Practical Computing

50p

September 1979

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The Intelligent Computer

Reviews:

Powerhouse desk-top micro

Acorn — the £80 computer

Anadex and Heathkit printers

Build your own joystick

Self-teaching games program

● Circle No. 101

Practical Computing

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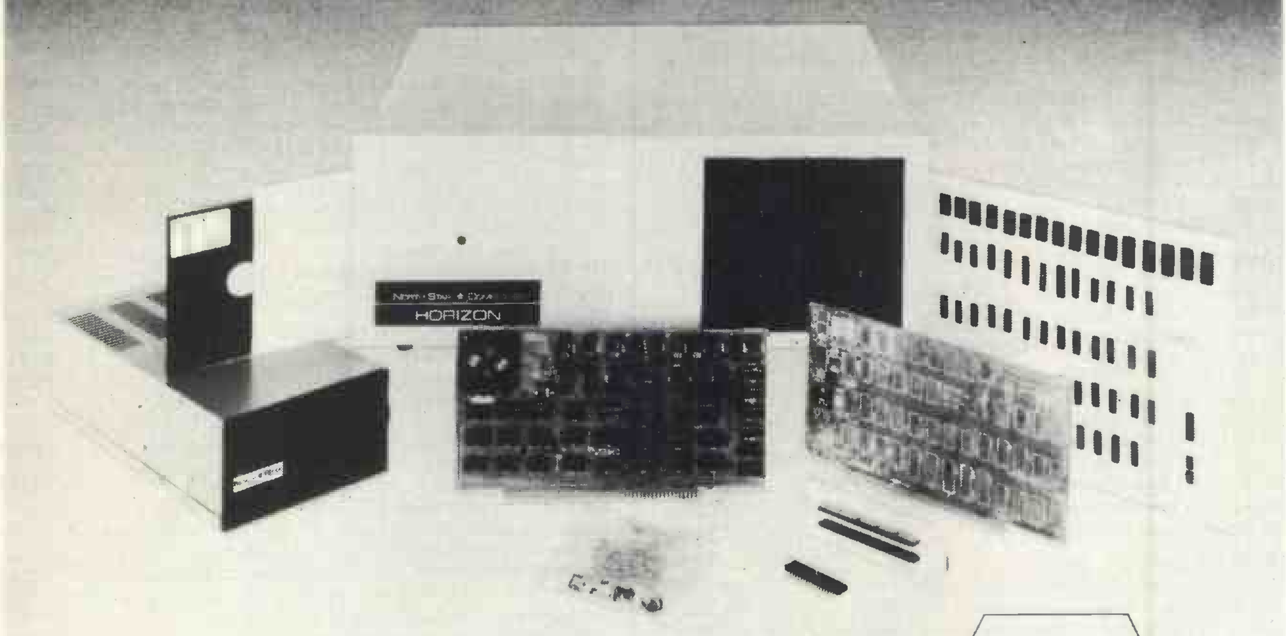

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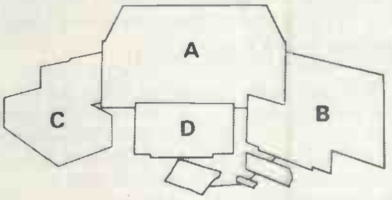

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High Speed Serial Interface Card

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DISASSEMBLER Can even display the PET's ROMs, and search them for strings of characters or patterns of hexadecimal bytes. Outputs to screen or printer.

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- **Comprehensive cursor controls**
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- **Cursor command codes can be displayed using:-**
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  TV monitor, or Modified TV set.

V28 I/O

- **High/low rates externally switchable and jumper selectable from:-**
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  220/110 bits/sec. (NOTE: at high receive speeds, remote software should allow 8.3 ms for CR, LF and 132 ms for Clear)
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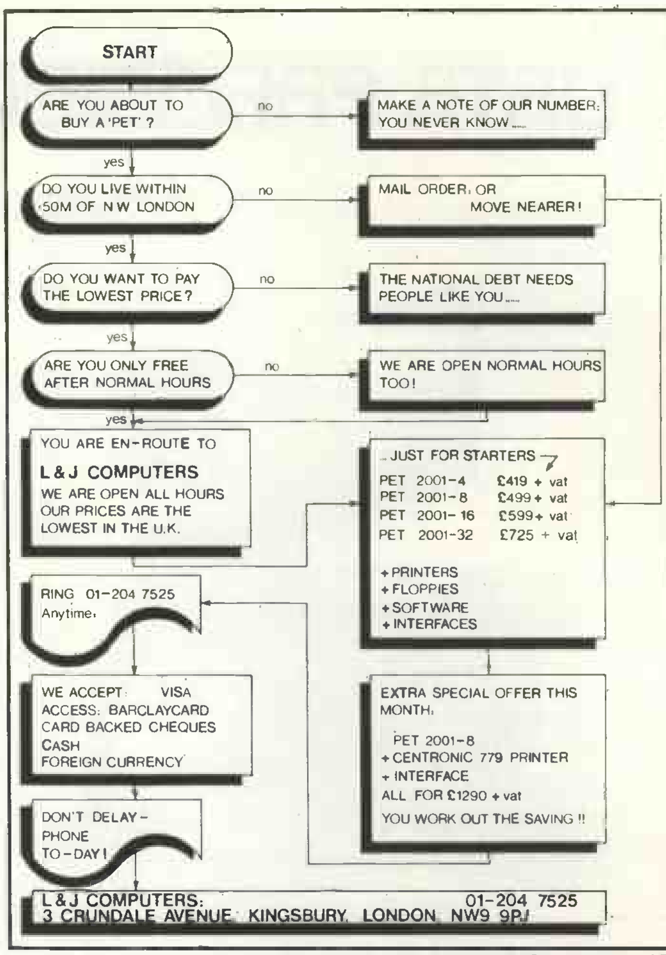

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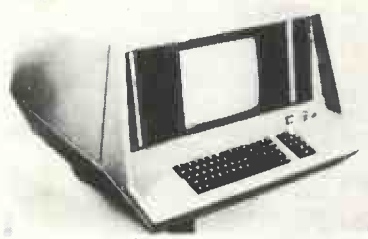

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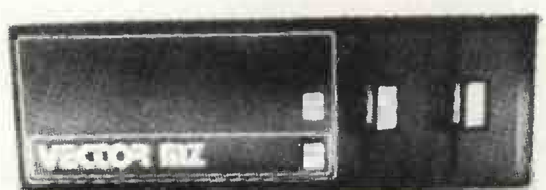

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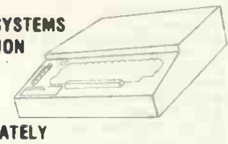

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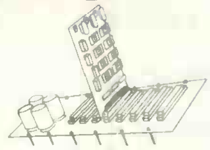

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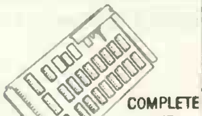

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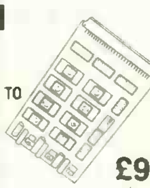

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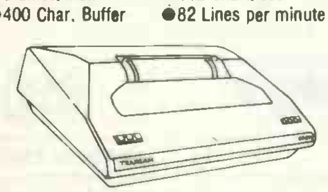

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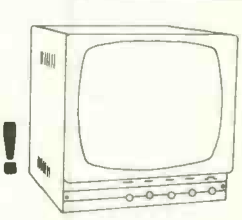

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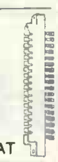

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SN74LS47N	.95	SN74LS132N	.75	SN74LS192N	1.45	SN74LS295AN	2.20	SN74LS668N	95
SN74LS48N	.95	SN74LS133N	.39	SN74LS193N	1.75	SN74LS298N	2.20	SN74LS669N	95
SN74LS49N	1.09	SN74LS136N	.40	SN74LS194AN	1.89	SN74LS324N	1.80	SN74LS670N	2.70

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SUPPORT		RAMS	
8212	2 20	2101	2.32
8216	2.20	2102L-4	1 20
8224	2 80	2111	2 32
8226	2 20	2112	2.46
8228	4 20	6810	4.08
8238	4 20	8154	8 18
8245	11 00	2114	5.50
8246	11.00	2102L-3	1.60
8251	5.00	74C920	11.00
8253	11 00	74C921	11 00
8255	5.00	74C929	11 00
8257	11 00	4027	11 00
8259	12.50	4044	14 70
8292	18.00	4045	9 15
6820P	4 50	4060	7 00
6821P	4.50	2107	7.80
6850P	4.60	4116	8.00
6852P	5 50	4118	20.00
AY-5-2376	11 50	Z80P10	10.00
MC14411	12 00	Z80CTC	10.00
M57109	12.43	Z80AP10	14.00
M57160	10 00	Z80ACTC	14.00
M57161	10 00	**EPROMS**	
TMS6011	5.00	1702	6.00
81LS95	1.30	520K	8.00
81LS96	1.30	2708	9.00
81LS97	1.30	2516	28.00
81LS98	1.30	2716	22.00

ROMS			
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745472	12 00	LM748CN-8	0.45
74570	8 00	LM748CH	0 46
745473	12.48	LM1458H	0 72
745474	12.48	LM1458N-8	0 48
I/O		LM1488D	0 85
2513	7 50	LM1489D	0.85
96364	10 95	LM1489AD	1 25
14412	12 90	LM1495N-14	0 99
LINEARS		LM3302N	0.65
LM301AH	0.39	LM3401N	0 65
LM301AN-8		LM3403N	1 20
LM (MINI DIP)	0.30	LM3900N	0.54
LM308N	0.99	TL080CP	1.49
LM309K		TL081CP	0.69
LMT03	1.45	TL082CP	1.29
LM311H	1.29	TL083CN	1 65
LM318H	2.25	TL084CN	1.69
LM323K	6.00	**VOLT REGS**	
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LM556N	0.75	7824	0.90
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LM723CN	0.43	7815K	1.50
LM733CN	1.30	7824K	1.50
LM739CN	1.30	7905	1.10
LM741CN-14	0.33	7912	1.10
LM741CN-8	0 25	7915	1.10
LM747CN-14	0.79	7924	1.10
		7905K	1.80

7912K	1.80	18M	2.90
7915K	1.50	48M	2.90
7924K	1.80	**CMOS**	
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14DIL	0.15	+full range	
16DIL	0.17	**MISCLE**	
18DIL	0.24	2513	7.50
20DIL	0.27	TMS6011	5.00
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28DIL	0.36	MC14412	12.90
48DIL	0.50	96364	10.95
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2457K	3.05	SCMP II	10.00
3276K	2.70	6802	13.95
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7MHZ	2.70	18DIL	0.60
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	7402	.15		7485	55		75108A	.35		74LS05	.35
	7403	.15		7486	.25		75491	.50		74LS08	.35
	7404	.10		7489	1.05		75492	.50		74LS09	.35
	7405	25		7490	.45		74H00	.15		74LS10	.35
	7406	25		7491	.70		74H01	.20		74LS11	.35
	7407	55		7492	.45		74H04	.20		74LS20	.30
	7408	15		7493	.35		74H05	.20		74LS21	.35
	7409	15		7494	.75		74H08	.35		74LS22	.35
	7410	.15		7495	.60		74H10	.35		74LS32	.35
	7411	.25		7496	.80		74H11	.25		74LS37	.35
	7412	.25		74100	1.15		74H15	.45		74LS38	.45
	7413	.25		74107	25		74H20	.25		74LS40	.40
	7414	75		74121	.35		74H21	.25		74LS42	.75
	7416	.25		74122	55		74H22	40		74LS51	45
	7417	40		74123	.35		74H30	.20		74LS74	45
	7420	15		74125	45		74H40	25		74LS76	.50
	7426	25		74126	35		74H50	.25		74LS86	45
	7427	25		74132	75		74H51	25		74LS90	.65
	7430	15		74141	90		74H52	.15		74LS93	.65
	7432	20		74150	.85		74H53	.25		74LS107	.50
	7437	20		74151	65		74H55	.20		74LS123	1.20
	7438	.20		74153	.75		74H72	.35		74LS151	85
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	7441	1.15		74156	70		74H101	.75		74LS157	85
	7442	45		74157	.65		74H183	.55		74LS160	95
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	7444	.45		74163	.85		74L00	.25		74LS193	1.05
	7445	65		74164	.60		74L02	.20		74LS195	95
	7446	.70		74165	1.10		74L03	.25		74LS244	1.70
	7447	70		74166	1.25		74L04	.30		74LS367	95
	7448	.50		74175	.80		74L10	20		74LS368	.95
	7450	.25		74176	.85		74L20	35		74S00	35
	7451	25		74180	.55		74L30	45		74S02	35
	7453	20		74181	2.25		74L47	1.95		74S03	25
	7454	25		74182	.75		74L51	45		74S04	25
	7460	40		74190	1.25		74L55	65		74S05	.35
	7470	.45		74191	1.25		74L72	.45		74S08	.35
	7472	40		74192	.75		74L73	40		74S10	.35
	7473	25		74193	.85		74L74	.45		74S11	.35
	7474	.30		74194	.95		74L75	.85		74S20	.25
	7475	35		74195	95		74L93	.55		74S40	.20
	7476	40		74196	.95		74L123	.85		74S50	20
	7480	55		74197	95		74LS00	.30		74S51	.25
	7481	75		74198	1.45		74LS01	.30		74S64	.15
										74S74	.35
										74S112	60
										74S114	65
										74S133	.40
										74S140	.55
										74S151	.30
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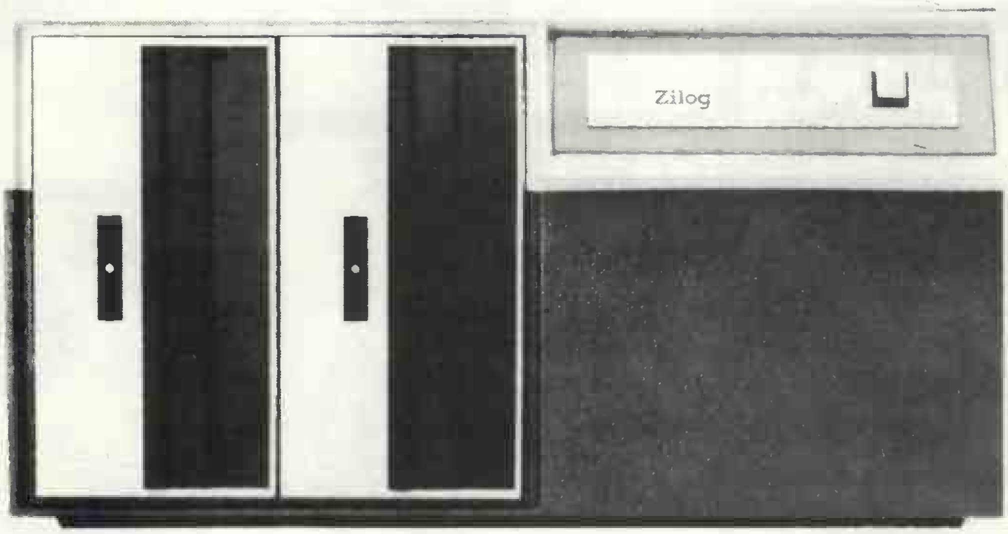

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● Circle No. 165

The Real World

WE HAVE five computers in and around the *Practical Computing* office. At the time of writing, only one is working. To give credit where credit is due, that one is the Pet. What of the others?

We have a £2,000 household name system which is supposed to be doing a useful job in the office. For many weeks, nothing has emerged from it but garbage and the sour smell of burnt ROM. It has been twice already for repair and will no doubt soon be making the journey a third time. We have a second household name with discs. Sometimes it loads, sometimes it doesn't. "Put your finger in the hole and stir", say its masters; we stir and it loads not.

For three days we have been trying to get another cheap but trendy computer to drive a popular matrix printer. Those days have been filled with endless three-way telephone conversations between the computer people, the printer people and ourselves.

One says one thing, the other something different, but it is of no importance — the machine gives not a click. Then a colleague pulled the computer power plug out of the wall accidentally and ended the debate, for now the machine will not work at all.

We have a mini which behaves reasonably well, as it should, considering how much it cost, but on some days it gets into a loop and has to run through its half-million irrelevant calculations before it will re-emerge several hours later into the real world.

Even if the machinery were working correctly, would we be happy? That is a big question and the answer for today must be in the negative. If the machinery is fragile, the software it runs is worse. The Pet works but the batch of sample tapes we are trying from a major software supplier often do not.

We have a good Life game but there are certain input patterns which lock-up the screen and the only remedy is to re-load. The business system alleged to be running on the second household name has no visible escape from many of its routines. It will sit, showing what you don't want to know, its discs buzzing and clicking like demented chickens, and no combination of keys will budge it.

In the wider world, some canny fellow has offered a prize of £100 for a British business system running on a microcomputer which will run for a month, or perhaps a week, without crashing. We think he may not have to pay in the foreseeable future.

Even programs which run are subject to problems. For instance, we published a Zombie game in our June issue. It was written in Basic on a PDP, and you would think that since Basic is a universal language, anyone who wanted to use it could do so.

Yet the office telephones rang for a month with the plaints of unhappy readers who could not get the wretched thing to run. The trouble, as it emerged after many aggravating hours, was in the random number generator. There are dialects of Basic, and one machine's RND is another machine's poison.

The whole thing puts one in mind of the early days of motor cars — well, what one has been told about them, since we're not that ancient. Cars then were very like microcomputers now. There were dozens of different kinds, allied only by their unreliability, incompatibility and the fanatical enthusiasm of their owners.

Those owners would speak disparagingly of "horse and buggy" ideas and would happily spend six hours travelling six miles because they had had the fun of fitting new big ends after the second mile, re-wiring the ignition after the fourth and then retrieving — as Kipling so movingly describes in one of his stories — the contents of a ball-race dropped along six furlongs of un-metalled road.

Well, so it is now. The difference is that the fans of microcomputing have a more gullible public. Many people are being persuaded to ride in our new bangers. They are holding their hats and waiting for the big thrill. It may come, or, what is more likely, the whole mess of machinery may blow up, cover all concerned with hot oil and sit lifeless by the roadside.

In plain terms, microcomputers and their software are not yet robust enough for the real world. At best, they are being built and sold by people who are fascinated by them, take great care how they use them, and expect others to do the same.

There is, of course, also a fair share of cowboys who do not care about these things, but we shall not mention them. The trouble is that the population of micro-freaks, who have the brain power to wrestle with raw micros, is almost used up. If our industry is to develop, the machines must be sold to people who want answers to their problems, not more problems still.

So far we have managed to make micros do more or less what we want. What we have not yet done is prevent them doing what we do not want, and there is a huge difference between these two states of affairs. For, if there is one way of doing something correctly, there are a hundred ways of doing it wrong.

If it costs £1 to make the thing which works correctly sometimes, it costs £10 to make it work most days and £100 to make it work properly always.

That is particularly true of software. Any intelligent fool can write a program to add a firm's invoices and deduct 15 percent for VAT. It takes a clever chap to write a program which will load and run, time after time; which will not crash or lock up no matter what silly key Minnie the office mouse hits. But it must come.

Next month — Teletext

In a roundabout way, that leads us to the subject of next month's delights. In the October *Practical Computing* we shall be devoting a good deal of space to the important subject of Teletext, or data-at-a-distance.

We shall look at the dissemination of software by television and wire, at *Ceefax*, *Oracle* and *Prestel*; at the coming generation of home data stations with micros built into television sets, which can take-in data and programs from central banks, or transmit them back along the line to friends, colleagues or for general use.

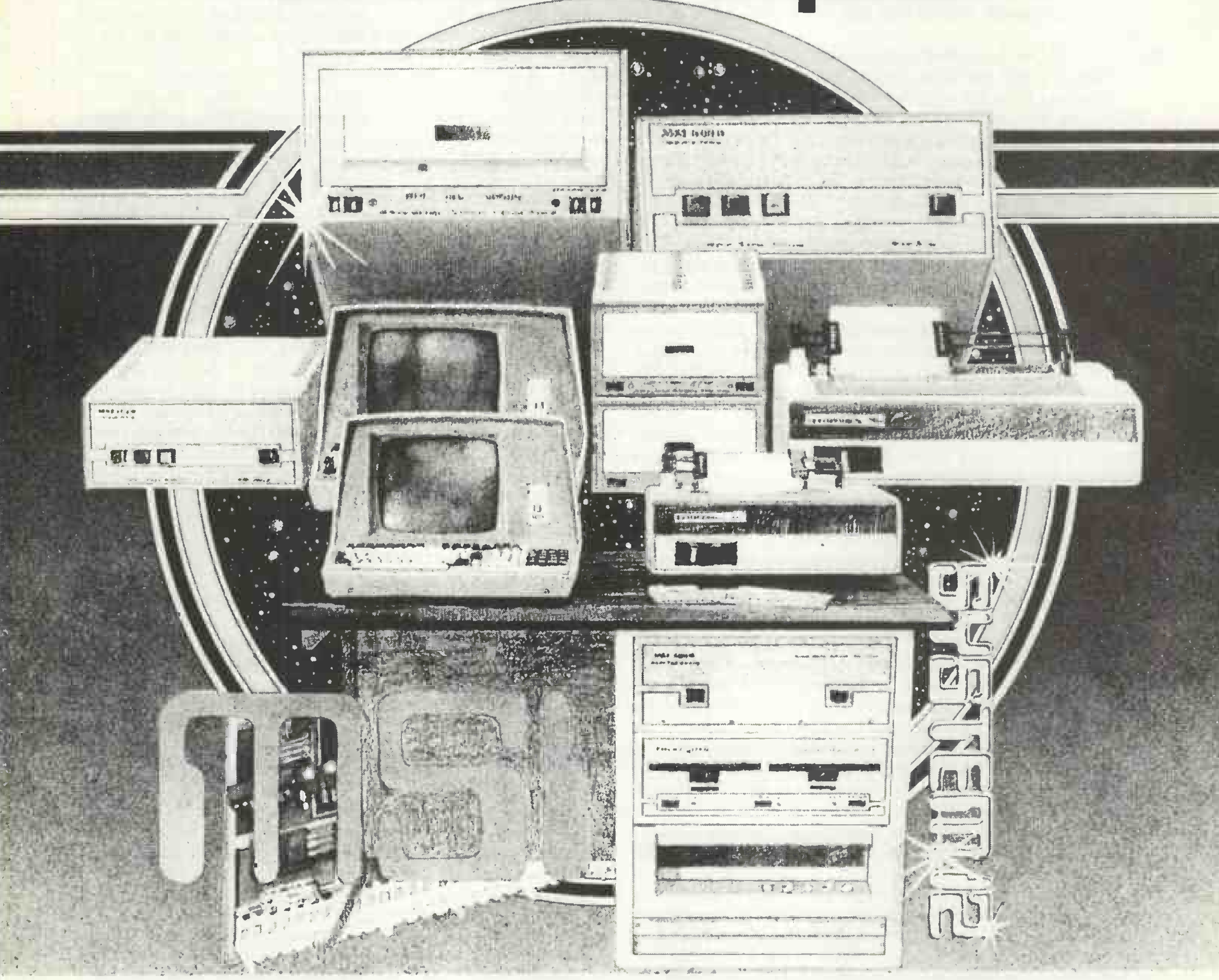
We shall be looking, in short, at the techniques and hardware which will link the many individual micro-revolutions into one — which may well, in time, disperse cities and jobs as we know them today.

It seems likely that the most important effect of this development for *Practical Computing* readers will be to create a vast new market for software. Reliable, never-crash software. It may be that many people who are now hobbyists will work full-time at home, writing programs to satisfy this market and having a better life than they do now. We hope so, anyway.

PROGRAM OF THE YEAR COMPETITION

This competition has now closed, slightly late because of postal problems, and we are happy to report a heavy crop of entries — at first glance of a high standard. It was not possible to do them justice in time to include the results in this issue. All entrants will be informed of the results by post and we hope to announce them in the October issue.

All Systems Are Not Created Equal



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As with hardware, computer software is not always created equal. Since there are a myriad of programs available, MSI offers a choice of Operating Systems for use with your MSI Computer System. Of course, our favorite is MSIDOS, but we offer the powerful SDOS operating system as well. All MSI Systems will support the other software products associated with each operating system.

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● **Circle No. 166**

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.

Suggestions

I AGREE with C Bowden's comments in the June issue and would further like to suggest articles which I, and many of my colleagues, would find valuable.

Assembly languages. A series covering programming techniques, perhaps using the 6502 and 808A derivatives as the basis for discussion. A short summary of the basic instructions and their use in simple routines, increasing gradually, should be included, together with flowcharting techniques and their implementation in assembly code. Perhaps the series could be moulded around a specified project, such as designing a Nascom-type monitor.

Systems software. Covering the principles of monitors, bootstrap loaders, assemblers and common start-up procedures. The series should explain how the software works, why the various techniques are used, and how they are tailored to the hardware.

Hopefully the reader should be able to write his or her own having read the article(s). It would be linked to specific micros, e.g. Kim, Elf, Superboard II, to provide the "10K of your own EPROMs holding self-developed functions" Vincent Tseng mentioned in his Superboard Review.

Hardware design. From the basics of Boolean algebra to TTL logic, leading to the construction of I/O structures and memory units. Simple examples and diagrams should be included, and the series could be based around, for example, designing a memory expansion of a commercial system — Kim, Elf, Nascom, Superboard.

Business applications. When contributors describe their implementation of a system, instead of the generalising on the principles used, I am sure flowcharts, file structures, and program coding would be of more value to readers.

Program codings. When they are reproduced, they are frequently difficult to decipher. If they could be re-set and printed as the tips in the Pet and TRS-80 pages instead of being reproduced from computer printouts I'm sure legibility would improve.

I hope these comments prove of value, and would like to thank you for an excellent, comprehensive magazine.

M. G. Walker.

● **Since this is a fully-interactive, hands-on magazine, would any readers like to rise to the challenge and write the articles suggested? We should say, in self-defence, that we reproduce listings from printouts because experience shows that re-setting them into something more legible can cause mistakes.**

Rental charges

WITH the advent of relatively cheap silicon chip technology, the price of microcomputer systems has fallen dramatically over the last year. I am sure that we are all aware of the proliferation of micros in the £300-£600 bracket — notably the Pet and TRS-80 — which can be obtained almost as easily as buying a television, however far from civilisation one lives.

What I would like to know — and until now I haven't received a suitable answer — is why the hire charges for renting a small computer are so incredibly high? After all, one does not need to deposit £150 plus approximately £5 a day to rent a £450 luxury colour TV. So let us have an explanation for what I believe is exploitation and blatant profiteering.

Martin Black,
Manchester, 8.

● **To be fair, TV rental companies can offer low rates because they buy sets in huge quantities at low prices. Also, TV sets are much more robust than micros and easier to repair. There seems, however, some substance in the complaints. Would any micro-renter care to defend the position?**

Not so difficult

IN HIS REVIEW of the CP/M operating system, Roland Perry makes it sound far more difficult to use than it really is. I have been using CP/M Version 1.44 for a few days and I find it easy to use, although it took an afternoon to master.

In particular, ED 1.4 — the text editor — allows reference to absolute line numbers within the text buffer, a feature which makes it easier to use than other character-orientated editors. The easiest way to change all occurrences of GAMMA to DELTA is

```
#SGAMMA↑ZDELTA<cr>
```

where # is the shorthand form for a repeat factor of 65535. Perry's version will also type the lines containing the new string DELTA.

My main criticism of CP/M is the way the "rubout" is echoed as the character is being deleted. For example, if FRAD is typed instead of FRED, pressing rubout twice and then entering the correct letters gives FRADDAED. This is so difficult to read that typing control — R will print the line as it appears to CP/M (i.e. FRED). Implementing "rubout" as a physical backspace, or backarrow for TTYs, is much neater.

The difference between CP/M and other systems is like the difference between APL and Basic; the investment in time to learn how to use it pays off in long-term ease of use.

S. J. Withers,
Coventry.

Futile quest

THE ADVERTISEMENTS in your journal proclaim that certain types of microcomputers are available but it is a very different story, and a very frustrating one, when it comes to purchasing the equipment.

I work for a research association and we have been seeking two microcomputers, the Kim and the Exidy Sorcerer, which were widely advertised in the February and May issues of your journal.

In respect to both systems, I have phoned as many as six to eight suppliers asking if we can purchase their advertised systems within a reasonable delivery period. The answer we got from the suppliers is "Sorry, we are waiting for delivery and we don't know when to expect them" or "Sorry, we can't supply within three to six months", or "We are out of this part or the other part", and "We cannot accept an order as we cannot give you any definite date of delivery".

I find this disquieting; if something is advertised, one would think it was available.

I would be interested to know if any more readers have met these "unavailable" products which seem accessible until it comes to ordering.

M. G. Hummel,
Wantage,
Berkshire.

Supply and demand

SOME of your advertisers imply that they have the articles they describe in stock. Very frequently this is not the case and if one cannot check beforehand because they won't answer the telephone or reply to letters — a common occurrence — then an abortive trip may be made.

Could you not assist by declining to publish an advertisement if the goods are not certified in stock at time of placement?

A. S. Goodenough,
North Harrow, Middx.

● **This is a serious problem which causes us some anxiety. Because of the world shortage of Schottky ICs, several manufacturers have difficulty through no fault of their own. That, of course, is no excuse for not responding to enquiries.**

We regard it as our responsibility to investigate unreasonable delays in supply of goods advertised in our pages, and if a company persists we would have to consider refusing to carry its advertising. To help readers in this way, we have to be informed of specific instances.

Here at last

INTEL has produced its long-awaited one-megabit bubble memory, under the designation 7110. The principal plus is non-volatility — you don't lose contents of memory when you switch off. Compactness also looks good — 128KB on 16 sq. in. of board space (4×4 in.), 1MB on 90 sq. in. Error correction is built in, too.

You need a separate controller and at $2,000 for the prototype kit, the early prices well not drive out the (much faster) MOS memories we all know and love. Still, the megabit bubble should provide more products to stand alongside the only bubble-using systems in our business, the pioneering terminals from Texas Instruments.

The megabit bubble has some other stories behind it, one of which demonstrates Intel's insight. Noyce is a breakaway entrepreneur (from Fairchild) and the megabit memory maker, a subsidiary called Intel Magnetics, was set up by Intel 18 months ago, when three ambitious youngsters from the Hewlett-Packard bubble memory development squad looked for finance.

The TI 92Kb bubble memory — as used in

(continued on page 47)

(continued from page 45)
the 763/765 printer terminals — will be joined soon by a 25Kb unit from the company and it reckons to join Intel in the megabit market later this year. The probable standardisation in components looks to be at 256Kb and 1Mb, with Rockwell likely to have them along with TI and Intel by the middle of next year.

IBM and Bell Labs are both reported to be near the technology for 4Mb bubble memories. Meanwhile, HP is probably the most active of the rest of the bunch in this field. The costs and problems of the bubble memory business were exemplified by the recent Univac decision to buy the components rather than make them,: the chosen suppliers are TI and Rockwell.

Univac, however, is going ahead with prototype work in the more esoteric areas of bubble memories, designs which will not appear until 1982 or thereabouts, and which Univac may not decide to manufacture even then.

In a speech at the Midcom Electronic Show and Convention at Dallas, Texas, in December 1978, Pasquale Pistorio, vice-president of the Motorola Semiconductor Division, made several predictions about the semiconductor industry which are worth noting:

- The world market for semiconductors will rise from $80 million in 1978 to $19 billion in 1985.
- The computer industry will be shaken up by the forward integration of semiconductor houses and backward integration of electronics equipment manufacturers.
- Members of the oil club — corporations or countries — will enter the electronics and semiconductor business.
- A consolidation process will materialise, with a small number of suppliers, with fewer large broad-range companies and more product or regional specialists.

Re-loading

ABOUT 18 months ago we decided to purchase a computer with word processing capability rather than a true word processor. In our ignorance, what an inspired decision it turned out to be. Not only has it revolutionised our marketing and management strategy, it has given us the incentive to read your excellent magazine.

It occurred to me, while reading your Feedback column, that you may be able answer a problem which we are experiencing with our Ricoh printer. It is the speed with which we go through carbon ribbons. We use about one-and-a-half cassettes a day at a cost of £2.25 each. The cassette appears to be very simple and refillable, however, but to date I have not been able to find any supplier to re-load existing cassettes. Perhaps you can help?

Alan Bosworth,
Sage Consultants,
Fleet, Hampshire.

Zombies again

HERE are suggested modifications and improvements to the Zombies game (June issue) to allow it to run on the Pet.

The dimensions are changed to allow the board to fill the Pet screen and also to make use of the numeric keypad. To this end, the data statement was changed, as were the instructions at lines 730-750. The alterations in lines 760-790 are to leave the instructions on the screen until a key is pressed. I hope these alterations will be of use to other Pet users.

```
150   Print"†"
160   Dim B(12,20),Z(25,2),P(9),Q(9)
290   Print "†":Z1=0
340   For N2=1to20
390   For N2=2to19
400   R=20*RND(T1)
420   If R 17.90 then 480
540   X=5+int(10*RND(1))
550   Y=3+int(5*RND(1))
760   ?:?:?
770   ? Tab(7)"‡Press a key to start"
780   Get A$:IfA$=""then780
790   ?"†"
940   For N2=1to20
1100  Input"Your move"A
1110  deleted
1600  Input "Another game"A$
1610  deleted
```

I missed these lines out of order:

```
200   For N1=1 to9
230   Data -1,1,0·1,1,1,-1,0,0,0,1,0,-1,-1,0,-1,1,-1
730   ? "789"
740   ? "4X6"
750   ? "123"
```

If the 5 key is pressed, the X stays still but the Zombies move. The ? is short for PRINT. The † is for clear screen. The ‡ is reverse on.

I hope these alterations are of interest.

Colin Spencer,
London, NW7.

Superboard aids

FOLLOWING the Superboard Review (June issue), may I just clear up a few points?

We fit a free 5V modulator to all our boards and thus maintain the single supply parameters.

The magnitude of numbers handled by the Basic is up to $\pm 10^{38}$, but remember it is a 6½ digit Basic so it sounds off at the 6th digit. It is easy, however, by programming to recover more information and produce results accurate to 1 part in 10^9 or no errors up to 999,999·99.

Although there are few commands in the machine code monitor, if you wish to work in machine code there are available on cassettes an extremely versatile Extended Monitor and also an Assembler/Editor. A disassembler is also included.

None of our customers has as far as I know, had to reduce the terminal width (characters per line) to fewer than the normal 24. If you have to do so and require to SAVE the programs on cassette, the following will allow you to do so without error:

```
POKE 15.72     return.
SAVE           return.
LIST           return.
```

This will also re-set your terminal width to 24; but you can re-set it to 23 by POKE 15, 23. No alterations are necessary on playback.

We also provide a listing of a machine code program which enables machine code programs to be dumped to tape in auto load format and/or displays blocks of memory on screen. In addition, we have a program which moves blocks of memory, while in Basic we have a re-number program, not yet converted to machine code.

Lastly, while you found that the Superboard performance in benchmark tests was very fast, a simple modification will run the processor at 2MHz instead of 1MHz, thus doubling the speed to make it almost the fastest home computer on the market — my demonstration Superboard runs happily at 2MHz with the standard 550ns memories, although I had to "select" them.

P. S. Fawthrop,
Calderbrook Technical Services,
Littleborough, Lancs.

Rotating view

YOU SEEM to have misunderstood Paul Benham's question — Astronomy, (Feedback, June). He wonders if home computers can show us the rotating perspectives and cross-section selections drawn as they are in computers shown on television.

His interests could be assisted by a rotating view of a sun/comet ellipse, as if in 3D. The answer is "no", since home computers produce their characters on the VDU as a dot formation in a definite square, which is large in area.

To obtain a line as an ellipse or circle, access is required to the line and frame scan for the cathode ray tube so that x and y waveform signals may be applied, and Lissajous figures drawn. The size and angles of the figures could be computer-controlled, a new device designed, and a program written.

With the TI 59 programmable calculator it would be truer to say that if it can almost be done on a personal computer it can certainly be done on a TI 59, but without the great display, graphics being limited to the PC 100 printer.

With the 58 or 59, Fourier transforms and functions are a simple programming procedure. Inputs are by "label" keys, complex numbers are handled with explicit ease, and the use of definite addresses for memory makes programming unlaboured. The ability to operate within a choice of degrees, radians or gradians makes life easy.

I have progressed from the Sinclair programmables, through the TI 58 to the Commodore Pet, which is a great delight, but I must admit that I was at first appalled by the careless mathematics of the home computer, compared to the delightful accuracy of the TI 58. Pet says TAN 45= ·999999999; TI 58 says 1.

Rex Tingey,
Holywood,
Co. Down.

Exchange

CHRIS CAIN of the Engineering Wing, RAF West Drayton, Middlesex, is interested in starting a TRS-80 software exchange. If you would like to help or contribute to it, write to him there, with a SAE, please.

Assurance

MR WITHNALL writes (July issue) lamenting the changes incorporated in the new ROMs of 32K and 16K Pets. He states specifically that Microchess 2·0 does not work with the new ROMs.

I would like to re-assure him and other Pet users that versions of all 160 Petsoft programs have been amended to run with the new ROMs. Withnall should be able to find a copy of a revised Microchess at his local computer store.

We will be happy to advise if anyone is experiencing difficulty running our programs on the new Pets, I think, however, that most users will eventually wish to upgrade to the new ROMs, which offer a number of significant advantages over the original set.

Julian Allason
Petsoft,
Newbury, Berkshire.

TV rental firms ready for computer market

Britain's TV rental companies are about to enter the personal computer market. The companies have for some time been offering TV sets capable of receiving Ceefax and Oracle — the BBC and ITV teletext services.

Since March, when the service was launched, they have also been offering sets capable of interfacing to the Post Office Prestel service, which allows the telephone user to access information from a large computer database for display on a TV set.

It is still very limited, and is available at the moment only in the London area.

The rental companies and the British TV manufacturers expect that more than 16,000 Prestel sets will have been delivered by the end of this year, with production running at about 1,000 sets a week.

Since a TV set capable of receiving Prestel will cost about £1,000, the rental companies expect that the majority of users initially will opt to rent rather than purchase. Rental is expected to be about £24 a month.

Over the next two years TV rental companies expect to have entered the personal computer market with units which can be linked into the home TV and perhaps can also be connected to the Prestel service. The companies expect to rent systems not only for the home, personal and educational markets but also for business, where rapidly-changing technologies can be tested by a potential user on a weekly rental basis before buying or entering into longer-term leasing.

Big names

Since many of the TV rental companies are owned by companies which also manufacture TV sets, it could be that we will see a range of all-British personal computer systems on the market within the next year to 18 months.

That speculation is to some extent reinforced by fairly persistent rumours that both GEC and Thorn are developing personal computer systems, though neither company has made any announcements.

Philips, however, has announced that it is working on integrating its new range of viewdata sets with some of its existing computer products, in particular word processing systems.

Such a system could consist of a viewdata terminal and a Philips 2650-based personal computer, together with a modified laser video disc for mass storage; this would probably have a capacity of about 1,000Mbytes.

This system might incorporate a facility for using telesoftware, a method of transmitting programs as viewdata frames. This is being researched by at least one of the major ITV companies, in conjunction with a software house. A system of that kind might cost less than £1,500 and be on the market within the next two years.

Investment in the next three years by some of Britain's big TV companies is expected to exceed £200 million.

Compiler for Z-80

RESEARCH MACHINES has produced an Algol compiler for Z-80 systems with CP/M, such as the Research Machines 380-Z. The Algol will run as little as 21K and one mini-floppy; it implements most of the features of Algol 60, the main exceptions in the current release being multiple assignments and own variables.

Added features include the byte arrays, logical operators, string handling, and interrupt handling — and graphics with the 380-Z.

Other attributes of the compiler noted by RML are "ease of use, speed, economic use of memory, and excellent I/O and file handling". Benchmark tests are available from Research Machines.

Stocktaking from a briefcase

STOCKTAKING can have a new look with an all-in-one computer in a briefcase developed jointly by Data Logic and Allied Breweries.

Launched at the Microcomputer Show, the Microframe 1 is based on the Intel 8080, weighs 21lb., and can be used "by anybody who moves around" in their jobs.

It is a complete system with 4in. video display, keyboard, floppy disc drive and thermal printer, as well as applications software. Full-size display, keyboard, printer and an extra drive can be attached if necessary. The machine has 16K RAM, expandable to 32K.

Allied Breweries controls more than 2,000 public houses throughout Britain and specified the applications software, which is written in PL/M. The machine will be used by the 120 stocktakers of the brewery, who visit the managed pubs to monitor the sale of beer, wines, spirits and tobacco.

It means that a good deal of paperwork will be eliminated, stocktaking results will be available much quicker, and it will be "a great assistance in overcoming the problem of mis-stocktaking", says Richard Havery of Allied Breweries.

Data Logic is looking at other applications for the Microframe, such as order processing, site management and point-of-sale. A typical cost per unit of the machine will be around £3,000 for bulk orders. It is expected to be available for the commercial market at the end of the year.

Microframe.

U.S.-Japan link for hand-held unit

THE first hand-held personal computer has been introduced in a joint venture between Matsushita Electric of Japan and Friends/Amis of the U.S. The project "will give birth to an entirely-new field of consumer electronics", according to a spokesman for the two companies.

The key to the system is AMI memory, which holds twice the amount of data of conventional systems in tiny, interchangeable capsules. Through pre-programmed and self-programmable memory capsules, people will be able to carry information on any area of science, business, language, education or the arts in their pockets.

Matsushita Electric and Friends/Amis will develop the hardware and software jointly. The former will manufacture and sell the product under its own label, as well as its private brand names — Panasonic, Technics and National. It will grant sub-licences to other manufacturers and both companies will develop new applications for the system by integrating their technology and software.

Translator

Friends/Amis is a Californian-based microcomputer software systems company which developed the system. It introduced the new technology earlier this year with a language translator.

The new system will be used in applications such as learning systems, a new generation of portable computers for home or business use, electronic dictation equipment, games, and an unlimited range of information systems, from first aid to recipes.

Export sales are planned for next year. A price has not been decided.

Industry growth

IT IS estimated that in 1978 some 250,000 personal computers were sold, mainly in the U.S. but with significant proportions in Europe and Japan, the total market value being about £175 million.

The industry is expected to grow at a phenomenal rate and sales for the first four months of this year show that estimated worldwide sales of 500,000 systems, valued at more than £300 million, is not over-optimistic.

If growth rates are maintained, there could be a world market for personal computers worth more than £3,000 million by the mid-1980s, despite the fact that unit prices will continue to fall.

If the trend is correct and there are, of course, numerous factors which could restrict growth, the size of the market in volume terms is enormous, and we could possibly see one in every two households owning or renting a personal computer.

Apex keyboard.

Micro keyboard

APEX MICROSYSTEMS has developed a miniature alphanumeric keyboard suited particularly to small microcomputers.

Designated the MKB.01, it measures 165 × 93 × 14mm and it will be useful for applications where size is important, such as portable or mobile data entry systems, or as an alternative to conventional keyboards in small systems.

It may offer a satisfactory alternative to the 8K Pet keyboard, which is difficult to use.

It is an 8-bit ASCII tri-mode keyboard, in ASR33 format, and uses MOS technology. The unit uses high-reliability tactile response keyswitches with 12·5mm spaced centres. All outputs are DTL/TTL/MOS compatible, so the keyboard can be interfaced directly to most electronic systems.

There are two uncommitted switches brought out to the connector to enable functions such as repeat and shift-lock to be implemented. It also provides a two-key rollover to ensure the minimum of operational errors.

A choice of eight key colours is available and, for stand-alone applications, a case and AC and DC power supply interfaces and DC packs. You can implement specialist codes such as Selectric by changing the ROM.

The MKB.01 is available at a one-off price of £55 plus 80p post and packing, plus VAT. If you order more than four, it will work out slightly cheaper. Apex can be contacted on (0443) 225578.

Screen problem for TI 99/4

TEXAS INSTRUMENTS has launched its personal computer amid a row with the U.S. Federal Communications Commission which will not allow the semiconductor giant to sell the machine in the States without a TV screen.

The long-awaited TI 99/4 was to cost around $300 to $500 until the company was forced to change its plans as the FCC prevented it selling the computer without a TV screen — because the design required a radio frequency generator to enable it to be connected to an ordinary TV.

The machine is expected to be available in the U.K. before the end of the year and users will need a separate monitor, unless they have a screen modified to receive PTSC input. It is hoped that later the 99/4 will be fitted with PAL circuitry to enable users to plug it into ordinary U.K. sets.

The European version of the 99/4 consists of a console with 16K RAM (non-expandable) sound generator, full colour graphics and extended Basic. It uses plug-in modules, much like the Sorcerer, which are all self-contained programs and make for much easier use.

Modules for the system will include home financial decisions, physical fitness, chess, educated eating and pre-school learning. Each module will range in price from around £15 to £45.

Accessories will include a multi-position joystick for games, a printer, disc memory, RS232 interface and a speech synthesiser. This is designed on the same basis as the successful TI Speak & Spell learning aid and has a built-in vocabulary of 200 words.

It can be used by the home programmer to produce spoken messages and results in his programs. Future command modules will also use it. The TI 99/4 will sell in the U.K. for around £700, including VAT.

Biproc kit with choice of two processors

A NEW kit for "those enthusiasts who are willing to use a soldering iron and wish to write programs at assembly level language" has been developed by BL Microelectronics.

This home microcomputer kit offers the choice of two processors — an 8-bit Z-80 or a 16-bit TMS9980, without the extra expense of separate RAMs, control and I/O interfaces. Either processor can be inserted in separate sockets, and each has a monitor and line-by-line micro-assembler in a 2K TMS2716 EPROM package.

The BIPROC board, as it is called, is a double-double-Eurocard size 1/16 in. thick, through-hole plated, and is solder-resistant-painted on both sides. It has been laid-out in two sections. Section B contains the TV scanning circuit and keyboard interface which can be cut off in dedicated tasks. Section A may be inserted in a double-Eurocard slot.

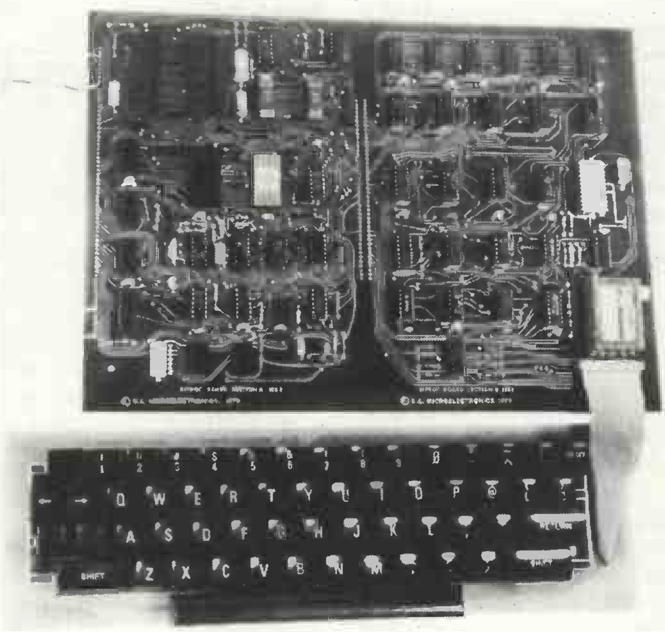
The board is fully socketed in three kits. The processor is either a Z-80 or a TMS9980. There is 1K of static RAM — about four percent of memory space is reserved for the monitor — and 4K ROM.

Interfaces include memory mapped with 1K × 6 static RAM TV scanning circuit for generating 16 lines of 64 characters each on a domestic TV set, cassette recorder, keyboard, fully-buffered data and address bus, RS232 interface for terminals and memory-mapped parallel I/O lines.

Software includes memory map, prominent cursor display and six commands which can be invoked via the keyboard. Documentation for the system is in the form of a users' manual with circuit diagram, parts lists, assembly and operating instructions. Some programming examples are included.

The Biproc kit 1, with Z-80 only, costs £194; kit 2, with TMS9980 only, costs £199; and kit 3, with both processors, costs £225. Two × 40-way DIL multiple insertion sockets are £7 extra. Contact BL Microelectronics, 1 Willow Way, Loudwater, Bucks (0454) 26670, for more details.

Biproc 8/16-bit mini



New Apple software

APPLE II and ITT 2020 users will be pleased to hear that Computech has launched a new range of low-cost business software for those machines.

Called Computaccount, the series comprises sales, purchase and general ledger, payroll and stock control. The packages are designed to run on 32K RAM, one or more disc drives, printer with serial or parallel interface, domestic TV or video monitor and Applesoft in ROM.

A version to run with Applesoft in RAM, needing 48K, is also available. A typical cost of each package is £295 and support and enhancements will be available to existing users at discount prices.

"Particular advantages", says Computech, "arising from this approach mean that the user can define his own parameters, on-demand data display and a random file structure which means that the fast response of the system is not degraded as the volume of data increases."

The packages have comprehensive manuals dealing with everything from the elements of double-entry bookkeeping through to notes for advanced users on system expansion. Computaccount packages are available from ITT and Apple dealers.

Sorcerer group

ANOTHER Sorcerer users' group, Exidy Sorcerer Users' Group (U.K.), is a British offshoot of the U.S. user group.

It aims at communication between owners, to offer software tips and to keep you informed of the latest software and hardware developments. There will be a monthly newsletter, based on the information of the U.S. group and the fee will be £5 per annum. The only stipulation for joining is that you must own a Sorcerer.

Contact is Andy Marshall, Micro44, 44 Arthurs Bridge Road, Woking, GU21 4NT. Tel: (04862) 66084/72650.

Bubbling at Intel Fair

INTEL FAIR again provided a platform for several products, including bubble memory, CIS-Cobol and Multi-ICE.

The world's first one-megabit bubble memory was there, with its entourage of supporting chips attracting the most attention at the exhibition. It is called the 7110 and is a product of Intel Magnetics, the company set up by Intel to accommodate three personnel from Hewlett-Packard's bubble memory development team. They had the knowhow and Intel had the money to produce the product.

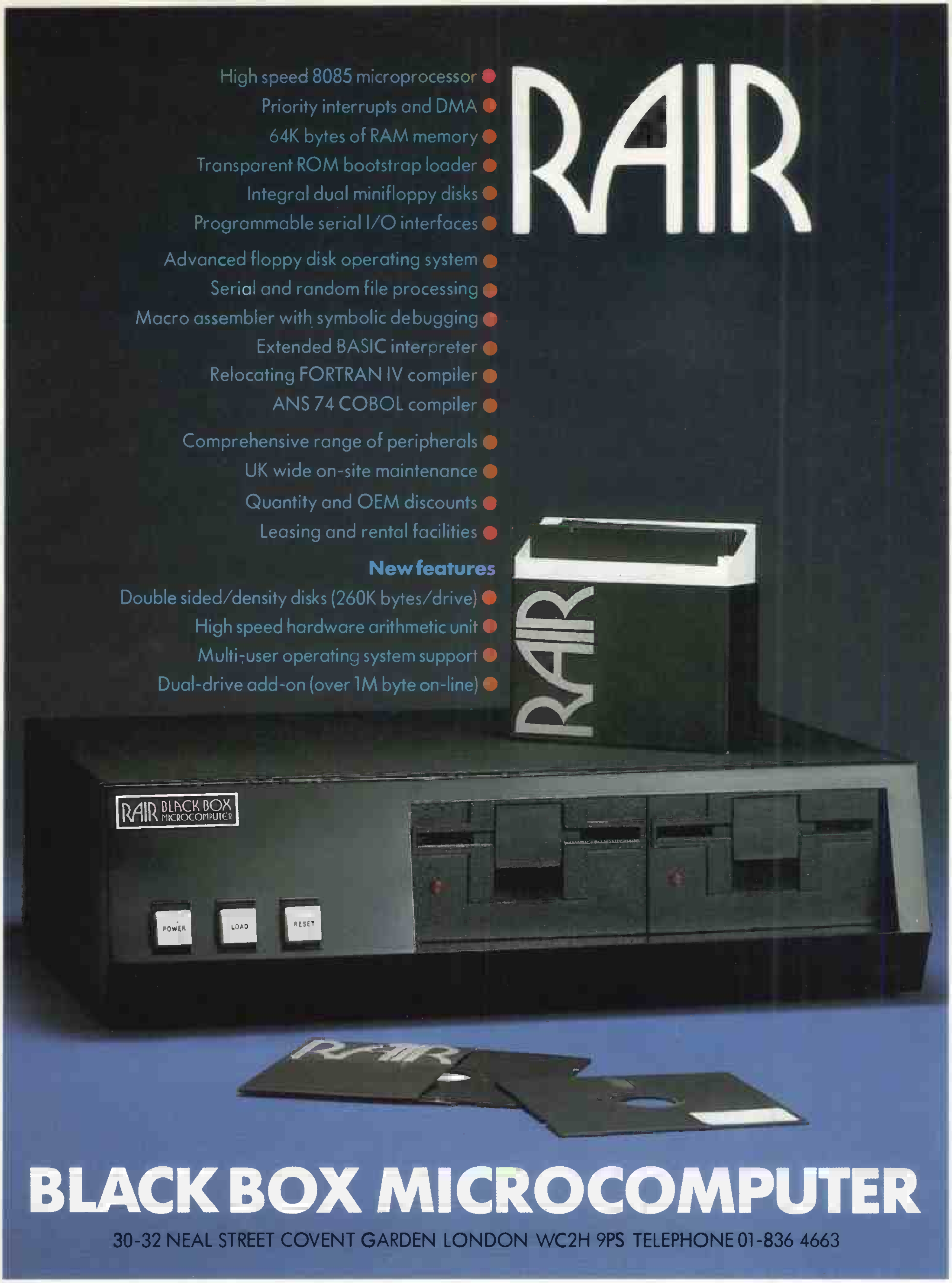
Intel's Vendor Supplied Products. CIS-Cobol, a Micro-Focus production, will run on the 8080/8085 processors and is a direct descendant of the well-liked version from the software house. It runs under the ISIS operating system on an 8080/8085 processor configured with 64KB memory and single-density floppy discs.

It features relative and indexed file handling, facilities for inter-program communication and library features. For interactive operation through a VDU, there are facilities for field formatting, protected areas and dynamic file-handling which allows file names to be assigned at run-time.

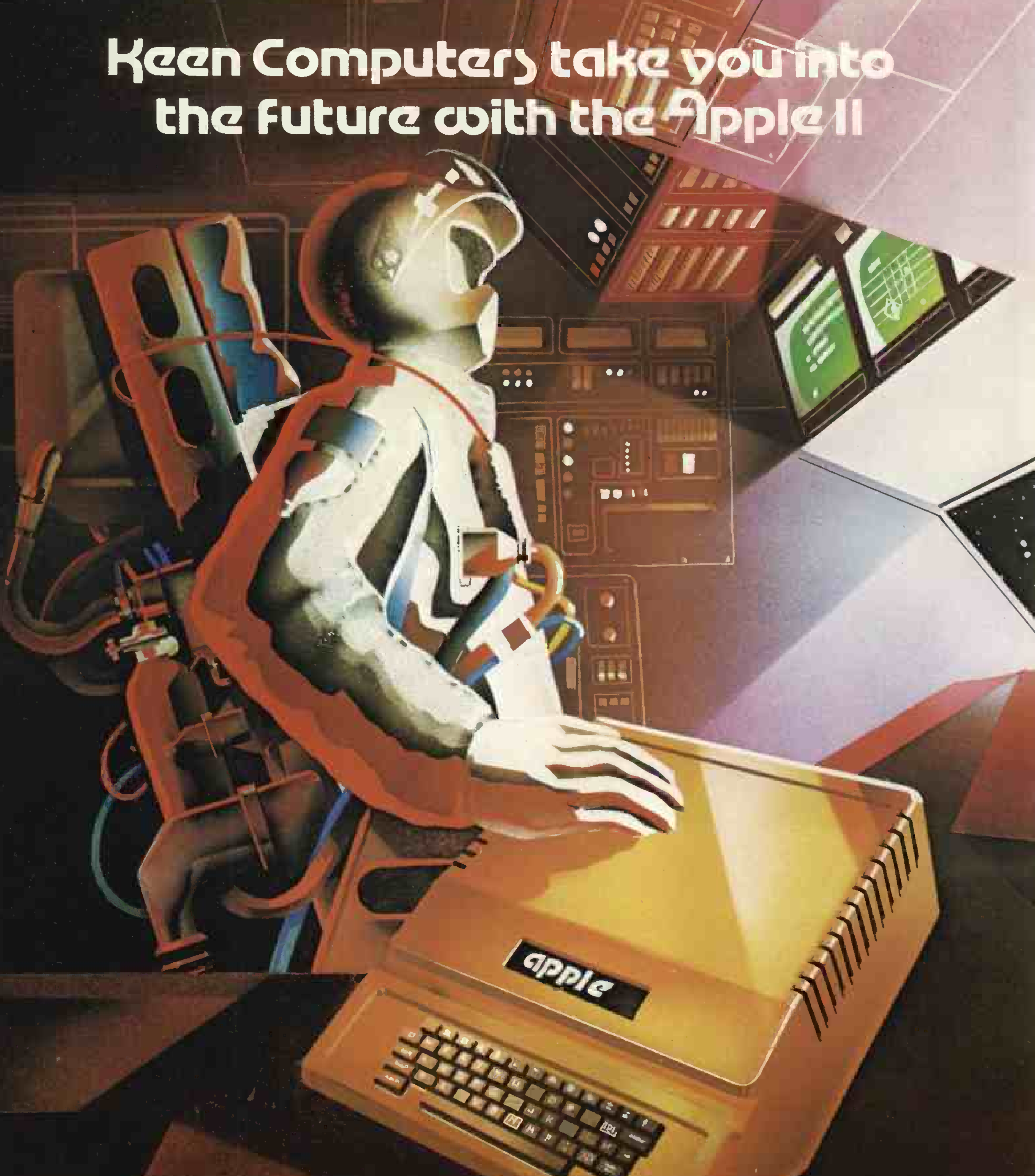
Multi-ICE, a software package for debugging dual processor configurations, was also given an airing. It is based on ICE — In-circuit Emulator — which helps to alleviate the problem of tracking where exactly an error has occurred on a processor, but allows two such emulator modules to run on a single Intellec system simultaneously.

Intel sees it being used in the first place on systems using two 8085A processors, or an 8085A and a single-chip processor from the 8049 family.

Intel Fair attracted some 800 visitors, and is turning into one of the company's most important annual events. As usual it was well supported by seminars and a healthy number of exhibits.



● Circle No. 168


Keen Computers take you into the future with the Apple II
apple

Compact for business

THE POWERHOUSE 2 is a compact, all-in-one microcomputer and it reaches the market in various forms, but all housed in the same cabinet. It probably will draw comparisons with computers like the Commodore Pet, Tandy TRS-80, Apple and the rest.

THE VERSION delivered for review, which was a pre-production model, has 32K bytes of RAM, 14K of Basic in EPROM, a mini-cassette drive and disc operating system (DOS) in EPROM.

Common to the range is a 5in. CRT VDU screen, a 58-key alphanumeric keyboard in the normal typewriter layout for most keys, Z-80 cpu and basic operating system (BOS) or monitor in EPROM. All is packaged in a neat, compact housing which stands on an area about the size of this magazine opened out, and around only 7in. high.

Setting-up

Because the Powerhouse 2 is a complete packaged system, it needs only to be plugged into the mains to be powered-up.

In use

On connecting the mains lead, the computer is powered-up by the mains on/off switch at the back of the unit. Our review model had an intermittent power supply problem which manifested itself on initial power-on — it would power-off momentarily and collapse the screen display.

There was not enough time to trace the fault, but as it happened only on powering-on and eventually it would settle, it did not affect the working of the computer once it has stabilised itself.

Because of this power problem, however, I could not determine whether the Powerhouse 2 does a power-on re-set as it sometimes is ready in monitor, and sometimes is not. Nevertheless, it is a simple matter to press the Re-set key — well, not so simple, it is actually Shift re-set. Although this seems a little awkward it may be intentional. Since the Re-set key is the top left-hand corner key on the keyboard it would be very easy to mis-hit it and possibly lose valuable work, hence, perhaps, the two-key re-set.

The keyboard has 58 keys of which the top row are special function keys and the next four rows have the alphanumerics in the normal typewriter QWERTY layout. Some of the punctuation marks are found in different places and the two shift keys are in a row on either side of the space bar.

The "return" or "enter" key is where the right-hand shift key is normally found; irritatingly, it is also of the same size as the other keys, so it is not convenient to hit.

All these unconventional positions are minor irritations, to which one can accustom, but why have a conventional keyboard layout which is only very slightly unconventional and shows no obvious ergonomic advantages over the standard form?

The keys have a low profile and although they can be hit positively, they lack some feel. Sometimes, on repeating a character quickly, the key does not register the second hit. Having said that, it is still workable and nowhere as bad as, say, the original Pet keyboard.

The CRT screen is of high quality, displaying 16 lines of 64 characters to the row. It is fixed to the keyboard and at the working distance it appeared to be about the correct size, clarity and contrast despite the fact that a 5in. diagonal screen sounds small. The brightness can be adjusted by a control at the back of the unit.

by Vincent Tseng

The character set displayed was small, 64 characters with upper-case only, from ASC2 Z0 to 5F hex inclusive. There are also flashing versions of the same set of characters defined by A0 to FF hex and a clear screen control character.

Built-in with the unit was a mini-cassette drive for mass storage. This is not the Philips audio mini-cassette — as for dictating machines — but a digital cassette drive using a certified digital cassette. All the cassette controls are internal so there are no play, record or rewind buttons.

Monitor

The firmware monitor is in 3K of EPROM which Powerhouse calls BOS or basic operating system. It is to this that the computer is initialised when the (shift) re-set button is pressed. The prompt symbol is an asterisk * followed by the cursor which shows the current position on the screen by an underline.

The usual machine code monitor commands are found, such as memory display "D", change memory location "I", display registers "R", jump to location and start execution "J". There are also some useful commands such as fill memory "F", between two addresses with any user-defined byte pattern and a RAM confidence test between limits of address by "Q".

There are no break points or even hints on how to set them up — e.g., using one of the restraint instructions; also the monitor lacks the single-step facility. This is very unsatisfactory, as the user does not have any convenient facilities to test and debug program.

(continued on next page)

(Continued from previous page)

Another annoying feature is that to enter or terminate a command line, the monitor uses the full-stop key which is situated next to the enter key. Since the other "software systems" on the Powerhouse 2 all use the enter key for termination, it is all too easy to lapse and use this key for the monitor as well; then the monitor shows 'error' by a flashing "<" sign and there is no recovery of that last command line.

The user has to re-enter the whole line again, this time remembering to use the full-stop key. So why have the two methods of working, as again there is no advantage in using the full stop?

Basic

When the DOS key on the top row is hit while the system is in the monitor (BOS) a jump into Basic is made. The Basic is the North Star version 6 in 14K of EPROM and has a useful set of instructions, including many string-handling functions. The functions available are comparable to those in the 8K microsoft Basic, as on the Superboard 2. The range and precision calculation is, however, higher, since the Powerhouse 2 Basic can go into exponential notation — like scientific calculators.

It is good that there is a command to edit a line defined by line number. The editing commands are primitive, using control keys, but useful. It certainly is far better than not having an edit facility. The now "standard" (by default) eight benchmark programs show that this version of Basic is not particularly fast, but is in the same region as the Pet and Apple Applesoft Extended Basic.

It is very peculiar that, though the Basic is in EPROM, when it is called-up the whole interpreter is loaded into RAM and occupies 15K worth of RAM area (from 2000 to 5BFF Hex). Therefore, the 32K machine becomes an 18K machine — what a waste, when the Basic interpreter is already in memory.

Having written a program and wishing to save it, one uses the Basic "SAVE" command but the system returns an error as the named file has not yet been defined, which leads conveniently into the Disk Operating System.

Distributor

Powerhouse Microprocessors Ltd
5-7 Alexander Road,
Hemel Hempstead,
Herts HP2 5BS 0442 48422

The Disc Operating System, like the Basic, is by North Star. The DOS allows the creation and storage of files by name and type on floppy discs or cassette tape, but the method of operation is somewhat primitive. For instance, to save a file from Basic, the user needs to drop into DOS first, and call up the "CR" for create command and specify the length of the file in numbers of 256-byte blocks — how many people know the number of bytes needed to store a Basic program?

Then the file type has to be specified by using "TY" — "Ø" for default pure machine code/data; "1" for machine code with a jump start address; "Z" for Basic programs and "3" for Basic data.

There are good points, too, like "L1" for listing-out all the files created so far; some files could have been created but not filled, and there are no indications of the file being empty.

Also there is a "CO" for compact, an instruction which, as the name implies, compacts the files stored, i.e. tidies them up, to create more spare storage space; this is especially useful when files have been deleted and holes have been left behind.

Those readers who have been paying attention will have noticed that floppy discs were not included with the review system. Does this mean the reviewer relied on the manuals for all this? The answer is no. This is a really excellent point about the Powerhouse 2 — the disc operating system is one and the same as the cassette operating system.

The two are identical in all operational commands. Naturally, only the access speeds are different. This means a user can upgrade from cassettes to floppies and still work the same way. Or he can use the system away from his base on cassettes instead of floppies. I do not, however, know if a system can have both floppies and cassettes working together so that files can be transferred from one to another. It would be a pity if it did not, because some of the advantages cited would not apply.

This, however, could be a simple matter of re-numbering the drives, so that, say, one of the "floppy drives" is the built-in cassette.

Other points

Basic and DOS use a different stack area to the monitor (BOS). This means that different stack pointers are initialised which can be dangerous to your software when returning into the monitor via a jump. The machine program can have unpredictable results, since the stack pointer now points at a different area. This is not very satisfactory. Also, since Basic dumps itself into RAM area 2000 — 5BFF Hex and as the DOS is called via Basic it is hard luck if you put in a 14K program in machine code starting at Z000 Hex and want to store it on cassette. The first really safe free address is 5C00 Hex and the user RAM in our version stretched to 9BFF Hex.

A few words about electrical safety. The test model was a pre-production version but it had a few potentially-dangerous faults, such as a wide ventilation grill on top of the unit with no protective mesh, so that fairly large objects could be dropped into the high-voltage spots. The plastic case top cover is fixed only by a lip and notch at the front and two self-tapping screws at the back which go straight into the bottom plastic base.

This arrangement does not look particularly robust. Once the cover is removed, the mains cable leading to both the on/off switch and the fuse is very exposed. To be fair to the company, these problems have already been noted and the faults should be corrected in the production versions.

The keyboard is not encased. What appears to be a case board is the PCB on which the keys are mounted, painted white, and again fixed in by self-tapping screws to the case.

Documentation

As this was a pre-production model it had pre-production documentation. The manual (pre-proof read) deals heavily with the hardware description but all the operating instructions are described, if somewhat briefly. The chapters on the different parts, however, appear to be derived from different sources. A list of usable subroutines in the firmware is given with the starting address. This is useful, but some programming examples would have been more useful. The distributor says that "the appearance, layout and content of the final version will be much improved".

Conclusions

- The major attraction of this system is is compact and neat packaging. The casing could be made more robust.
- Further external expansion is via a parallel interface but not to standard bus. There is an RS232 (or V24) serial interface, so that the Powerhouse could be used as an intelligent terminal.
- There are no particularly outstanding features, except perhaps the use of the same operations for both disc and cassette. There are some shortcomings, of which the worst is the Basic dumping itself into 15K of RAM — but what system is perfect?
- Value for money cannot be judged, because no price has been fixed, but the use of certified digital cassettes cannot be cheap. Although it is claimed not to be aimed at the amateur market, comparisons will be made and so competition from those quarters cannot be ignored.

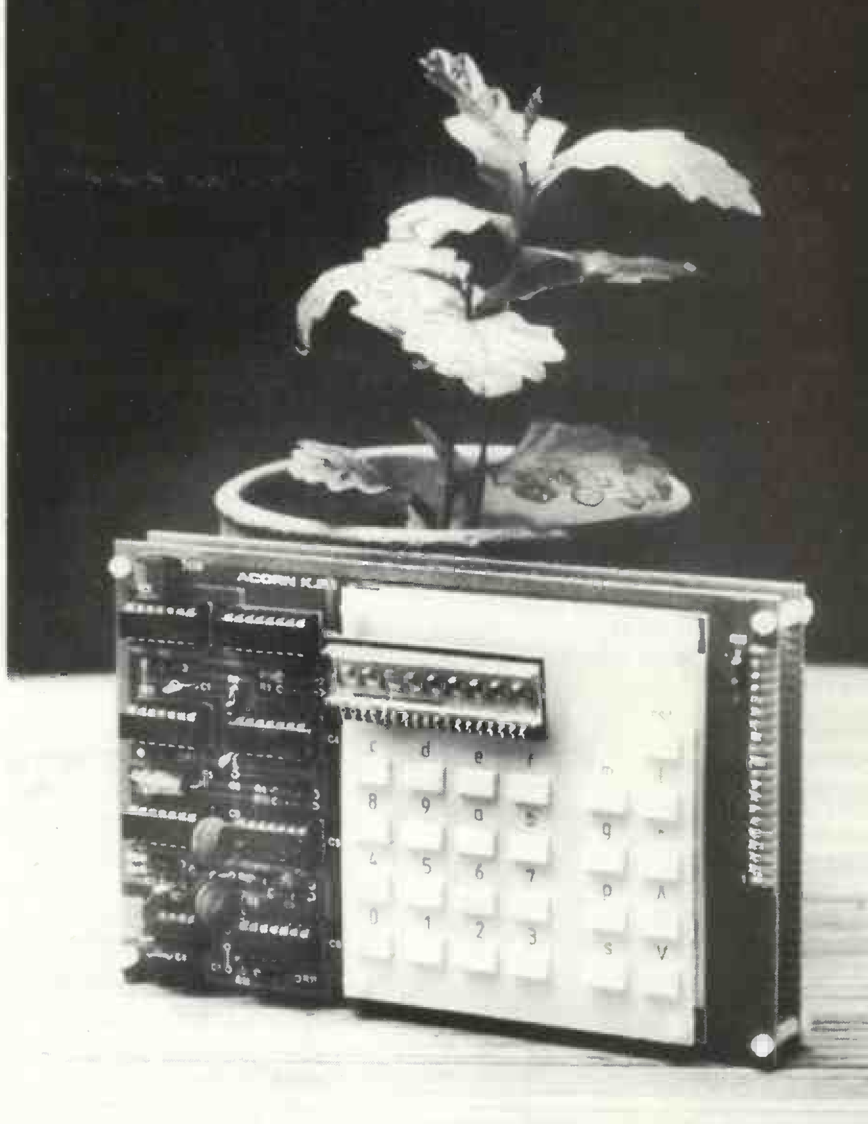
Practical Computing evaluation

	Yes/No NA	1	2	3	4	5
Ease of construction (where applicable)	NA					
Quality of documentation				●		
Can handle 32K of memory	Y					
Quality of video monitor (consider resolution and screen size)					●	
SS-50 Bus	N					
S-100 Bus	N					
Sockets for chips						
Numeric, calculator-type pad on keyboard	N					
Large amount of removable memory, randomly accessible	N					
Cassette tape recorder capability: Own	N.					
Built-in recorder	Y					
Floppy disc capability	Y					
Communications capability (can talk to other computers)	Y					
Speed of instruction cycle	2.5MHz					
Ease of expansion			●			

	Yes/No N/A	1	2	3	4	5
Lower power consumption				●		
Assembly language	M/C code					
Basic language				●		
Other languages	N					
Compatibility with other systems		●				
Appearance						●
Portability					●	
No. of software applications packages available		●				
Hobby use				●		
Business use			●			
Educational use			●			
Ability to add printer(s)	Y					
Ability to add discs	Y					
Ability to add other manufacturers' plug-in memory		●				

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

From little Acorns



The little Acorn computer is one of the neatest we have seen. It is arranged on two bolt-together boards. Notice the calculator-style display and the well-laid-out keyboard. The object in the background was built by Mother Nature Systems.

Continuing our reviews of single-board computers, John Bennett looks at the neatly-made Acorn.

AS THE COST of chips continues to fall, the number of low-cost microcomputers available appears to rise in inverse proportion, and one recent addition to the market is the Acorn microcomputer.

It is a two-board unpackaged system from a company called, somewhat confusingly, Acorn Computer, for £81 assembled and £70 in kit form. The Acorn also requires a separate 5V power supply before it will blink into life, as do many other low-cost computers.

In common with Apple, Pet, Kim and Aim-65 the Acorn uses the 6502 processor from MOS Technology. It is capable of addressing up to 65K of memory if all address lines are implemented on the processor board.

The Acorn, in fact, has just over 1K of RAM on the processor board. Additional RAM can be added using an expander board, together with one or more 8K memory boards when they become available.

The two Acorn circuit boards are mounted one above the other and are connected by a 20-way cable. The lower board, which is also available separately as an industrial controller board, contains the CPU, 1K RAM, a 16-way RAM I/O chip used by the keyboard, the monitor RAMs and address decoding circuitry. Sockets for an additional RAM I/O and 2K of EPROM are also included.

Three switches may be added to the board to generate RESET, Non Maskable Interrupt (NMI), and Interrupt Requests (IRQ) signals, or additional devices may be daisy-chained on to the board when more than one device which generates interrupts — or re-sets — is to be connected.

The re-set switch is duplicated on the upper board since the switches are hidden when the boards are mounted together. The upper board also contains a 25-key Hex keyboard, an eight-digit display, and a CUTS cassette interface.

Our review system was delivered already assembled so it is not possible to comment on ease of assembly. All chips are socketed, however, and their positions are marked clearly on both boards, so there should be few problems with chips being orientated incorrectly. Additionally, the circuit boards are coated in solder mask to prevent solder splashes from sticking to the tracks.

Assembly instructions are detailed in a separate manual, which contains a parts identification list and some useful hints on soldering technique, as well as instructions on assembly. A simple power-supply circuit is included for those who would like to build their own, together with details on the methods of configuring the available memory.

Our manual was rather flimsy, consisting of photocopied pages stapled together. Presumably a printed version similar to the programming manual is in preparation. As the cost of an assembled Acorn is £10 more than the kit it may well be simpler, unless of course you are an electronics buff, to buy a ready-built Acorn, and avoid those anxious moments before first switch-on.

The Acorn came to life as soon as power was applied, displaying eight dots on its LED display which signifies that all is well and a monitor command may be entered. The keyboard has 16 Hex keys — 0-9, A-F — and 9 command keys labelled RST,M,G,R,P,↑ ↓L,S.

The Re-set key initialises the processor to a known state and is often used to recover control from a program which is in a loop. The memory key M allows the contents of different memory locations to be examined and altered, while the ↑ and keys allow the next or previous addresses to be examined without entering a physical address.

Entering M,Ø,Ø,3,Ø,k,A,D,↑ — where k is any command key — causes the contents of ØØ3Ø to be displayed and then replaced by AD. The k and ↑ terminate the two phases of the memory command. The first phase allows the contents of a location to be examined and pressing ↑ or ↓ allows the next or previous location to be accessed.

Entering a hex character moves the value into the least significant digit of the current location, the contents of which becomes the most significant digit. This is repeated until a command key is pressed. The command is then executed as in the example where the contents 0031 would be displayed.

The load (L) and store (S) keys are used by the integral cassette interface. They permit the contents of contiguous sections of memory to be saved to and re-loaded from tape by writing the start and end addresses to tape prior to the contents of the memory block.

Breakpoint

A breakpoint may be inserted into a program at a specific location by pressing the P key so that the program may be debugged by examining registers and memory locations. Pressing the R key re-starts the program.

Programs are executed by using the GO (G) key, entering the start address, and pressing a further command key.

Each command causes a different letter to appear in the mode portion of the display so that it is possible to tell which command is in use. The M key, for instance, causes an A (for memory Alter) to be displayed.

A	01030	. AD
Mode	address	data

display format

An added refinement of the Memory and Go commands is that they remember the last address used, so that it is not necessary to keep re-entering the start address of a program, or a specific memory address. This is possible because the monitor reserves locations in memory for the addresses. The other locations used by the monitor, together with a monitor listing, are detailed in the system manual.

That contains a wealth of information about the system and its use, including a helpful glossary of terms encountered in the manual. As with many low-cost manuals, it suffers from a lack of editing. In fact, it probably attempts too much in the space available, which results in some portions being very readable while others appear to gloss over the finer points. The hardware sections are in parts particularly vague. Perhaps purchasers are expected to be interested in software or hardware, but not both.

The manual is divided into two parts. Part one deals with use of the system, while part two contains a selection of useful programs, including games and utility routines. A monitor listing is included in part one. The monitor, incidentally, includes several subroutines which may be used in other programs — for instance to put characters on to the display.

Part one also contains chapters on the binary number system, using tapes and breakpoints, the Acorn hardware, and three chapters on the use of the system and its commands, and the internal operations of the 6502. Those three chapters provide a clear indication of how to program the system by means of an example which increases in complexity as the chapters develop.

Resemblance

One possible improvement to the manual would be to devote it entirely to software and to develop the construction documents into a hardware manual.

This would in all likelihood push up the cost of what is at present a competitively-priced and well-designed, expandable system.

The Acorn manual bears a passing resemblance in its general layout to that from another Cambridge-based systems supplier, Science of Cambridge, which sells the Mk 14 kit. The Acorn, though, is slightly more upmarket, offering greater expansion capability, an integral cassette interface, and more monitor commands.

Printers

Anadex DP-8000

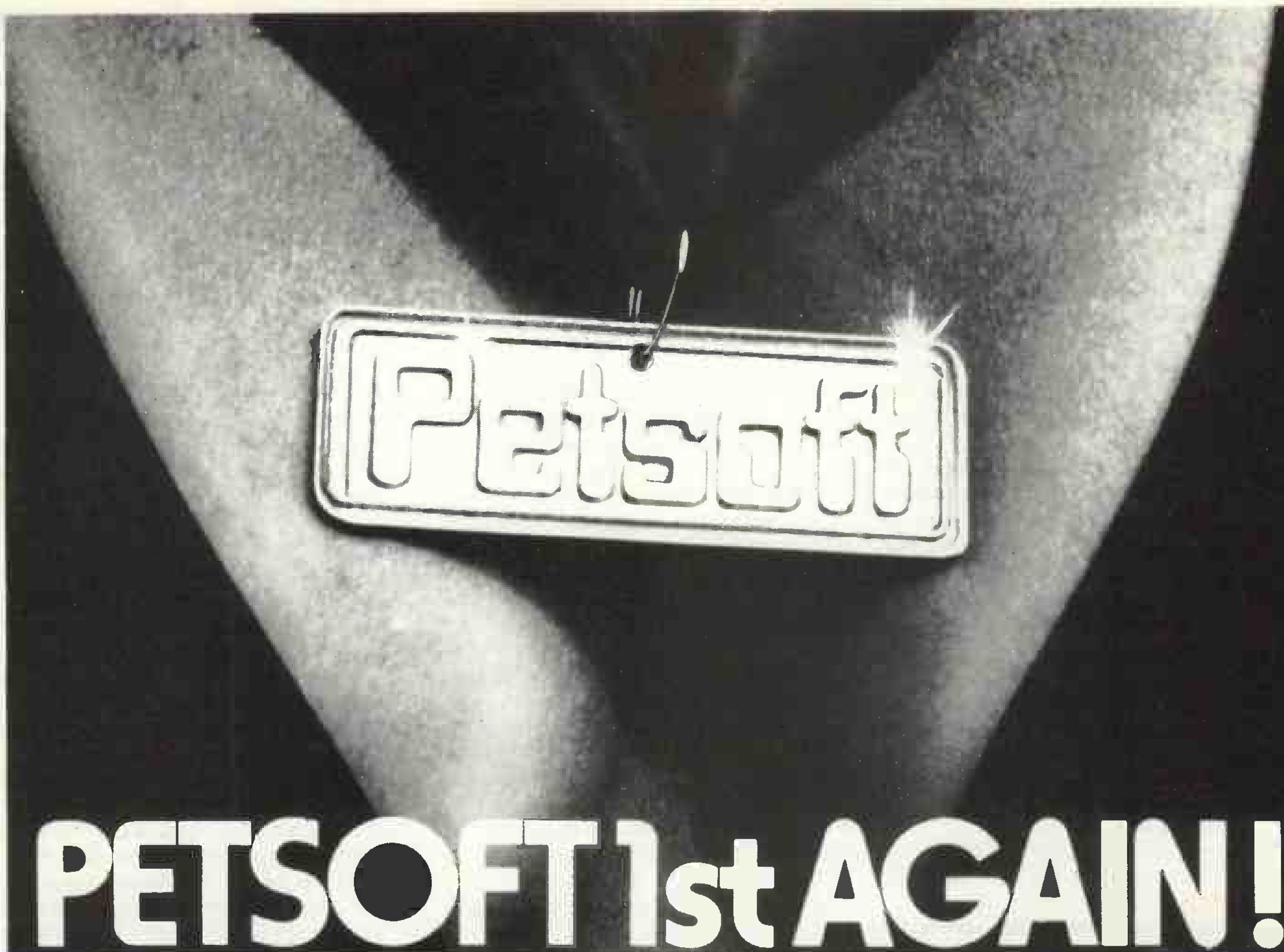
WITH microcomputers now so inexpensive, a large part of the cost of buying a system is in the peripherals attached to it.

The Anadex DP-8000 is one of the low-budget printers now available.

Its capabilities show why it has been so sucessful. It is an 80-column, bi-directional, dot-matrix printer using a 9 × 7 dot format and capable of working up to 112 cps (84 lines per minute).

It has sprocket - feed as standard, and other standard features include three interfaces — RS232C, 20/60mA loop and Centronics — plug-compatible synchronous/parallel input, double-

(continued on page 59)



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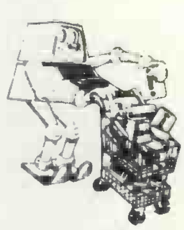

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(continued from page 57)
width printing, 96-character set including upper- and lower-case, capability to produce top copy plus three carbons, paper entry through bottom or rear, out-of- paper detector, 1,024-character storage buffer — an extra 2,048-character storage capability may be bought for approximately £30.

This enables a computer capable of high-speed data transfer to run at that high speed, provided that characters transferred do not exceed the capacity of the buffer; or provided hand-shaking is employed, top-of-form and skip-over perforations controls, eight programmable vertical tab positions, and off-line switch which halts printing but retains data not printed in the buffer.

The serial interfaces can accept data at rates from 110 to 9,600 baud (switch-selectable) and character codes of 10 or 11 bits are accommodated. The RS232C interface also generates a Data Terminal Ready Signal to indicate when the internal buffer can accept data.

The parallel interface can accept data at a maximum closed loop rate above 1,000 characters per second and all control signals are Centronics-compatible.

Internal switches are provided to program the printer to print automatically CR/LF at the end of a line; initiate a CR/LF upon receipt of a LF, VT, FF, or CR code only; truncate lines of 80 characters. Form length is also switch-selectable. The printer uses continuous stationery, with 5in. between sprocket holes (9.5in. paper).

The ribbon is a special matrix- printer type but is inexpensive and changed easily in a few seconds.

One of the most important features is the versatility of the Anadex. It can be, and has been, attached to most micro-computers. We managed to run it with the Exidy Sorcerer which is not entirely Centronics-compatible.

As far as availability is concerned, the prospects look good. So far Anadex has tended to sell in bulk to anybody who will buy. There are now plans to sell through recognised dealers and systems houses. This should make support and maintenance more obtainable and reliable. At the moment, a private user would have to send his machine to Kode Ltd, at Calne, Wiltshire, for repair.

Heathkit

AS A RESULT of some complicated deal in the States, Heathkit now call its printer the Heath Schlumberger Data Systems Printer. To save time, we'll call it Heathkit, as we have always done.

It is an obvious comparison with the Anadex. After we had looked at the Anadex we had the chance to try one of the first Heathkits in the country. As far as performance goes, it works. Data goes in and text comes out. To be honest, to that extent there seems little difference between all the small dot matrix printers.

They are all rather noisy, certainly too noisy to try to think next to if they're doing a good deal of printing. They all print quickly, they all produce rather horrible text — horrible, mainly because the descenders in lower-case can't be printed, and so those letters are squashed up into the line.

So, to compare these printers, one has to look to secondary features, and in comparing the Anadex to the Heathkit, we felt that:

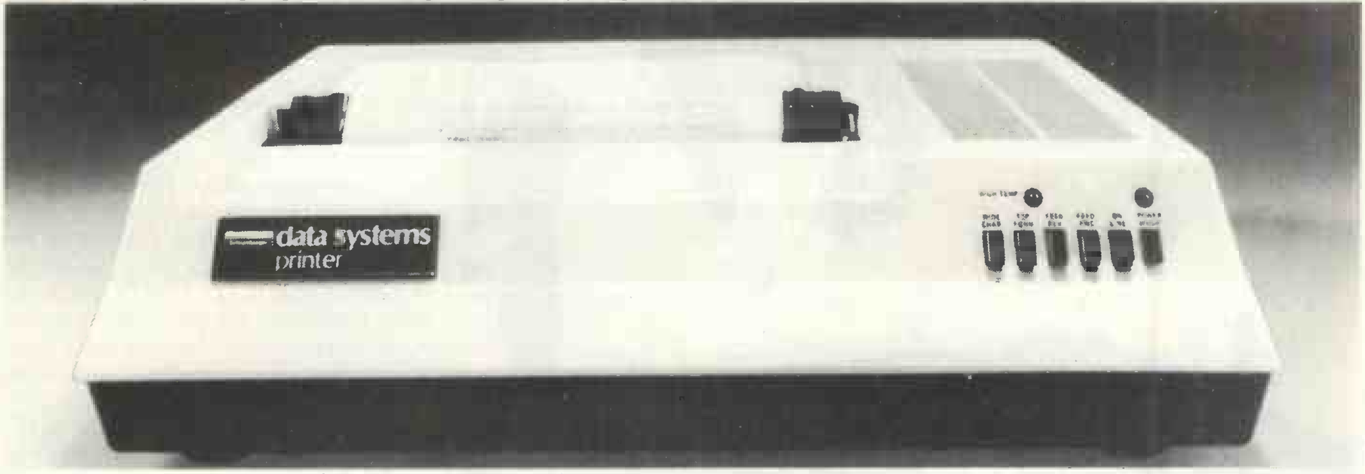
- The Heathkit was packaged more attractively in a flat box, so that one could stand cups of tea on it.
- The Anadex produces slightly more pleasant letters — they were less 'dotty' and easier to read.
- The Heathkit was more flexible. It would print either 80 or 132 characters per line and this could be chosen by a switch on the front.
- A feature we liked about the Heathkit was that one could set the form length into the machine from its front panel.
- Heathkit was slightly faster. It would do a maximum 135 characters per second as against the 112 of the Anadex. On the other hand, it has a print-head temperature warning light on the front panel, which is on about half the time. If it lights all the time, the printer stops to let the head cool. We didn't have this trouble but it might happen.
- Heathkit took wider paper — 9.5in. as against 8in. on the Anadex — and it could be adjusted to take paper down to 2.5in. wide. The Anadex would use only the one size.
- Inside, the Anadex machinery looked rather more robust than that of the Heathkit but Heathkit says that on test a machine printed 150 million characters without a stoppage.
- The Heathkit printer has an auto-test device; press a button and it prints-out its repertoire of characters. This will at least prove that it is not the printer which is at fault.
- On the assumption that every machine breaks down sooner or later, Heathkit looked the easier to cope with. The company has a London shop where machines can be mended, a depot at Gloucester which will do the same, and because it offers kits — of this equipment as well as many others — it has a team of engineers to answer telephone enquiries.
- Because the start is made with a kit, the documentation is excellent, and we felt that with the users' manual in one hand and a telephone in the other, one might often be able to get the machine going again. A broken Anadex, on the other hand, would have to be shipped to Kode at Calne.

Prices

Heathkit, assembled **£553, in kit form £386.28. Anadex**, assembled, **£575.**

Conclusions

- **In general, the Anadex DP-8000 looks good value for money. It is versatile and relatively fast with some neat features. The main fault is that it is noisy, which is not unusual for printers at this price. On the whole it can be recommended for most small business applications.**
- **We felt that the Heathkit was probably better value, though not by a vast amount. Building the kit would save £150 and since there is only one board of electronics in it, it would probably not be difficult.**



Preserving the vital link of comprehension

WHAT IS Artificial Intelligence? I will give a quirky answer which should provoke thought.

Figures 1, 2 and 3 depict three superficially similar games. They are Nim — "standard" computation, given one magic principle; Chess — "semi-hard" large catalogue of principles required. Roadblock — for large versions "hard"; no principles exist.

Nim exemplifies the whole class of problems which can be solved *algorithmically*, i.e. by compact computer programs. At the other end of the scale, Roadblock stands for a class of problems of high *inherent complexity*. Except in trivially small versions, they will never be solved by any computing system.

It might seem that Nim and Roadblock between them cover the whole range but this would be wrong — the real action lies in the no-man's-land between, a territory which I have termed "semi-hard". In taking chess to exemplify this category, I should remark that it has not yet been *proved* to differ from Nim. A simple mathematical rule for playing perfect chess *might* still be discovered.

I do not know anyone who believes this. Note, too, that the category exemplified by chess, soluble only by non-compact programs stuffed out with large bodies of knowledge-based rules, is the category which also contains innumerable socially-relevant problems of mental skill.

Computing technologies are about to break into this category on a large scale. The question is whether the break-in should be by AI methods modelled on the human style of cognition, or whether it should be by the brute-force technologies of nanosecond processors and trillion-bit stores.

This issue of *Practical Computing* starts a series on Artificial Intelligence which will, in the coming months, explore the basic ideas of this field and show how they can be made to work on microcomputers. In the first article Professor Donald Michie, head of the Machine Intelligence Research Unit at Edinburgh University, and visiting Professor at Stanford University in the United States, draws some lessons from history and discusses the basic AI task — problem-solving.

Here are three fundamental propositions:

● No semi-hard problem can be solved feasibly by computer program, unless the program is enriched with a larger or smaller catalogue of logically-redundant heuristic information.

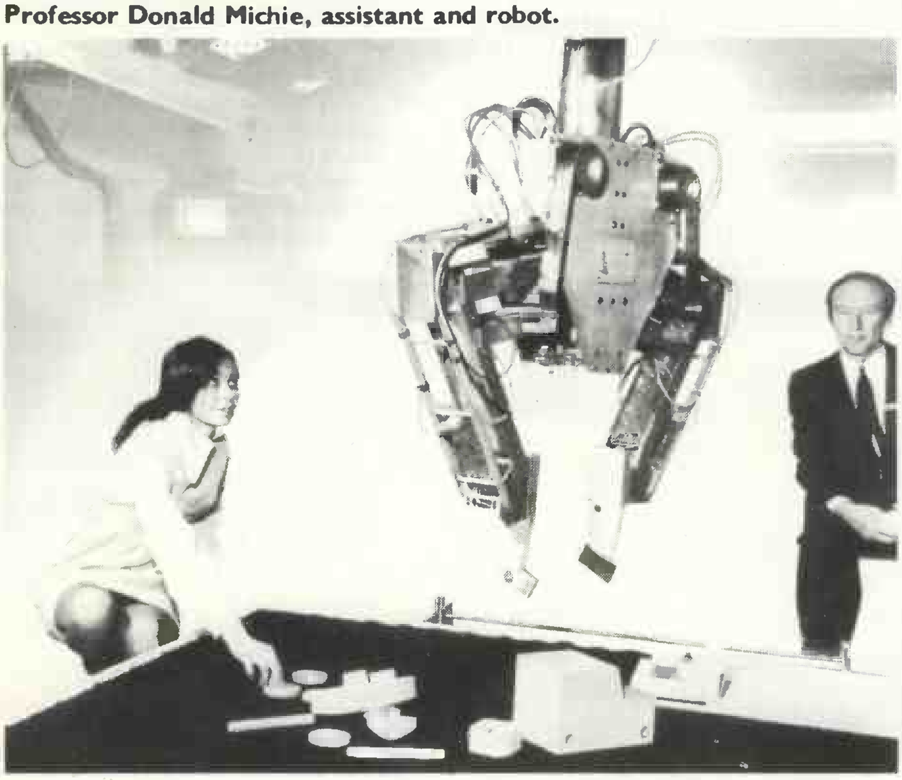
● Solubility can be conferred by a wide variety of such catalogues in each case but very few will do it so as to preserve human comprehensibility of the program and its operations. Unfortunately the *non*-human representations and strategies are those which on criteria of machine efficiency show up as necessarily more cost-effective in action. They are also, pending radical advance in AI, enormously cheaper to construct.

● Hence design philosophies of the humanising kind are likely to be swept aside in the "advanced automation" rush for economic profit.

The 1973 disaster at Edinburgh — of which more later — pre-figures in microcosm what may happen in the larger world of technology if we are not very careful.

I fear that the havoc of the first industrial revolution may be repeated on a more uncontrollable scale. To explain my reasons for this fear, let me repeat that there are two ways to solve a semi-hard problem by computer. The "brute force" way typically gives a "bigger bang for the buck". So it will be preferred by an institution with clout.

Professor Donald Michie, assistant and robot.



Slow and costly

In the Artificial Intelligence way, *human* representations of problem-solving know-how are built explicitly into the program structure, thus preserving the vital link of man-machine comprehension. In the present state of the art, "knowledge engineering" is a slow and costly process. Research directed towards automating it is thus the urgent task.

In this country, however, AI tends to be seen as, at best, an esoteric pursuit and, at worst, a shocking expense. There was a time when these snap judgments possessed more than a little truth. They have been once-and-for all unsnapped by the microelectronics tidal wave.

My friend Ed Fredkin, Director of the celebrated MIT Project MAC, asked me recently about I. J. Good's predicted *Ultra-Intelligent Machine*, that ultimate breakthrough when someone will exhibit for the first time a machine — to steal words from the calypso:

"Smarter than the man in every way".

Fredkin's point was that with computer power as cheap as water it may be a hobby computerist who, in his home, first works the trick.

I don't go all the way with Fredkin but I think that significant AI work can and will be done by home computer enthusiasts, such as readers of *Practical Computing*.

Let us consider robotics. Can hobbyists build robots? In the U.S. they not only build them but race them, in the regular *Amazing Micro-mouse Maze Contest*. Yet I regard those robots as boring, bad for all concerned, and a waste of good talent. The nature of the contest, running a simple maze against the clock, encourages intense devotion to sensors, to mechanical ingenuity, to clever circuitry, to cheap software tricks — to everything, in fact, which characterises the runaway technology of the larger world outside, with nothing of the more cognitive attributes which make real mice more interesting than micro-mice.

What technical objectives would be encouraged by the more cognitive type of contest? Humanly and nationally they are not without importance. I believe that it would apply a forcing function to systems which should be to some degree *teachable* and *self-programmable*.

Problem solving

Since our computing industries are facing a worsening programmer famine, the timeliness and social relevance of such goals cannot be in doubt and I hope that the imminent announcement of a British AI contest — to be sponsored, I understand, by *Practical Computing* among other bodies — will be a sign of the reversal of an unfortunate prejudice against the discipline in this country.

The first and most drastic manifestation of this prejudice was the withdrawal in 1973 of Science Research Council support for the Edinburgh University's *Freddy* AI project. Britain's chances of leading in robotics R & D were wiped-out for the foreseeable future. Robots are not essential to the study of Artificial Intelligence but Artificial Intelligence is as essential to advanced robotics as aerodynamics is to aero-engineering.

Still, enough of reproaches. How can computers be taught to think? How can they be made "artificially intelligent"?

The first problem to be solved in creating useful AI systems is to teach machines to solve problems by themselves. On its own, however, machine problem-solving is nothing exceptional.

Like tic-tac-toe or the "5-puzzle" sliding-block problem, the class of problem may just be too easy to be interesting. Alternatively, the problem may be *very hard indeed*, yet perfectly-executed computer solutions could be nothing but a yawn.

In chess, the defence of king and rook, against king and queen, no other pieces

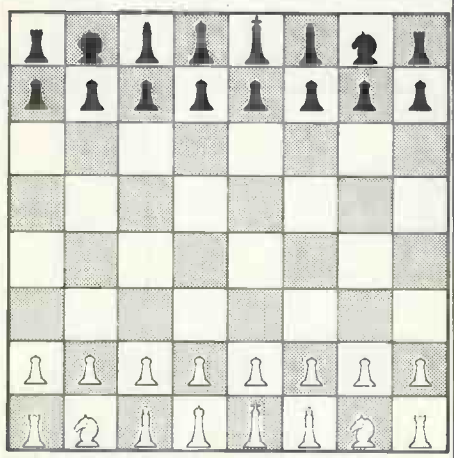


Figure 2. Chess: "A very complicated position".

being on the board, is so difficult that against Master play of the queen's side there is almost certainly no person alive who can solve it.

Moreover, for the queen's side this ending is known to be a theoretical win. So it seems hardly surprising that the task of averting defeat against Master play should be beyond human powers.

Nevertheless, this task can be accomplished by machine-stored expertise, as was demonstrated by Kenneth Thompson at the 1977 meeting of the International Federation of Information Processing in Toronto. He challenged two strong International Masters, Hans Berliner and Lawrence Day, to demonstrate the play of the king and queen's side against a king and rook's defence conducted by his program running on a PDP-11.

Naturally, the two chess masters accepted the challenge, expecting an easy time. To the amazement of onlookers and their own deep mortification, they could make no progress. Time and again new starting positions were set up, but in the ensuing variations the Masters repeatedly lost the thread. When play was abandoned finally the program remained undefeated.

Surely, then, the computer way of solving problems in the KRQR domain must be very interesting, since it passes with flying colours a gruelling test which chess-masters would flunk. Not at all. The machine's method, however powerful in this task environment, is in itself uninteresting. The machine has memorised a crib.

The total number of legal chess positions in the king-queen-king-rook ending is about three million. So a complete tabulation is possible, in principle, giving for each position the optimal move. Thus if it is a White-to-move position — suppose that the queen's side has the white pieces — a move is entered in the table

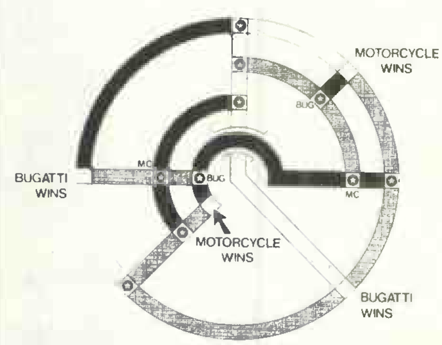


Figure 3. A small game of Roadblock. The running time of even the best program increases as the power of the number of intersections. This reflects the fact that no improvement on brute-force search is possible.

which lies along the shortest forcing path to checkmate or rook-capture.

If it is a Black-to-move position, the corresponding table entry will contain a move which allows the length of the residual forcing path to be shortened by no more than one move — Black cannot do better than that against best play.

A program for White which looks up its next move in the table is guaranteed to win in at worst the fewest number of moves needed theoretically to force the win, and with any luck, if the defence makes mistakes, in a good deal fewer.

Likewise a program for Black, such as that with which International Masters Berliner and Day had to contend, is guaranteed to spin-out Black's demise by

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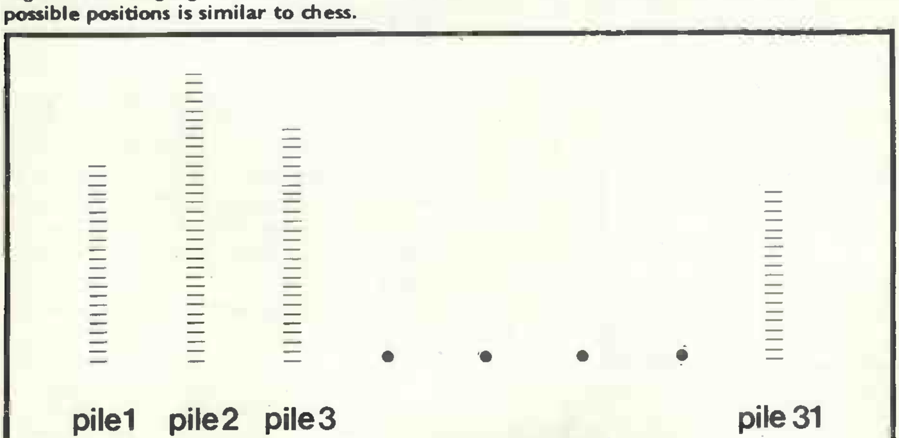
Figure 1. A large game of Nim. There are 31 counters in each pile. Total number of possible positions is similar to chess.



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the greatest amount possible. If White makes frequent small errors, or infrequent large ones, then the table-stored strategy for Black may survive indefinitely, as the two hapless chess-masters discovered. The longest optimal path consists of 16 moves by White and 15 Black replies.

In remarking that perfectly-executed computer solutions of very hard problems can be nothing but a yawn, I do not imply that what happened at Toronto was uninteresting. On the contrary, it was a gripping, even disturbing, experience for all present but the interesting phenomenon was not the machine's behaviour, but the *imperfection of Master performance.*

This leads to intriguing questions about its causes, which centre on the drastic resources limitations of the human brain relative to modern computing equipment. The expert practitioner is obliged to package his knowledge into a set of simplifying rules which he can carry in his head, even at the cost of being let down by his rules from time to time.

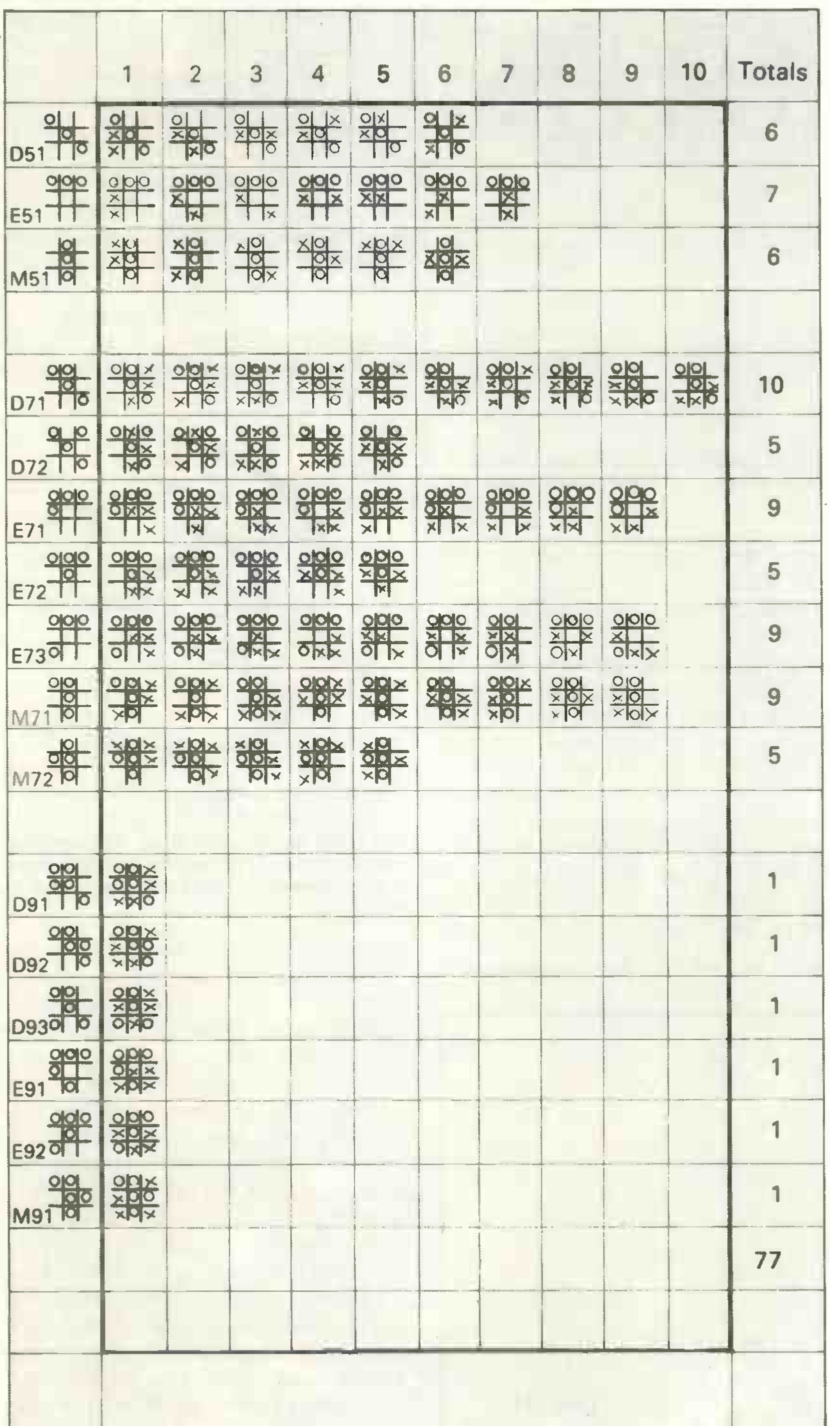
Unlike the final stored look-up table, the process by which such tables can be computed has something to interest the reader, particularly if he has a home computer with enough store to hold a strategy table for games of non-trivial dimensions.

Let us for convenience illustrate with a trivial one, namely Noughts and Crosses, called tic-tac-toe in the States. The method of construction is applicable to all games which, like chess, checkers, Go, and five-in-a-row, are:

- two-person;
- finite — the rules ensure that play must eventually terminate;
- zero sum — what is good for one player is bad for his opponent to an exactly equal degree;
- perfect information — both players have sight of the board and the moves;
- without chance moves — no dice, random draw of cards.

The idea is to start at the end of the game and work backwards. So we must find a procedure for generating all the terminal positions systematically. For a table-based program implementing perfect play for both sides we need construct only two sub-tables, one giving winning play for Nought for all Nought-winnable positions and the other giving Cross strategy for all Cross-winnable positions. If neither Nought nor Cross finds that the current position is missing from both sub-tables, that position is not winnable by either side. The program then has a theoretical draw and must avoid selecting a losing move.

Figure 4. Tabulation of all legal Noughts-and-Crosses positions which have been won by Nought, the opening player. D, E and M correspond to "diagonal", "edge", and "middle" winning patterns.

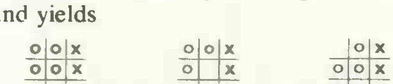


Sub-table creation

Sub-table creation will be illustrated for the case of building a winning Nought strategy. After eliminating recurrences of the same positions by mirror-imaging or rotation, the number of positions won for Nought can be grouped into 16 Noughts-only configurations, as in figure 4. From each of these, one or more positions can be constructed, according to where the crosses are placed. The corresponding numbers are shown in the right-hand column, making 77 to be stored in all.

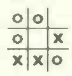
The next task is to construct all the possible direct predecessors. They are Nought-to-move positions winnable in one move. They can be obtained by making unit deletions in each position from the three-noughts-in-a-row line. In other words, we ask "What could have been Nought's last move? Un-make it". Going back one step further we want to create all the Cross-to-move predecessors which are winnable for Nought. This is more tricky. Let us start with D91.1 as an example.

The first of the steps is straightforward, and yields



Nought to move D91.1A — Nought to move D91.1B — Nought to move D91.1C

Next we try to find possible predecessors of D91.1A winnable for Nought — and draw a blank. Cross to move can plug the corner square and win. So, no table entry here. The next case, however, yields a winnable-for-Nought predecessor, and so does the last one, D91.1C.



Nought-winnable predecessor of D91.1B

Nought-winnable predecessor of D91.1C

The nought-winnable predecessors of *these* are generated by deletion of the "nought" which participates in both of Nought's potential winning lines, namely the top left corner in D91.1B and the centre of D91.1C. Other nought-winnable predecessors, if the backwards exploration is being done in systematic "breadth-first" fashion, will be found to have been encountered already and stored during backing-up from other terminal wins.

Proceeding in this way, the strategy-tree is grown backwards until it can be grown no more. Here, then, in essence is our table. The pre-terminal positions are the "arguments" — to use the language of schoolroom table-look-up — and the moves are the "values", just as the number 25 entered as an argument in a table of square roots has 5 as the corresponding value.

A few details remain, such as the occurrence of the same position more than once at a given level in the tree. These cases correspond to positions which have more than one equally good winning line.

Figure 5 shows another problem, a one-person game. The "5-puzzle" shown in the figure is a poor relation of the formidable "15-puzzle". The latter, incidentally, is discussed in the last published writing of A M Turing, the great mathematical logician and pioneer of computing.

As far as its mathematical properties are concerned, the 5-puzzle has been polished-off in a page by P D A Schofield, who points out an amusing correspondence between the classes of move-sequence in the 5-puzzle and the axes of symmetry of the dodecahedron — the twelve-faced perfect solid. This correspondence arises because in group theory both correspond to the same permutation group, namely the Alternating Group A5.

For any starting configuration of the 5-puzzle it is required to transform to the illustrated goal position in the minimal number of moves. In the worst case this minimum is 20 moves. There are 60 distinguishable starting positions — plus another 60 which are insoluble and ignored here — so that store requirements for a complete strategy-table are even smaller than for tic-tac-toe. Construction of the strategy table is easier, too; the procedure is left as an exercise for the reader using the basic facts about the puzzle summarised in the figure.

Now for the point of comparison between these two small problems. I spoke earlier of problems "too easy to be interesting". What objective measures can we use to characterise a problem's difficulty? Mathematicians have devised such measures, and they speak of "complexity". For finite problems there are two different measures, namely the problem's *space-complexity* — smallest number of store-bits needed to house the complete table — and time-complexity — smallest number of operations required for solution in the case that it is to be solved by pure calculation.

In terms of space complexity it is clear that tic-tac-toe emerges as the harder, since the strategy table has a few hundred entries compared to only 60 for the

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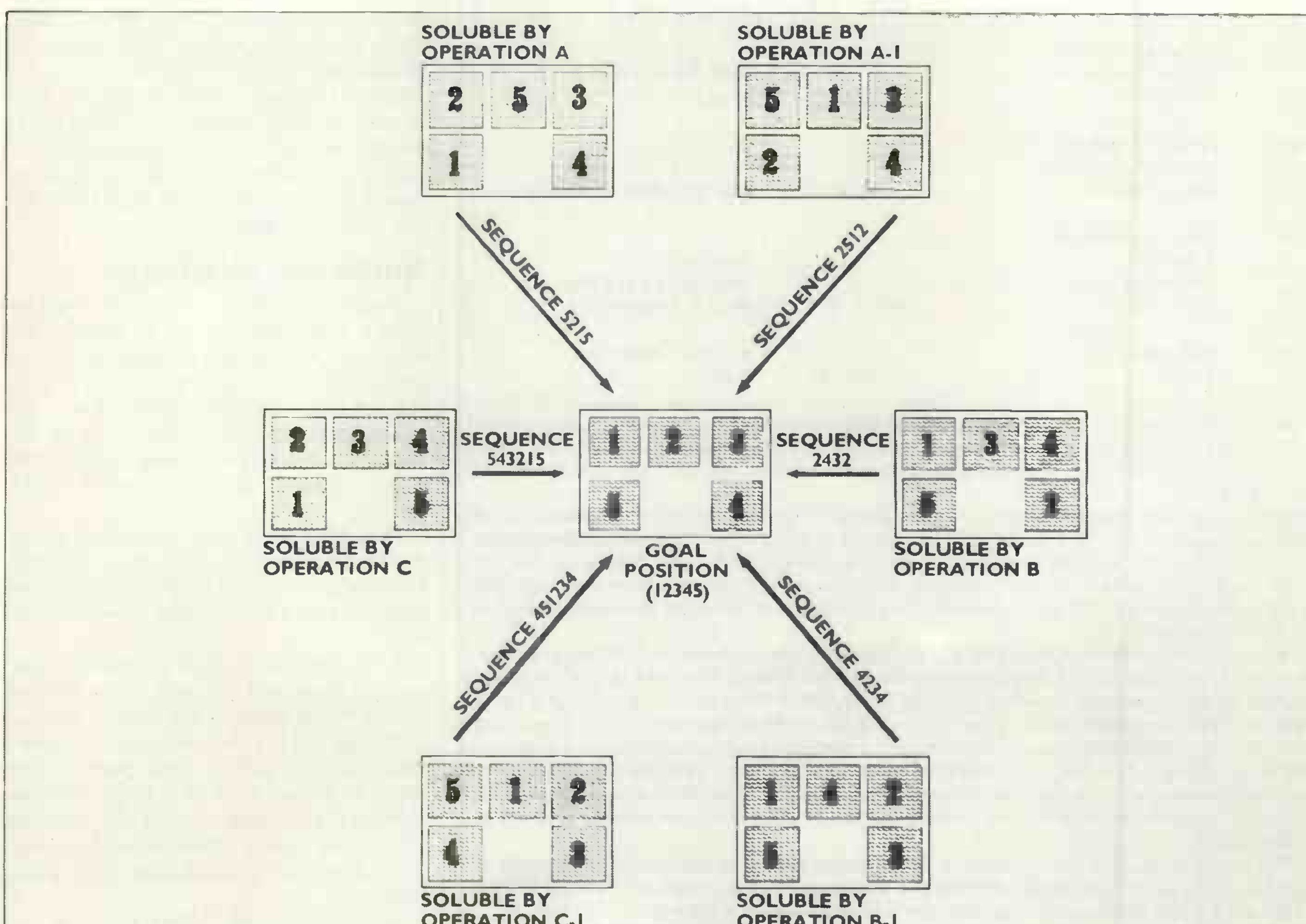
Figure 5. The four positions soluble in four moves and the two positions soluble in six moves have been arranged and labelled to explain the notation used in the strategy table for the six basic operations A, A— ', B, B— ', C, C— '. The first four operations correspond to move sequences of length 4, the last two to move-sequences of length 6.



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5-puzzle. It is equally clear that on pure calculation the 5-puzzle is harder.

This follows from the circumstances that the only known pure calculation adequate in all cases follows all possible paths to the end of the game; and that some paths, even corresponding to "best play", are as long as 20 moves. The complete "lookahead tree" for tic-tac-toe has an average branching factor of about 3 and a depth of, at most, 8. Corresponding figures for the 5-puzzle are 2 and 20.

The number of nodes in the tree, proportional to the number of basic operations to be performed, is thus 3^8 and 2^{20} for the two cases, i.e., 7,000 and 1,000,000 respectively. So on time complexity the 5-puzzle is the harder.

The magic trick on which human culture and intellectual history have been built, the trick of cognition, lies in ingenious compromise. Each of the two approaches is of impractical cost by itself. But the right blend can shrink costs miraculously.

What does this blend look like? Let me phrase the same question in the form of a table with a blank entry, as follows:

Approach

1. A try-everything program
2. What should we put here?
3. A situation-action dictionary.

1. Little store needed; but runs for ever.
2. Store and computation requirements both moderate.
3. Little computation needed; but store requirement would more than fill the world.

What belongs in the blank is a dictionary of a kind but instead of zillions of situations entered separately they are grouped into a smaller number of situation-*types*. Instead of each entry giving an action as a result, an action *scheme* is entered. A scheme is some more general structure — a set of goal-patterns and constraints — from which actions can be recovered by calculation.

So the new kind of dictionary is a dictionary of *patterns* in place of individual instances. Each entry, in effect, says to the processor: "If the present situation matches *this* pattern, then see if you can work out a way of creating a new situation matching one of the following *target patterns*, using only those actions which match these *constraint patterns?*"

What this might look like for the 5-puzzle is shown in the pattern-directed strategy-table from which we recover general pieces of *advice* rather than individual moves. Such a "knowledge-base" of pattern-directed rules might be the only way of getting a strategy into a machine if the latter were a hand-held programmable lacking enough memory for the complete 60-entry exhaustive tabulation. Needed definitions are given in table 2.

The table's strategy follows a well-worn approach often called "problem-reduction", whereby the goal is decomposed into constituent features to be tackled separately. For the 5-puzzle our strategy sets the sub-goal "solve an edge" and then proposes solving the residual problem.

It is common, as in the present case, for such a sweeping simplification to sacrifice the guarantee of optimality in the solutions generated but if the solutions are near-optimal the sacrifice may be judged worthwhile. Table 3 gives the results of running the "advice program" sketched in table 1 on an LSI-11 micro, coded in BCPL.

This last consideration comes to life in the present context as soon as we realise that the sub-goaling ruse adopted generalises to sliding-block puzzles in general. Moving to the 8-puzzle — 3×3 board, central square by convention empty in the goal configuration — problem-reduction takes the form solve one of the four edges, and then solve for the residual 5-puzzle.

Sufficient challenge

Clearly the technique can be pushed higher and higher, to the 11-puzzle, the 15-puzzle, the 19-puzzle, and so on. For a home micro owner, however, I would suggest that a sufficient challenge initially would be to extend to the 8-puzzle the methods illustrated, using Schofield's paper already cited as general background.

Best of all is the kind of program which has so general a structure that different knowledge bases can be slotted in and out according to which puzzle is to be tackled.

If we raise the scale of problems to the level of chess and the scale of the solving device to the level of the trained human brain, we can see the answer to an otherwise puzzling riddle. Since pure search takes us nowhere in such huge problem domains, and since a complete strategy table is also not a thinkable proposition, how does the chess-master find good moves?

Investigations by Alfred Binet at the

TABLE 1

	Condition-Pattern	**(Constraint)**	**Goal-Pattern**
Rule 1	total-distance =0	(NIL)	HALT
Rule 2	preferred edge-pair 0 apart & edge-pair-distance =0	(A, A^{-1}, B, B^{-1})	total-distance =0
Rule 3	preferred edge-pair 0 apart & edge-pair-distance >0	(C, C^{-1})	total-distance is reduced
Rule 4	preferred edge-pair 1 apart & intervening piece at place 2	(A, B^{-1})	edge-pair-distance is reduced
Rule 5	preferred edge-pair 1 apart & intervening piece not at place 2	(A^{-1}, B, C, C^{-1})	distance-of-intervening-piece-from-place-2 is reduced
Rule 6	both edge-pairs 3 apart	(A^{-1}, B)	not (both edge-pairs 3 apart)

Note: A CONSTRAINT is applied as follows. Each operation in the bracketed list is applied in turn to the current position and the resulting position is checked against the GOAL-PATTERN. When a match occurs, the successful operation is selected and the Table is re-entered at Rule 1.

Pattern-directed "advice program" for the 5-puzzle generates near-optimal solutions at miniscule cost of store and processor. The rules are taken in order, and the first whose condition-pattern matches the current state of the problem is executed. Each rule is interpreted in the style: *given* that the condition-pattern has been matched *then* (using the constraint to reduce needless move-trials) find a move-sequence which creates a match with the goal-pattern and *then* apply the sequence *and then* re-enter the table.

Bundles of rules processed according to this regime are often referred to in AI work as "production systems" owing to their resemblance to a formal scheme developed by the celebrated logician E.Post. A neat and eminently revisable framework is thus provided for packaging useful heuristic information about the problem, and keeping the resultant "knowledge-base" quarantined from the "knowledge-interpreter", which does the heavy-duty computation involved in search, pattern-matching and the like. Such knowledge-bases can be treated as data and edited by program — "machine learning" — to improve performance, or they can be modified or augmented interactively by a human expert in the given problem-domain, thus exhibiting the desirable property of "teachability".

The important thing is that the level at which the problem is conceptualised in such sets of pattern-based rules should correspond closely to the human's mental picture and thus lend itself to reciprocal transfer of knowledge between user and problem-solving system.

TABLE 2. Definitions required to implement the strategy of table 1, together with results obtained with a version written in **BCPL** for the LSI-11 micro.

total-distance: the sum of the five *piece-distances, where*

piece-distance =the shortest number of moves required to get the given piece home if all other pieces are removed from the board — equal to the sum of the absolute values of the x- and y-coordinate differences between present location and home location.

edge-pair: the piece-pair (5, 1) or the piece-pair (3, 4). In the goal configuration these two pairs occupy the left-hand edge and right-hand edge respectively.

edge-pair-distance: the sum of the *piece-distances* of the two members of the *edge-pair*

preferred edge-pair: the *edge-pair* with fewer intervening pieces; in case of a tie, then the *edge-pair* with the lesser *edge-pair-distance*; if still tied, then choose arbitrarily.

edge-pair n apart: starting with piece 5 (or 3 as the case may be) proceed clockwise round the board counting the intervening pieces until piece 1 (or 4 as the case may be) is reached.

place 2: the location on the board occupied in the goal position by piece 2.

turn of the century, by Adrian de Groot in the years after the second world war and by Herbert Simon and colleagues more recently, all point to the same trick. It is based on amassing pattern-based mental catalogues of the same essential kind as the table of advice illustrates for the toy example of the 5-puzzle.

Other work suggests similar conclusions for skilled intellectual know-how in general, whether in medical diagnosis, plant pathology, chemical compound identification and synthesis planning, or decision-taking in geological prospecting. Computing systems capable of this kind of practical thinking in specialist areas of applied knowledge are called "expert systems".

Once the essential principle has been grasped, it is within the resources even of the micro hobbyist to build interesting small systems of this type. The key principle is that programs must be written in a new way, namely in the form of modular and incremental bundles of pattern-based rules.

Rules are invoked by processes of matching with the current state of the problem rather than by explicit subroutine call. The ability of pattern-directed programming to steer between the clashing rocks — between the Scylla of processor-exhaustion and the Charybdis of store-exhaustion — is as fundamental to the success of today's expert systems as the phenomenon of aerodynamic lift was to the pioneers of heavier-than-air flight.

It may be thought that something has been said to illuminate the nature of human cognition. Certainly these machine models, the so-called "expert systems", throw light on one particular aspect of cognition — the use of the brain for routine execution of acquired skills.

Although this is the cognitive mode in which most of us spend the greater part of our waking lives, it occupies a fairly lowly rung on the ladder of the intellect. The next rung up is the ability autonomously to *acquire* pattern-directed skills. In learning from precept, from example and from practice, only modest progress has been so far made by the mechanisers.

Above that lie regions of creative insight and the higher flights of abstract reasoning. Machine systems for these higher levels still lie in the future. It may be apposite to close with a problem due to John McCarthy which is intractable to pure search, to pure table look-up, and to all mixtures and blends of the two. Yet it falls apart when the right insight is brought to bear.

The problem is posed in two stages. The first is trivial. Can a checkerboard be covered neatly with 32 dominoes, each domino being of a size exactly to cover two adjacent squares? Obviously, yes. Now cut off the top left and bottom right squares of the board. Can the mutilated board of 62 remaining squares be tiled with 21 dominoes?

If you think that your program might be able to slug it out by trial-and-error exhaustion of possible domino-tiling patterns, then I merely multiply the board's dimensions by 10, so that it has 6,400 squares, and declare the essential problem unaltered.

Finally someone points out that each domino covers exactly one white and one black square. Initially there are equal numbers of the two colours; but two opposite corner squares of an even-sided board must be of the *same* colour, say white, so that their removal creates a surplus of two black squares remaining at the end. Hence the even-sided mutilated checker-board cannot be tiled.

This type of thinking lies beyond current machine intelligence techniques. Extensions will be needed to the present tool-kit of computational logic before it can be brought within reach. A later article will review the present state of this tool-kit, with some illustrative exercises in "artificial reasoning" simple enough to be run on a home micro.

TABLE 3 Frequency distributions of lengths of solution-paths for the 5-puzzle.

Position	Program	Optimal	Position	Program	Optimal
12345	0	0	34125	16	14
12453	10	10	34251	10	10
12534	10	10	34512	12	12
13254	14	14	35142	16	14
13425	4	4	35214	20	16
13542	14	14	35421	8	8
14235	4	4	41253	16	14
14352	14	14	41325	14	14
14523	16	14	41532	14	12
15243	20	14	42135	14	12
15324	14	14	42351	10	10
15432	18	18	42513	16	16
21354	14	14	43152	20	16
21435	20	18	43215	18	16
21543	18	16	43521	14	12
23145	16	16	45123	12	12
23451	6	6	45231	10	8
23514	16	14	45312	16	14
24153	20	16	51234	6	6
24315	20	14	51342	4	4
24531	10	8	51423	10	8
25134	10	10	52143	14	12
25341	4	4	52314	10	10
25413	14	12	52431	24	20
31245	16	16	53124	10	10
31452	10	10	53241	20	18
31524	20	16	53412	10	8
32154	24	20	54132	8	8
32415	14	12	54213	14	12
32541	14	12	54321	18	18

Suggested reading

Ken Thompson (1979) Walter Browne v. Belle, May issue of *British Chess Magazine*, gives the results with commentary of two challenge games between a strong Grandmaster and the KRKQ database.

Articles by D. Michie and M R B Clarke in *Advances in Computer Chess 2*, Edinburgh University Press, 1977.

A M Turing (1954). Solvable and unsolvable problems. *Science News*, London: Penguin, pp. 7-23.

P D A Schofield (1967). Complete solution of the "Eight-Puzzle", in *Machine Intelligence 1* (eds. N L Collins and D Michie) Edinburgh: Edinburgh University Press, pp. 125-33.

Readers interested in the connection between machine problem-solving and certain issues in robotics might look at two popularisations by D Michie; Machine Intelligence at Edinburgh in *Management Informatics* vol. 2 (1973), pp. 7-12 and Machines and the theory of intelligence, in *Nature*, vol. *241* (1973), pp.507-12.

● Circle No. 172

Program which responds when you beat it

I'll try harder next time. That is how Trevor Lusty's learning program for noughts and crosses responds when you beat it. Compare his solution to Professor Michie's on earlier pages.

Until recently, the best computer algorithms were those where the programmer had foreseen all the possible situations which might arise and designed a suitable response. We examine how an old chestnut of a problem may be solved in a different way, for instead of having to foresee every position, the program "learns" which moves lead to defeat and discards them.

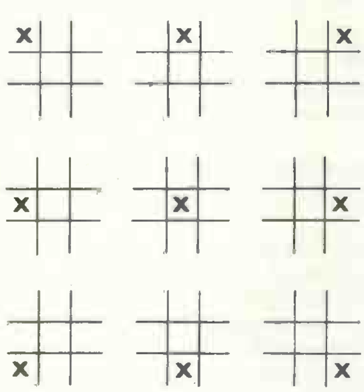
This approach means that you no longer have to worry in case you have overlooked something and opens the possibility of the computer finding an original line of its own — or teaching itself.

The problem

Although the approach is suitable for many problems, a new concept is often best understood if it is seen within familiar surroundings. For this reason noughts and crosses seems an ideal target.

The method

The general idea is that you — the expert — play against the computer and, if you win, the computer rejects the bad move it made immediately prior to defeat. The computer must be able to recognise when it has been in a given situation before and take appropriate action. The apparent simplicity of a noughts and crosses board, however, is deceptive. After the first move there are nine possible situations:



but each leads to a further eight possibilities when the second player has his turn, and things get much, much worse. The enormity of the task is shown in table 1.

Table 1

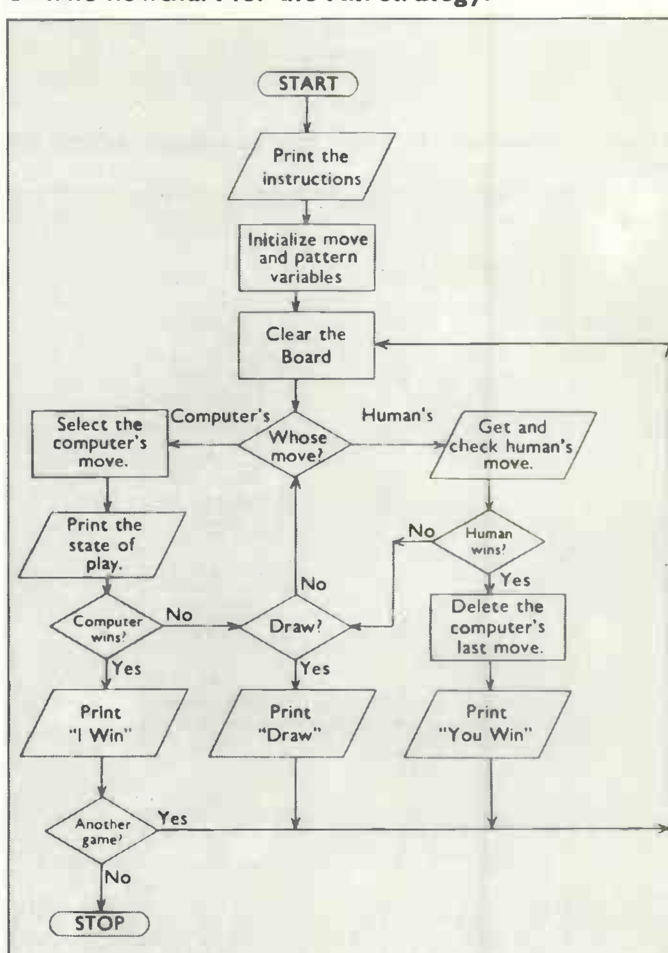
Number of moves			Number of possible patterns
1			9
2	9×8	=	72
3	9×8×7	=	504
4	9×8×7×6	=	3024
5	9×8×7×6×5	=	15120
6	9×8×7×6×5×4	=	60480
7	9×8×7×6×5×4×3	=	181440
8	9×8×7×6×5×4×3×2	=	362880

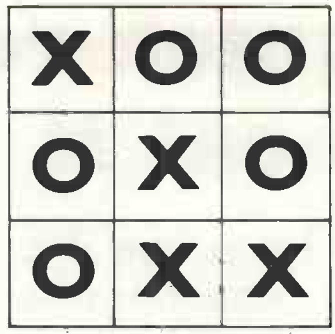
Therefore the total number of patterns is a possible 623,529.

If each board were stored as a 3×3 array we would need at least 5,611,761 bytes — owners of IBM 370s need read no further; what follows is for the rest of the peasants.

(continued on next page)

Outline flowchart for the A.I. strategy.





(continued from page 67)

Some way of reducing storage requirements obviously is needed and two ways are used:

- Only the patterns occurring in play are stored.
- Data packing is used to store the required pattern within a single real variable.

The first of the ploys means that the computer must update its file of stored patterns when it encounters a new one and, by inference, it is not necessary to work them out before you start. The data must, however, be stored in such a way that it is easy to search, for the majority of the running time is liable to be spent in this operation.

Besides the patterns, possible computer responses must also be stored and, again, ease of use is vital. The computer would prefer the board to be numbered 0 to 8, but for human convenience the playing positions are numbered:

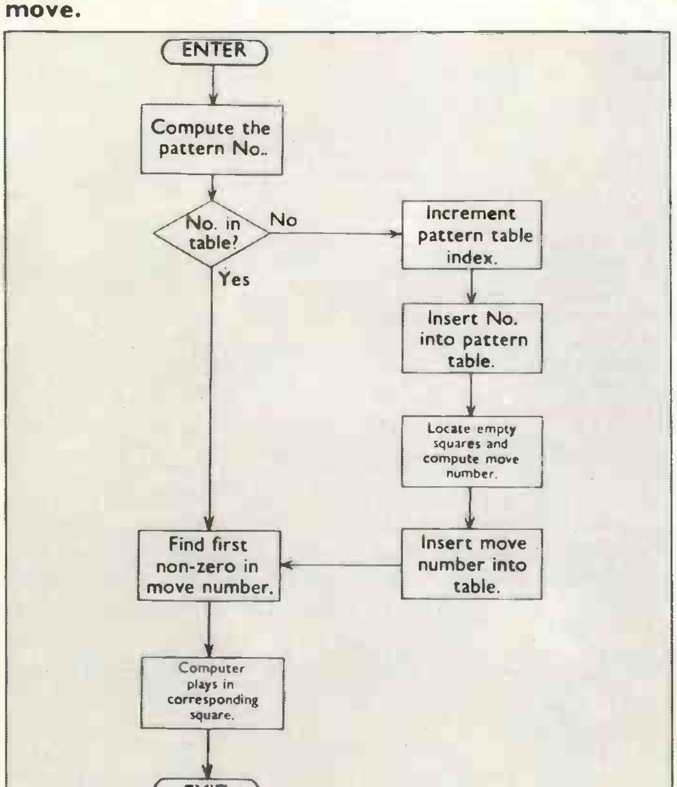
1	2	3
4	5	6
7	8	9

If, for example, the position after two human moves (Xs) is the computer must store this state of play and the numbers 3, 4, 5, 6, 7 and 8 which give possible computer moves. This latter information may be stored as the nine-digit binary number 011111100 which is $252_{(10)}$, where a zero represents an occupied square and a one a possible move.

X	O	
		X

Figure 1

Detailed flowchart of how the computer selects its move.



It is worth noting at this point that each bit of the binary number may be set or cleared by the addition or subtraction of suitable powers of 2, and the fact that we represent the numbers in base 10 does not alter this.

Any position on the board has three possible states — occupied by human; vacant; and occupied by the computer; and base 3 numbers are more suitable for this. The position shown can be represented by the base 3 number 201,111,112 which is $14{,}216_{(10)}$ and this is in many ways the most efficient.

For ease of computation and to preserve more of the original structure, each row is computed separately and the result packed into a six-digit decimal number.

X	O	
		X

$201_{(3)} = 19_{(10)}$
$111_{(3)} = 13_{(10)}$
$112_{(3)} = 14_{(10)}$

$191{,}314_{(10)}$

This representation works well for most machines but it should be noted that the straight base 3 method saves space and may be used with integer Basic. The method of storage is unimportant as, once the pattern number has been calculated, it is used only for comparison and no manipulation of the number is required.

Flowcharts

Flowchart 1 gives an outline of the strategy to be followed and, with two exceptions, is fairly straightforward. An example helps.

Let us assume that the computer has reached the situation shown in figure 1 for the first time, the sequence of events is (see flowchart 2):

- The computer works out the pattern number. (191314).
- It searches the table of pattern numbers but does not find a fit, so it inserts this new pattern into the table.
- It computes the move number (011111100) as shown earlier and decides to play in the first available position — square 3.

Now any reasonable human will play in square 5 and the computer will lose. The computer notes the loss and removes the possibility of playing in square 3 from its repertoire by setting the third digit of the move number to zero, i.e.:

$011111100 - 2^{3-1} = 011111000$ (n.b., mixed bases).

Unfortunately, the computer still has to make one further mistake before playing the blocking move but, once learned, it is never forgotten.

The program

Many of the possible patterns are duplicated and others are never reached because the game is already won. Also, the state of play and possible moves are condensed to two simple variables. The storage requirements are therefore not so great as feared.

The state of play of the game in progress is held in the 3× 3 array B. The pattern number table is held in array T and the corresponding possible moves in array M.

The dimension of these arrays is variable and should, if possible, be set to a fairly large number, but a size as small as 20 locations is sufficient if you take into account the rotational and line symmetries of the board.

The program is written in a modular form with a number of subroutines. This means that it is easy to alter part of the program if your version of Basic is different.

The win-testing subroutine counts the values of all possible lines and stores them in array S. A flag F1 is then set to zero, one or negative one depending on the state of the game.

The squares of the board are referred to in two ways:—

1	2	3
4	5	6
7	8	9

and

1,1	1,2	1,3
2,1	2,1	2,3
3,1	3,2	3,3

and the short subroutine starting at line 3100 is used to convert from the first to the second.

Line 2200 deletes a bad move and is easy to understand, provided you remember that $1 = 2^0$.

The printout shows the initial attempts of the computer and how it improves after a few moves.

Conclusions

- The game is surprisingly interesting to play, as it soon develops into a situation where you must think of new ways to win, and this is not as simple as it appears.
- It is possible to adapt the program so that the machine plays against itself a given number of times before it plays you. This removes some or all of the bad moves and makes it difficult to beat.
- The most successful and enjoyable ploy, though, is to win the first 12 games easily and then invite a friend — not for long — to try to do the same.

```
2080 REM      *****  HAS OPPONENT WON ?  *****
2100 GOSUB 3200
2120 IF F1=1 THEN 2200
2140 IF M9<9 THEN 2280
2160 PRINT "DRAW --- I MUST BE GETTING BETTER."
2180 GOTO 1640
2200 LET M[Q2]=M[Q2]-2↑(P2-1)
2220 PRINT "I CONCEDE --- YOU WIN --- I'LL TRY HARDER NEXT TIME"
2240 GOTO 1640

2260 REM      *****  COMPUTE PATTERN  *****
2280 LET T2=0
2300 FOR N1=1 TO 3
2320 LET T1=9*(B[N1,1]+1)+3*(B[N1,2]+1)+(B[N1,3]+1)
2340 LET T2=T2+T1*(10↑(2*N1))
2360 NEXT N1

2380 REM      *****  SEARCH TABLE  *****
2400 FOR Q1=1 TO Q
2420 IF T[Q1]=T2 THEN 2660
2440 NEXT Q1

2460 REM      *****  INSERT NEW POSITION IN TABLE  *****
2480 LET Q=Q1=Q+1
2500 LET T[Q]=T2
2520 LET M[Q]=0
2540 FOR N1=1 TO 3
2560 FOR N2=1 TO 3
2580 IF B[N1,N2] <> 0 THEN 2620
2600 LET M[Q]=M[Q]+2↑(3*(N1-1)+(N2-1))
2620 NEXT N2
2640 NEXT N1

2660 REM      *****  FIND COMPUTER'S MOVE  *****
2680 IF M[Q1]=0 THEN 2200
2700 FOR P1=1 TO 9
2720 IF M[Q1]/(2↑P1) <> INT(M[Q1]/(2↑P1)) THEN 2760
2740 NEXT P1
2760 LET Q2=Q1
2780 LET P2=P1
2800 PRINT "COMPUTER PLAYS POSITION ";P1
2820 LET H=P1
2840 GOSUB 3120
2860 LET B[Y,X]=-1
2880 LET M9=M9+1

2900 REM      *****  PRINT THE BOARD AND TEST FOR A WIN  *****
2920 GOSUB 3580
2940 GOSUB 3200
2960 IF F1=-1 THEN 3020
2980 IF M9<9 THEN 1880
3000 GOTO 2160
3020 PRINT "I WIN !!!  ---  DO YOU WANT TO TRY AGAIN ";
3040 INPUT A$
3060 IF A$="YES" THEN 1640
3080 STOP

1000 REM      ****************************************************
1020 REM      *****                                          *****
1040 REM      *****  ARTIFICIAL INTELLIGENCE                 *****
1060 REM      *****                                          *****
1080 REM      *****  NOUGHTS AND CROSSES  ---  5/2/79,       *****
1100 REM      *****                                          *****
1120 REM      *****  PROGRAMMED IN BASIC BY TREVOR L. LUSTY  *****
1140 REM      *****                                          *****
1160 REM      ****************************************************
1180 REM
1200 DIM B[3,3],T[200],M[200],S[8],A$[10],L$[3]
1220 PRINT "THIS IS A GAME OF NOUGHTS AND CROSSES WITH THE BOARD"
1240 PRINT "NUMBERED AS FOLLOWS :-"
1260 PRINT
1280 PRINT "1 I 2 I 3"
1300 PRINT "==I===I=="
1320 PRINT "4 I 5 I 6"
1340 PRINT "==I===I=="
1360 PRINT "7 I 8 I 9"
1380 PRINT
1400 PRINT "YOU MAY BEAT ME AT FIRST, BUT I LEARN FROM MY MISTAKES"
1420 PRINT "AND I NEVER MAKE THE SAME MISTAKE TWICE - - YOU HAVE"
1440 PRINT "BEEN WARNED !!"
1460 PRINT
1480 PRINT "WE WILL TAKE TURNS--- YOU WILL BE X I SHALL BE 0."

1500 REM      *****  INITIALIZE VARIABLES  *****
1520 LET L$="X.0"
1540 LET M7=0
1560 LET Q=1
1580 LET T[Q]=0
1600 LET M[Q]=511

1620 REM      *****  CLEAR BOARD BEFORE NEXT GAME  *****
1640 FOR N1=1 TO 3
1660 FOR N2=1 TO 3
1680 LET B[N1,N2]=0
1700 NEXT N2
1720 NEXT N1
1740 PRINT
1760 PRINT
1780 PRINT "OK --- LET'S START --- ";
1800 LET M9=0

1820 REM      *****  DECIDE WHO STARTS  *****
1840 LET M7=M7+1
1860 IF M7=2*INT(M7/2) THEN 2280
1880 PRINT "WHAT IS YOUR MOVE ";
1900 INPUT H

1920 REM      *****  CHANGE MOVE TO COORDINATES  *****
1940 GOSUB 3120
1960 IF B[Y,X]=0 THEN 2040
1980 PRINT "ILLEGAL MOVE --- PLEASE TRY AGAIN"
2000 PRINT
2020 GOTO 1880
2040 LET B[Y,X]=1
2060 LET M9=M9+1

3100 REM      *****  CONVERT TO COORDINATES X AND Y  *****
3120 LET Y=INT((H-1)/3)+1
3140 LET X=H-3*(Y-1)
3160 RETURN

3180 REM      *****  TEST FOR A WIN  *****
3200 FOR N1=1 TO 3
3220 LET S[N1]=B[N1,1]+B[N1,2]+B[N1,3]
3240 LET S[N1+3]=B[1,N1]+B[2,N1]+B[3,N1]
3260 NEXT N1

3280 REM      *****  TEST DIAGONALS  *****
3300 LET S[7]=B[1,1]+B[2,2]+B[3,3]
3320 LET S[8]=B[3,1]+B[2,2]+B[1,3]

3340 REM      *****  SEARCH TABLE FOR A WIN  *****
3360 FOR N1=1 TO 8
3380 IF S[N1]=3 THEN 3480
3400 IF S[N1]=-3 THEN 3520
3420 NEXT N1
3440 LET F1=0
3460 RETURN
3480 LET F1=1
3500 RETURN
3520 LET F1=-1
3540 RETURN

3560 REM      *****  PRINT THE BOARD  *****
3580 PRINT
3600 FOR N1=1 TO 3
3620 FOR N2=1 TO 3
3640 LET M8=2-B[N1,N2]
3660 PRINT L$[M8,M8];" ";
3680 NEXT N2
3700 PRINT
3720 NEXT N1
3740 PRINT
3760 RETURN
3780 END
```

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Extras

- Available expander board features 24K static RAM (additional mini-floppy interface, port adapter for printer and modem and OSI 48 line expansion interface.
- Assembler/editor and extended machine code monitor available.

Commands

CONT	LIST	NEW	NULL	RUN	

Statements

CLEAR	DATA	DEF	DIM	END	FOR
GOTO	GOSUB	IF...GOTO	IF...THEN	INPUT	LET
NEXT	ON...GOTO	ON...GOSUB	POKE	PRINT	READ
REM	RESTORE	RETURN	STOP		

Expressions

Operators

–, +, *, /, ↑, NOT, AND, OR, >, <, <>, >=, <=, =

RANGE 10^{-32} to 10^{+32}

Functions

ABS(X)	ATN(X)	COS(X)	EXP(X)	FRE(X)	INT(X)
LOG(X)	PEEK(I)	POS(I)	RND(X)	SGN(X)	SIN(X)
SPC(I)	SQR(X)	TAB(I)	TAN(X)	USR(I)	

String Functions

ASC(X$)	CHR$(I)	FRE(X$)	LEFT$(X$,I)	LEN(X$)	MID$ (X$,I,J).
					VAL(X$)
RIGHT$(X$,I)			STR$(X)		

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Practical Electronics June '79

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● Circle No. 173

Kay Floyd toured the North-west to look at microcomputing in its various aspects. She reports visits to a "Software cottage", a computer shop and a board manufacturer.

Happy to stay local

THE WORD consultancy conjures-up opulent offices, with several Chester Barrie-clad young men wandering around with important-looking leather briefcases — to my mind at least. So it was something of a surprise and a delightful shock when I visited B&B Consultants in Bolton to find one of the principals soldering an interface together and the other in his cardigan explaining to a misguided woman that they couldn't fix her dentures — she needed the dentist upstairs.

John Blackburn, who started the firm, is a good-humoured Lancastrian and describes himself as "a salesman with a management background". He runs the firm with Peter Binks, who takes care of the technical side, writing programs and, in this instance, making an interface which Blackburn was preparing to take to a customer.

The company was set up about a year ago and the showroom has been open since early 1979. As well as the consultancy and shop, B&B Consultants is heavily involved in microcomputer software.

It is writing packages for the garage industry (spare parts and stock control), insurance brokerage (financial and client records), finance house (financial and client records), employers' personnel records, plumbers' stock control and price list, estate agents' package, stock control in relation to electronic manufacturing and, finally, yarn converters which control a textile manufacturing process from the reel of cotton to the invoicing of the finished material.

Selling aid

The cost can range between £150 for the payroll to £1,000 for the insurance brokerage, depending on how much work and modification of a standard package is involved. "We see software as an aid to selling machines," say Blackburn, "not as a big money-maker."

There is a small range of educational software available which includes maths and programming, and one program which aids the deaf with their speech. As well as its special packages, B&B Consultants stocks off-the-shelf lines from Petsoft, Commodore and the PETACT range.

The software indicates that B&B Consultants is heavily involved with the Pet, and although it is the company's best seller, Blackburn explains:

"We can supply anything advertised. The Apple, Horizon, ITT 2020, Exidy Sorcerer. You name it, I can get it, but we don't stock them in quantity."

The consultancy has recently taken a dealership for the revolutionary TECS system, the full-colour computer which can turn a domestic television into a Teletext-cum-viewdata facility.

"I think it's one of the biggest things to hit England," says Blackburn. But he won't be giving up the Pet yet.

John Blackman with the Pet.

In the market

"I think Pet is a good machine, the price is right and it's readily available. For the small business it is ideal."

Blackburn has put the machine to good use in local businesses. He has attached a till to it and sold it to a two corner shops as a sophisticated cash register. When a receipt is issued to a customer, the Pet updates the stock order automatically, thus cutting out a good deal of paperwork. These modified Pets have been installed with a tobacconist and a toy retailer. The staff don't want to be computer operators, says Blackburn; people are buying the latest business machines which happen to be computers.

Blackburn is doing his best to dispel the myth of the computer by taking it to every local exhibition, computer course and demonstration in the area. Once he took a Pet to the town centre, set it up in the middle of the market and proceeded to demonstrate its capabilities. It drew terrific crowds and, he says, "I did a lot of good business that day".

He stood in the foyer of the local technical college when it ran its one-day

(continued on next page)

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management course, attracting a good deal of attention. In fact, that particular attendance paid off, as he has received an order worth £4,000 from Bolton Technical College for systems to be used in a full-time computer course.

B&B Consultants works on a simple system. "I find the customer, define the problems and give them to Peter to solve", says Blackburn. "We have a good team. I can sell and Peter handles the technical side. The two things go hand in hand."

There is one other person working full-time on the administration side and two part-timers. "I am seriously looking for full-time programmers," says Blackburn, "so that Peter is left free for more design work."

Binks writes almost all the software and is the technical back-up service. Occasionally B&B Consultants enlists the aid of another company to write the financial packages which are very time-consuming and not really Binks' *forte*. "He's good at number-crunching and that kind of thing," says Blackburn.

Customers are found by advertising in the local press and national computer journals and then there are those who visit the showroom. He is mainly concerned with the small businessman but he will cater for the hobbyist if necessary.

B&B Consultants would like to do more design work and is marketing its own interface. It drives a Teletype or other serial printer and it was one of them which Binks was soldering during my visit.

Blackburn feels that the interfaces on the market are over-priced and do not always work properly. His own model sells for £75 and can run both bi-directional and single-directional printers. He thinks there is a need for a standard computer-type interface on the market and hopes that this is it.

Most of B&B Consultants' assignments are in the Bolton area. "I don't particularly want to become a national firm," says Blackburn. "I'm happy to stay local."

He also believes in the personal touch when dealing with customers. "I don't want to be a mail order house. The competition here is healthy but we try that little bit harder. If anyone comes into our showroom, they will not be ignored, as I have seen happen in some places."

Shop route to success

HAVE YOU ever thought of starting your own computer shop? It may seem like a snip. You think you know enough about computers, and you've heard that there's a fortune to be made from selling microcomputers to the unsuspecting public.

Well, it's not so easy as it sounds, as I discovered when I spoke to Bruce Everiss, chairman and managing director of Microdigital. He describes the drawbacks and gives advice to the would-be shopkeeper.

Everiss started Microdigital more than a year ago, with his brother as the only full-time member of staff. Since then it has flourished into a successful mail order house, a hire company and, of course, the shop through which many of the big orders are made.

When he started, Everiss admits he had no real business experience. He had been running a dp department when he realised he really wanted to be involved in microcomputers.

Raising finance

"I played it by ear and asked advice from my father, who's a successful businessman and I had a friend who owns a chain store. I had a good deal of help and asked for advice when I got stuck," he says.

The first thing to do was to raise finance. "I went around begging for money," he said. "It is always the problem, even now." The next thing was to secure dealerships from various companies, so that he had something to sell.

"I just telephoned suppliers and got the dealerships — it was as simple as that." One of Microdigital's luckiest breaks was getting a dealership from Nascom. "No-one else on Merseyside can sell it," he said.

When Everiss had some cash and dealerships, the next item on the agenda was to find suitable premises. Having always lived on Merseyside, it seemed a natural choice to base himself in Liverpool.

"It was very difficult to obtain a shop here," he says. "It cost us a small fortune." But he found one in the "city"

Bruce Everiss

area, the financial quarter where the banks and lawyers are located.

Why did he choose that site rather than a popular shopping precinct? "Business — that's where the future of microcomputers lies," he maintains. He wants to be on the spot when the financial world realises it.

Everiss knew that if he was to make a success of the venture, he would need a good back-up service. Initially he sub-contracted all the necessary engineering work. "A number of people came to help us. We used a number of moonlighters."

That was not an ideal situation and Microdigital recently has employed a number of engineers with whom it is to establish a professional workshop to deal with repairs and development work.

Finding good staff who know about microcomputers is difficult. They are rare and very much in demand. "I have been lucky with my staff. They found me, I didn't have to go and look for them," says Everiss. Most of them are ex-customers.

In the city area of Liverpool, Everiss realised there would not be many people calling to buy £3,000 worth of equipment, so he devised a way of generating additional business quickly. It was the mail order firm, based on all items sold in the shop. Setting it up was "a matter of survival" and Everiss now receives more than £1,000 worth of business a day through it.

Prompt service is essential. "The goods or a letter of acknowledgment is sent the day the order is received."

Believer

Another important consideration is to define the market. It's no good trying to attract the hobbyist with a Sorcerer and it's no use trying to attract the businessman with something like a MK14. Microdigital caters for both markets, as well as the computer engineer. The Acorn, MK14 and Nascom serve the hobbyist sector, and for the small business user there is the Apple, ITT 2020, Pet and Exidy Sorcerer.

Finding the right staff, premises and financial support were all obstacles on the path to success but Everiss maintains that "judging how to advertise was the most difficult thing". He now writes all his advertisement copy himself and believes that it is one of the most important aspects to any business.

"You sell only what you advertise" is his motto. Certainly, Microdigital advertisments are prolific. Everiss advertises locally as well and has had a series of posters distributed to manufacturers and even has them displayed in the Merseyside underground system.

Microdigital has a few other products on the sidelines, to enhance systems, including discs and printers. One of the best-selling lines is cassette tapes — an average of 100 a day leave the shop.

Everiss tells what led to his involvement in this lucrative trade. "I realised that there would be a shortage, so I went to a manufacturer who made special tapes. They are top quality and people can use them at very high baud rates.

"We sell more of our tapes than Commodore or Petsoft," he claims. "They, incidentally, have now gone to the same manufacturer, but I sell the tapes more cheaply."

Books and magazines also constitute a large part of the business, with more than £20,000 worth in stock. Along with the Nascom-1, books are the biggest money-spinners this year.

A frequent problem with setting-up a shop is obtaining the supplies. "Customers are always harassing you," says Everiss. "I take a lot of stick over this."

Microdigital is undoubtedly successful but it hasn't been all plain sailing. "I've been unlucky at times," says Everiss. "I bought unsaleable stocks and created demand when there were no supplies. The business made a loss from April to September last year when we started."

It seems that you should not be discouraged when things go wrong, and learn from your mistakes.

Does Everiss have a final word of advice for anyone wanting to set up a shop? "Specialise," he says. "Choose software, interfacing or robots, and make sure you get plenty of publicity."

Boards in the attic

YOU COULD not find two companies more dissimilar in operation than our last manufacturer, Nascom, and Kemitron Electronics, although they both make the same product — computer boards.

Kemitron is a small operation run by John Drury from the attic of his Chester home. The peaceful countryside, the wife-secretary and tea in the garden seemed a long way from the swish offices and large manufacturing facilities which one comes to expect in the computer industry.

Drury trained as an electronic chemist — hence the name — Kemi from chemist and tron from electronic. After working for Shell for several years, he decided that life in a multinational wasn't for him.

He began on his own three years ago. He planned to base his business on electrochemical equipment and designed a multimeter to start the venture. "Sinclair did one at the same time and that was the end of that market," he said.

Drury then allied himself with Crofton Electronics and, while there, designed his microcomputer. It was not a happy venture and Drury left Crofton in 1978, taking his design with him.

Exceptional

His microcomputer, the Kemitron UBS 3000, is made up of a series of modular boards which you can plug into a rack to any configuration of your choice. The computer has an exceptional bus structure which is simple and cheap — less than half the price of the S100. The boards range from £5 to £6 and include such things as memory, PROM, processors and VDU.

Drury has perfected the technique of putting several processors on to one bus. He works with the 8060, Z-80, 8080 and is looking at the possibility of the 6502 and the 6800.

Kemitron is one of the few firms to work with the National Semiconductor SC/MP. "Most people think it's a useless processor; I don't," says Drury. He has re-written the Basic software for the chip and it now runs faster than the National version.

He became involved with National through the SC/MP introduction kit, which uses a calculator-like display. He found it difficult to work with, so decided to design a VDU board for it. When National heard of his work with its processor, it was naturally interested, and he now works closely with the company.

He has just taken delivery of a new processor from National, the 8070, and Drury reckons that it is "more powerful than the Z-80". He has written the operating system and the resident assembler for the processor and is hoping to base a single-board computer on it for around £100.

John Drury

Drury most enjoys the creative side of his work — designing boards and programming. The administration and sales side of the business has become too time consuming, so Drury has a partner to help.

"I always said I would keep it to one man but that has proved impossible," he says. "The company will grow and I will expand the workforce to an optimum of 15 people."

Kemitron is obviously a small operation, so I was intrigued to discover where the manufacturing of the boards was done. They are produced under sub-contract, by outworkers who call once a week to deliver the finished goods.

"I was surprised by the initial response I had to an advertisement for assemblers in the local paper. There were 200 applicants, so there will be no shortage of workers when I want to increase production. Each worker produces between 30 and 40 boards a week. The potential is tremendous," he says.

With so much work on the technical side, something has to suffer in administration and Drury admits that marketing is a "weak link". He would like to expand his distrubutor network — he has two — and generate additional systems business.

He does a little advertising and runs training courses at Leeds Polytechnic. He uses his own systems on the course and students often want to buy them when it is over.

Profit maxim

Drury says that he is not the "business school type". "It's more profitable to grab opportunities when they come. I think this policy pays. At the moment I have one job which could run into 100 units. They are all Z-80-based for one specific application."

So far, he has sold some 20 systems, costing anything between £800 and £1,000. No precise figures are available for company turnover, but "it is increasing all the time", he says. He is looking for more than £100,000 this year.

Drury's formula for success is simple. "High volume equals low profit. Small volume equals high profit. There is high profit in applications, and electrochemistry is high-profit throughout. I want to weld computers and electrochemistry together."

What of the future? "We shall be developing software support and looking to new processors. We are hoping to lay out the 6502 on a processor card, and develop a rival to the Ohio Superboard. That market sector is crying-out for a product and the Superboard isn't here to fill it. Ours will probably be a little more expensive but it will be modular and have an edge connector.

Pudsey is test-bed for Elite system

THE PROJECT was set up at Priesthorpe Comprehensive, Pudsey, Leeds, with the help of headmaster Ian Philp. "The experiment has resulted in the design for a machine which should fulfil most of the requirements for both computer education and computer-assisted education," say Peter Jackson, commercial director of MBS.

"The machine is an upward-expandable model which enables the school to buy, in small increments, a sophisticated piece of equipment which will cope with requirements of assembler language and machine-code programming and the needs of the departments within the school. It is also capable of tackling administration tasks, such as computerising school records, within the school budget.

MANY SCHOOLS using established microcomputers for computer studies have received attention from Practical Computing, but this is the first report on a school which has been the test-bed for a new computer — the Modular Business Systems (MBS) Elite — which has been built to teachers' requirements.

"The MBS Elite is designed around an all-in-one concept which encloses VDU, central processor and disc unit. External video outputs are provided to drive monitors which are found at most schools, and the overall size is determined by the standard school trolley.

"The machine can be expanded in memory capacity and disc storage by the addition of several cards. The standard operating system was designed for use with high-level languages, CP/M and a comprehensive Basic. It was designed for and specified by teachers.

Priced competitively

"The system is priced competitively at around £4,000 to meet the tight budgets of many schools. This has been made possible due to the upward-expandability of the system and because MBS is able to rationalise on cost and avoid overheads usually found in the field of manufacturing activity."

Jackson became involved with Priesthorpe Comprehensive a year ago through one of the maths teachers. "He felt there were strong reasons for going into a school which had no experience with computers," say Philp.

Jackson gave the teachers lectures on how to use the system and they referred to books and anything else they could find to increase their knowledge.

"We started programming at the assembler stage, which was a little difficult," says Philp, "but it helped to find out that what was going on inside the machine. Now we can write simple Basic programs and make our own mistakes.

"Purely from the company point of view, the whole thing was an experiment," Philp continued, "but one in which the school was delighted to take part. We had been thinking about getting a computer in the school before we were approached by MBS, but there was the financial problem and also that of who looked after the machine, as none of us had any experience. So it looked as though there was no way we could have one until Jackson stepped in and was prepared to help us."

The installation of the machine has meant that a new and exciting future has opened-up for Priesthorpe Comprehensive in the computer field. Philp envisages computer studies, with software written by the pupils, some standard packages and others which will be modified by the school.

Computerised learning is high on the list and Philp hopes to put together some software for remedial maths and English classes. "Some students have problems with the basic rules of numbers and with simple maths programs and a computer; I feel that this totally different approach will do much for the student. If he can see the old problem in a new and exciting way by using the computer, it will give him prestige and confidence, as well as increased motivation," Philp explains.

Students who will use the machine range in age from 14-18. The computer studies will start gradually with a small O level group in the sixth form, then an O level in the fourth year with a limited number of students and, hopefully, a higher examination for older members of the school.

The administration staff expect the machine to be a great help to them. "I don't think it can run the whole school records," Philp says, "but it will keep basic records, which include production of form lists in alphabetical order and transfer of classes.

"This will be very useful, as we have many students who join us halfway through the year. It takes a great deal of secretarial time and the computer will simplify things like that. We hope to put book-keeping on it as well."

Something for all

One point Philp stresses is that the computer is there for everybody's use. "The big danger is that it may become something for the maths teacher and his classes to play with — I want to prevent that," he stresses.

"As soon as we get to the stage where the machine is instantly available to anyone, then we will accept it as being a useful addition to the school.

"I will do anything to encourage people to use the computer. It doesn't matter what they do with it — even playing games helps. The fact that young people are using it is the most important thing."

There are around 1,000 pupils in the school and "if in five years' time, everyone in the school has not had some benefit from it, or experience with it — whether it be seeing it in action or operating it themselves, I will be disappointed," says the headmaster.

The MBS Elite

● Circle No. 177

Is the time ripe for a technology centre?

THE GROWTH of sales of microcomputers over the next 10 years will be astounding. There are, for instance, some two million small businesses, a high proportion of which will be able to make economic use of a micro. In addition, many lower-level managers in large firms and many home users will also be buying micros.

If you don't believe that such a sudden, widespread sale is possible, look at electronic calculators. Did you have a calculator in 1969? Did you know what they did or how to use them? How many small businesses are without one today?

Now computers may not spread at the speed of calculators — which took only five years — but the increase will still be fast.

Microcomputers are much simpler to understand than bigger machines and their operating systems. This is just as well, because almost all the micros sold in the future will be bought by *people who know nothing about computing today*. Worse, many of them distrust it, are afraid of it, dislike the jargon and mystification which surround it, and are generally anti-computer.

Yet it is important that, as a nation, we adopt the new technology at the fastest possible rate, for two reasons.

Firstly, we need to regain our position in terms of international competitiveness. Secondly, if we want to have our own micro industry, rather than importing everything from the Americans or the Japanese, we need a home market to build sales before we export.

For those reasons the Government is spending money on telling people about microprocessors and encouraging their use; and it has also shown great interest in the idea of a Microcomputer Centre.

The Centre is regarded as a means of providing the education and information needed to progress from complete ignorance of computing to buying a system.

In the process, the Centre would also help to improve the quality of hardware and software by publishing unbiased and objective comparative data — in the way WHICH COMPUTER? and *Practical Computing* do in the magazine field. It would help to improve reliability by collecting feedback from users. The Centre information would, of course, be available to suppliers and consultants, as well as to the public.

The important thing is that the information would have a very low cost to the "client". Traditionally information — like software — for computers has been very expensive. If you are installing a £40,000 minicomputer you think nothing of going to a three-day seminar for £400 to learn about computing, or of employing a consultant at equal expense to make recommendations.

If, however, you are to spend only £2,000-£3,000 on a system, you will not spend hundreds of pounds getting information about it.

So the Centre will need to avoid the face-to-face information-giving which is so expensive. Literature, designed carefully to give the information you need without confusing you with jargon, or things which are irrelevant to you, will probably be the main medium.

WOULD YOU like to be able to use an independent Microcomputer Centre to find out about micros? By the time you read this, the author, Ian Litterick, hopes to be carrying-out a feasibility study to see whether such a centre should be established, and how it should be run. It would form part of the Government programme to encourage small businesses and the application of microprocessors.

Similar to the Design Centre, Building Centre or Crafts Centre, the Microcomputer Centre would probably be based in central London, with an exhibition area showing systems running and available for the public to inspect.

A library and book-shop would form part of a service which would provide comparative information on hardware and software, as well as a broader education about micros in general.

The Centre might also run satellite centres in regional cities, or "travelling circus" caravans visiting smaller towns, or run stands at trade exhibitions.

The author would like to hear the views of *Practical Computing* readers, particularly micro-users or would-be users, on the proposal and on what the Centre should do. Please write to him care of *Practical Computing*.

Microcomputer Centres — our view

IN PRINCIPLE what Ian Litterick suggests is perfectly correct and the need for such centres has been felt, and to some extent, met in many other industries. There is always, however, a fundamental difficulty about impartiality. Such a centre is either funded by the industry through a voluntary levy or by some outside source, like Government, a trust or a university.

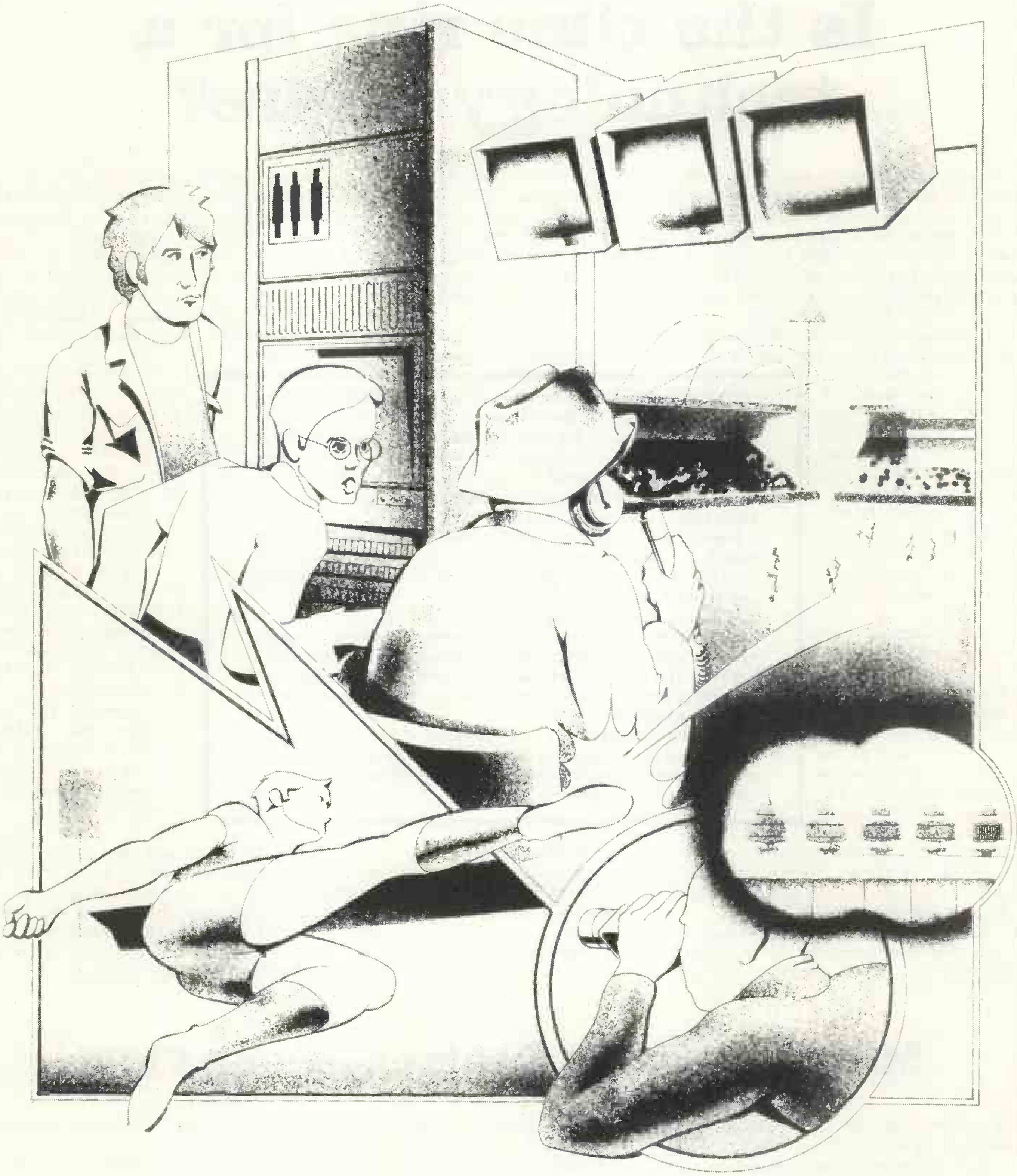
In the first case the job of the Centre is regarded by the people who pay for it as being to protect their interests; and therefore they resent it publishing 'unbiased and objective data', much of which is likely to be uncomplimentary. In the second case, it tends to settle into stodgy inactivity as the best way of avoiding pressure on its backers.

The only organisational escape is through building an 'editorial' reputation which is worth enough to its consumers to give it an independent existence, apart from the good- or ill-will of trade or Government. That is part of the function of magazines like this, and it is one we can partly fulfil.

Of course, if we decided that every manufacturer of software and hardware in the microfield produced rubbish, we might find ourselves short of advertising revenue; to that extent, we are not and can scarcely be absolutely impartial. No-one who earns a living by selling advertising space could properly discharge the functions of the Centre.

One of the few organisations to escape has been the Consumers' Association. To make enough to ensure an unbiased existence, however, its publication, *Which?* has to appeal to a huge number of people, by surveying the widest possible range of goods and services — from divorce lawyers to cat-mange cures.

It is most unlikely that an organisation devoted solely to microcomputing would be strong enough to withstand the pressures which would be ranged against it.



A whole new ball game

'HE STARED at the video screen on which each player was transformed into a moving dot of light and each movement into a silver snail's trail.'

Mackinaw, the referee, had an idiosyncrasy. At the start of each game he would not toss a coin. Instead, he used a large, silver medallion, won by a great-grandfather in some forgotten war. As he spun it in the air it caught the sun and sparkled. For three seconds it silenced the roars and shouts from the throats of the 50,000 crowd.

The audio-microelectronics were baffled temporarily by the moment of silence; they over-reacted by sending the banks of phallic sound booms sliding out on their telescopic arms to hunt from side to side; and the commentators saw the sparkle and pressed their lips to the microphones to explain about Mackinaw's idiosyncrasy to the watching millions.

The panels of experts in the sterile studios made notes on their pads; the scene was scanned by dozens of electronic eyes; and it was torn into shreds and pumped straight up the long antennae and streamed out through the stratosphere towards the huge weightless dishes; and the space stations scooped up the signal and cleaned it, tidied it and magnified it with the power from the sun and then pulsed it out, bouncing it around the globe from wire to wire, component to component.

Never a chance

In the double-glazed Alaskan huts, and the rain-soaked slums of Rio, and the tar-paper shacks of Johannesburg, anonymous people stared into cathode ray tubes and were joined in spirit with the boisterous crowd.

by John Abbatt

City won the toss, Carter kicked-off and passed to Wardle, who back-heeled to Thompson, who ran round a defender, feinted left and then hit a high cross ot Malloney, who leapt high into the air at precisely the right moment and nodded the ball perfectly to the feet of Fairclough, who belted it solidly into the top right-hand corner of the net. The defence didn't stand a chance.

Nobody congratulated Fairclough and, as he walked back to his position, he gave a thumbs-up sign to the glass-fronted City control box high in the West Stand.

In the box was Strickland, the City manager; squat beneath his archaic trilby hat, his lips clamped on an unlit cigar. He had given up smoking but retained the cigar for the image. He had binoculars slung around his neck and headphones over his ears. At intervals he spoke into a microphone. He spoke to a man who was lying flat on the roof of the stand with glasses trained on the rival United control box.

Faraway look

In the corner of the box, not even looking at the game, sat Mullen, the aged trainer, and Polchard, the groundsman. They had dragged out an old and well-worn relic of conversation and were tossing it between them.

"Charlie George, Kevin Keegan and George Best," said Mullen. "They had style and a feel for the game. They were artists."
Another roar outside. One-all.

"Goalless draws," prompted Polchard. "Do you remember goalless draws? Now it's 20 or 30 goals a game."

Mullen nodded. "They were real teams; squads we used to call them. Now you pull them off of the street and in six weeks they are top-class players. When they are injured you throw them aside and get another one."

All for a few weeks of glory," said Polchard, "but nearly all the money goes to them."

He nodded towards the other side of the box where Dearlove, the chief tactician, stared at a video screen, on which each player was transformed into a moving dot of light and each movement into a silver snail's trail. Beside him was Walker, the principal programmer, peering at another screen full of bunches of figures and characters.

Walker looked up. "Analysis read-out, Jim. That was one of their disc Beta attacks, track 3G."

Dearlove punched B3G into his console and looked at the screen again. "In that case we can stay with our Omega Disc and try attack 8Z. None of their defences on that disc can handle it."

Secret weapon

He punched more buttons and on the field the players responded. Carter kicked-off again and four minutes later Malloney had the ball in the net. Two-one.

Strickland clutched at his earphones. "He says they are changing discs," he shouted.

Dearlove and Walker looked at one another.
You know what the model predicted," said Walker. "They should be trying their Gamma disc attack 4J at this stage if they are being consistent."

Dearlove nodded. "So now we try our secret weapon, we'll give them the new Alpha defence, 9Q."

Walker already had the diskette in his hand and he pushed it in the slot as Dearlove keyed-in the code. The battery of 11 antennae below the box swivelled and locked on to each member of the team.

A fresh beam of micropulses was generated and sped unerringly to activate the pressure pads superglued between the shoulder blades of each player. The 12 pressure points in each pad were invoked. Each man responded as he had been trained; trained to react blindly and without thought to the patterns of pressure as they came. Swerve. Right. Leap. Kick. Shoot.

As the United winger executed a beautifully-positioned pass, Fairclough, to the delight of the crowd, got a head to the ball by split-second timing and nodded it down to the feet of Carter.

"Right," said Dearlove, excitement lifting his voice, "now we hit them with a 7C."

Mr. Fixit

He punched-in the code and two minutes later Thompson scored with an incredible shot. He had his back to the goal and kicked the ball backwards over his head. Three-one.

There came a whistle and the cigar fell out of Strickland's mouth. "The referee's given us offside," he said.

He turned to berate Dearlove but then touched his earphones. "He says to look at their aerials."

He focused his binoculars on the other box. "Twelve of them," he announced.

He panned downwards and fastened his gaze on Mackinaw. He could just make out the tell-tale circular shape under the back of the man's shirt.

He turned again, letting the binoculars fall to his chest. "O.K. so they must have fixed the ref. Get the jammers out boys — we've got a fight on our hands."

Same and Different — Letter Builder

Cassette for Apple, Pet and TRS-80 Levels I and II. Available from Program Design Inc, 11 Idar Court, Greenwich, Connecticut; $9.50.

THIS American package software house advertises a range of educational software for Pet, Tandy and Paale; it claims its programs to be of tested educational value. We bought the Apple version using VISA, and it took some four weeks to arrive.

Incidentally, it is very easy to buy U.S. products using Visa or Masterchange or Amex Credit cards — much easier than sending a dollar draft. Whenever possible we use this method of payment, always assuming, of course, that the vendor can accept the credit cards.

Same and Different is a suite of six similar programs in which the pupil (target age 3-6 years) starts by identifying as 'same' or 'different' a range of large colour squares. It then moves on to increasingly-complex letter-like shapes — like large boxes, and plus and minus signs — and finally to matching ordinary screen-sized letters.

Letter Builder takes this process a stage further but the pupil has to find the letter displayed on the keyboard which is displayed on the screen. Again the level of difficulty can be selected, starting with distinctive letters (A and S) and moving by stages to the whole alphabet.

Smile, please

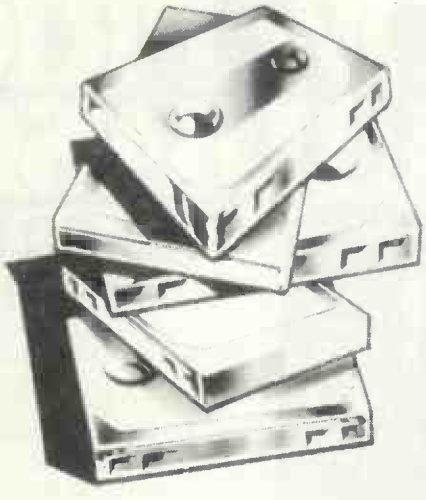
The program is accompanied by a six-page leaflet. For *Same and Different* this tells you to put 'smile' and 'sad' faces on the S and D keys on the keyboard, and to screen the rest of the keyboard with cardboard.

We didn't think young children would be too happy with this arrangement; the experience of some researchers in this area is that large buttons are preferred to small keys. So we altered the program slightly (line 350, and print statements in 140 and 180) to use H instead of S to separate the letters. We then made some large keys from plastic wall hooks from Woolworths, which were loose on top of the keyboard keys.

We used Loctite Handystrip on the bottom of the keys to provide a shape which would slot over the keys — an alternative might be Bluetack or something similar. The extension keys were held in place by the cardboard screening the rest of the keyboard.

Baby Suzanna being still too young to try, we took our Apple to a day nursery. There six four-year-olds tried *Same and Different*.

The conclusion was encouraging. All the children eventually grasped the idea after some patient explanation by the matron. Just as important, they enjoyed the exercise. A little to our surprise, two



managed the level 6 stage of *Same and Different* matching letters. The steady rhythm of changing patterns and the 'well done' and 'raspberry sounds', which I thought well-chosen, seemed to hold the children's attention well, although a longer test would be needed to see how this persisted.

One weakness in the arrangement was that the children tended to concentrate on the colours on the screen and not look too carefully at the keys. They distinguished keys as much by touch as by sight.

Next time we tried keys with different shapes and textures, and spaced them further apart at the edges of the keyboard, so the children had to turn clearly from one to the other. That seemed an improvement.

As to the educational value, it should take an elaborate, controlled test to prove the worth of the computer in relation to traditional instruction. For our review each child was supervised closely and encouraged by one of the staff. The exercise, however, seemed reasonably convincing as a development aid.

Convincing

The main defect from this point of view is that the letters are capitals. Children are taught normally to read and write using lower-case letters. Apple high-resolution graphics could be used with advantage to overcome this particular problem.

We also thought the reinforcement could be improved by some special display after, say, 10 correct answers. The programs score for the child but this is not directly to provide feedback.

The crux of the matter, however, is the children. They like the programs and I was convinced they were learning to look at shapes in the way they need to do to learn to read.

They definitely liked the programs. Better advice could be given on making the keys distinctive to the child but the price is very reasonable — as an education aid you may not have to pay duty or VAT — and there were no technical hitches. — K. F.

Escape

Templeman Software Services, PO Box 7, Stratford-on-Avon, for cassette or mini-floppy in 16K. No price decided.

MOST computer games are abstract entertainments. *Startrek*, for instance, is an almost completely intellectual business of dots and numbers, though, if one had to fight a deep space battle with the Klingons, this might well be how it felt.

Adventure is played through text messages on the screen; all the visual settings have to be erected in the player's head.

We have found one game, however, which is both intellectually gripping and visually striking. It uses the Apple graphics to create a crude but astonishingly compelling world from which you have to *Escape*.

On the surface, it's just another old maze. What you see on the screen is your view as you stand in a maze with 10-ft. walls. If you have colour, better yet — because the sky, walls and floor are different and this adds to the realism.

This view takes the top half of the VDU; below it is a little map of the directions in which you can move at that particular position in the maze, and the keys to press to execute a change.

Gripping

So, if you want to turn round and see what's behind, you hit the appropriate key. If you turn round again, there's the scene you had to begin with. If you move forward, turnings to left and right appear — you can look down them, go down them or pass on. As you explore the maze, you can sketch a map of the bits you've seen and traversed. But every so often you meet a denizen of the labyrinth.

You were warned that these people either always tell the truth, sometimes lie, or always lie. Each will make some cryptic remark like 'I always lie', which must mean that he sometimes lies because if he always lied he would have to say 'I always tell the truth.' He will offer a map of the maze but, since he may not be truthful, it may be misleading; and a compass which will indicate direction but, of course, it may be a 'joke' compass.

By correlating all the information from the maze, the maps, the denizens and their compasses, it is possible to find a way out.

There is nothing esoteric about the computing for this sort of game. The essential ingredient is imagination — making it possible for the player, or victim, to see things realistically.

For instance, it seems that the new computer games on the West Coast are about 'contact' sports. In a basketball game we've heard of, the players run and twist and their faces show pleasure, anger, pain, frustration. This is the way games must go. Why can't the U.K. produce some? — P. L.

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Peanut Butter and Jelly Guide to Computers

By Jerry Willis. Published by Dilithium Press 1978 (distributed by ISBS); paperback, 207 pages; price, £5.80.

WHETHER it's the fact that this book was written on a word processor or that the author is a specialist in instructional materials and methods which is responsible for its readability is anyone's guess. But it is, and it covers as much of the computer field as some books twice the size.

It's possible to write a book on a subject about which you don't know a great deal but that will certainly show in what you write. On the other hand, if you know your subject it will be clear in the finished work. Willis obviously knows his subject. He has learned a good deal, the hard way, about assembling kits and buying second-hand peripherals and writing programs.

Satisfying

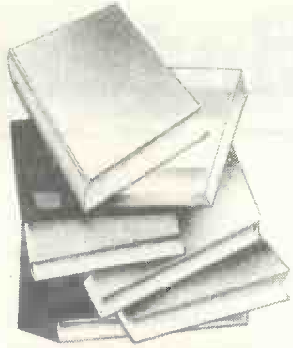
It would be no exaggeration to say that you'll obtain more solid information from this book than you would in several months of other reading. The details make it a satisfying read, plus the feeling that you're getting good, friendly and unbiased advice from a fellow fanatic.

The book includes introductions to micro architecture, memories, languages, a run-down on some typical computers, as well as sections on simple applications and computer art. The final three chapters cover the author's experiences with computer stores, mail-order buying and kit building. Most of it is U.S.-orientated, predictably enough, but let us hope that some of the sad stories are not repeated here.

The only real complaint we could make is on his explanation of number systems. It is not the best we've seen, perhaps because it's compressed into three or four pages. There are plenty of better introductions to the subject.

Conclusion

- **If you're a beginner, you'll learn plenty from this book. It's especially worth reading if you're thinking of buying your first microcomputer. The author has succeeded in his aim "to keep the writing style as light and comfortable as possible and to include technical material only if it would be helpful and understandable to a reader who didn't have a degree". Highly recommended.— R.G.**



The Future with Micro-Electronics

By Iann Barron and Ray Curnow. Published 1979 by Frances Pinter Ltd. hardback, 243 pages; price, £7.95.

THE HEALTH of *Practical Computing* is a living witness to the future outlined in this important book, probably the first practical — as opposed to science fiction — assessment of how the micro will change our lives. It was written originally for the Department of Industry early in 1978 to help shape government policy in relation to micro-electronics, microprocessors and microcomputers, and it aroused controversy at the time because of its "leaked" projections of the unemployment which might result from the micro revolution.

It estimates the number of jobs lost as 10-15 percent and a high proportion of them will be today's female jobs. Will this result in more equal opportunities for women? Or in a drastic decline in female employment?

The main lesson of the book is that we must plan for and so minimise the bad social and economic consequences of this huge dislocation; and to maximise the chances of replacing the lost jobs. Ironically, it seems the only way to do so is to make sure that we embrace the micro revolution at least as quickly as anybody else.

Five percent only

That is not so much because it is important to replace redundant jobs with a healthy microcomputer industry, although Barron has now become director of strategy at Inmos, the deposed Labour government's answer to Texas Instruments and Motorola.

For, the authors argue, micro electronics will never provide more than five percent of the economy, even if telecommunications is included; as fast as the volume of turnover soars the cost per item plummets and the labour input also drops. So, overall, there is little growth.

No, the main reason why we must embrace the micro revolution is that unless we use the damned things we will become totally uncompetitive — an undeveloped country by international standards. The Japanese, Americans, French, Germans, Koreans and all will be using them — and indeed are using them — to produce goods and services much more cheaply than we will be able to do.

Fortunately, recent governments and some of the unions — at least at TUC level — are beginning to realise the importance of accepting the challenge of the micro. The question is whether or not it is too late and whether or not our built-in resistances to these innovations can be overcome.

The major part of the book is the authors' forecast of how the technology will develop and how it will be used. They cover a wide area, from international packet-switched networks and mainframe computers to microprocessors and home computing.

Too difficult

They don't believe in the "computer-controlled home". It would have to be programmed by the owner, and programming, they think, is too difficult for the man in the street. Rather, microprocessors will be hidden for specific activities in the same way that electric motors are taken for granted today. Did you know that the average home has some 15 electric motors? Count your own.

Barron and Curnow predict that solid-state memory — ROMs and RAMs — will continue to get denser and cheaper. Discs and tapes, which are so slow, bulky and unreliable, will be superceded for storage by plug-in solid state silicon cassettes, at one-hundredth of today's cost.

In the longer term, perhaps we will access books and records through the public information network, of which Prestel is the beginning.

The other major development which will affect the hobbyist market is the electronic typwriter. It will have a solid-state flat screen, probably using liquid crystals and of A4 size. The flat screen should appear by the mid '80s and in the long term the electronic typewriter should cost no more than a calculator today.

The television, on the other hand, they say, has no role to play in the long-term development of the home information system.

Other changes in the way the householder receives information would be:

- selective radio and TV — ordered over the telephone.
- direct access to libraries.
- newspapers transmitted by telephone or radio.
- far more specialised information services — e.g., on sports.
- remote shopping and ordering.
- home electronic mail, delivered electronically to your computer rather than through the letter-box.

Social problems

In home, factory, and, above all, in the office, the electronic revolution will have a major effect on how we live; but time and again the authors emphasise that it is social, not technological, problems which must be overcome if the revolution is to happen at the necessary speed. They are pessimistic that they can be overcome quickly enough.

They identify two types of barrier to achieving the necessary adoption of micros in this country — the question of who derives the benefits and who suffers; and the problem of awareness.

The first is the problem as seen at Times Newspapers. The typesetters stand to lose their livelihood — not to mention public respect for their hard-won skills — if single key-stroking takes over, as it must be expected to do in the long term. Single key-stroking is when journalists type their copy directly on to the computer which will produce plates for printing, so eliminating the need for typesetting, which has until now been a skilled and very highly-paid job.

The second critical problem is awareness. Most people know nothing about computers or what they do, except that they are vaguely hostile to them because they go wrong, and that they cannot understand the computer jargon.

Removing fears

There is a huge job to do informing people about computers, removing their fears, de-mystifying them, providing them with the information they need to decide for what they can use micros, help them to choose the right hardware and software for their needs, and learn how to use it.

This book is the most important effort to explain the micro revolution so far. All the more pity, therefore, that it costs almost £8, though which, I suppose, is only the cost of a computer games program.

Conclusion

- **This book is probably the first of many about the micro-electronic future. It is expensive and sometimes too dry and technical. Many of its ideas and suggested policies are now old and widely-accepted.**
- **Its views and projections are important and deserve wide consideration, particularly by anybody who wants to keep ahead of the electronics game. — I.L.**

Practical Computing Back Issues

If you are interested in microcomputers you will want to read the *Practical Computing* reviews of the machines in which you are interested. Each month *Practical Computing* carries at least one hands-on test of a popular microcomputer for use in business, the home, schools and colleges. Each review contains the kind of information you need – technical data and unbiased critical comment on the strengths and weaknesses of each system.

Each issue is packed with essential reading on microcomputers, including all our regular monthly features: Book and cassette reviews; Glossary of computer terminology; Computabits; Pet Corner (February onwards); Apple Pie (May onwards); Tandy Forum (March onwards); serialised *Illustrating Basic* (October 1978 onwards).

All this makes *Practical Computing* the invaluable source for the whys, wherefores, hows, ifs and buts of microcomputing.

October 1978
Review 1: Commodore Pet I. **Review 2:** VDUs – Computer Workshop CT-64, Strumech Engineering ACT-1. Music on a KIM; Micro v. Calculator; VAT accounting complete program Part 1.

November 1978
Review: Tandy TRS-80. Projects for KIM; Pet goes to school; VAT accounting complete program Part 2; Complete game program – Mastermind; Software Dynamics Basic compiler review.

December 1978
Review: Research Machines 380Z. Choosing your first computer; ITT interview; Complete games programs – Battleships, Racing Cars and Monsters; A microcomputerised reservation system.

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Review: Nascom I. Convert an IBM typewriter into a terminal Part 1; In-car computing – Pet in the Panther DeVille; Report from the Los Angeles Computer Faire; Pascal v. Basic.

February 1979
Reviews: Cromemco Z-2D, Low-cost peripherals; Systems for estate agents and doctors; A £1000 payroll system; IBM typewriter conversion Part 2; Complete game program – Warlock Warren.

March 1979
Review: Single-board computers for less than £50. Low-cost stock-control systems; IBM typewriter conversion Part 3; New monthly column – Tandy Forum; Complete game program – NIM

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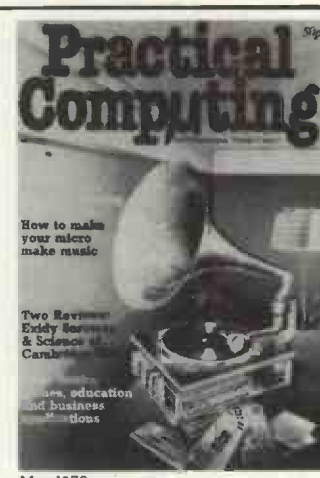
Review: North Star Horizon. Business accounting systems; Apple II design story Part 1; Computerised school meals; Finance for school computing; Build your own frequency meter; Star Trek game.



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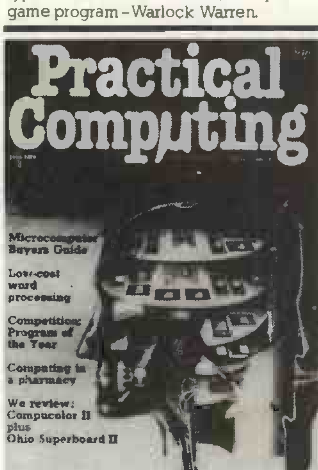
Reviews: Exidy Sorcerer, Science of Cambridge Mk 14; Printers for less than £1000, Order processing/invoicing packages; Retire with your computer; Apple II design story Part 2; Slalom game.



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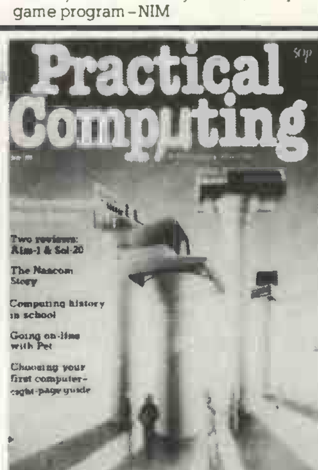
Reviews: Compucolor II, Ohio Superboard II; Low-cost word-processing; Computing in a pharmacy; Designing a small business application Part 1; Computer v. Brain; Zombie game.



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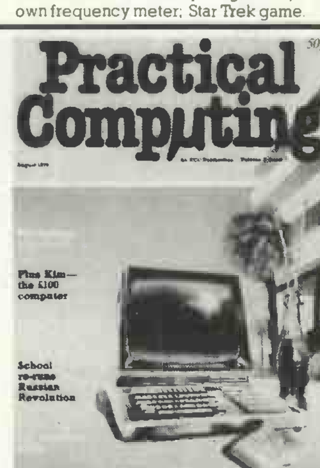
Reviews: AIM-65, SOL-20. Choosing your first computer; Interfacing Pet with a mainframe; Nascom story; Designing a small business application Part 2; Biorhythms program.



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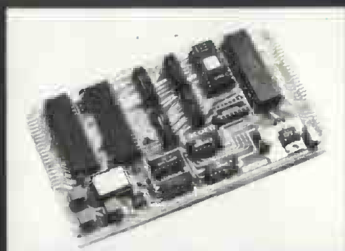

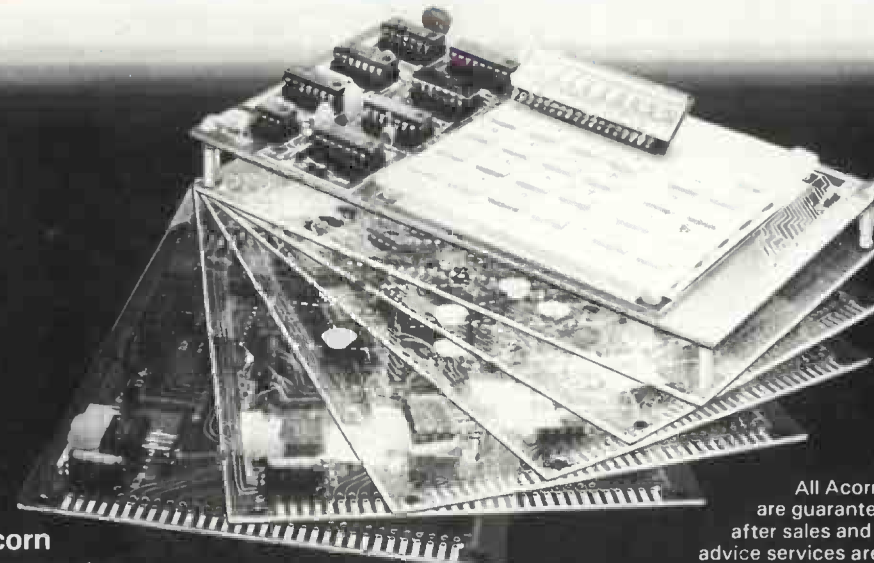

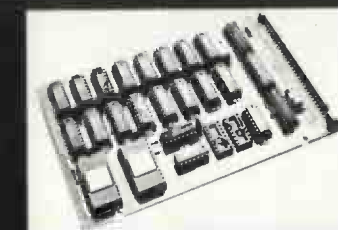

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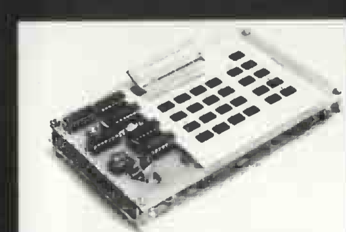

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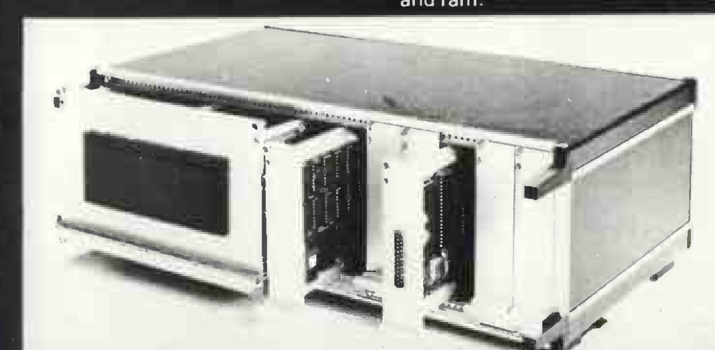

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How to build your own

David Annal describes how easy it is to make up joysticks to input graphical commands.

THE ADDITION of joysticks to games programs can be very rewarding. They speed the action and allow the players to concentrate on the screen instead of the keyboard. The players can also sit away from the computer and avoid getting in each other's way. Fights are therefore less likely. Drawing on the screen becomes easy.

For most applications, computer game joysticks need not be similar to those used by radio-control enthusiasts. In their case, precise control is needed and is obtained usually by the use of two variable potentiometers set at right angles to each other.

The resistance of each potentiometer alters with the position of the 'stick' and an infinite number of positions and combinations is possible. To enable this type of control to be used on a computer we should need to convert the output from analogue to digital form. That would involve the use of external circuits and more complicated programs.

The majority of games and drawing programs require information only as to whether the cursor — man, tank and the like—is to move up/down/right/left/or to stay still. The joystick has to be able, therefore to output only five states, each of which is absolute — either yes or no. That is a task suited ideally to a simple switch. We will need four per stick. With those four switches we can cater also for diagonal movements and the firing of guns. If two joysticks are used together, it is essential that they do no interference to each other.

The ideas for joysticks offered here were formulated with the Pet in mind and software will be given for Pet users. There is no reason why users of other machines should not adapt the methods to their own use. So long as an eight-bit parallel input port is provided on the computer, only the address will have to be changed.

The Pet possesses a very versatile user port through which data can be read or output. The port is provided with sophisticated handshake lines but we need only the eight bit lines, PA0-PA7. We do not need to program these lines to be used as inputs, since, in default of instructions to the contrary, Pet sets them as inputs at switch-on.

Each bit line is set high, i.e., to a '1', unless the line is grounded when it becomes low, i.e. a 'O'. As soon as the line is disconnected from ground, the bit reverts at once to the high state. All we need to do to cause a bit, or several bits, to go low is to place a push-switch between the pin and digital earth and press the button. The joysticks described do that.

Push switches

The simplest device which will perform all the tasks outlined is a small box with four push-buttons mounted on it. Each is a push-to-make type. They are connected as in diagram 1. The push switches can be used directly for the main movements as shown but, in addition, diagonals can be utilised by pressing two switches at the same time e.g., Up and Right to move diagonally in that direction. Any combination can be used for other instructions but the method becomes clumsy if three pushes have to be pressed at the same time.

A refinement is to turn over the box and use it on a hard surface, such as a table. Miniature push-buttons with fairly large operating movements work best in that way. The position of the left and right buttons must, of course, be reversed.

In use, the box is covered by the palm of the hand and moved as a whole with a downward tilting motion towards the direction required. The box acts as a joystick. Diagonals can be obtained by pressing down a corner so that two neighbouring pushes will close at the same time.

Other combinations of two or three are impossible but that with all four buttons closed can be used easily by pressing the box hard down on to the table. This could be made to fire a gun. It may be necessary to place small pieces of felt on the tips of each push-button to take-up any differences in operating movement when all buttons are pressed at once.

(continued on next page)

Diagram 1: Simple push-switch arrangement.

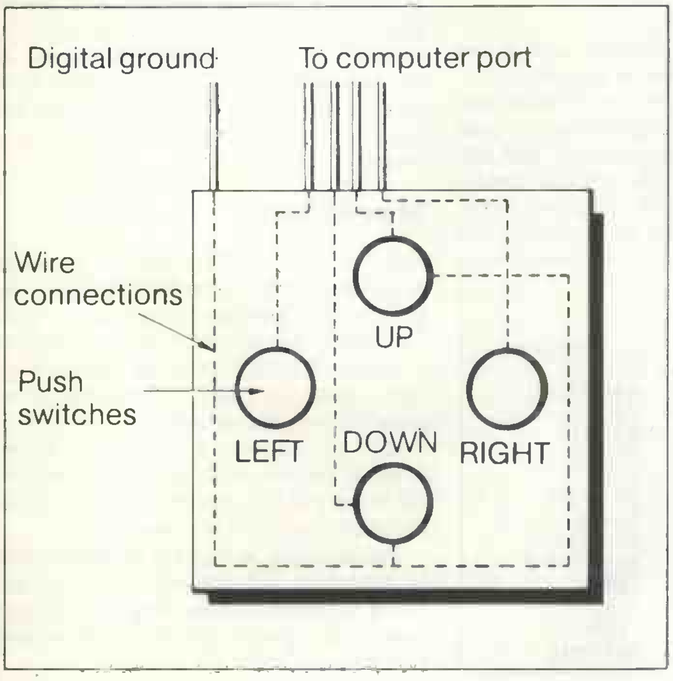
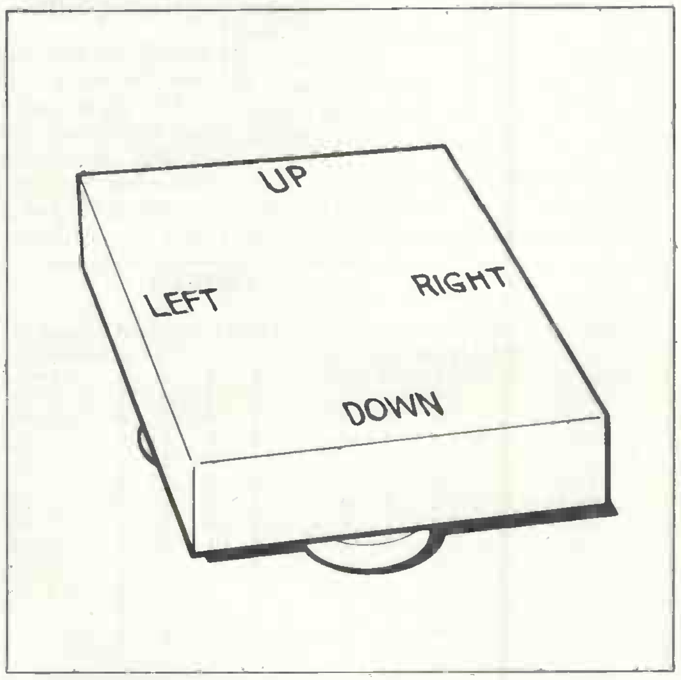


Diagram 2: Upside-down box.



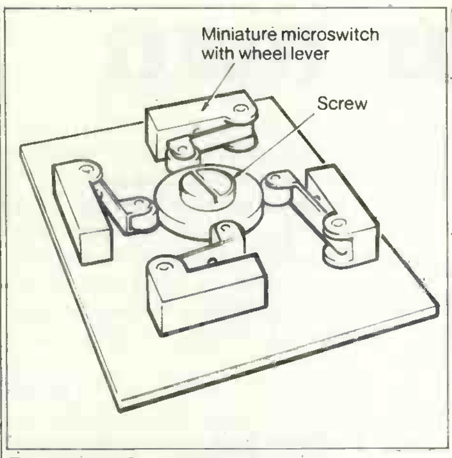


Diagram 3: Arrangement of microswitches.

Moving stick

A true compact joystick which works well and uses only easily-available components can be made with miniature microswitches. They must be the type operated by levers. They can be bought in lots of 10 from several electronic shops and are inexpensive. The switches are mounted as shown in diagrams 3 and 4.

The operating levers bear on a washer of about ¾in. diameter. The bolt hole must be larger then the diameter of the bolt by about ¼in. so that all-round movement is possible. Another washer and a knob, or terminal, is placed above the panel as shown. The switches can then be used to detect movement in the four main directions and also diagonally, when two switches will operate. The natural spring action of the levers returns the knob to the neutral position when the hand is removed.

This joystick works smoothly and I think it has a nicer 'feel' than those mentioned earlier. The disadvantage, however, is that no other easily-accessible codes are available to operate other functions. This can be overcome by using one or two extra push-switches with two make poles. They are connected across a pair of opposite switches as shown in diagrams 5 and 6. This then forms a compact box with satisfying, positive actions.

Other possibilities

Sliding bars Many commercial joysticks use the principle of a control rod moving in slots of two actuating levers at right angles to each other (diagram 7). Setting them up to operate switches is not easy without workshop facilities. Also, some form of centralising device must be provided but it could be two elastic bands.

Magnets can be made to operate sets of reed switches. Such a method can easily be made to operate the four cardinal switches but diagonals are difficult. Four more double-pole reed switches could be added at each diagonal.

Direct switching. The control lever can be made to contact spring metal slips situated round the eight directions required. Centring will have to be provided. This method seems easiest of all but it is difficult to obtain positive switching and prevent double movements.

Software

We will continue ourselves to reading the joystick positions in Basic. This is fast

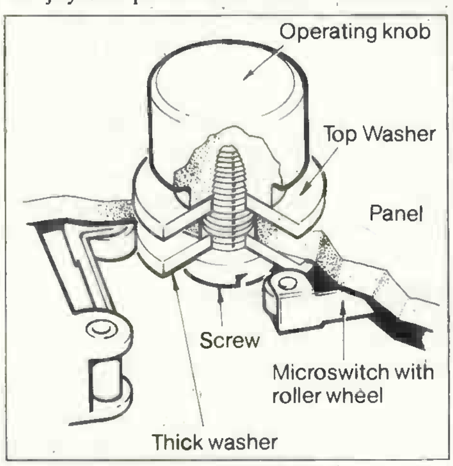


Diagram 4: Construction of operating button.

enough for most applications and, in any case, the whole routine is very short.

The eight input bits are divided into two lots of four. The higher four are used to read the left-hand joystick, and the lower four the right. The possible combinations of the two sides are shown in the table 1. 'O' shows an earthed line. For

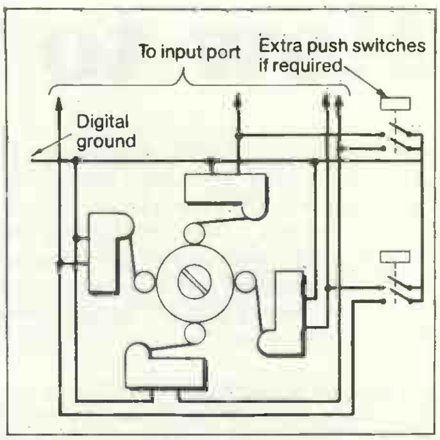


Diagram 5: Wiring for extra control buttons.

the reason given, combinations of three are not included. The state of all four lines grounded is shown, as it can be used in the upside-down box.

The numerical value given by the combination of inputs from one joystick is shown, together with the decoded function to which it is put. There is no set convention and those used are my own choice. The value is obtained, in the case of the lower ½ byte, by ANDing with 15 (i.e. 8+4+2+1), and in the higher by ANDing with 240 (i.e. 128+64+32+16). By dividing the value of the copper ½ byte by 16, a number corresponding to the lower half is given. If this is done, the same subroutine can be used to interpret both sets of figures.

The program required to decode the switches will depend on the configuration of the input port. The one given will work only on a Pet. Numerous IF THEN statements have been avoided by the use of an array with 15 subscripts. This leads to a very compact program.

In the demonstration program, the array contains statements which give the joystick position in words. In a games program they would be replaced by instructions relating to the movement of the cursor or tank. The Pet user port input is situated at dec.59471, hence the use of this number in the PEEK statements.

Movement

The Pet video RAM is located between 32768 and 33767. The former is the top left position, the latter the bottom right. The symbol for the 'man' required is first poked on to the screen in the desired position, using a number between those given above. Subsequent movement is made by adding a number, which depends on the joystick position, to the old value and then poking the result on to the screen to show the new position.

Before doing so, the old position could be poked out with a blank (,32) if a 'trail' is not required. For drawing, or trapping games, this would not be necessary and the old position is left showing.

TABLE I

AND 240 Gives Value of	LEFT JOYSTICK PA7 128	PA6 64	PA5 32	PA4 16	RIGHT JOYSTICK PA3 8	PA2 4	PA1 2	PA0 1	and 15 Gives Value of	MEANING
240	1	1	1	1	1	1	1	1	15	NEUTRAL
224	1	1	1	0	1	1	1	0	14	UP
208	1	1	0	1	1	1	0	1	13	RIGHT
176	1	0	1	1	1	0	1	1	11	DOWN
112	0	1	1	1	0	1	1	1	7	LEFT
192	1	1	0	0	1	1	0	0	12	UP & RT
160	1	0	1	0	1	0	1	0	10	Special
96	0	1	1	0	0	1	1	0	6	UP & LFT
144	1	0	0	1	1	0	0	1	9	DOWN & R
80	0	1	0	1	0	1	0	1	5	Special
48	0	0	1	1	0	0	1	1	3	DOWN & L
0	0	0	0	0	0	0	0	0	0	"FIRE" (see text)

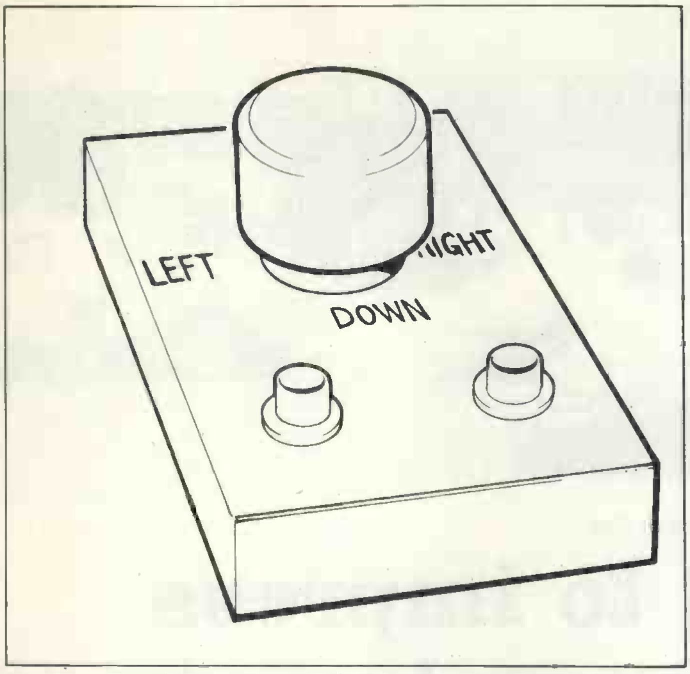


Diagram 6: Finished joystick with extra controls.

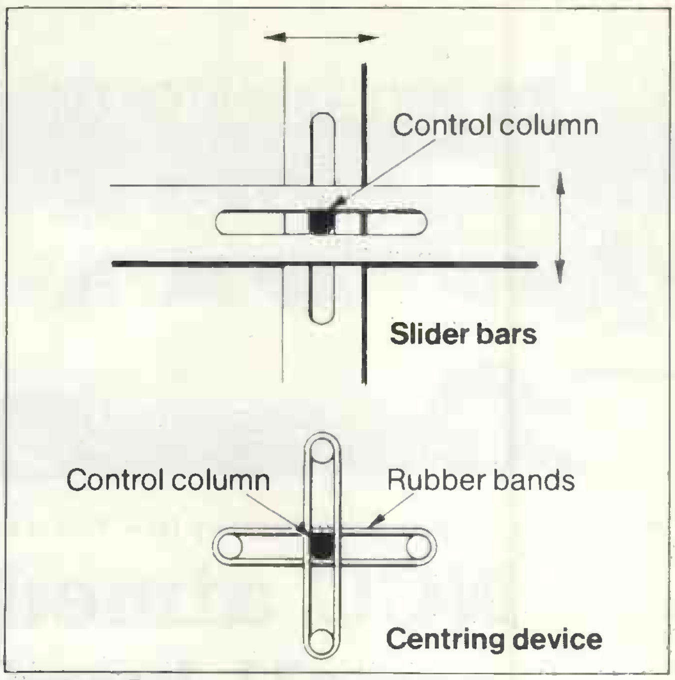


Diagram 7.

The SATA statements are altered to give the number needed to be added to the old screen position to give the new one. So, for instance, 40 will be inserted instead of Down. This is because there are 40 characters per line on the Pet. Other substitutions would be made as in diagram 9. It may be necessary to ensure that a man cannot be moved off the sides or top and bottom. This can be done easily with extra lines and is not detailed here.

Program listing

Note that we have connected the switches as per table 2. Note also the nul strings used to cover unused combinations in the data statements. Each data statement must be a total of 12 characters long to ensure erasure of the previous position.

```
100 REM JOYSTICK TEST PROGRAM
110 DIM J$(15)
120 FOR P+OTO15: READ J$(P); NEXT
130 PRINT "clr.cdx 12"
140 P+PEEK (59471) AND 15: PRINT TAB (25); J$
(P); "cu"
150 P+(PEEK (59471) AND 240)/16: PRINT TAB (2);
J$(P): "cu"
160 GOTO 140
1000 DATA "BANG!!    ",O,O,"DOWN & LEFT
        ";O" SPECIAL POSN","UP & LEFT"
1010 DATA "LEFT"O,"DOWN & RIGHT", "SPECIL
POSN","DOWN"
1020 DATA "UP & RIGHT ","RIGHT ","UP
","NEUTRAL"
```

Line 130 is — Print clear screen followed by 12 cursor downs. cu in lines 140 & 150 is cursor up.

TABLE 2

Switch Connections

	LEFT	RIGHT
UP	PA 4	PA 0
RIGHT	PA 5	PA 1
DOWN	PA 6	PA 2
LEFT	PA 7	PA 3

The author would be most interested to hear of any other home made joystick mechanics.

Diagram 8.

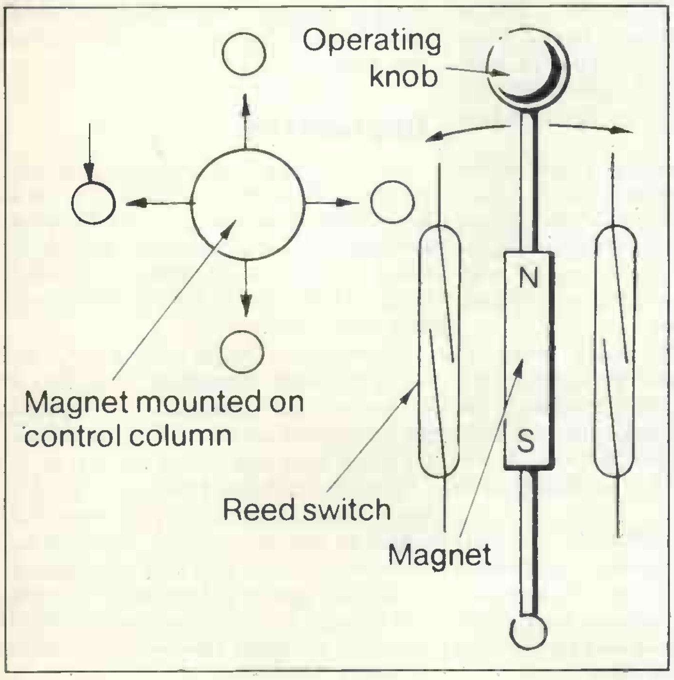


Diagram 9: Portion of Pet screen to show relationship of surrounding positions.

−41	−40	−39
−1	Present position	+1
+39	+40	+41

NCC Street scene with the obligatory New York Yellow Cab.

NCC aimed to impress small business buyer

IF YOU are American, and if you sell, buy, yearn for or just read about computers, the chances are that you were at the National Computer Conference.

The NCC is the world's biggest annual computer trade fair and every year it gets bigger. The 1979 model featured some 500 exhibitors who paid for 1,700 exhibition spaces and talked to at least 70,000 visitors in the four days of the show. On the morning of day one, the queue was taking more than three hours to move in. Fortunately your correspondent had the magical pin-on Press pass which gained instant admission to a Press room well equipped with Budweiser and Diet Pepsi.

The show is too big to hold in a single Olympia-style cattle market and it sprawled across several of the expense-account hotels in the centre of New York City. That meant journalists trekking through corridors of distressed Italian cornices and generally fake baroque joinery — hotel designers in New York seem to have impressively poor taste.

One mouse cheated

The Sheraton Centre did not seem to be in that league, though, and in its well-appointed basement were the 92 booths of the personal computing 'festival'. Elsewhere in the hotel was the associated personal computing conference, and the finals of the Amazing Micro-Mouse Maze Contest.

The aim was to design a mouse-like robot which would negotiate a maze course; and since the winner would receive $1,000, there was a good field. Most mice missed the finals and some which did not preferred to turn and retreat halfway through their run. One seemed to us to cheat — it kept turning left until it found a path to the end. "Heuristics is dead," said the designer.

The winner and the runner-up were both from a specialist research organisation, the Battelle Institute. Moonlight Flash earned the $1,000; Moonlight Express was second.

The exhibitors in the cellar generally outshone their expensive and glossy big-computer competitors in the main exhibition area. Apple Computers had a very impressive presentation in a suite away from the rest of the personal computers, emphasising discs and business software — as well as its own general corporate standing.

The aim, at least for the NCC, was to impress the small business buyer. Most new Apple products on show in New York were software, U.S.-orientated business packages and the new Pascal, which looked very good.

Another very interesting Pascal promotion was in the main NCC show. Pertec showed its Pascal Blaiser — after Blaise Pascal. It combines the Western Digital Pascal Microengine — a micro with Pascal on ROM — with two Pertec floppies in the cabinet.

Commodore also aimed hard at businessmen and sited its stand in the main exhibition. Tandy stayed with the personal computer fraternity, though, with a large booth in the Sheraton. It was worth it; the new TRS-80 Model II is most impressive.

Like the existing TRS-80, Model II uses the Z-80 micro, but running it rather faster, at 4MHz. Built into the screen is one full-size double-density floppy disc (512KB). An expansion unit supports up to three more of those discs.

The keyboard is new and has a numeric pad as well as two user-programmable function keys. Unlike the Model I, the Model II does not have Basic resident in ROM. It loads the operating system immediately and Basic from disc when power is turned on. Tandy says that is to allow the use of other languages without having ROM space go to waste; languages available include Fortran.

Five business software packages were unveiled with it, all for the U.S., priced between $150 and $400.

We were told that the U.K. wouldn't see Model II for "a few months". In the States the basic Model II system, with one disc drive and 32K of RAM, is priced at $3,450. A full-blown system with 64K, three drives, a line printer, and a workstation desk sells for $7,998.

Impressive

At the other end of the scale was another good-looking product. The New York-based Computer Systems Store has a relational database manager for micros, called REINS, which runs on a 64KB Pertec/Altair 300. The presentations were impressive.

Elsewhere on the floor there was much to try but little innovation. The likes of Cromemco and Compucolor were pulling the crowds but so were the many computer stores shouting their many wares.

Several established software vendors were there. Micropro had its word processor on two stands; GRT and Personal Software continued to look very professional with games and graphics; Lifeboat was listing "the latest and best" in 8080 and Z-80 packages from several sources, including Micropro.

Exidy had a new and neat screen-plus-floppy disc organisation and was at last demonstrating the plug-in ROM-PAC word processor — much-delayed but apparently fast and effective in operation.

There were fewer dramatic advances among peripherals than one might have expected. The cheap rigid disc is not yet with us and there seems little real opportunity to get away from screen and keyboard for communication between people and electrons.

Things are happening on the printer front, though, with falling prices on small matrix printers proclaimed by several vendors. Integral Data Systems had its BrighterWriter range there — more than 5,000 sales to date — but also showed a new printer called Paper Tiger. Aimed at bulk buyers, it offers 80 to 132 columns, full upper- and lower-case, tractor feed and a quantity price of $995 each.

The new Exidy screen and dual mini terminal. What you can't see — the ROM-PAC word processor inside.

In general, though, the personal computer side of the NCC was not a show for hobbyists or computer freaks. Most of the stallholders to whom we spoke were looking for the proprietors of small businesses or for people from systems builders and computer shops who would buy in large quantities.

The talks at the personal computing conference covered some good ground and if you have the opportunity to buy a copy of the papers, do so. Sadly you will not acquire the impressive evangelical favour of Ted Nelson's keynote speech — computers won't save the world, but they might make it a more pleasant place in which to live. On second thoughts, perhaps they will save the world at that.

Why Petsoft went to the NCC

by Julian Allason

AT PETSOFT we have been developing software for the Commodore dual mini-floppy. Now we were starting work on material to run on the Compu/Think device — hence my visit.

The Micromax has an enormous 105K internal memory plus up to 2·4 megabytes of on-line disc storage, substantially more than on other micro systems. The double-density dual drive stores or retrieves its 2·4 megabytes at 15,000 characters per second.

Of particular interest is the full-screen data-entry and editing capability. The screen can be divided into several distinct and separate application areas, each with its own separate data entry and display.

The screen is a 12in. integral CRT monitor with a format of 64 characters by 30 lines, giving a total of 1,920 characters per screen.

The internal memory consists of a 108,544-character semiconductor memory allocated to resident system software, Microsoft Basic with string capability and extended precision floating point. There is also a complete disc-operating system which includes random access datafiles. Space is also allocated to video memory, disc directories and disc data buffers.

Other resident features include the high-resolution graphics commands, a FIFTH language micro-programmed interpreter and a complete machine language monitor with Tiny Assembler, disassembler, dump facility and a debugging aid with break-point capability.

Some of the commands for the Disc Extended Basic are entered directly from the video/keyboard terminal. Others can be coded in Basic to perform disc-file input/output. Sequential and random access are supported on the disc drives, as well as the program and data files.

Visitors to the show particularly liked the high-resolution graphics, which are very sharp indeed.

The central processor is a hybrid 6502 which runs at 2MHz and executes all of the 6502 instructions, plus 64 additional user-definable instructions. At initialisation the instructions are microprogrammed to execute 64 instructions of the FIFTH universal machine language. Despite the pun, FIFTH appears to be a useful combination of FORTH and Pascal. Whether the world is ready for yet another computer language is another matter.

The user may also microprogram the 64 instructions to perform Pascal operations, FORTH operations, or to emulate any other computer whether on or off the drawing board.

Compu/Think is offering a database called Page Mate, which is a set of five programs designed to perform most of the common data manipulation functions for the computer user without requiring him to resort to programming.

I suspect that in developing what is arguably the most advanced microcomputer yet, Compu/Think has blazed a trail which other manufacturers will be obliged to follow.

At the time of writing, the Micromax was on sale in the States at $4,495 for the model with 800K of external memory and $5,995 with 2·4 megabytes of on-line disc storage. It should be available in the U.K. by November. A specification is available from MicroAct Ltd, 5 Vicarage Road, Edgbaston, Birmingham, B15 3ES.

A runner in the Amazing Micro-Mouse Maze contest.

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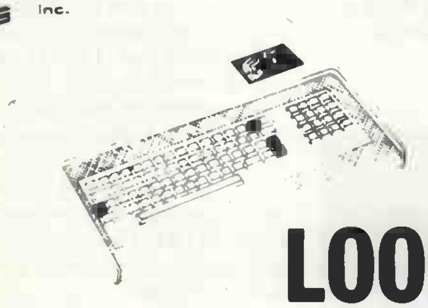

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Lien times

DAVID LIEN visited the office recently. So who's David Lien? Well, he is one of the three original designers of the TRS-80. He wrote the excellent Level I handbook; and his company, Compusoft Publishing, was responsible for the *Basic Handbook* we reviewed so enthusiastically in May.

David has just arranged an exclusive U.K. distributor for the handbook, the Rostronics Computer Centre, 118 Wandsworth High Street, London SW18, telephone 01-870 4805. The U.K. price will be £10.

Other works are due from the Lien stable later this year, and we like the sound of two of them. *Learning Level II* will be a Compusoft-produced equivalent of the *Level Users/Learners' Manual*, written in the same style and by the same author.

How about *Controlling the world with your TRS-80*? This promises to teach you how to use your computer to water the lawn, monitor a home security system, control an electric train, dial the telephone and "endless other applications". We'll keep you posted.

Birthdays problem

HOW MANY people do you have to cram into the same room before it becomes statistically likely that two of them have birthdays on the same day? John Dodridge contributes this program to find out:

```
10   B=1
20   Q=1
30   PRINT "DO YOU WANT WEEKDAY (ENTER
     '7') OR BIRTHDATE (ENTER '364')?"
40   INPUT D
50   A=D
60   N=D
70   B=B+1
80   N=N+1
90   Q=Q×N/A
100  P=1−Q
110  PRINT "WITH"; "PEOPLE IN THE ROOM
     THE CHANCE IS"; P
120  IF P=1 THEN END
130  GOTO 70
```

Working out the chances of two people in the room having the same day or date of birth is a classical one but the program proves to be simple, because of the repetitious nature of the calculation used to find the solution.

The proof hinges on the use of the probability theorem P+Q=1, where P is the chance of an event happening and + is the chance of it not happening. The re-arrangement of the formula gives P=1−Q and it is this which is used to reach the answer via the complement.

Entering '7' finds the number of people in the room needed for two to have the same day of birth in the week; for birthdates the program takes the number of days of the year as 364, but 365 gives only a slightly different answer.

It is surprising to find that only 23 people are needed in the room for the chance of the same birthday to be greater than 50/50, or odds-on. The last line reads:

$$Q = \frac{364 \times 363 \times 362 \times \ldots \times 343 \times 342}{364^{23}} = \cdot 491725$$

and so P = ·508275.

TANDY FORUM is devoted to the Tandy TRS-80. We will be using it to pass on news about the TRS-80 and its supplier and product announcements from Tandy and other vendors of compatible equipment. Above all, these are pages for users, and would-be users, of this personal computer. We want you to send tips, queries, moans and comments, and we want this page to become a market-place for TRS-80 information.

Tiddleywinks

THIS ONE COMES from Stephen Toop. Although the game is very simple, it illustrates the parabola function well.

The function, which is given $y=x^2$, can be plotted easily, but because of the large variation between the values of x and y, we must use different scales on the axes to make the graph as large as possible and so ensure the greatest possible accuracy of the results.

To use the TRS-80 SET/RESET functions we must start the plot at x+n — where *x* is negative and *n* is a number that when added to *x* makes *x* a positive number.

In the program the function is used to plot the trajectory of the tiddleywink. The height and length of the plot are calculated easily, although changing one will result in a change of the other.

The parabola subroutine has a number of variables for such a simple function. This was necessary for total control. *x* and *y* are exactly the same as they are in the formulae, but we plot z,y rather than x,y so it will all fit on to the screen. *L* is the variable controlling the length of the plot.

```
5    REM *TIDDLEYWINKS:PROGRAMMER
     S.G.TOOP:1/3/79*
10   CLS
15   PRINT AT 470 "*TIDDLEYWINKS*"
20   PRINT AT 904, "JUST SET THE LENGTH AND
     TRY TO FILL THE HOLE."
25   FOR A=O TO 800
30   NEXT A
35   LET G=O
40   LET P=RND(110)+10
45   CLS
50   PRINT AT 960, "O";
55   SET(1,42)
60   FOR X=1 TO 127
65   SET(X,43)
70   NEXT X:LET X=127
75   PRINT AT 1020,"100";
80   FOR X=42 TO 7 STEP−1
85   SET(X,Y)
90   NEXT Y
95   RESET (P,43):RESET (P+1,43)
105  PRINT AT O, "SET LENGTH";
110  INPUT C
115  IF L<0 THEN 105
120  GOSUB 1000
140  LET Z=Z−L/19
150  IF (INT(Z)=P)+(INT(Z)=P+1) THEN 220
160  LET G=G+1
165  PRINT AT 14,"          ";
170  IF G<3 THEN 105
180  PRINT AT O,"GIVE UP BUSTER, YOU'RE
     HOPELESS!"
190  FOR A=1 TO 1000:NEXT A
210  GOTO 35
220  SET(Z,Y+1)
225  PRINT AT O,"WELL DONE YOU GOT IT
     IN";G+1;"."
230  GOTO 190
```

Parabola subroutine

```
1000  LET X=−6
1010  LET Z=X+7
1020  LET Y=X*X+6
1030  IF Z>=127 THEN 2000
1040  SET(Z,Y)
1050  LET Z=Z+L/19
1060  LET X=X+0·5
1070  IF X<>6·5 THEN 1020
1080  RETURN
2000  PRINT AT O, "OVER SHOT A BIT DIDN'T
      WE MAC?";
2010  GOTO 190
```

Encore

T&V JOHNSON telephoned to say that our enthusiasm for Percom add-on discs can be qualified by their availability in this country; TVJ has them ex-stock from about £350. You will need the expansion interface and controller, which TVJ can also offer at prices better than Tandy.

If you want to consider other alternatives to Tandy, TVJ also has plug-compatible Micropolis and Shugart drives.

Enthusiasm

THE GENERAL impression put forward in Tandy Forum and in last year's review of the TRS-80 is that it is a vague, unre-

(continued on page 95)

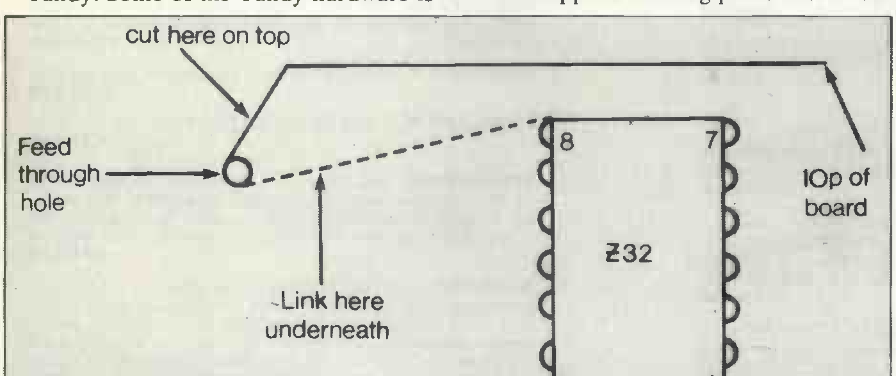
(continued from page 93)

liable machine. I have been using a 4K Level II TRS-80 since October and have been extremely pleased with it. It is a remarkably well-thought-out product when compared to most of the rest in its price bracket, writes N. J. Powell, of Yorkshire.

To set the record straight I have listed its attributes under several headings, which reflect the longer-term use of the machine rather than the 24-hour, review-type impressions.

Retail Organisation

- One-year guarantee; U.K. repair centre; all retail outlets are repair agents.
- Local retail outlets; over-the-counter service — no long journeys or six-month delivery delays after cashing your cheque; all Tandy products readily available and demonstrable locally.
- Full service manual available with detailed trouble-shooting routines.
- Software/hardware availability from Tandy. Some of the Tandy hardware is exceptionally good value; for example, the expansion interface contains decoding for an extra 32K RAM, a second cassette interface (for a standard cassette recorder), the Micropolis diskette controller (for four drives), real time clock, Centronics parallel printer interface, bus buffering, and power supply — all for £229.

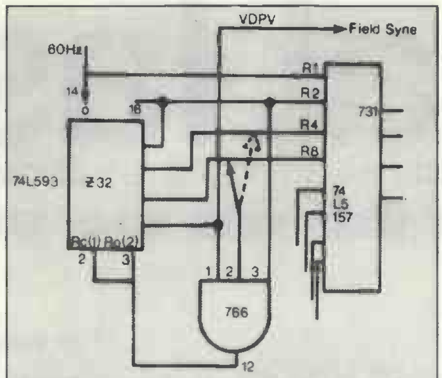


Locate Z32 on the board top.

Figure 2.

Operational Use (Level II)

- User-definable memory map for machine code routines. Pet owners please note, there's no poking into the second cassette buffer.
- Z-80 processor for running machine code programs.
- Superb line-editing and trace facilities for program debugging.
- Very compact code storage — 4K bytes goes a long way on a Level II.
- Very good output format control, and addressable PRINT statements — not a plethora of tab and cursor statements as with Pet.
- X-Y addressable graphic locations for plotting low resolution (6,144 points) graphics, which can be mixed with text on the screen. (Apple users, please note). High-resolution graphics could be written to a suitable plotter or printer by a machine-code subroutine. High-resolution plots on a screen are unlikely to be of much use other than as an expensive doodlemaster.
- Level I is better than most Tiny Basics as it supports floating point arithmetic.



Disconnect pin 2 of 766 from line R4 and connect to line R8.

Figure 1.

Hardware design

- Works with ASCII internally, including lower-case letters — unlike PET, the TRS-80 doesn't need an intelligent printer.
- Uses cheap dynamic RAMs which make it easily and cheaply upgradable.
- Has a proper keyboard which can be used by the nimble-fingered for program entry, word processing, and the like.
- Uses a standard cassette recorder.
- Lower-case letters are available to a printer without modification; the video is modified easily to display lower-case.
- Standard video out, modified easily to 50Hz if required.
- Compact, keyboard, power supply, cassette, and modulator fit easily into a briefcase.
- 40-pin expansion bus with all the required signals instead of enormous sockets and 100-way ribbon cables — a domestic controller circuit is given in the technical handbook.

Reliability (over six months)

- A dry joint in the power-on re-set was fixed under guarantee.
- Overheads and crashes occurred only if the air vents under the keyboard unit were covered or restricted.
- I have had no problems with the cassette — a very old Philips 3302. I use Memorex MRX2 tape.

Tips

So much for the banner-waving — now for three tips:

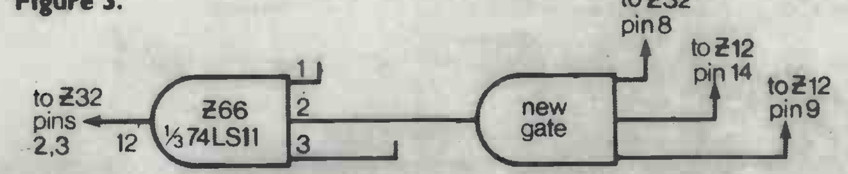
- PRINT (HR$(28) converts back from 32 characters per line to 64 without clearing the screen.
- To hook up a modulator, go for a high-resolution unit — which means spend £4.50 rather than £2.50 — running off +5V. Video goes to pin 4 of a 5-pin 180-degree display via about 2in. of co-axial cable; +5V goes to pin 1 via 2in. audio-screened lead. Both screens go to pin 5 with the co-ax screen only forming the common return on the modulator. I use a modulator from Computer Workshop, Manchester.
- Locking-in on a British TV will need adjustments of the line hold (from 15,625Hz to 15,835Hz) and the frame hold (50Hz to 60Hz). If the TV set is an old one — without flywheel sync or with valves — the picture is likely to be unstable due to the presence of 50Hz mains hum. In these cases the video chain should be converted to 50Hz as below.

A modification for the 50Hz frame is shown in figures 1 and 2. The video divider chain divides the 15,835Hz line frequency by 12, 2 and 11 to give 60Hz (264 lines per raster). We require about 625 ÷ 2 = 312 lines per raster, dividing by 12,2,13. This gives a frame frequency of 50 to 75Hz. This should enable most TVs to lock in, but with valve sets there may be some pronounced ham bars at 1·5Hz. The ÷ 13 modification is accomplished easily.

If hum bars still persist a frame frequency of 49·95Hz can be obtained by allowing 317 lines per frame. This requires an additional three input AND gate wired as in figure 3.

After either of these modifications the display should be centred with R20/R21.

Figure 3.



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MICRO FOCUS

☐ **CIS COBOL** — Version 3 is ANSI 74 subset with extensions which offer powerful interactive screen formatting and built in cursor control. Version 4 additionally offers full level 1 ANSI for Nucleus, Table Handling, Sequential Relative and Indexed I/O, Inter-Program Communication and Library
.... Version 3, **£295/£25**
.... Version 4, **£395/£25**

☐ **FORMS** — Interactive utility to create CIS COBOL source code to perform CRT screen handling in application programs. Supports full prompt text, protected fields and input validation against data type and range expected .... **£65/£10**
When purchased with CIS COBOL .... **£55/£10**

OTHER

☐ **tiny C** — Interactive interpretive system for teaching structured programming techniques. Manual includes full source listings .... **£45/£30**

☐ **C Compiler** — Supports most major features of language, including Structures, Arrays, Pointers, recursive function evaluation, linkable with library to 8080 binary output. Lacks data initialization, long & float type and static & register class specifiers. Documentation includes "C" Programming Language book by Kernighan & Ritchie .... **£65/£10**

☐ **Z80 Development Package** — Consists of: (1) disk file line editor, with global inter and intra-line facilities; (2) Z80 relocating assembler, Zilog/Mostek mnemonics, conditional assembly and cross reference table capabilities; (3) linking loader producing absolute Intel hex disk file for CP/M LOAD, DDT or SID facilities. .... **£50/£12**

☐ **DISTEL** — Disk based disassembler to Intel 8080 or TDL/Xitan Z80 source code, listing and cross reference files. Intel or TDL/Xitan pseudo ops optional. Runs on 8080. Standard CP/M and TRS-80 CP/M versions available .... **£35/£7**

☐ **DISILOG** — TEL to Zilog/Mostek mnemonic files. Runs on Z80 only. .... **£35/£7**

☐ **TEXTWRITER II** — Text formatter to justify and paginate letters and other documents. Special features include insertion of text during execution from other disk files or console, permitting recipe documents to be created from linked fragments on other files. Ideal for contracts, manuals, etc. .... **£45/£3**

☐ **WHATSIT?** — Interactive data-base system using associative tags to retrieve information by subject. Hashing and random access used for fast response. Requires CBASIC .... **£70/£15**

☐ **XYBASIC** Interactive Process Control BASIC — Full disk BASIC features plus unique commands to handle bytes, rotate and shift, and to test and set bits. Available in Integer, Extended and ROMable versions.
Integer Disk or Integer ROMable .... **£165/£15**
Extended Disk or Extended ROMable .... **£215/£15**

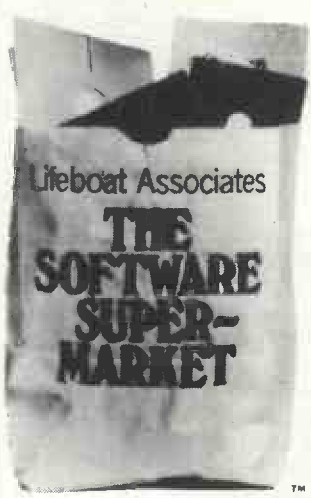
☐ **SMAL/80** Structured Macro Assembled Language — Package of powerful general purpose text macro processor and SMAL structured language compiler. SMAL is an assembler language with IF-THEN-ELSE, LOOP-REPEAT-WHILE, DO-END, BEGIN-END constructs .... **£40/£10**

☐ **Selector II** — Data Base Processor to create and maintain single Key data bases. Prints formatted, sorted reports with numerical summaries. Available for Microsoft and CBASIC (state which). Supplied in source code .... **£105/£12**

☐ **Selector III** — Multi (i.e., up to 24) Key version of Selector II. Comes with applications programs including Sales Activity, Inventory, Payables, Receivables, Check Register, Expenses, Appointments, and Client/Patient. Requires CBASIC Supplied in source code .... **£155/£12**
Enhanced version for CBASIC-2 .... **£185/£12**

☐ **CPM/374X Utility Package** — has full range of functions to create or re-name an IBM 3741 volume, display directory information and edit the data set contents. Provides full file transfer facilities between 3741 volume data sets and CP/M files .... **£125/£7**

☐ **Flippy Disk Kit** — Template and instructions to modify single sided 5¼" diskettes for use of second side in singled sided drives **£6**



Orders must specify disk type and format, e.g. North Star Horizon single density.

Add VAT to orders for software (not manuals alone). Add 50p per item postage and packing (minimum £1).

All orders must be prepaid (except COD or credit card). Make cheques POs etc. payable to Lifeboat Associates.

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● **Circle No. 187**

These pages represent an independent collection of news and views for owners of the Commodore Pet. If you wish to contact Pet Corner, send articles or ideas directly to us. We are not connected with Commodore or with the official Commodore-run Pet Users' Club, though we wish it well. We give space to Mike Lake, of the Independent Pet Users' Group (IPUG).

Plotters

SEVERAL members of IPUG have expressed interest in using X-Y plotters with their Pets, writes IPUG secretary Mike Lake. Investigation has turned up the following:

Sylvanhill Laboratories Inc, of Box 646, Pittsburg, Kansas 66762, offers plotters in assembled and kit form at sizes ranging from 11in. × 17in. to 22in. × 17in. at prices from $795 to $1,300. Postage is about 12 percent of cost.

Sintrom Electronics Ltd, Arkwright Road, Reading, Berkshire, is the U.K. distributor for the HIPLOT X-Y plotter, 7in. × 10in., at £656 and the HIPAD digitiser at £521.

District Computing, 174 Ifield Road, London, is the agent for the TALOS range of digitisers which sell for around $450 in the U.S.

Feed program

BETOS SYSTEMS, 155 Mansfield Road, Nottingham, has produced a program aimed at farmers with animal feed problems. The program allows the user to define the nutritional requirements of the animals — depending on yield and weight for cattle — and also the characteristics of up to 15 kinds of possible feeds.

The program then uses a linear technique to produce the cheapest possible food mix to meet the needs of the animals and any other constraints the farmer might include, such as "I want to use as much silage as possible".

The program outputs to the screen and/or a printer and runs in 8K. Betos offers it complete with 8K Pet and PR40 printer for about £950. The program is available separately.

Challenge

KESWICK Chess Club secretary was quoted in a local newspaper as saying that "microcomputers were just chess-playing Daleks", and suddenly found the club being challenged to pit its skills against six Pets.

The challenge was from David Fabri, a tutor at the local further education college, who set up the machines with the Microchess-2 program, written by Peter Jennings, and which finished fourth in the 1978 World Microcomputer Chess Championship.

The venue was a local hotel, but at the end of the evening, the Pets were second best. The humans beat them 5-1.

Paper

THE APPEAL for cheap stationery for the PR40 printer produced a letter from Rockcliffe Brothers, of 2 Rumford Street, Liverpool, L2 8SZ. The company is offering 10 PR40 rolls at £6, 10 C15 cassettes at £3·99, and 10 C60s at £4·99. All prices include VAT and postage, and there is an additional 10 percent discount if you are in IPUG member.

Rockcliffe is also seeking a supplier of cheap paper for the Teletype 43; if you know of a source please contact the company.

Conversion

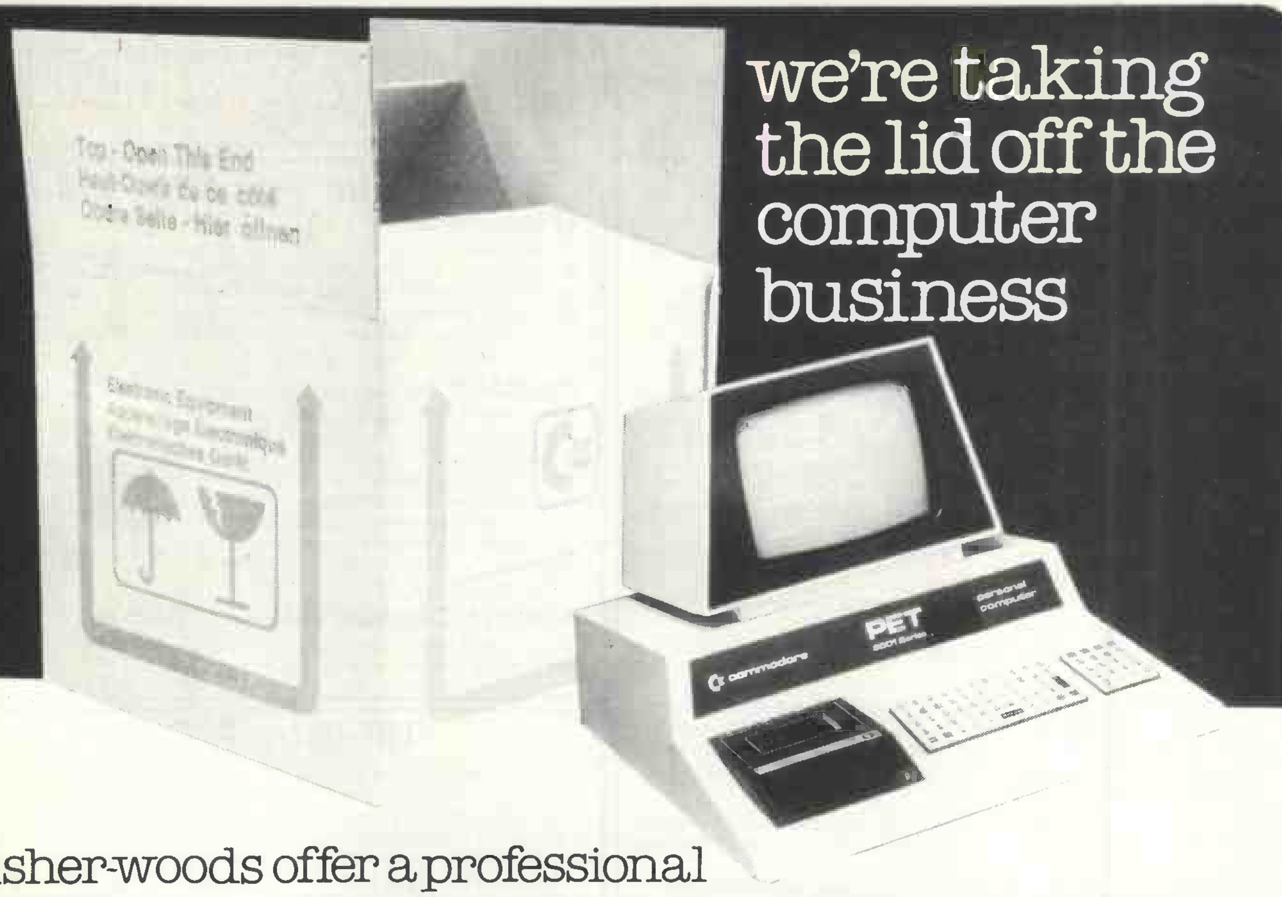
IF YOU are converting any programs from the old ROMS on the 8K Pet so that they will run on the new ROMS, then the table provided is vital. Many programs make use of locations in the first 1K of Pet memory and this has been changed completely in the new machines. The old and new locations — and meanings — are given in the table.

Thanks to Roger Gentry and Barry Miles of IPUG for their efforts in producing the list; they were helped considerably by Commodore.

Memory locations for ROM upgrade on PET computers
Jim Butterfield, Toronto

0000-0002	0-2	USR Jump instruction
0003	3	Search character
0004	4	Scan-between-quotes flag
0005	5	Basic input buffer pointer; # subscripts
0006	6	Default DIM flag
0007	7	Type: FF=string, 00=numeric
0008	8	Type: 80=integer, 00=floating point
0009	9	DATA scan flag; LIST quote flag; memory flag
000A	10	Subscript flag; FNx flag
000B	11	0=input; 64=get; 152=read
000C	12	ATN sign flag; comparison evaluation flag
000D	13	input flag; suppress output if negative
000E	14	current I/O device for prompt-suppress
0011-0012	17-18	Basic integer address (for SYS, GOTO etc)
0013	19	Temporary string descriptor stack pointer
0014-0015	20-21	Last temporary string vector
0016-001E	22-30	Stack of descriptors for temporary strings
001F-0020	31-32	Pointer for number transfer
0021-0022	33-34	Misc. number pointer
0023-0027	35-39	Product staging area for multiplication
0028-0029	40-41	Pointer: Start-of-Basic memory
002A-002B	42-43	Pointer: End-of-Basic, Start-of-Variables
002C-002D	44-45	Pointer: End-of-Variables, Start-of-Arrays
002E-002F	46-47	Pointer: End-of-Arrays
0030-0031	48-49	Pointer: Bottom-of-Strings (moving down)
0032-0033	50-51	Utility string pointer
0034-0035	52-53	Pointer: Limit of Basic Memory
0036-0037	54-55	Current Basic line number
0038-0039	56-57	Previous Basic line number
003A-003B	58-59	Pointer to Basic statement (for CONT)
003C-003D	60-61	Line number, current DATA line
003E-003F	62-63	Pointer to current DATA item
0040-0041	64-65	Input vector
0042-0043	66-67	Current variable name
0044-0045	68-69	Current variable address
0046-0047	70-71	Variable pointer for FOR/NEXT
0048	72	Y save register; new-operator save
004A	74	Comparison symbol accumulator
004B-004C	75-76	Misc numeric work area
004D-0050	77-80	Work area; garbage yardstick
0051-0053	81-83	Jump vector for functions
0054-0058	84-88	Misc numeric storage area
0059-005D	89-93	Misc numeric storage area
005E-0063	94-99	Accumulator#1: E,M,M,M,M,S
0064	100	Series evaluation constant pointer
0065	101	Accumulator hi-order propogation word
0066-006B	102-107	Accumulator#2
006C	108	Sign comparison, primary vs. secondary
006D	109	low-order rounding byte for Acc#1
006E-006F	110-111	Cassette buffer length/Series pointer
0070-0087	112-135	Subrtn: Get Basic Char; 77,78=pointer
0088-008C	136-140	RND storage and work area
008D-008F	141-143	Jiffy clock for TI and TI$

(continued on page 101)



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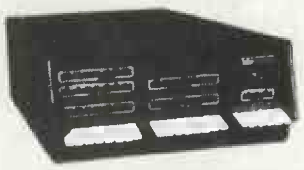
Introducing the DPS-1 the full IEEE S100 bus computer system from Ithaca Intersystems — the S100 experts.

FOR EDUCATION, INDUSTRY, RESEARCH and all professional uses, including hardware and software development, low cost OEM systems, teaching applications etc.



A MINI COMPUTER using MICRO technology at a ridiculous MICRO price!! The front panel with a backplane and power supply accepts S100 bus boards from many manufacturers.

Just look at these professional features!

★ FRONT PANEL (we won't ask you to debug our hardware, but we will give you the tools to debug yours!) Has lights and switches to allow inspection and control of addresses and data. Other features include programmed input switches, and output lights, Examine, Examine next, deposit, deposit next, single or slow step (0.1 to 1000 IPS), hardware breakpoint on any data or address byte, repeat instruction and many other hardware diagnostic facilities.

★ 30 Amp, 8V power supply. 5 Amps on ± 16v rails (all rails are seperately fused)

★ 20 slot IEEE S100 Motherboard with active termination and shielding between bus lines

★ Suitable for 6800, 6502, 8080, 8085, Z80, Z80A processors.

★ Guaranteed operation at 4MHz.

The DPS1 comes as a mainframe with front panel, Motherboard, power supply and 4MHz Z80A cpu board. The system is truly modular allowing the user to build up the system he requires in his own time.

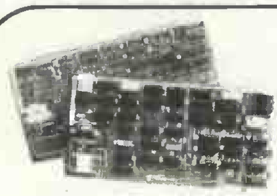
S100 boards from a number of manufacturers will plug into the DPSI IEEE S100 bus.

Just add S100 Memory Boards — S100 disk controller boards — S100 I/O boards — S100 video and/or graphics boards — S100 EPROM boards

All Ithaca Intersystems OEM products including K2 disk operating system and PASCAL/Z on 8" floppy drives will run in the DPS-1.

Fully assembled and tested
- **DPS-1 with S100 4MHz Z80 cpu board £695**
- **DPS-1 less S100 4MHz Z80 cpu board £645**

OEM S100 boards from the experts!



	Assembled and tested
8K Static RAM board (45 ons)	**£123.75**
8K Static RAM board (25 ons)	**£146.25**
Z80 cpu board (2MHZ)	**£131.25**
Z80 cpu board (4MHZ)	**£153.75**
2708/2716 EPROM board	**£63.75**
Prototype board (bare board)	**£18.75**
Video display board (64x16, 128U/L Ascii)	**£108.75**

New products from Ithaca audio!

High density graphics (1024 x 512 points)	**£660.00**
Disk controller (up to 4 single or double sided drives)	**£131.25**
I/O board (serial and parallel outputs)	**£210.00**
S100 front panel (as used in DPS1)	**£245.00**
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Available soon: ZBC-1 Single board computer for OEM market. Available in basic through to fully expanded. 4MHz Z80A, 64K RAM, memory mapped 4K screen buffer, composite video, up to 16K power on EPROM monitor, 4 parallel ports, 2 serial ports, 4 channel counter timer. 1 off **£895** — please phone for a quote for your needs. (quantity discounts available).

Over 15,000 boards delivered worldwide

InterSystems

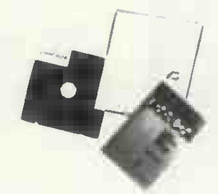
Software for your S100 system

K2 operating system

8" disk based operating system — distributed on Shugat compatible 8" floppy disk ★ TED — 52 command character orientated text editor with Macros. ★ PIP — File and directory handler. ★ ASMBLE — full Z80 2 pass assembler. ★ HDT—Hex debug tool. ★ QCI—Utility overlay/command decoder. ★ SYSGEN—System builder. ★ COPY—disk to disk file copier. ★ DUP—disk duplicator. **£56.25**

PASCAL/Z The new language for Micros £131.25

Runs under K2 operating system.



★ Compiler that produces Z80 macro assembler code — NO NEED for slow run time P-code interpreter. ★ Comes complete with Macro assembler. ★ Produces binary object modules — small and fast. ★ Modules are re-entrant and can be put into ROM. ★ IMBED, TRACE and ERROR debug facilities. ★ Recursion

ASMBLE/Z Z80 Macro assembler £37.50

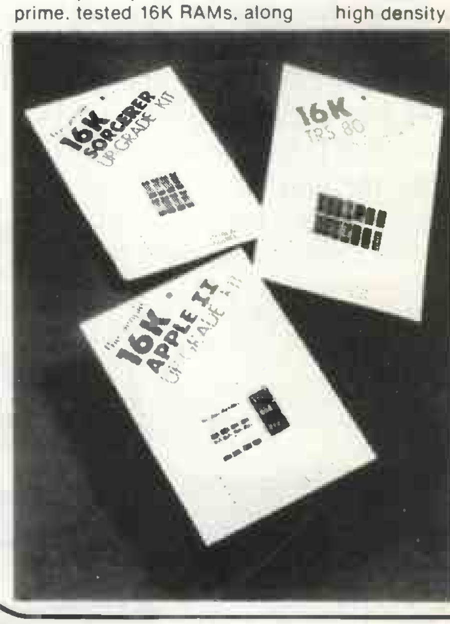
★ Full 2 pass Macro Assembler. ★ IF and ELSE — 255 nesting levels. ★ Produces symbol table. ★ Relative jumps.

UP-GRADE KITS

Trying to add computer memory is not much fun if you dont get everything you need. Receiving unprogrammed jumpers and having to program them yourself is not much better. Most important, that's the place where the problems are introduced.

So Ithaca Audio's better idea is the Simple Up-Grade. Each Simple Up-Grade is specially designed to make adding memory foolproof. We include all the parts you'll need: 8 prime, tested 16K RAMs, along with concise step by step directions and diagrams. And if a personality jumper is required, *it's premade*.

The TRS-80* memory expansion was our first Simple Up-Grade. Now there are two more — for owners of Apple II** and Exidy Sorcerer*** computers. Each kit is 100% guaranteed — if a part ever fails, we replace it FREE. Your Ithaca Audio dealer has them in stock, only £69. Now you can afford to add high quality, high density memory to your system for remarkably little — far less than you would expect to pay from Radio Shack, Apple, or Exidy directly. These Simple Up-Grades are Ithaca Audio's first step in adding more capability and reliability to your computer at lower cost. Other Up-Grades are on the way to your dealer now.



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● Circle No. 189

(continued from page 98)

0090-0091	144-145	Hardware interrupt vector
0092-0093	146-147	Break interrupt vector
0094-0095	148-149	NMI interrupt vector
0096	150	Status word ST
0097	151	Which key depressed: 255=no key
0098	152	Shift key: 1 if depressed
0099-009A	153-154	Correction clock
009B	155	Keyswitch PIA: STOP and RVS flags
009C	156	Timing constant buffer
009D	157	Load=0, Verify=1
009E	158	# characters in keyboard buffer
009F	159	Screen reverse flag
00A0	160	IEEE-488 mode
00A1	161	End-of-line-for-input pointer
00A3-00A4	163-164	Cursor log (row, column)
00A5	165	PBD image for tape I/O
00A6	166	Key image
00A7	167	0=flashing cursor, else no cursor
00A8	168	Countdown for cursor timing
00A9	169	Character under cursor
00AA	170	Cursor blink flag
00AB	171	EOT bit received
00AC	172	Input from screen/input from keyboard
00AD	173	X save flag
00AE	174	How many open files
00AF	175	Input device, normally 0
00B0	176	Output CMD device, normally 3
00B1	177	Tape character parity
00B2	178	Byte received flag
00B4	180	Tape buffer character
00B5	181	Pointer in filename transfer
00B7	183	Serial bit count
00B9	185	Cycle counter
00BA	186	Countdown for tape write
00BB	187	Tape buffer#1 count
00BC	188	Tape buffer#2 count
00BD	189	Write leader count; Read pass1/pass2
00BE	190	Write new byte; Read error flag
00BF	191	Write start bit; Read bit seq error
00C0	192	Pass 1 error log pointer
00C1	193	Pass 2 error correction pointer
00C2	194	0=Scan; 1-15=Count; $40=Load; $80=End
00C3	195	Checksum
00C4-00C5	196-197	Pointer to screen line
00C6	198	Position of cursor on above line
00C7-00C8	199-200	Utility pointer: tape buffer, scrolling
00C9-00CA	201-202	Tape end address/end of current program
00CB-00CC	203-204	Tape timing constants
00CD	205	00=direct cursor, else programmed cursor
00CE	206	Timer 1 enabled for tape read; 00=disabled
00CF	207	EOT signal received from tape
00D0	208	Read character error
00D1	209	# characters in file name
00D2	210	Current logical file number
00D3	211	Current secondary addrs, or R/W command
00D4	212	Current device number
00D5	213	Line length (40 or 80) for screen
00D6-00D7	214-215	Start of tape buffer, address
00D8	216	Line where cursor lives
00D9	217	Last key input; buffer checksum; bit buffer
00DA-00DB	218-219	File name pointer
00DC	220	Number of keyboard INSERTs outstanding
00DD	221	Write shift word/Receive input character
00DE	222	#blocks remaining to write/read
00DF	223	Serial word buffer
00E0-00F8	224-248	Screen line table: hi order address & line wrap
00F9	249	Cassette#1 status switch
00FA	250	Cassette#2 status switch
00FB-00FC	251-252	Tape start address
0100-010A	256-266	Binary to ASCII conversion area
0100-013E	256-318	Tape read error log for correction
0100-01FF	256-511	Processor stack area
0200-0250	512-592	Basic input buffer
0251-025A	593-602	Logical file number table
025B-0264	603-612	Device number table
0265-026E	613-622	Secondary address, or R/W cmd, table
026F-0278	623-632	Keyboard input buffer
027A-0339	634-825	Tape#1 buffer
033A-03F9	826-1017	Tape#2 buffer
03FA-03FB	1018-1019	Vector for diagnostic program
0400-7FFF	1024-32767	Available RAM including expansion
8000-8FFF	32768-36863	Video RAM
9000-BFFF	36864-49151	Available ROM expansion area
C000-E0F8	49152-57592	Microsoft Basic interpreter
E0F9-E7FF	57593-59391	Keyboard, Screen, Interrupt programs
E810-E813	59408-59411	PIA1 - Keyboard I/O
E820-E823	59424-59427	PIA2 - IEEE488 I/O
E840-E84F	59456-59471	VIA - I/O and Timers
F000-FFFF	61440-65535	Reset, tape, diagnostic monitor

Graphics printer

SIGMA SYSTEMS of Cardiff (telephone 21515) sent a sample of the output from what it describes as the first available printer to print Pet graphics. The advantage when reading a program listing is terrific, of course. Since this is the Axiom electrostatic printer working at a speed of 120 lines per minute with 40 characters per line on paper 5in. wide, it is interfaced directly to the IEEE bus, so you need no long subroutines in memory to run the printer. It costs £499 plus VAT.

Instant addition

WE HAVE heard of an interesting collection of add-ons from Palo Alto ICs, 810 Garland Drive, Palo Alto, CA 94303.

The Basic Programmer's Toolkit is a collection of firmware aids designed to enhance the development, debugging and polishing of programs for the Pet.

The toolkit provides 2KB of additional machine language tools permanently in ROM. No tapes need to be loaded, nor do you lose any RAM. The toolkit adds these helpful new commands to the Pet:

AUTO	enter auto-numbering mode, with the Pet providing evenly-spaced line number prompts.
APPEND	appends a Basic program from tape to the program in storage, using normal SAVEd tapes
DELETE	deletes a range of lines as easily as LIST.
DUMP	displays the names and values of variables in the symbol table during or after running a program.
HELP	used after an error in Basic to display the erroneous line, with the offending token highlighted.
RENUMBER	renumbers a Basic program — and all references — by specified step-size.
TRACE	allows you to see the line numbers of statements as they are executed, in a small scroll window in the corner of the screen. Also operates in single STEP mode.

The toolkit will cost $75 for 2001-8, $50 for 2001-16, 32; that includes documentation and examples of use.

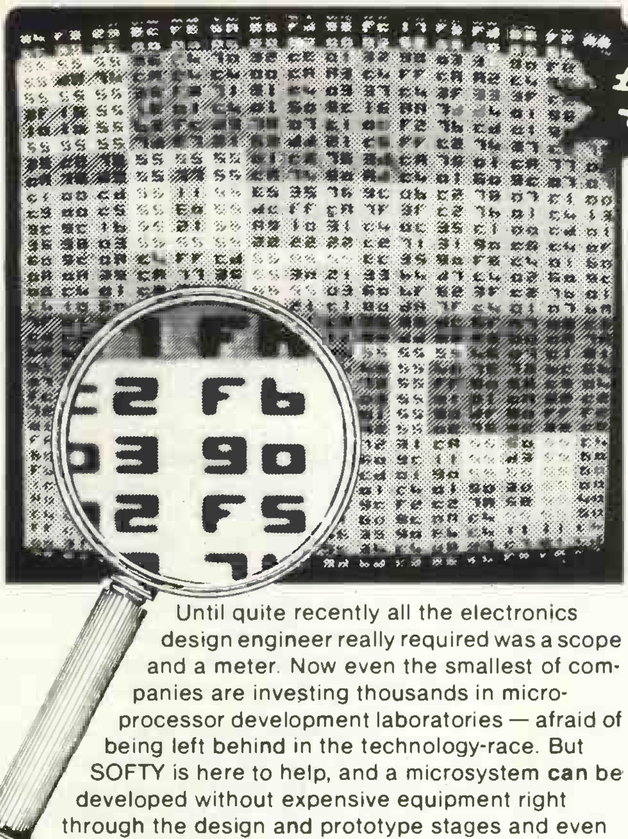
You will need to order directly from the States, but the company is interested in arranging U.K. representation.

Takeover

THE TAKEOVER of Petsoft by Applied Computer Techniques (ACT) seems to have had a propitious effect. Twenty-five new programs are listed in the latest catalogue, ranging from a £5 program to teach maths to children of six to 12 years old, and a tutorial to teach beginners how to write programs in Basic.

New games include space simulation for £5, and for £10 there is a steeplechase game. For £10 you can buy Gypsy Petulengro, an astrology program which might start a new trend on the seaside piers of Britain.

Copies of the latest free catalogue are available from Petsoft Division, Applied Computer Techniques Ltd, 5-6 Vicarage Road, Edgbaston, Birmingham, B15 3ES. Tel: 021-454 5348.



£79.50 + VAT

A NEW TOOL FOR A NEW TECHNOLOGY

SOFTY is not just another training aid for the engineer wishing to become acquainted with microprocessors – it is a BENCH-TOOL for the system designer.

"A revolution will probably take place soon, with the appearance of complete development systems costing less than £1,000 . . ."

Until quite recently all the electronics design engineer really required was a scope and a meter. Now even the smallest of companies are investing thousands in microprocessor development laboratories — afraid of being left behind in the technology-race. But SOFTY is here to help, and a microsystem **can** be developed without expensive equipment right through the design and prototype stages and even into production.

WHAT SOFTY WILL DO

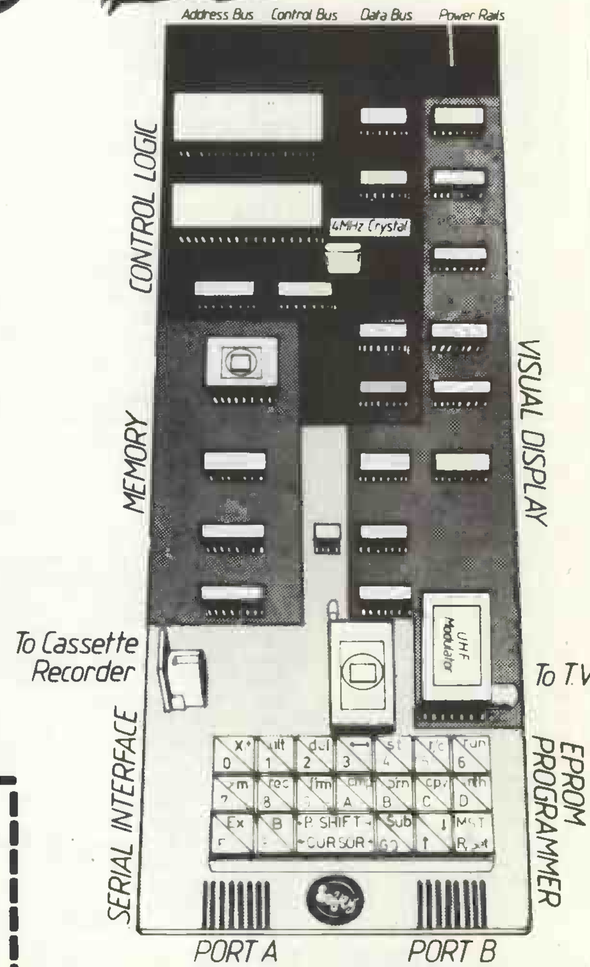
- IT COPIES MEMORY DEVICES (ROMs &c) presenting the data as an address-mapped hexadecimal display on the screen of a monitor or TV set.
- IT DEVELOPS PROGRAMS for virtually any microprocessor with facilities similar to an ASSEMBLER: you may enter, insert or delete instructions, shift blocks of data, match specific bytes, calculate displacements to labelled locations — and all with the overwhelming advantage of being able to test the program instantly and even develop it one instruction at a time!
- IT RECORDS PROGRAMS on ordinary cassette tape using an ordinary cassette recorder at ultra-high-speed — around 2000 baud equivalent!
- IT PROGRAMS EPROMS of the 2708 family at a speed which is close to the theoretical minimum (2 mins per 2708). It may therefore be used as an 'instant-copier' for software.
- IT IS A HANDY COMPUTER which may be programmed to do useful jobs in the home or workshop, and may even be included as the 'brains' of larger equipment, performing sequential or combinatorial control functions. SOFTY has a microcycle length of exactly one microsecond and there is a programmable timer. The manual lists a simple interpretive language which anyone may learn to use in ten minutes!
- IT IS A FABULOUS LEARNING AID because the trainee can actually see what is happening — SOFTY is completely transparent! The internal MPU will cease execution at a breakpoint, which may be substituted for any program step, and display contents of internal registers.
- IT FILLS THE GAP BETWEEN THEORY AND PRACTICE for the serious user who already has a computer and dedicated assembler to develop his software. The computer makes documentation — not prototypes. SOFTY places the program in addressing space to be actioned by the MPU of his choice in a real system — the proof of the pudding! Simple debugging and condensing of code may often be handled without recourse to the assembler.

SOFTY can be assembled in a couple of hours. No extras are required except for a power supply providing +5, +12 & —5 volt rails and +30 volts for the EPROM programmer. The kit includes sockets for all the 23 ICs, UHF modulator for TV use, 4MHZ crystal, DIN socket and lead for cassette interface, 21 key keyboard, a quality double-sided PCB of fibreglass with solder mask and component overlay and a comprehensive manual covering assembly and use.

A DEVELOPMENT KIT is also available which includes all of the above and a lever-operated ZERO INSERTION FORCE SOCKET for the EPROM programmer, 43 way card edge connector, ribbon cable and 24 pin header (for connection to the system under development as firmware) and a spare 2708 EPROM.

It is not possible to present a full technical specification in the space available here. We will therefore send you a SOFTY on the understanding that you may examine it and read the literature and, if you wish to do so, return the goods for a complete refund within 14 days.

VIDEOTIME PRODUCTS, 56, Queen Road, BASINGSTOKE, Hants, RG21 1RE
TEL: (0256) 56417 TELEX: 858747.
We welcome Barclay & Access orders by telephone.



Please send me: (I enclose Cheque/Company Order)

...... SOFTY Kits @£92.00(Incl. VAT & 50p p & p)
...... DEVELOPMENT Kits @£113.85(Incl. VAT & 50p p & p)
...... BUILT DEVELOPMENT Kits @£136.85(Incl. VAT & 50p p & p)
...... POWER SUPPLY Kits @£17.25(Incl. VAT & £1 p & p)

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Address ....
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SOFTY

● Circle No. 190

Pascal

ANNOUNCED at the NCC trade fair in New York was a language card designed to run Pascal. It is in the form of a 16K RAM card, bringing the total capacity of Apple II to 64K.

The card supports the full USCD Pascal and the high-resolution colour graphics extension designed by Apple; Pascal is compiled, making program running shorter. Features of the package include:

- A fast, screen-orientated editor for program development and word processing.
- 80-character lines in the standard Apple with horizontal scrolling.
- 80-character lines — upper- and lower-case characters — with external CRT terminal.
- Standard Pascal plus extensions for strings, disc files, graphics and system programming.
- Text procedures for cursor addressing, split screen, horizontal scrolling.
- FUNCTION Keypress tells whether a character is available.
- Library routines include randomising, support for a game paddle, and several others.
- Re-locatable assembly language routines can be generated and linked to Pascal programs.

Apparently Pascal operates only on a 48K Apple from disc with the language card installed. Because of the way the memory is mapped it may not be possible to use it with smaller machines.

Required reading

WE'VE MENTIONED *The Rainbow* previously in this page; it's the only independent newsletter of which we know for Apple II users, and is from Aresco, which also does newsletters for Pet and the RCA Cosmac VIP.

Rainbow carries news, reviews, tips, programs and explanations; and the potential of the newsletter to react to readers' input can justify a subscription.

Rainbow has some 24 pages and is monthly. Assembled and written largely by Rick Simpson, it uses two contributing editors and a number of readers' articles.

In issue 1, the major piece is the code and description for a data management system using Applesoft, 32K RAM and a disc. It's not exactly a full-scale DBMS but it provides a common format for storing files of numeric data which can be analysed subsequently by various applications; it can be used without any great understanding of programming techniques, and it looks well-suited to the production of business and technical charts and graphs. It has two bugs, corrected in later issues.

There is also an excellent piece on how to use the Apple I/O connectors. How many other computers have built-in interfaces for paddles and pushbuttons?

Issue 2 contains another good intro-

duction, this time to high-resolution graphics and shape tables. There are four software reviews, including plaudits for Muse's great *Escape* game and the Quality Software *Fastgammon*.

In issue 3 there is a handy DOS memory map, a look at the good points of integer Basic, a tip from Steve Wozniak, a good review of low-resolution graphics, and a fine high-resolution plotting program for polynomials. There are also the plans for an add-it-yourself colour killer to improve text display by showing monochome alphanumerics; some production Apple IIs are now incorporating this modification but yours may not have it.

There is an introduction to assembly language programming in issue 4, designed deliberately to fill the gaps in published books on 6502 machine language coding. More articles will follow in the series. There are also several reviews, including the Programmer's Aid ROM and the Mountain Hardware clock board — "well-designed, well-constructed and well-documented. If you have an application which requires precise time-of-day information or precisely-timed interrupts, this unit will do the job — and do it well".

Issue 5 looks in more detail at the Programmer's Aid and recommends its extra high-resolution facilities. Also a fairly unfruitful interview with Apple's marketing manager, letters and reviews — including a look at the Eclectic Corp Superchip we noted two issues ago.

The superchip is a ROM package for special graphics, including lower-case letters and plenty of text display variants. The reviewer found several small limitations with it, especially when running programs not designed for use with the Superchip, and concluded that "it does everything they say it will — and very well — but it also does some things you wish it wouldn't".

Our verdict is unqualified approval. There is no U.K. outlet so far as we know, though Aresco is interested in talking to dealers and shops here. Meanwhile, individuals can subscribe for $25; Aresco accepts Mastercharge and Visa. The address is *The Rainbow*, P O Box 1142, Columbia, MD 21044.

Number painting

S W HILTON of Lambeth sent a program which allows the more artistically-inclined user to paint by numbers, in 'Etch-a-Sketch' fashion. Hitting the space bar, or the next required colour code, allows the "electroartist" to change colour as desired. Well, at least it's not so messy as the real thing:

```
10 REM   COLOUR 'ETCH-A-SKETCH' PROGRAM FOR APPLE II
20 REM
30 REM   FOR COLOUR CODES REFER TO APPLE II BASIC PROGRAMMING MANUAL
40 REM
50 GR
60 PRINT "COLOUR ETCH-A-SKETCH"
70 PRINT "X = PADDLE 0, Y = PADDLE 1"
80 PRINT "HIT SPACE BAR TO START/CHANGE COLOUR"
90 POKE -16368,0
100 X = PDL (0) : Y = PDL (1)
110 PLOT X,Y
120 IF PEEK (-16384)<127 THEN GOSUB 200
130 GOTO 90
140 REM
150 REM    SUBROUTINE PLOTS REQUIRED COLOUR...
160 REM
200 PRINT "CHOOSE A COLOUR..."
210 INPUT C
220 IF C>15 THEN GOTO 316
230 GOSUB (300+C)
240 COLOR = C
250 POKE -16368,0
260 PLOT X,Y
270 RETURN
300 PRINT "BLACK" : RETURN
301 PRINT "MAGENTA" : RETURN
302 PRINT "DARK BLUE" : RETURN
303 PRINT "PURPLE" : RETURN
304 PRINT "DARK GREEN" : RETURN
305 PRINT "GREY" : RETURN
306 PRINT "MEDIUM BLUE" : RETURN
307 PRINT "LIGHT BLUE" : RETURN
308 PRINT "BROWN" : RETURN
309 PRINT "ORANGE" : RETURN
310 PRINT "GREY" : RETURN
311 PRINT "PINK" : RETURN
312 PRINT "GREEN" : RETURN
313 PRINT "YELLOW" : RETURN
314 PRINT "AQUA" : RETURN
315 PRINT "WHITE" : RETURN
316 PRINT "OUT OF RANGE, TRY AGAIN" : GOTO 200
```

ILLUSTRATING BASIC

(A SIMPLE PROGRAMMING LANGUAGE)

WE CONTINUE our series of articles on how to program in Basic, probably the most widely-used programming language for small computers. For the series, we have obtained the serialisation rights for one of the best books on the subject, *Illustrating Basic* by Donald Alcock.

★

Each month, we are publishing a part of the book, so by the end of the series you will have the complete book. It is written with a distinct informality and has a rather unusual presentation; but it is this style, we believe, which makes it one of the most easy to read tutorials.

★

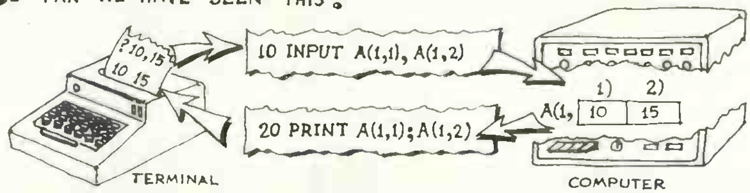
★

CONTENTS

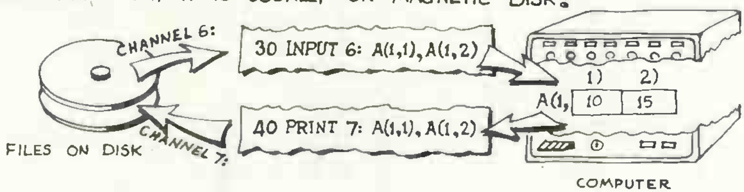
FILES OF DATA

THE KEYBOARD IS NOT THE ONLY MEANS OF INPUT NOR IS THE TERMINAL THE ONLY DESTINATION FOR OUTPUT.

SO FAR WE HAVE SEEN THIS:



BUT YOU MAY ALSO SEND DATA TO AND FROM A *FILE* IN THE *FILES AREA* WHICH IS USUALLY ON MAGNETIC DISK:



FILES ARE NEEDED MAINLY FOR:

- *COMMUNICATION*: RESULTS OF ONE PROGRAM MAY BE STORED IN A FILE FOR SUBSEQUENT USE AS INPUT DATA FOR OTHER PROGRAMS.
- *BACKING STORAGE*: A PROGRAM MAY GENERATE MORE INTERMEDIATE INFORMATION THAN *BASIC* CAN HOLD IN THE FORM OF ARRAYS (EVERY SYSTEM HAS ITS OWN LIMIT ON SIZE OF ARRAY).

TO TRANSFER DATA BETWEEN ARRAYS IN A PROGRAM AND FILES IN THE FILES AREA USE:

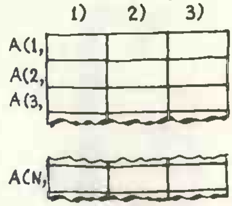
INPUT	(PAGE 18)
MAT INPUT	(PAGE 96)
PRINT	(PAGE 28)
PRINT USING	(PAGE 34)
MAT PRINT	(PAGE 98)

EXCEPT THAT YOU INSERT A *CHANNEL NUMBER* (FOLLOWED BY A COLON) AFTER THE WORD "INPUT" OR "PRINT".

ILLUSTRATING BASIC PAGE 120

HERE IS A SUBROUTINE TO TRANSFER ROWS 1 TO "N" OF ARRAY A(,) TO A FILE ON CHANNEL 7:

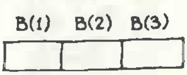
```
1000   REM SUBROUTINE TO TRANSFER N ROWS
1010   REM  OF A(,) TO FILE ON CHANNEL 7:
1020   FOR I = 1 TO N
1030   PRINT 7: A(I,1), A(I,2), A(I,3)
1040   NEXT I
1050   RETURN
```



IF YOU "CALLED" THIS SUBROUTINE A SECOND TIME THE NEW CALL WOULD CAUSE MORE ROWS OF NUMBERS TO BE APPENDED TO THE FILE FOLLOWING THOSE TRANSFERRED IN THE PREVIOUS CALL. THUS YOU CAN STORE AN "ARRAY" IN A FILE MANY TIMES LONGER THAN ALLOWED FOR BY THE "DIM" STATEMENT FOR THAT ARRAY.

HERE IS A SUBROUTINE TO INPUT JUST "RECORD R" FROM A FILE ON CHANNEL 6: . WE ASSUME THIS FILE HAS THE SAME STRUCTURE AS THE FILE ON CHANNEL 7: ILLUSTRATED ABOVE. A FILE IS SIMPLY A STREAM OF SINGLE ITEMS; *YOU* HAVE TO ORGANISE ITS STRUCTURE (SUCH AS *ROWS OF THREE* AS "RECORDS" AS IN THIS EXAMPLE).

```
2000   REM SUBROUTINE TO INPUT SINGLE RECORD
2010   REM  "R" INTO B( ) FROM CHANNEL 6:
2020   REM     FIRST RESET FILE TO RECORD 1
2030   RESET  6
2040   REM  WIND THROUGH (R-1) RECORDS
2050   FOR  I = 1  TO  R-1    )
2060   INPUT  6:   A,B,C      )  "WASTE" R-1 RECORDS
2070   NEXT  I                )
2080   REM  NOW INPUT RECORD R TO  B( )
2090   INPUT  6: B(1), B(2), B(3)
2100   RETURN
```



THIS EXAMPLE ILLUSTRATES THE INSTRUCTION "RESET" WHICH IS COMMON TO MANY *BASICS* ALTHOUGH AT LEAST ONE VERSION USES THE WORD "RESTORE" INSTEAD. YOU ARE USUALLY PERMITTED TO RESET SEVERALS CHANNELS BY A SINGLE INSTRUCTION:

```
100   RESET  1, 3, 6
```

THIS INSTRUCTION MOVES A CONCEPTUAL "POINTER" TO THE BEGINNING OF THE FILE ON THE SELECTED CHANNEL SO THAT THE NEXT "INPUT" INSTRUCTION TO BE OBEYED PICKS UP THE FIRST ITEM IN THE FILE. DO NOT USE "RESET" WHILST *PRINTING* A FILE.

CHAPTER 8

FILE NAMES + CHANNELS

WHEN THERE ARE FILES IN A *BASIC* PROGRAM YOU HAVE TO ASSOCIATE *NAMES* OF FILES AS THEY APPEAR IN YOUR "CATALOG" WITH THE *CHANNEL NUMBERS* USED IN "INPUT" AND "PRINT" INSTRUCTIONS. ("CATALOG" IS EXPLAINED ON PAGE 115.) THERE ARE ALMOST AS MANY WAYS OF DOING THIS AS THERE ARE VERSIONS OF *BASIC*. ASSUMING YOU WANT TO INPUT FROM A FILE CALLED "MYDATA" ON CHANNEL 6: AND PRINT A FILE CALLED "RESULT" ON CHANNEL 7: HERE ARE JUST A FEW DIFFERENT WAYS DIFFERENT *BASICS* REQUIRE YOU TO DO IT. (NAMES YOU INVENT ARE USUALLY LIMITED TO ABOUT 6 LETTERS AND DIGITS OF WHICH THE FIRST MUST ALWAYS BE A LETTER.)

```
10    FILE  #6:   "MYDATA"
20    FILE  #7:   "RESULT"
```

N.C.C. "STANDARD BASIC"

```
10    FILES  #6 = "MYDATA", #7 = "RESULT"
```

CASSETTE FILES NUMBERED — *DISK FILES NAMED* — *SIZE IN BLOCKS OF 1024 CHARS.*

```
10    FILES  1,2,3,4,5,"MYDATA"/10, "RESULT"/10
```

```
10    FILES  A;B;C;D;E;MYDATA;RESULT
```

CHANNELS NUMBERED BY POSITION IN LIST

```
10    OPEN  6 = "MYDATA", INPUT
20    OPEN  7 = "RESULT", OUTPUT
```

INPUT FILES DISTINGUISHED FROM OUTPUT FILES

```
10    OPEN "MYDATA" FOR INPUT AS FILE 6
20    OPEN "RESULT" FOR OUTPUT AS FILE 7
```

```
10    OPEN  "MYDATA"  TO :6, INPUT
20    OPEN  "RESULT"  TO :7, PRINT
```

A FURTHER COMPLICATION IS THAT SEVERAL *BASICS* DEMAND YOU FIRST USE THE "JOB CONTROL LANGUAGE" (*i.e.* THE CODE UNDERSTOOD BY THE COMPUTER'S OPERATING SYSTEM) TO DECLARE AND GIVE DETAILS ABOUT ALL THE FILES YOUR *BASIC* PROGRAM REFERS TO; IN SHORT TO GIVE DETAILS TWICE.

ILLUSTRATING BASIC PAGE 122

FILES (CONTINUED)

YOU CAN FILE TEXTS AS WELL AS NUMBERS:

```
100 REM   FILE NAMES AND DATA
110 PRINT  7: "CUSTOMER'S NAME "; N$; S$
120 MAT PRINT  7:  A
```

BUT SOME *BASICS* RESTRICT SUCH MIXTURES OF TEXTS AND NUMBERS TO FILES CODED IN *CHARACTER FORM* AS DEFINED OVERLEAF.

FROM THE PRECEDING EXAMPLES YOU WILL APPRECIATE HOW EASY IT WOULD BE TO PRINT A FILE AND GET IT OUT OF PHASE DURING RE-INPUT: REMEMBER YOU CAN'T *SEE* THE CONTENTS OF A FILE. HERE IS A ROUTINE TO INPUT ON CHANNEL 6: THE FILE PRINTED BY INSTRUCTIONS 100 TO 120 ABOVE ON CHANNEL 7:.

```
200 REM   RE-INPUT CUSTOMER'S NAME & DATA
210 INPUT  6:    M$, Q$
220 MAT INPUT  6:   A
```

BUT THERE IS A HORRIBLE BUG. THE TEXT "CUSTOMER'S NAME" WAS PUT ON THE FILE IN FRONT OF THE CUSTOMER'S TWO NAMES STORED IN N$ AND S$: LINE 210 FAILS TO PICK THIS UP, THUS MAKING S$ INTO THE FIRST ITEM OF MATRIX INPUT WHICH IS RIDICULOUS.

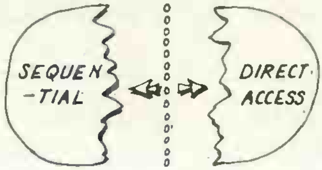
WHEN DEVELOPING PROGRAMS THAT USE FILES IT HELPS TO SEND, SAY, THE FIRST OR LAST ITEM IN EACH TRANSFER TO THE TERMINAL AS A RUNNING CHECK. THE (CORRECTED) DEVELOPMENT VERSION OF THE ROUTINE ABOVE BECOMES:

```
200 REM   RE-INPUT CUSTOMER'S NAME & DATA
210 INPUT  6:   T$, M$, Q$
211 PRINT  210; Q$
220 MAT INPUT  6:   A
221 PRINT  220; A(1,1)
```

LINES 211 & 221 JUST FOR DEVELOPMENT

KINDS OF FILE

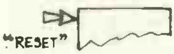
THERE ARE ESSENTIALLY *FOUR* KINDS OF FILE: SOME *BASICS* OFFER ONLY ONE KIND, OTHERS MORE. HERE IS A ROUGH ANALYSIS:



(OFTEN CALLED *RANDOM ACCESS*)

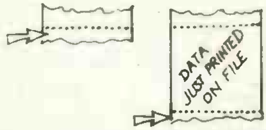
IN THE DOMAIN OF FILES THERE IS A "VERTICAL" DIVISION SEPARATING *SEQUENTIAL* FILES FROM *DIRECT ACCESS* FILES.

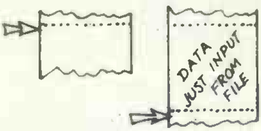
<u>*SEQUENTIAL FILES*</u>



EACH FILE HAS A CONCEPTUAL "POINTER" WHICH STARTS AT THE BEGINNING OF THE FILE AND MAY BE SET BACK TO THE BEGINNING AT ANY TIME BY THE INSTRUCTION "RESET".

WHEN YOU SEND INFORMATION TO THE FILE BY THE "PRINT" INSTRUCTION THE NEW INFORMATION GOES ON THE END OF THE FILE AND THE POINTER MOVES ON JUST PAST THE NEW END THUS CREATED.



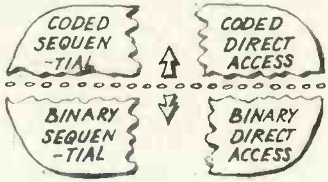


WHEN YOU INPUT INFORMATION FROM A FILE YOU GET THE INFORMATION POINTED TO; THE POINTER THEN MOVES ALONG TO THE NEXT SET OF INFORMATION READY FOR THE NEXT "INPUT" INSTRUCTION.

OBVIOUSLY, THEN, YOU CAN'T "INPUT" FROM A FILE BEING "PRINTED" UNTIL YOU HAVE FINISHED WITH PRINTING AND "RESET" THE CONCEPTUAL POINTER. IN SOME *BASICS* THIS MEANS CLOSING AN OUTPUT FILE AND OPENING IT AGAIN AS AN INPUT FILE; ON THE SAME OR ANOTHER CHANNEL. EXAMPLES ON PREVIOUS PAGES ILLUSTRATE THE USE OF *SEQUENTIAL* FILES.

<u>*DIRECT ACCESS FILES*</u> (THESE ARE OFTEN CALLED *RANDOM* ACCESS FILES: A MISNOMER BECAUSE NOBODY WANTS RANDOMLY CHOSEN RECORDS.) WITH DIRECT ACCESS FILES YOU MAY *CONTROL THE POSITION OF THE POINTER*. WHEN THE POINTER IS IN POSITION YOU MAY TREAT THE FILE AS THOUGH IT WERE A SEQUENTIAL FILE. SO *BASICS* THAT PROVIDE DIRECT ACCESS FILES MUST ALSO PROVIDE SPECIAL INSTRUCTIONS FOR MOVING POINTERS TO "RECORD N" AND FUNCTIONS FOR DISCOVERING WHERE THE POINTER HAS GOT TO. DIRECT ACCESS FILES ARE LESS COMMON IN *BASIC* THAN SEQUENTIAL AND ARE NOT FURTHER COVERED HERE.

THERE IS ALSO A "HORIZONTAL" DIVISION OF THE DOMAIN OF FILES SEPARATING *CODED* FILES FROM *BINARY* FILES.



CODED FILES YOU CAN PRINT THESE AT A TERMINAL OR ON A LINE PRINTER ⇔ EVERY LETTER, DIGIT AND SYMBOL IN THE FILE IS UNIQUELY STORED; USUALLY IN A.S.C.I.I CODE. A PROBLEM WITH CODED FILES IS THAT COMPUTERS USING BINARY ARITHMETIC HAVE TO CONVERT NUMBERS FROM CODED DECIMALS TO BINARY DURING INPUT ⇔ AND FROM BINARY TO CODED DECIMALS DURING OUTPUT. THIS IS WASTED WORK IF YOU DON'T NEED TO PRINT THE FILE AND READ IT: THERE CAN ALSO BE SOME LOSS OF ACCURACY DURING BOTH CONVERSIONS.

BINARY FILES THESE STORE DATA MORE COMPACTLY THAN IS POSSIBLE WITH CODED FILES AND REQUIRE NO CONVERSION DURING INPUT AND OUTPUT. ON THE OTHER HAND THEY WOULD PRODUCE GIBBERISH IF YOU WERE ABLE TO PRINT THEM AT THE TERMINAL. BINARY FILES ARE STRICTLY FOR STORING INTERMEDIATE RESULTS OF A CALCULATION ⇔ AND READING THEM BACK INTO THE COMPUTER FOR FURTHER COMPUTATION. SEVERAL *BASICS* OFFERING BINARY FILES IN ADDITION TO CODED FILES HAVE DISTINCT INSTRUCTIONS FOR BINARY INPUT AND OUTPUT; TYPICALLY:

THE WORD "GET" IN PLACE OF "INPUT"
THE WORD "PUT" IN PLACE OF "PRINT"

AND SOME USE THE WORDS "READ" AND "WRITE" RESPECTIVELY. SOME *BASICS* ALLOW BINARY FILES CONSISTING OF TEXTS. A FEW *BASICS* ALLOW BINARY FILES COMPOSED OF A MIXTURE OF NUMBERS AND TEXTS.

THERE IS NO HOPE OF WRITING COMPLETELY PORTABLE *BASIC* PROGRAMS WHICH USE FILES ⇔ BUT IF YOU STICK TO USING *CODED SEQUENTIAL FILES* YOUR PROGRAM SHOULD NOT NEED MUCH ALTERATION TO MAKE IT RUN ON SOME OTHER INSTALLATION.

Fourier transforms on the Pet

WE PRESENT an entirely practical, non-mathematical and basic — and Basic — description of how to take a single cycle of any waveform and reduce it to its component parts, revealing in some detail the 'nuts and bolts' which go to make up all kinds of sounds and vibrations. This should prove of considerable interest to Pet owners who also happen to be musicians, engineers, mechanics, teachers and students in various branches and stages of physics and elementary mathematics.

It is possible, and sometimes useful, to describe any periodic waveform in terms of a number of pure sinewaves. Fourier analysis is a technique which can be used to extract each of the possibly numerous harmonics that constitute a complex waveform. Harmonic content distinguishes the tone of one musical instrument from another, even though they are playing the same note.

Spoken vowel sounds are different because the throat, nose and mouth form filters with different resonant frequencies which emphasise certain of the harmonics

by Nick Hampshire

inherent in the sound produced by the vocal cords. As we speak, the shape of the mouth changes continually, altering the patterns of the harmonics produced in the sound, so allowing the varied range of sounds we use for communication.

The number of times a waveform — which could be sound or vibration in any material or structure, or a mathematical function — repeats in a given period — or axis space — is called the fundamental frequency. Harmonics are tones which are integer multiples of the fundamental. Thus, if a waveform has a fundamental frequency of 100 cycles per second (Hertz), then the second harmonic is twice that frequency — 200Hz, the third 300Hz, the 10th 1000Hz, and so on.

A complex waveform, such as the tone produced by an oboe or the human voice, can be regarded as containing a certain amount of a pure sinewave at the fundamental frequency, a certain amount of sinewave at the second harmonic, some at the third and so on. Most complex waveforms will have harmonics stretching to a theoretical infinity — i.e., an infinite number of harmonics must be added to the fundamental to build up the exact waveforms.

In practice, the higher fundamentals tend to add only a very small proportion of energy to the total and may be ignored at some arbitrary level. An audio amplifier being fed with a squarewave, which is rich in harmonics, of 1KHz will pass only the first 20 harmonics or so because it has an upper frequency limit of 20KHz. That will lead inevitably to a distorted squarewave being fed into the loudspeakers, since the theoretical harmonic series of a squarewave continues to infinity in the sound spectrum.

Figure 2 shows the relative content of the first 15 harmonics, showing that the higher harmonics are less and less significant and contribute less to the final sound. Such distortion may not be particularly important, as the human ear cannot hear these higher harmonics. This transcription error, however, would be detected by audio test equipment.

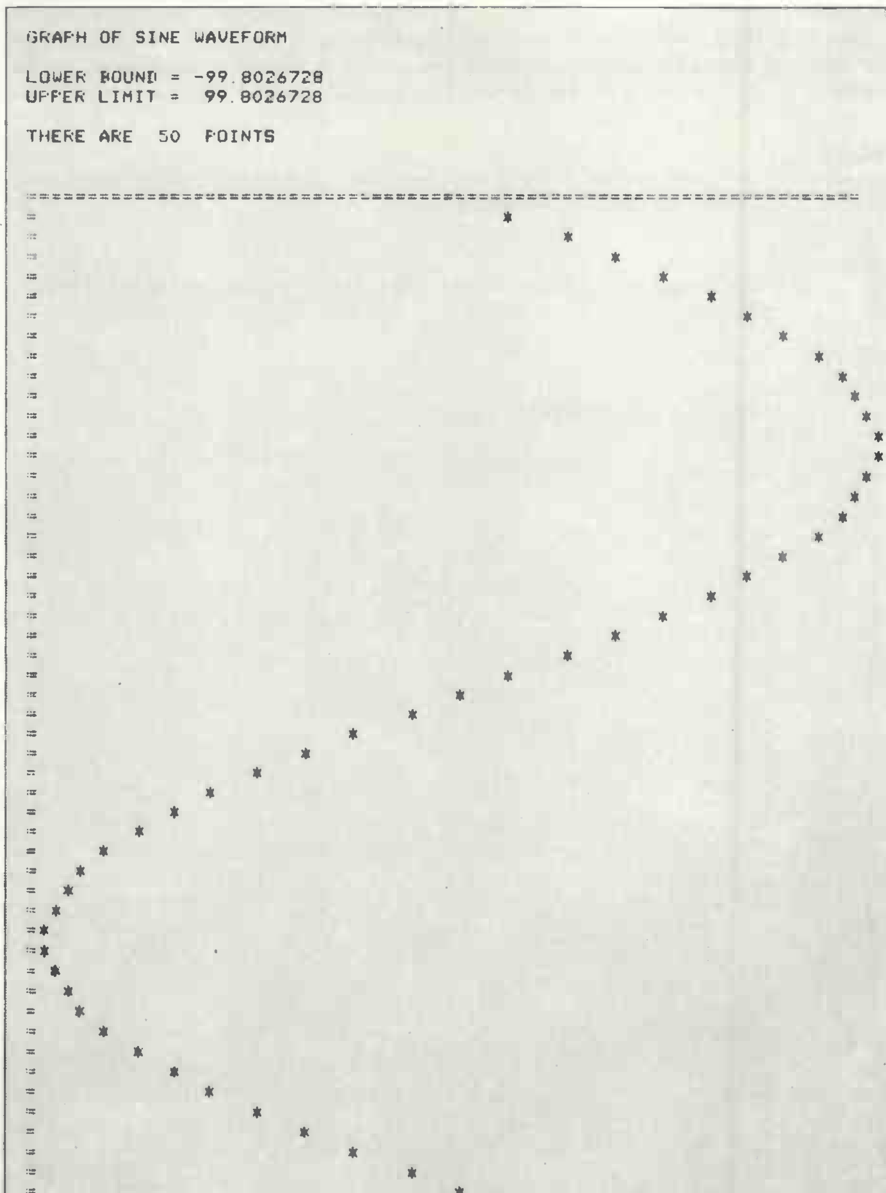
It may not be immediately obvious that a periodic waveform need consist of only its fundamental — the period with which it repeats — and harmonics of that fundamental. Note, however, that fundamental frequency means just that. If the waveform contains any component waveform not an integer multiple of the fundamental, the fundamental was chosen incorrectly.

Harmonic analysis of the tides might show that the fundamental frequency of oscillation was the lunar month. After all, it is the attraction of the moon which causes the tides. Should the sun have any effect on the tides, the periodic fundamental would have to be the lowest common denominator between the effect of the moon and the sun.

A practical tide predictor, which is one application for such analysis, may, for the

(continued on next page)

Figure 1.



(continued from previous page)

sake of simplicity, ignore the minor effect of the sun if the prediction is accurate enough.

Figures 2 and 4 show the harmonic content of a square wave and a triangle wave. Figure 2 shows that the square wave contains a greater proportion of harmonics than the triangle. Both contain only odd harmonics — fundamental, third, fifth, seventh and so on — yet in one case they add up to a square wave and in the other a triangle. This is due to phase differences between the harmonics.

If one considers two sine waves of the same frequency (as figure 1) and superimposes them, when the peaks occur in the same place both the peaks and the troughs are magnified. The new waveform is the sum of the two.

If the second waveform is shifted along half of the total wavelength (180 degrees) the peak of the first would be summed with the trough of the second, similarly with the trough of the first and the peak of the second.

The nett result would be of the two waveforms cancelling-out to leave nothing at all. When two stones are dropped in a pond and the ripples meet, the wavelets are amplified in some places, reduced to still water in others.

Three peaks

The third harmonic has three peaks in the same length, space or time as the one of the fundamental. When the third harmonic is added to the fundamental in such a way that the peak and trough of the fundamental are accentuated, then a triangle wave is produced. When the third harmonic reduces the peak and trough of the fundamental, a squarewave is formed.

All the examples were generated by the program given at the end. Fourier analysis is set firmly in the realms of applied mathematics, although we settle for a descriptive, and, where possible, a pictorial approach. No attempt will be made to prove, or even show, that the technique or theory is soundly based.

The program is in several logical subsections. First, the user has the option to generate a waveform within the code by calling one of a number of subroutines, or to input a sequence of numbers representing a digitised waveform. In the second section the user may print-out a graph of the waveform so produced, either on the Pet screen, or to an external printer through an IEEE bus-to-RS232 converter.

The third stage is to analyse the waveform once for each harmonic, printing the amplitude of that harmonic and its phase angle. They are the two items of information required to say how much of each harmonic must be added to the fundamental, and in what phase relationship.

In the last section the user may printout a pictorial representation of the harmonic content, either on the screen or the external printer. As a further option the bar chart of the harmonics may be displayed as a logarithmic value; this has the effect of compressing widely-diverging values, so making the display more usable.

When the program is started it asks the user for the number of sample points the waveform is to contain (120). Ten or fewer are too few for a meaningful analysis, more than 255 would not fit in a Pet Basic array (130-150).

Next, the user must select one of six options to set up the waveform in the array WV (160-250). If a zero is entered the program executes subroutine 1000 (260-280). This subroutine then asks the user to input NO — the number of sample points — digitised waveform points.

If the user typed "1" when selecting the waveform option, WV is set equal to a sine wave (1100-1150). The inherent SIN() function is called. It takes a value in radians — there are X 2*PI radians in a full circle, equivalent to 360 degrees; this accounts for the 6.283... constant in the calculation (1130).

Normalising

SIN() returns a value in the range −1 to +1; this is multiplied by 100 to normalise it partially with the other waveforms and also to provide reasonably large numerical values from the calculations.

By selecting option "2" a square wave is placed in WV (1200-1290). The first half of the array is set to −100, the second half to +100. A triangle wave, option "3" (1300-1375), is constructed by starting a counter at zero (TM, statement 1310) adding +10 for the first quarter of the cycle (1315-1330), then subtracting 10 for the next half of the cycle (1335-1350).

The last quarter of the cycle is constructed by adding +10 to the counter until it reaches zero again (1355-1375).

A sawtooth waveform, option "4" (1400-1470), is produced by starting TM (1420) at a negative value chosen to give a ramp equally above and below the zero line. The last option "5" (1500-1520) shows a 'clipped' sine-wave, as might be produced by an overloaded audio amplifier. Here the sample point is limited to 85 percent, both positive and

Figure 2.

```
HARMONIC CONTENT OF SQUARE WAVEFORM


HARMONIC       VALUE
 1         *************************************************************
           *
           *
 2         **
           *
           *
 3         *********************
           *
           *
 4         **
           *
           *
 5         *************
           *
           *
 6         **
           *
           *
 7         **********
           *
           *
 8         **
           *
           *
 9         ********
           *
           *
 10        **
           *
           *
 11        ** ****
           *
           *
 12        **
           *
           *
 13        ******
           *
           *
 14        **
           *
           *
 15        *****
           *
           *
```

negative, of its full value. In each case the string variable HD$ is loaded with the name of the waveform which will be used later as a header for graphs.

Having placed one cycle of a periodic waveform in WV it might be useful to print it out, either on the Pet screen or to an external printer. A "YES"/"NO" reply is expected to two questions — "DO YOU WANT A PET GRAPH" (320-340), in which case subroutine 3000 is called; and "DO YOU WANT A PRINTER GRAPH" (350-370), in which case subroutine 4000 is called.

Printing a graph like this is a useful general subroutine. It is unfortunate that two separate subroutines are required, one for the screen and one for the printer, but in Pet Basic it appears to be impossible to use one type of write statement to write both.

Values

The algorithm, however, is the same and remarks about one generally will apply to both. A line-printer graph is most conveniently produced by drawing the Y-axis first as a line across the page or screen. Then, for each point, printing a single character for the X-axis line, a number of spaces, followed by a "*" or some other character to represent the point value. It is also important to 'normalise' the upper and lower limits of the graph to the smallest and largest value in the array of points to be displayed.

Subroutine 4500 places the smallest and largest values to be found in WV into MN and MX. Again the algorithm is a simple and effective one. MN and MX are loaded with the first value in WV — WV(1) (4510-4520). Then the remaining values are checked; if any value is greater than MX it is placed in MX (4540) and if any value is smaller than MN, it is placed in MN (4550).

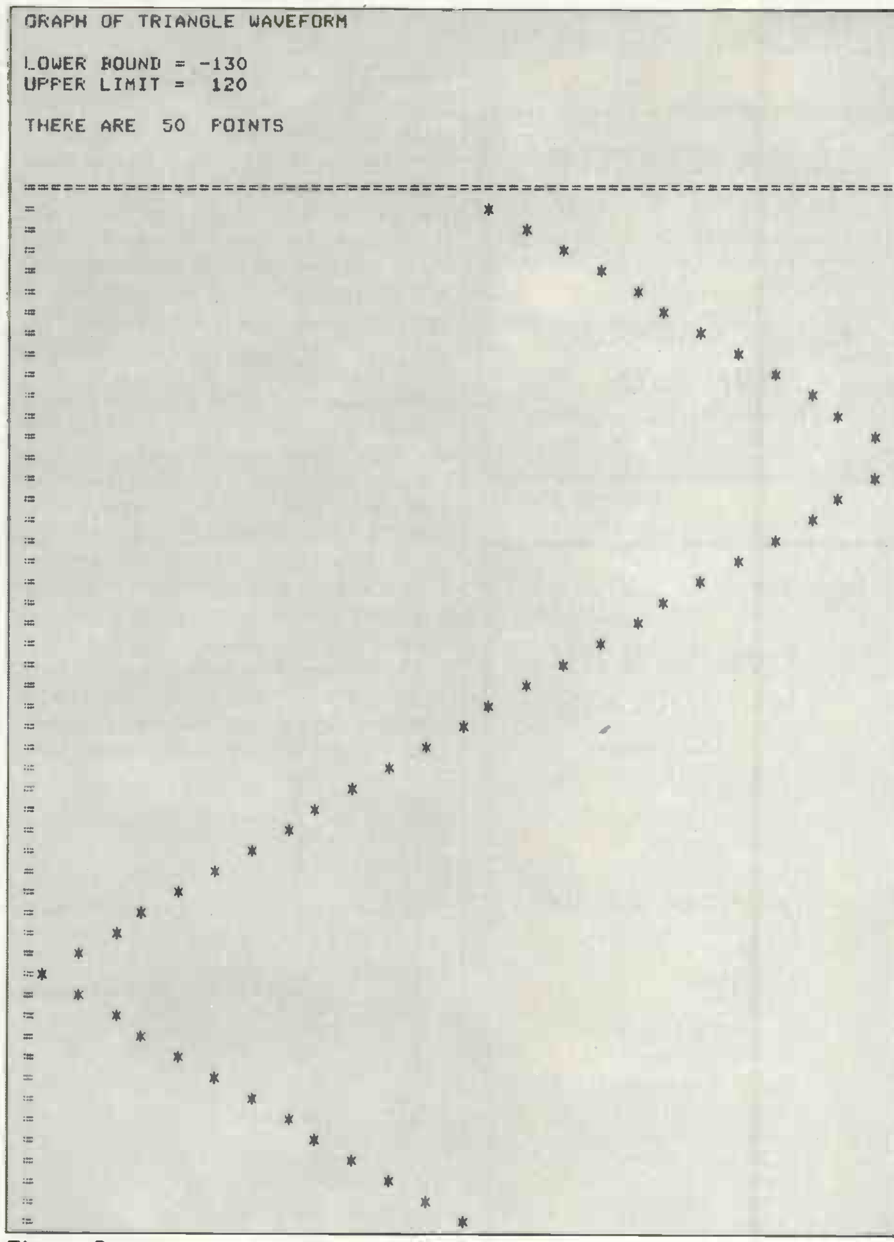


Figure 3.

Both the graph plotting routines first print-out a header consisting of the name of the waveform — from HD$, the upper and lower graph plot limits and the number of points which make up the plot (3030-3050 or 4030-4120). Next a line of 'hash' characters is printed to form the Y-axis line (3060-3090 or 4130-4160).

The line length is fixed at 39 for the Pet as its screen is 40 columns wide, but it will be varied for the printer according to the paper width in use. The column width is stored in the variable PW, which is set initially to 70 in statement 54. One line of output is generated for each waveform point.

TW contains the total width of the plot (3120 or 4190) and each point will be some proportion of this (3130 or 4200). 0.5 is added to the value generated before the function INT() is applied, which has the effect of rounding the value in SP to the nearest integer. This is a useful trick — well worth remembering.

SP contains the number of spaces which must be printed between the X-axis line and the graph point. The PRINT function SPC() can be used on the Pet screen. It moves the cursor X places to the right, and is much faster than printing-out spaces in a FOR-loop.

Due to a Pet Basic bug, referred to in the manual and certainly present in the earlier Pets, in which SPC(O) is incorrectly handled, the special case SP=O must be treated separately (3140-3160 or 4210-4230).

Our Pet-to-printer interface is a microprocessor simulating the IEEE to RS232 converter. It has its eccentricities but it handles the cursor control characters produced by SPC(). If you use an interface which does not map these characters, subroutine 8000-8040 has the same effect, but using space characters.

CH contains the channel number of the IEEE printer. It is set initially to four in statement 16; change this and every instance of the channel number will be altered. As an added precaution against various 'time-outs' in the interface, the channel is opened and closed each time a routine using the printer is called.

It is the statements 400 to 600 which calculate the harmonic content of the waveform. The process is very simple. For each harmonic every point in the waveform is multiplied by a point on a sinewave in the corresponding place in the wavelength, and then by a cosine point.

A cosine wave is always 90 degrees out of phase with a sinewave of the same wavelength — one-half PI radians, a quarter wavelength. The inner loop (480-520) multiplies each point in the waveform by the value a sinewave and a cosine wave would have at that point.

For the first harmonic — the fundamental — there is one complete sine and cosine wave. The products are

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summed into CS and SS. BN is an indication of how much cosine component there is in the waveform at the fundamental frequency, and AN how much sinewave component. Inherent in this pair of numbers is the phase angle, and the harmonic is often interpreted as having so much sine component and so much cosine component. This is sufficient to describe the harmonic completely.

Always positive

Alternatively, we can use the harmonic amplitude — the square root of the sum of these two components squared (HA = SQR (AN*AN+BN*BN)) and the phase angle — the arctangent of AN/BN. The harmonic amplitude will always be positive, as there cannot be less than zero harmonic amplitude. The phase angle will always be in the range of −PI radians to +PI radians.

This process is repeated, so that each sample point is multiplied by points generated as though there are two complete sine and cosine cycles in the wavelength. This gives the sine and cosine components, the harmonic amplitude and phase angle for the second harmonic. Then with three cycles, and four, and so on.

The variable DG is used to determine how many harmonics will be tackled. With DG set to 10 (statement 20) a harmonic series up to one-tenth of the number of sample points will be produced — i.e., five harmonics for 50 points, 15 for 150.

If DG is reduced more harmonics are computed for the same number of sample points. It should not be reduced to one, as then only one point would be sampled in each cycle of the highest harmonic and the result would be meaningless.

The graphs show a sample containing 50 points and the harmonic charts show one containing 150 points. There is no particular reason for this discrepancy, except that it looks better that way.

Distorted

Figure 6 shows what the numeric table output looks like for a clipped sine-wave. Note that although this example contains

Figure 4.

```
HARMONIC CUNTENT OF TRIANGLE WAVEFORM

HARMONIC      VALUE
  1          ***************************************************************
             *
             *
  2          **
             *
             *
  3          ********
             *
             *
  4          **
             *
             *
  5          ***
             *
             *
  6          **
             *
             *
  7          **
             *
             *
  8          **
             *
             *
  9          **
             *
             *
 10          **
             *
             *
 11          **
             *
             *
 12          **
             *
             *
 13          **
             *
             *
 14          **
             *
             *
 15          **
             *
             *
```

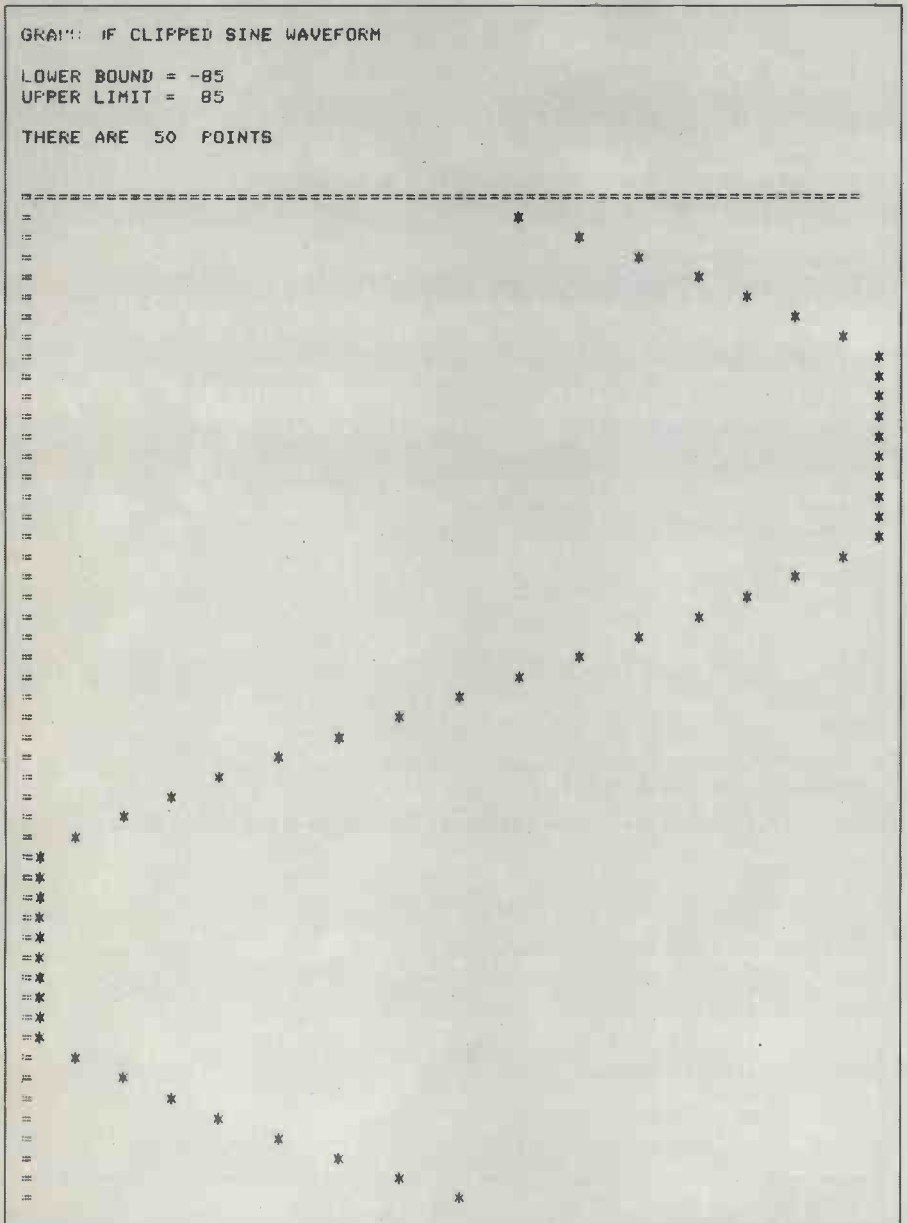

Figure 5.

harmonics, there is no cosine component — they are all very close to zero. This is hardly surprising, as it is only a distorted sine-wave, computed with the Basic SIN() function.

The last stage in the Fourier analysis of the chosen waveform is to print-out the bar chart of the harmonics. Subroutine 6000 displays a series of lines of stars on the screen, one for each harmonic produced. The bars are normalised so that the harmonic with the most power (greatest amplitude) stretches right across the screen and all the others are some percentage of this.

Subroutine 7500 finds the largest value in HB and puts it into MX. HB contains all the values of the harmonic amplitudes, HA, as they are produced. SP contains the number of stars which will represent the harmonic (6030 or 7070). A FOR-loop is set to print-out the stars (6040-6060 or 7080-7100).

The printer routine has a few extra aids to improve the layout. For instance, there are two blank lines between each of the bars, thus increasing legibility many times (7024-7040).

The harmonic number is printed. It is unfortunate that the printer interface did not like the use of a comma as a tabulate function in the PRINT statement. Because of that, subroutine 8100 was written to print a number padded-out to 10 columns with spaces.

This is also something of a cunning trick; convert the number to a string with STR$(), concatenate 10 spaces, and then print only the first 10 characters of the resulting string using LEFT$().

Fourier analysis is used widely throughout the engineering sciences to examine sounds and vibrations. Every building or bridge has its own natural

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```
HARMONIC NUMBER 1
COS COMP=  2.56050262E-07  SINE COMP=  93.2256294
HARMONIC AMPLITUDE=  93.2256294
PHASE ANGLE=  2.74656512E-09

HARMONIC NUMBER 2
COS COMP= -9.71951522E-09  SINE COMP= -1.2501856E-07
HARMONIC AMPLITUDE=  1.2539581E-07
PHASE ANGLE=  .077588509

HARMONIC NUMBER 3
COS COMP=  1.18365278E-07  SINE COMP=  5.28212875
HARMONIC AMPLITUDE=  5.28212876
PHASE ANGLE=  2.24086318E-08

HARMONIC NUMBER 4
COS COMP=  4.56365524E-08  SINE COMP= -1.35236187E-07
HARMONIC AMPLITUDE=  1.42728838E-07
PHASE ANGLE= -.325458277

HARMONIC NUMBER 5
COS COMP=  2.72912439E-08  SINE COMP= -2.98098795
HARMONIC AMPLITUDE=  2.98098795
PHASE ANGLE= -9.15510039E-09
```

```
HARMONIC CONTENT OF CLIPPED SINE WAVEFORM

HARMONIC      VALUE (LOG)

 1            *************************************************************
              *
              *
 2            **
              *
              *
 3            ** *********************
              *
              *
 4            **
              *
              *
 5            ***************
              *
              *
```

Figure 6.

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resonant frequencies, since it is impossible and undesirable to make them totally rigid. Cracks and faults can be detected in such things as pipes and locomotive wheels by the way they ring when tapped.

The defects will cause different harmonics to appear; this is not to say that there are not more direct methods of testing.

High accuracy

An analogue-to-digital converter could be added to this program to enable the user to analyse many waveforms. For instance, the clipped sinewave could have been produced by an audio amplifier under test. It shows that the amplifier has saturated, and has produced harmonic distortion, primarily the odd harmonics. It must be realised, however, that results obtained with these waveforms are an ideal, produced to high accuracy by the internal SIN() function. Real digitisation will upset the results by introducing spurious harmonics.

For those who wish to experiment with the program, try the ramp waveform, since it should contain all harmonics, both odd and even. A pure sinewave will produce only one harmonic bar, at the fundamental frequency.

Try also placing a sheet of transparent graph paper over some oscillograms and inputting some real waveforms using the "O" option.

In a later part of this article some further waveforms will be analysed, including a pulse and pseudo-random noise. Further, having dissected a waveform in this way, it is possible to reconstitute it.

In practice this is like dismantling a complex mechanism — there is always something left over which should have been included. By using only some of the constituent harmonics, the effect of a perfect filter can be investigated. Those familiar with imperfect audio filters will notice the difference. In any case, we will continue to ignore such wonders as the fast-Fourier transform and vast amounts of mathematical theory.

```
10 REM DICTIONARY
12 REM AN - COSINE COMPONENT
14 REM BN - SINE COMPONENT
16 CH=4:REM PRINTER CHANNEL
18 REM CS - SUN OF COSINE
20 DG=10:REM HARMONIC INTERVAL
22 REM DX - SINE INTERVAL
24 REM FG - A FLAG
26 REM HA - CURRENT HARMONIC AMPLITUDE
28 REM HB(NO) - HARMONIC AMPLITUDES
30 REM HD$ - WAVEFORM NAME
32 REM I - LOOP COUNTER
34 REM J - LOOP COUNTER
36 REM K - LOOP COUNTER
38 REM L - LOOP COUNTER
40 REM MN - MINIMUM VALUE IN ARRAY
42 REM MX - MAXIMUM VALUE IN ARRAY
44 REM NO - NUMBER OF POINTS IN SAMPLE
46 REM OP - OPTION SELECT
48 REM P - NUMBER OFHARMONICS
50 REM PA - PHASE ANGLE
52 REM PR - 0 IF NOPRINT, 1 OTHERWISE
54 PW=70:REM PRINTER WIDTH
56 REM SP - SPACE/BAR LEHGTH
58 REM SS - SUM OF SINE LOCATIONS
60 REM TM - TEMPORARY LOCATION
62 REM WV(NO) - POINTS IN SAMPLE
64 REM Y$ - YES/NO OPTION
100 PRINT"FOURIER ANALYSIS PROGRAM"
110 PRINT"======= ======== ======="
120 INPUT"HOW MANY SAMPLE POINTS";NO
130 IFNO>10ANDNO<255THEN155
140 PRINTNO;" OUT OF RANGE - TRY AGAIN"
150 GOTO120
155 DIM WV(NO),HB(NO)
160 PRINT"PLEASE SET OPTION"
170 PRINT"0 - INPUT WAVEFORM FOR ANALYSIS"
180 PRINT"1 - FOR SINE WAVE"
190 PRINT"2 - FOR SQUARE WAVE"
200 PRINT"3 - FOR TRIANGLE WAVE"
210 PRINT"4 - FOR SAWTOOTH WAVE"
220 PRINT"5 - FOR CLIPPED SINE"
250 INPUT"OPTION";OP
260 IF OP<>0 THEN290
270 GOSUB 1000
280 GOTO330
290 IF OP>0AND OP<6THEN320
300 PRINT"NO SUCH OPTION - TRY AGAIN"
310 GOTO160
320 ON OP GOSUB1100,1200,1300,1400,1500
330 INPUT"DO YOU WANT A PET GRAPH";Y$
340 IF Y$="YES"THEN GOSUB3000
350 INPUT"DOYOU WANT A PRINTER GRAPH";Y$
360 IF Y$="YES" THEN GOSUB4000
370 PR=0
380 INPUT"DO YOU WANT RESULTS TO PRINTER";Y$
390 IFY$="YES" THEN PR=1
400 REM DO THE HARMONIC ANALYSIS
410 REM INTERVAL DEGREE
420 P=INT(NO/DG)
430 FOR I=1TO P
440 DX=2*3.14159265/NO
```

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```
450 CS=0
460 SS=0
470 REM THE SUMMATION
480 FOR J=1 TO NO
490 TM=I*J*K
500 CS=CS+WV(J)*COS(TM)
510 SS=SS+WV(J)*SIN(TM)
520 NEXT J
530 REM COSINE COMPONENT
540 AN=2*CS/NO
550 REM THE SINE COMPONENT
560 BN=2*SS/NO
570 REM HARMONIC AMPLITUDE
580 HA=SQR((AN*AN)+(BN*BN))
585 HB(I)=HA
590 REM PHASE ANGLE BETWEEN AN AND BN
600 PA=ATN(AN/BN)
610 PRINT"HARMONIC NUMBER ";I
620 PRINT"COS COMP= ";AN;" SINE COMP= ";BN
630 PRINT"HARMONIC AMPLITUDE= ";HA
640 PRINT"PHASE ANGLE= ";PA
650 PRINT
660 IF PR=1 THEN GOSUB5000
665 NEXT I
670 FG=1
680 INPUT"DO YOU WANT HARMONIC CHART ON PET";Y$
690 IF Y$="YES" THEN GOSUB6000
700 INPUT"DO YOU WANT CHART ON PRINTER";Y$
710 IFY$="YES" THEN GOSUB7000
720 IF FG=0 THEN STOP
730 FG=0
740 INPUT"DO YOU WANT LOG(AMPLITUDES)";Y$
750 IF Y$<>"YES" THEN STOP
760 FOR I=1TOP
770 HB(I)=LOG(HB(I))
780 NEXT I
790 GOTO680
1000 REM INPUT WAVEFORM POINTS
1010 INPUT"NAME WAVEFORM";HD$
1020 PRINT"THERE ARE ";NO;" POINTS TO BE ENTERED"
1030 FOR I=1 TO NO
1040 PRINT"INPUT POINT ";I;
1050 INPUT WV(I)
1060 NEXT I
1070 PRINT"O.K."
1080 RETURN
1100 REM GENERATE SINE WAVE
1110 HD$="SINE WAVEFORM"
1120 FORI=1TO NO
1130 WV(I)=SIN(I/NO*6.28318531)*100
1140 NEXT I
1150 RETURN
1200 REM GENERATE SQUARE WAVEFORM
1210 HD$="SQUARE WAVEFORM"
1220 TM=NO/2
1230 FOR I=1 TO TM
1240 WV(I)=-100
1250 NEXT I
1260 FOR I=TM TO NO
1270 WV(I)=+100
1280 NEXT I
1290 RETURN
```

```
1300 REM GENERATE TRIANGLE WAVE
1305 HD$="TRIANGLE WAVEFORM"
1310 TM=0
1315 FOR I=1 TO INT(NO*.25)
1320 WV(I)=TM
1325 TM=TM+10
1330 NEXT I
1335 FOR J=I TO INT(NO*.75)
1340 WV(J)=TM
1345 TM=TM-10
1350 NEXT J
1355 FOR I= J TO NO
1360 WV(I)=TM
1365 TM=TM+10
1370 NEXT I
1375 RETURN
1400 REM GENERATE SAWTOOTH WAVE
1410 HD$="SAWTOOTH WAVEFORM"
1420 TM=-NO*5
1430 FOR I=1 TO NO
1440 WV(I)=TM
1450 TM=TM+10
1460 NEXT I
1470 RETURN
1500 REM GENERATE CLIPPED SINEWAVE
1520 GOSUB 1100
1530 FOR I=1 TO NO
1540 IFWV(I)>85THEN WV(I)=85
1550 IFWV(I)<-85THEN WV(I)=-85
1560 NEXT I
1565 HD$="CLIPPED SINE WAVEFORM"
1570 RETURN
3000 REM PRINT GRAPH OF WAVEFORM
3001 REM IN WV ON PET SCREEN
3010 PRINT "GRAPH OF ";HD$
3020 GOSUB 4500
3030 PRINT "LOWER BOUND = ";MN
3040 PRINT "UPPER LIMIT = ";MX
3050 PRINT "THERE ARE ";NO;"POINTS"
3060 FORI=1TO39
3070 PRINT "#";
3080 NEXT I
3090 PRINT
3100 FOR I=1 TO NO
3110 PRINT"#";
3120 TW=MX-MN
3130 SP=INT(((WV(I)-MN)/TW*36)+0.5)
3140 IFSP>0THEN3170
3150 PRINT"*"
3160 GOTO3180
3170 PRINT SPC(SP);"*"
3180 NEXT I
3190 RETURN
4000 REM PRINT GRAPH OF WAVEFORM
4001 REM IN WV ON EXTERNAL PRINTER
4010 OPEN CH,CH
4020 GOSUB 4500
4030 PRINT#CH
4040 PRINT#CH
4050 PRINT#CH,"GRAPH OF ";HD$
4060 PRINT#CH
4070 PRINT#CH,"LOWER BOUND = ";MN
```

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```
4080 PRINT#CH,"UPPER LIMIT = ";MX
4090 PRINT#CH
4100 PRINT#CH,"THERE ARE ";NO;" POINTS"
4110 PRINT#CH
4120 PRINT#CH
4130 FORI=1TOPW
4140 PRINT#CH,"= ";
4150 NEXT I
4160 PRINT#CH
4170 FOR I=1TONO
4180 PRINT#CH,"= ";
4190 TW=MX-MN
4200 SP=INT(((WV(I)-MN)/TW*PW)+0.5)
4210 IF SP>0 THEN4240
4220 PRINT#CH,"*"
4230 GOTO4250
4240 PRINT#CH,SPC(SP);"*"
4250 NEXT I
4260 CLOSE CH
4270 RETURN
4500 REM FIND LAGEST (MX) AND SMALLEST
4501 REM (MN) VALUES IN WV
4510 MX=WV(1)
4520 MN=WV(1)
4530 FOR I=2TONO
4540 IFWV(I)>MXTHEN MX=WV(I)
4550 IFWV(I)<MNTHEN MN=WV(I)
4560 NEXT I
4570 RETURN
5000 REM PRINT RESULTS ON PRINTER
5010 OPEN CH,CH
5020 PRINT#CH
5030 PRINT#CH,"HARMONIC NUMBER";I
5040 PRINT#CH,"COS COMP= ";AN;" SINE COMP= ";BN
5050 PRINT#CH,"HARMONIC AMPLITUDE= ";HA
5060 PRINT#CH,"PHASE ANGLE= ";PA
5070 CLOSE CH
5080 RETURN
6000 REM PRINT HARMONIC BAR CHART ON PET
6010 GOSUB7500
6020 FOR K=1TO P
6030 SP=INT(((HB(K)/MX)*38)+0.5)
6040 FOR L=1TO SP
6050 PRINT"*";
6060 NEXT L
6070 PRINT
6080 NEXT K
6090 RETURN
7000 REM PRINT HARMONIC BAR CHART ON PRINTER
7010 GOSUB7500
7020 OPEN CH,CH
7022 PRINT#CH,"HARMONIC CONTENT OF ";HD$
7024 PRINT#CH
7026 PRINT#CH
7030 PRINT#CH,"HARMONIC      VALUE ";
7035 IF FG=0 THEN PRINT#CH," (LOG)"
7040 PRINT#CH
7050 FOR I=1 TO P
7055 GOSUB8100
7060 PRINT#CH,"# ";
7070 SP=INT(((HB(I)/MX)*(PW-10))+0.5)
7080 FOR J=1 TO SP
7090 PRINT#CH,"* ";
7100 NEXT J
7105 PRINT#CH
```

```
7110 PRINT#CH,"           #"
7120 PRINT#CH,"           #"
7140 NEXT I
7150 CLOSE CH
7160 RETURN
7500 REM LARGEST VALUE IN HB TO MX
7510 MX=HB(1)
7520 FOR K=2 TO P
7530 IF HB(K)>MX THEN MX=HB(K)
7540 NEXT K
7550 RETURN
8000 REM PRINT SP SPACES TO THE PRINTER
8010 FOR K=1 TO SP
8020 PRINT#CH," ";
8030 NEXT K
8040 RETURN
8100 REM PRINT NUMBER IN I ON PRINTER
8101 REM IN 10 COLUMNS
8110 PRINT#CH,LEFT$(STR$(I)+"          ",10);
8120 RETURN
READY.
```

Hotting-up in the 16-bit war

THIS COULD well be described as the year of the 16-bit microprocessor with devices due or already available from all the major semiconductor manufacturers. Single-chip 16-bit microprocessors are not, of course, new, since devices like the Texas Instruments 9900 and the General Instruments 1600 have been around for several years. What makes the new devices different is their power and memory addressing capability, writes **Nick Hampshire.**

While the 9900 can address 64K bytes of memory, the Z-8000 can address 8 megabytes. The new devices are the 8086 from Intel, the Z-8000 from Zilog and the MC68000 from Motorola. Of the three devices, the first two are already available and the MC68000 is scheduled for this month.

Intel first

The first of the new 16-bit microprocessors to reach the market was the Intel 8086, which is available both as a component and as a prototyping system (the iSBC 86/12). Probably the most significant feature of the device is its use of dual-processor architecture to produce an advanced pipe-line machine.

Pipe-lining is a process in which the next instruction is fetched while the processor is still executing the previous one. The dual-processor architecture of the 8086 does this by having one processor as the execution processor and the other as the bus interface and instruction fetch processor.

The Z-8000 has just reached the market in volume and is claimed by Zilog to be more advanced than the Intel 8086 — a claim which only time and user experience will verify. There are two versions of the Z-8000. The Z-8002, the smaller version, is capable of addressing directly just one megabyte of memory and the Z-8001 can address a full eight megabytes of memory.

High speed

The Z-8000 is best described as a general register machine, which, like the 8086, incorporates dual processor pipelining to obtain high speed of execution. The processor has 16 16-bit registers which can be subdivided logically into 16 8-bit registers, eight 32-bit registers and four 64-bit registers, giving a high degree of symmetry to the architecture and offering the user great flexibility.

All the 8- and 16-bit registers are general-purpose accumulators and 15 of them can also act as index registers. There are two pairs of stack pointers, one containing the address and the other the segment number.

The reason for two pairs is that the Z-8000 has been designed to support multiprocessing and can run both a supervisor and user program concurrently by using one stack pointer for the supervisor and the other for the user.

There is also a 64-bit status register which contains the flags, control bits and a 32-bit program counter. So that the system can use dynamic memories easily, a rate-programmable refresh counter is included as one of the registers.

There are 115 instructions in the Z-8000 instruction set and, like the 8086, many of them more closely resemble high-level language instructions than those found on the current generation of 8-bit micros.

BUYERS' GUIDE

If a computer has been reviewed by *Practical Computing*, the date of the appropriate issue is indicated.

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Acorn. Single Eurocard-sized microcomputer with 6502 processor, 1KB RAM, 16-way I/O. Max size: a second Eurocard adds hex keypad and CUTS cassette interface. Monitor and machine-code programming now. Basic and disc operating system in the future. "Highly cost-effective basis for a computer or an industrial development system". Available from Acorn (0223) 312772 or Microdigital (051) 236 0707.

£74.75 kit, £86.25 assembled

APPLE COMPUTERS

Apple II. Min size: 16K memory; 8K ROM; keyboard; monitors; mini assembler; colour graphics; Pal card; RF modulator; games; paddles and speakers; 4 demo cassettes. Max size: Expandable to 48K memory; floppy discs and printers are now available. Two versions of Basic, PASCAL; Assembler; games; business packages. An American system regarded as suitable for any kind of applications. Maintenance contracts offered. Personal Computers Ltd (01-283 3391) is the sole U.K. agent but has a distributor network of 20 dealers. (Reviewed July, 1978.)

Around £1,000

ATTACHE

Attache. Min size: system with 10 slots, S100 bus, 8080 processor and 16KB housed in desk-top case with built-in keyboard. Max size: 64KB, parallel printer interface, two single- or double-density 8in. floppies, video screen. Disc Basic; business applications produced by Moncoland, the sole U.K. agent. Distributors include Keen, GBH, Alba, and Lion.

From £1,737. Full business system about £5,000

BRUTECH ELECTRONICS

BEM-CPUI: Single-board processor with 6502 and no RAM. Applications software. Available from Data Precision Equipment (04862 67420). (Reviewed March, 1979.)

£133 exc VAT

COMART

Microbox. Chassis with three to six PCB sockets for S100 boards, plus fan. Several S100 boards available. Aimed mainly at OEM industrial users and perhaps the serious hobbyist. It will take Cromemco, North Star and other processors. Available from Comart (0480 215005).

£255

COMMODORE SYSTEMS DIVISION

Pet. Single unit containing screen, tape cassette and keyboard. Floppy disc, printer and full-size keyboard are options, as are external cassettes. Basic; games; business packages. The British subsidiary of Commodore Systems of the U.S. sells Pet for home, educational and small business applications. About 80 distributors.

£460-£795 exc VAT

Kim-1. processor (6502 chip); small calculator-type keyboard; LED six-digit display; built-in interfaces for audio-cassette and Teletype; 1K RAM; 2K ROM (can add up to 64K). No software available, but it has three good manuals. An American import which gives Pet-type capabilities with a maximum configuration. For the hobbyist but used mainly as an evaluation board for the 6502 chip. Twelve to 15 dealers. (Reviewed October, 1978.)

£99.95

COMPELEC ELECTRONICS

Series 1. Z-80 processor 512MB floppy, 32KB, Centronics printer, VDU. Up to 4MB disc and 64KB. CP/M, Basic, Cobol, PASCAL, Fortran IV, Assembler, Business and word processing packages available. From Compelec (01-580 6296), which is also sole supplier of Altair systems.	*Less than £5,000 for basic system*

COMPUCOLOR

Compucolor II. Packaged system including 13in. eight-colour display with alphanumerics and graphics, 72-key detachable keyboard, 8KB, and built-in mini-floppy. Max size: 32KB. Extended disc Basic in ROM, graphics programs and games. The system now ranks fourth behind Pet, TRS-80 and Apple in personal computer sales. Abacus (01-580 8841) is sole U.K. agent and is arranging distributors, including the Byte Shop and Transam. (Reviewed June, 1979.)	*From £1,390*

COMPUCORP

610: desk-top unit using Z-80 and incorporating screen, 150KB floppy, 48KB. Up to 60KB memory, four floppies, printers. Basic, Assembler, DOS, text editor, file manager; business packages. Nine dealers.	*From £3,890*

COMPUTER CENTRE

Mini kit: Z-80 CPU, CTC, USART, serial and parallel I/O, 16 bytes memory, Western Digital disc controller, SA400 5in. drive plus CP/M, cables and connectors.	*Mini kit: £786*
Maxi kit: As above but with DRI 7100 8in. drive instead of 5in. drive. All (33) volumes of CP/M user group library available for cost of media. Library includes utilities, games. Basic compilers/interpreters and Algol compiler. Microsoft Basic, Cobol, Fortran also available. Computer Centre (02514 29607).	*Maxi kit: £886*

COMPUTER WORKSHOP

System 1. Typical size: 40K memory; dual 8in. floppy discs, total storage capacity 1.2MB; Ricoh daisywheel printer.	*System 1, £5,000 plus; System 2, around £3,000*
System 2. Typical size: 24K memory; dual minifloppy discs of 80K bytes each; Centronics 779 dot matrix printer; VDU.	
System 3. 12K memory, cassette interface; 40-column dot matrix printer. Editors, Assemblers, Basic, games, information retrieval package. The systems were designed and built in Peterborough and are suitable for educational and small business users and perhaps the more serious hobbyist. Twenty-five dealers.	*System 3, from £1,300*

CROMEMCO

Single-card computer. 4MHz Z-80 CPU, S100 bus, 1KB RAM, sockets for 8K ROM. 20mA/RS232 serial interface and parallel bi-directional interface. Basic in ROM and Z-80 monitor. For OEM and industrial users; used with backplane for "full computer capability". Datron Interform and Comart are agents, the latter with 12 distributors. (Reviewed February, 1979.)	*£247-£281*
Z-2. Min size: chassis, 30A power supply, motherboard, Z-80 processor, 16KB memory. Max size: 512KB, 21 sockets, three mini-floppies or four 8in. floppies. Basic, Fortran, Cobol, assemblers. For serious hobbyists, OEMs, educational applications, and industrial/scientific users.	*£372 (in kit form) to more than £4,000*
System Two. Min size: factory-assembled system with 32KB, dual 90K minifloppies, dual printer interface, serial interface. Max size: two additional floppies, 512KB, up to seven terminals. CP/M-compatible operating system (DCOS), Fortran, Cobol, Basic, assemblers, word processing, database manager. Multi-user system for software development, or scientific/industrial/business users.	*£2,294 upwards*
System Two/64. New configuration featuring mini-diskette drives and 64K bytes memory. Software and applications as System Two.	*£3,050*
System Three. Min size: 32KB, dual 256KB floppies, dual printer interface, 20mA/RS232 serial interface, Z-80 processor. Max size: two additional discs, 12KB, seven terminals, multi-channel A/D and D/A interface, PROM programmer. Software as for System Two. Described as appropriate for small to medium business, scientific and industrial users — "rivals minicomputers at more than twice the price".	*£3,444 to more than £10,800*
System Three/64. New configuration featuring dual 8in. diskette drives; Z-80A processor; 64K of 4MHz memory; console and printer interfaces. Macro Assembler, Fortran IV, Extended Basic, Cobol, Multi-user Basic.	*£4,385*

EQUINOX

Equinox 300. Min size: 48K memory; dual floppy discs giving 600K bytes of storage; 16-bit Western Digital m.p.u. Max size: up to 256K memory; up to four 10MB hard discs. Basic, Lisp, PASCAL, Macro Assembler, Text Processor. All software bundled. The system is a multi-user, multi-tasking, time-sharing system for two to 12 users. Application software available for general commercial users. Sole distributors Equinox Computers Ltd (01-739 2387).

£5,000-£40,000 plus

EXIDY

Sorcerer: based on Z-80. 16K and 32K; cartridge and cassette interfaces; 79-key keyboard; 256-character set (128 graphics symbols), 12in. video monitor; expandable with Micropolis floppy discs. Basic, Assembler and Editor; games, word processor. Other pre-packaged programs plus EPROM pack for your own programs on cartridges. Factor One is sole distributor for U.K. (Reviewed March, 1979.)

From £760 without VDU to £1,200 with floppy discs

HEWART MICROELECTRONICS

Mini 6800 Mk II. IK monitor; IK user RAM, IK VDU RAM; CUTS. Upper- and lower-case VDU with graphics option. 128-byte scratchpad; decoder/buffer; power supply; Basic in ROM; monitor command summary, SWTPC programs; Newbear 6800; Scelbi 6800 Cookbook. Markets are small business, education and home user. Cash with order to Hewart. (0625) 22030.

From £127.50 plus VAT

6800S. 16K dynamic RAM; IK Mikbug-compatible monitor; room for 8K Basic in ROM; upper- and lower-case graphics; single floppy disc drive; printer and high-speed tape interfaces. "Mountains of software available." Test tape with CUTS test tones, test message and games with kit.

From £275 plus VAT

DIGITAL MICROSYSTEMS

DSC-2. Min size: 32KB, but 64K standard; Z-80; over IMB floppy disc on two single-sided 8in. drives; four programmable RS232 and one parallel interface. CP/M and Basic included in price. Extended Basic, Fortran, Cobol, text processing, Macro Assembler, Link Loader, business packages and CAP-CPP business software. Add-on rigid disc system (14 and 28MB) available soon. Modata (0892 39591) is sole U.K. distributor; dealers being appointed.

From £4,465

IMSAI

VDP 40: 32K or 64K RAM memory; 9in. display screen, standard keyboard. Two 5¼in. floppy disc drives; serial I/O. Full software support, and packages available for the VDP 42, which has larger disc capacity. Packages for VDP 80 could be converted for smaller systems. This would be from about £700 per package. Two main dealers in the country.

£4,507 for 32K model. £4,950 for VDP 42

ITT

2020. Identical to Apple II. Min. size: 4K memory; 8K ROM; keyboard, monitor, colour graphics, mini assembler; Powell card; RF modulator, games, paddles and speaker; Max size: 48K with floppy discs and printers. Basic, Assembler, games, business packages. Generally suited to any type of application. Fifteen wholesalers, including Fairhurst Instruments.

From £827 to £3,003 for 48K, two floppies and printer

LUXOR

ABC 80. Min size: 35K with keyboard, CPU, 12in. screen and cassette. Max size: 40K RAM with discs. Z-80 processor, loudspeaker with 128 effects, real-time clock. Options: printers, plotter, discs, module cards, digitiser, modem. 60 compatible I/O memory boards. Software: Basic with resident editor; assembler; games; business and educational packages. Personal computer' aimed at home market, small business and education. CCS Microsales is U.K. agent and is looking for distributors.

£795 plus VAT

MICRONICS

Micros. Typical size: IK monitor; 47-key solid state keyboard; interfaces for video, cassette, printer and UHF TV; serial I/O, dual parallel I/O ports; 2K RAM; power supply. 2K Basic; British-designed and manufactured system. Claimed to be the cheapest data terminal – a system with an acoustic coupler and VDU for £1,020. Prospective applications for small businesses, process controllers and hobbyists. Manufacturer is sole distributor (01-892 7044).

From £400, assembled

MICRO V

Microstar. Single box with twin 8in. floppy discs, 64K RAM, three RS232 serial inputs, STARDOS operating system enables system to have three VDUs, plus a fourth job running simultaneously. Word processing software available. Packages being developed include invoicing system, payroll, accountancy type system. Price includes a reporter generator language. Imported by a Data Efficiency subsidiary, Microsense Computers, Microsolve is London agent; other distributors being arranged.

£4,950 machine and software

MIDWEST SCIENTIFIC INSTRUMENTS

MSI 6800. Min size: 16K memory Act I terminal; cassette interface. Max size: three disc systems – minifloppy system with triple drives of 80 bytes each and 32K memory, large floppy system with up to four 312K-byte discs and 56K of memory mounted in a pedestal desk, or hard disc system with 10MB and 56K. Basic interpreter and compiler; editor; assembler; text processor on small disc system. American-designed system being manufactured increasingly in the U.K. Sole U.K. agent is Strumech (SEED) (05433 4321) but a distributor network is being established.

Basic system: £1,100 (£815 as kit); Minidisc, £2,500; floppy disc £3,200; hard disc, £8,000-£12,000

NASCOM MICROCOMPUTERS

Nascom I. Min size: CPU; 2K memory; parallel I/O; serial data interface; 1K monitor in EPROM. Max size: CPU; 64K memory; up to 16 parallel I/O ports. Mostly games, but also a dedicated text editor system written by ICL Dataskil. Nascom is working on large versions of Basic, and 8K Microsoft Basic should be available soon. Eleven distributors in U.K. Nascom is negotiating to increase the number. (Reviewed January, 1979.)

£165 exc VAT

NATIONAL MULTIPLEX

Pegasus. Min size: 48K; Z-80; double-density floppies (320KB); S100 bus; 12in. CRT; 58-key keyboard; two serial and one parallel interfaces; bi-directional printer. Options: 8in. drives; 1-2MB additional drives; digital recorder 9,600 baud. Assembler, Cobol, Fortran, Extended Basic. General business package available as well as text editing and mailing list. All run under CP/M. Suitable for education, business and home users. London Computer Store (01-388 5721) sole supplier.

£2,700 exc VAT

NETRONICS

Elf II: single-board computer in kit form or assembled. RCA Cosmac 1802 processor, hex keyboard, 256 bytes RAM; options include up to 64KB, ASCII keyboard, cassette and RS232 I/O, and video output. Machine code or Tiny Basic. Promoted as a teaching system in minimal form, but expandable for more general use. Sole U.K. distributor HL Audio (01-739 1582).

Basic kit £79.95. Assembled £99.95. I/O board £35

NEWBEAR

7768. CPU board, 4K memory, cassette and VDU interfaces. Range of Basics and games, British-manufactured system for hobbyists. Expandable to 64K memory available only in kit form. From Newbear; also from Bearbag dealers, Microdigital, Microbits.

From £45

NORTH STAR

Horizon. Min size: 16K memory; Z-80A processor, single minifloppy disc drive (180KB). Max size: 56K memory, four minifloppy disc drives (180KB), any acceptable S100 peripheral boards. Basic (includes random and sequential access), disc operating system and monitor. Options: Basic Compiler, Fortran, Cobol, Pilot, PASCAL and ISAM. The system is suitable for commercial, education and scientific applications. Application software for general commercial users. Twenty distributors. (Reviewed April, 1979.)

£995 to £2,500

OHIO SCIENTIFIC

Ohio Superboard II: Min size: 6502 processor, 8K Basic in ROM; 2K monitor in ROM; 4K RAM; Cassette I/F, full keyboard; 32 × 32 video I/F, 8K Basic in ROM; Assembler/Editor; American single-board system with in-board keyboard. Aimed at hobbyist/small business. Ohio makes games, personal maths tutors, and business programs. This and other Ohio products have six U.K. distributors. (Reviewed June, 1979.)

From £298

Challenger C24P: similar to Superboard but with a 32 × 64 character set. Supplied as two separate boards with open slots for expan-

£343 to £1,204

sion. The 'professional portable'; similar to Superboard but packaged and ready to use. Aimed at small business, education, research.

Challenger C28P: similar to 4P but expandable to include two 8in. floppies, allowing use of Ohio software. Personal computer for larger business/commercial programs. Aimed at small business, education and research. — *£435 to £1,900*

Challenger C3. Min size: 32K RAM, dual 8in. floppies, triple processor architecture (6502A, Z-80, 6800). Max size: 768K RAM, 74MB hard disc, multiple terminals, printers. Can run virtually all 6502, 6800, 8080 and Z-80 code. Runs Basic, Cobol and Fortran under OS CP/M. Full business software packages available, including word processing and database management. Multi-programming available. — *£2,450 to £13,000*

PERTEC

System 1300. Min size: 32K memory; dual minifloppy discs 71 bytes each, formatted; serial interfaces. Max size: 64K memory; four serial ports. Basic (single and multi-user), Fortran, Cobol. The hardware for Compelec Altair systems is from Pertec but the software is Anglo-Dutch. Sole distributor Compelec (01-580 6296). — *£3,000-£5,500*

PROCESSOR TECHNOLOGY

Sol. 808-based S100 microcomputer packaged with cassette and video interfaces (including graphics), keyboard with numeric pad, and 16KB RAM. Basic, assembler, word processors. Floppy disc systems available. Several distributors including Comart (0480 215005), which can offer nationwide maintenance contracts. (Reviewed July, 1979.) — *From £1,750 (excluding monitor and cassette). Complete floppy disc systems with word processing about £5,000*

RAIR

Black Box. Min size: 32K memory dual minifloppy discs, 80K bytes each; two programmable serial I/O interfaces. Max size: 64K memory; eight serial interfaces; IMB disc storage (or 10MB hard disc); range of peripherals. Basic, Fortran IV; Cobol. Hardware distributors are being signed and agreements made with software houses to add software. A warranty and U.K.-wide on-site maintenance is given. From manufacturer (01-836 4663) and systems houses. — *From £2,300*

RESEARCH MACHINES LTD

380-Z. Min size: 4K memory; 380-Z processor, keyboard, Max size: 56K memory. Options: cassette, single or dual minifloppy discs, dual 8in. double-sided discs (IMB); serial interfaces; parallel interfaces; analogue interface; printer available. Basic Interpreter, Z-80 Assembler; interactive text editor: terminal mode software; data logging routines; CP/M, DOS, text processor, CBasic, Fortran, Algol, Pilot, Cobol, CP/M users' club library. Sold principally to higher and secondary education, and for scientific research, data processing and data logging. Available from Sintel and the manufacturer. (Reviewed December, 1978.) — *From £830-£3,500*

280-Z. Board version of 380-Z system, 4K or 32K (identical in performance to the 380-Z). Interfaces, software as for 380-Z. — *4KB version at £398; 32KB for £722*

RCA

Cosmac. 1802 micro with hex keypad and output to TV screen. Assembler and machine code programming; options include Tiny Basic. Available by mail order from HL Audio (01-739 1582). — *Kit £79.95. Assembled £99.95 exc VAT*

ROCKWELL

Aim-65: Kim-compatible with full keyboard and on-board printer. IK or 4K RAM. The 4K version is described as a development system rather than a personal computer. Assembler, editor. Basic. Available from Pelco and Microdigital. (Reviewed July, 1979.) — *IK – £249.50; 4K – £315*

SCIENCE OF CAMBRIDGE

Mk14: SC/MP processor, 256 bytes user memory; 512-byte PROM with monitor program; hex keyboard and eight-digit, seven-segment display; interface circuitry; 5V regulator on board. To this can be added: ¼K RAM (£3·60); 16 I/O chip (£7·80); cassette interface kit (£5·95); cassette interface and replacement monitor (£7·95); PROM programmer (£9·95). No software provided but a 100-page manual includes a number which will fit into 256 bytes covering monitors, maths, electronics systems, music and miscellaneous. Based on American National Semiconductor chips. Science will soon have a VDU interface and large manual on user program- — *£39.95 basic* ming. Mail order from manufacturer (0223 312919) and by selected dealers. (Reviewed May, 1979.)

SDS

SDS 100. Single unit containing 32K memory (expandable to 46K); up to 8K PROM; twin double-sided floppy disc drives of 500 bytes each, serial and parallel RS232 interfacing; keyboard; 12in. video display; power supplies; SD monitor program; line printer available. CP/M, 8080 assembler, E Basic, Editor supplied with system; M Basic, Fortran, Cobol available for business use, industrial process monitoring and control (with additional hardware). All CP/M games and business packages. Sole supplier Airamco (0294 65530). — *From £3,750*

SEMEL

Semel 1. Min size: 4K with CPU, keyboard and monitor. Max size: 64K with single floppy disc unit, printer, VDU and keyboard. Can be coupled to any external device and controls up to 8×250K floppy disc units. Four configurations available. Options: Light pen attachment; 12V DC power supply; remote terminals. Software: Editor, Assembler, debug, full file-handling capabilities in Basic. Fortran and Cobol available on 64K machine; user-defined programs written and compiled by agreement; word processing. General-purpose unit for use as a terminal controller. Suitable for small business and OEMs. Available from Semel exclusively (0822) 5439. — *£1;950 with Basic*

SORD

M100. Min size: 16K RAM; 4K ROM monitor; full keyboard plus function keypad; two-channel joystick dual cassette I/F; 11K EBasic on cassette; video; graphics; printer; S100 bus; converters; speaker; 24-hour clock. Max size: 48K RAM; 8K ROM; black and white or colour graphics; mini-floppy discs. Suitable for OEMs, small business, education, laboratory and scientific and home computing. Main distributor is Dectrade, but for London and South contact Midas Computer Services (0903) 814523. — *From £726*

M222. Min size: 64K RAM; VDU; full keyboard; numeric keypad; graphics; real-time clock; 70K minifloppy disc drive; audio cassette interface; two serial ports; programmable 110 to 9,600 baud; three S100 slots; power and interface for two external minifloppy drives; ROM bootstrap. Max size: 70K byte minifloppies; black and white or colour graphics; bar code reader; TMS-1000 development system. EBasic interpreter; compiler EBasic; matrix Basic; Fortran; Cobol; assembler editor; re-locatable linker/loader; debugger. Application software includes word and graphics processor; business demonstration packages and games. — *From £3,450-£4,123 including desk and printer*

M223. Min size: 64K RAM; hardware as M222 plus one or two 350K byte minifloppy drives. Max size: Four 350K minifloppies; up to four 11.4Mb hard discs; range of S100 devices. As M222 plus Cobol-80, CAP-CPP BOS MicroCobol. Application software includes word and graphics processor; personal information processing system; games; CAP-CPP range of MicroCobol software. — *From £3,775-£4,448*

SYNERTEK

Sym 1: 6502 chip and keypad with memory available in 4K blocks to 64K. Any Kim software. American, meant to be the foundation system for very small business and hobbyist users. Available from Newbear (0635 49223). — *From £200*

TANDY CORP.

TRS-80. Min size: Level I 4K memory; video monitor; cassette; power supply. Max size: Level II 48K up to 350K on-line via floppy discs; line printer; tractor feed printer and quick printer; floppy disc system. Modern, telephone interface soon available. Basic; some business packages. Level I aimed at the hobbyist and education market and Level II at small business applications. Hundreds of dealers. (Reviewed November, 1978.) — *Level I – £499; Level II – from £578-£4,700*

TRANSAM COMPONENTS

Triton: British-made kit computer. Up to 65KB. Full graphics capability, 64 characters. Power supply; cabinet. Communications interfaces. Tiny Basic or 2K Basic, IKB monitor plus new option 4K firmware on board. Available from manufacturer. (01-402 8137). — *£286 kit with 5KB*

VECTOR GRAPHIC

48KB RAM, Z-80 micro: 63K bytes, mini-discs are standard, Options: graphics. Monitor, MDOS, Basic; business packages from dealers. Several distributors. — *£2,300*

SHOPWINDOW

MICRO ADS

are accepted from private readers only, pre-paid and in writing, 20p per word, minimum charge £2.

For sale two months' old, hardly-used Pet 32KN new QWERTY board personal computer, including two cassette tapes and many programs. Price asked £790 — contact Mr. Gregory, Tel: 01-940-3930.

Expand KIM.4K board (2114). Fully socketed and tested. Plugs on to KIM. £55. S. Ramsbottom, 20 Roydene Rd, Plumstead.

For sale. Tandy TRS-80 Level 2 4K. Perfect condition. Little used. £500. Buyer collects. Phone: Gillingham 31757 (code Medway).

For sale — Data Dynamics Teletype KSR-33 in excellent condition, £350. Also keyboard in plinth, £20. Call 01-894-3761.

A PRACTICAL GLOSSARY

Continuing the terminological gamut from M to N

Microcomputer
Really it's a small computer. Look at the glossary reference to "C" and check what we wrote there on *computer* — a computer is more than just a *processor*. It's a functioning whole with I/O and some storage capability as well. So microcomputer includes a microprocessor but it involves enough extra equipment to be usable — like a VDU, floppy discs, memory and perhaps a printer.

Microinstruction
One statement of microcode.

Microprocessor
The $64,000 definition. What exactly is a micro? Simple; it's a central processor — a programmable, electronic, logic-driven, rule-following idiot.

Microprogram
A bunch of microinstructions.

Microsecond
One-millionth of a second, usually abbreviated as μ (μ being one of those Greek symbols mathematicians use which typewriter manufacturers do not include on typewriters). Incidentally, you might see "μp" used: it's a witty shorthand for microprocessor.

Millisecond
One-thousandth of a second, abbreviated as ms.

Minicomputer
A small computer. Nobody really has a better definition so here's a pragmatic one. A minicomputer — colloquially a mini — is a small computer which is not a micro and which is made and sold by a company interested in volume production and low overheads. A mini is sold as a system component, usually in quantities larger than one and without the noisy support, software, customer service people, pamphlets, manuals and prices of the mainframe computer vendors.

The mini makers want volume sales and high turnover; their profit margin per machine is small, so they want to sell plenty. Micro manufacturers take the same line.

By contrast, the mainframe makers sell comparatively few high-cost systems; they make their high profits per sale by all the extra services, products and general support provided with the computer.

MITS
The personal computer business really got under way late in 1974 with an unlikely parent. MITS was Micro Instrumentation and Telemetry Systems, a small company in the southern United States which began life in 1969 making electronic control systems for model rockets but moved to $199 programmable calculators in 1971.

In 1974, MITS put together a microcomputer kit and featured it in a U.S. magazine *Popular Electronics*. The technical editor persuaded MITS to look for a catchy name, and his daughter offered "Altair" — she derived it from the TV as *Star Trek* was showing.

MITS sold the 8080-based Altair kit for $398 and expected 800 orders in 1975. In fact, it sold 1,500 in two months.

MITS and Altair effectively defined the home micro market. MITS was sold to Pertec two years later and the Altair name is now being submerged under newer product developments.

Mnemonic
A memory aid. So mnemonic code is an assembly language code in which the instruction names are easy to remember, like MPY and for multiply STO for store — and ADD for add, too.

Monitor
The kid who used to look after the milk at school. Also the most basic kind of operating system; we treat it as being synonymous with *executive*.

MOS
Metal Oxide Semiconductor. A number of semiconductor technologies are used in micros but this is the most widespread. It is a fairly obvious way of manufacturing integrated circuits by using metal for the electrical conductor and laying it on an insulating layer of silicon oxide.

The two popular alternatives to MOS are bipolar semiconductors and SOS — silicon-on-sapphire. MOS is king at the moment — cheap and simple to manufacture and to use. The availability of MOS made *LSI* possible.

MOSFET is an IBM version of MOS; don't worry about it, though.

MPU
Motorola abbreviation for microprocessor unit, now used widely to mean "microprocessor".

MSI
Medium Scale Integration. See *LSI*.

MTBF
Mean Time Between Failure. As an indication of reliability, an MTBF figure — given usually in hours — can be useful to someone who wants maximum performance, though you have to be careful about what exactly has been measured and in what circumstances.

MTTR
A much less-frequently-quoted statistic, the Mean Time To Repair.

Multi-access
A multi-access system is one several users can access at the same time. The term is usually associated with time-sharing — organising the resources of the computer so that all users have a bite at the cherry — and multi-programming — so that several users can run different programs concurrently.

Multidrop
You probably won't ever hear this term. Generally, each peripheral — printer, disc drive, VDU — is connected to the computer by a cable. A multidrop line is something like an electricity line, in that several different units can be connected to it. So several VDUs, say, can be connected to a computer but take up only one I/O port.

Of course, this requires some clever internal extras, notably an operating system which can decipher which terminal wants to do what. If you are sitting at a multidropped VDU and you want to call-up the *Practical Computing* index to check back references, the computer will require some means of identifying you as the recipient of the index rather than any other terminal on the line.

Multiplex
Another term the personal computer user will rarely encounter. Multiplexing is using one communications channel to send several messages at the same time. What happens is that individual messages are chopped up and the pieces interleaved in a single long message. You need a special hardware item called a multiplexer (or multiplexor) to do this. At the other end of the link you need another to decode the chopped stream and re-assemble it into several messages.

It means you can economise on transmission line charges, because if you have eight 30 cps terminals you would be paying for eight 300 baud lines; multiplexing allows you to have all that traffic on to one 2,400 baud line.

Multipoint
Synonym for multidrop.

Multiprocessor
Obviously a bunch of linked processors. There is much to be said for this, particularly for throughput reasons — each processor runs one part of the system or one part of a program, so there's no waiting; and for improved reliability, things might be set up so that if one processor fails another can take over without interruptions.

A number of the cleverer microcomputers use two processors, one to handle data into and out of floppy disc storage while the other runs programs. Normally a single-processor system has to stop executing program instructions while it looks after a transfer of data to or from disc.

Multiprogramming
Multi is almost as popular a prefix as micro, isn't it? Multiprogramming is a clever way of obtaining as much work as possible from the computer. It means the operating system can run two or more programs at the same time, switching from one to another and giving each a few milliseconds of operation.

Multiprogramming becomes very complicated, though. The operating system has to be able to decide on an order of priorities for programs and the actions they will want to perform. It must also watch that programs do not over-write any of each other's workspace. It has to make the best possible use of memory by detecting when one program is finishing and perhaps loading another from disc into the memory space thus vacated. And so on.

That means full-blown multiprogramming operating systems tend to be too complex, too expensive, and too big to run economically on micros. Some microcomputers allow a limited kind of multiprogramming, with an interactive foreground program (some use of a VDU, typically) going on at the same time as a background batch job (like printer output).

MUX
Abbreviation for multiplexer.

Mylar
A trade name for a polyester film used widely as the base for magnetic tape. It can be coated with magnetisable particles.

NAK
Ephemeral mid-60s play and film. Whatever happened to Anne Jellicoe? Still, that one had a "c". This one is "negative acknowledge", an *ASCII* (qv) character code sent between computer and terminal to indicate that some duff transmission has occurred.

Nanosecond
One billionth of a second. That's a U.S. billion, which, by the way, is the one we prefer — it's 1,000,000,000, or 10^{-9}.

National Semiconductor
One of the giants in the U.S. electronics business, a $500 million company which makes most of its money from bulk manufacture of semiconductor components like

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(continued from page 129)
computer memories. It also makes some microprocessors, notably the SC/MP micro the Science of Cambridge MK14 uses.

Needle
Remember the discussion of matrix printers? Impact matrix printers build a character by firing metal pins against a ribbon, so that a dot is transferred on to the paper. Using the correct dot positions gives you a recognisable character, even if it is not in proper joined-up writing. Those metal pins are also called needles, funnily enough, and some people speak of "needle printers" to mean an impact dot matrix mechanism.

Network
A network is any system comprising a series of interconnected points. So a TV service with local stations connected, by signals, to a central service is a good example. In computing generally, a network is either a number of terminals connected to a computer, or it is a number of computers connected together.

That second definition is the more usual one. Networks are complicated technically, since there are all kinds of traffic control and routeing considerations, apart from what is actually being sent. Network control usually involves add-on black boxes and complex special software, though, so that the user does not have to do too much of the network management.

A few systems are now appearing allowing inter-connection of micro computers — your Pet can talk to someone else's TRS-80 over telephone lines, if you have the proper connectors. A more usual configuration would probably be a bunch of computers all sharing each other's local storage, or local peripherals, and this, too, is becoming possible now.

For instance, you could load a program on your computer, send it to another computer, and run it there. Or you could pick up information stored on another computer's discs or cassette files and use it in your own program. You'll probably have to know the correct passwords and access codes, of course.

Say you have a cheap computer with no printer, you might want to dump a load of program listings quickly to give yourself a paper copy of your programs. So how about this for a scenario? You send a message to every other computer in your friendly neighbourhood network saying: "Does anyone have a fast printer doing nothing?" Someone answers "Yes", plugs in the printer, and you can run a little code dump program which prints its output on that friendly faraway printer. The results arrive in the post next morning.

NMOS
Also N-channel MOS, a type of MOS (qv) used widely in microprocessors and other electronics circuits. We're not going to tell you exactly how it differs from PMOS, an earlier technique for making MOS circuits but, in general, NMOS is faster, although PMOS can usually put more circuits on to a chip.

Noise
The otherwise indefinable and thankfully sole quality shared by the St. Matthew Passion and the Bay City Rollers — and transmission lines, for noise is unwanted electrical signals on a cable or some other connection. Since computers work electrically, a spurious electrical effect of some kind can cause errors; an extra amount here or there will totally destroy the meaning of a single-character code, and misapprehension of a single character can affect the computer's comprehension of a whole message.

Noise is unavoidable in all electrical circuits. It's a property of all materials, including those used to make computers, that they will generate a certain amount of electrical activity on their own. Generally, though, the signals being generated and passed around in a computer system are powerful enough, and the receiving ends sensitive enough, to separate the desired signals from the dross.

Non-volatile
Some types of memory lose their contents when you turn off the power; that's because they need a permanent electric current so that they can hold information. Because switching-off loses contents, they are termed *volatile*.

This doesn't happen with non-volatile memory because those devices don't store information by requiring a constant source of electricity.

Examples are discs and tapes, which work by altering the magnetic characteristics of the medium; this alteration is done electrically but once that has happened, the whole thing is only encoded *magnetically*. This also applies to some types of internal memory, notably core and ROM. The one big advantage of core memories is that their contents aren't lost when you switch off.

By contrast, the semiconductor MOS memories used normally these days in computers are volatile. MOS has many advantages over core, though, notably its speed; reading and writing information is much faster with MOS; its heat output — MOS runs much cooler, so reliability is better; and its cost — MOS is already much cheaper and it's becoming even more so.

ROM (read-only memory) is the other significant form of non-volatile storage. These are semiconductor chips with data sealed-in.

Diary

September

●3-5 **Computer Appreciation.** Venue: London. An introduction to computers – what they are, what they do, how they do it. The three-day course is organised by Control Data Institute, 77-79 Wells Street, London, W1. Fee: £180.

●10-11 **Computer appreciation for beginners.** Venue: Worthing. Very basic introduction, designed apparently for those involved in clerical systems which may be computerised. Fee: £190. Organised by MSS, 18A Chapel Road, Worthing, Sussex.

●10-12 **Technology Employment Education International Conference.** Venue: Southampton University. The topic is changing technology and our future and constitutes "an exploration of the consequences of fast-changing technology upon our education and work". Each day there will be a separate examination of industry, education and Government policies on employment. The list of speakers includes Basil de Ferranti and Barrie Sherman (ASTMS). Each day costs £40 (non-residential) or £75 (residential). It is sponsored by the Southern Science and Technology Forum and registration forms can be obtained from that organisation at Building 25, The University, Southampton. Tel: 559 122, ext. 2430.

●11-13 **Electrical & Electronics Exhibition.** Venue: Exhibition Centre, Bristol. This is the second year Exhibitions for Industry has run this show and there will be more than 100 exhibitors displaying electronic equipment and microcomputers. Entry is free. More information from Exhibitions for Industry Ltd, 157 Station Road East, Oxted, Surrey. Tel: 988 4373.

●12-13 **User Involvement in Computing.** Venue: London. An introduction for non-data-processing staff who will be involved with computer systems. The fee is £175 and the course is organised by Learmonth Burchett Management Systems.

●18-19 **Microprocessors.** Venue: London. Unequivocal if somewhat general title for this two-day introduction. These seminars promise a non-technical introduction plus a look at applications in "business, industry, government and education". Speakers are promised from manufacturers, consultancies and users. The fee is £78 and the seminar is organised by Informex, 61 Harland Avenue, Sidcup, Kent.

●17-21 **Microcomputers for the Uninitiated.** Venue: London. This five-day course is aimed at industry, management and people "with a wide range of backgrounds". It is designed to give an insight into what a microcomputer is, covering the basic principles of languages and programming, binary counting, memory, CPU storage, addressing systems and 8080 instruction sets. There is a good deal of practical work in the course and each delegate has his own I/O device and microprocessor. The fee is £125, to include refreshments, lunches and course material. Further information from the Course Co-ordinator, Babcock Controls Training College, 165 Great Dover Street, London, SE1. Tel: 01-407 6373.

●24-28 **Microprocessor-based Equipment Design and Development.** Venue: Sevenoaks, Kent. This five-day residential course is intended for project managers and engineers concerned with incorporating microprocessors into measurement and control equipment. It covers design methods and good practice, development procedures, development aids and how and where to obtain further help. The fee is £480 plus VAT, which includes accommodation, course documentation and full board. Further information from Sira Institute Ltd, South Hill, Chislehurst, Kent. Tel: 01-467 2636.

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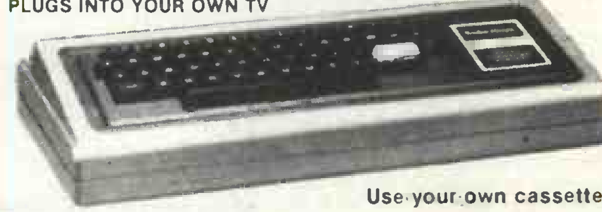

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