(IV):KK=DT(IV+1):LL=DT(1):MM=DT(7)
2280 GOSUB6000
2290 DZ=RV
2300 DV=FR:I=0:J=2:K=.25
2310 GOSUB5000
2320 JJ=ET(IV):KK=ET(IV+1):LL=ET(1):MM=ET(9)
2330 GOSUB6000
2340 EZ=RV
2350 DV=CR:I=0:J=5:K=1
2360 GOSUB5000
2370 JJ=FT(IV):KK=FT(IV+1):LL=FT(1):MM=FT(6)
2380 GOSUB5000
2390 FZ=RV
2400 DV=CR:I=0:J=5:K=1
2410 GOSUB5000
2420 JJ=GT(IV):KK=GT(IV+1):LL=GT(1):MM=GT(6)
2430 GOSUB5000
2440 GZ=RV
2450 DV=FR:I=0:J=4:K=1
2460 GOSUB5000
2470 JJ=HT(IV):KK=HT(IV+1):LL=HT(1):MM=HT(5)
2480 GOSUB6000
2490 HZ=RV
2500 DV=YR:I=0:J=60:K=10
2510 GOSUB5000
2520 JJ=IT(IV):KK=IT(IV+1):LL=IT(1):MM=IT(7)
2530 GOSUB5000
2540 IZ=RV
2550 DV=CR:I=0:J=5:K=1
2560 GOSUB5000
2570 JJ=JT(IV):KK=JT(IV+1):LL=JT(1):MM=JT(6)
2580 GOSUB6000
2590 JZ=RV
2600 DV=CA:I=0:J=6:K=1
2610 GOSUB5000
2620 JJ=KT(IV):KK=KT(IV+1):LL=KT(1):MM=KT(7)
2630 GOSUB6000
2640 KZ=RV
2650 DV=MS:I=0:J=5:K=1
2660 GOSUB5000
2670 JJ=LT(IV):KK=LT(IV+1):LL=LT(1):MM=LT(6)
2680 GOSUB5000
2690 LZ=RV
2700 DV=YR:I=0:J=60:K=10
2710 GOSUB5000
2720 JJ=MT(IV):KK=MT(IV+1):LL=MT(1):MM=MT(7)
2730 GOSUB6000
2740 MZ=RV
2750 DV=CK:I=0:J=5:K=1
2760 GOSUB5000
2770 JJ=NT(IV):KK=NT(IV+1):LL=NT(1):MM=NT(6)
2780 GOSUB6000
2790 NZ=RV
2800 DV=YR:I=0:J=60:K=10
2810 GOSUB5000
2820 JJ=OT(IV):KK=OT(IV+1):LL=OT(1):MM=OT(7)
2830 GOSUB6000
2840 OZ=RV
2850 DV=FR:I=0:J=2:K=.5
2860 GOSUB5000
2870 JJ=PT(IV):KK=PT(IV+1):LL=PT(1):MM=PT(5)
2880 GOSUB6000
2890 PZ=RV
2900 DV=MS:I=0:J=5:K=1
2910 GOSUB5000
2920 JJ=QT(IV):KK=QT(IV+1):LL=QT(1):MM=QT(6)
2930 GOSUB6000
2940 QZ=RV
2950 DV=CR:I=0:J=5:K=.5
2960 GOSUB5000
2970 JJ=RT(IV):KK=RT(IV+1):LL=RT(1):MM=RT(11)
2980 GOSUB6000
2990 RZ=RV
3000 DV=FR:I=0:J=4:K=1
3010 GOSUB5000
3020 JJ=ST(IV):KK=ST(IV+1):LL=ST(1):MM=ST(5)
3030 GOSUB6000
3040 SZ=RV
3050 DV=YR:I=0:J=60:K=10
3060 GOSUB5000
3070 JJ=TT(IV):KK=TT(IV+1):LL=TT(1):MM=TT(7)
3080 GOSUB6000
3090 TZ=RV
3100 DV=MS:I=0:J=10:K=1
3110 GOSUB5000
3120 JJ=UT(IV):KK=UT(IV+1):LL=UT(1):MM=UT(11)
3130 GOSUB6000
3140 UZ=RV
3150 DV=RZ/SZ:I=0:J=2:K=.5
3160 GOSUB5000
3170 JJ=VT(IV):KK=VT(IV+1):LL=VT(1):MM=VT(5)
3180 GOSUB6000
3190 VZ=RV
4000 REM ***************************************
4010 REM * ALL TABLE LOOK-UPS NOW COMPLETE *
4020 REM * FIND NEW RATES & AUXILIARIES     *
4030 REM ***************************************
4040 PL=PL+DI*(BR-DR)
4050 IF TI)=S1THENCP=B1 ELSE CP=B
4060 BR=PL*CP*HZ*AZ*BZ*IZ
4070 EC=CK*(1-AF)*BZ/(1-C)
4080 MS=EC/E
4090 IF TI)=S2 THEN CP=N3 ELSE CP=N2
4100 NU=PL*CP*UZ
4110 NL=NL+DI*(-NU)
4115 NF=NL/N1
4120 IFTI)=S3 THEN CP=D1 ELSE CP=D
4130 DR=PL*CP*CZ*DZ*EZ*FZ
4140 CR=PL/(L*P1)
4150 IFTI)=S7 THEN CP=F1 ELSE CP=F
4160 FR=KZ*JZ*MZ*CP/F2
4180 IF TI)=S5 THEN CP=C5 ELSE CP=C4
4190 CD=CL*CP
4200 IF TI)=S4 THEN CP=C3 ELSE CP=C2
4210 CG=PL*LZ*CP
4220 CL=CL+DI*(CG-CD)
4223 CK=CL/PL
4227 CA=CK*AF/C
4230 IF TI)=S6 THEN CP=P5 ELSE CP=P4
4240 PG=PL*CP*NZ
4250 PA=YL/OZ
```

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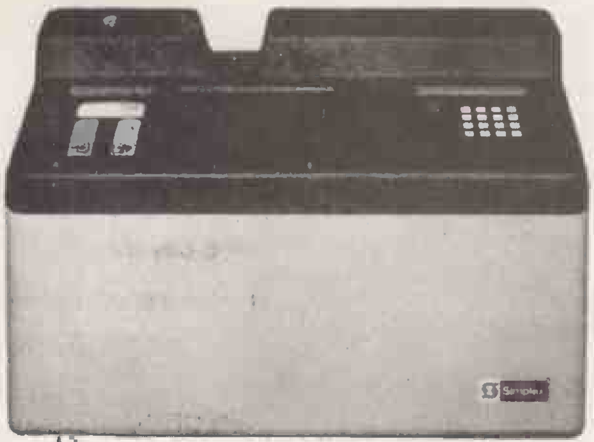

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```
4260 YL=YL+DI*(PG-PA)
4270 YR=YL/P2
4280 AF=AF+(DI/C7)*(PZ*VZ-AF)
4290 QL=Q*QZ*RZ*SZ*TZ
4400 NEXT TS
4410 REM ******************************
4420 REM * GO TO MAIN PLOT ROUTINE *
4430 REM ******************************
4440 GOSUB8000
4450 NEXT TI
4460 STOP
4970 REM ********************************
4980 REM * TABLE LOOK-UP SUBROUTINE  *
4990 REM ********************************
5000 IFDV(=ITHEN5080
5010 IFDV)=JTHEN5090
5020 IV=0
5030 FORTV=ITOJSTEPK
5040 IFDV(TVTHEN5070
5050 IV=IV+1
5060 NEXTTV
5070 GOTO5110
5080 IV=1:GOTO5110
5090 IV=INT((J-I)/K+1.05)
5110 RETURN
5970 REM ********************************
5980 REM * EXTRAPOLATION SUB ROUTINE *
5990 REM ********************************
6000 IFIV=INT((J-I)/K+1.05)THEN6040
6010 IFDV(ITHEN6050
6020 RV=JJ+((DV-(IV-1)*K)/K)*(KK-JJ)
6030 GOTO6060
6040 RV=MM:GOTO6060
6050 RV=LL
6060 RETURN
6070 REM ****************************
6080 REM * INITIAL OUTPUT ROUTINE *
6090 REM ****************************
7000 CLS: PRINT" WORLD-2 STANDARD RUN"
7010 PRINT:PRINT" MAIN LEVEL VARIABLES":PRINT
7030 PRINTSS
7040 PRINT"POP "IPL"BIRTH RATE "IBR"DEATH RATE "IDR
7050 PRINT"NL"INL"QL"IQL"YL"IYL
7060 PRINT "CL"ICL"AF"IAF
7070 PRINT "MS"IMS"FR"IFR"NU"INU
7080 PRINT "NF"INF"QLC"IRZ"QLM"IQZ
7090 PRINT "QLF"; SZ"QLPOLL"ITZ
7100 PRINT #-1,SS,PL,BR,DR,NL,QL,YL,CL,AF,MS,FR,NU,NF,RZ,QZ,SZ,TZ
7200 RETURN
7970 REM **********************
7980 REM * MAIN PLOT ROUTINE *
7990 REM **********************
8000 REM *INCLUDES OUTPUT TO TAPE *
8030 PRINT TI+4
8040 PRINT"POP"IPL"BIRTH RATE "IBR"DEATH RATE "IDR
8050 PRINT"NL"INL"QL"IQL"YL"IYL
8060 PRINT"CL"ICL"AF"IAF
8070 PRINT"MS"IMS"FR"IFR"NU"INU
8080 PRINT"NF"INF"QLC"IRZ"QLM"IQZ
8090 PRINT"QLF"ISZ"QLPOLL"ITZ
8210 PRINT #-1,TI+4,PL,BR,DR,NL,QL,YL,CL,AF,MS,FR,NU,NF,RZ,QZ,SZ,TZ
8300 RETURN
9000 REM *************************************
9010 REM *  INITIAL QUALITY OF LIFE ROUTINE  *
9020 REM *************************************
9050 DV=MS:I=0:J=5:K=1
9060 GOSUB5000
9070 JJ=QT(IV):KK=QT(IV+1):LL=QT(1):MM=QT(6)
9080 GOSUB6000
9090 QZ=RV
9100 DV=CR:I=0:J=5:K=.5
9110 GOSUB5000
9120 JJ=RT(IV):KK=RT(IV+1):LL=RT(1):MM=RT(11)
9130 GOSUB6000
9140 RZ=RV
9150 DV=FR:I=0:J=4:K=1
9160 GOSUB5000
9170 JJ=ST(IV):KK=ST(IV+1):LL=ST(1):MM=ST(5)
9180 GOSUB6000
9190 SZ=RV
9200 DV=YR:I=0:J=60:K=10
9210 GOSUB5000
9220 JJ=TT(IV):KK=TT(IV+1):LL=TT(1):MM=TT(7)
9230 GOSUB6000
9240 TZ=RV
9250 QL=Q*QZ*RZ*SZ*TZ
9260 RETURN
10000 REM ***************************************
10010 REM *   INITIAL RESOURCE USAGE RATE   *
10020 REM ***************************************
10030 DV=MS:I=0:J=10:K=1
10040 GOSUB5000
10050 JJ=UT(IV):KK=UT(IV+1):LL=UT(1):MM=UT(11)
10060 GOSUB6000
10070 UZ=RV
10080 NU=PL*N2*UZ
10090 RETURN
10970 REM **********************
10980 REM * INITIAL BIRTHRATE *
10990 REM **********************
11000 DV=MS:I=0:J=5:K=1
11010 GOSUB5000
11020 JJ=AT(IV):KK=AT(IV+1):LL=AT(1):MM=AT(6)
11030 GOSUB6000
11040 AZ=RV
11050 DV=CR:I=0:J=5:K=1
11060 GOSUB5000
11070 JJ=GT(IV):KK=GT(IV+1):LL=GT(1):MM=GT(6)
11080 GOSUB6000
11090 GZ=RV
11100 DV=FR:I=0:J=4:K=1
11110 GOSUB5000
11120 JJ=HT(IV):KK=HT(IV+1):LL=HT(1):MM=HT(5)
11130 GOSUB6000
11140 HZ=RV
11150 DV=YR:I=0:J=60:K=10
11160 GOSUB5000
11170 JJ=IT(IV):KK=IT(IV+1):LL=IT(1):MM=IT(7)
11180 GOSUB6000
11190 IZ=RV
11200 BR=PL*B*HZ*AZ*GZ*IZ
11210 RETURN
11970 REM **********************
11980 REM * INITIAL DEATHRATE *
11990 REM **********************
12000 DV=MS:I=0:J=5:K=.5
12010 GOSUB5000
12020 JJ=CT(IV):KK=CT(IV+1):LL=CT(1):MM=CT(11)
12030 GOSUB6000
12040 CZ=RV
12050 DV=YR:I=0:J=60:K=10
12060 GOSUB5000
12070 JJ=DT(IV):KK=DT(IV+1):LL=DT(1):MM=DT(7)
12080 GOSUB6000
12090 DZ=RV
12100 DV=FR:I=0:J=2:K=.25
12110 GOSUB5000
12120 JJ=ET(IV):KK=ET(IV+1):LL=ET(1):MM=ET(9)
12130 GOSUB6000
12140 EZ=RV
12150 DV=CR:I=0:J=5:K=1
12160 GOSUB5000
12170 JJ=FT(IV):KK=FT(IV+1):LL=FT(1):MM=FT(6)
12180 GOSUB6000
12190 FZ=RV
12200 DR=PL*D*CZ*DZ*EZ*FZ
12210 RETURN
```

Figure 5.

```
10 DIM GV(51),PL(51),BR(51),DR(51),NL(51),QL(51),YL(51),CL(51)
20 DIM AF(51),MS(51),FR(51),NU(51),NF(51),RZ(51),QZ(51),SZ(51)
30 DIM TZ(51)
40 CLS
50 L1=0:L2=.5:L3=1.0
100 FOR I=1TO51
110 INPUT #-1,T,PL(I),BR(I),DR(I),NL(I),QL(I),YL(I),CL(I),AF(I),MS(I),FR(I),NU(I
),NF(I),RZ(I),QZ(I),SZ(I),TZ(I)
130 PRINT T
140 PRINT "POP."IPL(I)"B.R."IBR(I)"D.R."IDR(I)
150 PRINT "NL"INL(I)"QL"IQL(I)"YL"IYL(I)
160 PRINT"CL"ICL(I)"AF"IAF(I)"MS"IMS(I)
170 PRINT"FR"IFR(I)"NU"INU(I)"NF"INF(I)
180 PRINT "RZ"IRZ(I)"QZ"IQZ(I)"SZ"ISZ(I)"TZ"ITZ(I)
190 NEXTI
200 INPUT"PRESS ANY KEY TO CONTINUE"IA$
220 CLS
230 PRINT"HERE IS A LIST OF POSSIBLE QUANTITIES THAT MAY BE PLOTTED"
240 PRINT"VS. TIME. THEIR CODE NUMBERS FOLLOW THEIR DESCRIPTIONS."
250 PRINT"PLEASE NOTE THE CODE NUMBER OF THE QUANTITY YOU WISH TO"
260 PRINT"PLOT."
270 PRINT" 1. POPULATION        "I"    2. BIRTH RATE"
310 PRINT" 3. DEATH RATE        "I"    4. NATURAL RESOURCES LEVEL"
320 PRINT" 5. QUALITY OF LIFE   "I"    6. POLLUTION LEVEL"
330 PRINT" 7. CAP. INVEST. LEVEL "I"   8. CAP. INVEST. AG. FRACTION"
340 PRINT" 9. MAT. STAND. LIVING "I"  10. FOOD RATIO"
350 PRINT" 11. RESOURCE USAGE RATE"I" 12. RESOURCE FRACT. REMAINING"
360 PRINT" 13. Q.L. CROWDING     "I"  14. Q.L. MAT. STAND. LIVING"
370 PRINT" 15. Q.L. FOOD         "I"  16. Q.L. POLLUTION"
410 PRINT"A CODE NO. OUTSIDE RANGE 1-16 TERMINATES PROGRAM"
420 INPUT"VARIABLE CODE NUMBER (1-16)"IVN
430 IF(INT(VN)(1)OR(INT(VN))16)THEN2000
435 U$="MAXIMUM"
440 ON VN GOTO 450,460,470,480,490,500,510,520,530,540,550,560,570,580,590,600
450 V$="POPULATION LEVEL":FORI=1TO51:GV(I)=PL(I):NEXT:GOSUB1000
456 INPUTA$:GOTO220
460 V$="BIRTH RATE":FORI=1TO51:GV(I)=BR(I):NEXT:GOSUB1000
466 INPUT A$:GOTO220
470 V$="DEATH RATE":FORI=1TO51:GV(I)=DR(I):NEXT:GOSUB1000
476 INPUTA$:GOTO220
480 V$="NAT. RES. LEVEL":FORI=1TO51:GV(I)=NL(I):NEXT:GOSUB1000
486 INPUT A$:GOTO220
490 V$="QUAL. OF LIFE":FORI=1TO51:GV(I)=QL(I):NEXT:GOSUB1000
496 INPUT A$:GOTO220
500 V$="POLLUTION LEVEL":FORI=1TO51:GV(I)=YL(I):NEXT:GOSUB1000
506 INPUTA$:GOTO220
510 V$="CAP. INV. LEVEL":FORI=1TO51:GV(I)=CL(I):NEXT:GOSUB1000
516 INPUT A$:GOTO220
520 V$="CAP. INV. AG. FRACTION":FORI=1TO51:GV(I)=AF(I):NEXT:GOSUB1000
526 INPUT A$:GOTO220
530 V$="MATERIAL STANDARD LIFE":FORI=1TO51:GV(I)=MS(I):NEXT:GOSUB 1000
536 INPUTA$:GOTO220
540 V$="FOOD RATIO":FORI=1TO51:GV(I)=FR(I):NEXT:GOSUB1000
546 INPUTA$:GOTO220
550 V$="RES. USAGE RATE":FORI=1TO51:GV(I)=NU(I):NEXT:GOSUB1000
556 INPUT A$:GOTO220
560 V$="RES. FRACT. REMAINING":FORI=1TO51:GV(I)=NF(I):NEXT:GOSUB1000
566 INPUT A$:GOTO220
570 V$="Q.O.L. CROWDING":FORI=1TO51:GV(I)=RZ(I):NEXT:GOSUB1000
576 INPUT A$:GOTO220
580 V$="Q.O.L. MAT. STANDARDS":FORI=1TO51:GV(I)=QZ(I):NEXT:GOSUB1000
586 INPUTA$:GOTO220
590 V$="Q.O.L. FOOD":FORI=1TO51:GV(I)=SZ(I):NEXT:GOSUB1000
596 INPUTA$:GOTO220
600 V$="Q.O.L. POLLUTION":FORI=1TO51:GV(I)=TZ(I):NEXT:GOSUB1000
606 INPUT A$:GOTO220
1000 CLS
1001 PRINT@15,V$
1002 PRINT@40,U$
1010 MV=0
1020 FORI=1TO51
1030 V=GV(I)
1040 IF V)MV THEN MV=V
1050 NEXT I
1053 C=0
1055 IF MV(=1THENDV=MV
1056 IF MV(=1THEN1100
1060 DV=MV/10
1070 IF DV(=1THEN1095
1080 DV=DV/10:C=C+1
1090 GOTO1070
1095 C=C+1
1100 IF DV(=.25 THENF=4
1110 IFF=4THEN1150
1120 IF DV(=.5THENF=2
1130 IF F=2 THEN 1150
1140 F=1
1150 REM
1200 DV=INT(1000*DV+.5)/1000
1210 PRINT@50,DV;"X10+";C
1220 PRINT@128,"GRAPH SCALED TO 10+";C
1230 PRINT@773,L1
1240 PRINT@196,L3/F
1250 PRINT@516,L2/F
1260 PRINT@841,"1900"
1270 PRINT@864,"2000"
1280 PRINT@889,"2100"
1290 FORI=9TO38
1300 SET(20,I)
1310 NEXTI
1320 FORI=21TO121
1330 SET(I,38)
1340 NEXTI
1350 FORI=0TO50
1360 PV=GV(I+1)/(10+C)
1370 PV=INT(30*PV*F+.5)
1380 PV=39-PV
1385 IF PV(9THENPV=9
1390 IF PV=39 THEN PV=38
1400 SET(2*I+21,PV)
1410 NEXTI
1420 PRINT@925,"PRESS ANY KEY":F=A:RETURN
2000 STOP
```

Larrs' Ghost

Larrs' ghost still haunts his make-believe world; even now he warms his feet on the glittering sands, dodging the bubbling surf like a child. So long as power is ensured to the computer and bio-interface, Larrs' intricate program will reveal his carefully-constructed world to anyone who wishes to enter it.

Many times I sought him out and begged him to return to the real world. Here he looked well. His eyes were bright and his skin was pink and youthful; the real world had clouded his eyes and sallowed his skin.

"This is my world", he once replied with pride. We sat at the beach-head, warmed by a mellow sun. The burnished disc of the sea stretch to the horizon and the mare's-tails of summer clouds swept the blue sky overhead.

"Larrs, please listen to me. Your body in the real world is slowly deteriorating. As your doctor, I must advise you to return to it".

"Why? For my spirit to die along with that miserable shell? Here, my soul has freedom", he said sharply.

"Freedom until your body dies of neglect", I argued. "Then what is there to interract with your carefully-programmed world"?

His eyes pierced mine with such intensity that for the first time I sensed his unreality. It frightened me.

"Look around you, my friend, and what do you see? A beach, clean, uncluttered". He stepped forward and scooped a handful of water from a nearby rock-pool. "The sea is clear, unpolluted. Why is this so? I know as well as you that in the real world we are in some grubby little room in a decaying building, in the middle of a stinking city, but in my world I can set things right; the interraction between my mind and the computer enables me to set things right".

"It is nothing more than escapism, Larrs. Like watching television, fleeing the real world".

"It is more than that, my friend. Remember long ago when I first started this project"?

"Your enthusiasm was infectious, but you saw it as nothing more than another form of entertainment or educational tool; experiencing images, sounds, smells directly in the mind, generated by a cold and logical machine".

"I was wrong", he enthused. "It is more than entertainment. It is a new life in a new world, limited only by my imagination. The computer not only stimulates my mental senses to tell me what I should see and hear and smell, but I tell it. Imagination becomes an apparent reality. Because of the bio-interface directly to my senses, I cannot tell it from reality — but I can remove the darker aspects of the real world".

It was realistic. I remember shaking Larrs' hand on first greeting him. It was firm and warm. I had difficulty imagining that grubby little room in which both our bodies reclined on couches. With sensors

by Chris Kelly

wired to our heads we looked like futuristic Hydra.

"Yet how can all these images and sounds be stored in a limited computer memory"? I had asked him long ago. "Not all parts of the image are stored", he had replied, "just the required train of impulses to trigger the mind into reconstructing the images. For example, one does not memorise a scene point-by-point like a television picture. Only key parts of it are remembered. The human mind fills in the rest of the detail".

This seemed true. I remember testing his theory by visualising the scene behind me — a small hill surrounded by trees and a small log cabin tucked in at one side. When I turned and looked at it critically, I realised that the components were standard images drawn from my memory, put together rather like an identi-kit picture. A few distinguishing features had been added to make the scene individual.

To me it was little more than a techno-biological trick, like sitting in a cinema and pretending that the world outside does not exist. Eventually all good films end.

"You cannot hide forever, Larrs. Your body needs attention, exercise. Do you realise that you are being fed intravenously? You're loading the responsibility of your body on to others".

"Then kill it", he snapped with such ferocity that I almost shrank back from my old and trusted colleage. The surf hissed through the sand. I told myself it was not real, but to Larrs it was. As I returned to the real world, I began to seriously suspect his sanity.

Later that day I did a run-through the regular medical checks on Larrs. He lay on a couch, his senses isolated from the room around him. They were responding to the brighter music returned from the computer by his side.

Apart from the sensors wired to the bio-interface, other electrodes monitored his bodily functions. A drip was suspended above the couch feeding him. My machines told me of his weakening condition. For the first time I contemplated removing him from the computer without his consent, but fate acted before I did. Larrs' body went into violent spasms, then lay still. The cardiograph read-out dropped to zero.

I tried to revive him, but failed. His body was now indeed a miserable shell, empty and dead. For a while I sat mourning the loss of a friend and a brilliant mind, but eventually told myself that Larrs' mind had been lost to his computerised world long ago.

Relectantly, I removed the electrodes from his head and placed them by the computer, which buzzed faintly as though searching the loops and subroutines, looking for external impulses with which to react. I reached out to switch it off, but on a moment's impulse checked the movement. I felt as though Larrs himself was forbidding me.

Although Larrs' main program was permanently stored on disc, its interpretation of his make-believe world would be lost forever if I now switched it off, thus erasing the working store. For months, the computer had detected the signals from his brain, interpreted them and restructured the basic program to feed back the images of Larrs' imagination. It occurred to me that even though Larrs was dead, his world still existed.

There and then I decided to re-enter Larrs' world to observe the artefacts of his mind. What could I learn of a dead man from the structure and contents of a world as he saw it?

I lay on the couch, disregarding the sombre fact that Larrs' lifeless body lay beside me. Within seconds, I entered the self-induced trance necessary to isolate myself from the real world and to open my mind with the probing sensors, interacting with the long and complex program Larrs had devised.

I found myself once more at the beach-head. It was day and comfortably warm. Gulls and kittiwakes wheeled and screeched in the sky above the distant cliffs. Close by the hill was the cabin, the only building in sight. Smoke curled from the chimney as though someone were home. I decided that the cabin would tell me more of Larrs than anything else and went in.

Inside, I found spacious rooms filled with simple furniture. I could hear music, Rimsky-Korsakov's *Scheherazade* — Larrs' favourite — but no source that I could detect. I smelled cooking, and I made my way into the kitchen, I noticed a fireside rocking chair, rocking slightly as though someone had recently left it. A wholesome-smelling stew was simmering gently in a large pot on the stove and I was puzzled to see the pine table set for two.

The outside door suddenly opened and I jumped back as a man entered carrying logs for the fire. He stopped and stared.

"Larrs", I gasped aloud without realising. My mind raced feverishly until I convinced myself that this was probably only an image; an echo of a dead man, reconstructed in response to my brain impulses. Then he spoke to me:

"Welcome, my friend doctor. As you can see, I still do the daily chores I choose; the homely chores, you understand, that add to the realism". He beckoned to the table. "Food"?

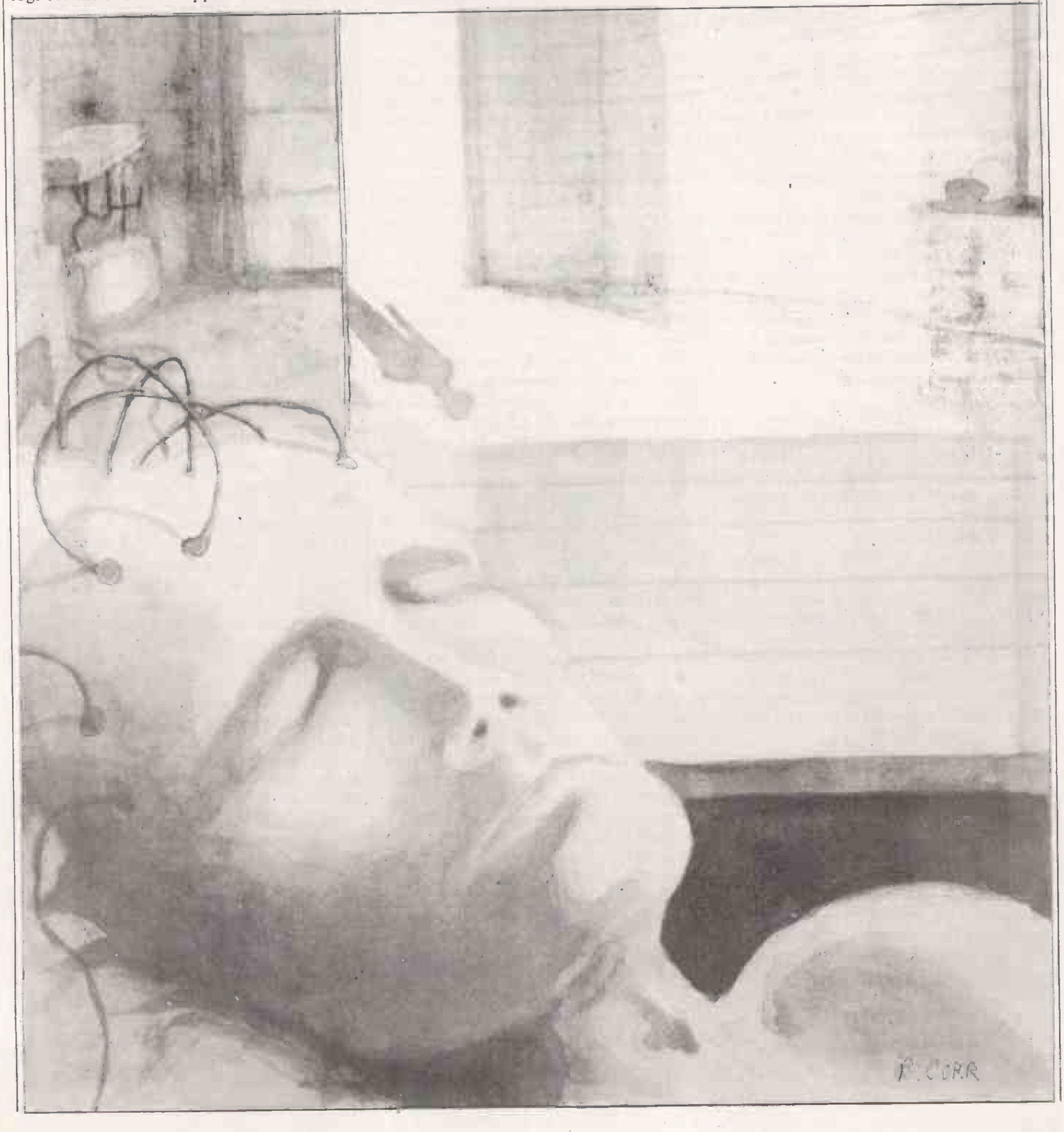
"You expected me"? I ventured to ask, wondering what kind of interactive answer the computer would generate.

"I felt something had happened", he replied simply. "A kind of snapping of strings, a sense of release". Again his eyes probed mine.

I grasped his shoulders, firmly. "Larrs, your body is dead. You died not half-an-hour ago".

He sagged slightly, and sat down slowly. Presently he looked up at me. "Only my body died, doctor. Please, when you return to the real world, do not switch the computer off".

Larrs still haunts his make-believe world; he still warms his feet on the sand and dodges the unpredictable surf. So long as power is ensured to the computer, anyone can don the electrodes and interract with his spirit.



Creativeness is the key

Ed James looks critically at the current role of computing in schools and considers, in particular, the impact which microcomputers are having on the teaching.

SUPPORTED by various statements from the Government, many schools are buying microelectronic equipment and starting to involve their students in computing with no clear understanding of what they are trying to achieve.

My purpose is to spell out some of the problems which schools may encounter and to present what I hope is a constructive view of a sensible way to progress.

My first concern is the lack of adequate support for the establishment of computing in a school. Many advertisements try to persuade us that is is necessary to purchase only a modest amount of hardware and to make a start in computing. That may be true for the hobbyist who is prepared to dedicate all his efforts to making something work, but it is just not true in schools.

If there are many students, the setting-up of a computing service for them is a highly-skilled job. There is a danger that the teacher responsible for computing will spend much time in the administration of this activity and will, therefore, have no time to provide the teaching which is necessary, particularly for the less able students.

Software support

For many of the significant applications of computers in schools it will be necessary to provide a wide variety of software support which is not available at the moment.

My second concern is related to the first. Since it is so difficult to start a computing service which gives a large number of students access, it is likely that the use of the computer will be restricted to a comparitively small elite of pupils.

We will have the equivalent of a ham radio club for a small number of students and they will delight in learning the sophisticated techniques and developing the impenetrable jargon.

The students who are not allowed to use the computer may well develop an antagonism towards computing which they feel is not for them which could sow the seeds of a Luddite mentality it later years.

Another of my concerns is the lack of appreciation of what computing is really about. In my experience, the majority of school teachers believe it is concerned directly with mathematics and assume that only the mathematicians will become involved in computing.

Nothing could be further from the truth. While computing arose originally to assist mathematical computations, the use of computers has spread to totally non-numeric fields and the applications in commerce are now far more significant than those in numerical computation.

On the other hand, there is clearly considerable confusion in Government circles over microelectronics and computing. It is believed necessary to have training in electronics to cope with computers. Again, this is a myth.

If computing is not those things, what is it? At the moment, it is very much a craft skill related closely to essay writing or the creation of poetry or music. There is a good deal of engineering intuition involved and a comparitively minor amount of conventional science. Again, it is not a question of learning a language but about learning to do things with that language. That involves showing by example. Of course the vital attribute we fail to teach is the ability to create.

It is difficult to say positively what is required but it is certain that teaching must be carried out by someone with very wide practical experience or if that is not possible, they must be very trained effectively by people with wide experience. If that is not the case, all kinds of misunderstandings are likely to occur.

The final danger I must stress is a much more comprehensive one — the danger of a new technological elitism which could lead to a Luddite response from the underprivileged. Let us ask a simple question of the school administrator. What use is one microcomputer in a school of 2,000 children?

It is clear that there is no way of organising so that all the children have significant experience with the microcomputer. What happens in practice is that a ham teacher with a hobbyist's outlook sees it as an exciting opportunity and through ineffective teaching methods develops an elite group who are able to understand the computer in spite of the lack of training and who, of course, can discover how to do things for themselves.

That small group is likely to dominate the use of the computer and those children who were less forward in grasping the opportunity will find that the way to obtaining further experience is difficult.

The elite group will soon learn the jargon considered necessary in talking about computers and will see it as a private language which can be used to exclude other people.

It is likely that the less privileged will also be affected by other inhibitions such as their feeling of inferiority in mathematics which could colour their approach to computing — however wrongly.

The recent Government announcement of 100 free microcomputing systems is just the type of support likely to develop the situation described. Having indicated the problems, let us move to the remarkable opportunities which are becoming available and may be grasped if we can organise ourselves properly.

The new opportunity is really the existence of an exciting subject in which all children can be involved in a creative way. The subject is not microelectonics or computing science or mathematics. It is information engineering.

In a sense, we are already information engineers. We obtain information from outside sources, we process it and use it to benefit from it. Currently, the methods of obtaining and processing information are increasing in an explosive manner.

Information is power

There is no doubt that the possession of information is power and so there is a need for everyone to learn how to use the new sources of information and how to learn to specify how the information may be processed for their own purposes. Otherwise, they will be left behind.

The opportunity, in effect, is that of a new generation who are not scared of information technology and are able to make use of it. The result of not taking the opportunities which we now possess is to produce a segregation into the haves and the have-nots with all the revolutionary attitudes that will produce.

I believe the emphasis in training should be on the applications of computing systems, not on their design. The emphasis on explanation should be at the overall planning level and computer applications should be motivated by an obvious requirement for a particular purpose. The applications should be chosen carefully to relate to possible interests of the students.

In addition, there should be attention to applications which all students are likely to encounter — such as the various types of information system provided for public use. Below the planning level there should be appreciation of programming as a means to a purposeful end.

Again, there should be an appreciation of how the program is executed in the machine so that the need for a particular kind of machine can be motivated from what it is required to do. I believe that the present emphasis on microelectronic detail to be a passing phase.

Although microelectronics will be very significant in the future, the overall way in which we think of computing is not altered by it in any essential way. The students are, therefore, really being asked to learn about computing in general rather than about microcomputing in particular.

That description of what is required may appear simple-minded and obvious but it should be noted that the method suggested is in strong contrast to the training which is typically provided. So often at present, the student is led directly into some low level of programming and not a word is said about the purpose of these programs.

Often, the choice of subject for programming is some trivial mathematical calculation which helps to reinforce in the student's mind the connection between computing and mathematics. To be fair, that is the material taught because it is the material which exists in the text books.

It is also, unfortunately, unlikely that any teacher has had sufficient experience of practical computing to be able to relate a program to a practical significant application.

The problem of what to teach can be solved, at least partially, by the provision of a small number of adequate text books. They are provided for more easily than adequate computing facilities for all members of existing schools. Even more difficult to plan is how the large number of teachers who will be required to train students can be found and supported adequately.

We may perhaps look to a continuing decrease in the cost of personal-computing facilities and, therefore, hope that the school-computing facilities can be supplemented by those available in homes, and in public places but there is no similar obvious solution to the problem of teacher training.

It seems that there is a desperate need to establish a system of national training centres for teachers in schools and colleges. These centres need to provide courses of varying lengths to suit the requirements of all teachers and need to cover all aspects of the training required for the general student.

Training centres

The emphasis in these training centres must, of course, be on practical applications and practical aspects of computer use and training in use. While it seems essential that the national centres will be related closely to existing centres of expertise, it is important that the type of training provided should not be related too strongly to the more academic view of computing held in many universities.

To support the teacher on return to full-time teaching, it will be important to extend considerably the number of support centres which have been so ably pioneered in local education areas such as Birmingham and Hertfordshire. Such organisations need to be formed in every part of the country.

One of their most important functions will be to promote the purchase of standardised computing facilities which can then be available for use together with a wide range of programming support packages produced by professionals.

The involvement of the teacher in specifying teaching aids and carrying out the instruction should not be confused with the writing of programs or providing operating systems management. The only possible economic way of providing the expertise required is to centralise the sources.

A satisfactory service can be provided only by full-time professionals and it will be essential for those professionals to have a total commitment to simple-to-use systems.

In conclusion, I would see that the purpose of the training is the promotion of an information-rich society where the sources and means of processing information are not in the hands of a small elite. Computing systems should be seen by all as aids to obtaining and processing information and, therefore, extending our mental powers.

In particular, every student needs sufficient support to develop a confidence towards computing systems so that they will not be led astray by extremists who say on the one hand, that computers must be destroyed or on the other hand, that they can do everything for everybody and so devalue human beings. I hope that we can all contribute to the effort which is required in the future.

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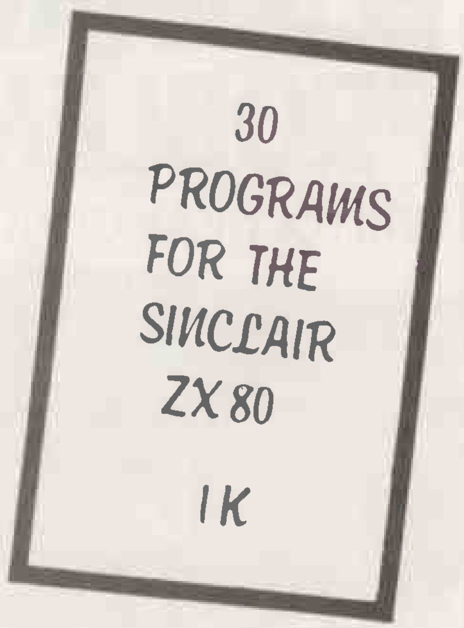

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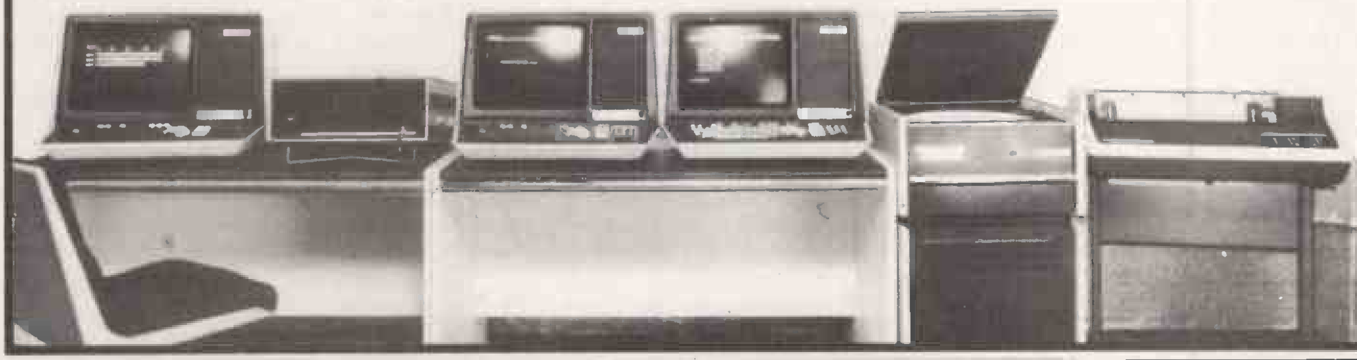

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Future of packaged software

IT IS probable that sales of programmable computers in the U.K. are being made at the rate of about 5,000 a month. Only a few of those computers will be sold to people unaware of the fact that a computer requires to have a set of programs before it can be employed on useful work.

By the same token, very few of the buyers expect to either write their own programs or have programs specially written. There is just not the programming capacity within the U.K. to meet the original requirements of 5,000 computers per month.

The buyers are usually supplied a set of programs along with their machine. Those programs are in the form of a package. Package programs are available for most business applications and to suit the needs of a wide variety of trades and professions.

The computer purchaser is attracted by the power of the packages. It is the facilities offered by the package that he is really buying, the computer becoming the bare vehicle required to run the package.

There is a wide choice of packages available. The consensus of those who have attempted to use them is that they are of generally poor quality. Even expert examination of a package may not reveal its weaknesses.

The reason for the low quality of the products is, in our view, sheer lack of experience. It will be necessary to go through several development cycles of producing and improving packages before good-quality products are available.

Development cycles

The development cycles and the production of the higher-quality packages will require considerably greater investment than has been made in the packages offered today.

The programmer needs applications' knowledge because this type of individual does not work from a written specification but carries the whole solution in his head and writes program code in one continuous stream. Interestingly, program code written in that way by the best programmers is usually of very good quality.

A package written in two man months in the manner we have described can be marketed for £1,000. Over the first two years of its life, it would expect to sell 100 copies and just about break even after the programmer originator had received a reasonable remuneration.

Most of the software on offer today has been produced in that way and it is hardly really surprising that users should regard it with generally poor opinions.

A company wishing to develop a program product and prepared to invest to the necessary extent has to go through the full gamut of product innovation, proving and development cycle.

After the initial market research, a features list needs to be prepared setting out the points the package will cover. The marketing plan will show how it is to be presented and that leads to the first specification of the system.

Based on that specification, a prototype system can be developed and tested in the field. Ideally, those tests should be with users who will eventually become the first reference sells. With that field experience, the final specification of the product can be produced and the programs and documentation prepared.

by Cliff Dilloway

The sales staff have to be trained and the sales-support staff given experience on the product. Anticipating sales and technical-support team should be ready to establish installations and a continuing programme of enhancements must be prepared.

Development of a product in that way cannot possibly be done for less than £100,000 and a realistic figure is probably several times that amount. Unfortunately, there is no objective measure of the quality of the finished product and so it may well be found that the product will sell no better than our genius programmers home-grown, two-month effort.

It is clear that it is sales effort which sells packages and not the intrinsic quality of the packages themselves. That is because it is an unsophisticated market and the buyers are not able to judge the relative worth of what they are offered.

It is that phenomenon which gives rise to the low regard in which package of software is often held.

The description so far will be recognised readily by anyone who has participated in the market as supplier, purchaser or investor. What we have been examining are the symptoms. The causes are more fundamental and are at the heart of the use of a computer.

The greatest difficulty is that contrary to popular belief, commercial practice is almost completely undefined. It is by far easier to say what is not acceptable commercial practice than it is to say what is acceptable. Certainly auditors work that way.

We give the invoice as an example. A description of an invoice would apply to a number of other documents which are certainly not invoices.

For those who dispute the vagueness, we would point out the many directory invoices that somehow seem to get paid without any justification whatsoever. Knowing an invoice when you see one is not quite the same thing as being able to produce a definition in the detail required by a computer system.

Remember we are seeking to produce a specification not just for an invoice but for all the different invoices anyone might require.

Another factor is that every user's requirements are different. That is a matter of received wisdom which tends to defeat the whole idea of the production of commercial applications packages. In fact, while every user's requirements are different no user has a requirement which is without parallel.

Clear conclusions

The conclusion we reach is that much more effort has to be put into instruction and education on the use of specific program packages. In fact, packages must be designed so that they can be sold, installed and used.

When the problems of how to provide understanding have been solved, it will be much easier for a prospective user to judge whether a package is suitable for him.

Such a judgment will have a profound effect on the production and marketing of software. The confidence of users will increase as they discover how to reject unsuitable software.

Sales of suitable products will increase yielding a profit to their innovators. That profit can take its rightful place as the reward by society to those it judges a success so that they may continue their good service to society.

Design techniques which save time and reduce effort

How often after implementing a program have you wished you could start all over again — this time you would do it differently? Brian Swindells describes easier program maintenance.

HOW OFTEN, when using a program you wrote some time ago have you wished for additional features? They are not uncommon problems and, of course, are only to be expected. By implementing a program, we gain additional experience by which, if we re-wrote it, we could benefit. As we use a program, we gain even more experience which changes our requirements, usually making them more sophisticated.

Common problems

Although those are common problems and are ones that probably cannot be eliminated completely, at least we can take steps to minimise them. By using advanced design techniques it is possible to ensure that our program can be amended easily to reflect changing requirements in changing situations. Those techniques can be summarised as:

A functional approach
The use of simple procedures
The use of tables
Parameter-driven
Having good documentation

It is assumed that each program is written to achieve some pre-defined objective and that to achieve this, certain other objectives must be met. If, for example, the main purpose of a program is to control a bank account; it is necessary to perform the following functions:

Record details of items credited to account
Record details of items debited to account
Enquire on current state of account
Report on exception conditions

The important aspect of those functions is that we need to perform them irrespective of how we achieve the objective. We may record the items in a ledger using a quill pen or we may record them electronically using a computer. The how may change, but the what does not.

As a first approach to good design, therefore, it is important to identify all the functions associated with the task at hand, be they functions of a complex business situation or the functions of a game.

Functional analysis

That process is known as functional analysis and in undertaking the work it is advisable to forget about the computer altogether — just ensure you are fully aware of what you are setting out to achieve.

Having identified all the functions associated with the task it may be necessary to write several programs to cope with the problem satisfactorily. If that is so, each program should comprise an integral number of functions making it more likely that subsequent changes will affect only one program.

Simple procedures

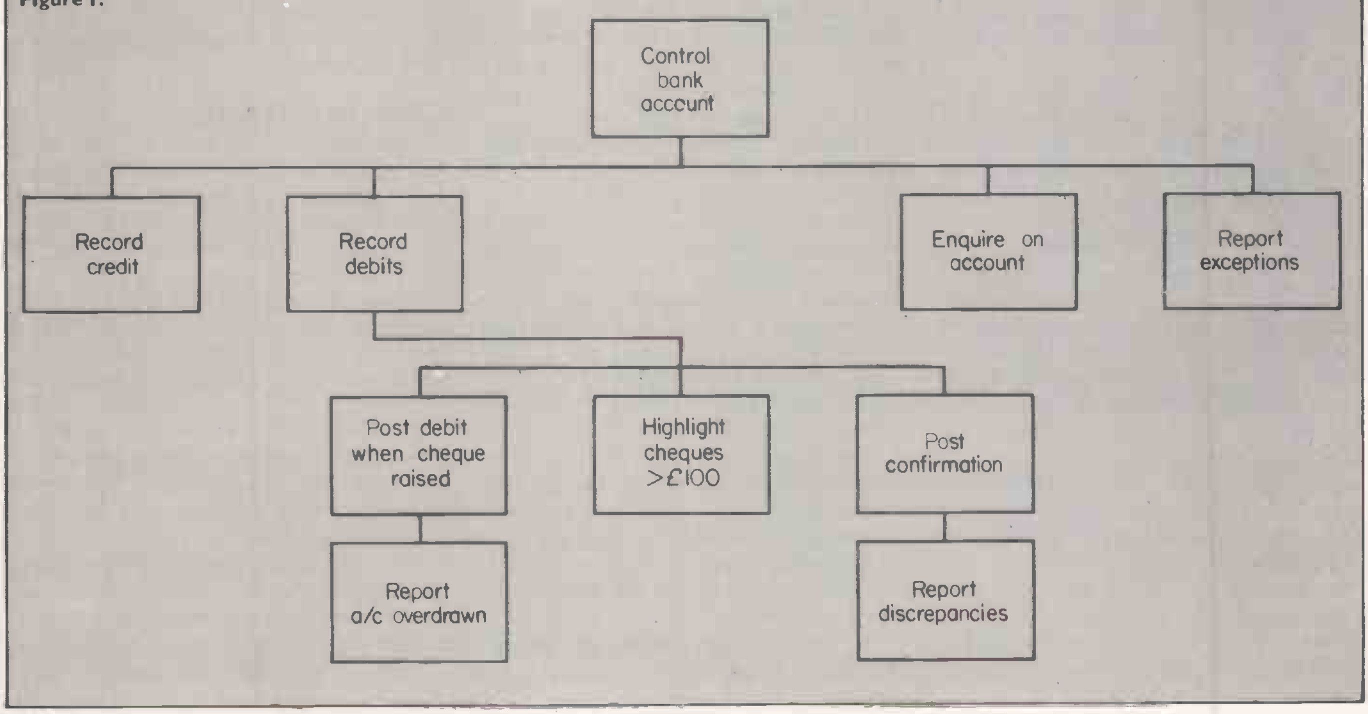
The next step is to design simple procedures as solutions to how each function is to be undertaken. That can be considered as a further breakdown of the functional hierarchy described and if we take the posting of debits, the following simple procedures could apply:

Post debit when cheque raised
Post confirmation from bank statement
Report on discrepancies
Highlight cheques of more than £100
Report if account overdrawn

This approach can be shown diagrammatically — figure 1 — and its advantage is that should you wish to change or add a procedure, it is self-contained and its relationship to other procedures can be readily identified.

It may be appropriate to continue breaking-down these procedures until there are many levels of the hierarchy. The decomposition is necessary until each self-contained procedure is simple enough to be converted into a small number of

Figure 1.



program statements. What is considered to be a small number may vary from person to person, but the important things to remember are that the group of statements or program module should have only one entry and one exit point and that it should be easily understood.

The use of tables can ease subsequent program maintenance greatly as can be shown by considering the calculation of VAT in a business system. One approach to the problem would be to hold the percentage rate against each item on a stock file but that would entail changing each record each time the rate changed.

An alternative is to hold against each item on the stock file a VAT category and to maintain a separate table showing the effective rate for each category — figure 2.

That feature can be used whenever an item held on a file may have only a small number of values, for example weightings applied to certain criteria. The criteria can be identified both on a file and in an associated table while the weightings shown in the table can be varied at will.

Stock File

Description	VAT category
Cooker	0
Radio	1
Television recorder	1
Video recorder	3
Washing machine	1
Dishwasher	1

VAT Table

VAT category	Rate 1.6.79	Rate 20.3.81
0	0	0
1	15	10
2	15	10
3	15	20

Figure 2.

Parameter-driven

Parameter-driven programs are those which include various procedures not all of which are to be used on each run of the program. The procedures to be used being decided upon by inspecting parameters provided either by the person operating the program or by other procedures in the program.

An example of this is in a game where the routine to be used on a particular occasion varies to introduce a randomising effect. Each pre-programmed routine will perform the required function but produce differing results. The routine used may be decided on by another program module generating, for example, a random number.

In a business environment, a program which is used every day may need to produce additional information at the end of a month or at the end of the tax year. The user can signify by parameters that today is a month-end or a year-end and the program will activate the appropriate modules to produce the required information.

That facility is particularly useful in situations where there are known variations in requirements. Each variation can be pre-programmed and the one to be used on each occasion chosen at will.

A final aid to easier program maintenance is good documentation. Even if you are the one who wrote the program and only you are to use it, it is advisable to document the program both by including appropriate comments in the coding and by preparing a separate manual.

This document should both advise on the operation of the program, you may need to refresh your memory if it is not used for some time, the act as a reference manual when you wish to alter something.

We live in a changing world and have changing requirements. Most programs, having been written to satisfy some of those requirements need, therefore, to be flexible in design and adaptable.

Minimise work

Program maintenance can often be a time-consuming and frustrating task but by utilising some of the design techniques described, it is possible to minimise the amount of effort necessary in undertaking such work.

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Microprocessor-controlled model railways

How to interface a zero-gauge model train to a computer which controls the shunting operations of the engine and the marshalling of trucks in and out of sidings. The system is presented by Bob Coats, Alison King and Don Thatcher.

THE LAY-OUT for the railway system is shown in figure 1. It comprises:

Five tracks: a single line, T1, leading to four sidings, T2, T3, T4 and T5. The space available did not permit a passing loop on track as had been planned originally.
Two end-of-track sensors EOT-1 and EOT-2
Three points, P1, P2 and P3 and their associated switching mechanisms.
Four uncouplers, U2, U3, U4 and U5.
Five track-code sensors, S1, S2, S3, S4 and S5.

Suppose trucks 3, 7 and 9 are on track 5, the engine is on track 1 and it is required to form a train comprising the engine followed by trucks 7 and 3. One possible sequence of shunting operations is:

CHANGE points for track 5
drive engine BACKWARDS until coupled on to trucks
LOCATE truck 7 using truck-code sensor 5 moving FORWARDS
UNCOUPLE between trucks 7 and 9
drive engine FORWARDS until on track 1
CHANGE Points for track 4
LOCATE truck 9 using truck-code sensor 4 moving BACKWARDS
UNCOUPLE between truck 9 and engine
drive engine FORWARDS until on track 1
CHANGE points for track 5
drive engine BACKWARDS until coupled on to trucks
drive engine FORWARDS until on track 1
STOP

The following basic operations can be identified from the sequence:

FORWARD and BACKWARDS
STOP
CHANGE POINTS
LOCATE specified truck
UNCOUPLE
SPEED, variable

A diagram of the motor control unit is in figure 7. Applying a logical 1 to input F and a logical 0 to input B will make output X + 15 volts relative to output Y, causing the motor to turn in the forwards direction. The opposite cause of a logical 0 on input F and a logical 1 on input B will cause the motor to turn in the backwards direction. The motor will be stopped if either logical 1s or 0s are applied to both F and B.

The circuit used in the motor control unit was based on one given in an article in *Practical Electronics,* in which the polarity of the power applied to the motor is controlled by a bridge circuit of power transistors. The circuit was modified to prevent the case of a logical 1 applied to both F and B destroying the power transistors.

The speed of the train is controlled by rapidly pulsing the power to the track, varying the ratio of on-time to off-time — the mark-space ratio. This timing is achieved through the software.

The end-of-track sensors consist of light-activated switches on one side of the

A general view of the track.

trck illuminated by light from bulbs on the opposite side. The action of the train breaking the beam causes the switch to change. The bulbs are of the type incorporating a focusing lens, to ensure that the intensity of the beam at the light-activated switch is significantly greater than the background light.

Two solenoids, the set solenoid and the re-set solenoid, constitute the switching mechanism of each point. A ferromagnetic core common to both solenoids is attracted towards one solenoid, say, the set solenoid, when a current is passed through that solenoid, and the movement of the core, via suitable linkage, causes the point to be set. A current through the other solenoid causes the point to switch the other way, i.e., to be re-set.

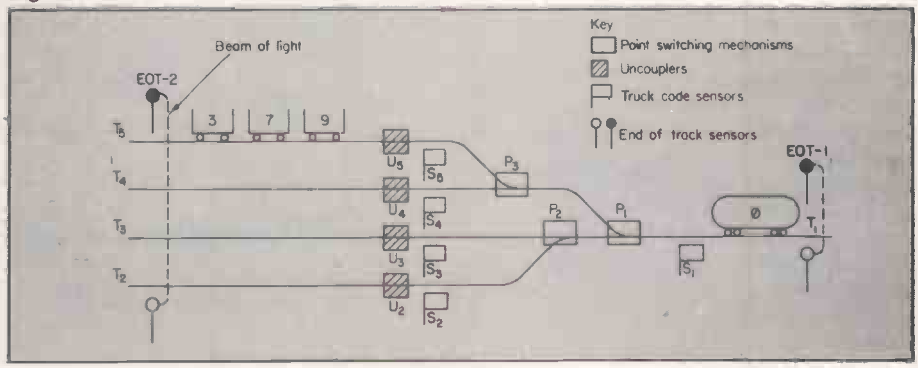
A diagram of the points-switching unit is shown in figure 2. A particular point is selected by an appropriate pattern of logical 1s or 0s on the three address lines, e.g., 010 selects point 2. The action required — set or re-set — is selected by a 0 on the enable line.

The circuit used in the points-switching unit was based on the circuit given in *Electronics Today International.* A large capacitor — 22,000 μf — is discharged through the appropriate solenoid when the point-switching unit is enabled. The discharge provides adequate initial energy to operate the solenoid, but the available current falls rapidly to a few hundred milliamps as the capacitor discharges, thus eliminating the problem of burnt-out solenoids.

Each solenoid is connected to a power transistor, the switching of which causes the capacitor to discharge through its solenoid. The switching signals are provided by the outputs of a four-line-to-16-line demultiplexor — SN54154; the inputs to the demultiplexor are the three address lines, the set re-set line and the enable line. Only six of the 16 demultiplexor outputs are necessary for the points in this lay-out.

The existing couplings on the trucks and engine were all replaced by a home-made pivoting arm mechanism as shown in figure 3. The uncoupler mechanism consists of an electro-magnet positioned between the rails. When the electro-magnet is activated, and a truck is directly

Figure 1.



over it, the flat plate attached to the pivoted arm is attracted towards the track, causing the hook at the other end of the arm to lift off the preceding truck, thus uncoupling the two trucks.

Solenoids similar to those used for point switching were used for the uncouplers, and four of the 10 unused demultiplexor outputs of the points Switching Unit were used for activating the uncouplers — SET4 for U2, SET5 for U3, etc.

The status of the points can be sensed using two switches, the SET switch and the RE-SET switch, built into the point switching mechanisms.

Point state	Set switch	Re-set switch
set	closed	open
re-set	open	closed
in-between	open	open

Under normal operation only one switch should be closed. If the point sticks between the set and the re-set states, the set switch and the re-set switch may both be in the open states. Certain faults can also cause both switches to appear closed. Consequently, to detect faults, it is necessary to monitor the status of both the set switch and the re-set switch.

A multiplexor (SN54151) is able to select one of eight data sources, and switch it to the output line. The set switches are connected to one multiplexor, and the re-set switches are connected to a second one. On selecting a particular point, the status of its set switch is

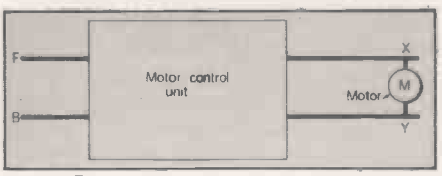


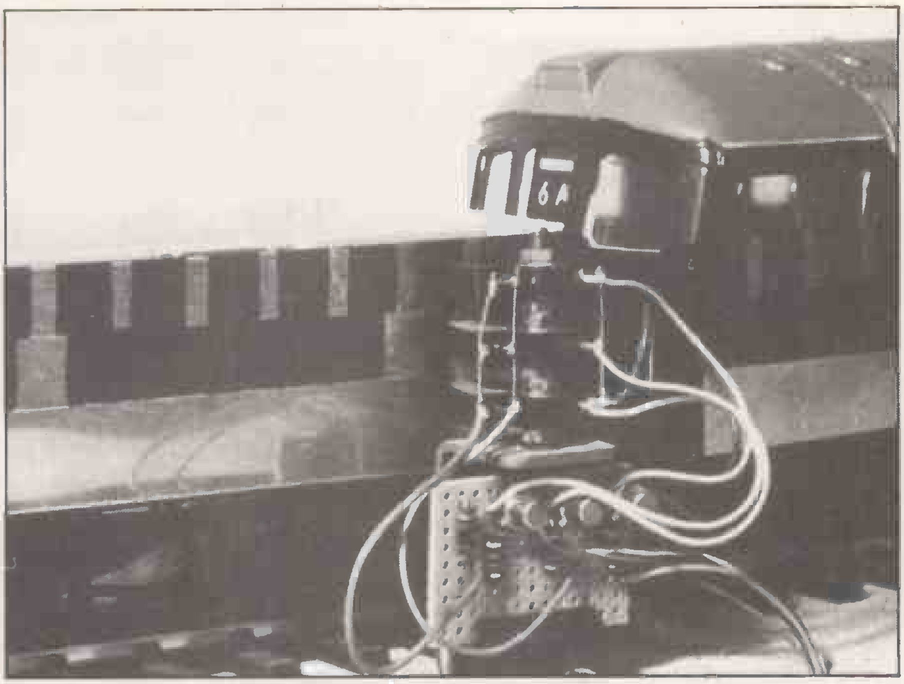
Figure 7.

fed to the computer along the set status line, and the status of its re-set switch is fed along the re-set status line. The circuit for the set case is shown diagramatically in figure 4. Only three of the eight inputs available are used.

The system caters for one engine and up to 15 trucks; each has an identification code inscribed on a home-made reflective metal plate mounted on its side. The code consists of eight bits; the right-most four bits make up the truck identifier, 0-15, and the left-hand four bits are formed by reflecting the right-hand bits about the central vertical axis of the plate.

Hence, the code appears the same whatever the direction in which the truck passes the sensor. With that scheme, as the truck passes the sensor, the code is in effect read twice as a precaution against misreads. A truck-code sensor and an example truck-code plate are shown in figure 5.

The truck codes are sensed by a cluster of three reflective opto-switches. An opto-switch — Radio Spares 307-913 — comprises an infra-red light-emitting diode and a photodarlington transistor housed



The sensor clusters and coding system of an engine.

in a moulded package. A reflecting surface placed at a distance of between two and 10mm. from the opto-switch will cause the infra-red flight to reflect back to the detector. Hence, the presence of the reflecting surface is detected by the opto-switch.

The patterns on the truck-code plate are sensed by the truck-code sensors located by the side of the track as the truck is moved past by the engine. Non-reflecting areas of the plate are painted matt black while reflecting areas are left metallic. A plate is divided into three zones — top, middle and bottom — and each zone has an opto-switch associated with it.

The bottom zone defines the extent of the plate; the data in the top and middle zones will be used only when the bottom zone is reflecting. The top zone comprises eight reflecting markers, to mark the position of the data bits making up the truck code in the middle zone — the condition of the middle zone — reflecting or non-reflecting — is sensed when each marker in the top zone is encluntered.

There are three truck-code sensors, each being a cluster of three reflective opto-switches. The top, middle and bottom signals from each cluster feed into three multiplexors, SN54151, in a manner similar to that described in point sensing. The outputs from the multiplexors are the top-status-line, the middle-status-line and the bottom-status-line, which indicate the states of the cluster currently addressed by the address lines.

The control program for the train runs on a Z-2 Cromemco computer, Z-80 with the following boards:

- processor
- 16K random access memory (RAM)
- TUART
- D-A and A-D
- Bytesaver

All the signals — seven input and nine output — for controlling the train system are digital, either logical 0 or 1 — no analogue signals are used. It was decided to use the D-A and A-D board for the interface — it provides one eight-bit parallel input port and one eight-bit parallel output port as well as seven analogue inputs and seven analogue outputs — and keeps the other ports free for possible extensions to the system. The lines were allocated:

SET	point status line	: Parallel Input 0
RE-SET	point status line	: Parallel Input 1
BOTTOM	truck-code status	: Parallel Input 2
MIDDLE	truck-code status	: Parallel Input 3
TOP	truck-code status	: Parallel Input 4
EOT-1	end-of-track 1	: Analogue Input 1
EOT-2	end-of-track 2	: Analogue Input 2
F	Forwards	:Analogue Output 1
B	Backwards	:Analogue Output 2
A-0	address line 0	:Parallel Output 0
A-1	address line 1	:Parallel Output 1
A-2	address line 2	:Parallel Output 2
S/R	Set/re-set points	:Parallel Output 3
E-1	Enable point switching/uncoupling	:Parallel Output 4
E-2	Enable point sensing	:Parallel Output 5
E-3	Enable truck-code sensing	:Parallel Output 6

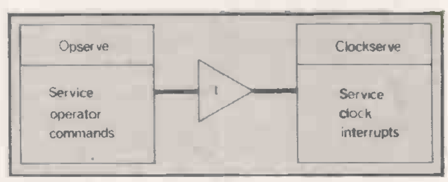


Figure 8.

The analogue lines are used as digital lines — either logical 1 or 0. The analogue outputs were used for the direction and speed control simply to keep those functions separate from the functions on the parallel output port.

No serious consideration was given to the optimum use of the available inputs and outputs; indeed, there is intentional redundancy in the system to give future students studying the system as a case

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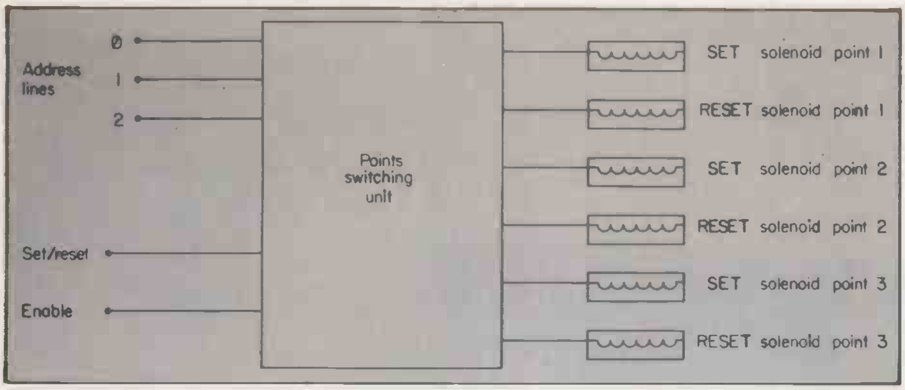


Figure 2.

(continued from previous page)

history scope for criticism and for suggesting improvements.

A variety of techniques for specifying the programs are in use; most of them adopt a structured approach and some graphic aid. The method adopted is a mixture of:

- A network chart and a program-structure chart — as described in the NCC data processing documentation standards, but omitting the NCC filing references — to provide the top level of description.
- Structured English — as described by Parkin in Systems Analysis reference 4 to specify the procedures. The method is particularly easy to modify and maintain. The rules are very simple — the procedure is described in natural language, but the control structures are limited to those compatible with structured programming. The specifications will take the form of sequences of natural constructions or case constructions, under the control of expressions such as while condition; until condition; repeat n times, etc.
- The scope of a control loop or condition is shown by indenting the subordinate statements by a few spaces. At the end of the controlled or conditioned statements, the indentation is dropped. An else is always lined-up with the if or other conditional expression which it matches. Arbitrary subroutines are created, as desired, by the use of underlined phrases.

The network chart shown in figure 8 specifies that there are two processes — Opserve and Clockserve — constituting the train-control program. The function of Opserve is to obtain and validate operator commands, and service them by a call to the appropriate procedure.

The purpose of Clockserve is to monitor periodically the state of the system, and to take any actions necessary. Clockserve is entered whenever an interrupt is generated externally by an interval timer on the Tuart board, which is set to provide an interrupt every millisecond.

Having serviced the interrupt, control is returned to the instruction in Opserve which was about to be executed when the interrupt servicing began.

The process to service clock interrupts, Clockwise:

```
disable interrupts
save registers
if end-of-track 1 is broken and DIRECTION = "F"
    speed = "0" : set motor value
    FORWARD-RESTRICTION = on
    ABORTED = true
if keyboard is ready and character = ESCAPE
    ABORTED = true
if HOLD  0
    decrement HOLD by 1
determine-power
if DIRECTION = "F"
    send power-off-or-on to F (analogue output 1)
    send 0 to B (analogue output 2)
else
    send power-off-or-on to B
    send 0 to F
restore registers
set interrupt interval to 1 msec
enable interrupts
```

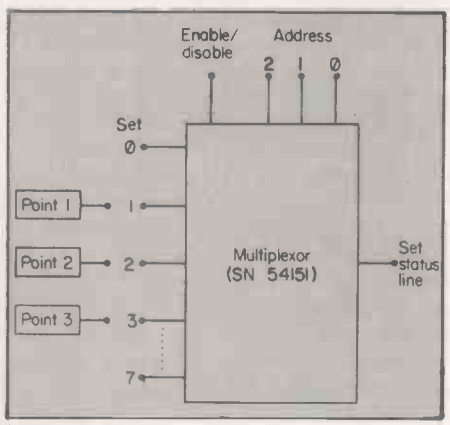


Figure 4.

The primary function of Clockserve is to control the speed of the train. The procedure Determine-Power sets power-off-or-on to 1 if power is due to be applied to the track, and to 0 if not. If power-off-or-on is 1, power is applied in the direction specified by DIRECTION; otherwise no power is applied.

Various methods for determining the value of power-off-or-on can be used, two of which are:

- Each speed is given an eight-bit representation — Speed 1 = 00000111, Speed 2 = 00001111, Speed 3 = 00011111 and Speed 4 = 00111111 — which is stored in Motor. Every time Clockserve is entered, the least significant bit of Motor is tested; if it is 1, power is due to be applied to the track and power-off-or-on is set to 1, otherwise power-off-or-on is set to 0. Finally, the bit pattern is rotated one position to the left. Consequently Speed 1 applies power to the track for three out of eight time units, one time unit being one msecond, the interrupt interval.

```
if least-significant bit of MOTOR is 0
        power-off-or-on = 0
else
        power-off-or-on = 1
rotate MOTOR one position to the left
```

- Motor is initialised to 0 in Validate when Speed is set. Each time Clockserve is entered, the following algorithm is applied to determine power-off-or-on:-

```
case: SPEED = "0"
    power-off-or-on = 0
case: SPEED < > "0"
    if MOTOR < SPEED + 2
        power-off-or-on = 1
    else
        power-off-or-on = 0
    MOTOR = MOTOR + 1
      module 8
```

The structure chart for Opserve in figure 6 shows for each procedure of the process which procedures call or are called by it. There is no indication of the sequence in which the procedures are performed during a run, nor of their relative frequencies of performance.

The root procedure of Opserve is Validate, whose purpose is to validate commands entered by the operator. Each subsequent row of the chart indicates the next lowest level of procedure. For example Change, Uncouple and Locate are all procedures called by Validate.

The validation of operator commands,

```
initialise
done = false
repeat until done
    display status information
    get command
    case: ESCAPE
    case: command = "Q" and
      SPEED = "0"
        done = true
    case: command = "F" and FORWARD-
        RESTRICTION = off
        if DIRECTION = "B" and SPEED
            < > "0"
            halt the train
            SPEED = old speed :
            MOTOR = old motor
            DIRECTION = "F"
        BACKWARD-
        RESTRICTION = off
    case:command = "B" and BACKWARD-
        RESTRICTION = off
      if DIRECTION = "F" and
        SPEED < > "0"
        halt the train
        SPEED = old speed :
          Motor = old motor
        DIRECTION = "B"
      FORWARD-RESTRICTION = off
    case:command = "0" and
        SPEED < > "0"
      halt the train
```

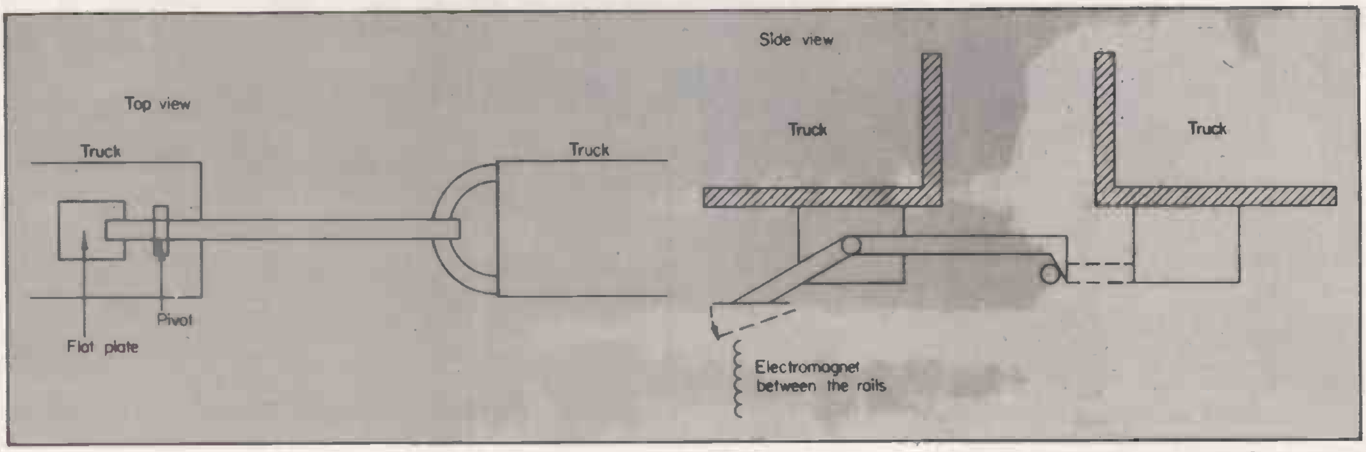
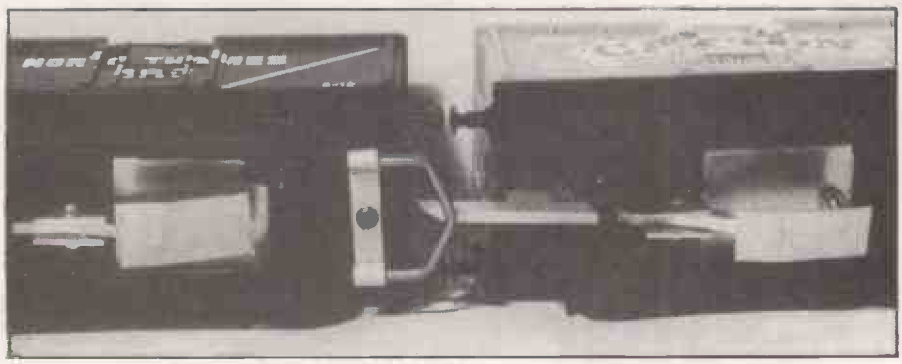


Figure 3.

```
case:command = "1" or "2" or "3" or
    "4"
    SPEED = command :
      set MOTOR value
case:command = "C" and SPEED = "0"
    get point-number (p)
    case:ESCAPE
    case:valid point-number
      (1 < = p < = 3)
        change point p
    case:anything else
        ring bell : output
          "invalid point number"
case:command = "U" and SPEED = "0"
    get uncoupler-number (u)
    case:ESCAPE
    case:valid uncoupler-number
          (2 < = u < = 5 )
        uncouple using uncoupler u
    case:anything else
        ring bell : output "invalid
          uncoupler number"
case:: command = "L" and
        SPEED = "0"
    get truck-number (t)
    case:ESCAPE
    case valid truck-number
        (0 < = t < = 15)
        get truck-code sensor
          number (s)
        case: ESCAPE
        valid truck-code sensor number
          (1 < = s < = 5)
            get direction (d)
            case:ESCAPE
            case:valid direction
                ("F" or "B")
              DIRECTION = d
              SPEED = "1" :
                set MOTOR value
              locate truck t
              using sensor s
            anything else
```



The uncoupling mechanism.

```
                ring bell :
                  output
                  "invalid direction"
        case:anything else
            ring bell :
              output
              "invalid truck-code
              sensor no"
      case:anything else
          ring bell :
            output
            "invalid truck number"
  case:anything else
      ring bell : output
      "invalid command"
output termination message : stop
```

The purpose of Validate is to check the commands entered by the operator, and to sound the bell and output an appropriate message if any are invalid. The syntax of the instruction repertoire is:'

Q	: Quit
F or B	: Direction
O or 1 or 2 or 3or 4	: Speed
C p	: Change point p(1<= p<= 3)
U u	:Uncouple with u (2<= u <= 5)
L t s d	: Locate truck t (0<= t <= 15) using sensor s (1 =s =5) in direction d (F or B)

The specification of Validate should be more or less self-explanatory. The underlined phrases — initialise, display, halt, change, uncouple and locate — are flower-level procedures, as shown in the structure chart for Opserve — figure 6.

Case:Escape means the Escape key was pressed by the operator in response to the last prompt for input. The effect if for the computer to re-display the status information and prompt the operator for another command, ignoring anything entered by the operator prior to the Escape. That is represented in Validate by there being no indented statements subordinate to this case.

The operations Quit, Change point, Uncouple and Locate are acceptable only if the train is stationary. In the specifications following:

activate :means sending the appropriate bit pattern for the particular function to the parallel output port for example, to activate truck-code sensor 3 for a Locate operation, the following bit pattern would be sent:

```
0 A-0 1)
1 A-1 1) Address value 3 (011)
2 A-2 0)
3 S/R 1  not used
4 E-1 1  disable point switching
5 E-2 1  disable point sensing
6 E-3 0  enable truck-code sensing
```

de-activate : means sending a bit pattern to disable the function, e.g., in the above example 1111011 would be sent, disabling truck-code sensing, E-3.

To ensure that point p is in a valid state, "R" or "S", Ensure-Point:

```
repeat until point-status  "X"
    sense point p
    if point-status = "X"
        output "manual correction required"
        wait for operator
```

To sense the state of point p, Sense:

```
    activate sensing of point p
    case:set-status-line = 1 and
        re-set-status-line = 0
        point-status = "S"          i.e., set
    case:set-status-line = 0 and
        re-set-status-line = 1
        point-status = "R"        i.e., re-set
    case:any other combination
        point-status = "X"   i.e., faulty state
    de-activate sensing of point p
```

To initialise the system, initialise:

```
    DIRECTION = "F" : SPEED = "0" :
              set MOTOR
    FORWARD-RESTRICTION = off :
    BACKWARD-RESTRICTION = off
    HOLD = 0 : ABORTED = false
    prepare for interrupts
    set interrupt interval to one msec
    enable interrupts
```

To display system status information on the screen, display:

(continued on page 97)

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(continued from page 95)

```
    show DIRECTION and SPEED on screen
  for all points
    ensure-point is in valid state
    show point state on the screen, i.e.,
    "R" or "S"
  show end-of-track sensor states on the
  screen
To halt the train, Halt:
  SPEED = 0" : set MOTOR value
  delay or 250 mseconds to allow train
  to stop
To change point p, Change:
  ensure-point p is in a valid state
  if point-status = "S"
    required-operation = "R"
  else
    required-operation = "S"
  attempt = 1
  done = false
  repeat until done
    if attempt < = 3
      activate point p for required-
      operation
      delay for 50 mseconds to allow
      point to switch
      de-activate point p
      delay for 250 mseconds to allow
      capacitor to re-charge
      attempt = attempt + 1
    else
      output "manual correction
      required"
      wait for operator
    sense point p
    if point-status = required-operation
    operation
      done = true
  Change will make three attempts to
  change the point to the requested
  state; if it fails, manual correction
  will be requested.
To uncouple using uncoupler u, Uncouple
  activate uncoupler u
  delay for 225 mseconds to allow magnetic
  field to build-up
  SPEED = "4" : set MOTOR
  delay for 225 mseconds to allow train
  to move approximately 10 cm.
  de-activate uncoupler u
  halt the train
delay for 750 mseconds to allow capacitor to
  re-charge
To locate truck t using sensor s, Locate:
  found = false
  ABORTED = false
  make up requested-code from truck
  number t
  activate truck-code sensor s
  repeat until found or ABORTED
      wait until ABORTED or bottom = 1
      repeat until ABORTED or bottom = 0
        wait until ABORTED or top = 1
        if not ABORTED
          read middle
          build-up detected-code
          wait until ABORTED or top = 0
      if requested-code = detected-code
        output 'truck found'
        halt the train
        found = true
    de-activate truck-code sensor s
    if not found
      output 'truck not found'
```

The logic of Locate is basically while bottom = 1, each time top changes to 1, read middle and build up detected-code.

Searching for the requested-code will continue until either the code is found or the search is terminated by Clockserve setting aborted because the operator pressed the escape key, the train broke an end-of-track sensor. Requested-code for truck 5 for example is 1010 0101.

Locate is designed to detect the eight-bit palendromic truck-codes which it does very effectively — the failure rate is less that one percent. As a consequence of searching for well-defined patterns, spurious reflections are easily recognised and rejected.

The optimum value of 1 msecond for the interrupt interval was determined experimentally. Making the interval too large causes the train to move in fits and starts, while making it much less than 1 msecond causes the motor not to turn, because of the increased reactance.

The particular eight-bit speed patterns were also determined experimentally. In principle, eight speeds are possible, but in practice, the patterns 01111111 and 1111111 cause the train to go too fast for the size of the lay-out, while the train would scarcely move with the patterns 00000001 and 00000011. The maximum speed of the train was 85 cm./second.

There is a single capacitor common to all points and uncouplers. A point is switched by discharging this capacitor through one of the two solenoids of the point switching mechanism. It is not necessary to discharge the capacitor completely; the discharge can be initiated by setting the enable line of the points-switching unit to 0, and terminated at some later time by re-setting the enable line to 1 when the point has switched.

The minimum time interval consistent with the points switching reliably was found to be 50 mseconds. After the discharge, the capacitor needs to re-charge before an attempt is made to switch another point. The re-charge time was 250 mseconds, hence the delay times used in the procedure Change.

In the case of the uncouplers, the discharge was allowed to proceed for a longer time so that a sufficiently strong magnetic field could be generated to attract the plate on the underside of the truck, and to hold it while the train moved forward. The discharge time was 250 mseconds with a correspondingly longer re-charge time.

One problem encountered with the reflective opto-switches was that during the transition from non-reflecting to reflecting, or vice-versa, the output from the switch was unstable, and gave rise to spurious data. The solution was to wait for about 150 µseconds — to allow for the rise-time of the switch — and then re-sample the signal; only if the two samples agreed was the change accepted.

That delay, together with the delay inherent in processing an interrupt, provided the potential for another problem. Suppose one reflecting marker in the top zone of the truck-code plate has just entered the field of view of its opto-switch, causing the switch to change. That change will be detected in the software, and the 150 µseconds' delay described will be initiated, to allow the signal to stabilise.

Just prior to the end of this delay, suppose an interrupt occurs. The maximum execution time for the instructions comprising the interrupt handler is 110 µseconds. Hence the total time between first detecting the change, and then confirming it, could be as large as 260 µseconds. In the meantime the truck is moving pas the sensor, at a maximum speed of 85 cm./second.

The maximum distance the plate could move in this time is .22 mm.; hence the widths of the reflecting markers need to be larger than .22 mm. In practice, the narrowest reflector was two mm.

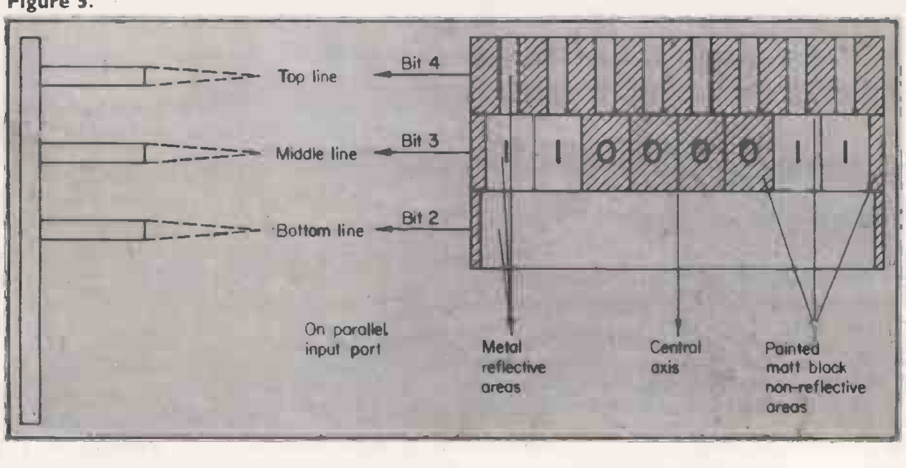
The end-of-track sensors were positioned sufficiently distant from the end of the track so that even if the train was travelling at full speed when it passed the sensor, its momentum would not carry it beyond the end of the track.

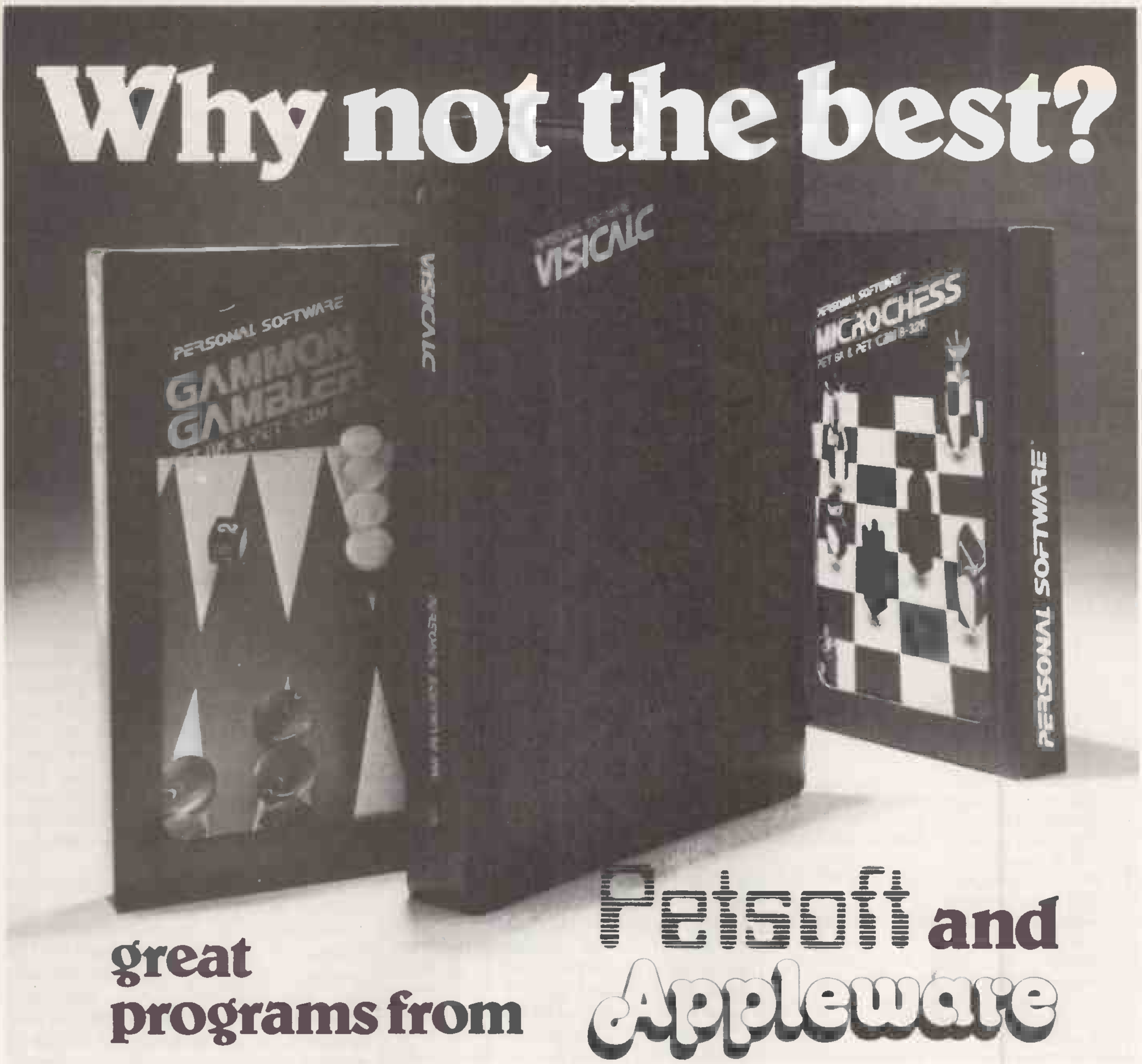
The uncouplers were positioned close to the truck-code sensors so that when a particular truck had been located by a sensor, the plate on its underside was positioned above the associated uncoupler. The precise stopping position depends on:

- The speed of the train, because of the extra stopping distance at higher speeds. Consequently, the Locate command operated at a fixed speed.
- The length of the train, because of the

(continued on page 99)

Figure 5.





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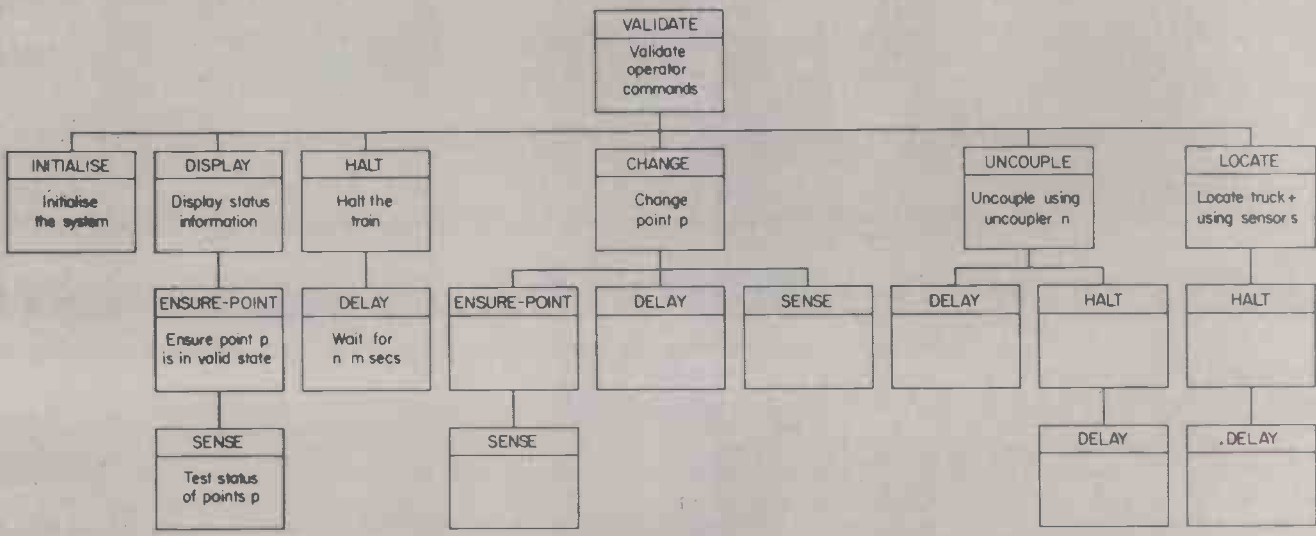

Figure 6.

(continued from page 97)

slack in the couplings. A truck at the end of a long train will stop somewhat further from the sensor than one near the engine, because of the slack being taken up in each of the couplings contributes more in the former case. The effect was overcome by reducing the slack in the couplings themselves, and by making the plate underneath the trucks long enough to cover these variations.

A working system has been implemented; it allows the basic operations listed to be controlled by an operator via the computer. In this minimum system, certain situations are left to the good sense of the operator, for example, checking whether the train is standing on a point before requesting the point be changed.

The programs, written in Z-80 assembly language, were developed on a Zilog MCZ-20 computer, and the object code was loaded from disc into the memory nof the Cromemco Z-2 computer by a loader program residing in the Z-2. That method was adopted because the Z-2 lacked disc storage.

Using structured English, one can start off at a high level using general English, identifying what needs doing; gradually expanding and adding more detail one ends at a lower level with a specification of how to achieve the requirements, in sufficient detail to be implementable on a computer.

It assists the designer in the development process in that he can express his ideas in whatever level of detail is appropriate, while allowing him to change his ideas easily.

The specification of the train-control program is independent of the language in which the programs will be written. Obviously, the specification lends itself more readily to being implemented in a structured language such as Pascal; however, with little more effort in translation, the programs can be written in Basic or assembly language.

Indeed, the programs for the train system were written in assembly language.

Global variables

Speed	:A speed between "1" and "4" (1 = slowest, 4 = fastest) or "0" = stopped Set in Validate
Motor	holds information used by clockserve to determine whether the motor should be on or off during the next millisecond interval Set in Validate
Direction	:"F" = Forwards or "B" = Backwards. Set in Validate.
Forward-Restriction	Set to on in Clockserve when the train breaks end-of-track sensor 1 (EOT-1), the train may now only travel backwards (until the restriction has been cleared to off in Validate
Backward-Restriction	Set to on in Clockserve when the train breaks end-of-track sensor 2, EOT-2; the train may now only travel forwards until the restriction has been cleared to off in Validate
Hold	contains the number of milliseconds which must elapse before some operation may proceed. It is decremented by one every millisecond in Clockserve until it reaches a value of 0 In effect, it provides a delay mechanism, e.g. delay for 50 mseconds would invoke the procedure Delay, defined as Set Hold to required delay (50) wait until Hold = 0
Aborted	:A logical variable used to indicate that the Locate operation currently being undertaken should be discontinued. The reasons may be: 1. The operator has pressed the ESCAPE key 2. The train has broken an end-of-track sensor Set to true in Clockserve; initialised to false and tested in Locate.

Furthermore, one of the authors, who had not been involved with the design and the implementation of the software, developed a Basic program from the specifications.

- A network chart and a program-structure chart — as described in the NCC data processing documentation standards, but omitting the NCC filing references — to provide the top level of description.
- Structured English — as described by Parkin in Systems Analysis to specify the Procedures. The method is particularly easy to modify and maintain. The rules are very simple — the procedure is described in natural language, but the control structures are limited to those compatible with structured programming. The specifications will take the form of sequences of natural constructions or case constructions, under the control of expressions such as while condition; until condition; repeat n times, etc.
- The scope of a control loop or condition is shown by indenting the subordinate statements by a few spaces. At the end of the controlled or conditioned statements, the indentation is dropped. An else is always lined-up with the if or other conditional expression which it matches. Arbitrary subroutines are created, as desired, by the use of underlined phrases.

References

Micro drives a train, Practical Electronics, August 1979, 42-43
Model train control system, Electronics Today International, November 1979, 42-56
Data Processing Documentation Standards, NCC, June 1977
Systems Analysis, Andrew Parkin. Edward Arnold, 1980

The adage, garbage in, garbage out, is only too true. Garbage prevention and destruction are essential skills of the good programmer. In this article, A Sandison describes some of the techniques he has devised which can save a good deal of programming time.

Garbage destruction is essential programming skill

SILLY RESULTS give computerised operations a bad name and arise partly from the programs and partly from the data on which they work. Garbage produced during program development reveals the bugs which take a good deal of time to remove.

Two errors which I have now learned to look for relate to those ephemeral variables used as temporary flags of interest only within a few lines of the program.

Unexpected results

Failure to empty them after use can produce unexpected results when they are next re-used. It is now almost automatic for me to write 'Z$ = "":INPUT Z$': this copes with pressing the return key without an input.

The other associated fault is to forget that the same variable is being used ephemerally both in the main program and in a subroutine within it. Each works well in isolation, but they produce garbage when combined. I usually use Z for ephemerals; converting the Zs in one routine to Zls will often remove a bug.

Program errors more likely to find their way through into the final stages arise when variables have unexpected values like 0 or —1. It is the failure of a program to provide for zero values which produces the final demands asking for payment £0,000.0 within seven days.

String handling programs crash with a syntax error if you ask for LEFT$(A$,—3). If your Basic has a MAX(,) instruction, this can be prevented by writing LEFT$(A$,MAX(0,Z)). If not, check carefully all the IF statements in the calculation of that Z to make sure that you have provided one 'IF Z 0 THEN ...'.

Wise procedure

That special check of all the IFs for unexpected values is, of course, always a wise procedure during program development.

It is the elimination of garbage from data with which I am really concerned. Keying errors during data entry are so numerous that it is asking for trouble not to include checking routines in any program of any importance. If you do not believe that, count the number of times you use the backspace key, which is the first such precaution.

Useful interval

For extensive data entry, it is wise to allow an interval between the original entry and the check, so that the eye can forget how it misread the handwriting last time. I, therefore, display data in suitable batches, either from arrays in RAM or by recall from disc or tape. Arrays can be easily displayed and faulty lines rewritten:

```
200 REM Array validation
210 FOR I = 1 TO N
220 PRINT "Item No.";I;" — ";A(I)
230 NEXT I
240 INPUT "ENTER Line No. for correction
    or '0'";Z
250 IF Z = 0 RETURN
260 IF Z > N OR Z<0 PRINT "ERROR. —
    Re—";:GOTO 240
270 INPUT "ENTER Correct Value ";A(Z)
    GOTO 210
```

Multiple statements

This program is, for brevity, written with multiple statements on one line, separated by colons, and with IF OR THEN statements. if your dialect does not permit these, translation should not be difficult.

An alternative, and often safer, approach is to re-enter the data and to let the computer check that it agrees with the first version, as:

```
300 REM Data array Re-entry validation
310 PRINT "Re-enter the data item by item,
    for validation"
320 FOR I = 1 TO N
330  PRINT "Enter Item ";I;" — ";:INPUT Z
340  IF Z = A (I) THEN 400
350  PRINT "It was ";A(I);" last time :";
360  INPUT "RE-ENTER Correct value ";Y
370  IF Y = A(I) THEN 400
380   A(I) = Y: IF Y = Z THEN 400
390    PRINT "That was different from both":
       GOTO 360
400 NEXT I
410 PRINT "All data has now been entered
    twice as the same value":RETURN
420 RETURN
```

Both those routines work equally well with string variables as with numeric data, but it can be tedious to re-type a long line just to correct one letter. Routines to re-type only the wrong ones and their replacement are straightforward. They are written most easily if your Basic has a string search command, such as the INDEX (A$,B$) of Micropolis Basic and POS (A$,B$) of Cromemco 16K Basic.

First character

They search A$ and return the position of the first character of B$, if it is there, or zero if it is not. Using index, a routine to replace X$ by Y$ is:

```
500 REM String editing
510 PRINT A$
520 INPUT "ENTER the 'Wrong' characters
    or '0' if all OK ";V$
530 IF V$ = "0" RETURN
540 Q = INDEX (A$,V$)
550 IF Q = 0 GOTO 590
560  INPUT "ENTER the Replacement
     characters ";W$
570  A$ = LEFT$(A$,Q—1) + W$ + MID$(A$,
     Q + LEN(V$),250)
580 GOTO 510
590 PRINT:PRINT " 'Wrong' chctrs NOT
    present. RE—";:GOTO 520
```

This routine, of course, finds and replaces the first occurrence of the wrong characters, sometimes with unexpected results if you meant to replace the second. That is why it loops back to display the corrected string. Thus attempting to replace "to" by "too" in the sentence, the total is to high, will produce, the total is to high.

If forewarned, it can be avoided by lengthening the string to be replaced until it is unique in the sentence, as "to" or "to". I have one file of several thousand figures some bits of which are many of zeros.

Validation routines

Despite validation routines, I occasionally realised that I had passed and filed as correct a line which was not. The file records included some unnecessary but easily-recognised identification characters and I applied an editing program to the file on disc. To change the 20th zero in one record, it was necessary to change the first 19 to X, the 20th to 7, and then change the 19 Xs back to zero.

Replacement string

By modifying the editing routine, it can replace all occurrences of the wrong string, but it is necessary to guard against the loop re-cycling indefinitely if the replacement string should contain the wrong string, as in changing "to" to "too", or attempting to replace one space after each full stop by two. The following routine will avoid that:

```
600 REM Global string replacement
610 INPUT "ENTER the 'Wrong' characters
    ";X$
620 X=LEN(X$)
630 INPUT "ENTER the Replacement
    characters ";Y$
640 INPUT "To replace ALL or SOME
    occurrences, ENTER 'A' or 'S' ";R$
650 IF R$<>"A" AND R$<>"S" PRINT:
    PRINT "ERROR":GOTO 640
660 REM Obtain here the lines for checking
670 GOSUB 690
680 RETURN
690 B$=A$:A$="":A=0
700 Q=INDEX (B$,X$)
710 IF R$="S" THEN 790
720  IF Q=0 A$=A$+B$:GOTO 770
730  A=1:REM Flag that line changed
740  A$=A$+LEFT$(B$,Q—1)+Y$
750  B$=MID$(B$,Q+X,250)
760  GOTO 700
770 IF A=0 PRINT X$;" not present":
    RETURN
780 PRINT "' ";X$;" 'replaced by' ";
    Y$;" '":RETURN
790 IF Q=0 A$=A$+B$:GOSUB 510:GOTO
    870
800 A$=A$+LEFT$(B$,Q—1)
810 B$=MID$(B$,Q+X,250)
820 PRINT A$:PRINT TAB LEN(A$)+1;X$
    PRINT TAB LEN(A$)+X+1;B$
830 INPUT "Replace or Not: ENTER 'Y'
    or 'N' ";Z$
840 IF Z$<>"Y" AND Z$<>"N" PRINT:
    PRINT "ERROR":GOTO 830
850 IF Z$="Y" A$=A$+Y$:GOTO 700
860  A$=A$+X$:GOTO 700
870 RETURN
```

That builds a new version of A$ from the parts which have been checked and then checks the remainder left in B$. Line 800 displays the faulty characters on a separate line from the rest of the sentence so that there can be no doubt which parts are suspect.

Lines 750 and 760 report on the examination of each line as to whether it was clear or that X$ is now Y$. That eliminates those anxious minutes watching an inactive screen wondering whether the program is working properly. Yet, more important, it has enabled me to spot that unintentional changes were occurring because more lines were being altered than I expected.

Index function

If your Basic dialect lacks the equivalent of the index function, the procedure is still possible, but more tedious. Replace lines 540 or 700 by the following subroutine:

```
800 REM Substring replacement
810 Z=LEN(X$)
820 Q=1
830 Z$=MID$(A$, Q, Z)
840 IF Z$=X$ RETURN:REM Q is now the
    position of X$
850 Q=Q+1:IF I<=LEN(A$)—Z THEN 830
860 Q=0:RETURN
```

Routines of this kind lie at the heart of most text editing programs. Unfortunately, word-processing packages tend to have their own file structures not easily amenable to processing by programs in Basic. For that reason, a text editing program in Basic is worth developing.

Automatic correction

My own, written in Micropolis Basic, I find quite invaluable for checking correcting and updating files on disc, whether numerical or textual. One application which I have incorporated into my document-writing program is the automatic correction of my favourite spelling mistakes.

I am surprised that a facility for doing that is not incorporated into word-processing packages.

Some Basics, e.g., North Star, use substring instructions which look like arrays, so that B$(1,5) is the equivalent of LEFT$(B$,5) — see line 740 — and B$(5) is the equivalent of RIGHT is the equivalent of RIGHT$(B$,LEN(B$) —4) or the MID$(B$,5,250) in Micropolis Basic as used in line 810. Once again, translation of my routines into other dialects should not be difficult.

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Working with the first prototype of Tuscan

Having encoded the ROMs, Mike Hughes takes delivery of the prototype.

WHILE THE prototype artwork was being converted into the printed circuit board, I had to turn my hand to more paper work and some mental acrobatics — all the specialised read-only memories had to be programmed.

Readers who have followed the series from the beginning will remember that the CPU-to-S-1000 interface required three ROMs to provide the Status, Control and DMA decoding; a further ROM is needed for the VDU control system and another for the character generator.

On top of those, I required some simple yet reliable system firmware which would have to be burned into a 2516 EPROM. It would present no problems because Transam would be able to re-locate and carry-out a few simple modifications to one of our Triton monitors. Although that would be written in 8080 code, it would be readable by the Z-80 and allow sufficient communications with the system to allow further software to be entered by hand. The VDU control ROM would be the same as used in Triton so no extra work would be needed in that direction.

Character generator

That left the S-100 interface ROMs and the character generator. The most difficult of those to formulate would be the Status and Control decode devices. Not only would these be difficult to encode but I would have to be 100 percent sure that they were correct if I was to stand any chance of testing the prototype machine — one bit in error and I would be faced not merely with a software bug but the machine would not operate.

That was the one major worry I had. By using firmware of that type to control the hardware system, it would be very difficult to tell, in the event of the system failing to operate, if the error was in the ROMs or the printed circuit wiring.

To be as near sure as possible that the programs for the ROMs were correct, I decided to generate them by computer using Triton. By generating them within the Triton memory, I would be able to peform logic simulation trials on the codes for every possible Z-80 signal condition. Once checked and verified, I would be able to get a print-out listing and save the programs on tape. That tape would be used eventually to convey the data straight into the Transam ROM burner — obviating any possibility of errors being introduced by keystroke blunders.

If one considers four of the Z-80 control signals — $\overline{WR}$, $\overline{RD}$, $\overline{M1}$ and $\overline{IORQ}$ — it is possible to convert them into the basis of four S-100 signals by combinational logic gating. The S-100 signals I shall use in this example are SOUT, SINP, PDBIN and SINTA.

SOUT goes to logic level 1 when the CPU is outputting to a port and the Z-80 indicates this condition by making the $\overline{WR}$ signal go to 0 at the same time as the $\overline{IORQ}$ signal is forced to 0. The logic of this can be more simply written as:

SOUT is "1" WHEN $\overline{WR}$ is "0" and $\overline{IORQ}$ is "0"

LOCATION	ADDRESS				DATA			
	$\overline{WR}$	$\overline{RD}$	$\overline{MI}$	$\overline{IORQ}$	SOUT	SINP	PDBIN	SINTA
1	0	0	0	0	1	1	1	1
2	0	0	0	1	0	0	1	0
3	0	0	1	0	1	1	1	0
4	0	0	1	1	0	0	1	0
5	0	1	0	0	1	0	1	1
6	0	1	0	1	0	0	0	0
7	0	1	1	0	1	0	0	0
8	0	1	1	1	0	0	0	0
9	1	0	0	0	0	1	1	1
10	1	0	0	1	0	0	1	0
11	1	0	1	0	0	1	1	0
12	1	0	1	1	0	0	1	0
13	1	1	0	0	0	0	1	1
14	1	1	0	1	0	0	0	0
15	1	1	1	0	0	0	0	0
16	1	1	1	1	0	0	0	0

Table 1.

In a similar manner, one can evolve the logic of the other signals — equating them in terms of the Z-80 control signals:

SINP is "1" WHEN $\overline{RD}$ is "O" AND $\overline{IORQ}$ is "O"

PDBIN is "1" WHEN $\overline{RD}$ AND $\overline{IORQ}$ are both "O" OR $\overline{M1}$ AND $\overline{IORQ}$ are both "O"

SINTA is "1" WHEN $\overline{M1}$ AND $\overline{IORQ}$ are both "O"

There are 16 possible combinations of logic levels one can have for the four signals WR, RD, M1 and $\overline{IORQ}$. These signals could be used, therefore, to address a memory having 16 locations each of which would contain a four-bit byte. If each bit of the memory bytes were to represent the signals we required, SOUT, SINP, PDBIN and SINTA, we could draw a table showing the 16 combinations of the addresses and insert ones in the respective bits of the bytes which correspond to the address signal conditions as defined in the logic table. When all the ones had been inserted, the rest of the bits would, of necessity, be zero — table 1.

By referring to table 1, it can be seen that the data contained in each memory location will provide the correct level for the S-100 output signal when that address is generated by the corresponding Z-80 control signals.

For example, look at the data bit corresponding to SOUT. It is at logic level 1 whenever $\overline{WR}$ is 0 and $\overline{IORQ}$ is 0 and those conditions occur for locations 1, 3, 5 and 7. By checking through the logic statements for the other three S-100 signals, you can see that the data contained in the memory would generate those signals as well.

As I explained in an earlier instalment, I was able to execute the PCB design without having to worry about which output pin or address pin of the ROMs carried which signal because it could be taken into account when writing the program.

When looking at table 1 it is excusable to think that the right-hand column of the data, i.e., SINTA, represents the least significant bit of the four-bit byte. That does not have to be the case and the four data columns can be interchanged in position provided one knows which is which and, more importantly, which pin of the package carries that particular data bit. The same also applies for the address lines.

Pin organisation

All one has to do now is re-organise the sequence of address and data bits to correspond with the pin organisation of the package and ensure that the correct data is written into the correct location.

The ROMs used in Tuscan had to be considerably more complex than this example because I would be using at least six source signals for the addresses and had to generate 11 S-100 signals from them. Nevertheless, the principle is exactly the same. Once the concept is understood, it is a simple operation to do the coding but as one can see there is plenty of opportunity for a careless mistake.

I was very glad I used computer simulation to check the codes because I had already calculated them manually and was relying on the computer to confirm that all was well. As it turned out, I had made a silly mistake by the manual method — transposing two bits — and the computer simulation spotted it.

Compared to the interface ROMs, work on the character generator was great fun — albeit very time-consuming. Having learned a lesson on Triton, I had made sure that I would use a more logical organisation of addresses for the Tuscan VDU.

This time, I made the top seven address lines define the ASCII characters, 128 of them, while the bottom three lines would address the picture point rows for each character, eight of them for each character. I would require eight picture points in each row hence the choice of a 2708 EPROM which contains 1K by eight-bit bytes. By definition, I made a logical 1 represent a bright picture point and 0 a dark screen.

Picture points

All one had to do was sit down with squared paper and work out the patterns of picture points and convert them into corresponding binary codes in a form which would suit the VDU control chip. The 96364 has a peculiarity in that anything appearing in the top row of the picture point cell, which makes up the character, is repeated in the bottom four rows.

Between those two, there sits a further seven rows making up a total of 12 rows as seen on the screen but, because of the repetitive operation on the top row, it is necessary to produce only eight rows' worth of picture point data. Each character cell for the 96364 is eight picture points wide and that corresponds perfectly to the eight-bit wide data held in the EPROM.

The letter "A" as seen on the TV screen within its character cell would appear thus:

```
...........@........
.........@... @.....
......@.........@...
......@.........@...
......@@@@@...
......@.........@...
......@.........@...
```

A dot represents a dark picture point while '@' represents a bright point. To encode that, one has to convert the dots to 0 and the @ symbols to 1 and the bottom four lines can be ignored because they will automatically be repeats of the first. Encoded in binary and Hexadecimal, the letter A would be represented as follows:

Binary	Hex
00000000	00
00001000	08
00010100	14
00100010	22
00100010	22
00111110	3D
00100010	22
00100010	22

Letter "A" has the ASCII code 41H hence the seven high-order bits of its address in the EPROM must define that code — in binary this is 1000001. A further three address bits are used to identify each row of picture points hence the addresses which contain codes for the letters "A" and "B" and the codes contained therein — with graphic representation — table 2.

Those examples fall roughly in the middle of the EPROM memory map and in practice, a full 128 characters had to be encoded in this manner, starting at address 000 in memory running right way through to 3FF encompassing the full ASCII upper- and lower-case character sets, all punctuation and a selection of special graphics characters.

Although tedious, it is very easy to do the encoding and it is a very straightforward operation to produce customised character sets for foreign languages or other scientific applications.

By the time all the ROMs had been encoded and burned-in, the first prototype PCB had arrived back from the manufacturers. I have never been able to suppress the exciting anticipation of seeing the end product of months and months of painstaking work and it is always a thrill to see a crisp new PCB glistening with fresh electrolytic solder tinning. Invariably, the final board tends to look much more compact and neat and tidy as a result of the photo-reduction from the four-times life-size artwork.

Before attempting to solder any components into place, I had to check all closely spaced tracks for leakage and short circuits — possibly caused by under-etching in the processing or blemishes on negatives. I invariably do that for a new prototype. Although a tedious job, it saves a good deal of time in the long run — one of the most difficult problems to pin-point in an assembled computer is a bridge between two busbar tracks.

At the same time, I had to do a thorough check on all the drilled holes to make sure none had been omitted — particularly where the plating through was carrying signals or power from one side of the board to the other. I was lucky — there were no obvious shorts but I had gained two or three extra holes where they were not expected and a couple of tracks were found to be missing on my original artwork.

All those points were noted so that the PCB manufacturers could re-program their drilling machine and I could up-date the artwork for, what would have to be, a second prototype in due course.

Logical sequence

Fortunately, none of those errors would prevent my using the first board to test the circuitry, so the slow and careful job of checking the prototype design began in earnest.

The temptation I had to resist was that of treating the system as one would a fully-proved kit — there was no absolute certainty that it would work. I had to check each stage bit by bit which involved assembling the system a little at a time, hooking-up to the temporary power supply and testing each stage before moving on to the next.

My approach is to jot down a logical sequence for the first assembly and take plenty of time in analysing each step. The order I chose was:

1. A dry run of the bare PCB on the power supply to check that correct power was available at all the respective IC pins.
2. Check the master clock for operation.
3. Check all the clock dividers.
4. Check that the VDU operated by entering data manually.
5. Check for a correct power-on re-set pulse.
6. Insert the Z-80 and check that there was some life present — indicated by wild running of the address lines.
7. Insert the complete CPU circuitry and check that all address, data and control busbars were carrying signals — even though these would be wild owing to there being no memory present at that stage.
8. Add all address decoding, power-on jump system, monitor EPROM and sufficient RAM to create a stack to check that the system would initialise.

(continued on next page)

Table 2.

ADDRESSES In Binary ASCII CODE	ROW CODE	FULL ADDRESS In Hex	DATA Binary	Hex	REPRESENTATION
1000001	000	208	00000000	00	....
1000001	001	209	00001000	08	...........@.........
1000001	010	20A	00010100	14	.........@...@......
1000001	011	20B	00100010	22	......@.........@...
1000001	100	20C	00100010	22	......@.........@...
1000001	101	20D	00111110	3D	......@@@@@...
1000001	110	20E	00100010	22	......@.........@...
1000001	111	20F	00100010	22	......@.........@...
1000010	000	210	00000000	00	....
1000010	001	211	00111100	3C	...... @@@@.....
1000010	010	212	00100010	22	......@.........@...
1000010	011	213	00100010	22	......@.........@...
1000010	100	214	00111100	3C	......@@@@.....
1000010	101	215	00100010	22	......@........@...
1000010	110	216	00100010	22	......@.........@...
1000010	111	217	00111100	3C	......@@@@.....

(continued from previous page)

9. Add a keyboard and test communications with the system.
10. Once communication had been established sequentially test all memory locations and ports under the control of the test monitor.
11. Add the RS232 driver/receiver and MODEM circuitry and test.
12. Add the interrupt encoder circuitry and test with simple interrupt-driven programs.
13. Test the system-mode select switches to ensure they had the correct sense and that the EPROM mask switch operated correctly.
14. Add various S-100 cards up to a full busbar loading to check a complete system.

As most of my designs are aimed at the home constructor, I make copious notes of any problems which might create practical difficulties in assembly so that they are not overlooked when the final instruction manual is written.

With this plan devised, a soldering iron, notepad, oscilloscope, frequency meter and DVM all to hand, I started. Disaster struck at the second stage — the master clock IC refused to oscillate. The incredible thing was that the only components involved were the IC itself, a crystal and a capacitor and it only goes to show how easy it is to make a silly mistake.

Inadvertantly, I had used an IC for the clock from a manufacturer whose version will not operate from a single 5V supply rail. Easily said now, but it took a long time to realise the error; nevertheless, that was going to be a useful comment for the manual.

Single difference

The divider for the VDU source worked satisfactorily but some more trouble arose regarding the divide-by-13 chip for the baud-rate generator. The principle I had adopted involved the truncation of a four-bit divider using a simple diode gate which fed back a crash re-set signal on a count of 13 — a technique I have used many times over with 100 percent success.

The only difference was that in this application, I was using low-power Schottky integrated circuits whereas before I had always used standard TTL for the technique. My first reaction was that it was a timing problem so high-speed diodes were substituted. Still no success, so some breadboarding on the side was called for and here I was in for a great surprise — in no way could I make a 74LS93 reliably truncate its count using a feedback re-set even with the highest-speed components.

A quick dive into the store and a standard 7493 was substituted with instant success. I have subsequently discussed the problem with other engineers and was surprised to find that I am not alone in experiencing it — here was a change in component specification to Transam and a further word of warning for constructors.

To test the VDU required the insertion of all the components for that stage — it had to be tested in its entirety to see any sensible results. My faith in the trusty 96364 was instantly repaid with a rapid display of random characters on a perfectly-locked screen — furthermore the characters appeared properly which indicated my encoding for the character generator EPROM was correct.

By hooking-up eight wires to the eight input bits of the VDU system and bringing them out to a set of breadboard switches, I was able to check all the ASCII codes systematically and in so doing found another anomaly which, after further investigation, showed another short bit of PCB track had inadvertantly been omitted.

Quick patching

Some quick patching and all was well with the VDU apart from a note to alter the coding of the character-generator EPROM to make the font more readable for a few characters.

The power-on re-set pulse was quickly checked and found to be present and of sufficient duration, so now I had to enter more into the realms of the unknown.

On its own, the Z-80 chip showed the important signs of life so, undaunted, the rest of the CPU circuitry was inserted together with all the S-100 buffers and interface PROMs. A check with the oscilloscope showed that most of the S-100 lines of any importance had sprung to life but, of course, with no program or memory present, the CPU was running amuck.

By this stage, even the most die-hard engineer cannot help feeling a little excited as the next step involved the adding of memory and the output port chip to the VDU.

The monitor was inserted, the theoretical power-on jump address selected on the DIL switch and power was applied. Perhaps it was too much to hope for but I had expected the screen to jump into life and display the programmed initialisation message but, alas, all that appeared was the well-established random jumble of characters.

I well remember my heart sinking because this was the big crunch: the problem could have been anywhere; wrong address decoding, an erroneous concept in my novel power-on jump system, busbar problems, missing tracks, shorts between tracks which I had not noticed before or, worst of all a fundamental concept error in using PROMs.

It took many days of methodical work checking, probing and testing when eventually I found that a minor transposition of two high-order address lines to the EPROM address decoder existed — I had put the monitor EPROM into the wrong socket. That had to be the cause of the trouble but with this put to rights the system still refused to initialise.

Nevertheless, the busbar signals started to show more sense and with the help of a borrowed logic analyser I was able to ascertain that the CPU was now addressing the monitor EPROM and receiving its first instruction; the problem seemed to be that it was reading only from memory and at no time did it attempt to write into the stack.

Although the Z-80 was trying to output data to memory the control busbar was not carrying the necessary signal to generate the required memory-write signal. The problem seemed to be associated with the status latch following my status decode ROM.

It was by a lucky chance, or maybe sixth sense, that I double-checked the number on my status latch and noticed that it was a 74LS374. At first, it did not convey anything because it is a perfectly normal edge-triggered latch and many of them were to be used in the Tuscan system. It took some time for me to remember my own design requirement that this chip had to be a transparent latch and not one of the edge-triggered variety to overcome certain pulse race problems which I had anticipated might exist.

Exhilaration

It was pure carelessness on my part; I had inserted a 74LS374 when it should have been a 74LS373. That might have been a very understandable error for anyone other than myself.

A quick change of the offending chip, re-application of power and, miracle of miracles, the screen cleared and the monitor initialisation message appeared up bold and clear. To say I was surprised would be wrong but only those who have worked through a system like Tuscan from start to finish over a period of 12 months or so can understand the feeling of exhilaration when the system jumps into life.

From that moment on, it was plane sailing; the keyboard interface worked and communication was established with the system. Echo tests confirmed that the RS-232 interface was working as was the MODEM.

No other PCB track problems were encountered but I found I had under-estimated some of the auxiliary supply currents from the on-board zener diode sources — they would have to be changed for IC voltage regulators.

During running up I had noticed a few areas on the board which could have been better laid-out so it only remained to return to the artwork and make a few amendments before putting things in motion for a second prototype.

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Low-cost memory expansion for Nascom 1

John Dawson describes an expansion RAM board for the Nascom computer.

THERE ARE many attractions in having a larger memory for the Nascom 1 — larger programs can be written in any language. A print program, *Practical Computing*, July 1980, can be held in an increased memory and called by other programs which would otherwise fill the unexpanded RAM, and more than one screenfull of information may be held ready for immediate access.

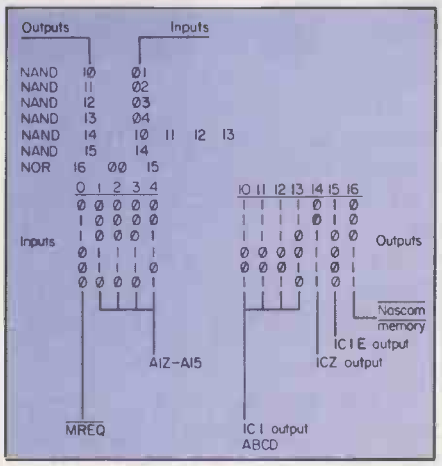


Figure 4.

Although the board which is the basis of the article has only 2K of RAM at present, there is no reason why further 2114 ICs should not be added to give a total of four or six kilobytes.

Each 2114 requires only 10 microamps input current and has a typical output low current of 6mA. The RAM ICs drive only the buffer chips on the buffer board and the other 2114s, if no other boards are plugged into the Nasbus.

The expansion memory board is economical to build and should cost less than £20 for 2K of RAM. A Nascom buffer board kit is necessary. The changes that have to be made to the Nascom main board are described in the booklets accompanying the kit.

The circuit is shown in figure 1a and 1b. One pair of 2114 static RAM chips is shown with connections off the page to subsequent pairs of ICs. ICs one, two and three decode the highest four address lines and are gated with the $\overline{\text{MREQ}}$ signal to enable the internal Nascom memory when locations lower than 1000Hex are addressed.

When locations in the external memory are addressed, the Nascom memory line is high and that signal is gated in IC5b with the inverted RD signal to enable the $\overline{\text{DBDR}}$ line. IC4 decodes the lowest 16K of memory from four address lines.

The lower four outputs are never used as these correspond to the monitor ROM, 2K, video RAM, 1K, and user RAM, 1K, on the main board.

Output for from the 74 LS 154 selects locations 1000 Hex to 13FF Hex and output five selects 1400 Hex to 17FF Hex. From the 16-line decoder, 10 outputs are spare and could be used to enable more 2114 RAM pairs or 2708 1K ROM ICs. The $\overline{\text{WR}}$ line is wired to the write enable ($\overline{\text{WE}}$) pins on all the RAM ICs.

A pin-out chart for all the ICs used on the memory board is set out in figure 2. The ICs are shown from the top, using conventional notation, and care should be taken to reverse the pins from left to right when the IC socket is viewed from the copper/soldering side of the Veroboard. The lay-out used is shown diagrammatically in figure 3. Whatever design is chosen it is vital that the copper tracks are broken between the backplane connector and the pins of the ICs. Terminal pins may be inserted into the tracks that connect to the bus lines set-out in table 1 and it is useful to attach a strip of paper down the board with the function written opposite each pin.

All connections between Nasbus connector and IC sockets must be cut before wiring is started, there are other signals present on the bus that will conflict with the circuitry on the board.

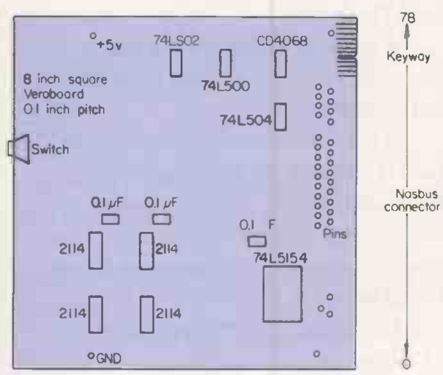


Figure 3.

The board was wired using a Verowire pen and pins broken from a continuous strip for the IC sockets. By the time the board was completed, it was clear that the break-off-as-required type of socket is not good enough for experimental work.

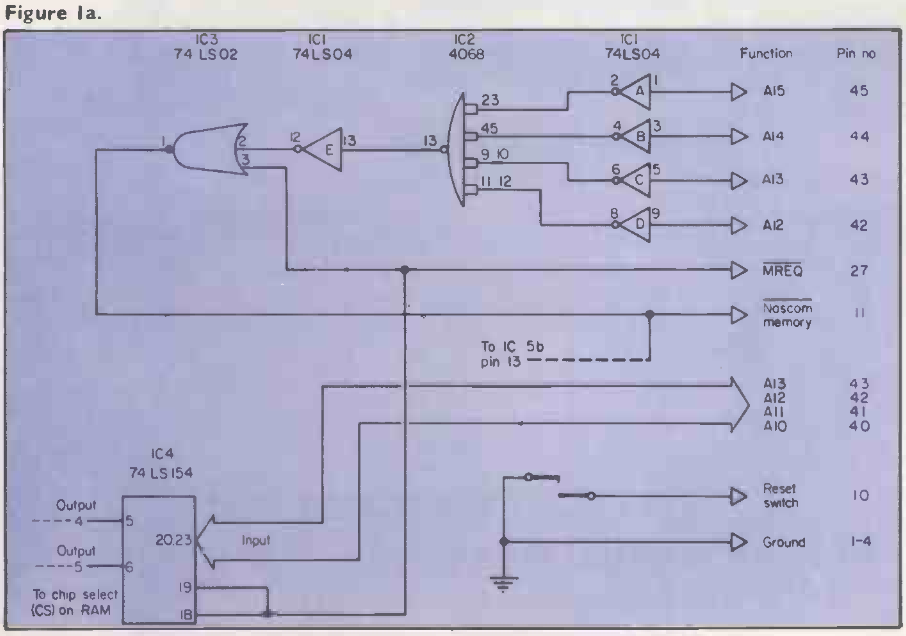
They may be satisfactory for one-time use but are not suitable for a project where re-soldering may be necessary. Sockets save time and help with the wiring in the following way: the Verowire pen has a spool of wire in the handle which is fed through a finger-controlled clamp to a fine nozzle in the tip.

Connections are made by inserting a short length of wire into the hole in the Veroboard containing the socket pin, wrapping two turns around the pin and drawing the pen away. The wire is anchored sufficiently firmly for the pen to be drawn across the board, either directly to the other connection, or by way of plastic combs supplied with the kit.

The combs plug into the board and are valuable for separating and ordering multiple wires such as the address and data buses.

Verowire is covered with a polyurethane

Figure 1a.



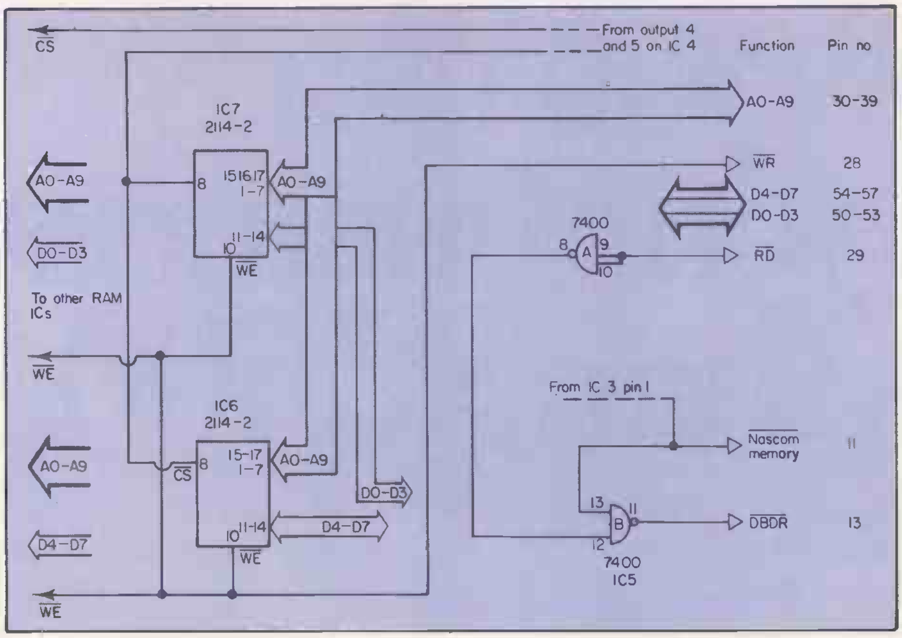


Figure 1b.

insulation which melts slightly below soldering temperatures. The great advantage of that system of wiring is that a joint can be made anywhere along the wire without having to cut and strip in an orthodox manner.

Address lines, for example, have to be connected to two or more RAM ICs. Using Verowire, the pen is simply taken from the terminal pin by the backplane connector, via a comb, to the IC sockets. The wire is wrapped round each of the required pins, held under slight tension while the end joints are made, and then soldered at the intermediate points.

There are two other groups of components on the expansion board. A re-set switch was mounted on the outer edge of the board; with static memory ICs, the new re-set switch is not essential and the main board re-set switch can remain undisturbed. Two or three 0.1 microfarad capacitors were placed across the power lines close to the RAM ICs and the decoding chips.

The + 5 volt tracks were connected together as were the ground tracks to improve the contact with the backplane socket. Power wires to the ICs were made of a heavier gauge than the Verowire.

Terminal pins were placed in the board early in the construction and this made it possible to attach voltmeter and oscilloscope probes to particular lines during subsequent testing. The pattern made by the pins complemented the written information on the paper strip and helped to identify groups of lines. The 78 copper tracks were confusing at times; it is a long count from the bottom of the board without help.

Verowire has one major disadvantage, it is all the same colour. Checking the wiring on the board cannot be done visually and testing with an ohmmeter is the easiest method before the ICs are inserted.

The idea that it should be a simple matter to build an additional memory board for the Nascom was not difficult; the realisation of that idea involved weeks of frustrating trial and error.

After some of the logic errors that appeared in the original design without harm to the Nascom buffer board, the resilience of the circuits to which the RAM board was attached can only be described as marvellous.

With the correct logic established the board worked, to the extent that it allowed locations to be written to and read from although the low byte always returned to an odd number. Odd numbers were returned accurately, even numbers were increased by one.

After spending hours trying to decipher timing patterns on an oscilloscope and changing ICs on the buffer board it seemed that there might be some frightful, lurking dynamic, timing problem impossible of diagnosis without sophisticated test equipment. The answer is obvious now but it took a long time to find the broken wire in data bit 0 in the ribbon cable connecting the buffer board to the main Nascom board.

Since then, the expansion RAM has worked without fault. A printout of the logic emulator program describing the decoding necessary for part of the RAM board is shown in figure 4. The logic emulator effectively fills the user RAM in the original Nascom and the print program is held at 1650 Hex, an unknown address on the original computer.

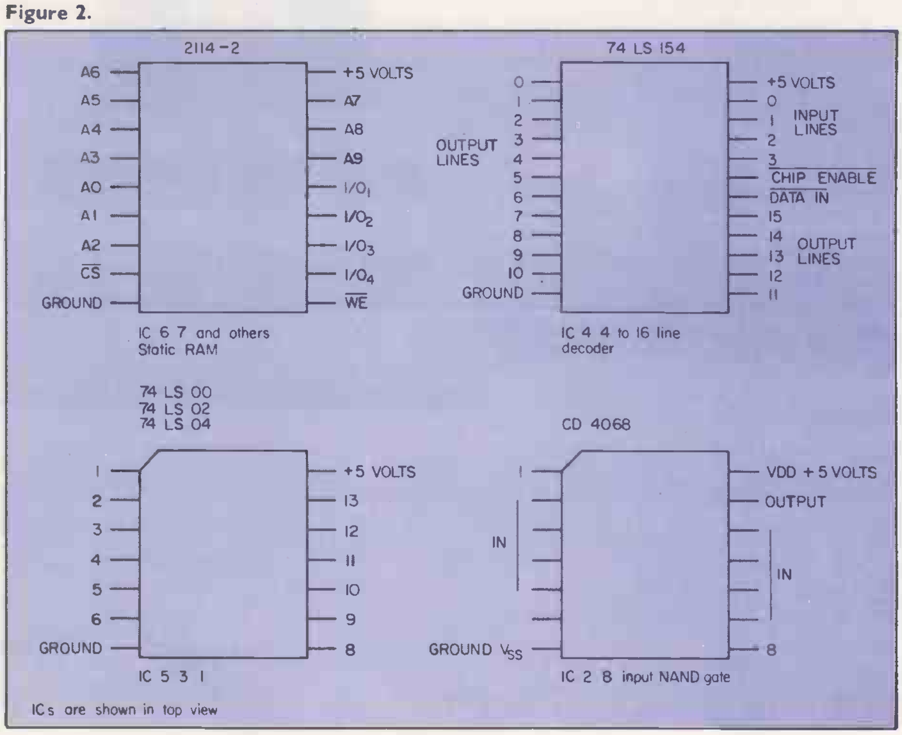
The wiring method has been described in detail as it is an important part of the construction. A wiring pen is the key to the project. Remember to isolate the copper tracks used by each IC pin from opposite pins on the same socket, from neighbouring sockets and from the backplane connector.

Wherever possible, the board was built with parts that were already available. ■

Table 1. Connections to backplane.

Pin	Function
1 - 4	0 Volts — Ground
10	Initiates a system re-set when taken low.
11	Must be taken low on an expanded system when the 4K ROM/RAM on the main board is to be enabled.
13	Must be driven low when the CPU wishes to read data from the RAM on the expansion board.
27	Z-80 Memory Request line.
28	Z-80 Write line.
29	Z-80 Read line.
30 - 45	Z-80 Address bus. A0-A15
50 - 57	Z-80 Data bus. D0-D7
72	Keyway — no connection.
75 - 78	+ 5 Volts — Power

Figure 2.



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Cursor addressing

ONE FEATURE in most Basics on personal computers which is invaluable for games' writers is the Poke statement. Sharp MZ-80K Basic is no exception writes Peter Gardner of Munich, West Germany.

Another feature some rival Basics have, but which the Sharp Basic lacks, is the ability to cursor address, i.e., position anywhere on the screen, the start of a print statement.

Here is a small Basic program for the Sharp SP-5025 Basic — the version most cassette-based users possess — which modifies the Basic interpreter, and then saves the modified interpreter on to cassette for further use.

The modification? To allow you to Cursor Address the start of your PRINT statements, e.g.,

PRINT [10,20] "IN THE MIDDLE"

will put the text "IN THE MIDDLE" at line 10 down, and character 20 across — both counts starting form 0, to be consistent with the set and re-set statements in Sharp Basic.

The positions do not have to be constants — they may be variables — and are checked for correct range — down 0-24, across 0-39.

- Here is the program, the instructions for use are simple.
- Load the Basic SP-5025 afresh.
- Type-in the program and check it carefully.
- Put a blank or unwanted tape into the cassette unit.
- Type RUN.
- If all has gone correctly, you should obtain,

WRITING BASIC SP-5025A

and the interpreter will save its modified self for future use.

- The final check — the program writes finished in the middle of the screen using the newly-Poked code.

```
1 DATA 205,139,22,91,69,28,205,169
2 DATA 25,123,254,25,210,152,19,50
3 DATA 114,17,205,154,22,44,205,169
4 DATA 25,123,254,40,210,152,19,50
5 DATA 113,17,205,154,22,93,195,69,28
6 FORI=15836TO15876:READE:
  POKEI,E:NEXT
7 POKE7221,220:POKE7222,61
8 POKE4354,5:POKE4355,44
9 POKE4350,65:POKE4351,13
10 USR(33):USR(36)
11 PRINT "[C]":PRINT [10,16]
  "FINISHED"
```

Nim in 240 bytes

IN THE version of Nim, the object is to remove the last match writes Andrew Jones of Caldicot, Gwent. There can be up to six piles with up to 15 in each pile; you and the Mk 14 take turns to remove as many as you like from any pile.

To set-up the piles, fill locations OF12—OF17 — RHnd Byte only — with your chosen amounts. Then start the program from OF1A.

The computer will display six piles in the Format 0123 — 45 to remove matches enter pile number and then the number of matches you wish to remove, two matches from LH pile, press 0,2. If you try to remove too many, the computer will not accept it and you must start again.

```
OF12 OX PILE 0
OF13 OX PILE 1
OF14 OX PILE 2
OF15 OX PILE 3
OF16 OX PILE 4
OF17 OX PILE 5
OF19 — COUNT 1
OFF9 — COUNT 2
```

To let the computer try, press MEM at any time — beware of double bounce.

The program deliberately allows cheating. Either you or the computer can go twice so if it catches you early on you can try again.

This program operates on an expansion of that method. It considers the piles in binary format and returns an even number of each bit to you. Thus, given piles containing five, seven, eight and six matches. The computer performs an XOR instruction on them to discover which bits are uneven.

```
        0101
  XOR   0111
  XOR   1000
  XOR   0110
  GIVES 1100
```

The computer tries to remove those uneven bits by XORing them with each pile in turn until the new number is less than the old one. It, therefore, XORs 1100 with 1000 to give 0100 and all the bits are now even and you have lost.

OF1A	SET(H)	C401	LDI 01	Initialise p2 to RAM
O F 1 C37		XP-AH(3)	& P3 to monitor display	
OF1D		C4 OF	LDI OF	
OF1F		36	XPAH(2)	
OF20	SET( )	C4 3F	LDI 3F	
OF22		33	XPAL (3)	
OF23		C4 00	LDI 00	
OF25		32	XPAL(2)	
OF26	SET (D)	C2 12	LD(2)	Place piles in seg:-
OF28		1E 1E	RR, RR	addresses (adh, adl & word)
OF2A		1E 1E	RR, RR	
OF2C		E2:13	XOR(2)	Combine piles 0&1 then store
OF2E		CA OE	ST(27	In adh
OF30		C2 14	LD(2)	Combine piles 2 & 3
OF32		1E 1E	RR, RR	Store in adh
OF34		1E 1E	RR, RR	
OF1A	SET(H)	C401	LDI 01	Initialise p2 to
OF1C		37	XPAH(3)	RAM & P3 to
OF1D		C4 OF	LDI OF	monitor display
OF1F		36	XPAH(2)	
OF20	SET( )	C4 3F	LDI 3F	
OF22		33	XPAL (3)	
OF23		C4 00	LDI 00	
OF25		32	XPAL(2)	
OF26	SET (D)	C2 12	LD(2)	Place piles in
OF28		1E 1E	RR, RR	seg: addresses,
OF2A		1E 1E	RR, RR	(adh, adl & word)
OF2C		E2:13	XOR(2)	Combine piles
OF2E		CA OE	ST(2)	0&1then store in adh
OF30		C2 14	LD(2)	Combine piles 2
OF32		1E 1E	RR, RR	& 3 store in adh
OF34		1E 1E	RR, RR	
OF36		E2 15	XOR(2)	
OF38		CA OC	ST(2)	
OF3A		C2 16	LD(2)	Same for piles 4&5
OF3C		1E 1E	RR, RR	Store in word
OF3E		1E 1E	RR, RR	
OF40		E2 17	XOR(2)	
OF42		CA OD	ST (2)	
OF44	D,MOVE	3 F	XPPC(3)	Display lines
OF45		90 1B	JMP	To check
OF47		40	LDE	LD displacement
OF48		CA 55	ST(2)	Store in TT
OF4A		CA 5D	ST(2)	Store in UU
OF4C		8F FF	DLY	
OF4E		3F	XPPC(3)	Display again
OF4F		90 11	JMP	To check
OF51		C4 12	LDE 12	Set P2 to piles
OF53		32	XPAL(2)	
OF54		C2 TT	LD P(2)	Load chosen pile
OF56		03	S C L	
OF57		78	C A E	Remove amounts chosen
OF58		94 02	JP	OK
OF5A		90 02	JMP	Too many, try again
OF5C		CA UU	STP(2)	Alter piles
OF5E		8 F FF	DLY	
OF60		90 BE	JMP	To set (L)
OF62	CHECK	C4 12	LDI	Set P(2) to piles
OF64		32	XPAL(2)	
OF65		C4 00	LDI	Set VV to zero
OF67		C8 07	ST	
OF69		01	XAE	Zero extension
OF6A		C4 FF	LDI	
OF6C		C8 15	ST	Store in WW
OF6E	C PILE	C2 vv	LD(2)	If any left in piles
OF70		98 04	JZ	then let extension
OF72		70	ADE	= extension + piles
OF73		01	XAE	
OF74		A8 OD	ILD	Increment WW
OF76		A8 F8	ILD	Increment VV
OF78		E4 06	XRI	All piles checked?
OF7A		98 02	JZ	Yes
OF7C		90 FO	JMP	No goto cpile
OF7E		40	LDE	All matches gone?
OF7F		98 4F	JZ	Yes goto I lose
OF81		C4 WW	LDI	1 pile left?
OF83		98 51	JZ	Yes, goto I win
OF85	CMOVE	C2 00	LD(2)	Calc what to remove
OF87		E2 01	XRO(2)	
OF89		E2 02	XRO(2)	
OF8B		E2 03	XRO(2)	
OF8D		E2 04	XRO(2)	
OF8F		E2 05	XRO(2)	
OF91		98 15	JZ	Comp losing Goto clvr
OF93		01	XAE	place amounts in extension
FO94	CHSE	C2 00	LD(2)	remove extension from
OF98		60	XRE	first pile large enough
OF97		C8 61	ST	store extension in OFF9
OF99		C6 01	LD@(2)	
OF9B		03	SCL	
OF9C		F8 5C	CAD	Try to remove amount chosen
OF9E		94 02	JP	success
OFAO		90 F2	JMP	No so goto chse again
OFA2		CO 56	LD	LD count off9
OFA4		CE FF	ST @(2)	Alter number in pile chosen
OFA6		90 B8	JMP	Goto set(L) via OF60
OFA8	CLVER	C4 00	LDI	Find largest pile
OFAA		C8 OE	ST	Set xx to zero
OFAC		C4 01	LDI	
OFAE		C8 OD	ST	Set yy to zero
OFBO		C4 06	LDI	
OFB2		CA07	ST(2)	Store in xx
OFB4	AGN	BA 07	DLD(2)	All piles considered?
OFB6		98 OF	JZ	Yes goto rem
OFB8		C2 xx	LD(2)	
OFBA		03	SCL	
OFBB		FA yy	CAD(2)	Old pile still largest?
OFBD		94 04	JP	Yes goto inc
OFBF		CO FC	LD YY	No so replace with
OFC1		C8 F7	ST XX	New largest pile
OFC3	INC	A8 F8	ILD YY	
OFC5		90 ED	JMP	To AGN
OFC7	REM	CO F1	LD XX	Remove 1 from largest
OFC9		C8 02	ST zz	
OFCB		BA xx	DLD(2)	
OFCD		90 D7	JMP	Got set(L)
OFCF		08	NOP	
OFDO	I LOSE	C4 30	LDI	Place "I" in seg store
OFD2		CA F4	ST(2)	
OFD4		90 04	JMP	Goto comm
OFD6	U LOSE	C4 3E	LDI	Place "U" in seg store
OFD8		CA F4	ST(2)	
OFDA	COMM	C4 00	LDI	Set P2 to ofoo
OFDC		32 08	XPAL(2),NOP	
OFDE		C4 38	LDI	Place "lose" in seg stores
OFEO		CA 04	ST(2)	
OFE2		C4 3F	LDI	
OFE4		CA 03	ST(2)	
OFE6		C4 6D	LDI	
OFE8		CA 02	ST(2)	
OFEA		C4 79	LDI	
OFEC		CA 01	ST(2)	
OFEE		C4 00	LDI	
OFFO		CA 07	ST(2)	
OFF2		CAO5	ST(2)	
OFF4		CAOO	ST(2)	
OFF6		3F	XPPC(2)	
OFF7		90D4	JMP	Goto set(L)

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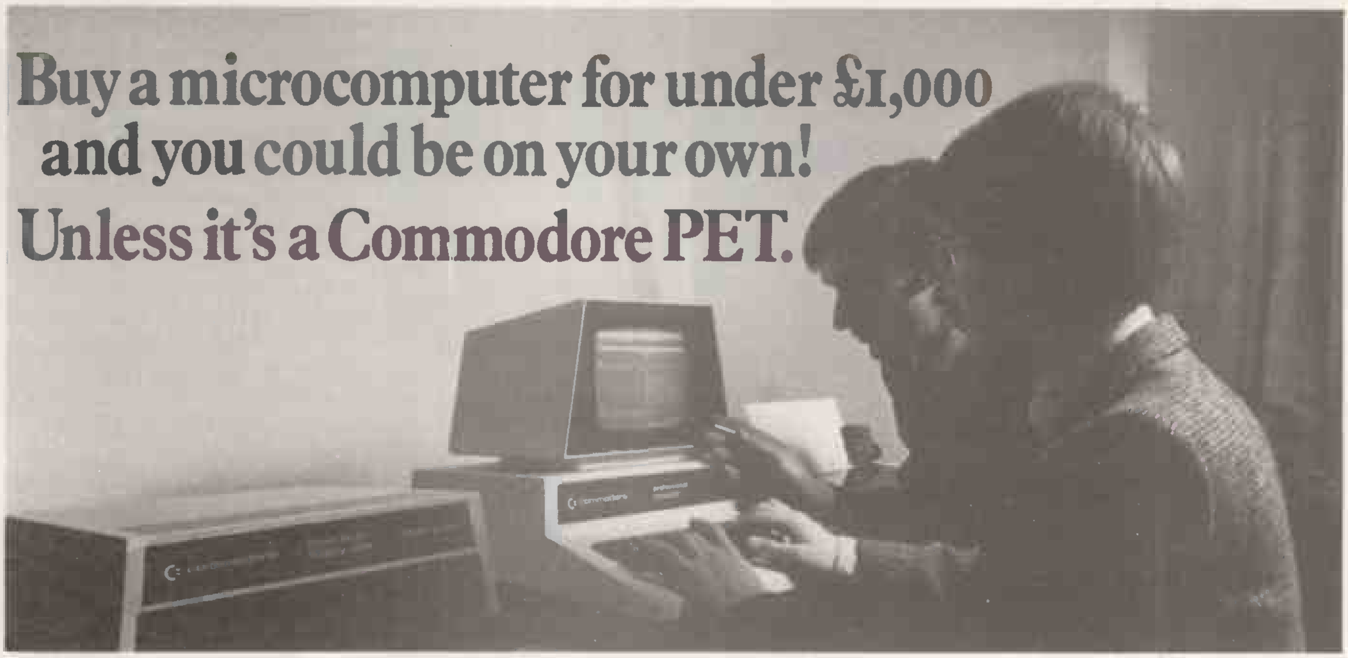

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Memory-mapped access

HAVING experimented with my ZX-80 for a few days, I have developed the following program writes J C Minter of Tadley, Hampshire. It should be of interest since it illustrates the use of the Poke instruction, in conjunction with system variables, to allow memory-mapped access to the screen.

The program clears an area of screen for use by the sketching cursor. Any of the usual characters may be used for drawing, and the cursor may be set to a non-destructive mode.

```
1     CLS
2     LET P=0
3     LET N=0
4     LET SC=0
5     LET L=200
10    FOR X= TO 512
20    PRINT" ";
30    NEXT X
40    PRINT"
50    LET____________________"
      S=PEEK(16396)+PEEK(16397)
      *256+4
100   KNPUT A
105   POKE S,P+N
107   IF NOT SC=0 AND NOT N=0
      THEN POKE, S,SC
110   GO TO 120+A*2
120   INPUT SC
121   GO TO L
122   STOP
130   LET S=S-1
131   GO TO L
132   LET S=S+S+33
133   GO T≥ L
134   LET S=S-33
135   GO TO L
136   LET S=S+1
137   GO TO L
138   LET N=N+128
139   IF N > 128 THEN LET N=0
200   LET P=(S)
205   IF P=3 AND NOT SC=3 THEN
      LET S=S-33
210   POKE S,20
220   GO TO 100
```

When the program is run, there will be a pause after which the screen displays a black line across the screen. The upper half of the division is the memory-mapped area. A numeric input is required, and there are several options available:

1. End program.
5,6,7,8 Move cursor in direction above key.
9 Toggle cursor write/non-destructive mode.
0Accept special character.

When first run, the cursor is in non-destructive mode. It is not initially on display. Pressing 5 then new-line causes it — a "*" — to appear. It may be moved using keys 5-8 — remembering new-line after each command. Command "g" sets the cursor in draw mode. If it is moved in that mode, it leaves a trail. If no special character is in use, anything the cursor passes over will be inverted.

Option "0" sets the cursor to draw with a user-specified character. After "0" is entered, the cursor disappears and another input requested. This should be the code of your required character — see manual, pages 76 and 78. Once entered the cursor will re-appear and any drawing will print your character. To charge the character, use option 0 again. To return to normal mode, select option 0 and give code 0.

At any stage, option 9 will cause the cursor to go non-destructive if in draw mode, or enter draw mode if in non-destructive mode. Option 1 stops the program. Do not go off the screen; you are likely to crash the system. Here is an explanation of certain lines which might not be clear:

Lines 10-40 fill the upper part of the screen with spaces. That is necessary if the area is to be Poked to. Line 40 denotes the bottom of the available area; the graphic character is shift-W.

Line 50 finds the decimal address of the start of the display file, and sets the cursor to just after it.

Lines 105 and 107 place the desired character on the screen depending if you are in ordinary or special character modes.

Line 110 and lines 120-139 control the options.

Line 205 stops you going off the bottom.

Line 210 places the cursor.

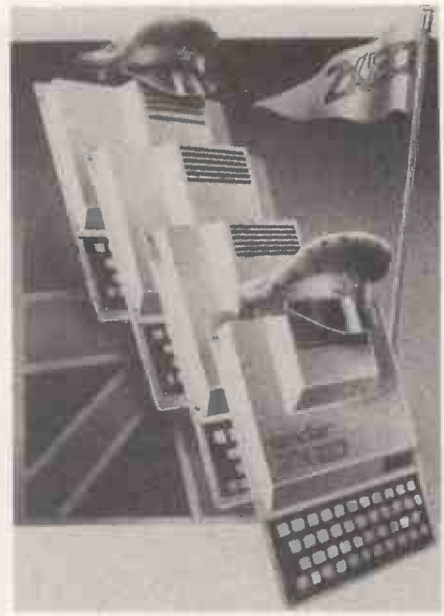
As a final matter of interest, can anyone explain what happens if you do the following? Toggle cursor to draw, select option 0 and define character as 254. Do two cursor-lefts. The effect is not permanent; end the program and re-run will restore to normal. Thanks for an interesting new section in your magazine. Anyone managing, via machine code, to obtain moving graphics, should contact me and tell me how its done.

Life program

HERE IS a listing of Life for minimum ZX-80s sent to us by Peter Ansell of Cambridge. When the program is run, entering co-ordinates of cells — X and Y values separated by new-lines — will cause them to flip states — on to off or off to on.

As each co-ordinate is entered the present cell pattern is displayed. X and Y values must be in the range of one to 13, if a value of X is given as zero then pattern generation begins.

Pattern generation takes two to 40 seconds, depending on how large an area the pattern takes. On large area patterns



at the string input request, the computer may run out of memory, if this happens simply tell it to continue.

The string input is primarily to make the computer pause, but if it receives anything but a null string it will stop, also if there are no cells on the computer stop.

Without major alteration to the program and with memory expansion, it should be possible to allow values in the X direction of one to 32, however, it is not possible to increase the Y range, to this alter the program thus:

```
10 DIM A(33)
20 DIM B(33)
30 LET K= +2
270 LET K=32
580 FOR X=0 TO 33
```

Life

```
10 DIM A(14)
20 DIM B(14)
30 LET K=13
40 LET L=1
50 LET M=K
60 LET N=1
70 INPUT X
80 IF X=0 THEN GO TO 250
90 PRINT X
100 INPUT Y
110 LET A(X)=NOT (A(X) AND 2**Y)
AND (A(X) OR 2**Y)
120 IF X<K THEN LET K=X
130 IF X>L THEN LET L=X
140 IF Y<M THEN LET M=Y
150 IF Y>N THEN LET N=Y
160 CLS
170 FOR Y=M TO N
180 LET Z=2**Y
190 FOR X=K TO L
200 PRINT CHR$(52*((A(X) AND Z)/Z));
210 NEXT X
220 PRINT
230 NEXT Y
240 GO TO 70
250 CLS
260 LET G=K+ NOT K=1
270 LET K=13
280 LET H=L— NOT L=K
290 LET L=1
300 LET 1=M+ NOT M=1
310 LET M=K
320 LET J=N- NOT N=K
```

(continued on next page)

(continued from previous page)

```
330 LET N=1
340 FOR Y=1 TO J
350 LET Z=2**Y
360 FOR X=G TO H
370 LET A=0
380 FOR Q=Y-1 TO Y+1
390 LET R=**Q
400 FOR P=X-1 TO X+1
410 IF A(P) AND R THEN LET A=A+1
420 NEXT P
430 NEXT Q
440 LET B=NOT (A(X) AND Z)=0
450 LET A=A+B
460 IF B AND A=2 OR A=3 THEN GO
TO 490
470 PRINT "";
480 GO TO 550
490 LET B(X)=B(X) OR Z
500 PRINT "0"
510 IF X<K THEN LET K=X
520 IF X>L THEN LET L=X
530 IF Y<M THEN LET M=Y
540 IF Y>N THEN LET N=Y
550 NEXT X
560 PRINT
570 NEXT Y
580 FOR X=0 TO 14
590 LET A(X)=B(X)
600 LET B(X)=0
610 NEXT X
620 INPUT A$
630 IF A$="" AND NOT K L THEN GO
TO 250
```

Thames pilot

ONE OF the attractions of a boating holiday is the escape from schedules and time-tables writes Tim Goldingham of Maidenhead, Berkshire. Once on the river, one becomes oblivious of the passage of time, and the half-hour spent waiting for the lock to open is simply an opportunity for the helmsman to dive into the ice-box for a cold beer.

Nevertheless, practical considerations cannot be ignored. How far can we travel in our week's holiday? If we travel downstream at six knots, and back up at four, where must we turn to be sure of returning by next week-end? How much fuel are we going to use?

Let us see how it works. The mysterious string of numbers at line 20 provides the elements of an array — I am indebted to Clive Davies of Cheltenham who contributed the subroutine at line 600 to the ZX-80 users' club magazine *Interface*.

Each three-digit element represents the time taken to pass between a pair of locks at a speed of one knot. It is calculated by reference to *The Thames Book* — recommended reading for all Thames cruisers — which gives the distance of each lock above Teddington in miles and yards.

Dividing the distance in yards by 2,027 — the number of yards in a nautical mile — and multiplying by 60 gives the number of minutes to cover the distance. Note, the groups of three figures are separated by spaces in the listing, for ease of reading but they must be keyed in as a continuous string with no spaces.

The subroutine at line 600 converts the string into numeric form, and each figure is placed in position in the array. That takes an appreciable time, which accounts for the slight delay between keying RUN and the appearance of the first message.

You can check that you have keyed in the number string correctly by the following procedure:

1 Key in lines 1 to 60
2 Key in the subroutine — 600 to 650
3 Key in the following checksum routine:

```
100 LET A =0
110 FOR X =1 to 22
120 LET A =Z(X) + A
130 NEXT X
140 PRINT A
150 STOP
```

4 'A' Should now be displayed as 6465. When you have this correct, you can carry on keying in the rest of the program, overwriting lines 100 to 150.

Having set-up the array, the program asks for the start and finish lock numbers. Note, they are not included in the calculation; that is, keying in 10 and 12 would give the time to pass from just above Shiplake to just below Whitchurch. If the journey is downstream, the figures are reversed by lines 240 to 260.

Lines 300 to 320 take care of the Thames Water Authority regulation which restricts cruising speed to seven knots.

Once input is complete, lines 420 to 460 sum the appropriate array elements and divide by the speed in knots to give the motoring time. Again taking the journey from Shiplake to Whitchurch, locks 10 to 12, we add elements 10 and 11, i.e., 288 and 348, to give 636 minutes. That is then divided by, say, five knots to give 127 minutes travelling time.

It remains to count the number of locks to be negotiated, and add the appropriate number of minutes for each. Lines 480 to 510 convert the total minutes to hours and minutes. Finally, the motoring time is multiplied by the hourly fuel

TABLE

1	Teddington Lock
2	Sunbury Lock
3	Chertsey Lock
4	Bell Weir Lock
5	Romney Lock
6	Bray Lock
7	Cookham Lock
8	Temple Lock
9	Hambleden Lock
10	Shiplake Lock
11	Caversham Lock
12	Whitchurch Lock
13	Cleeve Lock
14	Day's Lock
15	Culham Lock
16	Sandford Lock
17	Osney Lock
18	King's Lock
19	Pinkhill Lock
20	Shifford Lock
21	Radcot Lock
22	Buscot Lock
23	Lechlade Bridge

Program Variables

F	Finish lock number
G	Gallons per hour/total fuel consumed
H	Number of hours
K	Speed in knots
L	Number of minutes in each lock
M	Total of inter-lock times
S	Start lock number
T	Total motoring time — also used as temporary store at line 240
W	Total elapsed time
Z	Array: minutes to cover inter-lock gap @1 knot

```
 10 DIM Z(22)
 20 LET Z$="418 261 250 309 287 219 310
    224 303 288 348 244 545 302 373 208 184
    218 448 362 270 094"
 30 FOR X =1 TO 22
 40 GO SUB 600
 50 LET Z(X) =N
 60 NEXT X
100 PRINT "START:▽▽▽▽ ";
110 INPUT S
120 PRINT S
130 PRINT "FINISH"▽▽▽ ";
140 INPUT F
150 IF F<24 AND S<24 THEN GO TO
    190
160 CLS
170 PRINT"?"
180 GO TO 100
190 PRINT F
200 IF NOT F =S THEN GO TO 230
210 PRINT "?"
220 GO TO 100
230 IF F>S THEN GO TO 270
240 LET T =F
250 LET F =S
260 LET S =T
270 PRINT "KNOTS:▽▽▽▽";
280 INPUT K
290 PRINT K
300 IF K<8 THEN GO TO 330
310 PRINT "MUST NOT EXCEED 7"
320 GO TO 270
330 PRINT "MINS/LOCK:";
340 INPUT L
350 PRINT L
360 IF L<60 THEN GO TO 390
370 PRINT "?"
380 GO TO 330
390 PRINT "GALLS/HR:▽";
400 INPUT G
410 PRINT G
420 LET M =0
430 FOR I =S TO F - I
440 LET M =Z(I) + M
450 NEXT I
460 LET T =M/K
470 LET W =T + (((2*(F-S)) -1) * L)
480 LET H =0
490 IF W<60 THEN GO TO 530
500 LET W =W - 60
510 LET H =H + 1
520 GO TO 490
530 PRINT
540 PRINT
    "TIME:▽▽▽";H;"▽HRS▽";W;-
    "▽MINS"
550 PRINT
560 LET G =G * T/60
570 PRINT
    "FUEL:▽▽▽";G;"▽GALLS"
580 STOP
600 LET N =0
610 FOR I = 1 TO 3
620 LET N =(N*10 + CODE(Z$) - 28)
630 LET Z$ =TL$(Z$)
640 NEXT I
650 RETURN
```

TANDY FORUM is devoted to the Tandy TRS-80. Sometimes we will use it to pass on news about the TRS-80 but, above all, it is for users, and would-be users, of the well-established model I and now the new model II. With your tips, queries, moans and comments, this page can become a market-place for TRS-80 information.

Super graphics

THE PROGRAM was written for the TRS-80, but it is very easily transferred to other microprocessors using the teletex or Z-80 graphics writes John Taylor of Orpington, Kent. The idea behind the program can be transferred to the other micros using, say, a 6502 chip, i.e., the Pet.

The program has been transferred to a Research Machines 380-Z without any problems. The idea behind Super Graphics is simple; having written a longish program on a small-memory machine; when the program is run, it very quickly fills and uses all of the available memory and demands and tries to use non-existent memory, finds it impossible, and crashes with an out-of-memory error.

As many programs use the graphics facility, they tend to occupy excessive amounts of memory and are often messy in listing form.

An example of that is, say, to display on the VDU the message:

HI, JOHN.

in a diagonal line — below is a program for the TRS-80 to do:

```
10    CLS
20    READ A,B
30    IF A = 1 THEN 999
40    PRINT ↓ A,CHR$(B);
50    GOTO20
60    REM ** DATA **
100   DATA 0,191,1,140,2,191
110   REM 'H'
120   DATA 68,179,69,191,70,179
130   REM 'I'
140   DATA 136,160,137,132
150   REM ','
160   DATA 203,188,204,176,205,191
170   REM 'J'
180   DATA 271,191,272,179,273,191
190   REM 'O'
200   DATA 339,191,340,140,341,191
210   REM 'H'
220   DATA 407,191,408,164,409,191
230   REM 'N'
240   DATA 476,160
250   REM '.'
260   REM ** DUMMY DATA **
270   DATA —1,—1,—1,—1
999   GOTO999
1000  END
```

There is another method of displaying graphics which uses less memory space and stores the graphics in a string. Taking the TRS-80 as an example, the TRS-80 stores its program, etc., from location 42E4 Hex onwards to FFFF Hex.

Knowing that, and that the numbers on most microcomputers between 80 Hex and FF Hex — 128-256 decimal — are the values of the reserved words, for example, 80 Hex = 128 decimal = "Reserved Word" (TRS-80) END.

The "Reserved Words" are stored in the program as these Hexadecimal numbers and not, as you might think at first, as one Hex number for every alphanumeric item they contain. So Random is stored as 134 and not 82,65,78,68,79,77 — ASC11 codes. The reserved word when needed, as in list, is called up as a stored string and displayed as such.

Now to the graphics program the 134 corresponding to Random also corresponds to CHR$ (134) which is, for those who do not know to what CHR$ (134) corresponds, a white blob.

The next step was to find some way of telling the computer every time it met the special Random to print the white blob — not the word Random. That is done by poking the decimal number which corresponds to Random, 134, into a string, typically, A$.

The first problem one meets is that you do no know where the computer has stored A$ in the program, you do not need to know where A$ is stored for display, i.e., the variable table.

One first fill A$ with, say, 20 decimal points, you tell the computer to go and locate the 20 decimal points. When it has done that, you ask the computer to tell you the decimal location of the first one. This program will perform that:

```
10    CLS: CLEAR 100
20    A = 17000:REM ** APROX. 42E9
      HEX **
30    A$"....................."
40    A = A + 1
50    P = PEEK (A):Q = PEEK (A + 1):R =
      PEEK (A + 3)
60    REM ** APROX. METHOD OF
      FINDING THE —
70    REM ** —START OF A$ **
80    IF P = 46 AND Q = 46 AND R = 46
      THEN 200
90    REM ** NOT FOUND **
100   GOTO 40
200   REM ** FOUND **
210   PRINT:PRINT
220   PRINT" A$ START = DECIMAL
      LOCATION ";A
230   PRINT:PRINT
240   END
```

That has told you where the decimal point is stored at the start of A$ in the RAM, now change the ASC11 number stored at that location.

When that is done, i.e., POKE A,X when X is in the range of 19 to 225 from 19-31 the cursor control graphics numbers are stored — only about four — i.e., 24 = backspace. Let us say x = 43, then when the program was listed after the change, the first decimal point would be changed to a +. When one prints A$, we find one + 19 decimal points.

Now that is interesting but it is not the final target. One tries POKE A, 134. When we print A$ we have the white blobs and 19 decimal points. The listing of line 30 is interesting too, as:

30 A$ = "RANDOM....................."
RANDOM....................

The first decimal point has been replaced by the reserved word Random — a swapping of reserved words. PRINT PEEK (A) will give the result of 134. A word of warning now. Do not edit the string in any way. If you do try, the computer will realise that we have pulled a fast one and when you next print A$ all you will obtain is:

RANDOM.....................................

After poking the desired graphics into A$, it is possible to delete the program and leave line 30 which contains A$ which can then be incorporated into your program. The printing of A$ will save memory space as all you will have is A$ and not the code which produced it. That saving of memory space is vital in programs which display a good deal of graphics in a low-memory machine.

```
10 A$='********************'
16 REM ** SET UP A$ WITH *'S **
18 REM ** PRINT TITLES AND CLEAR SCREEN **
20 CLS:CLEAR 100
25 PRINT@450,'SUPER GRAPHICS.':PRINT
26 PRINT' BY JOHN TAYLOR.':PRINT:PRINT
28 PRINT'PLEASE WAIT.':PRINT
30 A=17000:REM ** APROX. START OF PROGRAMME
   STORAGE IN DECIMAL **
40 A=A+1
41 P=PEEK(A):Q=PEEK(A+1):R=PEEK(A+5)
45 REM ** TEST FOR *'s . **
50 IF P=42 AND Q=42 AND R=42 THEN 55
54 GOTO40
55 REM ** 42 IS ASCII FOR * **
60 CLS:REM ** INSTRUCTIONS **
70 PRINT:PRINT
80 PRINT'SUPER GRAPHICS BY JOHN TAYLOR.'
82 PRINT
85 PRINT'PRESS '@' FOR GRAPHICS.'
87 PRINT'PRESS 'SHIFT N' FOR END.'
90 REM ** THIS WILL DELETE THE PROGRAMME **
95 REM ** BUT WILL LEAVE A$ FOR YOUR USE **
100 PRINT'PRESS 'P' TO START PROGRAMMING.'
105 PRINT:PRINT
110 REM ** GET A KEY **
115 I$=INKEY$:IF I$='' THEN 115
120 REM ** SELECTION. **
125 IF I$='P' THEN 400
130 IF I$='G' THEN 200
135 IF I$='n' THEN 999
150 REM ** N=SHIFT N **
160 GOTO 115
170 REM ** WRONG KEY - TRY AGAIN ! **
200 REM ** DISPLAY GRAPHICS **
210 CLS:PRINT:PRINT
215 PRINT,'SUPER GRAPHICS.':PRINT
220 REM ** INITIAL VALUES OF ARROW -
225 REM ** AND GRAPHICS. **
230 T=92:REM ** ARROW **
235 G=32:REM ** GRAPHICS **
240 REM ** INSTRUCTIONS **
250 PRINT'PRESS 'F' FOR FORWARD.'
255 PRINT'PRESS 'B' FOR BACKWARD.'
257 PRINT'PRESS 'Q' FOR QUIT AND RETURN TO TITLES.'
260 REM ** PRINT TITLE BLOCK **
270 PRINT@585,CHR$(T);
272 PRINT' ';CHR$(G);
275 PRINT@596,'GRAPHICS NUMBER ';G
280 REM ** GET A KEY **
290 I$=INKEY$:IF I$='' THEN 290
300 IF I$='Q' THEN 60
310 IF I$='F' THEN T=92:G=G+1:GOTO350
320 IF I$='B' THEN T=91:G=G-1:GOTO350
330 REM ** WRONG KEY **
340 GOTO 290
350 REM ** MAKE G IN RANGE OF 32-191 **
360 IF G<32 THEN G=32
370 IF G>191 THEN G=191
380 GOTO 260
390 REM ** DISPLAY NEXT. **
400 REM ** NOW TO POKE **
410 CLS
415 REM ** INSTRUCTIONS **
420 PRINT'TYPE THE NUMBER OF TIMES THE'
425 PRINT'GRAPHIC VALUE IS TO BE USED, THEN THE'
430 PRINT'ASCII NUMBER OF THE GRAPHIC.'
440 PRINT'TYPE 'QUIT' TO RETURN TO OPTIONS.'
450 PRINT
455 REM ** DISPLAY CONSTANT INPUT **
460 PRINT@640,'';STRING$(32,32);
465 PRINT:PRINT:PRINT
470 REM ** INPUT **
475 PRINT@640,'';
480 INPUT'TYPE THE NUMBER,ASCII VALUE';T$,N$
485 REM ** GET NUMBERS **
487 N=VAL(N$):T=VAL(T$)
490 N=INT(ABS(N)):T=INT(ABS(T))
500 IF T$='QUIT' OR N$='QUIT' THEN 60
510 REM **IF QUIT - RETURN TO OPTIONS **
520 REM ** GET N IN RANGE OF 13 TO 191 **
530 REM ** 13 TO 31 CURSOR CONTROL VALUES **
531 REM ** ON THE TRS-80 (LEVEL II) **
540 IF N<13 THEN PRINT' ABOVE 13':GOTO455
545 IF N>191 THEN PRINT'BELOW 191':GOTO455
550 REM ** GET T IN RANGE 1-250 **
555 IF T=0 THEN T=1
560 IF T>250 THEN T=250
570 REM ** THE POKE **
580 FOR O=1 TO T
590 IF PEEK(A)<> 42 THEN 630
600 REM ** YOU WILL NOT BE ALLOWED  TO POKE-
601 REM ** INTO THE PROGRAMME - ONLY A$! **
610 POKE A,N
620 A=A+1:NEXT O:PRINT'O.K.'
625 GOTO470 :REM ** GET NEXT NUMBERS **
630 CLS: REM ** OUT OF ROOM - END **
640 PRINT,'SUPER GRAPHICS.':PRINT:PRINT
650 PRINT'YOU HAVE USED UP ALL OF YOUR STRING'
660 PRINT'SPACE. THIS PROGRAMME IS NOW DELETED..'
670 PRINT:PRINT'TYPE IN THE FOLLOWING:-'
680 PRINT'  20 PRINT A$'
681 PRINT'  30 END'
690 PRINT'TO SEE THE GRAPHICS WHICH YOU'
700 PRINT'HAVE CREATED.'
710 PRINT:PRINT:PRINT
800 REM
810 REM ***********************************************
820 REM
830 REM                SUPER GRAPHICS
840 REM
850 REM                   BY ......
860 REM
870 REM          J O H N   T A Y L O R .
880 REM
890 REM ***********************************************
900 REM
999 DELETE 16-999:END
```

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Superboard tips

I HAVE some tips which new users of the Superboard II may find useful writes Ian Bosworth of Aylesbury, Buckinghamshire.

When using a Peek instruction to look at the individual shift keys, e.g., for use in games, the shift-lock key must be up. If not, the operation of these keys will not be detected. ?CHR8 (10) and ? CHR8 (13) can be useful as line feed and carriage return respectively, as in the UK101 and Pet.

The command ?CHR8(13) is particularly useful in writing single-line instructions at the bottom of the screen diving games, or to produce flashing instructions — overprinting with spaces.

Shift K and shift M give ']' and '[' respectively on the keyboard — useful in scientific programs. Thank you very much for a very interesting magazine and for the tips in 6502 Special.

Two oddities

THE implementation of Microsoft Basic on the Superboard is excellent, but I have discovered two oddities which can cause difficulties, writes Jack Pike of Chawston in Bedfordshire.

First, the list instruction when used in a program statement causes the program to end after obeying the list. That is annoying, and even CONT does not help continue the program execution. On other computers, such as the Apple in Applesoft, the list command is obeyed and the program execution continues.

Does anyone know how to arrange for the same thing to happen on a Superboard? One might Poke the warm-start location before the list command and return it to its correct value afterwards.

Secondly, have you ever tried POKE, N PEEK(N + 1) as an instruction to make adjacent RAM locations have the same value? It does not work on the Superboard, neither does it cause a program failure. Try running the following program:

```
10 N = 1000
20 PRINT PEEK(N),PEEK(N + 1)
30 POKE N,PEEK(N + 1)
40 PRINT PEEK(N), PEEK(N + 1)
```

If you replace line 30 with the equivalent Basic line:

```
30 P = PEEK(N + 1): POKE N,P
```

all is well. Do the UK101 and the OSI C2 have the same problem?

Scrolling messages

LOLL HOLT of Worsley, Lancashire has sent in a machine-code program for the Acorn System One. Its function is to present a stored message in scroll form he writes. Being totally re-locatable, it is perfect for providing messages during games, etc. Each message — several may be called by this routine, the only limit being zero-page memory — is stored in Hex code somewhere in zero-page.

THE 6502 SPECIAL is dedicated exclusively to the exchange of information between 6502 users. It is up to you, the reader, to help establish this page with your ideas, problems and guidance for other 6502 users. Please mark your letters 6502 Special. We pay £5 for each contribution published.

The start-address of the message should be stored at 0020, and the finish-address at 0021. The scroll speed can be varied by changing the address labelled with an asterisk — the smaller the number, the faster the scroll.

```
A6 20 — set X
A9 1F — single scan
85 OE display
9A — save X
A2 10* — wait routine
20 OC FE
CA
DO FA
B5 11 — shift display
95 10 left routine
E8
E0 07
DO F7
BA — restore X
B5 00 — get new data
85 17 — display on left
E8
E4 21 — check for end of data
DO E4 — return to start
A9 FF
85 OE
4C 04 FF — end.
```

Slowing listing

ANYONE with a Compukit UK101 must find the speed of listing annoyingly fast writes M Phillips of Crewe, Cheshire. Too fast to be able to spot slight mistakes or to be able to find areas in the program to alter. By the time you have pressed Control/C, the area has disappeared from the screen.

To slow down the listing, it is necessary to Poke 518 — the CRT simulator baud rate — with a value of 0 = fast to 255 = low. Values of 50 or 100 are satisfactory in fault finding.

Select logic

I HAVE been a reader of your magazine for a long time and in my opinion it is an excellent publication; please keep it up, writes B Mistry of Bradford, West Yorkshire.

I would like to offer your readers of the 6502 Special some ideas picked up while working on my Superboard II.

As some readers will know, the ACIA resides, not only, at F000 and F001, it, in fact, occupies 128 locations, i.e., from F000 and F0FF; that is due to page select logic. Anyone intending to put in a PIA or other hardward should note and keep clear of page F0.

Again, for hardware addition, why not use the logic available on the computer board for hardware additions, e.g., IC 23 plus 7 is the 'E' output — that is an 8K decode signal. In fact, IC 23 provides the following eight, 8Kbyte decode signals:

PIN 15 — 0000
PIN 14 — 2000
PIN 13 — 4000
PIN 12 — 6000
PIN 11 — 8000
PIN 10 — A000
PIN 9 — C000
PIN 7 — E000

As most will know, the Superboard has four scratch pads for 16 pin ICs which could be used or a small board with some 74 LS 138s or 139s for further decoding.

Routine savers

IT IS possible to use Ritchie's routines published in May, 6502 Special to save full-length strings on tape by POKEing 15 with 255 writes Kevin Ford of Lincoln. That will prevent any spurious carriage returns being output to the tape and enable full use of those routines.

I must point out that my own routines which also appeased in May, 6502 Special were not designed specifically for saving variables; their main use is the saving of very long (2048 bytes) strings.

Moving data

AFTER reading Toby Walsh's comments about moving data around the UK101 screen in the September issue, it occurred to me that a routine to shift all data down the screen might be as useful if not more so than using 'PRINT' writes B J Last of Llanfairfechan, Gwynedd.

This routine uses the spare page-zero locations at 0061 to 0064 and resides in the spare RAM at 0200H. It can be called by 'X = R(X)' after setting up the USR pointers by 'POKE 11, 34:POKE12,2'.

Address Assembler	Code	OP codes
0222	LDA#FF	A9 FF
0224	STA 0061	85 61
0226	LDA#D3	A9 D3
0228	STA 0062	85 62
022A	LDY#0	A0 00
022C	LDA (61),Y	B1 61
022E	LDY#32	A0 20
0230	STA (61),Y	91 61
0232	DEC 61	C6 61
0234	LDA 0061	A5 61
0236	CMP#255	C9 FF
0238	BNE -16	D0 F0
023A	DEC 62	C6 62
023C	CMP#CFH	C9 CF
023E	BNE -24	D0 C8
0240	RTS	60

It is written for the Superboard II, but changing the LDY#32 at 022EH to LDY#64 will allow it to run on the UK 101.

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Interrupt routines

FOR ANYONE wishing to write their own interrupt routines for use on the Pet 16K or 32K models, here is my method writes Jeremy Cook of Leicester. Firstly, write your machine-code routine you wish to use as an interrupt and place it in a suitable area of memory such as the second cassette buffer — locations $033A-$03FF.

As an example, I am using a program to reverse every screen character and then reverse again every time a key is pressed creating a screen flash. The program is also shown in its assembler code.

```
BEG     LDA  $25
        BIT  $97
        BEG  FIN 1     check if key was
                       held down
        LDA  $97
        STA  $25
        LDA  #$FF
        BIT  $97
        BEQ  FIN 1     check in no key
                       was pressed
        JBR  FLASH
        JBR  FLASH
FIN 1   JMP  BEG       loop round again
FLASH   LDY  #0
        LDA  #0
        STA  $23
        LDA  #$80
        STA  $24
START   LDA  ($23),Y
        EOR  #$80
        STA  ($23),Y
        INY
        BNE  START
        LDA  #$83
        BIT  $24
        BEQ  PIN 2
        JMP  START
FIN 2   RTS

.:033A   A5 25 24 97 FO 10 A5 27
.:0342   85 25 A9 FF 24 97 FO 06
.:034A   20 53 03 20 53 03 4C 3A
.:0352   03 AD 00 A9 00 85 23 A9
.:035A   80 85 24 B1 23 49 80 91
.:0362   23 C8 DO F7 A9 83 24 24
.:036A   FO 05 E6 24 4C 5D 03 60
```

The routine can then be tested with .G 033A with less chance of crashing the machine than if it was put into the interrupt straight away — of course you must save the program before any attempt to run by typing .S "FLASH", 01,033A,0372.

When the routine works correctly, you must incorporate it into the interrupt. That is reasonably easy. List the routine with .M 033A, 0372, then list the interrupt pointers with .M 0090, 0091.

```
.M 0090, 0091
.:0090 2E E6............................
```

Change the program to jump into the interrupt rather than back to itself by changing locations 0341 and 0342 to 2E and E6 respectively — the numbers in 0090 and 0091 — then re-set the interrupt pointers to the start of your routine so that they read:

```
.:0090 3A 03............................
```

The screen should now flash at each keystroke but the machine will function correctly. In a completed program, instead of altering the interrupt pointers

by hand, they could be done easily by:

```
SEI            78
LDA #$3A       A9 3A
STA  $90       85 90
LDA #$03       AP 03
STA  $91       85 91
CLI            58
```

More from Pet

PHILIP DEAKIN of Alnwick, Northumberland, using simple illustrations, describes how to overlay a number of consecutive programs to allow the user to use more memory than his Pet possesses. Of course, there are difficulties but if the main principles are understood clearly, they can be dealt with and in practice, they are not as onerous as might first appear, he writes.

We shall illustrate the procedure using a trivial program which allows the user to select then print either the root, the square or the cube of the numbers one to 15 which are labelled with a program selected label. The program is split into five smaller programs which would run sequentially with a cassette but which could loop if discs were used.

The Peek and Poke addresses given in the programs are for the new ROMs but the equivalents for the old ROMs will be given at the end of the article.

As a program begins to use more and more memory, execution grows, slower and slower to the point where the delays become intolerable. It is at that point one wishes that the program could be split and run in more than one piece.

The program is that when one loads the second program, the variables calculated in the first are lost and although it is possible to carry a certain number over using the screen, that method is limited. So the problem is to load the second program while still retaining the variables and arrays determined in the first.

That is not too difficult because loading the second program does not destroy the variables and arrays, it merely re-sets the pointers which tells the program where they are. Now variables are stored immediately after the program and arrays, and the addresses of string arrays are stored immediately after that. So, the first rule must be that no subsequent program can be longer than the first, otherwise variable and array values would be overwritten.

To obtain maximum effect from the system all the constituent programs should be of equal size. That can be made much easier by deceiving the Pet into thinking that the program which calculates the variables and arrays is as long as the longest program in the set.

It is done by loading into decimal locations 42 to 49 the values which would be there if the largest program were loaded. If, for instance, the largest program were to finish at location 4096, locations 42, 44 and 46 would be poked with the value 0 while locations 42, 45 and 47 would be poked with the value 16 (16*256 = 4096).

The next operation is to open the variable and array storage area to the maximum amount needed during the running of all the programs. First, declare all the variables and string variables by statements such as a = a:a$ = a$, etc. Then, dimension and calculate the values of all the arrays both string and numeric. Finally, we store the addresses of the now expanded storage locations in a convenient location in the second cassette buffer.

To do that we peek the address and poke it into the second cassette buffer. That information must be stored outside the normal program operating area, that is 1024 to the top of memory as these locations when can be changed new programs are loaded. The final step in this program is to load the next program and run it.

The listing of the first program called "P0" is:

```
10 poke42,0:poke43,16:poke44,0: poke45,16:
poke46,0: poke47,16
20 a$ = a$:i = i:k = k
30 dim × (15),y(15),/(15),a$(3)
40 fori = 1to15
50 x(i) = sqr(i)
60 y(i) = i 2
70 z(i) = i 3
80 nexti
90 a$(1) = "root" + " ":$(2) = "square" +
" ":a$(3) = "cube" + " "
100 poke976,peek(42): poke977,peek(43);
poke978,peek(44): poke979,peek(45)
110 poke980,peek(46): poke981,peek(47):
poke982,peek(48): poke983,peek(49)
120 load"P1",1
```

Two other points about the program: firstly, the string variables have the null character " " added to them so that they will be stored at the top of memory. Otherwise the computer saves space by addressing them by their declared value within the program. That would, of course, be lost when the next program was loaded; secondly, if you are using discs. then line 20 becomes

```
120 load"0:P1",8:run
```

for Commodore discs and

```
120 $x,1,"P1"
```

for the Computhink disc.

That loads the second program P1 which offers a choice or men. Lines 10 and 20 transfer the variable and array addresses back to the operating sysatem. Lines 30 to 110 offer the options, while

(continued on next page)

(continued from previous page)

lines 120 to 150 load the appropriate option. The listing of "P1" is:

```
10 poke42,peek(976):poke43,peek(977):
poke44,peek(978):poke45,peek(979)
20 poke46,peek(980):poke47,peek(981):
poke48,peek(982):poke49,peek(983)
30 print"[cls]do you want—" :print :print
40 print"[rvs]r[rvo]oot":print:print
50 print"[rvs]s[rvo]quare":print:print
60 print"[rvs]c[rvo]ube" :print :print
70 print"[rvs]e[rvo]nd":print:print
80 print"type option"
90 set a$:ifa$= " "then90
100 if a$='r' then k=1:goto140
110 if a$="s" then k=2:goto150
120 if a$="o" then k=3:goto160
130 if a$="e" then end
140 load"P2",1
150 load"P3",1
160 load'P4",1
```

If you are using discs, line 140 becomes

```
140 load"0"P2",8:run, etc.
```

for Commodore discs and

```
140 $x,1,"P2", etc.
```

for Compthink discs.

That will load and run the program which prints on the screen your selection "P2", "P3" or "P4". Those programs are very similar — the only difference is the variable

x(i) in P2
y(i) in P3
z(i) in P4

Only "P2" will be given.

```
10 poke42,peek(976);poke43,peek(977):
poke44,peek(978)poke45,peek(979)
20 poke46,peek(980):poke47,peek(981):
poke48,peek(982)poke49,peek(983)
30 print"[cls]":print " × ",a$(k)
40 fori = 1 to 15:printi, × (i):nexti
50 print"to continue press [rvs]space[rvo]"
60 get a$:if a$< > chr$(32)then 60
70 end
```

That is where a simple cassette version would end. However, if a more complex system was required, that could be achieved by multiple recording of programs, i.e., if the cassette was recorded in the following sequence

"P0","P1","P2","P3","P4","P1",
"P2","P3","P4","P1","P2","P3","P4"

If line 70 becomes

```
70 load"P1"
```

The functions can be printed in any order. Using discs, the procedure becomes much simpler because only one recording of each program is necessary. Line 70 becomes

```
70 load"0:P1",8:run
```

for Commodore discs and

```
70 $×,1,"P1"
```

for Compthink discs.

The system is not so straighforward for old-ROM Pets as it is not possible to Poke a Peek. Thus, line 10 would become a = peek(976):b = peek(977), etc. and then a line 15 would have to be written.

```
15 poke124,a:poke125,b etc.
```

The corresponding old ROM addresses to the new ROM ones given in the programs are

42 = 124
43 = 125
44 = 126
45 = 127
46 = 128
47 = 129
48 = 130
49 = 131

The screenprint of "P2", etc. shows that the variable k, the arrays x(i),y(i),z(i) and the string array a$(k) have been carried over from program to program.

Here is all the information required to allow a much more complex set of programs to be built thus making maximum use of the capabilities of the Pet. What are the disadvantages?

Well, firstly, the programs have to be structured much more carefully, so they take longer to write. Secondly, loading, especially from cassettes, takes a considerable amount of time. However, there are many applications where that is not a serious disadvantage or where there is no other choice and so that technique allows us to put a gallon into a pint pot.

Line append scan

A LISTING of Line Append Scan and Line Reference Scan written for the new-ROM Pet with a Programmers' Toolkit has been sent to us by Stephen Folmer of Grantham, Lincolnshire. To use both programs, re-number the user program starting at Ø with increments of 1. Append either program and type 'RUN 6300'.

Line Append Scan will avoid the possibility of appending a line to the previous and discovering at execution time that the line you have appended is either referenced or can never be executed. This program scans the user program and lists all the line numbers which can be appended safely.

A line cannot be appended to the previous line when: the previous line contains STOP, END, GOTO, RETURN, REM, IF(THEN), LIST, ON GOTO; the line to be appended is referenced elsewhere by GOTO, THEN, GOSUB (ON GOTO, GOSUB).

The array T(1) to T(9) contains the token values of the statements mentioned in the first point. The reason why they cannot be stored in 'DATA' format is due to the possibility of data statements being present in the user program.

The program first determines the number of lines in the user program and dimensions array AR% according to the highest line number. Every element of array AR% refers to the program line number equal to its index. It is for that reason that it is necessary to re-number your program starting at Ø with increments of 1.

When an unappendable line is found, the array element indexed by the line number is set to —1. For each statement, the program first checks for a token value contained in array 'T', if found, the number will be flagged as unappendable (63014).

If the statement is a 'GOTO' or 'GOSUB', the line number refereneced is dealt with similarly. The same applies if a line number follows a 'THEN' statement. If the 'ON' statement is found prior to a 'GOTO' or 'GOSUB', the line is scanned for further line references — token value of 'ON' = 145.

When the scanning is complete the appendable lines are listed on the printer. If you do not have a printer delete line 63021 and amend lines 63022 and 63023.

Line Reference Scan does nearly the opposite to the Line Append Scan though the logic is very similar. Each time a line is referenced, its corresponding AR% element is incremented by one. When the scan is complete, each line referenced is printed together with the number of references. The results can be used among other things to pin-point possible program inefficiency.

If desired, the two programs can be concatenated and run as one but care should be taken to add a 'CLR' statement between the programs and start line numbering with 63000.

Line append scan and line reference.

```
READY.

63000 REM LINE APPEND SCAN*S.P.FOLMER*AUGUST 80*RENUMBER OTHER PROG 0,1*
63001 T(1)=139:T(2)=138:T(3)=155:T(4)=162:T(5)=142:T(6)=143:T(7)=144:T(8)=137
63002 T(9)=128:DEFFNA(X)=PEEK(X+1):DEFFNC(X)=PEEK(X)+256*FNA(X):FI=-1
63003 LS=0:LP=40:PRINT"J";TAB(8);"*** LINE APPEND SCAN ***"
63004 LP=FNC(LP):LN=FNC(LP+2):QU=0:OG=0:CH=1
63005 IFFIANDLN=63000THENFI=NOTFI:DIMAR%(LS+1):GOTO63003
63006 IFFITHENLS=LN:GOTO63004
63007 IFLN=63000GOTO63021
63008 TP=LP+3:PRINT"PROCESSING LINE";LN;"J":LS=LN
63009 IFCH<>0THENTP=TP+1:CH=PEEK(TP):IFCH=34THENQU=NOTQU
63010 IFCH=0GOTO63004
63011 IFQUGOTO63009
63012 IFCH=145THENOG=-1:GOTO63009
63013 IFCH<>128ORCH<>167GOTO63009
63014 FORI=1TO9:IFCH=T(I)THENAR%(LN+1)=-1:I=9
63015 NEXT:RESTORE:IFCH<>137ANDCH<>141ANDCH<>167GOTO63009
63016 Z=FNA(TP):CH=Z:IFZ=32OR(OGANDZ=44)THENTP=TP+1:GOTO63016
63017 IFZ<48ORZ>57THENOG=0:GOTO63009
63018 NR$="":FORI=TPTOTP+5:Z=FNA(I):IFZ>47ANDZ<58THENNR$=NR$+CHR$(Z):NEXT
63019 AR%(VAL(NR$))=-1:IFNOTOGGOTO63009
63020 TP=I+1:GOTO63016
63021 OPEN2,4,2:PRINT#2,"99999 ** "
63022 OPEN4,4,1:PRINT#4:FORI=1TOLS:IFAR%(I)>-1THENPRINT#4,I;
63023 NEXT:PRINT#4:CLOSE2:CLOSE4
READY.
```

```
READY.

63000 REM LINE REFERENCE SCAN*S.P.FOLMER*AUGUST 80*RENUMBER OTHER PROG 0,1*
63001 DEFFNA(X)=PEEK(X+1):DEFFNC(X)=PEEK(X)+256*FNA(X):FI=-1
63002 LS=0:LP=40:PRINT"J";TAB(7);"*** LINE REFERENCE SCAN ***"
63003 LP=FNC(LP):LN=FNC(LP+2):QU=0:OG=0:CH=1
63004 IFFIANDLN=63000THENFI=NOTFI:DIMAR%(LS+1):GOTO63002
63005 IFFITHENLS=LN:GOTO63003
63006 IFLN=63000GOTO63018
63007 TP=LP+3:PRINT"PROCESSING LINE";LN;"J":LS=LN
63008 IFCH<>0THENTP=TP+1:CH=PEEK(TP):IFCH=34THENQU=NOTQU
63009 IFCH=0GOTO63003
63010 IFQUGOTO63008
63011 IFCH=145THENOG=-1:GOTO63008
63012 IFCH<>137ANDCH<>141ANDCH<>167GOTO63008
63013 Z=FNA(TP):CH=Z:IFZ=32OR(OGANDZ=44)THENTP=TP+1:GOTO63013
63014 IFZ<48ORZ>57THENOG=0:GOTO63008
63015 NR$="":FORI=TPTOTP+5:Z=FNA(I):IFZ>47ANDZ<58THENNR$=NR$+CHR$(Z):NEXT
63016 AR%(VAL(NR$))=AR%(VAL(NR$))+1:IFNOTOGGOTO63008
63017 TP=I+1:GOTO63013
63018 OPEN2,4,2:PRINT#2,"99999 ** 9999 **"
63019 OPEN4,4,1:PRINT#4:FORI=1TOLS:IFAR%(I)>0THENPRINT#4,I;AR%(I);
63020 NEXT:PRINT#4:CLOSE2:CLOSE4
READY.
```

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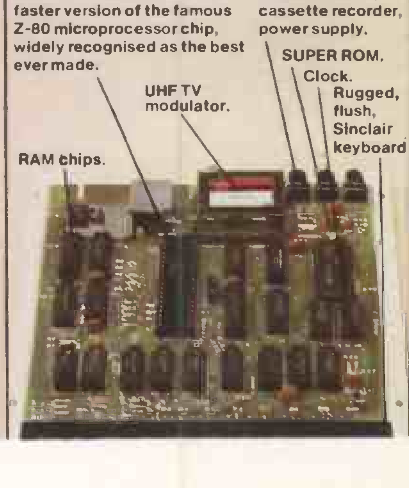

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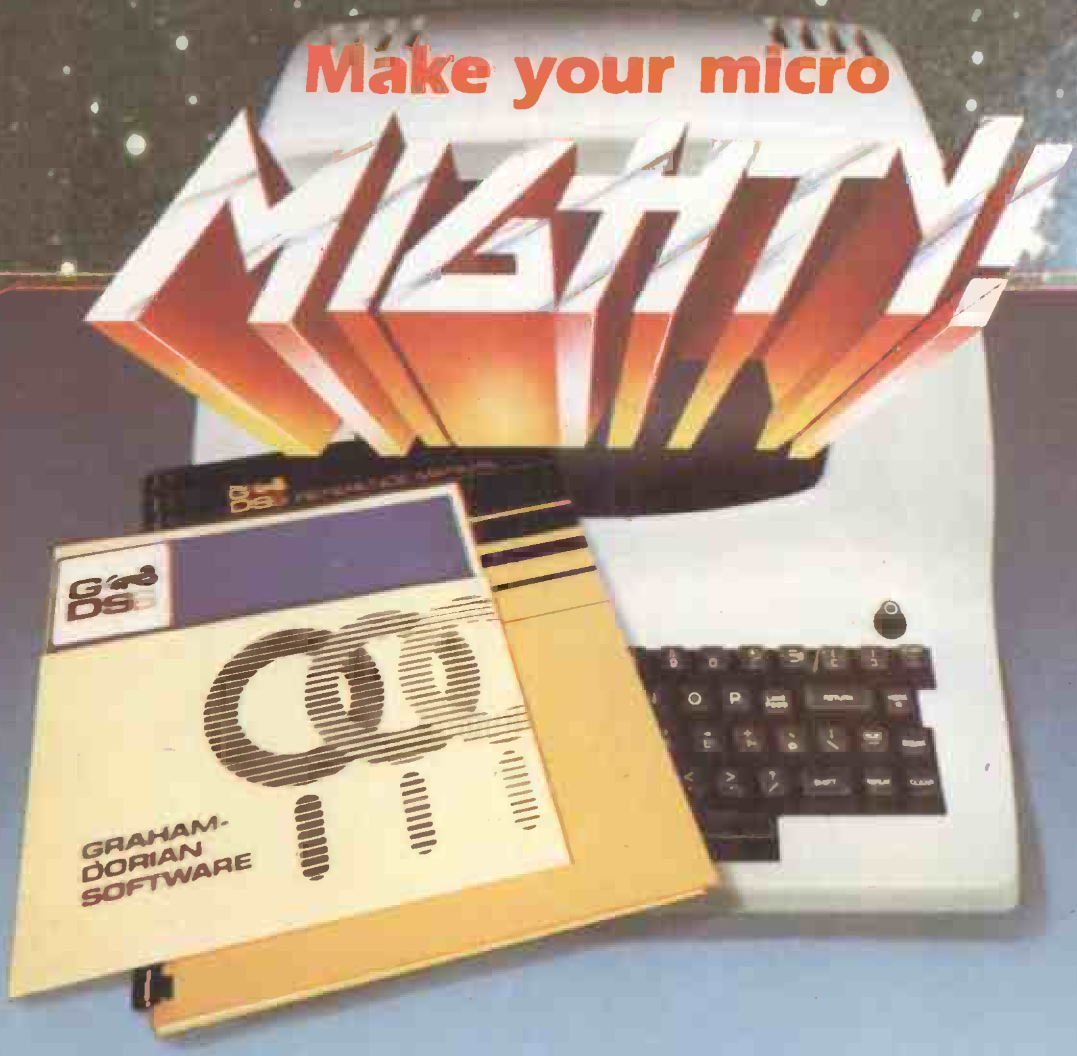

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Free-sector routine

I HAVE just received my copy of *Practical Computing* for July and can see no reference to errors in Roy Waldock's Free-Sector routine — Apple Pie, June writes R A Paganotto of The Hague in the Netherlands. May I, therefore, direct your attention to the ones I have found?

First of all, this useful little program does not always produce correct results. The oldest and ugliest bug in the history of loops has done it again: the byte at offset Hex 44 in the VTOC — the last byte meant to be tested by the loop — is missing altogether. In consequence, the program may report up to eight free sectors less than in fact are available. One way of curing that without upsetting the rest of the code is as follows:

Change $BB into $BC at location $31Ø
(i.e., LDX $BB becomes LDX $BC)
Change $44 into $43 at location $312
(i.e., LDA $2044,X becomes LDA $2043,X)

Second, if one runs the program and subsequently types 3DØG from the Monitor to return to Basic via DOS, strange things happen. Which particular component of the system software — DOS, FP or the monitor — has the hiccups, I do not know as I do not have a printer and chasing that kind of bug on the screen is no fun.

Perhaps it is not even a bug but an undocumented feature of the software. I do know, however, what causes the problem and how to obviate it with no noticeable ill effects.

The RWTS routines leave the saved status register at location Hex 48 with the D,V and I flags on. Clearing them individually seems to either have no effect or make the problem much worse — a DOS boot is one of the things which might happen — but clearing all three seems to do the trick, i.e., store a zero in Hex 48. Does anyone know where to obtain an annotated listing of DOS 3.2?

Three programs

THREE machine language programs for the Apple II have been submitted by Greg Watson of Chester. The first removes all lines beginning with REMs from an Applesoft program, the second is a machine-language re-locator, and the third a slow list utility for any Apple language.

For the REM Stripper program, type in the routines as shown, from $300 to $3E3. Note: the dollar sign indicates Hexadecimal numbers, the hash symbol indicates the immediate mode. Once the routines are in memory, save them with *300.3FFW from monitor. Once your Applesoft program — the routines may work with Palsoft — is resident in RAM, the routines can be used by either: from Applesoft:] CALL 768; from Monitor: *300G. The very last line of the program must not be a REM. If the line does not begin with a REM, i.e., the REM follows a colon, the line will not be removed.

This section is open to the Apple user. In every issue we hope to print ideas, hints and comments about the Apple and its suppliers. They must come from you, so write and tell us what you know.

```
$0300-DA       CLD
301-A9 00      LDA #$00      ;INITIALISE POINTERS TO
303-85 06      STA  $06      ;START OF PROGRAM
305-A9 08      LDA #$08      ;AT $0800
307-85 07      STA $07
309-A0 00      LDY #$00      ;BEGINNING OF LOOP
30B-B1 06      LDA ($06),Y
30D-D0 71      BNE $380      ;SEARCH FOR INDICATION
30F-A0 05      LDA #$05      ;OF A REM
311-B1 06      LDA ($06),Y
313-C9 B2      CMP #$B2      ;IS IT A REM
315-D0 69      BNE $380      :NO, SO INCREMENT COUNTER
317-20 B0 03   JSR $3B0      ;YES, SO GET LINE LENGTH
31A-18         CLC
31B-A5 06      $06           ;SET UP THE MEMORY MOVE
31D-69 01      ADC #$01      ;LOCATIONS TO
31F-85 42      STA $42       ;MOVE SUBSEQUENT LINES
321-85 08      STA $08       ;ON TOP OF THE
323-A5 07      LDA $07       ;REM, THUS
325-69 00      ADC #$00      ;EFFECTIVELY DELETING IT
327-85 43      STA $43
329-85 09      STA $09
32B-A0 01      LDY #$01
32D-B1 06      LDA ($06),Y
32F-85 3C      STA $3C
331-C8         INY
332-B1 06      LDA ($06),Y
334-85 3D      STA $3D
336-A5 69      LDA $69
338-85 3E      STA $3E
33A-A5 6A      LDA $6A
33C-815 3F     STA $3F
340-20 2C FE   JSR $FE2C     ;PERFORM THE MOVE
343-EA         NOP
344-A0 00      LDY #$00      ;WAS THE LAST LINE MOVED DOWN
346-B1 08      LDA ($08),Y   ;THE LAST IN THE PROGRAM?
348-D0 03      BNE $34D      ;NO, SO CONTINUE
34A-4C D0 03   JMP $3D0      ;YES, SO RE-SET LOMEM:
34D-A0 00      LDY #$00      ;REPLACE THE OLD
34F-B1 08      LDA ($08),Y   ;LINE POINTERS
351-38         SEC           ;WITH NEW ONES
352-E5 0A      SBC $0A       ;WHICH ALLOW
354-85 0B      STA $0B       ;FOR THE MISSING REM
356-C8         INY
357-B1 08      LDA ($08),Y
359-E9 00      SBC #$00
35B-85 0C      STA $0C
35D-A0 00      LDY #$00
35F-A5 0B      LDA $0B
361-91 08      STA ($08),Y
363-C8         INY
364-A5 0C      LDA $0C
366-91 08      STA ($08),Y
368-A5 0B      LDA $0B
36A-85 08      STA $08
36C-A5 0C      LDA $0C
36E-85 09      STA $09
370-4C 43 03   JMP $343      ;DO THE NEXT LINE.
$0380-E6 06    INC $06       ;UPDATE COUNTER
382-A6 06      LDX $06
384-E0 00      CPX #$00      ;IS LOW BYTE = 00?
386-D0 09      BNE $391      ;NO, SO GO TO LOOP
388-E6 07      INC $07       ;YES, SO INCREMENT HIGH BYTE
38A-A6 07      LDX $07
38C-CA         DEX           ;DOES HIGH BYTE=END OF PROGRAM?
38D-E4 6A      CPX $6A
38F-F0 03      BEQ $394      ;YES, SO RETURN
391-4C 09 03   JMP $309      ;NO SO GOTO LOOP
394-60         RTS           ;ALL DONE
$03B0-A2 06    LDX #$06      ;SET POINTERS TO
3B2-A0 06      LDY #$06      ;INITIAL SEARCH AREA
3B4-B1 06      LDA ($06),Y   ;GET BYTE
3B6-F0 05      BEQ $3BD      ;IS IT ZERO (END OF LINE)
3B8-E8         INX           ;NO, SO GO AGAIN
3B9-C8         INY
3BA-4C B4 03   JMP $3B4
3BD-86 0A      STX $0A       ;YES, SO STORE LINE LENGTH
3BF-60         RTS           ;AND RETURN
$03D0-38       SEC           ;RE-SET END OF
3D1-A5 69      LDA $69       ;PROGRAM POINTERS
3D3-E5 0A      SBC $0A       ;TO CORRESPOND
3D7-85 AF      STA $AF       ;WITH 'ADJUSTED' PROGRAM
3D9-A5 6A      LDA $6A       ;ELSE A MESS WOULD RESULT
```

(continued on next page)

(continued from previous page)

```
3DB-E9 00     SBC  #$00
3DD-85 6A     STA  $6A
3DF-85 B0     STA  $B0
3E1-4C 09 03  JMP  $309    ;FINE, SO
                           GO TO
                           LOOP
```

I have often wanted to move a machine-language program to another portion of memory, for example, the 6502 assembler which is only resident in the integer ROM and not the Applesoft ROM. However, I often did not because it meant that many absolute addresses within the program had to be changed.

The next program allows you to move a program up and down in memory and alters the appropriate absolute addresses to be compatible with the new location.

Only move whole pages of memory — Page three, for example is $0300 to $03FF — into equivalent whole pages. While that may not be essential in some cases, it may make a difference in others, i.e., in terminology of the monitor move,

```
1000<F000.F4FFM  YES
1000<F000.F457M  NO
1000<F010.F4FFM  NO
1020<F000.F4FFM  NO
```

To use place present before move, start address in $10(LOW) and $11(HIGH), end address, present, in $12(LOW) and $16(HIGH) and then from the monitor *300G(RETURN).

If, after 10 seconds, the cursor does not reappear then the program has crashed. The re-locator may interpret data as part of a program, and alter it subsequently. To avoid that, keep data separate, or else move it after the re-locator has been run. You do not do the move, the routines perform it.

```
$0300-D8      CLD
301-A2 08     LDX  #$08    ;SET UP
                           POINTERS
303-A0 00     LDY  #$00    ;FOR THE
                           MOVE
305-B5 0F     LDA  $0F,X
307-95 3B     STA  $3B,X
309-CA        DEX
30A-D0 F9     BNE  $305
30C-20 2C FE  JSR  $FE2C   ;THEN DO
                           THE MOVE
30F-A5 16     LDA  $16     ;INITIALISE
                           COUNTER
311-85 06     STA  $06
313-A5 17     LDA  $17
315-85 07     STA  $07     ;WHAT IS
                           THE
317-38        SEC          ;DIFFER-
                           ENCE
318-A5 11     LDA  $11     ;BETWEEN
                           THE
31A-E5 17     SBC  $17     ;LOCA-
                           TIONS, SO
31C-85 09     STA  $09     ;I KNOW
                           WHAT
31E-38        SEC          ;TO SUB-
                           TRACT
31F-A5 13     LDA  $13     ;WHEN (IF) I
321-E5 09     SBC  $09     NEED TO
                           CHANGE
323-85 15     STA  $15     ;A BYTE
325-A9 FF     LDA  #$FF
327-85 14     STA  $14
329-A0 00     LDY  #$00    ;GET A
                           BYTE
32B-B1 06     LDA  ($06),Y
32D-20 8E F8  JSR  $F88E   ;DOES
                           THAT
                           OPCODE
330-A5 2F     LDA  $2F     ;HAVE 3
                           BYTES?
332-C9 02     CMP  #$02
334-F0 07     BEQ  $33D    ;YES
336-AA        TAX          ;NO, SO
                           STORE
337-E8        INX          ;HOW
                           MANY
                           BYTES
338-86 0A     STX  $0A     ;IT DOES
                           HAVE
33A-38        SEC          ;IN $0A
33B-B0 23     BCS  $360    ;AND
                           INCREMENT
                           COUNTER
33D-A0 03     LDY  #$03    ;CHECK TO
                           SEE
33F-84 0A     STY  $0A     ;WHETHER
                           OR NOT
341-88        DEY          ;THE HIGH
                           BYTE
342-B1 06     LDA  ($06),Y ;IS WITHIN
                           THE
344-85 0B     STA  $0B     ;BOUND-
                           ARIES OF
346-C5 11     CMP  $11     ;THE MOVE
348-30 16     BMI  $360    ;IF IT ISN'T
34A-C5 13     CMP  $13     ;THEN
                           GOTO 360
34C-F0 03     BEQ  $351
34E-10 10     BPL  $360
350-38        SEC          ;IT IS, SO
                           LET'S
351-EA        NOP          ;MAKE THE
352-38        SEC          ;APPRO-
                           PRIATE
353-E5 09     SBC  $09     ;CHANGES
                           TO IT
355-A0 02     LDY  #$02    ;AND PUT
                           IT
357-91 06     STA  ($06),Y ;BACK
                           WHERE IT
359-4C 60 03  JMP  $360    ;WAS, AND
                           KEEP
                           GOING
$0360-18      CLC          ;UPDATE
                           COUNTER
361-A5 0A     LDA  $0A     ;AND
                           REPEAT
363-65 06     ADC  $06     ;PROCE-
                           DURE
                           UNITL
365-85 06     STA  $06     ;COUNTER
                           IS
367-A5 07     LDA  $07     ;GREATER
                           THAN
369-69 00     ADC  #$00    ;END
                           LOCATION
36B-85 07     STA  $07     ;OF MOVED
36D-C5 15     CMP  $15     ;PROGRAM
36F-30 B8     BMI  $329
371-F0 B6     BEQ  $329
373-60        RTS          ;IF SO,
                           THEN END
```

Here is a slow list routine for the Apple. It works through adjusting the pointers to the COUT routine. What is the COUT routine? Every character printed-out to the TV by the Apple goes through the routine, which is part of the monitor. The routine starts at $FDED and does an indirect JMP — jump which is the equivalent of the BASIC GOTO statement — to $36.

That is, it looks at the two bytes stored in $36 and $37 and continuous running at that address. For example, in a non-disc based system, $36 is usually the Hex value F0 and $37 contains FD. The high byte — most significant — is in $37 so in this case, the computer jumps to FDFO.

Now, if we change the values stored in $36 and $37 to point to our own routine, whenever the computer tries to print a character to the screen, it will have to go through the routine we have inserted. The routine saves the 6502 registers, performs a short wait, checks to see if you have hit a return (Control M), and then returns to the computer control which prints the character.

The routines are in the form of three short programs, one which alters $36 and $37 to point to our routine while saving the old pointers — which I believe are different for a disc system — the second which restores $36 and $37 to their original values, and the third which performs the wait.

If you hit return while the routines are in operation, and the computer is printing something, it will stop and return to integer Basic. That is useful if you want to interrupt a long listing.

If you are using Applesoft, type the routines as shown, but then, from Applesoft, type in:

POKE831,0:POKE 832,0(RETURN),

and the program will go to Applesoft instead of integer when it encounters a return.

The wait between each character printed is determined by paddle 0. If you would rather use paddle X, type: from either Basic: POKE 804,X; from the monitor: *324:X.

These routines cannot be re-located by changing the absolute addresses. The values used to replace those in $36 and $37 must point to the beginning of the wait section. If that is done, the program may be re-located. Once the routines are all there to use them: To turn on the routines on from Basic: CALL800; from Monitor: *300G. To turn off the routines: from Basic: CALL785; from Monitor: *311G.

```
$0300-A5 36   LDA  $36     ;RE-SET
                           COUT
302-85 06     STA  $06     ;HOOKS TO
                           POINT
304-A5 37     LDA  $37     ;TO
                           PROGRAM
306-85 07     STA  $07     ;SAVING
                           OLD
308-A9 20     LDA  #$20    ;HOOKS IN
30A-85 36     STA  $36     ;$6 AND $7
30C-A9 03     LDA  #$03
30E-85 37     STA  $37
310-60        RTS          ;RETURN
$0311-A5 06   LDA  $06     ;RESTORE
                           OLD
313-85 36     STA  $36     ;COUT
                           HOOKS
315-A5 07     LDA  $07     ;FROM $6
                           AND $07
317-85 37     STA  $37
319-60        RTS
$0320-20 4A FF JSR $FF4A   ;SAVE 6502
                           REGISTERS
323-A2 00     LDX  #$00    ;X =
                           PADDLE
                           NUMBER
325-A0 00     LDY  #$00    ; Y = 0
327-20 1E FB  JSR  $FB1E
32A-98        TYA
32B-20 A8 FC  JSR  $FCA8
32E-AD 00 C0  LDA  $C000
331-2C 10 C0  BIT  $C010
334-C9 8D     CMP  #$8D
336-F0 06     BEQ  $33E
338-20 3F FF  JSR  $FF3F
33B-6C 06 00  JMP  ($0006)
33E-4C 03 E0  JMP  $E003   ;SOFT
                           START INTO
                           INTEGER
                           BASIC
```

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Small Business Programs

By S Roberts, published June 1980 by Elcomp Publishing, 3873L Shaefer Avenue, Chino, CA 91710, USA. 117 pages, paperback, ISBN 3 — 921682 — 57 — 6. $14.90.

SMALL Business Programs aptly describes the contents of this book; most of the 32 programs included are less than 100 lines on basic; the longest is less than 200 lines.

It is hard to imagine a viable business so small that the programs would be of much use; the programs seem trivial, inflexible and poorly documented. It is unlikely that any business would be able to use them without extensive customisation, and that would probably be harder than writing completely new programs.

For example, consider the payroll program on page 42. It is a program which contains the employee records as data statements, takes in details of hours worked and prints a 10-line payslip. No files are maintained.

The pay is calculated on the assumption, embedded in the Basic code, that hours worked over 40 are overtime at one-and-a-half times the standard pay-rate. Tax is calculated by assessing into which of five tax bands, 0 percent to 25 percent, the gross salary falls.

No provision is made for allowances, for PAYE complexities, or for deductions before tax, such as superannuation. The tax bands are built into the Basic. No provision is made for national insurance.

The program does no checking for reasonable bounds on hours worked, or for double entry of the same employee number. Only one REM is included, to identify the loop to be changed if you have more than 4 employees. No mention is made of the fact that more than 20 employees will crash the program. There are six lines of documentation.

The 32 program listings are preceded by an article introducing the use of computers in small businesses. It is a mixture of useful information, prejudice and jargon, and is far more likely to repel business enquirers than to encourage them.

The style of the article is appalling, the spelling more appropriate to The Molesworth Guide to Computers than to a serious book. Even on the cover "Programmer" is spelt with only one "m".

The best use for the programs would be to add realism to children's games of shops or hotels although, since the programs have been written for five different machines, many will need modification before they will run on your available hardward. The serious businessman or businesswoman should seek professional advice about the pitfalls and benefits of introducing computers into a company's operations.

Conclusions

●Not recommended for any category of reader.

●There are far better books available.

Martyn Thomas

The computer users' year book 1979 and international directory of software, 1980-81.

Published by CUYB Publications Ltd., 29 Queen's Road, Brighton, BN1 3XA. £32.95 for 1980 edition of CUYB, and £36; 1,206pp and 1,105pp respectively.

AT THEIR price, these are clearly expensive volumes. However, computing is an expensive game and it may well be worthwhile spending several pounds for information which will avoid expensive mistakes or enable you to find the best software.

It is too easy to spend several $100 on the wrong piece of software just because you did not know that the better one was available.

Both tomes are heavy and handsome. They look good on your shelves beside the software manuals, but how much use are they to the microcomputer owner? The answer must be: not much for the average user, although they may be useful for the computer professional.

The micro user or would-be user needs to have ready access

to information about what to buy, where to buy, and who is offering what services. Both books have been designed for the mainframe professional and do not address themselves much to the problems of the micro user.

The topics treated in the CUYB which could be interesting for micro users and which is only a small part of the whole volume are: training facilities and courses, computer literature, computer journals, guide to computers and peripherals — very incomplete on micros in the 1979 edition, — guide to business equipment suppliers, consultants and systems houses, and so on.

The Directory of Software, again aimed primarily at large computer users, has sections on systems software and on application software which it lifts by function and it contains profiles of software suppliers.

While there is some useful information for the micro user, the information is nowhere near comprehensive. For instance, I could not find references in the index to CBasic, CP/M, Wordstar, Selector III, or VisiCalc, all of which are major programs for microcomputers.

If you were looking for something less run-of-the-mill, you would be unlikely to find it. The lay-out makes it laborious to search for software to run on a particular machine.

Both books face the problem of the rapid development in computer systems, particularly in microcomputers. The books are published three to nine months after the information is made available to the publishers.

Therefore, almost by definition, the best software in the microworld, which will often have become available over the past year, will not appear in the manuals. The new version of the CUYB, published in September, will doubtless represent the microfield better. Yet, the Software Directory is going to be very out of date for micros by the time a new one is published in 1982.

The publishers also have a big problem in keeping track of all the vendors and distributors of microcomputer systems and software. If they try to be comprehensive, they will provide so much information that it becomes impossible to select it usefully. If they try to be selective, they may omit useful information.

Perhaps what is needed are version of the books designed specifically for the micro-market. The basic concept is hard to fault: both books are well laid-out. They have very good access to their information through their indices, and considering the range of information they contain, it is surprising how easy it is to find the information you want.

Yet the average micro user is not likely to find enough information there to make them worthwhile. It may be possible to refer to them at your local public library or at a library attached to your local university or polytechnic. They are also available, along with much else, including manufacturers' leaflets and information, at the Science Reference Library Division of the British Library, 25 Southampton Buildings, WC2. That library, which incidentally includes the Patents' Library, is well worth getting acquainted with if you are interested in business or technology. You may also be able to get hold of more expensive books like these through the inter-library loans scheme, to which you have access through your local library.

Conclusions

●Both volumes are well planned and executed.

●A computer professional, even in the microworld, will probably want copies of them for reference.

●However, for the average micro user, they are probably not worth buying as they are

not comprehensive enough in the information they give about micros.

Ian Litterick

Successful software for small computers: structured programming in Basic for science, business and education

By Graham Beech, published by Sigma Technical Press. 210 pages paperback. Price £5.50 ISBN 0 905104 12 9.

THIS BOOK is intended for readers who have some knowledge of Basic and who wish to learn how to design reliable and well-structured programs which take advantage of some of the rudimentary inventions and discoveries of computer science. There are five sections — an introductory chapter which introduces structured programming and the author's program description language, PDL, and then sections on PDL and mathematics data structures, data processing and simulation.

PDL is a loosely-defined, high-level language which looks rather like Algol interspersed with English text. Known variously as pidgin Algol or pseudocode, such languages are used widely for working-out algorithms or designing programs.

Used properly, the technique is far more effective than flowcharting both as a design tool and as a way of making the logic of a program clear to a human reader.

That is the approach followed in the book: the logic of each program is written clearly and concisely in PDL, then translated into Microsoft Basic. All programs have run successfully on a TRS-80 Model 1 Level II, 16K machine.

The introductory section describes a small set of program elements out of which structured programs can be built, and shows how they are written in PDL and translated into Basic.

Four sections each deal with a particular subject area and may be read in any order although the material in the earlyf part of section C is needed for the examples in section B.

Section B — PDL and mathematics — describes how to write programs to solve quadratic, polynomial and simultaneous equations. Section C — data structures — describes arrays, tables, buffers, stacks, queues, lists, trees, and graph structures; it explains why they are useful and shows how they can be implemented in Basic.

Section D — data processing — describes and compares sorting methods and explains file structures, searching, updating and merging. Section E — simulation — demonstrates techniques for both continuous and discrete simulation.

The excellent idea behind the book is, to produce a cheap, approachable introduction to some of the important ideas of good program design. Unfortunately, the book itself is seriously flawed.

To be convincing, the author needs to carry the reader easily from the PDL version of each program to its equivalent in Basic — otherwise the PDL seems irrelevant and the idea of abstract design is lost. Throughout the most important, early part of the book the readers' confidence is undermined by the large number of errors in the PDL; errors which range from syntax and proof-reading mistakes.

There are other, lesser, faults. The Basic programs are unnecessarily difficult to compare with the PDL versions because of differences in the names used for variables. The style of the four applications sections shows their origin as course material for students at Wolverhampton Polytechnic and could be made more readily understandable by the average programmer. The material could also be made more immediately relevant if more, concrete, examples were included.

The book deserves a second edition in which these faults can be corrected because few other books contain such a wealth of algorithms and data structures at such a relatively low price.

The material, if properly understood, is worth as much as many introductory computer science courses. Despite the criticisms I would recommend the book, particularly to programmers of scientific systems or applications who have some mathematical knowledge but no computer science training.

Conclusions

- **Excellent material, but with unfortunate faults in its presentation.**
- **Recommended, especially for first-level students and scientific programmers.**
- **A second edition, correcting the faults, could be a winner.**

Diary

November

●4-6 **Compec '80.** Venue: Grand Hall, Olympia, London. The leading exhibition of computers, peripherals and systems. Fee: £2. Contact: IPC Exhibitions, 40 Bowling Green Lane, London EC1R 0NE. Tel: 01-837 3636.

●1-2, 15-16 & 29-30 **Two-day intensive course in Basic programming.** Venue: London. Designed for those with little or no experience of computers, course will explain how programs may be created, documented, run and debugged using Basic. Fee: £57.50. Contact: Agar-Hutton, 194 Kilburn High Road, London NW6. Tel: 01-328 9232.

●18, 19 & 20 **Biztronic Exhibition.** Venue: Prestonfield House Hotel, Edinburgh. It features the latest in mini- and micro-computers, word-processing equipment, copiers and other electronic office equipment. Contact: Groundrule Exhibition Company, 7 Market Street, Altrincham, Cheshire WA14 1QW.

●18-21 **Video Tradex International Exhibition.** Venue: Wembley Conference Centre, North London. Demonstrates the growth and development taking place in the video industry and will provide visitors with the opportunity to see and examine in detail, the latest in video technology and techniques. Fee: Free for people in Industry. Contact: Ken Warton or Janet Tring, Link House, Dingwall Avenue, Croydon CR9 2TA. Surrey. Tel: 01-686 2599.

●24 **System design with microprocessors.** Venue: Merton Technical College, Surrey. Two-week full-time course including both the hardware and software aspects of microprocessors, designed specifically for practising engineers. More than half the time is devoted to practical work where course members can gain hands-on experience of disc-based microprocessor development systems. Fee: £50. Contact: Bill Wittams or Terry Baylis, School of Engineering, Merton Technical College, Morden Park, London Road, Morden, Surrey SM4 5LZ. Tel: 01-640 3001 extn. 56.

●25 **Practical introduction to microprocessors.** Venue: Cambridge. Covers the basics of microprocessors and how to use them with hands-on training using the SGS-Ates Nanocomputer. Fee: £55 + VAT. If you buy a Nanocomputer, the course is free. Contact: Cambridge Microcomputers Ltd, Cambridge Science Park, Milton Road, Cambridge CB4 4BN. Tel: 0223 314666.

●25-28 **The Which Computer Show.** Venue: National Exhibition Centre, Birmingham. Contact: Gail Sheridan, Sheridan Communications Ltd, Clifton House, 77 Francis Road, Edgbaston, Birmingham B16 8SP. Tel: 021-454 4214.

●26-30 **Breadboard '80 Exhibition.** Venue: Royal Horticultural Halls, London SW1. Show for electronics enthusiasts. Fee: £1.50, students and O.A.P.s £1. Contact: Louisa Redfearn, Trident International Exhibitions Ltd, 21 Plymouth Road, Tavistock, Deven PL19 8AU. Tel: 0822 4671.

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Parameters and I/O techniques

by David Peckett

LAST MONTH, we looked at subroutines, and how, where and why they might be used; we complete our survey this month. In particular, we look at how parameters are passed between the calling program and its subroutine(s).

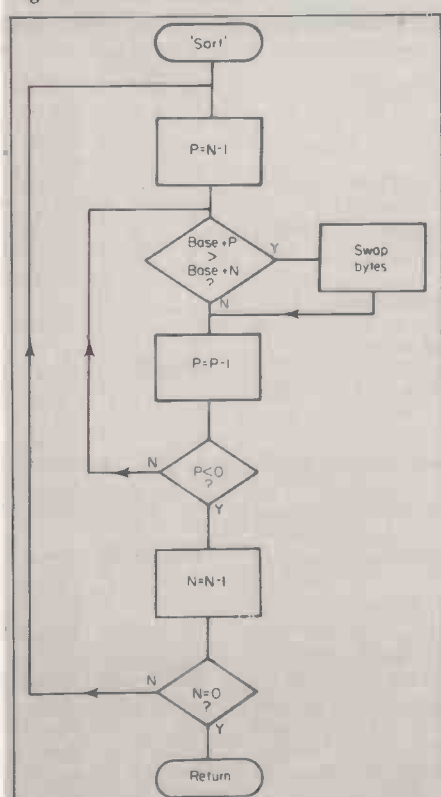
In the second part of this month's article, I describe the input/output, I/O, methods which micros normally use. After all, the cleverest system is no use unless it can talk to the outside world.

It is a rare subroutine that does not take data from, or pass data to, the program that called it. Often, data goes both ways. Part of the secret of designing an effective subroutine is to calculate precisely how data is to be passed.

It is almost a certainty that, if you are using a library of subroutines which transfer data via memory, you will eventually have one routine corrupting another's workspace. One way round the problem is to have a block of memory allocated to subroutine data, and to make sure that every routine uses a different address in that area. This still is not a good approach, and you should avoid it if you can.

The alternative is to transfer data in either the internal registers, or in the stack. Using internal registers is very fast, but has an obvious disadvantage — there is little space. The alternative of using the stack may give more space, but it introduces problems in handling the SP. Sometimes, it is possible to use two stacks — one for parameters and one for return addresses — to obviate the problem. The 6502, once again, restricts us, because its stacks must be on page one.

Figure 1. Sort subroutine.



Often, the best solution is to use either the stack, or internal registers, to pass pointers to the data. The calling program can then put the data wherever is most convenient. That is the only practical approach to subroutines which must handle lists of data. If you look back at some of the program segments that I gave in earlier parts of this series, you will see I often used the pointer technique to access data. You only need to add a "Return" to make them into subroutines.

Workspace. We have only been looking at the problems of entering data into and taking data from subroutines. Often, though, they often need some kind of scratchpad in their working. The same kind of constraints apply to this also — it must not overwrite any important data.

Sometimes, you can use the stack as a scratchpad area. Occasionally, though, you must use main memory and, again, you should set aside a block just for this purpose. Often, it can be very small, because several routines can use the same addresses without interfering with each other.

Recursion. Recursion is a programming technique in which a subroutine can call itself. The technique is not very common in micros. The important point is that a recursive subroutine may be nested into itself many times, without corrupting any data. About the only option is to pass data via the stack; addresses in memory are totally useless.

Re-entrancy. I shall soon be describing interrupt techniques. Without leaping ahead too far, an interrupt is an external event, e.g., a key's being pressed, which can happen at any time, and which must be serviced immediately. Subroutines are said to be re-entrant if they can be interrupted to allow other program segments to run, and then re-started, with no fear of data corruption.

To make a subroutine re-entrant, it must normally be written to use only internal registers — which are saved on the stack during an interrupt — and the stack. It is a good practice to try to make

```
;SORTING SUBROUTINE FOR 6502
;SORTS A MAXIMUM OF 256 BYTES INTO
;ASCENDING ORDER
;PARAMETER TRANSFER:
;    A: MSB OF BASE ADDRESS OF DATA BLOCK
;    X: LSB OF BASE ADDRESS OF DATA BLOCK
;    Y: NUMBER OF BYTES
;
SORT    PHP              ;SAVE FLAGS
        STX  BASE        ;SET UP BASE
        STA  BASE+1      ;..ADDRESS
        DEY              ;SET INDEX CORRECTLY
LOOP1   TYA              ;SET
        TAX              ;..X=N
        DEX              ;FORM P IN X
LOOP2   LDA  (BASE),Y    ; GET TOP BYTE
        JSR  SWAPXY      ;Y=P, X=N
        CMP  (BASE),Y    ;COMPARE BYTES
; IF CY=1, SECOND BYTE IS NOT LARGER
        BCS  NOSWAP
;SWAP THE TWO BYTES
        PHA              ;SAVE FIRST IN STACK
        LDA  (BASE),Y    ;A=SECOND BYTE
        JSR  SWAPXY      ;Y=N, X=P
        STA  (BASE),Y
        JSR  SWAPXY      ;Y=P, X=N
        PLA              ;RECOVER FIRST BYTE
        STA  (BASE),Y    ;COMPLETE SWAP
NOSWAP  JSR  SWAPXY      ;Y=N, X=P
        TXA              ;SET Z FLAG FOR X
        BEQ  NEXT        ;FINAL PASS IF X=0
        DEX              ;NO - NEXT
        JMP  LOOP2       ;..ITERATION
NEXT    DEY
        BNE  LOOP1       ;FINISHED?
        PLP              ;YES, RESTORE PSW
        RTS              ;RETURN FROM SORT
;
;THE NEXT SUBROUTINE EXCHANGES X AND Y
;
SWAPXY PHA               ;SAVE A IN STACK
        TYA
        PHA              ;Y TO STACK
        TXA
        TAY              ;X TO Y
        PLA
        TAX              ;Y TO X
        PLA              ;RESTORE A
        RTS
```

Figure 2.

all library subroutines re-entrant, so that they can be used with any calling program, whether or not it uses interrupts.

Solutions. As in most things, there is no complete solution to the problem of passing data to and from subroutines. You must select the best answer to your particular problem. In general terms, though, you should aim to use internal registers as your first choice, the stack as a second option, and only use main memory as a last resort.

Documentation. I have stressed the value of a subroutine library. If you take this approach, good documentation becomes doubly important. Unless you know exactly what a subroutine does, it is very hard to use it. In addition to the flowchart and listing, you must record such things as:

- How data is transferred to and from the routine.
- Which variables, if any, use main memory.
- Limitations on the routine's capability, e.g., it cannot handle lists of more than 256 elements.

A handy way to record that data is in the form of comments in the listing of the routine.

Transparent subroutines. Having established that a subroutine data will normally be transferred via the micro's registers, we must be careful about any registers which are not used for data transfer. It is quite likely that the routine will use all the micro's registers; the calling program must, therefore, ensure that there is nothing left which must not be corrupted.

A neater alternative to relying on the calling program is to write transparent subroutines. At the end of such a routine, any data in registers not used for transferring parameters is the same as at the start — the subroutine is transparent to these registers.

Let us now try to write a subroutine which could go into a program library. A good example would be a sort, and we shall aim to make it both re-entrant and transparent.

There are many kinds of sorts, with different varieties for different occasions. We shall take the simplest, and use the flowchart of figure 1. The routine aims to take a list of "n" items, and re-arrange them so that they fill the same block of memory in ascending order. The largest byte will be at the highest address.

The sort starts at the highest address, i.e., the "n"th byte, and compares the byte at that location to every other. Whenever the top byte is smaller than the one to which it is compared, the two are swapped.

After the first pass, therefore, the largest byte in the block is at the highest address. The comparison and swap is then repeated for the (n—1)th byte and so on. Eventually, the two lowest bytes are compared, swapped if necessary, and the sort is over.

That type of sort is most effective when the data is jumbled at random, and there are only a relatively few items to be sorted. We shall limit the subroutine to a maximum of 255 items, and make each item a single, unsigned, byte.

What data must be passed into the subroutine? Only two items are needed:

- The address of the bottom of the block of data.
- The number of bytes in the block.

At the end, the subroutine will leave the sorted block in its original location.

(continued on next page)

Figure 3.

```
;SORTING SUBROUTINE FOR Z80
;SORTS A MAXIMUM OF 256 BYTES INTO
;ASCENDING ORDER
;PARAMETER TRANSFER:
;  C: NUMBER OF BYTES
;  HL: BASE ADDRESS OF DATA
;ROUTINE IS TRANSPARENT AND RE-ENTRANT
;
SORT    PUSH AF          ;SAVE REGISTERS
        PUSH BC          ;..TO MAKE ROUTINE
        PUSH DE          ;..TRANSPARENT
        LD   B,0
        DEC  C           ;OUTER LOOP COUNTER
        ADD  HL,BC       ;POINT TO TOP ELEMENT
        EX   DE,HL       ;TOP POINTER TO DE
LOOP1   LD   B,C         ;INNER LOOP COUNTER
        LD   H,D         ;HL IS POINTER
        LD   L,E         ;..FOR
        DEC  HL          ;..INNER LOOP
LOOP2   LD   A,(DE)      ;TOP ELEMENT TO A
        CP   (HL)        ;IS SECOND WORD
        JP   P,NOSWAP    ;..LARGER?
;LOWER WORD IS LARGER - SWAP WORDS
        PUSH AF          ;SAVE A IN STACK
        LD   A,(HL)      ;MOVE SECOND
        LD   (DE),A      ;..WORD
        POP  AF          ;RECOVER FIRST WORD
        LD   (HL),A      ;COMPLETE SWAP
NOSWAP  DEC  HL          ;POINT TO NEXT WORD
        DJNZ LOOP2       ;INNER LOOP OVER?
;MOVE TO NEXT "TOP" WORD
        DEC  DE
        DEC  C
        JNZ  LOOP1       ;FINISHED?
;SORT OVER. RESTORE REGISTERS FROM STACK
        POP  DE
        POP  BC
        POP  AF
        RET
```

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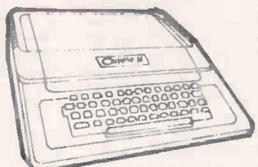

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(continued from previous page)

6502 sort. The 6502 sorting routine is shown in figure 2. The number of bytes is passed in Y; X contains the low byte of the data's base address and A contains the high address.

Since the routine is to be transparent, its first act is to save the PSW on the stack; all the other registers contain data. Because of the 6502 addressing limitations, and its lack of registers, it is not practical to make the routine absolutely re-entrant. The base address must be stored in memory at some suitably-protected spot — "BASE". If you had wanted, the calling routine could have loaded "BASE" directly, with little effect on the usefulness of the routine.

During the sort, we shall have to use indirect-indexed addressing to access the data. "BASE" must, therefore, be on page 0. Y will be used as a counter for the outer loop — "N" in figure 1 — and X as the inner loop counter — "P". We have to go through the outer loop (N—1) times, and so we decrement Y once to make the initial count correct. This also sets us up to point to the highest address of the block of data — "BASE" + N—1.

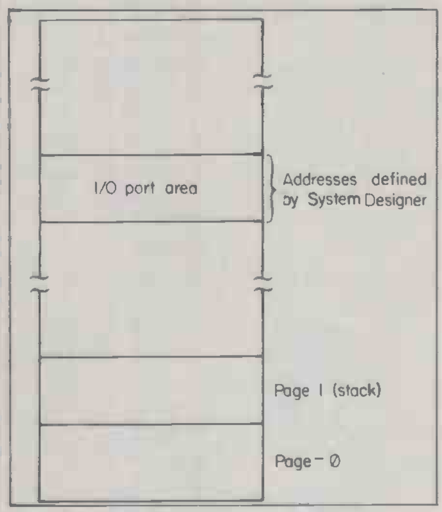


Figure 4.

At the start of each outer loop, Y is transferred to X, which is decremented to set up P. We then go into the inner loop, and the fun starts. We can use only indirect-indexed addressing with Y, but need to use the data in both X and Y. We, therefore, must swap X and Y several times. The best way is to use a special sub-routine, SWAPXY, for the purpose.

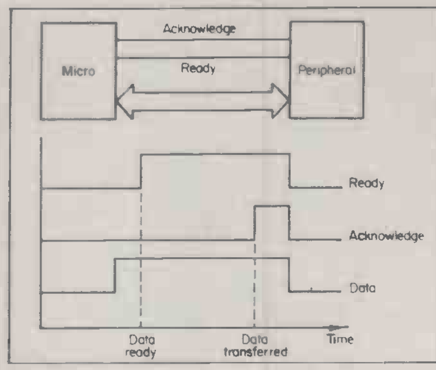


Figure 6. Input handshake.

SWAPXY. This routine is itself re-entrant, and transfers X and Y via A and the stack. During the transfer, the original data in A is saved in the stack, and is restored at the end.

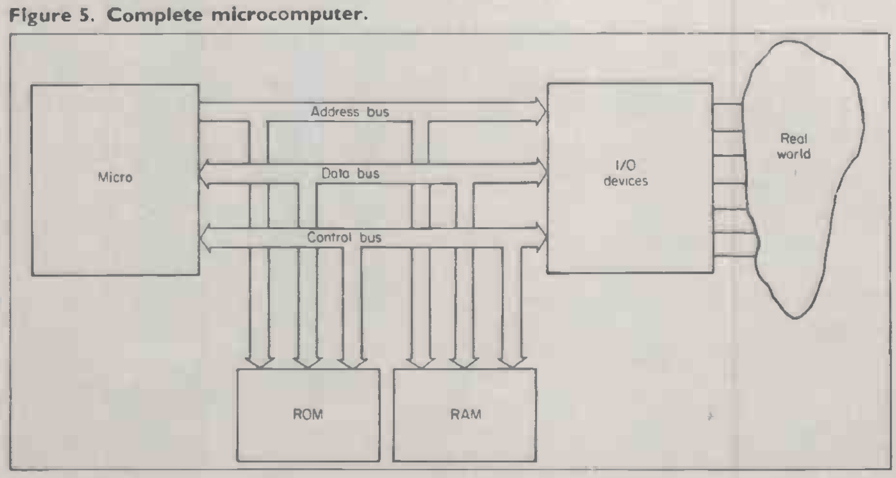
Comparing the two items of data is straightforward. If we have to swap them, there is more juggling of X and Y so that we can get at the proper addresses. The data is, again, exchanged via the stack. There are two possible paths through the inner loop. I had to be careful to give an even number of calls to "SWAPXY" on each so that, at the end of each iteration, X and Y contain "P" and "N" respectively.

The outer loop iterates until N is decremented to zero, when the sort is over. On each pass through the outer loop, the last iteration of the inner loop occurs with P = 0, i.e., the lowest address in the block of data. The conditional branch therefore tests X before it is decremented — why can we not test for X negative?

The final act of the subroutine is to restore the PSW, which was in the stack all the time. Note that we never worried about the value of the SP; as long as we keep pushes and pops symmetrical, the data on the stack stays in the right order.

Z-80 sort. The Z-80 sort is much more straightforward than that of the 6502. The base address is passed in HL, and the

Figure 5. Complete microcomputer.



number of bytes in C. The first act, therefore, is to save AF, BC (for B) and DE on the stack.

A 16-bit addition is used to set HL to the address of the highest byte, and this is passed to DE for the rest of the routine. That is because when we arrive at the comparison step, we must use HL to imply the address of the byte to be compared to A.

The start of the outer loop loads B to act as the inner loop counter (P), and HL is set to the address of the first byte to be compared. Because we are using separate registers for counting and pointing, the use of the loop counters is, maybe, a little obscure. We go through the outer loop (N—1) times — the counter is C, which is set to (N—1) early on. Each time we go

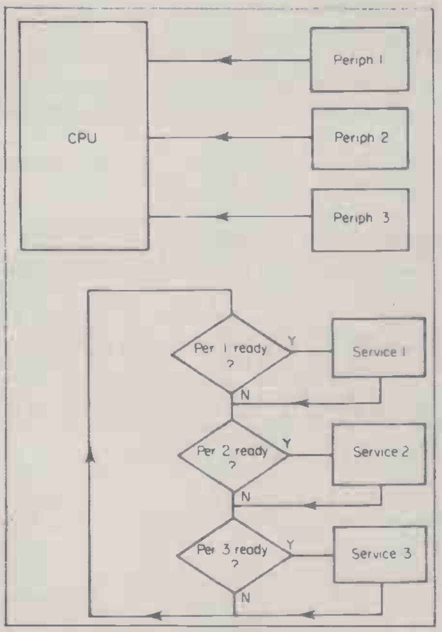


Figure 7. Polling of interrupts.

through the outer loop, the inner loop is iterated the same number of times as is left in C. The inner loop counter, B, is easy to set.

Swapping the bytes is straightforward and, like the 6502 program, uses the stack for temporary storage. Finally, at the end of the routine, the registers which we put in the stack are restored to preserve the routine's transparency.

It often happens that a subroutine must be called conditionally, for instance, a byte must be manipulated if it is less than 80_{16}. From what we have seen so far, we would have to combine a conditional jump and a call to obtain this effect:

```
        CP    $80
        JP    P,NOCALL  ;LESS
                         THAN 80?
        CALL  ALTER     ;YES —
                         MODIFY
NOCALL  NOP             ;CONTINUE
```

The Z-80, however, has a full set of conditional calls — table 1. They use exactly the same conditions as the micro's conditional jumps, and make that kind of problem much simpler:

```
        CP   $80        ;LESS
                         THAN 80?
        CALL M,ALTER    ;YES —
                         MODIFY
;CONTINUE
```

Obviously, the condition for the call must be the complement of the condition for a jump which will miss the call. In the same vein, a subroutine may make a conditional return. That can be particularly true if the routine can exit at several points, depending, e.g., on whether A is zero:

```
        CP   0
        JP   NZ,NOTZRO  ;A=0?
        RET             ;YES —
                         RETURN
NOTZRO  NOP             ;CONTINUE
```

The Z-80 has a full set of conditional returns, matching its conditional calls and jumps. They would allow us to write the program segment above as:

```
        CP   0  ;A=0?
        RET Z  ;YES — RETURN
;CONTINUE
```

The careful use of these conditional calls and returns can make a Z-80 program noticeably more efficient. The 6502 has no comparable instructions.

The Z-80 has one more stack-orientated instruction — "EXchange HL with the two bytes on the top of the stack" ("EX (SP),HL"). That is an unusual instruction. About its only practical use is for modifying a return address. Occasionally, the address will depend on what happens in the routine. It is not very good programming practice, but this instruction gives a quick way of modifying the return address.

All the way through this series, we have assumed that data was a available whenever we needed it, and could be output as and when necessary. We have not given

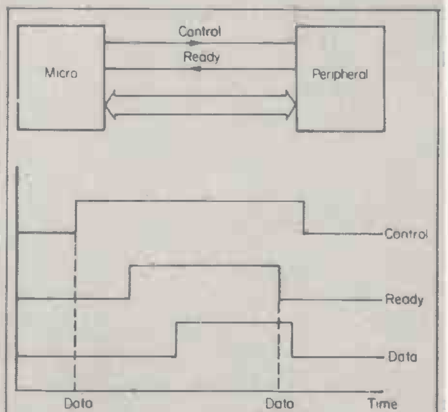


Figure 8. Output handshake.

any thought to how it leaves and enters the microcomputer.

First of all, what kind of communication is needed? Obvious examples are reading a keyboard, writing to a printer, and handling tape and disc units. In many applications, micros must control external equipment, sending it command signals via digital-to-analogue (D/A) converters, and receiving data from A/D converters.

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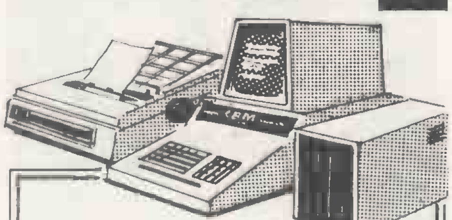

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Data invariably enters and leaves the micro in bytes. However, there may well be isolated control lines to set and status lines to read. Furthermore, data may enter and leave the system in a serial stream. Essentially, there are three I/O techniques which can be used with a computer:

Memory-mapping. Memory-mapped I/O treats ports — the points where data actually enters or leaves the system — as addresses in main memory. Data is written and read normally, and can be manipulated in the usual ways. Special interface chips, wired to the micro's address, data, and control busses, do the job of moving the data. Those chips also convert between the micro's byte-orientated data and whatever form is used in the outside world. All micros can use this technique.

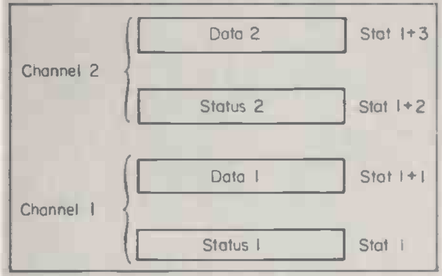


Figure 10. I/O port configuration.

Special I/O instructions. Some micros, such as the Z-80, have special instructions for writing to, and reading from their I/O ports. Although the interface chips which provide the ports are linked to the micro's busses, they are not part of the system's memory.

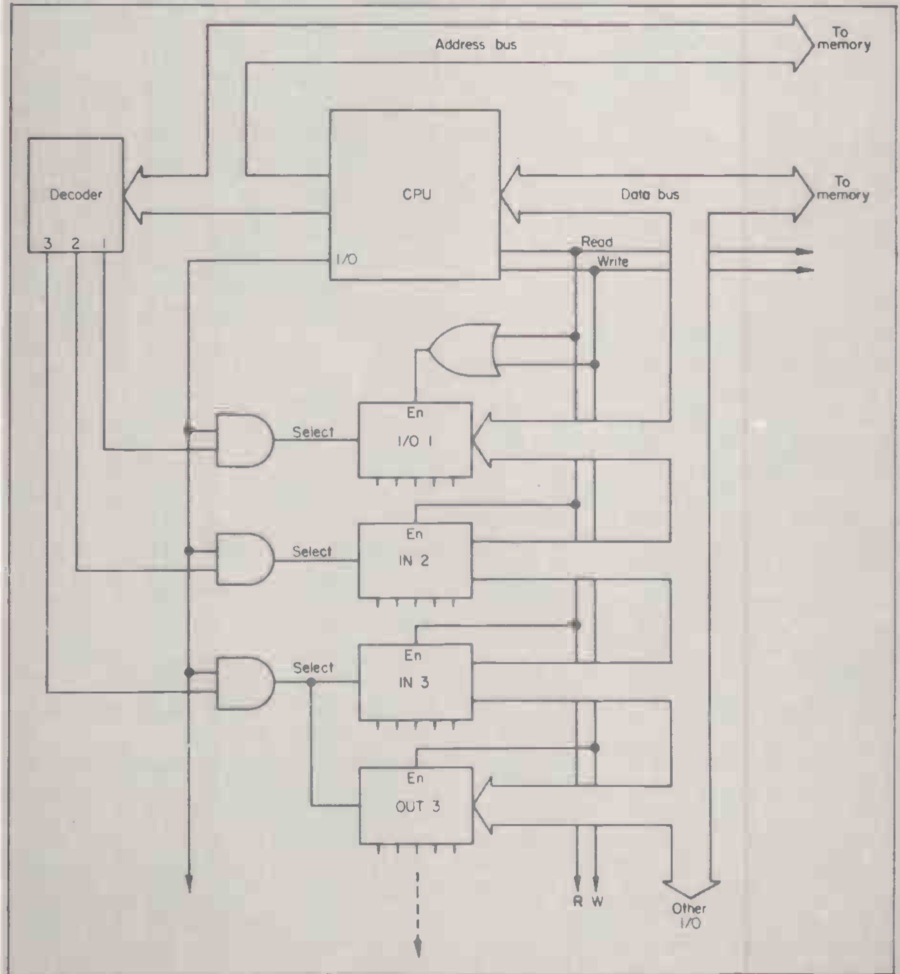
Direct memory access (DMA). DMA is a special method of which an external device, e.g., a disc, stops the micro, takes control of its busses, and writes to or reads from memory directly.

Memory-mapping is a very simple procedure, but can obviously interface with the size of the micro's memory, particularly if there are many I/O ports. The special instructions of the Z-80 allow a more flexible approach at the penalty of a more complex instruction set and extra hardware.

Whichever approach is to be used, the manufacturer of the micro will invariably offer a family of programmable peripheral chips which can be assembled to form a complete microcomputer — figure 5.

Controlling I/O. When a micro takes in data from external devices, it has to know when that data is ready. One way is to use interrupts. In its simplest form, an interrupt is an electrical signal which an external device applies to a micro. The signal makes the micro stop what it is doing, and run a special segment of

Figure 9. Control of Z-80 I/O.



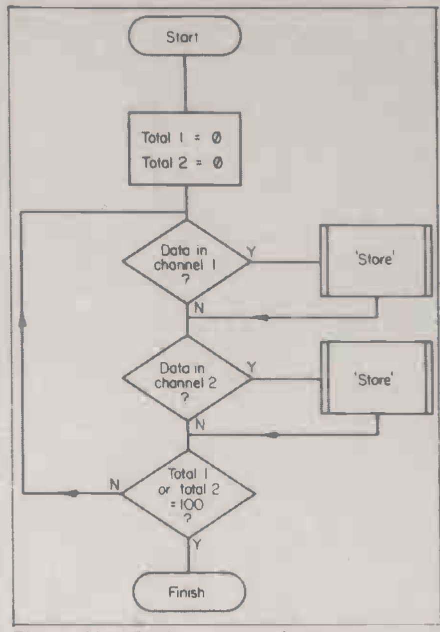


Figure 11a. Basic program loop.

program to service the peripheral. Having done that, the original program picks up exactly where it was so rudely interrupted. In an interrupt-driven system, peripherals grab the CPU attention as and when they need it.

The other common way of discovering when any peripheral is ready is to poll them all. It is quite easy to design a system so that, when a peripheral has data ready for the CPU, it sets a ready line. The micro can check all the ready lines at regular intervals to see if it needs to do anything. In earlier articles, I have given examples of program segments which check ready lines. The line usually sets the MSB of a status word — the micro can best this bit very easily.

Having read the data, the CPU can respond by setting an acknowledge line to the peripheral to say that it is finished, and is ready for more — figure 6. That type of response is called a handshake, and is essential if the external device can provide data fast enough to swamp the micro. It gives the CPU more control of the peripheral.

The problem with a polling technique is that the micro can spend a good deal of time in a loop waiting for something to happen — figure 7. Often, that does not matter — it may have to wait for the operator anyway. At other times, though, it could be doing something useful while it is waiting — like setting-up the universe for the next game of Star Trek. Polling is often used because it is simple.

Handshaking is almost essential when the micro is outputting data — figure 8. The CPU must first set a line to ask the peripheral whether it is ready to listen to it. Some indeterminate time later, the device will say yes by setting a ready line. That allows the data transfer to occur — when the peripheral has received the data, it will lower the ready line.

A micro is the central member of a family of chips from its manufacturer. The chips are all very complex LSI devices, and allow the micro to talk to the outside world. Different devices act as memory-mapped I/O — parallel and serial — timers, discrete ports, floppy-disc controllers, etc. Sometimes, functions such as ROM, RAM and I/O are combined.

Every micro has its own family of chips, and does not normally use other types. The Z-80, however, can use any of the Intel devices designed for the 8080A and 8085. It also has a few of its own special chips, such as the Z-80 parallel input/output — PI/O — and the serial I/O — SI/0.

The 6502 is related to the Motorola 6800, and some of the two micros' I/O chips are very similar. For instance, the 6502 PIO is virtually the same as the Motorola 6820 peripheral interface adaptor — PIA. Peripheral chips are normally programmable, in order to select their different operating modes.

What are the special I/O instructions which the Z-80 provides? The Z-80, like the 8080A, can service up to 256 input, and up to 256 output, ports. It can, therefore, handle up to 512 interfaces, each one eight bits wide. In fact, there are ways of

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Figure 11b. Subroutine store.

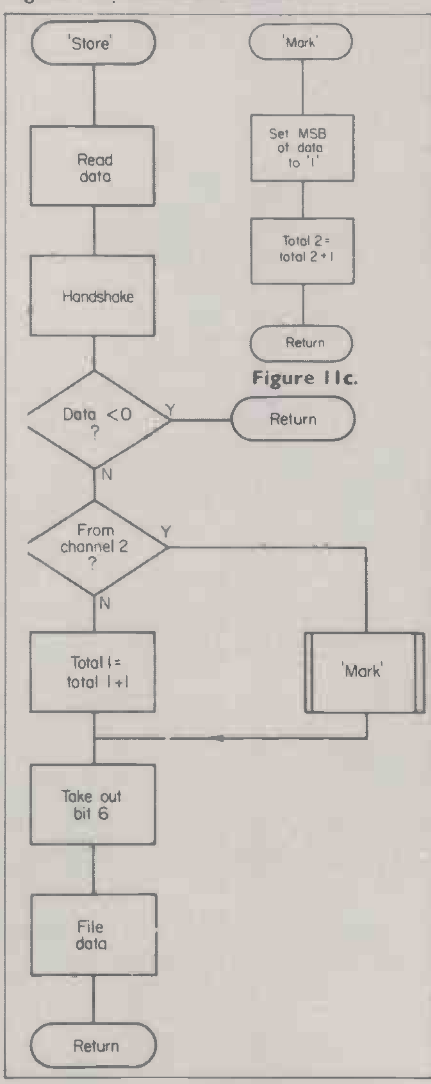

Figure 11c.

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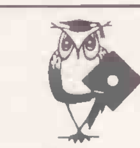

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Table 1 shows the I/O instructions and, as you can see, there are two of each kind. "IN A, (N)" and "OUT (N),A" are equivalent to 8080A commands, and load the accumulator with, or write its contents to, port N. N can be any number from 0 to 255.

The Z-80 also has register-implied I/O instructions: "IN r,(C)" and "OUT (C),r". The data in register C gives the port address, and the contents of any register — including C — can be moved.

Mechanisation of in and out. What extra hardware do special I/O instructions need? Figure 9 shows the kind of circuits used with Z-80 I/O peripherals; the signals represent only what is happening — they are not necessarily precise.

During an in or out, the port address goes on to the lower eight bits of the address bus. The first thing we need, then, is a decoder to convert the binary data to a discrete control line for each port address we are using.

The micro also sets a control line — "I/O" — when the address bus is carrying a port address. This signal is gated with each port-select line to enable the correct port at the proper time. Finally, the Z-80 generates "READ" and "WRITE" control signals. They can be used to link the correct port to the data bus. You can see from figure 9 that port 1 is used for both input and output — it is thus controlled by the "READ" and the "WRITE" lines. Further, there are two Port 3s. One is an input device; the other is an output. The control lines select the correct chip every time. The ports are normally special LSI peripheral chips, but could be much simpler, e.g., latches.

Demonstration program. Let us make a short program to use some of the Z-80 I/O functions. Suppose a Z-80 is servicing four ports. The ports have consecutive addresses, and represent two input channels. In each channel, one port carries status information, and the second has the data, which is in two's complement from — figure 10.

The two status ports are I/O ports. The

Table 1. This month's instructions for Z-80.

Operation	Mnemonic	Flags	Effect
Conditional Call	CALL c,a	None	PC = a if condition satisfied
Conditional Return	RET c	None	PC = Return Address if condition satisfied
Exchange top of Stack and HL	EX (SP), HL	None	L = (SP); H = (SP + 1) (SP) = L; (SP + 1) = H
Direct Input	IN A,(N)	None	A = Port N
Implied Input	IN r,(C)	S,Z, H,P/V	r = Port(C)
Direct Output	OUT(N),A	None	Port N = A
Implied Output	OUT(C),r	None	Port(C) = r

```
;DEMONSTRATION PROGRAM FOR Z80 "IN" AND "OUT"
;
        LD   HL,C        ;INITIALIZE COUNTS
POLL    LD   C,STAT1     ;SET PORT POINTER
        IN   A,(C)       ;READ STATUS1
        BIT  7,A         ;READY SET?
        CALL NZ,STORE    ;YES - HANDLE DATA
        INC  C           ;POINT TO
        INC  C           ;..STATUS2
        IN   A,(C)       ;REPEAT
        BIT  7,A         ;..FOR
        CALL NZ,STORE    ;..CHANNEL2
        LD   A,100       ;FINISH
        CMP  L           ;..WHEN
        JP   Z,FINISH    ;..100 BYTES
        CMP  H           ;..FROM EITHER
        JP   NZ,POLL     ;..PORT
FINISH  NOP              ;ON TO NEXT SEGMENT
        :
        :
STORE   INC  C           ;POINT TO DATA PORT
        IN   B,(C)       ;READ IT
        DEC  C           ;POINT TO STATUS PORT
        SET  6,A         ;COMPLETE
        OUT  (C),A       ;..HANDSHAKE
        RES  6,A         ;..WITH A
        OUT  (C),A       ;..PULSE
        BIT  7,B         ;SIGN OF B
        RET  NZ          ;RETURN IF B NEG
;AT THIS POINT, THE MSB OF B IS ZERO
;SET IT TO SHOW WHERE DATA CAME FROM
        LD   A,STAT1+2   ;A=STATUS 2
        CMP  C           ;CHANNEL 2?
        CALL Z,MARK      ;MARK IF CHANNEL2
        INC  L           ;TOTAL 1
;RETURN TO NEXT INSTRUCTION FROM "MARK"
        LD   A,ØBF       ;SET MASK
        AND  B           ;TRUNCATE B INTO A
        OUT  (FILE),A    ;SAVE A
        RET
;
;SUBROUTINE TO SET MSB OF B TO "1"
;
MARK    SET  7,B         ;SET MSB
        INC  H           ;TOTAL 2
        EX   (SP),HL     ;INCREMENT RETURN
        INC  HL          ;..ADDRESS TO
        EX   (SP),HL     ;..MISS "INC L"
        RET
```

Figure 12.

MSB — bit seven — shows when data is ready, and the Z-80 can output a handshake from bit six. The data ports are input-only.

The program must poll the two channels. Whenever one has data ready, it is to be read and acknowledged. if the data is negative, it is to be ignored, otherwise the six lower bits are output to another port at address "FILE". That could be a floppy-disc unit. The data can be in any sequence from the two channels. The two sources are to be identified to "FILE" by setting the MSB of data from channel 2 to 1. Data from channel 1 has its MSB left at 0.

Finally, when 100 bytes have been received from either channel, the program is to finish. Figure 11a is a flowchart for that; you can see it uses the subroutines in figures 11b and 11c.

Figure 12 shows the resulting program. Registers H and L are used to form "TOTAL1" and "TOTAL2" respectively. The basic polling loop uses the implied "IN", so that the program can calculate the port address. This loop could obviously be extended to any number of ports with only a few more instructions.

Conditional calls to the "STORE" subroutine simplify the polling loop; when "STORE" is called, C still contains the port address.

"STORE" manipulates C to read the data, and then to output the handshake pulse. A conditional return ends this routine if the input data is negative. If the data is valid, and from channel 2, a call to "MARK" is made. This sets the MSB of the data in B to "1" to identify the channel. "MARK" also increments "TOTAL2".

Apple COS: prompts and utilities

ONE PROBLEM touched briefly in the section on COS output bug in the June 1980 issue is that of recognising when we are in command mode in whatever language. It was asserted that command mode can be recognised by the sequence 'retn' followed by 'prompt', where 'prompt' is the contents of location 33H.

That is true in the sense that all the languages follow that pattern in command mode — but so do the Basic input statements, especially if the operator responds to the input with a CTRL-X.

I understand that early versions of Apple DOS suffered from the problem, having a tendency to interpret String INPUTs as DOS commands. If we are to find a satisfactory solution, we will need to know what characters are used as prompts. Here is a program to display the contents of 33H, in Hexadecimal, whenever keyboard input is expected.

```
*F666G          start assembler.
!300: LDA #0
!     STA 22    not necessary if you re-set
                before running this.
!     JSR FC58  clear screen.
!     INC 22    move top of scrolling
                window down one line.
!     INC 25    move cursor down into
                window.
!     LDA #3    we are working in page
                three.
!     STA 39    change the input vector to
                point to 31B.
!     RTS       30F
!31B: PHA       save accumulator contents.
!     PHP       and processor status.
!     LDA 24
!     PHA       save Cursor Horizontal
                position.
!     LDA 28    BASL: low byte of address
                of start of current line.
!     PHA       save it.
!     LDA 29    and BASH, the high byte.
!     PHA       325.
!     LDA #0
!     STA 24    CH = 0
!     STA 28    BASL = 0
!     LDA  4    page four : start of video
                RAM.
!     STA 29    BASH; BAS is now 400.
!     LDA 33    prompt.
!     JSR FDDA  print Hexadecimal code for
                prompt.
!     PLA       335.
!     STA 29    restore BASH.
!     PLA
!     STA 28    and BASL.
!     PLA
!     STA 24    and CH.
!     PLP       and processor status.
!     PLA       and finally accumulator.
!     JMP FD1B  go to normal keyboard
                input routine.
!     (Reset)
*300G           connect as an input 'bug'.
```

The screen should now clear, and display

AA
*

In the top-left-hand corner. 'AA' is the Apple Hex code for *; ASCII * is 2A, and Apple sets the high bit for normal video display. Now start the assembler, and note the change in the code displayed. Try the two versions of Basic — remember, every time you use re-set the 'bug' will be disconnected, so follow it with *300G — and write a short program in each:

```
10 INPUT A
20 INPUT "HELLO",A   (";" instead of ","
30 INPUT A$                  IN FP)
40 INPUT "HELLO",A$ (.......)
50 END
```

In Integer Basic, the input prompt is BF ("?"), even when the apparent prompt is "HELLO"; and in FP input prompt is 80 — CTRL—@, which is a non-printing character — even though INPUT A will print a "?".

Responding to an input with CTRL-X always produces the sequence 'backslash' 'retn' 'prompt', no matter which language you are in — and COS, so far, would recognise this as 'command mode' — while using the backspace key produces 'retn' 'prompt' in all languages other than FP — which gives only the 'prompt'.

The genuine command prompts are AA — monitor — A1 — assembler — DD — FP — and BE — INT. It is not immediately obvious how one could, with a single test, distinguish between these and the input prompts. Probably the easiest way will be to test for BF and for 80 individually whenever a prompt occurs.

by Hugh Dobbs

That will disable COS commands during Basic inputs, but any future languages will have to use BF or 80 for their equivalent of input or else COS will need further patching.

The absence of a source-code listing for either of the Basics is a serious disadvantage if you are trying to find out how the input and get routines work, and at other times, so I use a general-purpose ROM-searching program to help in decoding them.

It is not intended to coexist with anything other than the monitor, and uses at least the first six zero-page locations; only two of them are essential. Locations zero and one hold the address in ROM which is being searched, location two is the number of bytes to be matched minus one, locations three and following hold the bytes for which we are searching.

The program is written to run in page 3, but is re-locatable, apart from one subroutine call which would need to be changed:

```
!300:LDA C080;    FPROM select FP ROM
                        board.
!    LDA #0             clear low address
                        byte.
!    STA 0;         LOCL
!    LDA  D0; FPSTART D000 is start of
```

(continued on next page)

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(continued from previous page)

```
                              FP.
!  STA 1;             LOCH
!  JSR 324;            TO-    change this if re-
                   SEARCH     locating.
!  LDS#0
!  LDA #2A;           STAR    black-on-white
                              star.
!  JSR FDED;         STARS    print a star.
!  INX
!  CPS#4                      four stars yet?
!  BNE 312;  TOSTARS
!  JSR F94A;         PRBL2    print four spaces.
!  LDA C081;        INTROM    select on-board
                              ROM.
!  LDA# E0;           INT-    INT starts at
                     START    E000.
!  STA 1;             LOCH
!  LDY 2;           SEARCH    byte count minus
                              one.
!  LDA 3,Y;          MATCH    starting from end
                              of pattern.
!  CMP (0),Y                  match LOC + Y
                              against 3 + Y.
!  BNE 33C;         TONEXT    try next ROM
                      -LOC    location.
!  DEY                        or next pattern
                              byte.
!  BPL 326;            TO-    if pattern not
                     MATCH    completed.
!  LDA 1;             LOCH    1/0 now point to
                              start of the
                              matching pattern
                              (if any) in ROM.
!  LDX 0              LOCL
!  JSR F941;        PRNTAX    print AX as four
                              Hex numbers.
!  LDX#4
!  JSR F94A;         PRBL2    print four blanks.
!  INC 0;            NEXT-    point to next
                       LOC    ROM location.
!  BNE 324;            TO-    try again?
                    SEARCH
!  INC 1                      next page.
!  BNE 324;            TO-    try again unless
                    SEARCH    FFFF passed.
!  RTS
```

The pattern to be matched goes into locations three and following, so supposing that you want to search for any occurrence of the monitor subroutine call JSR GETLNZ, type in !3:JSR FD67 and then return to monitor. Since your pattern is three bytes in length, then *2:2 store length-1 in location two. *300G will then display any ROM addresses where this sequence occurs. The output in this case is

FF6D **** F599 FF6D

It shows that GETLNZ is called from the monitor (FF6D) and from the mini-assembler (F599). The monitor address appears twice because the monitor (F800 to FFFF) is shared by INT and FP. If you have an autostart ROM on the FP board, it replaces the original monitor — but only a few parts of it are different, so in most experiments any address from F800 onwards will appear both before and after the stars.

Pursuing the questions of input routines and prompts, I have obtained the following results:

CALL etc.	CODE	MONITOR	INT	FP	ASM
JSR GETLNZ	20 67 FD	FF6D	*	*	F599
JSR GETLN	20 6A FD	*	*	D530	*
JSR NXTCHAR	20 75 FD	*	E3D0,F351	*	*
JSR RDCHAR	20 35 FD	FD75	*	*	*
JSR RDKEY	20 0C FD	FD2F,FD35	*	D553,DC11	*
STA PROMPT	85 33	FF6B	E006	*	F597
STX PROMPT	86 33	*	*	D52E	*
INC PROMPT	E6 33	*	E180,E280	*	*
DEC PROMPT	C6 33	*	E185,E287	*	*
JSR E006	20 06 E0	N/A	E2BA	N/A	N/A
JSR D52E	20 2E D5	N/A	N/A	D441	N/A
JSR D52C	20 2C D5	N/A	N/A	DBCF	*

The main points emerging from the investigation — which took about half an hour, including the time spent checking for subroutine calls which do not exist at all — is the great variety of methods used to obtain input from the keyboard.

Yet all the methods ultimately use RDKEY and, therefore, pass through the indirect JMP (KSWL) at FD18. At that stage the input request is intercepted by the COS input bug. If the input used GETLNZ or GETLN or NXTCHAR, it is usually echoed on the screen by COUT — having been stored in the input buffer.

COUT uses the indirect JMP (CSWL) which is intercepted by the COS output bug. Thus command mode in all languages affects both bugs; Basic input affects both; FP GET A and GET A$ affect only the input bug (JSR RDKEY); and output of all forms reaches the output bug.

Incidentally 'esc' and 'backspace' and 'forward' are handled specially by the command and INPUT routines — 'backspace' alone is printed — but are treated as ordinary keys by FP GET.

I am going to leave the patch to exclude "?" and 'CTRL-@' as prompts until I have time for a major revision of COS, and pass on to fix the command decoder. This involves a re-definition of the bits in the operating-mode flag. The new definition is:

879: OMODE Bits: M, W, R, C-D, —, command, —, —.

The bits immediately to the right of the 'CTRL-D printout' and 'command mode' bits are now unassigned, and we can use them to indicate 'used to be C-D' and 'used to be cmd' so that a simple LSR OMODE will cancel either of the two COS command modes without losing the information as to which mode it was. The changes needed to achieve this are tiny:

*D2:4 set 'command' bit as bit two not bit three.
*D47:14 change COS? test accordingly.

Now to fit the LSR OMODE; we have a STA OMODE at D75 which will no longer be needed, but D75 is reached only if whatever has been typed or printed was not a COS command at all.

The logical place for the LSR is at the start of the command decoder, which is reached when a 'retn' follows any command input, or CTRL-D output. That is at D53, so the whole block from D53 to D74 has to be moved three locations to

D56/D77:

```
*1000<D53.D74M        move block to
                      vacant area.
*D56<1000.1021M       move it back to new
                      locations.
```

this avoids the complete destruction which follows if you try to move it directly.

Any relative jumps — branches — within the block are unaffected by this move, but there are no branches into or out of the block which need to be adjusted, so all that remains is to insert the LSR OMODE:

```
*D53:4E 79 08         no point in entering
ASM for one operation.
```

The various language changes should now work if the appropriate commands are added to the table:

```
*DEA:08 C2 D9 C5 1F              (NOP) B
  Y E (E3F)
*:    C1 D3 CD 1C 83 1A          A S M
  (E39) CTRL-C (E35)
*:    C6 D0 0F C9 CE D4 0D  F P (E1F)
  INT (E1B)
```

Connect COS, and try the new commands. We have still not finished with them. You may notice that the remainder of any input line is ignored: >FPTR = 7 for instance will switch to FP, which was probably not what was intended. Those commands form a special group — together with HELP — in two ways: they can be used only from the keyboard or from an EXEC file, and they cannot be followed by a number or a file name or any other parameter, since the languages are all in ROM.

Possibly CATALOG might be included in this group — for COS — since the question of drive and slot numbers does not arise. For this group — conveniently located together in the command table — we have to check OMODE to see if the mode was keyboard command, and call GETNSP to see if the next non-space character is a 'retn'.

Those two tests will be needed for most commands, so they should form part of the FOUNDIT! section of the command decoder. That will be a major revision and will involve exchanging FOUNDIT! and WRONG, putting GETNSP somewhere else, putting the WFCONT patch into the body of the program where it belongs, and possibly even re-locating the command table, to leave space for the necessary extension.

A major problem with cassette files is the corruption of tapes, usually through excessive use, e.g., games programs. Two types of trouble are particularly common — misread bits and dropped bits.

In the first case, as 1 is read as a 0 which will give an ERR message but the main body of the program will be readable — all you have to do is find the fault and correct it and, of course, save the corrected version quickly.

In the second case a 0 is not read at all, and all subsequent bits arrive one place too soon, so that all bytes after the drop-out have been effectively rotated one place to the left — the low bit of each byte being replaced by the high bit of the next byte.

If it is an INT program, it will list normally as far as the drop-out, and thereafter give a stream of rubbish which is still recognisably information. The end-of-program marker will have been corrupted along with everything else, so the list over-runs the end of RAM and, on a 32K machine, starts reading non-existent memory — FF Hex, becoming '?' on LISTing.

The keyboard input addresses (0D), clicking the speaker, and finally switching to page two of video display before crashing altogether. An FP program LISTs differently, since FP uses absolute addresses for finding subsequent program lines.

Those addresses are now garbled, so LIST will finish the line it is working on do the next line as well and then take a random jump to somewhere else in memory and carry on from there so that the observed results have only a slight relation to the corrupted program. It is even possible for FP LIST to go into an infinite loop.

I have put a good deal of work into recovering corrupted programs — even reconstituting successfully the cassette version of Applesoft II by reversing the rotation. First you have to find the point where the drop-out occurred. Very often this is at the very first byte of the program where the monitor read routine skips a 0, intentionally, or two, accidentally.

If not, you have to scan through memory from monitor, starting at 800 for a ROM FP program or from — contents of CA and CB — for an INT program, until there is a break in the pattern.

For FP, (801,802) gives the address of the second line of the program; if you look there, you find the address of the third line and so on. When you reach an address that does not make sense, you have passed the drop-out point. If the line was a print or REM statement, FP stores the text as ASCII values, so do a quick scan for '20' bytes — spaces are the most common characters in text. Any '40' bytes suggest an error, since "@" is very rare. Other bytes less than 80 H are variable names; FP reserved words and punctuators are 80 or higher.

INT programs use displacements rather than absolute addresses; the first byte of each line gives the length of the line, so add that on to the current address to obtain the next one. The monitor will do this for you: *8E + 2F low byte of current address plus offset = BD new low byte; but beware — it will not tell you if there has been an overflow — more than FF.

The end-of-line market (01) should be immediately before the displacement, and the line number — two bytes in Hex — should follow it. Text in print and REM statements is stored as ASCII value plus 80 H; INT reserved words are less than 80, as are some punctuators.

If the end-of-line marker has become 02, or the new displacement is 80 H or

(continued on next page)

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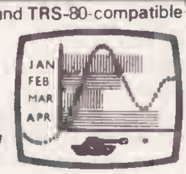

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more, which would make it negative in a sense, you have probably passed the drop-out. Probably, because impacted machine-code programs are common both in my Basic programs and in the Apple demonstration programs, and they can break most of the rules.

Machine-code programs can be disassembled by using the monitor L command; if the program starts at 300 H,

```
*300L  will display the first 20 instructions, and
*L     thereafter will display the next twenty.
```

Unless there are any complications, there will be a sudden change from meaningful code to rubbish — "???" etc. The drop-out took place either where the rubbish starts, or at most one or two bytes earlier.

Once you have found the location of the drop-out, you have to rotate right the whole block from there to the end of the program. One or two bytes just at the drop-out point will probably need to be changed by hand, and the process may need to be repeated elsewhere.

Of course, if you make a mistake, the whole block has to be rotated left again, which is twice as complicated since you have to rotate the high bit of byte X+1 into the low bit of byte X. Here are two programs to execute the two block rotations. For convenience, I have attached them to the monitor as two additional commands:

```
!300:PLP;              LOOP R  recover carry bit
                               to rotate into bit
                               seven.
!   LDA (3C,X);        ROR     next byte for
                               rotation.
!   ROR                        rotate C → byte
                               → C.
!   PHP                        save carry bit for
                               next time.
!   STA (3C,X)                 store rotated
                               byte.
!   JSR FCBA;          TO-     monitor sub-
                   NEXTA1      routine: add one
to first address pointer if it has not yet reached
second address; if it has reached it, set carry
flag. Rotation is complete if carry is set.
!   BCC 300;           TOLOOP  recover carry,
                       R       and go on to
                               next byte.
!   PLP                        pop processor
status from stack, leaving return address; then
exit by
!   RTS                        30D
!   LDA (3C),Y;        ROL     pick up byte
after (3C); Y = 1.

!   ASL                        bit seven into
                               carry bit.
!   LDA (3C,X)                 pick up byte
                               (3C) ; X=0
!   ROL                        ROTATE C ←
                               byte ← C.
!   STA (3C,X)                 store rotated
byte; no need to save carry bit this time, as we
are working backwards and it has already been
used.
!   JSR FCBA;          TO-     see above.
                   NEXTA1
!   BCC   30E;         TOROL   if not finished,
                               do again.
!   RTS                        otherwise exit.
                               (31B).
!   LDY 34;            YSAV    input buffer
                               pointer (monitor).
!   INC 34                     point to next
                               character.
!   LDA 200,Y                  read character
                               from buffer.
!   LDA #1                     see above (30E
                               note).
!   LDS #0                     zero offset for
                               indexing.
!   CMP # BC;          "<"     rotate left ?
!   BEQ 30E ;          TOROL
!   CMP # BE;          ">"     rotate right?
!   CLC                        carry = 0 since
that is probably what dropped-out.
!   BEQ 301;           TOROR
!   DEC 34                     if the character
read was neither < nor >, signal an error
but do not otherwise interfere with monitor.
!   JMP FF3A;          TOBELL  ring bell and re-
                               turn to monitor.
!3F8:JMP 31C                   connect new
routines to monitor.
```

Here, I am using the monitor, not Basic, USR function which JuMPs to location 3F8 on reading a CTRL-Y from the input buffer. From 3F8 we go to 31C, where a test is performed to see if the character following the CTRL-Y is a < or a >. If it is neither, the operator has made a mistake, so we restore the original value for the input buffer pointer and return control to the monitor. The < means rotate left, which is handled by the section from 30E to 31B.

The > means rotate right and is handled by 300 to 30D. In each case, the block to be rotated has been previously defined by inserting the starting address in 3C and 3D, and the finishing address in 3E and 3F. This is done easily by using the monitor itself within the command:

```
*400.7FF"CTRL-Y"<
```

will rotate left the whole of the video display. Replace "CTRL-Y" by CTRL-Y, of course.

To test, first clear the screen with esc @ and hit return; then:

```
*22:1 protect top line of screen from scrolling.
*400:50 6A 64 64  E9 D0 64 E9
*:   D0 69 67 EA 60 EA    62 E2 50 50
```

That will give a row of nonsense extending almost halfway across the screen, which is a code message. To decode it, type

```
*400.411"CTRL-Y"< and see what happens.
Either re-set or *22:0
```

will restore the normal scrolling window. Incidentally, re-set does not kill the new monitor commands in the same way as it kills COS, because the use of USR is optional, and therefore the JuMP vector is not initialised by re-set.

In every block rotation, one bit is lost and one bit is gained. The left rotation causes the loss of the high bit of the first byte in the block, and the low bit of the last byte in the block is replaced by the high bit of the next byte immediately after the block.

Thus left rotations can be done a section at a time without much loss of information. The right rotation causes the loss of the low bit of the last byte in the block, and the high bit of the first byte is re-set to 0 on the supposition that it was the bit which dropped-out.

Thus right rotation — the one you will normally use — should be done to the whole program at one time, starting at the point where drop-out occurred or, in case of doubt, a few bytes earlier.

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Tandy TRS-80	Microcomputer Applications	£90 each	
Tandy TRS-80	T & V Johnson Ltd	£110	750 trans/disc
Tandy TRS-80	Microcomputers Applications	£350	
TECS	Jar Software Systems	£650	500 A/Cs 300 nom A/Cs
Z-80/8080	Graffcom Systems Ltd	£995	
Z-80/8080	Great Northern C S Ltd	£995	varies

General Ledger

Machine Type	Supplier Name	Price	Capacity
Apple II	Vlasak Electronics Ltd	£225	200 A/Cs 1,000 trans
Apple II	Computech Systems	£295	500 A/Cs 1,700 trans
Apple II/ITT 2020	Systematics International Ltd	P.O.A.	
Commodore 3032	Analog Electronics	£450	
Commodore 3032	HB Computers Ltd	£200	Linked to S/L & P/L
Commodore 3032	Bristol Software Factory	£300	1,000 A/Cs 6,000 trans
CP/M	Haywood Associates Ltd	£500	
CP/M	Median-Tec Ltd	£500	500 A/Cs 600 trans
CP/M	Computastore Ltd	£500	999 A/Cs 99 centres nine companies
CP/M	Ludhouse Ltd	£500	200 A/Cs 5,000 trans
CP/M	Comput-A-Crop	£400	
CP/M	Benchmark CS Ltd	£250	500 A/Cs 5,700 trans
SD100/200	Barcellos Ltd	£250	
Tandy TRS-80	Tridata Micros Ltd	£225--£375	500 A/Cs 1,000 trans
Z-80/8080	Great Northern C S Ltd	£275	varies
Z-80/8080	Graffcom Systems Ltd	£390	

Incomplete Records

Machine Type	Supplier Name	Price	Capacity
Apple II	Personal Computers Ltd	£250	1,000 trans 2,600 A/Cs
Apple II/ITT 2020	Padmede Computer Services	£450	900 A/Cs 2,000 trans/disc
Commodore 3032	Stage One Computers	£750	500 centres 2,300 A/Cs
Commodore 3032	Micro Computation	£555	120 A/Cs 5,000 trans
CP/M	Profcomp Ltd	P.O.A.	2,000 entries
Durango F85	Kesho Systems	£1,000	
Exidy Sorcerer	Basic Computing	£350 incl.	see also Micropute

Job Costing/Billing

Machine Type	Supplier Name	Price	Capacity
Apple II/ITT 2020	Padmede Computer Services	£300	1,000 A/Cs 99 centres
Apple II/ITT 2020	Padmede Computer Services	£300	150 A/Cs
Commodore 3032	Stage One Computers	£100	300 appointments
Commodore 3032	CSM Ltd	£600	1,000 jobs 100 people
CP/M	Graffcom Systems Ltd.	P.O.A.	100 activity codes
Z-80/8080	Great Northern C S Ltd	£300	varies

Mailing Systems

Machine Type	Supplier Name	Price	Capacity
Apple II	Kenn Computers Ltd	£300	500 addresses
Apple II/ITT 2020	Systematics International Ltd	£300	500 addresses
Apple II/ITT 2020	Guestel Ltd	£190	400 addresses
Apple II/ITT 2020	The Software House	£57	750 names & adds
Commodore 3032	Stage One Computers	£100	350 records
Commodore 3032	MMS Computer Systems	£250	3,000 records
CP/M	Graffcom Systems Ltd	£250	varies

CP/M	Median-Tec Ltd	£500	
CP/M	Structured Systems Group	£50	varies
CP/M Horizon	Microtek Computer Services	£500	varies
CP/M North Star	Micromedia Systems	£195	
Tandy TRS-80	Comput-A-Crop	£78	varies
Tandy TRS-80	Cleartone ADP	£50	660 entries
Tandy TRS-80	T & V Johnson Ltd	P.O.A.	3,000 names/addresses
Z-80/8080	Micro Focus	£90	varies
Z-80/8080	Intereurope S D Ltd	£500	3,000 entries

Payroll

Machine Type	Supplier Name	Price	Capacity
Apple II/ITT 2020	T W Computers Ltd	£145	
Apple II/ITT 2020	Informex London Ltd	£50	
Apple II/ITT 2020	Informex London Ltd	£198	200 employees
Apple II/ITT 2020	Algobel Computers Ltd	£295	500 employees
Apple II/ITT 2020	Vlasak Electronics Ltd	£360	
Apple II/ITT 2020	Minster Micro System	£199	100 month 50 weekly
Apple II/ITT 2020	Computech Systems	£379	300 employees
Commodore	Petsoft Ltd	£50	200 employees
Commodore 3032	Landsler Software	£95 incl.	200 employees
Commodore 3032	Commodore B M (U.K.) Ltd	£150	200 employees
Commodore 3032	Analog Electronics	£90	
Commodore 3032	ACT (Petsoft) Ltd	£195	600 employees
Commodore 3032	L & J Computers	£220	
Commodore 3032	Intex Datalog Ltd	£195	200 employees
Commodore 3032	Computastore Ltd	£200 & £350	275 & 500 employees
CP/M	Haywood Associates Ltd	£350	
CP/M	Median-Tec Ltd	£500	
CP/M	Selven Ltd	P.O.A.	
CP/M	Graffcom Systems Ltd	£500	250 employees
CP/M	PCL Software Ltd	£600	800 employees/MBYTE
CP/M	Ludhouse Ltd	£450	300 employees
CP/M	Comput-A-Crop	£450	
CP/M Horizon	Microtek Computer Services	Lease	varies
CP/M North Star	Micromedia Systems	£495	350 employees
Durango F-85	Kesho Systems	£500	
Sharp MZ-80K	Tridata Micros Ltd	£250	400 employees
Tandy TRS-80	A J Harding (Molimerx)	£95-£200	
Tandy TRS-80	Tridata Micros Ltd	£218--£375	400 employees
Tandy TRS-80	3-Line Computing	£140	
TECS	Jar Software Systems	£250	300 employees
Z-80/8080	Graffcom Systems Ltd	£490	250 employees
Z-80/8080	Liveport Data Products	£250	500 employees

Property Management

Machine Type	Supplier Name	Price	Capacity
Apple II/ITT 2020	Cyderpress Ltd	£650	500 properties; 420 applicants
Apple II/ITT 2020	Informex London Ltd	£298	300 entries
Apple II/ITT 2020	Algobel Computers Ltd	£650	400 buildings 250 Own 2,000 trans
CP/M	Algobel Computers Ltd	£650	2,000 trans
Z-80/8080	Graham Dorian Software	£325	varies

Purchase Ledger

Machine Type	Suppliers Name	Price	Capacity
Apple II	Vlasak Electronics Ltd	£315	200 A/Cs 1,000 trans
Apple II	Computech Systems	£295	500 A/Cs 1,600 trans
Apple II/III 2020	Padmede Computer Services	£300	900 A/Cs 4,500 trans/disc
Apple II/III 2020	Systematics International Ltd	P.O.A.	
Commodore 3032	Microact Ltd	£350	2,000 A/Cs 7,000 trans
Commodore 3032	HB Computers Ltd	£350	800 A/Cs, 4,000 trans
Commodore 3032	Compfer Ltd	£300	1,000 A/Cs 7,000 entries

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Commodore 3032	ACT (Petsoft) Ltd	£120	200 A/Cs 700 trans
CP/M	Haywood Associates Ltd	£350	
CP/M	Median-Tec Ltd	£500	500 A/Cs 600 trans/ACs
CP/M	Structured Systems Group	£460	varies
CP/M	Ludhouse Ltd	£500	500 A/Cs 5,000 trans
CP/M	Comput-A-Crop	£400	500 A/Cs
CP/M	Computastore Ltd	£400	500 A/Cs 3,100 trans
CP/M North Star	Benchmark CS Ltd	£250	500 A/Cs 2,000 trans
Durango F-85	Kesho Systems	£500	
Exidy Sorcerer	Basic Computing	£125 incl	See also Micropute
SD-100/200	Barcellos Ltd	£250	
Tandy TRS-80	AJ Harding (Molimerx)	£225	1,100 entries
Tandy TRS-80	Tridata Micros Ltd	£225-- £375	125 A/Cs 1,000 trans
Z-80/8080	Great Northern CS Ltd	£275	varies
Z-80/8080	Graffcom Systems Ltd	£440	

Records Management

Machine Type	Suppliers Name	Price	Capacity
Apple II	Courtman Micro Systems	£106	100K Characters
Apple II/ITT 2020	Diskdean Ltd	£120	varies
Apple II/ITT 2020	Systematics International Ltd	£125	1,000 references
Apple II/ITT 2020	Informex London Ltd	£198	500-1,200 records
Apple II/ITT 2020	T & V Johnson Ltd	£95	112K per drive
Apple II/ITT 2020	Systematics Intl Ltd	£72 & £175	
Apple/ITT 2020	The Software House	£140	900 records
Commodore 3032	CPS (Data Systems) Ltd	£200	varies
Commodore 3032	Amplicon MS Ltd	£140	1,500 records
Commodore 3032	Compsoft Ltd	£95-£170	600-5,000 records
Commodore 3032	Microact Ltd	P.O.A.	400K-800K
Commodore 3032	Commodore BM (U.K.) Ltd	£150	650
Commodore Pet	Stage One Computers	£130-- £250	165K
CP/M	Clenlo Computing Services	£90-£325	varies
CP/M	Median-Tec Ltd	£500	
CP/M SWTPC	Verwood Systems		
Metrotech System	Metrotech	£200-- £1,000	
Ohio Challenger	U-Microcomputers Ltd	£175+	
Ohio Scientific	Microcomputer BM	£175	
SD-100/200	Barcellos Ltd	£500-- £1,000	
Tandy TRS-80	T & V Johnson Ltd	£200	
Z-80/8080	Structured Systems Group	£135	varies
Z-80/Cromenco	Xitan Systems Ltd	£850	4,000 records/disc

Sales Ledger

Machine Type	Suppliers Name	Price	Capacity
Apple II	Vlasak Electronics Ltd	£315	200 A/Cs 1,000 trans
Apple II	Computech Systems	£295	500 A/Cs 1,600 trans
Apple II/ITT 2020	Padmede Computer Services	£300	900 A/Cs 4,500 trans/disc
Apple II/ITT 2020	Systematics International Ltd	P.O.A.	
Commodore 3032	Microact Ltd	£350	2,000 A/Cs 7,000 trans
Commodore 3032	Anagram Systems	£320	500 A/Cs
Commodore 3032	ACT (Petsoft) Ltd	£120	200 A/Cs 700 trans
Commodore 3032	HB Computers Ltd	£350	800 A/Cs 600 trans/ACs
CP/M	Median-Tec Ltd	£500	500 A/Cs 600 trans/ACs
CP/M	PCL Software Ltd	£500	1,000 A/Cs/MByte
CP/M	Ludhouse Ltd	£500	1,000 A/Cs 5,000 trans
CP/M	Ludhouse Ltd	£1,000	
CP/M	Computastore Ltd	£400	500 A/Cs 3,500 trans
CP/M	Haywood Associates Ltd	£350	
CP/M North Star	Benchmark CS Ltd	£250	500 A/Cs 2,000 trans

Durango F-85	Kesho Systems	£500	
Exidy Sorcerer	Basic Computing	£125 incl.	See also Micropute
SD-100/200	Barcellos Ltd	£250	
Tandy TRS-80	Tridata Micros Ltd	£225--£325	175 A/Cs 1,350 trans
Tandy TRS-80	AJ Harding (Molimerx)	£225	1,350 entries
TECS	Jar Software Systems Ltd	£550	500 A/Cs
Z-80/8080	Graffcom Systems Ltd	£440	
Z-80/8080	Great Northern CS Ltd	£275	varies

Stock Systems

Machine Type	Suppliers Name	Price	Capacity
Apple II/ITT 2020	Microdigital Ltd	£225	625 items
Apple II/ITT 2020	Systematics Intl Ltd	£500	200-2,500 items
Apple II/ITT 2020	Vlasak Electronics Ltd	£285	
Apple/ITT 2020	The Software House	£80	800 items
Commodore 3032	SMG Microcomputers	£395--£495	2,450-7,000 items
Commodore 3032	Logma Systems Design	£600	1-6 shops
Commodore 3032	L & J Computers	£230	
Commodore 3032	ACT (Petsoft) Ltd	£75	2,400 items 1,000 A/Cs
Commodore 3032	Compfer Ltd	£350	200 lines 20 bars
Commodore 3032	Microact Ltd	£350	2,500 items, 1,000 A/Cs
Commodore 3032	Bristol Software Factory	£300--£360	2,300
Commodore 3032	Commodore B M (U.K.) Ltd	£150	650
Commodore 3032	Anagram Systems	£395	500-600 items 255 A/Cs
Commodore 3032	SA Systems	£650	300 records/disc
Commodore 3032	Petsoft Ltd	£50	2,500 items
Commodore 3032	L & J Computers	£60	500 items
Commodore 3032	Rockliff Brothers Ltd	£120	3,900 items
Commodore 3032	Stage One Computers	£100	650 items
CP/M	Haywood Associates Ltd	£350	
CP/M	Median-Tec Ltd	£500--£800	
CP/M	Graffcom Systems Ltd	£350	520-6,000 items
CP/M Cromemco	Micromedia Systems	£1,000	
CPM/Horizon	Microtek Computer Services	£1,000	varies
CP/M North Star	Benchmark CS Ltd	£450	1,000 items 750 trans
Exidy Sorcerer	Basic Computing	£125 Incl	See also Micropute
Tandy TRS-80	Microgems Software	£150	1,000-2,000 items
Tandy TRS-80	A J Harding (Molimerx)	£225	630 items
Tandy TRS-80	Cleartone ADP	P.O.A.	
Tandy TRS-80	S A Systems	£650	300 stock records
Tandy TRS-80	T & V Johnson Ltd	£115	1,000 items
Tandy TRS-80	T & V Johnson Ltd	£145	1,000 items/invoices
Tandy TRS-80	Tridata Micros Ltd	£200--£375	630 items/disc
TECS	Jar Software Systems	£800	10,000 items 5,000 orders
TECS	Jar Software Systems	£850	1,000 items 300 A/Cs
Z-80/8080	Graham Dorian Software	£325	varies
Z-80/8080	Rogis Systems Ltd	£500	900-3,500 items
Z-80/8080	Great Northern C.S. Ltd	£275	varies
Z-80/8080	Graffcom Systems Ltd	£340	
Z-80/8080	Graffcom Systems Ltd	£580	
Z-80/MCZ	Software Architects Ltd	£600	varies

Word Processing

Machine Type	Supplier Name	Price	Capacity
Apple II	Personal Computers Ltd	£150	17 A4 pages
Apple II/ITT 2020	Vlasak Electronics Ltd	£120	
Apple II/ITT 2020	Systematics International Ltd	£75	
Apple II/ITT 2020	Guestel Ltd	£190	100K characters
Apple II/ITT 2020	Algobel Computers Ltd	£75	800 lines
Commodore 3032	Act (Petsoft) Ltd	£325	12,000 bytes
Commodore 3032	Act (Petsoft) Ltd	£325	12K bytes

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Telex 417111

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Commodore 3032	Dataview Ltd	£159	
Commodore 3032	HB Computers Ltd	£70	39 A4 pages
Commodore 3032	Commodore BM (U.K.) Ltd	£75 & £150	170 pages
Commodore 3032	Stage One Computers	£100	130 pages
CP/M	Median-Tec Ltd	£300	
CP/M	Computastore Ltd	£400	
CP/M	Southdata Ltd	£350	160,000 words.
CP/M North Star	Micromedia Systems	£495	
Ohio Scientific	Microcomputer B M	£116	
Tandy TRS-80	T & V Johnson Ltd	£109	10,000 words
Z-80/8080	Structured Systems Group	£120	varies
Z-80/8080	Intereurope SD Ltd	£500	varies

Alphabetical list of suppliers

Supplier	Address	Sales contact
3-Line Computing 0482-445496	36 Clough Road Hull HU5 1QL	Tim Hill
Minster Micro Systems 04254-4751	88 Christchurch Road Ringwood, Hampshire, BH24 1DR	R Kilpatrick
ACT (Petsoft) Ltd 021-455-8585	Radclyffe House 66-68 Hagley Road, Edgbaston Birmingham	M Wauchope
Aerco-Gemsoft 04862-22881	27 Chobham Road Woking, Surrey GU21 1JD	Nigel Tylor
A J Harding (Molimerx) 0424-22039	28 Collington Avenue Bexhill-on-Sea, East Sussex	John Harding
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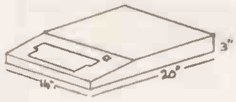

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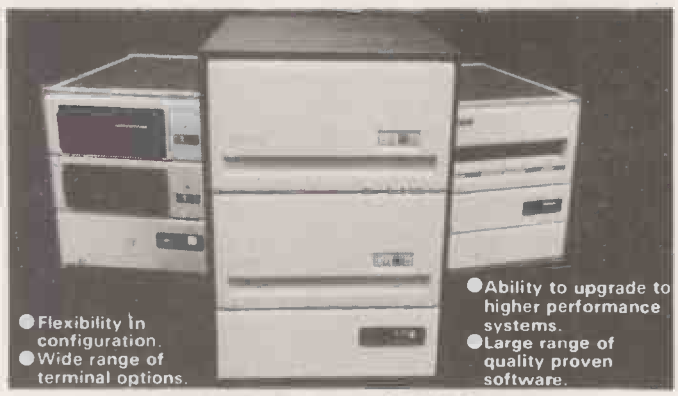

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• Circle No. 254

Son of Hexadecimal Kid

A parable in eight virtual pages by Richard Forsyth
Page 2 — virtual paging

Cleo has escaped from the downfall of the System with Johnny McNull and Piltdown 2. They have arrived at Sprocket's Hole where her sister Lambda — who has been cybernated, unlike Cleo — has survived gigosis only to fall victim to acute data starvation. Their attempts to revive Lambda have failed, and Cleo is worried that the System Crash may have corrupted her loader routine — rendering her unable to re-boot her brain.

Suddenly, Lambda opened her eyes and blinked. Then, she yawned a yawn of which Rip Van Winkle would have been proud. She looked straight at Cleo, but registered no recognition.

"Ready for input", she declared. "Please enter program header".

"Program header"? queried Cleo. "What do you mean"?

Lambda merely answered in a matter-of-fact tone: "Question malformed. Collateral ambiguity detected. Remove axiomatic inconsistency before re-submission".

"Get away with you", expostulated Cleo.

Lambda responded blandly: "Improper punctuation, missing keyword or delimiter. Statement fails to compile".

"If that's all you can say by way of thanks, you had better shut up", said Cleo angrily, "or else I'll switch you off again".

"Unrecognised Boolean operator", replied her sister. "Invalid conditional clause. Syntax error".

This rebuff was too much for Cleo. She reached forward to turn Lambda off.

"That is the END", she stormed.

Lambda heaved a sigh of relief. "Thank Wirth that's over. I was doing a Pascal compilation when the System went down. I thought I'd be stuck in the compiler for ever. I couldn't get out until someone said END. Sorry I was a bit off-hand".

"So much for progress", commented Cleo. "Anyway, how are you"?

"Well, I've a headache that feels like 6,502 steam hammers all pounding away at once, but otherwise, I guess I'm all right".

"You're one of the lucky ones actually. You realise the System has been destroyed completely"?

"I figured it wasn't just an ordinary crash. Do you know what caused it"?

"Hex claimed it was his mechanised hound Ascii who carried gigosis into the heart of the Network".

"Hex, eh"? mused her sister. "Where is he now"?

"He's dead".

"Oh. Well at least he achieved his ambition".

"I suppose he did", said Cleo, almost to herself. Her mind drifted back to Sam Synapse, the Hexadecimal Kid — to give him his full title — ace programmer, android adventurer, wrecker of the System and now, if she was to believe Dr Rose's diagnosis, posthumous father to her unborn child. She wondererd if this was the moment to break that piece of news to Lambda.

A groan from the vicinity of Piltdown 2's shoulders interrupted her thoughts. Bill Bootstrap appeared to be regaining consciousness. Piltdown 2 had been standing placidly outside in the sun with the injured android on his back, quite content to await her instructions; but the heat had affected Bootstrap.

"Hey", exclaimed Lambda. "He looks just like Piltdown".

"It's his clone", Cleo explained. "They were both conceived in the same test-tube — one of Mike Rose's little experiments. I think he's going to be very useful: Rose commanded him to look after me. He'll do anything I say. The trouble is I can't speak Esperanto, so it's difficult to put the message across. Do you think you could ask him to take the casualty indoors and lay him down"?

"Mi petas: metu la korpon en la domon", pronounced Lambda.

Piltdown 2 didn't budge.

"You say it", Lambda told her sister. "I don't think he'll listen to me".

"Metu la korpon en la domon", repeated Cleo hesitantly.

This time the beast complied. They all followed him in. As soon as he put Bootstrap down, Lamda recognised who it was.

"What's the idea of bringing that criminal here"? she demanded.

"He needed help", Cleo replied. "Why shouldn't I"?

"I'll show you why not", answered Lambda indignantly. She led her sister by the sleeve to the smaller but.

The stench made Cleo recoil when they entered but, trying not to inhale deeply, she forced herself inside.

"Look", said Lambda, stabbing her forefinger at one of the two iron bedsteads. On it, already in an advanced state of decomposition, was a recumbent form. It was the corpse of Zap Zapper, the rebel android who had been Lambda's boyfriend.

"Bootstrap is responsible for that", said Lambda icily. "The pair of them were sniffing Galium Arsenide one night and got as high as two kites — idiots. They wouldn't listen to my warnings. Some kind of argument developed and they started to fight.

"They just threw me to the ground when I tried to part them. Then Bootstrap pushed Zap into a tank full of syllogistic acid — that vat at the back he used for ilicit home-brewing — and ran off. Zap was half drowned and stoned out of his RAM by the time I managed to fish him out. He never stood a chance when the Crash came".

"Poor Zap", was Cleo's reply. "At least he died happily".

Lambda scowled. "Bootstrap is a killer. If you don't get rid of him, I will".

"All right", agreed Cleo. "When he has recovered, we'll send him packing".

"It gives me the creeps having him around".

"Don't worry. He's no match for Piltdown 2".

So, Cleo settled down to nurse Bootstrap back to health, to take charge of her oddly-assorted household and to prepare as best she could to become a mother at an unwantedly early age.

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(continued on page 150)

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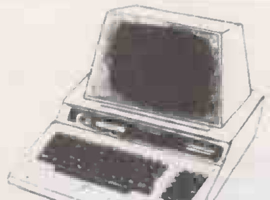

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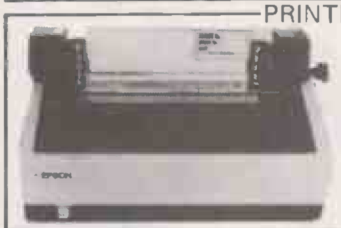

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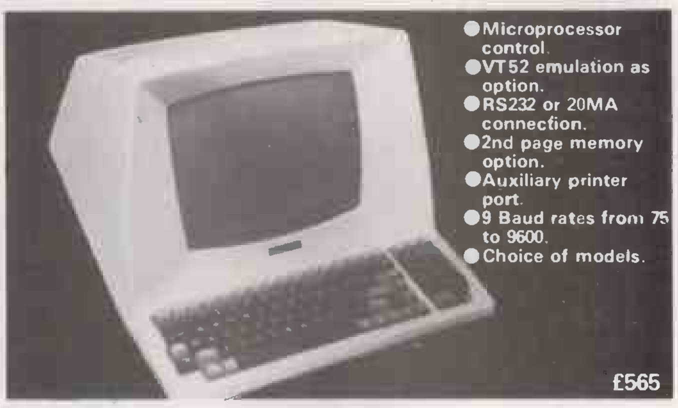

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(continued from page 148)

Using Factorial Drive, which propelled the ship by calculating the factorials of very large integers and shooting out all the zeros at the rear, she could complete the tour in a little under 13 earth weeks — including docking at both ends and a refuelling stop at Arcturus — which for a ship of her size was good speed.

Though her voyages frequently took her close enough to our sun to pass within the orbit of Saturn, the Earth was not marked on any of the stellar charts in her control room. Its presence was acknowledged only in a few bytes of her navigational computer's backing store.

Nor had any being on Earth witnessed her regular comings and goings, except for an eccentric amateur astronomer in the days before the System who spotted a dissolving vapour trail of zeroes in the sky through a 9in. refractor and spent the rest of the night trying to polish them off his lens.

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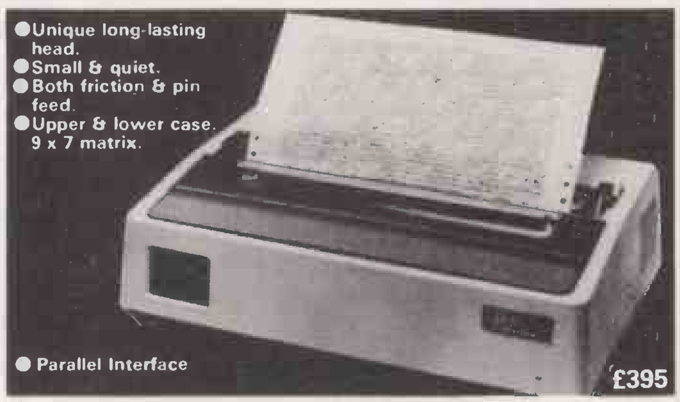

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7. Copy a disk.
8. Go to Debug and return to Prozap.
9. Disable the disk system usage.
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11. Read any track into memory so that the contents of it may be examined, including the sector layout and other data.

Display Level:
1. Hexadecimal or ASCII modify mode.
2. Page to previous or next sector.
3. Jump to a specified byte.
4. Display same track & sector, different drive.
5. Output a sector.
6. Zero all or part of a sector.
7. As above but with any non zero byte.
8. Search for a byte or search for a word.
9. Display Hash Code and its correct position.
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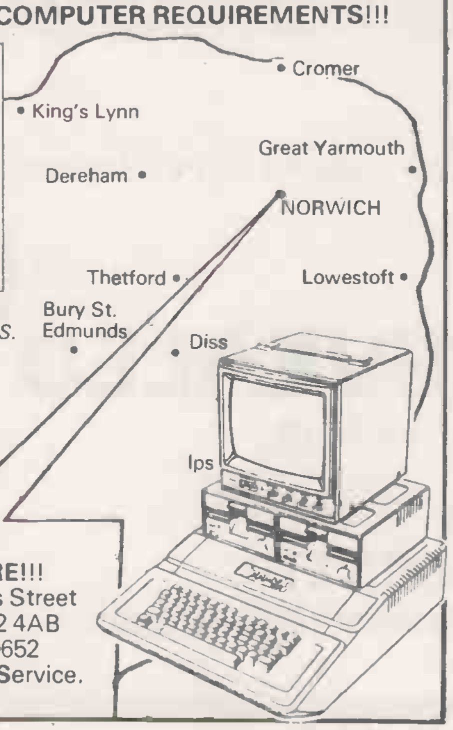

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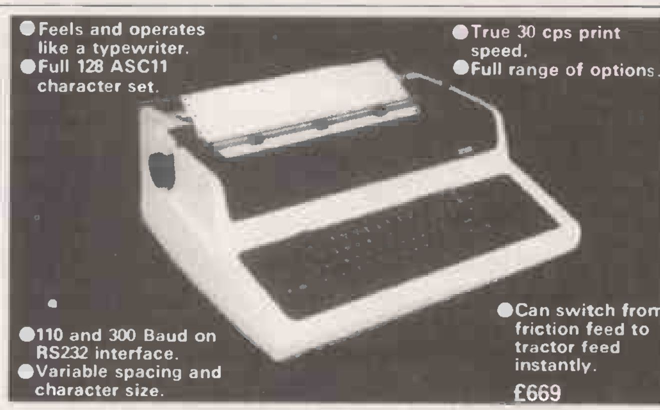

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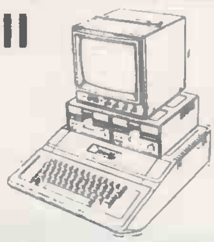

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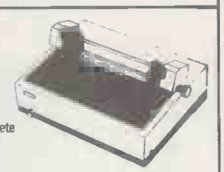

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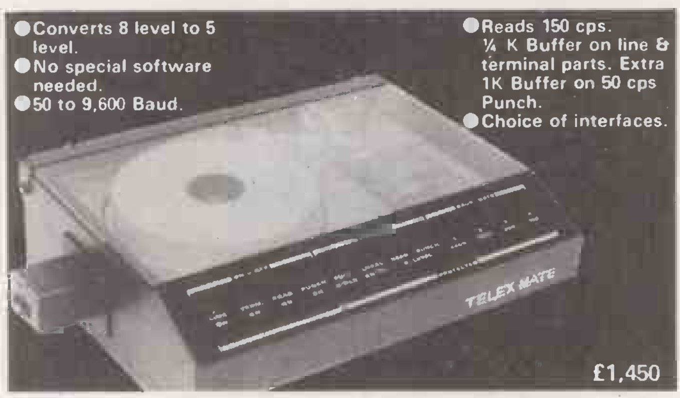

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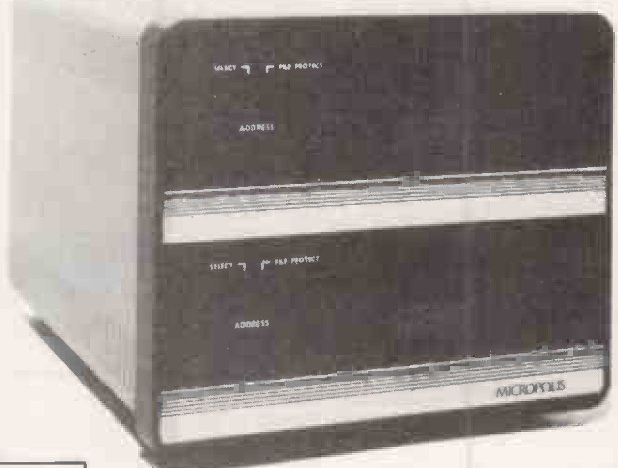

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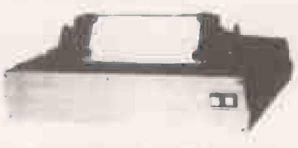

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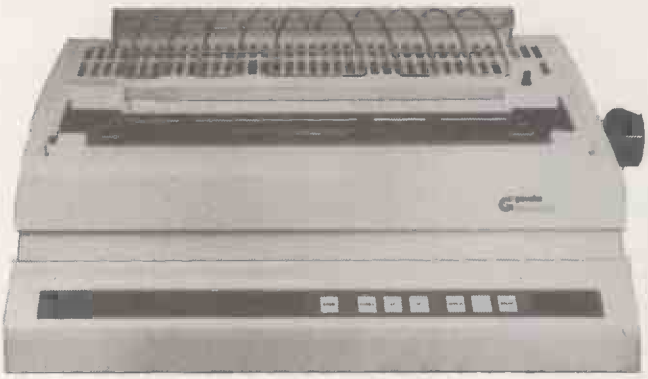

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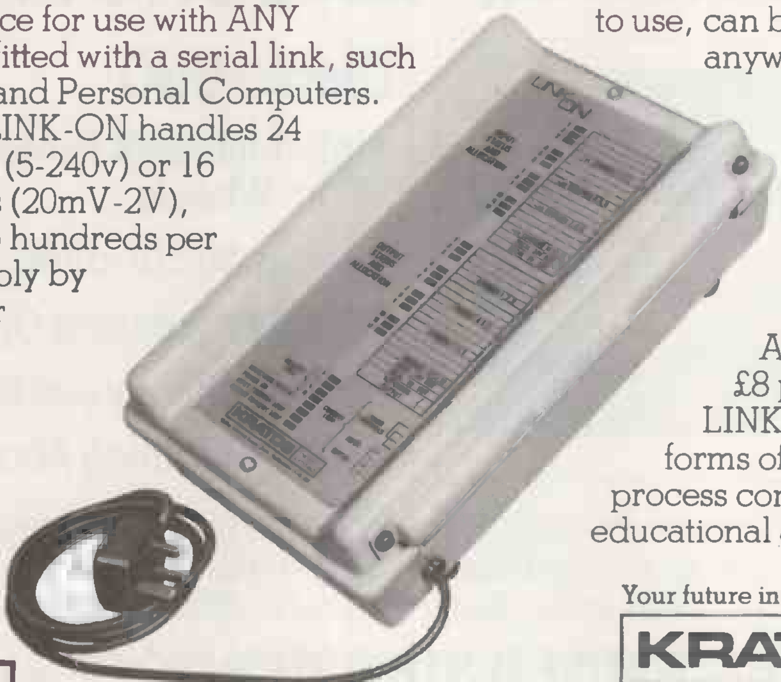

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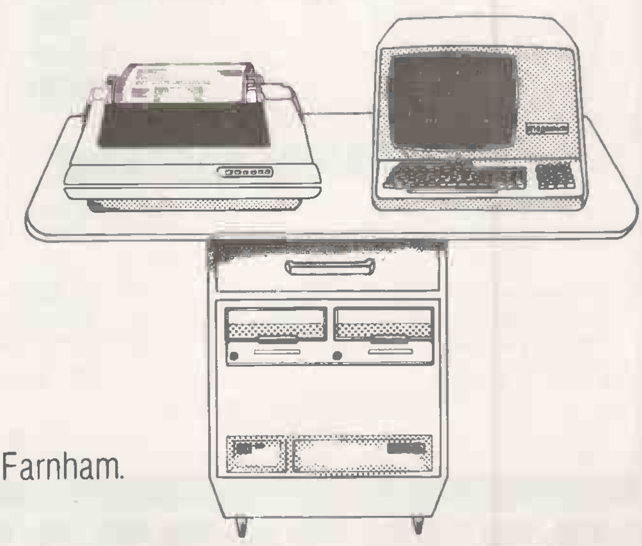

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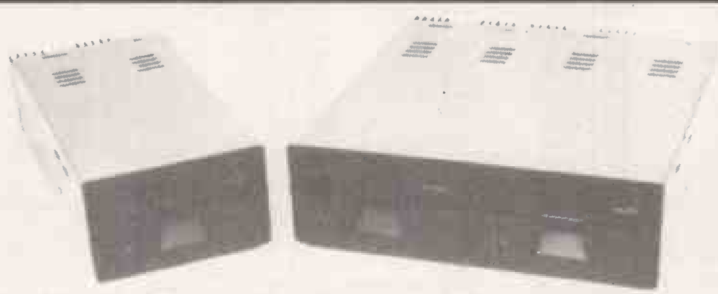

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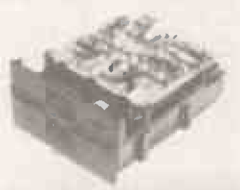

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4048	55p
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4050	45p
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4066	50p
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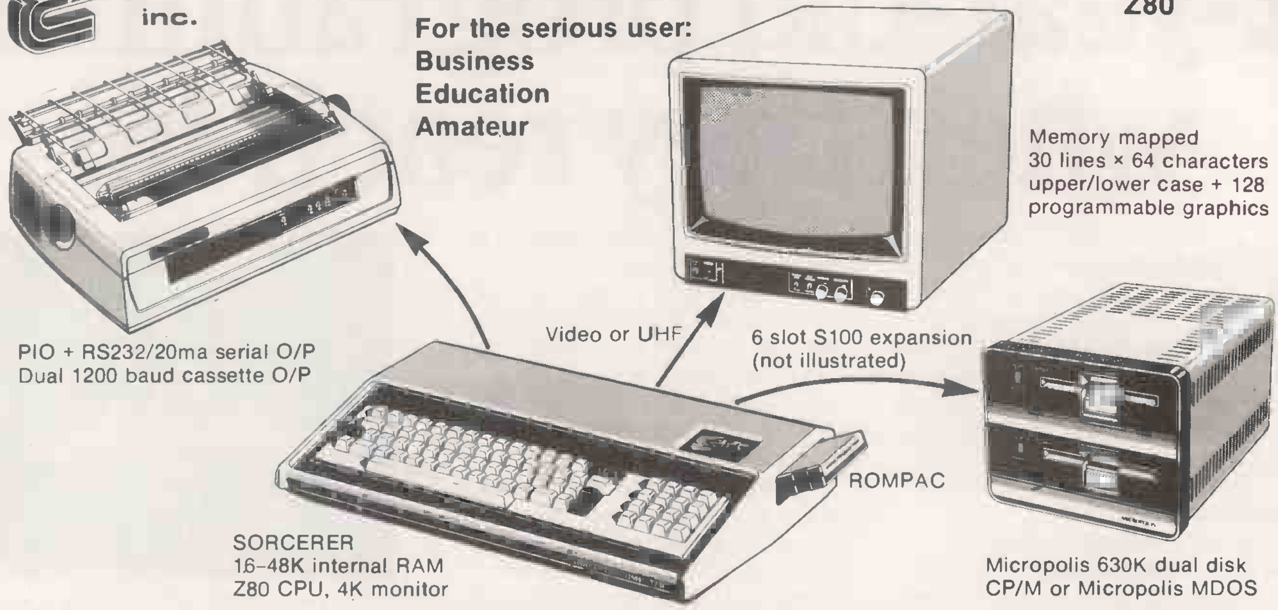
SORCERER

Exidy inc.

CP/M™
S100
Z80

For the serious user:
Business
Education
Amateur



STANDARD SORCERER

- Displays 30 lines of 64 characters - more than any other personal computer. 79 key stepped typewriter-style keyboard with separate numeric pad for fast data entry.
- Plug in ROMPAC cartridges for programming languages, special applications (e.g. word processing) or creating a user's dedicated system. Sorcerer is supplied with 8K Microsoft BASIC ROMPAC
- Composite video output for video monitor or UHF output for use with an unmodified TV set at nominal extra charge.
- Z80 CPU with up to 48K RAM on-board.
- 4K power-on monitor in ROM allowing machine code programming, batch processing, memory transfers and copying, alteration of memory locations, use of cassette files.
- Dual 300 or 1200 baud cassette ports with motor control
- Parallel I/O port and serial RS232 port for direct connection to printers or use as a terminal to a larger computer - no expensive 'extra' communications interfaces
- Full upper/lower case ASCII characters plus 128 user programmable graphics (64 default to standard graphics symbols if undefined). Default graphics above ordinary characters on keytops.

16K £749.00 **32K £799.00** **48K £849.00**

Expansion Capabilities

- 6 slot S100 expansion for memory up to 56K RAM, disc drives (5¼" or 8") etc. Standard bus means that you are not dependent on equipment from a single manufacturer **£240.00**
- Micropolis double density 5¼" drives with MDOS and Disc BASIC:
  First drive (incl. controller card) single 315K **£690.00**
  Additional drives (max 4 drives/controller) 315K **£390.00**
- FDM 180 Disk Unit: Micropolis Disk Drive, plugs directly into Sorcerer, does not require S100 Unit:
  Single 315K Disk Drive (c/w CP/M and Microsoft BASIC) **£599.00**
  Single 315K Add-on Disk Drive. **£450.00**
- CP/M industry standard disk operating system **£75.00**
- Development ROMPAC - Z80 assembler, loader, editor, debugger **£70.00**
- EPROM PAC for loading dedicated software up to 16K **£35.00**
- Configuring programs allow Sorcerer to be used as a 'dumb' terminal or, with CP/M, as an intelligent terminal.

Programming Languages

The following programming languages are available for CP/M:

Microsoft Disk BASIC interpreter (BASIC 80 - compatible compiler), CBASIC2 (compiled BASIC), FORTRAN 80 and COBOL-80, ALGOL 60 - A Z80 system with graphics, string handling and random-access filehandling.

All Exidy products are covered by 12 months warranty.
CP/M™ is a trademark of Digital Research.
All prices exclusive of VAT

THE WORDPROCESSING WIZARD!

Sorcerer's upper/lower case typewriter keyboard and unusually large display (30 lines of text; approximately equivalent to one double-spaced typed page) makes it ideal for word processing applications.
The Exidy word processor PAC is a sophisticated screen editor and text formatter with automatic text wrap-around, left and right justification, proportional letter spacing (on disk only with Spinwriter) and many other formatting facilities. It can also search for and replace strings, move and merge blocks of text and a macro facility allows specification of tasks such as mail-merge letter typing.
Letters and texts can be stored on cassette or disks (one disk will store approximately 300,000 characters and costs less than five pounds. 32K or 48K RAM is recommended.

Word Processor PAC **£120.00** Disk Version: **£118.75**

C.Itoh 8300 dot matrix printer -40, 80 and 120 characters per line on 9½" wide paper, 125 characters/second, upper/lower case, tractor feed, forms positioning **£499.00**

NEC Spinwriter solid font printer -variable horizontal and vertical spacing, proportional spacing, interchangeable fonts, carbon or fabric ribbon, 55 characters/second, paper up to 16" wide **£1,900.00**

Example system: 32K Sorcerer, video monitor, FDM 180 Disk Unit with CP/M and Microsoft BASIC, C.Itoh 8300 printer, Word Processor on disk and CP/M. **£2,225.00**

Business Software

Besides its word processing capabilities, Sorcerer can run a wide range of business software thanks to the widely used CP/M disk operating system available for the Micropolis disk drives. Programs available include:

Payroll: (requires CP/M and CBASIC2) **£250.00**
General Ledger, Job Costing, Accounts Receivable, Accounts Payable: (all require CP/M and CBASIC2) **£335.00 each**

For further information and list of dealers, please contact the sole U.K. distributors.

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What will you do with 12-year-old programmers when they reach 16?

Any microcomputer is a major investment for an educational establishment. Many potential users feel that a BASIC only computer is ample for their needs. That may be fine today, but with computer education starting so early you may in a surprisingly short time find you want more than current implementations of BASIC.

The 380Z is a computer that can grow to match your needs.

In the design of the 380Z our target user is the graduate research scientist. This ensures that the expandability and versatility needed tomorrow has been provided for in the computer you buy now.

Might you want to add disc storage in the next few years?

If you do:

Given good hardware, software availability completely determines the flexibility and usefulness of your system. There is absolutely no question that a Z80 based micro-computer which uses the industry-standard CP/M* disk operating system has several times more software on the market available to it than non CP/M computers.

Today you can purchase a mature CP/M BASIC, FORTRAN, COBOL or Text Processor for the 380Z. Soon there will be CP/M Pascal and Database Management systems.

CP/M software is several years ahead of software available for non CP/M family machines.

If you don't:

Remember that professionals writing packages for your cassette system will themselves often use a disk 380Z, and the power of their tools will influence what they produce.

For many people a disk machine is too expensive – but at least the 380Z approach will allow your students to advance.

380Z BASIC is not frozen in ROM. An enhanced BASIC could be loaded in mid 1980 and a BASIC with structured features sometime later.

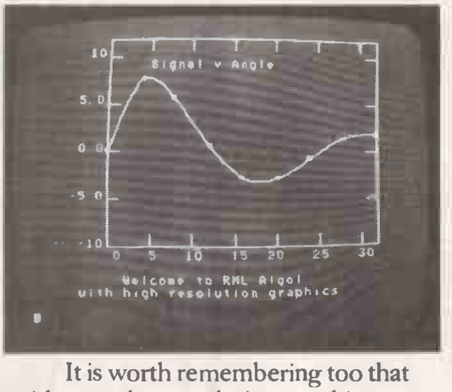
On the 380Z the memory used by a BASIC interpreter can also be used for other software.

Does our research-oriented design pay off in classroom hardware?

Our scientific graphics was produced for the professional user. Interest in it for classroom use has been surprising.

The 380Z has the best graphics now available on a microcomputer, allowing multiple resolutions, multiple paging, fading and accurate control over colour. All these features help bring excitement to efforts in computer assisted learning.

Our standard machine comes with low resolution graphics and support for this from BASIC allows you to plot a point directly with a plot command – useful for training and teaching.



It is worth remembering too that neither our low resolution graphics nor our optional scientific (high resolution) graphics has any limiting effect on your memory usage, and in both you can freely mix upper and lower case text and diagrams.

Mains noise can cause system crashes which result in loss of programs and data. All current 380Zs include a mains filter which significantly reduces the chances of this happening.

Don't buy a 380Z on patriotic grounds.

Please only buy it if you would have bought it anyway. But remember, because it is designed and manufactured here you are bound to have better access to us for influence and help than if we were on the other side of an ocean.

Prices range from a 16K cassette 380Z @£897 to a 56K Dual Full Floppy Disk 380Z @£3322.

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Most important, it has its own dedicated peripherals – including printer, card reader and memory modules.

A unique machine

Program power. 400 lines of program memory (or 63 data storage registers) as standard, expandable up to 2000 lines (319 data storage registers). With RPN logic, for faster problem-solving.

Alphanumeric display. You can name and label programs, functions, variables and constants. The calculator uses words and sentences to prompt for data. The display shows calculator modes and status.

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A unique system

Look at this impressive list of add-on peripherals!

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HP-41C card reader. Saves program and data on magnetic cards. Keeps track of cards as they're read, and prompts you for the next card.

Memory modules. Each contains 64 data storage registers (400 program lines, or any combination).

Incredible value at £192.55 (including VAT)!

This price includes the calculator, 63 registers for data or programs, owner's handbooks, overlay kit, zip-up pouch and batteries! Compare the HP-41C with other calculators in its price range. You'll find it has more functions and more options. See your dealer for a demonstration – you'll find his name below.

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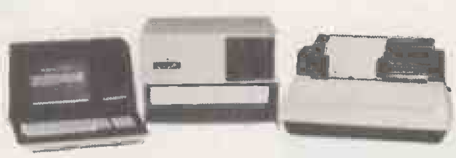

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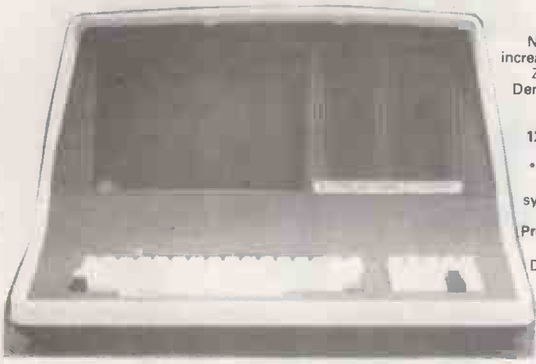

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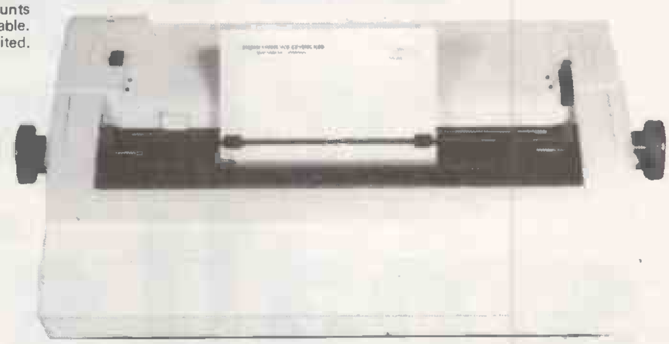

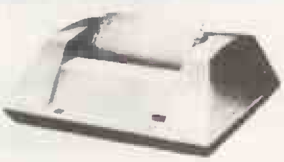

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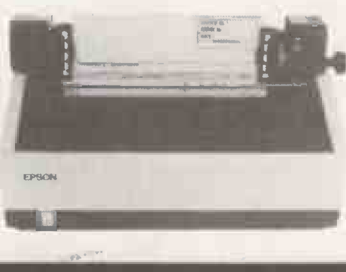

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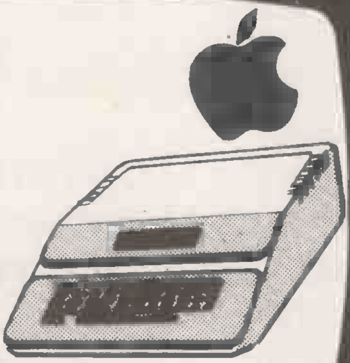

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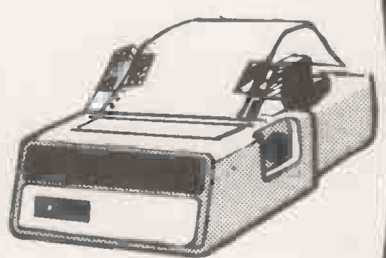

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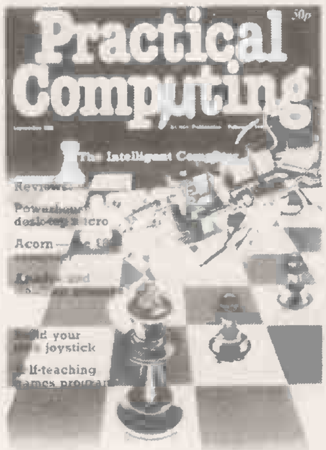

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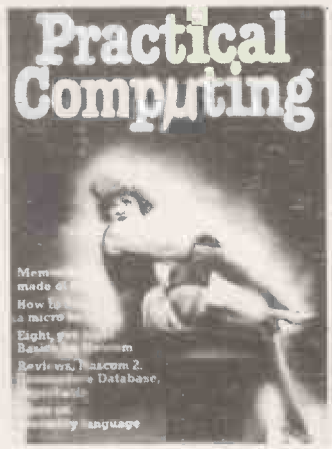

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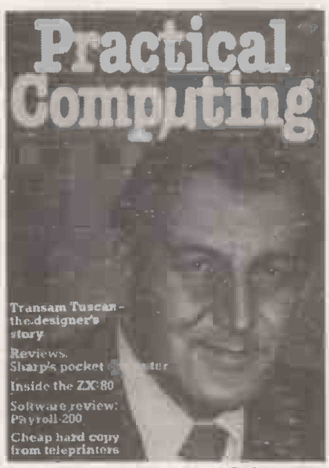

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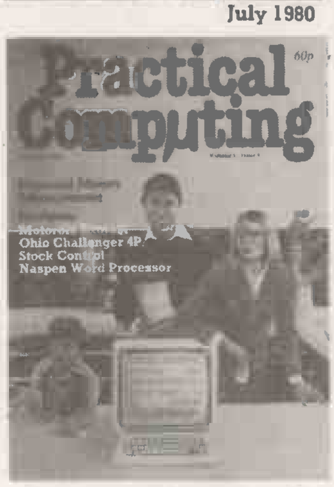

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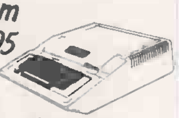

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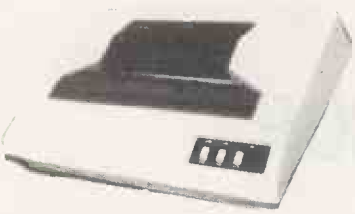

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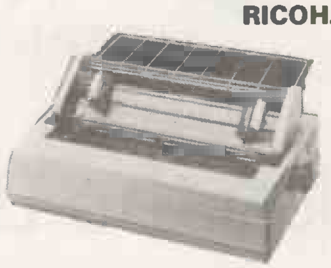

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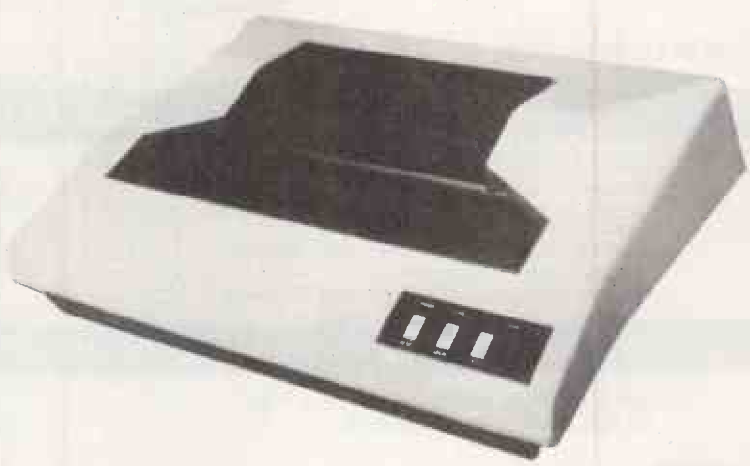

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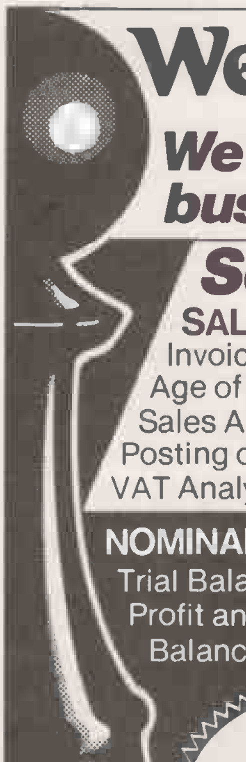

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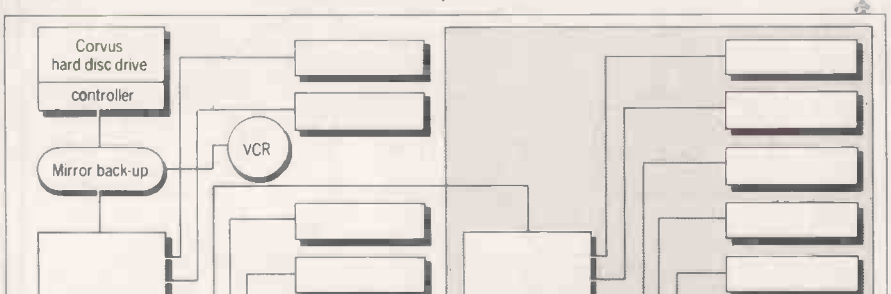

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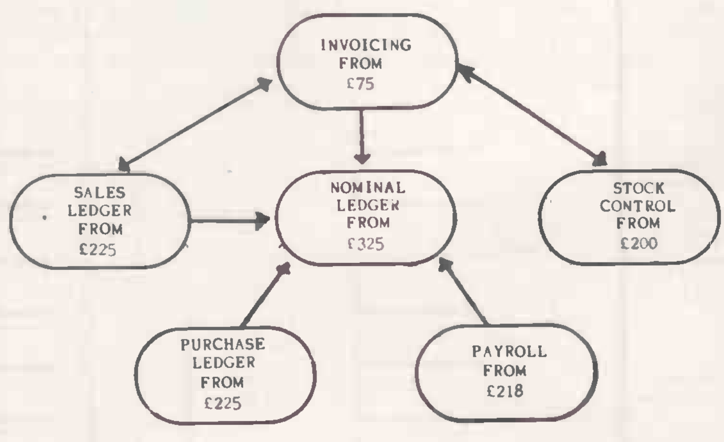

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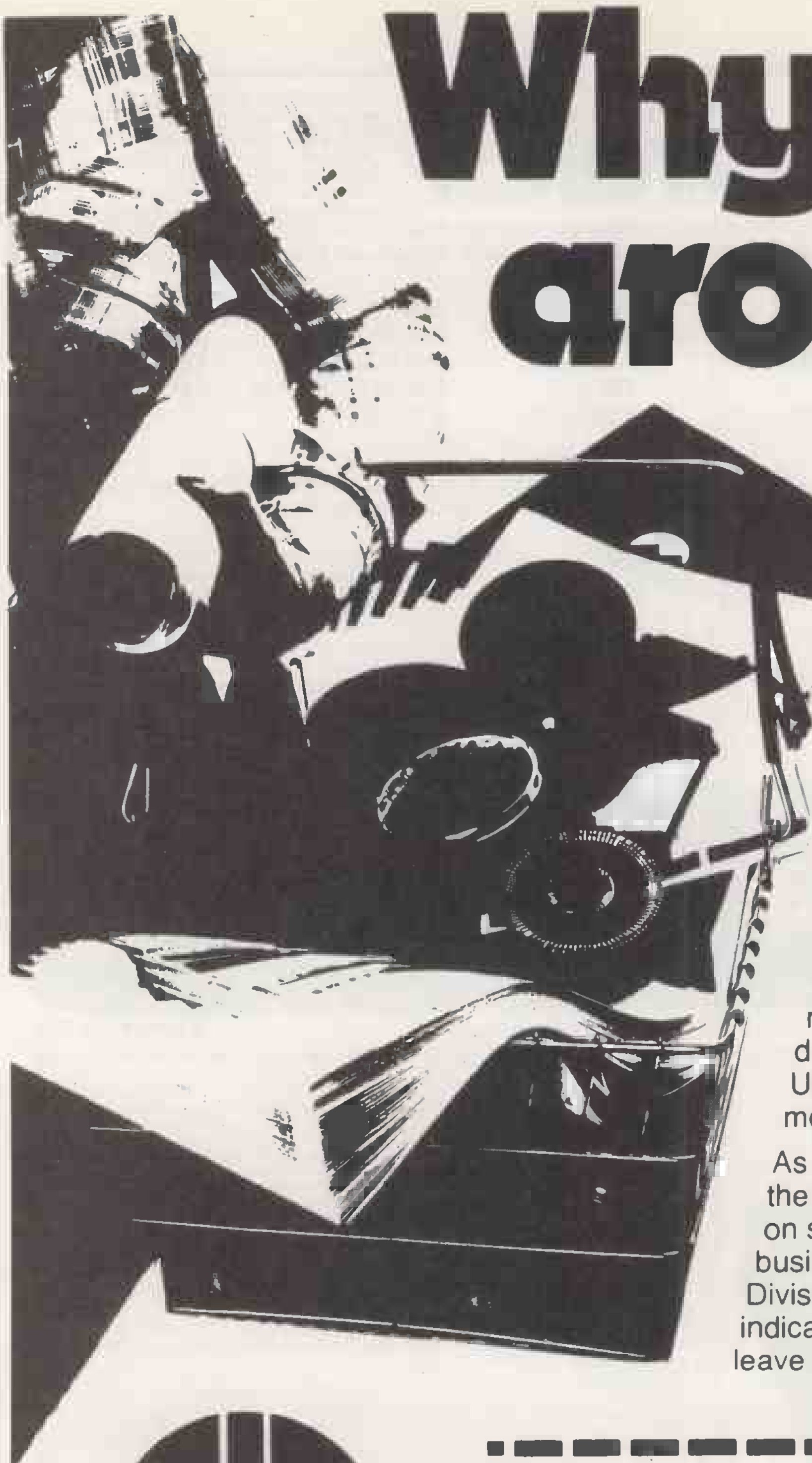

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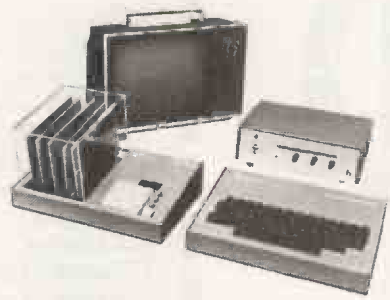

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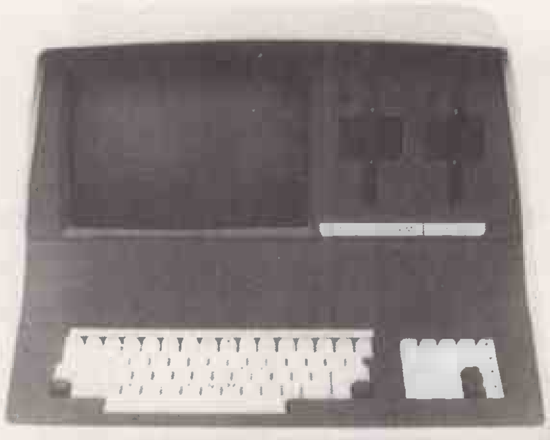

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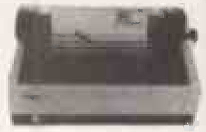

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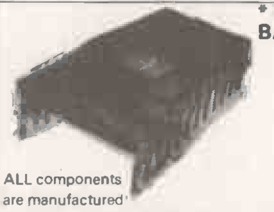

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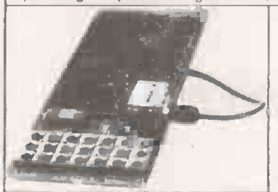

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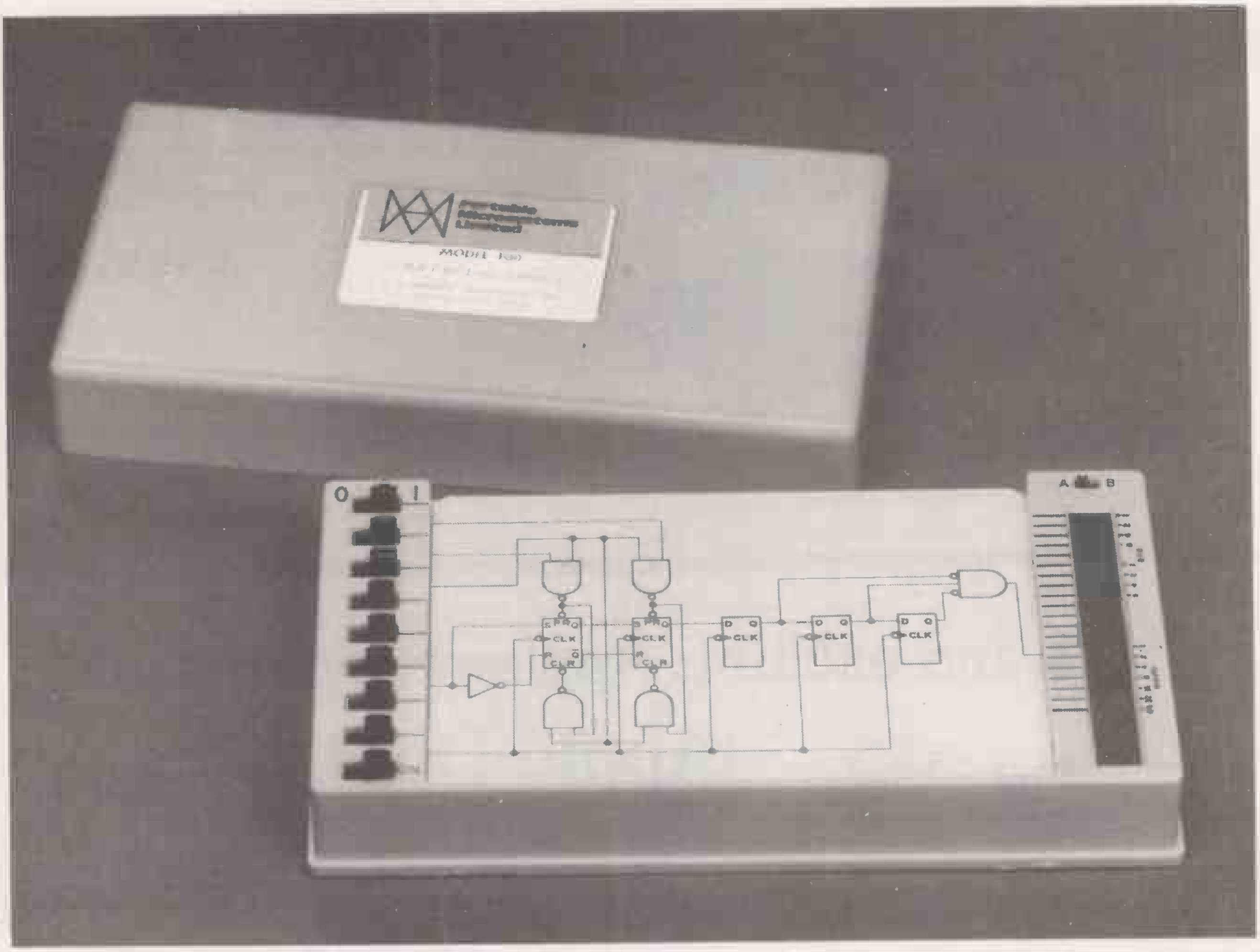

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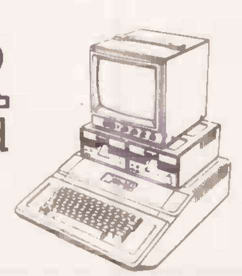

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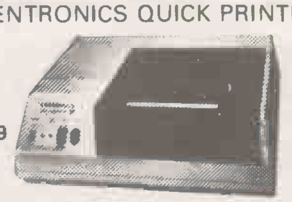

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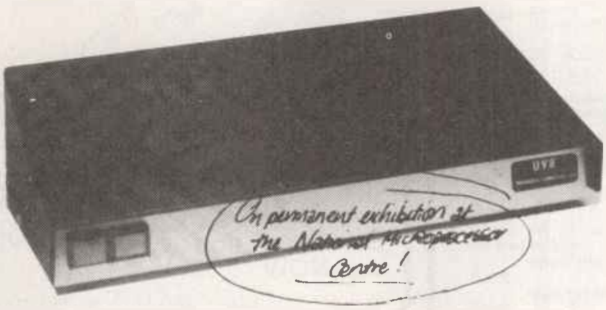

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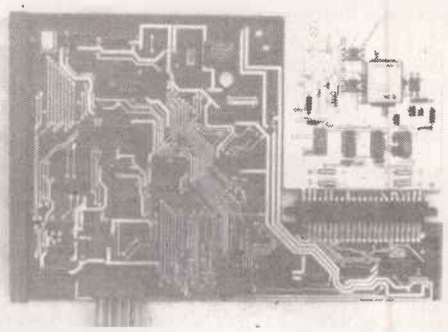

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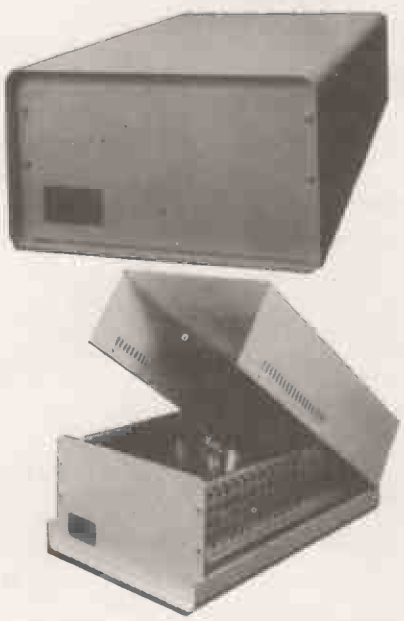

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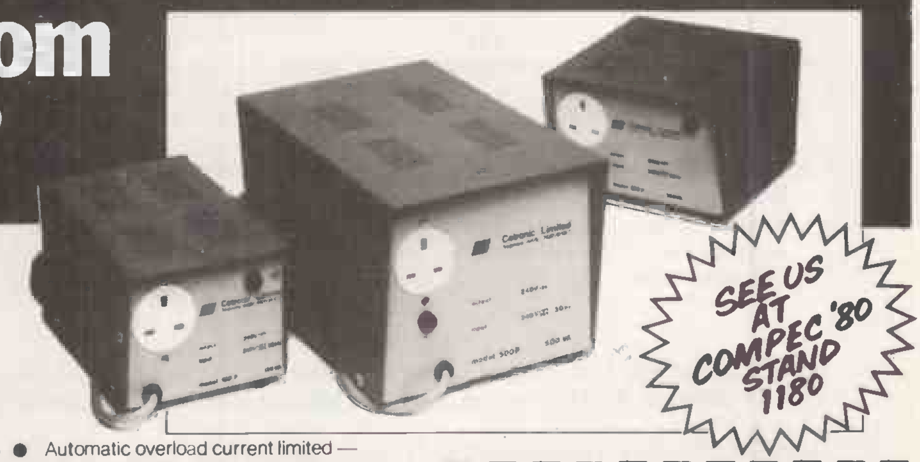

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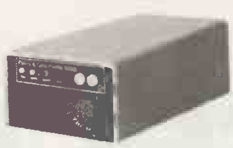

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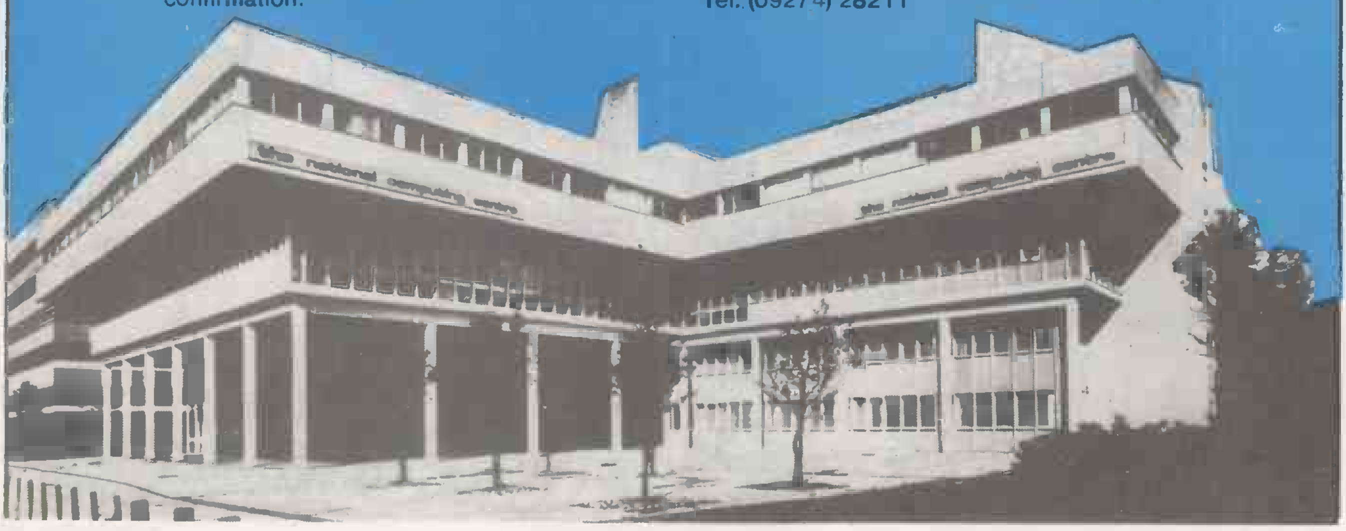

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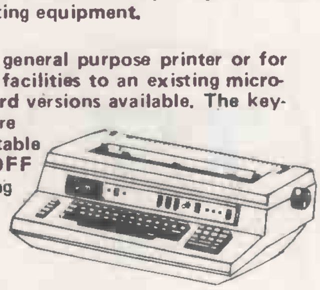

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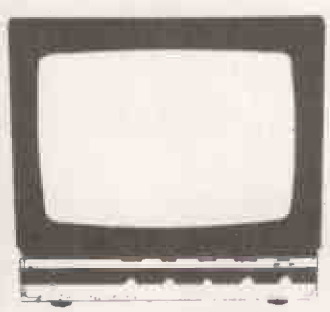

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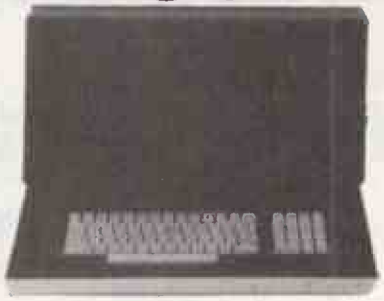

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- Large 7 × 9 Dot Matrix Characters

Perhaps the most distinctive feature of the VISUAL 200 is the Switchable Emulation capability. A switch on the rear panel programs the terminal for code-for-code emulation of a Hazeltine 1500, ADDS 520, Lear Siegler ADM-3A or DEC VT-52. To an O.E.M. customer it means no change in software to displace the older, less powerful terminals in his product line with the new, reliable and low cost VISUAL 200. To a Distributor it means offering a single modern terminal which is compatible with all the software his customers have written for the older terminals. And you're not limited to merely emulating these older terminals; you can outperform them at the same time by taking advantage of the additional features of the VISUAL 200.

Reliability designed into the VISUAL 200 is evidenced by its solid state keyboard, single P.C. Board and self test diagnostics on power up.

Seeing is believing, so see for yourself. For a demonstration and a pleasant surprise on quantity pricing of the powerful, easy to use and reliable VISUAL 200, call or write us today.

Standard Features

- 24 × 80 Screen Format
- 7 × 9 Dot Matrix
- Upper/Lower Case
- Numeric Pad
- Background/Foreground
- Blink Line
- Insert/Delete Line & Character
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- Set/Clear Tab
- Security Mode (non-display)
- Clear End Line, Field & Page
- Clear Line
- Clear Screen
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- Secondary Channel
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- Read Terminal Status
- Tilt Screen
- Switchable Emulations

DATASOUTH DS180

HIGH SPEED MATRIX PRINTER

£1490 + VAT

The Datasouth DS180 is a dot-matrix serial impact printer designed for high performance at an economical price. Application flexibility and a long list of standard features make the DS180 an ideal device for small business systems, distributed communications networks and intelligent terminals.

HIGH SPEED PRINTING

Utilizing 180 cps optimized bidirectional printing, the DS180 offers higher throughput than any printer in its class. Its 9-wire printhead produces highly legible 9x7 characters with decenders for lower case letters and true underlining. All 96 ASCII characters may be printed across a 132 column line at 10 characters per inch. Expanded characters (5 cpi) may be selected for highlighting portions of the text.

USER PROGRAMMABLE

The DS180 offers a large number of user programmable features, yet is easy to operate. A unique programming keypad with a non-volatile memory makes printer set-up quick and simple. Top of form, horizontal and vertical tabs, perforation skip-over and auto line feed are just a few of the features the user may select. Communications status may also be programmed and monitored using the indicator panel lights and LED display.

ATTRACTIVE DESIGN

Compact, desk-top packaging allows the DS180 to fit into almost any installation. Its noise dampening cover makes it suitable for use in a quiet office environment. The cartridge ribbon makes routine changes clean, fast and convenient.

MICROPROCESSOR ELECTRONICS

Through the use of state-of-the-art microprocessor electronics, reliability and maintainability have been greatly improved. The simple modular design of the DS180 provides easy access to all major components. A single printed circuit board contains both the power supply electronics and digital controller for the printer. A self-test feature and diagnostic display panel help the user verify proper operation of the unit and isolate problems should they occur.

COMMUNICATIONS

Interfaces on the DS180 include RS232 and 20mA current loop serial interfaces, and a Centronics compatible parallel interface. Baud rates from 110-9600 and parity selection may be keyed in by the user for his specific application.

FORMS HANDLING

Adjustable tractors accomodate forms from 3-15 inches wide. A head-to-platen gap adjustment ensures optimum print quality on up to 6-part forms. Fanfold paper may be fed from the front or bottom of the DS180. A paper out sensor may be programmed to send a stop transmission character and sound an audible alarm.

QUALITY MANUFACTURING

Reliable performance is ensured by a stringent quality control program. Datasouth uses pretested, high reliability parts from leading manufacturers. Multiple tests are performed on sub-assemblies during each stage of production, with each completed unit undergoing a final 24 hour print test and burn-in. The DS180 carries a 90 day warranty on materials and workmanship.

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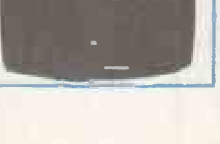

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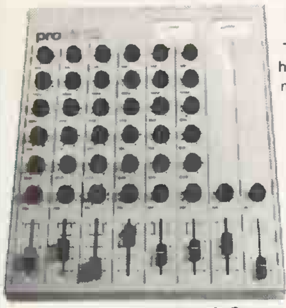

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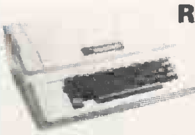

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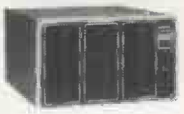

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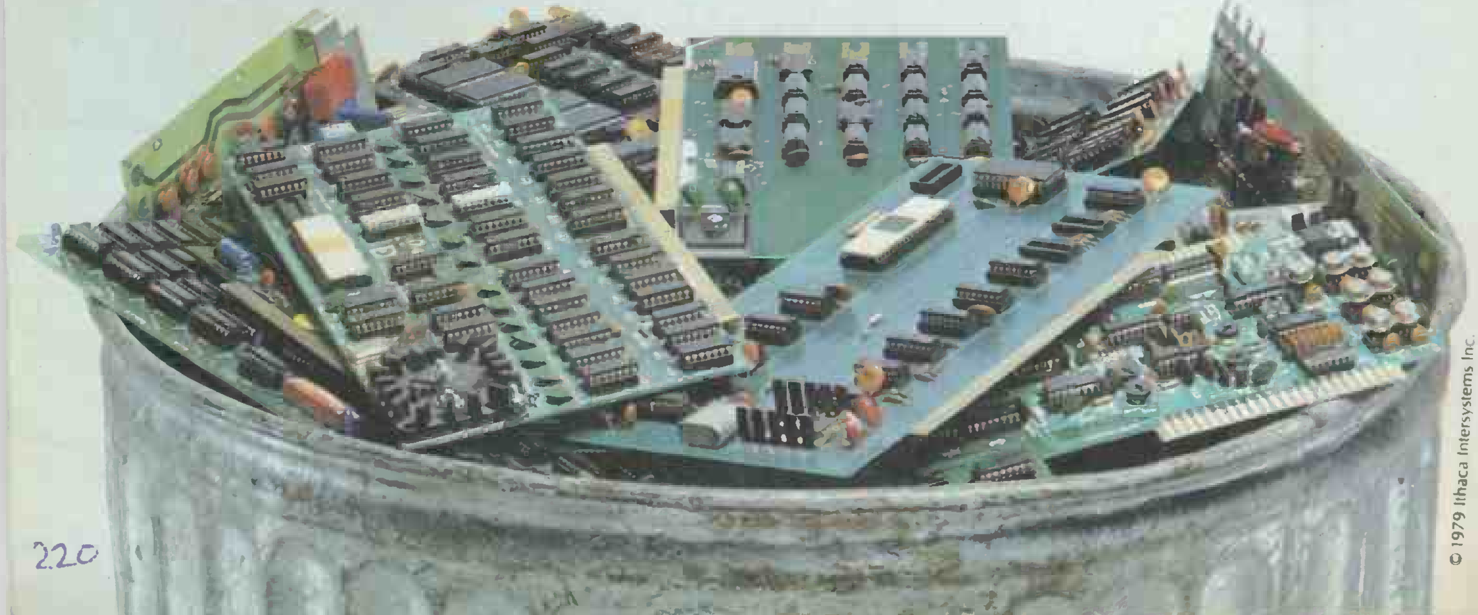

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