Artificial Intelligence
Cell Scanning

Eurapple v. ITT
2020

Triton Review

Self-testing micro
Sample catalogue prices:

- System Two computer: £1995
- System Three computer: £3293
- Z-2H computer: £4996
- Extra 64K memory: £893
- 3101 visual display unit: £1147
- 3355 daisywheel printer: £2297
- HDD 11-mbytes hard disc: £4022
- ANSI Cobol compiler: £55
- ANSI Fortran IV compiler: £55
- 16K extended Basic: £55
- Word processing system: £55
- Database management: £55
- Macro relocating assembler: £55

Prices exclude VAT and delivery.

MicroCentre also supply peripherals, applications software, and multi-user timesharing systems; a PROM programmer; analogue-digital interface; and much more. On site maintenance can be arranged throughout the UK.

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Complete Micro Systems Ltd.
132 St. Stephen Street,
Edinburgh EH3 5AA.
Tel: 031-225 2022.
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SOFTWARE

This is how your business appears on the screen.
Approx 60 entries update require only 1-2 hours weekly and your entire business is under control.

* PROGRAMS ARE INTEGRATED
1 = ENTER NEW NAMES/ADDRESSES
2 = ENTER/PRINT INVOICES
3 = ENTER PURCHASES
4 = ENTER A/C RECEIVABLES
5 = ENTER A/C PAYABLES
6 = ENTER/UPDATE STOCKS REC'D
7 = ENTER ORDERS REC'D
8 = EXAMINE/UPDATE BANK BALANCE
9 = EXAMINE SALES LEDGER
10 = EXAMINE PURCHASE LEDGER
11 = EXAMINE INCOMPLETE RECORDS
12 = EXAMINE PRODUCE SALES
SELECT FUNCTION BY NUMBER
13 = PRINT CUSTOMER STATEMENTS
14 = PRINT SUPPLIER STATEMENTS
15 = PRINT AGENTS STATEMENTS
16 = PRINT QUARTERLY TAX STATEMENTS
17 = PRINT WEEK/MONTH SALES
18 = PRINT WEEK/MONTH PURCHASES
19 = PRINT YEAR AUDIT
20 = PRINT PROFIT/LOSS ACCOUNT
21 = UPDATE ENDMONTH FILES
22 = PRINT CASHFLOW ANALYSIS
23 = ENTER PAYROLL
24 = RETURN TO BASIC

WHICH ONE (ENTER 1 TO 24)

EACH PROGRAM GOES IN DEPTH TO FURTHER EXPRESS YOUR REQUIREMENTS.
FOR EXAMPLE (9) ALLOWS: a. list all sales; b. monitor sales by stock code; c. invoice search; d. amend ledger files; e. total all sales.

BUSINESS PROGRAM VERSION 1 ............... £275
(VERBOSE SIMPLE LANGUAGE AND UNITARY FILE HANDLING)

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• PET 2001 SERIES
  PET Computer 2001 32K ............. £795
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  Hazeltine 1510 .................... £895
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  Soroc IQ120 ....................... £695

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  Teletype 43 Printer .............. £895
  Centronics 779 Printer .......... £950

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PRACTICAL COMPUTING December 1979
Super software from the world's leading microsoftware supplier.

DIGITAL RESEARCH

- CP/M* FDOS - Diskette Operating System complete with Text Editor, Assembler, Debugger, File Manager and system utilities. Available for wide variety of disk systems including North Star, Heios II, Micropro, IOM (all systems) and Altair. Supports computers such as Sorcerer, Horizon, Sol System III, Versatile, Altair 6800, COMPAL-80, DYNABYTE D802, and IOM Attachte. Specify desired configuration. £75/£15

- MAC - 8080 Macro Assembler. Full Intel macro definitions. Pseudo Ops include IRC, IRP, REPT, TITLE, PAGE, and MACLIB. Z-80 library included. Produces Intel absolute hex output plus symbols file for use by SID (see below) £55/£10

- SID - 8080 symbolic debugger. Full trace, pass count and break-point program testing system with back-trace and history of program. When used with MAC, provides full symbolic display of memory labels and equalized values £45/£10

- TEX - Text formatter to create paginated, page-numbered and justified copy from source text files, directable to disk or printer £45/£10

- DESPOOL - Program to permit simultaneous printing of data from disk while user executes another program from the console £30/£7

MICROSOFT

- Disk Extended BASIC - Version 5, ANSI compatible with long variable names. WHILE, WEND, chaining, variable length file records £155/£15

- BASIC Compiler - Language compatible with Version 5 Microsoft interpreter and 3-10 times faster execution. Produces standard Microsoft relocatable binary output. Includes Macro-80. Also linkable to FORTRAN-80 or COBOL-80 code modules £185/£15

- FORTRAN-80 - ANSI 66 (except for COMPLEX) plus many extensions. Includes relocatable object compiler, linking loader, library manager with. Also includes MACRO-80 (see below) £205/£10

- COBOL-80 - ANSI 74 Relocatable object output. Format same as FORTRAN-80 and MACRO-80 modules. Complete ISAM, interactive ACCEPT DISPLAY. COPY EXTEND facilities £325/£15

- MACRO-80 - 8080/Z80 Macro Assembler. Intel and Zilog mnemonic supported. Relocatable linkable output. Loader, Library Manager and Cross Reference List utilities included £75/£10

- EDIT-80 - Very fast random access text editor for text with or without line numbers. Global and intra-line commands supported. File compare utility included £45/£10

XITAN (software requires Z80** CPU)

- Z-TEL - Text editing language. Expression evaluation language for text and commands. Command macro strings can be saved on disk for re-use £40/£12

- ASM Macro Assembler - Memonics per Intel with Z-80 extensions. Macro capabilities with absolute Intel hex or relocatable linkable output modules. New version 3 with added features £40/£12

- LINKER - Link-edits and loads ASM modules £40/£12

- Z-BUG debugger - Trace, break-point tester. Supports decimal, octal and hex modes. Disassembler to ASM mnemonic set. Simulation technique permits full tracing and break-point support through ROM £45/£12

- TOP Text Output Processor - Creates page-numbered, justified documents from source text files £40/£12

- A4 package includes Z-TEL, ASM. LINKER, Z-BUG. TOP £155/£30

EIDOS SYSTEMS

- KISS - Keyed Index Sequential Search. Offers complete Multi-Keyed Index Sequential and Direct Access file management. Includes built-in utility functions for 16 or 32 bit arithmetic, string integer conversion and string compare. Delivered as a relocatable linkable module in Microsoft format for use with FORTRAN-80 or COBOL-80, etc £65/£15

- K BASIC - Microsoft Disk Extended BASIC with all KISS facilities. Integrated by implementation of nine additional commands in language. Package includes KISS.REL as described above, and a sample mail list program £495/£30

MICROPRO

- Super-Sort I - Sort merge, extract utility as absolute executable program or linkable module in Microsoft format. Sorts fixed or variable records with data in binary, BCD, Packed Decimal, EBCDIC. ASCII, hexadecimal, character, field justified, etc. etc. Even variable number of fields per record £125/£15

- Super-Sort II - Above available as absolute program only £105/£15

- Super-Sort III - As II without SELECT/EXCLUDE £75/£15

- Word-Master Text Editor - In one mode has super-set of CP/M's ED commands including global searching and replacing, forward and backwards in file. In video mode, provides full screen editor for users with serial addressable-cursor terminal £75/£15

- Word-Star - Menu driven visual word processing system for use with standard terminals. Text formatting performed on screen. Facilities for text justify, page number, locate center, underscore and PRINT. Est facilities include global search and replace, read write to other text files, block move, etc. Requires CRT terminal with addressable cursor positioning £225/£15

GRAFFCOM SYSTEMS

- PAYROLL - Designed in conjunction with the spec for PAYE routines by HM Taxes. Processes up to 250 employees on weekly or monthly basis. Can handle cash, cheque or bank transfer payments plus total tracking of all year to date figures. Prints emp master, payroll log, payslips and bank giro. Requires CBASIC-2 £475/£15


- COMPANY PURCHASES - Performs purchase accounting function. Controls invoices, credit notes and cash transfers. Delivered as complete, string integer conversion and string compare. Delivered as a relocatable linkable module in Microsoft format for use with FORTRAN-80 or COBOL-80, etc £65/£15

- STOCK CONTROL - Designed in conjunction with the spec for IN. Controls invoices, credit notes and cash transfers. Delivered as complete, string integer and string compare. Delivered as a relocatable linkable module in Microsoft format for use with FORTRAN-80 or COBOL-80, etc £425/£15

- ORDER ENTRY & INVOICING - Performs order entry and invoicing function. Handles invoices for services and consumable items. Sales Analysis report shows sales movements and trends for user-defined period. Interfaces with Stock Control, NAD and Company Sales systems. Requires CBASIC-2 £325/£15

- NAD - Complete control of all your names & addresses including suppliers, clients, enquirers etc. Assign your own coding system and select all output via the report generator. Will print anything from mailing labels to directories. Requires CBASIC-2 £225/£12

PRACTICAL COMPUTING December 1979
SOFTWARE SYSTEMS

- CBASIC-2 Disk Extended BASIC — Non-interactive BASIC with pseudo-code compiler and runtime interpreter. Supports full file control, edit, search, change, and protected precision variables etc. £75/£10

STRUCTURED SYSTEMS GROUP

- QSORT — Fast sort/merge program for files with fixed record length, variable field length information. Up to five ascending or descending keys. Full back-up of input files created. Parameter file created, optionally with interactive program which requires CBASIC. Parameter file may be generated with CP/M assembler utility £50/£12

GRAHAM-DORIAN SOFTWARE SYSTEMS

- APARTMENT MANAGEMENT SYSTEM — Financial management system for receipts and security deposits of apartment projects. Captures data on vacancies, revenues, expenses etc. for an annual trend analysis. Daily report shows late rents, vacancy versus income lost through vacancies, etc. Requires CBASIC. Supplied in source code £300/£25

- INVENTORY SYSTEM — Captures stock levels, costs, sources, sales, ages, turnover, markup, etc. Transaction information may be entered for reporting by salesman, type of sale, date of sale, etc. Reports available both for accounting and decision making. Requires CBASIC. Supplied in source code £300/£25

- CASH REGISTER — Maintains files on daily sales. Files data by sales person and item. Tracks sales, overruns, refunds, payouts and total net deposit. Requires CBASIC. Supplied in source code £300/£25

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

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

- When purchased with CIS COBOL £55/£12

OTHER

- tiny C — Interactive interpretive system for teaching structured programming techniques. Manual included 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 specification. Documentation includes C Programming Language book by Kernighan & Ritchie £65/£10

- ALGOL 60 Compiler — Powerful block-structured language featuring economical run-time dynamic allocation of memory. Very compact (24K total RAM) system implementing almost all Algol 60 report features plus many powerful extensions including string handling direct disk address (40) etc. Requires 28K CPU £110/£12

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

- Z80 Debugger — Trace, break and examine registers with standard Zilog/Mostek mnemonics/assembly displays. Facilities similar to DDT. £20 when ordered with Z80 Development Package £30/£7

- DISTEL — Disk based disassembler to Intel 8080 or TDL X816 Z80 source code. Listing and cross reference files. Intel or TDL-X816 pseudo ops optional. Runs on 8080. Standard CP M and TRL-80 CP/M versions available £35/£7

- DISLOG — 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 inclusion 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 byteste, rotate and shift, and to test and set bits. Available in Integer, Extended and ROMable versions. £165/£15

- Extended Disk or Extended ROMable £215/£15

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

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

- Selectors 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 3741 volume, display directory information and edit the data set contents. Provides full file transfer facilities between 3741 volume data sets and CPM files £125/£7

- Flippable Disk Kit — Template and instructions to modify single sided 5¼" diskettes for use of second side in single sided drives £6

Orders must specify disk type and format e.g. "Norm Star Horizon single density"
Add VAT to orders for software purchase. Add 50p per item postage and packing (minimum £1)
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The sale of each proprietary software package conveys a license for use only on one system four times.
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- 16K RAM board (expandable to 32K).
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The Nascom 2 kit is supplied complete with construction article and extensive software manual for the monitor and BASIC.

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- 16K RAM board (expandable to 32K).
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- 1K Video RAM.
- 1K Workspace/ User RAM.
- Main board sockets for the 8x4118s or 2708 EPROMs.

**NASCOM HARDWARE**
- Motherboard: £5.50 + VAT + 50p P+P
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- VERO DIP board: £10.50 + VAT + 50p P+P

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- 10 line print buffer.
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Plastic Print Wheels IBM etc. £5.95
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Accessories and cables available for use with PET/SORCERER/TRS-80 (with or without expansion interface) APPLE/IT/O/RL380Z etc., etc.
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daissywheel printer £2,115

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Panel 108
PRACTICAL COMPUTING December 1979

DPS-1 MAINFRAME
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.

SOFTWARE for your S100 system
PASCALIZ The new language for Micros
CPU Version £165.00 (6¼” or 8”)
K2 Version £131.25 (8”)

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
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<td>Z80 CPU (2 mhz) including 2708 and power on jump</td>
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<td>Z80A CPU (4 mhz) including 2708 and power on jump</td>
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ROMS

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<tr>
<td>Introduction to Pascal</td>
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<tr>
<td>Algorithms Plus Data Structure = Programs</td>
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<td>Microprocessor/Microprogramming Handbook</td>
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<td>Structured Design</td>
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PET

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<tr>
<th>Model</th>
<th>Price</th>
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<tbody>
<tr>
<td>Pet Bk</td>
<td>£550</td>
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<td>Pet 16k</td>
<td>£675</td>
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<tr>
<td>Pet 32k</td>
<td>£795</td>
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<td>2nd Cassette</td>
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Disk Units

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<tr>
<td>Computhink 400k</td>
<td>£796</td>
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<tr>
<td>to fit 16/33 Pet (direct fitting)</td>
<td>£640</td>
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<tr>
<td>Memory Expansion</td>
<td>£168</td>
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<tr>
<td>24k Exandamem for Pet</td>
<td>£320</td>
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<tr>
<td>Interfaces</td>
<td>£89</td>
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<tr>
<td>Bi-direct I-EEE to RS232</td>
<td>£140</td>
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<tr>
<td>Bi-direct 2 ported I-EEE to RS232</td>
<td>£175</td>
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<tr>
<td>A/D Converters</td>
<td>£130</td>
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<tr>
<td>AIM 161 16 channel A/D converter for Apple, Am, Nascom etc</td>
<td>£168</td>
</tr>
<tr>
<td>Petset A, AIM 161 including all interfacing requirements for Pet</td>
<td>£168</td>
</tr>
<tr>
<td>Stack Peripherals</td>
<td>£25</td>
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<tr>
<td>Stack Joystick a balanced, calibrated unit supplied with software and examples of use, complete</td>
<td>£25</td>
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</table>

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<table>
<thead>
<tr>
<th>Model</th>
<th>Price</th>
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<tbody>
<tr>
<td>Apple II (colour) 16k</td>
<td>£885</td>
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<td>Apple plus (6k/w) 16k</td>
<td>£830</td>
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<tr>
<td>ITY 2000 (colour) 16k</td>
<td>£850</td>
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<td>16k RAM upgrade</td>
<td>£85</td>
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<td>Printer Card</td>
<td>£110</td>
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<td>Communication Card</td>
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<td>High Speed Serial Card</td>
<td>£110</td>
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<tr>
<td>Disk Drive with DOS</td>
<td>£225</td>
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<td>Extra Disk Drive</td>
<td>£375</td>
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<td>Diskettes (10's)</td>
<td>£30</td>
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SORCEROR

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<td>Sorceror 16k</td>
<td>£750</td>
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<td>Sorceror 24k</td>
<td>£850</td>
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<tr>
<td>AIM 65 (NASCOM)</td>
<td>£249.45</td>
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<td>KIM I</td>
<td>£168</td>
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<td>MANUALS New Pet user manual</td>
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<td>6500 Programming manual</td>
<td>£8</td>
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<td>6500 Hardware manual</td>
<td>£8</td>
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PRINTERS

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<td>Teletype 43 pinfeed RS232</td>
<td>£860</td>
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<td>friction RS232</td>
<td>£888</td>
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<td>pin and friction RS232</td>
<td>£920</td>
</tr>
<tr>
<td>Anadex DP8000</td>
<td>£875</td>
</tr>
<tr>
<td>Perkins Elmser Pussycat CRT copier</td>
<td>£839</td>
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<tr>
<td>Also Centronics Range, Texas Instruments, Lear Siegler</td>
<td>£875</td>
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<tr>
<td>Ring us for a quote on individual models</td>
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(All paper add £5 carriage per box)

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Comuthink £30 per 10
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Horizon £30 per 10
Sorceror £30 per 10

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<th>Model</th>
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<tr>
<td>Pet User Port/I-EEE Port</td>
<td>£1.10 each</td>
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<td>Pet 2nd cassette Port</td>
<td>£85 each</td>
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<tr>
<td>Hoods for User/I-EEE connectors</td>
<td>£3.25</td>
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<tr>
<td>D.25 RS232 Connectors (State Male or Female)</td>
<td>£0.00</td>
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<tr>
<td>D.25 Hoods</td>
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- Full set of utilities
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Zilog UK Ltd, Babbage House, King Street, Maidenhead, Berks. Tel: Maidenhead (0628) 36131. Telex: 848609.

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Welcome to tomorrow’s world

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PRACTICAL COMPUTING December 1979

Circle No. 177
A crowd of peasants with clogs

THROUGHOUT recorded time there has been no man more disliked than the inventor of new ways of doing things. Old ways might not be brilliant, citizens of the more solid kind tend to say, but they work. New ways could be disastrous. So, when the young say, "Dad, why don’t we ...?", those citizens sigh.

For some reason this almost immutable law of nature has been suspended over the last 200 years. So frayed has it now become that people advertise themselves as ‘innovative’, a term which in more conservative periods would have right-thinking persons looking for six feet of stout rope and a convenient branch.

No-one has more immunity from this natural law than computer people. Although the advantages of data processing are very real in business, banking, insurance and the distributive trades, they are more advertised than perceptible to the man in the street.

So far, if anything, computers have been a nuisance. Now, the microchip revolution promises to make them a menace. The immunity the computing profession has enjoyed for 20 years from serious public criticism may well be about to end. As is foreshadowed in the title of this piece, a crowd of peasants with clogs is gathering with a glint in their collective eyes.

The first protagonists of computers could see very clearly that such machines would, potentially, abolish almost all jobs which require a modest amount of routine skill. That it has taken almost 40 years to make this foreboding come true is a testimony to the amount of skill needed for even the simplest-looking job. Now, that bastion is crumbling. Advances in software and the rapid growth of computing power on chips threaten a large number of jobs by the end of the next decade.

It is odd that people outside computing can visualise it much more clearly than those inside. If you say to the majority of computing professionals that the chip may destroy life as we know it, they smile pityingly and say that, on the contrary, the spread of automation will increase jobs.

In the short term, they are correct. It is all very much harder work than people outside can guess, but in the long term the professionals are wrong and the lay persons are right, because the effects multiply each other. If anyone who knows something of computing were asked, say, to automate an office, he would decline because he knows that the vast amount of work needed on word processing, storage, communication, display.

That reaction overstates the difficulties. The new armies are converging on the office from a dozen different directions. Yearly, huge advances are made in data storage and retrieval. Advances are being made in providing digital exchanges, satellites, high-speed cables. Display devices are improving vastly. Thousands of people are at work on graphics and linguistics, on intelligent databases and printers.

All those advances are like rival guerilla bands creeping-up on an enemy stronghold, under cover, up separate valleys from separate directions. You could stand on the ramparts of the threatened fortress and see only a wisp of smoke from a camp fire on the horizon. The fullness of the threat is known to no single person because the simultaneous assaults are being made by autonomous bands who may well be almost unaware of each other’s existence. Yet, one day, they will all meet at ‘Fort Office’ and abolish it.

The peasants quietly till the fields around the protective castle know that the woods are full of bandits. The bandits know only how small is their band and how far they have to go. The peasants are correct when they slip off their clogs and hold them by the heel, when they pick up rocks from the fields and look around for a target.

The campaign is not fought in one fell swoop. It has already started. One of the first bands of peasantry to take the threat seriously was the ASTMS — Association of Scientific Technical and Managerial Staffs — whose members, one might suppose, to be towards the forefront of the threat.

The union’s argument is simple. The days when fears of unemployment caused by computing could be discounted have definitely vanished. The lengthy and impassionate discourse on a document — Technological Change Employment and the Need for Collective Bargaining — gives many examples of employment erased by automation.

Phillips expects to have to reduce its near half-million workforce by a half in 10 years. Western Electric, the main American supplier of telephone exchanges, expects to reduce its labour from 39,000 in 1970 to 17,400 in 1980. As many as 128,000 workers in the U.S. car industry will lose their jobs by 1985. The Japanese Methodology for Unmanned Manufacture factory could use a control crew of 10 to do the work of 700. Although British industry lags behind, and perhaps just as well in many ways, examples are quoted from the insurance industry of staff savings between 30 and 70 percent.

Some industries are so mechanised already that they cannot be automated — for instance, farming. Yet there is little doubt that the ASTMS predictions of 3.8 million people unemployed in Britain by 1985 and 5.2 million by 1991 are of the right sort of magnitude.

Many of the promised benefits of the chip can only be good. The abolishment of dirty, dangerous and, above all, boring work must be an advance for civilisation. The difficulty is the speed with which change happens. A generation of workers lasts 40 years. In that time an industry can disappear and another take its place without too much strain. Perhaps, if society made a determined effort, we could cope with major change over 20 years. If, by some malign miracle, all the wonders the chip promises were installed by the end of next week, the effect would be worse than World War III.

What compounds our problems is that we are competing with societies which take much a tougher line about social dislocation. Some countries could if its workers out of a job, they are invited to leave, and if they try to return with sabots in their hands, intending to deal with the offending machinery in the time-honoured way, the army will stop them — dead, if necessary.

In Britain, we are used to a much gentler level of industrial strife. We opt almost automatically for the soft solution, for industrial inefficiency rather than para-military riot police and barbed wire in the streets.

It is one of Britain’s admired assets. It is difficult to see how we can retain it while automating our production industry to compete with tougher and cheaper nations. Rather, we should adopt a higher strategy. We should tolerate a level of industrial inefficiency in our manufacture to make the transition easier, while concentrating our efforts on the crucial technology.

The American system has proved to be a great success in creating hardware. Computing power is no longer a problem; the IBM 370 on a chip is a realistic target by 1990. The problem now is software, the skill to blend that computing power with the incredibly complex traditions of politics, business, language, in living societies. There the Americans may be at a disadvantage, and the Eureopeans, with our older and subtler social skills, find ourselves to the fore.

There are certainly huge opportunities, particularly, one would imagine, for the kind of people who read this magazine but let us be warned by ASTMS that the peasants are gathering, watching, weighing their sabots in their hands. We must all be very careful.
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Feedback

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.

Magic square

My "PROCESSOR" is a humble TI 59 calculator—I don't have a printer—and the noughts and crosses programs are beyond its capacity. About two years ago, soon after I bought the calculator, I decided to try to create a noughts and crosses program. The key to this I found in a simple mathematical model for the game. I have no way of knowing whether this is an original idea.

Thinking of the game I realised its structure and winning forms corresponded exactly to a 3 x 3 "magic" square. As shown, I chose a square using the numbers one to nine.

The winning lines all add up to 15. So I program the calculator to search for lines adding up to 15 and to block any moves of its opponents.

So far I have programmed the calculator to play first. The first few moves are rather predictable, of course, and I have programmed it to start on the centre square—the calculator displays 5 for this. My move is made by keying-in the number corresponding to the particular square in which I wish to put my 0. I have biased the second move—for the calculator—for the corners, which you will notice are all even numbers, a property which is useful later in the program.

Although the first few moves are somewhat boring, once the game develops the calculator searches for numbers needed to make its stored moves up to the "magic" 15. If this is not possible it blocks its opponent's move. You must always be careful that the move the calculator produces has not already occurred, of course.

I won't go into all the details of my program, but using this basis I expect sophisticated programs may be produced for many types of processor.

I believe that this type of program has important lessons for those in the Artificial Intelligence field. To start, it uses patterns which are already part of the calculator logic—the numbers 1 to 9, simple addition, subtraction and comparison. The human brain, emulation of which is the goal, has its own parameters, but many of them are visual patterns which a computer cannot understand without digitisation and interpretation.

In this noughts and crosses program, I have replaced the visual pattern of a line with the numerical pattern, those numbers adding to 15.

Possibly more work should be done into defining rigidly what basic patterns the brain uses. When they are found, the search for mathematical substitutes should begin, thus enabling a machine to "think" like a human.

Although I know very little about the study of the operation of the mind, I think that the basic patterns found will be mostly visual, like the line idea in noughts and crosses. It was Einstein who said he thought in pictures and I believe it will be shown that we all do. For the human brain, the number is the abstraction for the computer, the visual must be.

Baldur Van Lew, Newtownards, Co. Down.

Apple discs

You malign the Apple II DOS 3.2 in your October review; there is no problem with multi-file access. The misconception is that PRINT D "WRITEFILENAME" should be associated with PRINT D "OPENFILENAME" in the program sequence. Rather, it should be placed immediately before the INPUT or PRINT statements which read or write a line or record.

It is advisable to follow the statements by PRINT DS. In this way any number of files may be referenced and interleaved with keyboard input, screen printing, hard copy printing. DOS ensures that only the logically necessary physical reads and writes are performed.

The following program will write records consisting of single strings to files A and B. Each file is deemed to contain no more than 101 records of length 10 bytes. The keyboard input determines which file and which record each string is written to.

```
10 CLS
20 PRINT D$"OPENA.LIO";
30 PRINT D$"OPENB.LIO"
40 PRINT D$"OPENC.LIO"
50 INPUT "FILE A OR B? ":IFS: IF FS ("A" OR FS) "B" GOTO 200
60 INPUT "RECORD NO.? ":RI: IF R (0 OR R>100) GOTO 200
70 INPUT "TEXT" :IFS: IF LEN (IFS) THEN GOTO 200
100 PRINT D$"WRITE" :IFS: R:R:REM SWITCH ON WRITE-TO-FILE & STATE RECORD number
110 PRINT A$:REM WRITE RECORD
120 PRINT B$:REM SWITCH OFF WRITE-TO-FILE
130 GOTO 40
200 PRINT D$"CLOSE"
```

John Kilpatrick, Sheffield.

Happy customer

Feedback is on occasions critical of suppliers. Perhaps my experience is more typical but of the kind which does not usually inspire a letter.

I ordered a Superboard II by telephone on a Friday, asking for it to be modified to 30Hz standard, fitted with modulator, and supplied with a power pack. It was delivered personally the following Wednesday and the proprietor of the firm spent some two hours checking that it worked in all modes, and fixing a fault on my cassette recorder—dirty heads. Because the company was out of stock of power packs, I have a very expensive-looking one on loan from the service department.

Having made a tape of a Starwars game for my 12-year-old, the supplier insisted that I telephoned if I had any problems. He then explained that the price had gone down since I placed my order, so the bill was less than I had anticipated.

My thanks to CTS of Littleborough, and to Practical Computing Shopwindow, where I saw the advertisement.

As far as the Superboard is concerned, I have found the problems in your review are almost irrelevant. I can't see why I should want to dump at less than full screen width. CTS supplies a subroutine to get round the problem anyway. I can debug happily with a few stop statements.

I'm no enthusiast for machine code when I have 8K of Basic. I am still astounded at how easy and versatile it is to use, and at the price I can not see any competition.

John Freeman, Stockport.

Birth problems

I am surprised that there were no comments in your October issue on John Dodridge's program (Tandy forum, September) presenting a programming solution to the "Birthday problem".

While Dodridge's program is neat and elegant, it indicates one reason why software producers are so often criticised—it produces the correct answer to the wrong problem.

This is because the problem is badly written.

(continued on page 55)
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I have a new/old ROM PET

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PRACTICAL COMPUTING December 1979
formulated. The program solves the problem for the situation where we are seeking to calculate the probability of at least two people having the same birthday — excluding the year of birth — not the probability of two people having the same birthday.

In probability theory, the word "two" means "exactly two", not "at least two".

The logic of the difference between the two formulations, and its effect upon the mathematical solution of the problem, is found in most standard texts on probability theory.

Additionally, the assumptions made in the solution should be made explicit. Thus, it is important to state that it is assumed that there are no seasonal fluctuations in the birth pattern. It would also have been better to use the term 'birthday' rather than 'birth date'. The latter is an unused expression which implies the inclusion of the year of birth — which is specifically excluded from the problem — whereas the former more often than not, includes the year of birth.

Clive Loveluck, Director, Ulster Management Centre, Co. Antrim.

Time to blush

THE BENEFITS I've received from my subscription to Practical Computing have been more tangible than enjoyable reading. Your reviews of small systems on the market are generally packed with useful information, and were a great help to me when I decided to buy a microcomputer. It was a simple matter to peruse all your back issues to decide which system suited my needs. Perhaps the way I purchased the system would interest you.

Having decided to buy a TRS-80, I found that the price in Israel of a system with Level II Basic and 16K RAM was about twice the price of the same system in England, or roughly three and a half times the price in the States. So I decided to import a system privately from the States. That is how the fun began.

Knowing next to nothing about electronics, it was an unpleasant surprise to find that I could not use the system in Israel, because of the difference in line frequencies — in Israel (as in England) the frequency is 50Hz, as opposed to 60Hz in the States. Radio Shack sells only 60Hz VDU monitors outside the States, and even buy buying a system in England and thereby paying double import duties — British and Israeli — I would still have saved several hundred dollars on the local price.

Not wanting to waste my limited budget on unnecessary taxes, I decided to buy only the keyboard in the States with Level II Basic and 4K, which cost me $450, a 16K upgrade kit for $100 — not from Radio Shack — and a UHF modulator and 220V power supply in England.

Taxes here on microcomputers were about 50 percent, and, after all the expenses, I paid roughly half the local price. To cure the slight "video shakes" caused by using 60Hz equipment with a 50Hz TV, I intend performing either the minor surgery described in September's Tandy forum, or to buy the modification from Comp Computer Components for £7.50.

The point I am making is that contrary to what the importers would have us believe, American equipment will often run on European current with slight — often very slight — modification.

Another point: recently I had the wonderful opportunity of some hands-on experience on three systems — Apple, Pet and TRS-80. The impression I received was that the disc drives supplied by Radio Shack worked considerably slower than those I used with the Pet, besides the fact that storage capabilities of the Radio Shack drive are nowhere near those the Pet used.

I am glad to see that there are now other drives on the market suitable for use with the TRS-80, which greatly increase storage capabilities of the latter, especially since the DOS and other necessary software — e.g., disc basic — take up over 30K, leaving you with a mere 55K of storage space on the first Radio Shack drive. With the new, better drives, that problem would seem to cease to exist. Still, it would be pleasant to have the DOS in ROM.

R. Schreiber, Jerusalem, Israel.

Ellipses

REFERRING to the reply to Paul Benham's letter concerning the simulation of comet orbits on a computer screen, a slight misunderstanding seems to have arisen — Feedback, September, 1979.

Tingey makes the statement that to draw an ellipse or circle it is necessary to use Lissajous figures. That is not so. Although it is possible to use this method it would be just as effective as a visual aid to use the high-resolution graphics capabilities of many of the present microcomputers, e.g., Apple II, TI 99/4, Computor. It is not too difficult to deduce equations of the form

\[
\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1
\]

which can then be plotted as a graph on the screen.

The real difficulty arises when trying to simulate an orbit at the actual speed or scaled-up speed. This is certainly possible with a real-time clock and high-resolution graphics but Tingey would certainly be hard put to modulate the speed of an oscilloscope trade at the required speed.

If Benham wishes to deduce suitable equations for this, may I suggest the book Teach Yourself Dynamics.

Finally, for anybody interested in comparison of prices here and in the States of microcomputers, may I point out that the proposed British price of approximately £700 for the TI 99/4 is about four times the predicted price TI was to charge ($300) to $500 according to the September magazine. For anybody who might point out that this was for a different model, this U.S. price was indeed for the monitorless console as it will be sold in the U.K.

P. J. A. White, Harpenden, Herts.

Noughts and crosses

I was fascinated by the article and program of Trevor Lusty on Artificial Intelligence. As I have a Pet (8K) I found a certain difficulty in getting the program to print. The following slight alteration may help others:

3600 PRINT LR ("two options") 3710 PRINT.
3710 PRINT 'Mat Print', which Pet does not have.

J. Patterson, Leeds.

RE Trevor Lusty's learning programme, I found the main ideas very interesting and the presentation clear. Surely, however, line 2340 and 3660 should read:

2340 LET T2 = T2 + T1 (*C10 (6-ZN1) for pattern no.
3660 PRINT LR (ML): add 3710 PRINT.
Line 3710 'opens' the square somewhat.

The idea is from Donald Alcock's Illustrating Basic on his page 98 when explaining the long way around 'Mat Print', which Pet does not have.

Kieran Lundy, Scarborough.

No sorcery

IN RESPONSE to your Editorial 'The Real World' (September), I would like to inform you of some of my experiences with an Exidy Sorcerer 32K. I am writing to state that this is an excellent machine which lines up to its title of 'computer'. I say this having had seven years' experience, programming in Basic on the Harfield Polytechnic Digital 10.

The Sorcerer was bought with the intention of developing an interactive engineering analysis program, using graphics. This has so far been its almost sole use.

The 32K memory proved more than adequate for a program which was large, and also required many variables.

It is easy to plot graphs to the full screen resolution (512 X 240) provided only one dot is required per character location.

The Basic compiler lacks certain features found in other versions - user functions are only single variable; no print formatting; no statement to output to a printer. This results in printouts which

(continued on page 57)
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PRACTICAL COMPUTING December 1979
Star-Trek veracity

NOT MUCH to do with micro-computing but we were fascinated by a paper in the Journal of the British Interplanetary Society Vol 36, pp99-104, 1977; Detection of Starships by D R J Viewling et al. The authors look at different types of starships and the chances we might have of spotting them and conclude that "No matter how awesome the starship might be in a terrestrial context, it is in its own environment — interstellar space — virtually invisible."

Perhaps authors of future Star-Trek programs might like to take these considerations into account?

From Newcastle

THE NEWCASTLE PERSONAL COMPUTER Society sent us its newsletter — well-produced and interesting. Computer freaks in the north-east might find it worth contacting the society. If, that is, they can find someone to contact.

It seems to be a rule of small newsletters not to give a contact address or telephone number. Editor P Scargill, however, incautiously admits in one issue to the telephone number North Shields 73905.

Computers in schools

COMPUTERS IN SCHOOLS is the new title of the journal of MUSE, the national body for co-ordinating interest in mini and micro computing in secondary education. We were delighted to receive the September issue with its new format, new publishers (Longmans) and new editor, Bryan Speelman, who writes in this issue on the rivalry between the Eurapple and the ITT.

Computers in Schools is available at £1.25 per issue from Charles Sweeten, the honorary secretary of MUSE, at 18 South Road, Oundle, Peterborough.

TV challenge

HAVING WORKED as an electronic engineer in the television industry for the last 13 years, I cannot allow your article (October, 1979) on David Graham's work to go without comment.

A number of staggering generalisations were made which can only mislead. The reference to portable TV cameras and recorders presumably refers to ENG/EFP equipment which, while it certainly has a place in journalism, can in no way replace existing equipment without substantial a lowering of technical standards.

Those of us who have seen programmes originated in Italy, the U.S. and the like, using these techniques would be horrified to see this appear on U.K. TV screens. I could be the first to agree that over-manning occurs in the TV industry but that is a union problem rather than a technical one.

Computers are making significant inroads into TV studio technology, perhaps too slowly, but computer-controlled lighting grids, switching matrices and vision mixers exist and it is not the engineers who are 'knocked-out', as Graham suggests, but the production staff.

J. Hill

Criticisms

THERE HAS been much at fault with every issue of Practical Computing. Readers may well be contemplating spending hundreds, or even thousands, of pounds on a microcomputer and might expect from such a publication informed, professional advice, and accurate, responsibly-presented reviews and information.

Unfortunately, the advice, information and reviews are not only often inaccurate but are nearly always very much out-of-date. We appreciate you are trying to keep up with a very fast-moving industry and that such a task is not easy, although the American publications seem to manage very well indeed, but there is no excuse for unreasonable and misleading reviews and unhelpful and misinformation.

The over-all impression is one of a publication prepared not only for amateurs but also by amateurs.

To illustrate our criticisms we could use almost any review of hardware, software or documentation which has appeared but we have chosen a recent example — the review of Robert Rogers' The Users' Guide to North Star Basic, which appeared in the October 1979 issue, to highlight the apparent lack of knowledge and experience on the part of your reviewers and which typifies the misleading information given to readers.

In the paragraph 'Secrets', your reviewer says "... how to print to an external printer in Basic (sic), a procedure which we (who?) regard as a flaw ion the North Star Basic." For the benefit of readers not familiar with North Star Basic I feel that it is very important to draw to their attention the versatility and sophistication of the North Star's implementation of the PRINT statement, a versatility and sophistication not found in the Microsoft Basic implementation.

In North Star Basic, to print to any port, the appropriate format is PRINTfi, where i = 0, may be abbreviated to PRINT0.

The North Star Basic implementation of the PRINT statement has the versatility necessary for sophisticated software. And, of course, is detailed in the North Star Basic manual.

It is also stated that "... data files ... must be created and/or deleted when in DOS." This is not true. These functions have been implemented in versions of North Star Basic obtainable in this country since the end of 1978, if not earlier.

The conclusion states: "There is a lack of good North Star documentation ..." This is also untrue. Excellent manuals have been supplied by North Star since 1978 and have been readily available in this country for about eight or nine months, thus making Rogers' book unnecessary for all except those with no computing experience.

I hope that there are drastic improvements in the quality of material appearing in Practical Computing in the next few months. Such improvements are urgently needed.

Andrew Ward
Hotel MicroSystems Ltd
Londo, N18 1PN

Feedback

- It is easy to make sweeping criticisms of incompetence and difficult to refute them in detail.

In this case, our review of Rogers' book concerned the book, not North Star Basic. Let us assume for the moment that Rogers was wrong about the points to which Ward takes exception. Surely, if someone who has written a book about this implementation of the language can be incorrect, then the ordinary reader should be aware of difficulties which may be in store?

Graham says, and he probably does not mean it as a compliment, that Practical Computing gives the impression of being prepared 'by amateurs'. To a large extent that is true and we are not shy about it. In the flood of computing power micro have released, almost all are amateurs.

An amateur readership needs an amateur magazine. We are baffled by the same things as you; we are pleased by the same successes as you are. If the readership wished for a magazine run by omniscient professionals who never make a mistake, there are others from which to choose. They, presumably, do not choose such a magazine because they know they would not learn much from it.

Ignorance is a journalist's main stock-in-trade — knowledge is his enemy. He should know very slightly more than his readers and that only because he learned it yesterday. By tomorrow he will have passed on the knowledge and all will have the same level of knowledge, or ignorance.

If in the process we mislead you occasionally, we are sorry. We also mislead ourselves.
How to make your ideas turn to money

AS THE National Research and Development Corporation celebrated its birthday, the Corporation was criticised by New Scientist for its lack of support for the small inventor, including those who have new ideas for microprocessor applications.

A reply by the chairman of NRDC has been circulated, stating: "Money by itself may often be of no real value to a small inventor. Someone once said that offering money to a small inventor is like giving a bottle of chilled champagne to a man dying of thirst in the Sahara Desert. In his desperation to open the bottle, our thirsty man breaks off the neck, spills half the wine, cuts himself badly and, having consumed the balance of the wine, is thirstier than ever half an hour later".

In the last seven years 6,600 applications have been received. Of those, 44 were considered worth backing.

New disc family

MEMOREX CORPORATION has announced the first in a planned family of 8in. rigid disc drives. They have more than seven times the capacity of the largest floppy disc drives in the same space.

Known as Model 101, the new drive features 11.7 megabytes of fixed storage capacity on two discs. It has been designed for OEMs and includes the usual advantages of 8in. disc technology, including reduced package size and less head mass.

It also has a number of new features, including a direct drive spindle motor. By incorporating the motor with the hub, Memorex engineers have managed to eliminate belts, brackets and side-loaded bearing wear.

First shipments of the 101 will not start until the first quarter of next year, when it should be available for $1,560 in quantities of at least 100 units. Memorex U.K. Ltd is on Staines (0784) 51488.

Minifloppy for Pet

ACT PETSOFT has entered the hardware market with a double-density minifloppy system for the Pet. Developed by the Californian company Compu/Think, the Petsoft professional disc system will aimed at business users. It is available in two configurations which offer either 400,000 or 800,000 bytes of storage online. Prices start at around £800.

Although double-density floppies have a reputation for unreliability, Act Petsoft says: "We've moved one hundred units in the last month and we had no complaints."

The disc operating system is in ROM and adds line additional commands to Pet Basic. Act can supply many Petsoft programs.

The Petsoft professional disc system is available from most U.K. Pet dealers. If you have any difficulty, Act Petsoft Peripherals is based at Radcliffe House, 66-68 Hagley Road, Edgbaston, Birmingham. Telephone: 021-455 8395.
Viewdata terminal from STC

STC, the British arm of ITT, has introduced its specially-designed view-data terminal, the Novatel. It costs at least £750 for which you have a 7in. black and white screen/terminal. Despite the price, STC predicts that it will have sold more than 1,000 of them by the end of the year.

The Novatel has been built for business use. At 14.1in. deep, by 11.9in. wide and 7.6in. high, it should fit easily on to a desk-top. There is a high-definition 7in. display and an anti-reflective screen.

One useful point is that the Novatel can be connected to a standard cassette or tape recorder and any pages accessed can be recorded and played-back without recalling the database. For message-sending, a socket is also provided for connecting a full alphanumeric keyboard.

STC is still appointing dealers. If you would like to find out more about the terminal, telephone STC on 01-368 1234.

System to work for ‘slackers’

Every year the British Aerospace Training Department at Bristol sponsors pre-university students for short projects in which they have 14 weeks and £150 to produce a money-spinner for the company.

This year these four contestants developed a system to discover ‘slackers’. They devised a “computerised attendance clocking system which could eliminate the use of clock cards and clerical recording.” That means that the company knows when you arrive, and when you leave, and cuts wages accordingly.

The system, which consists of a reader and central control unit, was built for only £141.

The reader units, at the left of the photograph, are supposed to replace existing time clocks. The employee has to use a pass or identification card. The reader transmits data in the form of 16-bit words to the central control unit, from where the data can be fed, once a week, to the company’s mainframe computer.

The reader has a digital recording system and can operate from either mains or battery supplies. It can record starting and finishing time, for bonus calculations, and can also accommodate personnel working flexible hours. The central control units can be matched up to 250 reader units.

Forty-track disc capacity

If Tandy users are still having trouble with their disc drives, they could try a new system designed and developed by Computer Instruments Ltd of Chandler’s Ford, Hampshire. The disc system has been designed to interface easily with most micro and minicomputers, via a suitable controller. The unit is based on the Pertec FD200 microfloppy disc drive and is directly interface-compatible with the Shugart Model SA400. The capacity is 250K per side of double-density diskette and the device is suitable for double or single-density disc operation. It claims a 40-track capacity which will give users 14 percent extra capacity by comparison with competitive disc drives. Transfer rate is 125/250kbits per second.

The unit is available from Rostronics Ltd, 118 Wandsworth High Street, London SW18.

Old and new with Apple Pascal

APPLE COMPUTER INC has introduced its version of Pascal, to be known as Apple Pascal. It was written by the University of California in San Diego and is an implementation of standard Pascal.

The Apple Pascal is intended to run on the Apple II and Apple II Plus computers. The system requires 48KB of installed memory and one or more Apple II disc drives. While the system is intended primarily to use the Apple keyboard and monitor, an external CRT terminal may be used to give the full 80-character screen display.

The heart of the language system is the language card, which adds 16K to the Apple 48K of RAM. In addition, the language system includes the Autostart ROM which facilitates screen editing of Basic programs and starts your disc drive automatically when you turn on the computer.

The system includes two new PROMs for the disc interface card, which make it possible for a one-drive system to run Pascal. It also includes the Basic diskette, which allows the user to run Integer and Applesoft-Basic.

Catalogue

TRANSAM COMPONENTS has published a new computer products catalogue containing details of products and specialist services for microcomputer users in the U.K. Transam manufactures the Triton personal computer system. The catalogue is available from 12 Chapel Street, London NW1. Telephone: 01-402 8137.
Triton is impressive

There are many single-board computers on the market. Most of them failed to impress me but I am writing about one of the few which does. The Triton is British-designed and engineered and was launched in November, 1978.

Transam, the supplier, has not rested on U.S. laurels, however, but has introduced an expansion motherboard which will accept plug-in daughter boards to configure the computer to the user’s requirements.

The Triton is based on the 8080 processor which, although not my personal favourite, has a considerable following. The design of the Triton makes it ideal for the beginner with the minimum of cash and know-how. Not only is it available as a complete kit but also as a part-kit, so that the constructor can choose which parts to buy and which to use from his existing stock.

When the constructor outgrows the initial system, it is easy to expand it, using a range of plug-in modules based on the same kit philosophy.

Documentation

An impressive array of documentation is available. It ranges from simple construction and how-it-works notes on the plug-in cards to the mighty half-inch thick Triton Manual. Between those extremes are descriptions and listings of the five alternative firmware packages. Sufficient detail is given for advanced programmers to modifying vectors and pointers, making possible those clever tricks which are part of the fascination of programming. Even listings, both source and object code, of Basic are available.

The beginner need not have the feeling of being left alone. The Triton User Group Newsletter is available to provide news of new products, programming units, program listings and circuit additions. The issue which I read contained in its 35 pages a Tiny Basic Star Trek program by Ron Geere

Editor, Independent Pet User Group Newsletter

—one of the few computer games which appeals to me — a version of 3D noughts and crosses and a game called Time Warp. Hardware items mostly dealt with analogue interfacing and control applications.

The 116-page manual contains a detailed description of the Triton, its construction and assembly. The how-it-works sections covers the power supply, processor, memory, the peripheral interfaces and the VDU graphics. Included are ASCII/decimal/hex code tables, a table of graphic symbols and their corresponding codes and a table of control codes.

Firmware packages

EPROMs are used for all firmware and Transam allows one to trade-in an EPROM pack and have it upgraded to another. That makes it easy to keep abreast of software improvements, as, for instance, Pascal might be preferred as an alternative to Basic.

There is a choice of five Basic firmware packages. Three of them, the L4.1, L5.1 and L6.1, represent differing levels of Basic — tiny, extended and scientific. The latter lives in nine 2708 EPROMs with a comprehensive 2K monitor and a 7K Basic which will handle numbers within the range 10\(^7\) to 127 to six-digit precision. To house the additional EPROMs, an 8K EPROM card and expansion motherboard is required. The smaller packs can be housed on the main PCB.

The monitors increase in versatility for a minimum of seven single-character commands in the 1K version to one of the most comprehensive monitors I have seen on this type of computer. Its single-character command set uses all the letters of the alphabet, except K and Y, to give 24 commands.

Two more packs, the L5.2 and L6.2, are the same as their .1 equivalent but designed for use with an 18MHz crystal instead of the standard 7.2MHz version to control the processor clock.

One further firmware package is available, aimed at the machine code enthusiast. It has an 8K EPROM call TRAP—Triton Resident Assembler Package. It gives nine facilities which, apart from the usual editor and two-pass assembler, includes a disassembler giving standard Intel mnemonics and the ability to create a symbol table which will put labels into listings for clarity.

Further facilities permit the setting of break points, single-stepping, trace — which displays register contents after stepping automatically through each instruction of a specified block of code — and a 10-command monitor.

Processor unit

The single board housing the CPU is well made and clearly laid-out. The circuitry is conventional, good use being made of LSI chips appropriate to the tasks performed, with low-power Schottky devices filling-in the details.

The keyboard is a full 56-station ASCII model complete with shift-lock, escape
and control keys. The VDU screen will accommodate 16 lines of 64 characters. Use of the shift and control keys should produce 64 graphic characters from the keyboard but I found some oddities. The DEL key does not delete but moves the cursor left, so one can re-type a character. To delete, say, 10 characters requires 10 such cursor steps followed by 10 spaces. Reset (home) cursor is given as 'CTRL \ ' and since there are two keys marked ' \ ' I found the wrong one initially. There are also two ' = ' keys — one produces a graphics character, the other does not.

**Interface**

One criticism I have of the graphics was due to limitations arising from the VDU chip and graphic generator combination. The lower area of the dot matrix array must, by default, be the same as the top row. That imposes a restriction on the graphic symbols which can be generated. Improvement in operation could be made by using a keyboard which was VDU-oriented in respect of cursor controls. I found it an inconvenience to press two simultaneous and unrelated keys each time.

The processor has five interfaces — keyboard port, LED port, cassette interface, TV interface and bus extension. The TV interface uses the popular Astec modulator type 1111E36. U.K. modulation standards are used to output a carrier on TV channel 36. Interlacing of lines is random; line and field frequencies are determined by the SFC 96364 VDU chip. The combination of the two devices eliminates any synchronisation problems, such as arises occasionally in the U.S.-designed equipment.

The cassette interface uses a UART which drives the Motorola MC14412VL mode to generate the crystal-derived tones for the cassette recorder. A 'mark' (1) is 1270Hz and a 'space' (0) is 1070Hz. The baud rate is determined by a 555 timer circuit which has an adjustment for fine frequency-control.

The LED port, as Transam calls it, need not be used for LEDs. It could be used equally well to drive a device such as a printer. A number of spare output lines exist and would enable handshaking to be used if necessary.

**Expansion**

The keyboard data and strobe lines are connected to port zero. The keyboard routines does not seem to be interrupt-driven. There are eight interrupt inputs, one of which (INT3) is labelled 'spare to keyboard' in the documentation.

The bus extension lines are buffered from the processor. Additional buffers are provided on the expansion motherboard input. The unit reviewed had a ribbon cable of about one metre long and the length appeared to present no problems.

The expansion motherboard kit has its own power supply and the 5V rail can supply up to 6A with the components supplied. The printed circuit board, as with all the circuit boards in the system, has plated-through-hole, double-sized construction to professional standards.

**Conclusions**

- The prospective buyer is advised to study the Transam computer catalogue to determine the options required and the best method of purchase.
- Sufficient documentation is provided to make assembly and testing a straightforward process and then, if the constructor still does not have a working unit, Transam operates a get-going service to purchasers of their components.
- If your electronics is satisfactory but the housing is a problem, Transam can supply a vacuum-formed case.
- It is difficult to design something to suit everyone within the constraints of price, reliability and performance. In this respect the Triton has scored remarkably well. The piece-wise availability enables one to tailor the unit to one's own requirements and not to pay for unrequired facilities.

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**Practical Computing evaluation**

<table>
<thead>
<tr>
<th>Ease of construction (where applicable)</th>
<th>Yes/No</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
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</thead>
<tbody>
<tr>
<td>Quality of documentation</td>
<td>✔️</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>Can handle 32K of memory</td>
<td>Y</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Quality of video monitor (consider resolution and screen size)</td>
<td>N/A</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>Sockets for chips</td>
<td>Y</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Numeric, calculator-type pad on keyboard</td>
<td>N</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Large amount of removable memory, randomly accessible</td>
<td>Y</td>
<td></td>
<td></td>
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<tr>
<td>Cassette tape recorder capability: Own</td>
<td>Y</td>
<td></td>
<td></td>
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<tr>
<td>Built-in recorder</td>
<td>N</td>
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<tr>
<td>Floppy disc capability</td>
<td>N</td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>Speed of instruction cycle</td>
<td>✔️</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Ease of expansion</td>
<td>✔️</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

**Ratings**

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

<table>
<thead>
<tr>
<th>Lower power consumption</th>
<th>Yes/No</th>
<th>1</th>
<th>2</th>
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<tr>
<td>Assembly languages</td>
<td>Y</td>
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<td>Basic language</td>
<td>Y</td>
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<tr>
<td>Other languages</td>
<td>N</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Compatibility with other systems</td>
<td>✔️</td>
<td></td>
<td></td>
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<tr>
<td>Appearance</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Portability</td>
<td>✔️</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>No. of software applications packages available</td>
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<td></td>
<td></td>
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<tr>
<td>Hobby use</td>
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<tr>
<td>Business use</td>
<td>✔️</td>
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<tr>
<td>Educational use</td>
<td>✔️</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Ability to add printer(s)</td>
<td>✔️</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Ability to add discs</td>
<td>Y</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ability to add other manufacturers' plug-in memory</td>
<td>✔️</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Ease of expansion**

- If your electronics is satisfactory but the housing is a problem, Transam can supply a vacuum-formed case.
- It is difficult to design something to suit everyone within the constraints of price, reliability and performance. In this respect the Triton has scored remarkably well. The piece-wise availability enables one to tailor the unit to one's own requirements and not to pay for unrequired facilities.
Contrasting Euroapple with ITT 2020

WHAT HAS the latest European Apple II, the Europlus, to offer? How different is it from the latest ITT 2020? How well do these computers perform and what can an owner expect in the way of support and reliability?

To try to answer those questions and to shed some light on what makes their special features tick, Jim Hurst of Micro-control and I have examined them and this is a report of our findings. We are grateful to Microssense Computers Ltd and to ITT for their help and co-operation but our investigations and conclusions are our own.

Apart from the colour of the plastic case and the keyboard, the two computers look alike. The case is strong, yet light, making it more easily portable than almost any other computer of comparable capability.

The motherboard of the 2020 is manufactured by Apple but is different in design from the boards in the computers which bear the Apple name. In the ITT Basingdon factory, the board receives further modification. The keyboard, too, is imported from the U.S. but the remainder of the 2020 is home-produced. Assembly and testing is by the same procedures of quality control as are used in the manufacture of other ITT products.

Powerful and fast

The capability, under either brand name, reflects the flair which is evident in the concept of the Apple computer. The functional structure borrows from the philosophy of large computers rather than being an ad hoc creation stemming from the nucleus microprocessor. They are powerful machines and, for micros, are fast. In high-resolution graphics the Apple performs faster than the ITT.

There is an elegant Integer Basic available in ROM and an extended Basic in two versions, to accommodate the two versions of high-resolution graphics employed by Apple and ITT respectively. This extended Basic, called variously APPLSOFT or PALSOFT, is excellent, apart from some minor flaws, and meets a high professional standard. It is also available in ROM.

The main manuals are produced by Apple and are literate, lucid, lively, thorough and accurate, though they could be enhanced further by the addition of more non-trivial examples. Unfortunately, some of the programming facilities described will not work on the 2020, and the ITT supplementary documentation does not cover all the amendments it should. ITT is trying to correct this but it would be more satisfactory if the price of one of its machines included an automatic after-sales information update service. There has been talk of an ITT-sponsored users' club but as yet there has been no action. A good mini-assembler and disassembler are provided in ROM together with a pseudo machine interpreter which imitates a 16-bit processor and goes by the name of Sweet 16. There is a rich repertoire of monitor commands and a first-class software front panel. The mini-assembler and Sweet 16, however, have to be sacrificed if Applesoft or Palsoft is in ROM on the main board.

It differs from its predecessor in that it has 'Autostart' ROM. It replaces the standard system-monitor ROM and, with disc drive, enables the computer to function in turnkey mode — it can move directly into a pre-selected program by being turned on. It includes improved edit facilities and gives a less tormenting response than that to which Apple owners are accustomed on hitting RESET.

This ROM is all that distinguishes a Europlus from a plain Eurapple and an instant update is achieved by plugging it in. It works equally well in a 2020.

The ease with which one can hit reset accidentally is a notorious irritant with these machines. The RESET key is next to the RETURN key so it is almost impossible to miss. ITT is ahead of Apple in having corrected the difficulty on its latest model by linking the RESET key to the CONTROL key, making it necessary to press both simultaneously for anything to result.

Penalty

Those are some of the good points. What about the other side of the picture? The first disappointment is in the display; that applies to both brands but there are differences. The fact that a well-known professional found the Apple II 'monochrome' only and cannot ordinarily be mixed with graphics. Nor can graphics be mixed with text. It is possible to put four lines as a caption to a page of graphics, however, but the text is apt to be revealed in a riot of colours, whether you like it or not.

Graphics mixtures

The low-resolution graphics give colour more or less as expected but the resolution is very low — a maximum of 48 rows of 40 points, those 'points' being fearsome rectangles. The ITT colours are very good but those of the Apple look washed-out and also create an effect of worms wriggling all over them.

The high-resolution graphics are a mixture of marvels and disasters. They are extraordinarily easy to use in programs, with some wonderful facilities which supposedly draw lines and shapes and put them anywhere, and enlarge and rotate them and are full of promise. Alas, the promise is not always fulfilled. Some of the facilities work only to a point. The ITT colours, although subject to the same disorders of unpredictability as the Apple, are purer and richer.

Since a change in U.K. distributorship earlier this year, the Apple II — the European version, the Eurapple — has been sold as standard without colour output. The price is correspondingly lower and you have to pay the difference for the special colour card as an extra. A new colour card is due from Apple soon which uses digital techniques. We have tested an
advance sample and consider it to be up to that of the ITT achievement, but no better.

The geometry of the high-resolution graphics reveals a great contrast. The Apple has a plot grid of 280 x 192 while the 2020 gives 360 x 192. The extra points crammed into a horizontal line by the ITT machine give increased resolution, true, but also present problems in that the horizontal scale factor is different from the vertical one.

A rectangle made up of 40 plots horizontally by 40 plots vertically, for instance, is a square on the Apple but not on the 2020 and it distorts badly when the facility for rotating shapes is used. Neither is the Apple perfect. Certain orientations of a rotated shape are accompanied by unwanted changes in scale; but how many low-cost computers can do this kind of thing at all?

A further consequence of the differences is an incompatibility of software between the Apple and the 2020 in cases where high-resolution routines are included using machine code. The problem can be overcome by writing programs in Applesoft or Palsoft and running them with the interpreter appropriate to the machine on which they are running (irrespective of the interpreter or machine used when the program was created). **Simple adjustments**

Any such program which runs on a 2020 will run on an Apple provided X co-ordinates are kept to less than 280. A program which runs on an Apple might need a little more adjustment to run on a 2020 if they happen to use any of the Applesoft commands which do not work on the ITT machine. These adjustments are usually quite simple, though. For instance, on the Apple, the instruction

```
10 HPLT 0, 0 TO 100, 0 TO 100, 100 TO 0,0
```

will plot a right angled triangle:

```
0 0
100 0
100 100
```

With the 2020 it is necessary to use

```
10 HPLT 0, 0 TO 100, 0 TO 100, 100 TO 0,0
```

and all will be well, although the triangle won't be isosceles.

With the Apple method for high-resolution colour, the 53,760 points or picture elements, on the screen can be regarded as 7,680 sets of seven. There are 40 of those sets of seven per horizontal line. The state of every point is one set, whether it is on — i.e. glowing — or off and, if it is on, what colour it is, is encoded in one byte of memory. So if, for example, you plot any of the points with co-ordinates (0,1) to (6,1), the information — which points are on, and in what colour — is contained in location $2400 of HI-RES page 1 or $4400 of HI-RES page 2.

Essentially, the whole method is something of a cheat. Although you can name patches of colour to order, you cannot do the same thing with individual points. The colour of aggregates of points results from the mixing of the colours of neighbouring points. No point is ever white, for instance, but two horizontally-consecutive points, when both are on, will always appear white, because their respective colours are always complementary.

There are only two colours which any one point can possibly assume. For example, the point (0,1) can be either blue or magenta — or off, of course; but the point next to it, (1,1), can only be yellow or green, which are the respective complements of blue and magenta. I should remark that these colour names are for purposes of explanation and might not exactly describe what emerges in practice.

The information is encoded in memory like this:

```
SCREEN (1st 7 pts of second horizontal line) read left to right

| 0 | 1 | 1 | 0 | 1 | 1 | 0 |
```

```
MEMORY (location $2400) read right to left

| 1 | 0 | 1 | 1 | 0 | 0 |
```

Bit 7 of the byte — bit 7 is the eighth from the right — codes the colour choice. If bit 7 is 0, the colours of the points (if on) will be blue-yellow blue-yellow-blue-yellow-blue, and if bit 7 is 1 they will be magenta-green-magenta-green-magenta-green-magenta. So, adding colour to the above diagram, we have either:

```
0,1
```

```
Magenta
Green
Green
```

Various colour effects can be produced on lines and patches by varying the combinations. Here are some examples:

```
Appearance: yellow

O,0

Mauve

Y

Mauve

Y

Mauve

Y

pink

Y

G

B

G

B

B

B
```

```
aqua

G

G

B

B

G

G

B

B

B

B
```

All those combinations are realisable in practice but some only by writing special routines. Using standard the standard programming provisions, you determine (continued on next page)
the colour by setting a parameter called HCOLOR equal to a number from 0-7.

The values 0 and 4 give black — ensure that a 0 is put into the appropriate bit corresponding to any point which is plotted; 3 and 7 give white, obtained by ensuring that a 1 is put there. Each of the remaining four values selects respectively one of the four possible colours available on a given line, the particular depending also on whether the Y co-ordinate is odd or even. Diagram (a) above corresponds to HCOLOR =1.

Since any specified colour can be produced only at alternate points, there is a 50 percent chance that a point plotted at random will fail to appear — likewise also for an entire vertical line.

Because of the inadequacies of the colour generation effected by the circuitry which converts the output from NTSC standard to PAL, when the colours appear they might, for many purposes, equally well have been in white. The new colour card will be improved in this respect.

Room to spare

We have seen that, for the Apple, 40 bytes of memory are needed for each horizontal line of high-resolution points. So the total number of bytes needed is 192 x 40 = 7,680. Each HI-RES page of memory is 8K, that is 8192 bytes, whence there is plenty of room to spare. The 61,920 points on the ITT high-resolution display, if divided into sets of seven as with the Apple, would give more sets than there are bytes in 8K. Hence the Apple way of doing things is not directly possible.

So let us abandon the colour-choice bit and allow each point to be able to light up in only a single colour. For the effect of being able to vary colour of the output, at least for lines and patches, we will have to rely wholly on the device of varying the combination of points which are in play. It is perfectly feasible and allows us to divide the full number of points into sets of eight. But 69,120 ÷ 8 = 8,640, which is still too many to be contained in 8,192 bytes.

The ITT solution is to enlarge the bytes. Instead of having eight bits to a byte in the HI-RES memory, it has added a ninth bit. More precisely, Apple has added it. It is done by adding an extra 8K-bit RAM chip, one bit of which is adjoined to each byte of the HI-RES memory as required.

It is addressed by way of a latch, which has to be enabled before the ninth bit can be read or written to, and then has to be disabled. The extra procedures take time and contribute to the comparative slowness of the ITT. Another reason for the slowness is, of course, the need to plot more points than the Apple to cover the same horizontal distance.

To the right of the page are the respective patch patterns which are yielded by plotting all the points in a patch in conjunction with the eight possible values of HCOLOR.

Given a non-black-or-white setting of HCOLOR there is still a 50 percent chance of failure of anything appearing on the screen if you plot a single random point. Moreover, if the point lights-up, it is likely to be in an unexpected colour.

Neither Apple nor ITT is at pains to point-out the limitations of the high-resolution colour facilities. That is a pity, for provided one understands the organisation of the colour system it is possible to take account of it in programming and, without frustration, produce some very respectable, trouble-free effects.

Different card

The Apple as sold in the U.S. generates an NTSC signal on the logic board, which can be fed directly to American TV sets and monitors. In the U.K. the signal is converted to the PAL standard by a plug-in card which is a rather second-best affair. In Europe a different card is needed to convert the signal to the SECAM standard. Early forms of the SECAM card have been even less successful that the PAL card.

Possessors of Eurapples, however, should be warned that they cannot plan improved output only by buying an NTSC monitor, because the clock crystal fitted in the European model is not of the same frequency as in machines intended for use in the States.

On the English 2020, the PAL signal is generated on the logic board in identical fashion to the way the NTSC signal is produced in the Apple. That enables the best-quality result to issue without the need for a special card. If the ITT machine had kept the high-resolution graphics in the original Apple form, I think it would have been the better one to buy on this side of the Atlantic.

With the new colour card the Apple will constitute a serious challenge to ITT.

There is an established range of ancillary products for the machines and it is being extended all the time. Most items are usable freely with either brand of computer but there is the inevitable small difference.

Languages available for the Apple/2020 now include FORTH, which is reported to be very good, and a version of PILOT called APPILOT which is on disc, includes the facility for using the low-resolution graphics, and is first-rate. There is a Pascal system, including a card with impressive firmware and an extra 16K dedicated RAM.

Conclusions

- This account is critical and should not be taken to imply that the two are not good machines. On the contrary, they are so good that they merit this kind of scrutiny.
- Both are expandable and it is easy to make modifications to existing machines.
- Any Apple or ITT 2020 can be improved by suitable provisions from the manufacturers, if they choose, and could still have a good part to play for some time after many of their contemporaries are obsolete.
Corvus hard disc for Apple

The standard Apple II floppy disc system provides 110 kilobytes of storage per drive, immediately accessible to the computer. What that means, for example, to a sales ledger program, is that the Apple is limited to about 600 customers and 1,600 transactions. What is more, the speed at which the computer can print reports is often limited by the disc, and certainly it is a tedious operation to have the computer search 600 names on disc for an account number you have forgotten.

So the Apple or, indeed, any microcomputer, would be improved by using a faster disc system with a greater capacity, like the Corvus 11A hard disc system. It provides 9.5 megabytes of storage, all immediately accessible, and is claimed to be about 10 times faster than mini-floppy discs; 9.5 megabytes is sufficient to store:

- 50,000 customer names and addresses;
- 4,000 pages of poetry, report, manual;
- one-sixth of the Encyclopaedia Britannica;
- 12 hours of digitised speech;
- 1,000 Apple high-resolution graphics pictures;
- One second of colour TV signal.

The disc system we had for review was in three parts. The main unit is the drive, which is a black box 500mm by 150mm by 200mm. There is a separate power supply unit which is about half the size of the drive. Finally, there is an interface printed circuit board which plugs into a slot in the Apple in the standard way.

Simple process

A brief instruction booklet and two warning notices were also supplied. The system was already assembled but all that appears to be necessary is to plug it together. The instructions for doing so were complete and comprehensive; the process would probably be no more difficult than installing an Apple floppy disc or printer.

Starting the drive working was equally simple. Turn on the drive and the disc starts to rotate. It takes about 15 seconds to reach speed and the booklet warns you to wait that long before trying to use it. Unlike a mini-floppy drive, this rotates all the time it is switched on, rather than only when access to date is required. When the disc is ready, type PR# 4 on the Apple keyboard and in two seconds the Corvus banner appears on the screen and the Corvus disc operating system is installed in the computer.

On an Apple Plus, the PR# 4 should be unnecessary; the drive should boot itself automatically when the Apple is turned on.

To the user at the Apple keyboard the disc system seems much the same as the floppy disc operating system (DOS). All the usual CATALOG, DELETE, RUN, LOAD and OPEN commands are there. There is little new to learn. The only difference is that the Corvus disc is organised to look exactly like 82 floppy disc drives.

To choose among the 82 so-called volumes, you use the volume parameter on disc commands. In the normal Apple DOS, that is used to check that the correct disc has been inserted in the drive. So a Corvus disc command would look like:

OPEN BOTTLE, V61, to access a file called BOTTLE on the 61st section of the disc.

The division into volumes provides almost complete compatibility with the original Apple DOS and may mean that some programs can be transferred to the Corvus disc with very small changes. This system, however, makes spreading files over more than one volume rather awkward. That is important because if you need a 9.5MB disc you probably have files which are larger than the capacity of one floppy disc.

There is a fundamental difference between the Corvus disc and a floppy, in that the discs are not interchangeable. In fact, the Corvus disc drive is a sealed unit which may be opened only in a dust-free room. That creates a problem about the security of the data.

The speed of the disc was tested by setting the computer to search through a name and address file. It managed about 10 records per second. At that rate the program may well be limited by the Basic interpreter rather than the disc. The CATALOG, V99 command takes five seconds to traverse the disc and read the first file name of the catalogue of each of 82 volumes.

Technically, the drive consists of the IMI 7710 Winchester disc drive. To this Corvus has added a controller based on a Z-80 microprocessor with 16K of RAM, the power supply and the Apple interface. The drive is made up of two solid magnetic coated discs.

Both sides of each are used, to make four surfaces. One is used for head positioning and the other three hold data.

Conclusions

- The Corvus 11A disc drive offers a hundredfold increase in storage capacity and a 10 times increase in speed over the Apple floppy disc system. It should also be more reliable.
- The documentation is adequate to use the disc but more help could be given, particularly with the advanced facilities available.
- There are potential difficulties in keeping back-up copies of the large amounts of data the disc can store.
- Compatibility with the Apple DOS should make for easy program conversion.
- Price is £3,500 for an initial unit; a second drive can be added for £2,500.

Corvus 10MB hard disc system. On the left, power supply; centre, the disc drive in its sealed black box; right, an ordinary Apple with mini-floppies.
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PRACTICAL COMPUTING December 1979
Artificial Intelligence

Chip takes step forward in picture processing

IN ABOUT 1952 Von Neumann, the father of the modern serial computer, first proposed a two-dimensional cellular computer. His work was the inspiration for much of the subsequent thinking on 32 x 32 PEs. Intended applications were numerical modelling, solving differential equations and radar data analysis. The project, however, never fulfilled its promise and only a simpler 16 x 16 array processor was built.

Solomon's designer, Daniel Slotnick, moved on to work on the ill-fated ILLIAC IV computer which was designed to be operated in SIMD or MIMD — multiple instruction, multiple data — modes. The aim was a machine performing a gigaflop — one thousand million floating-point operations per second — but the project proved too costly and only a quarter of the original design was built.

Returning to computers for image processing, ILLIAC III was conceived as a machine for the automatic analysis of bubble chamber photographs. It consisted of a 32 x 32 array which could be configured in either a square or hexagonal arrangement (figure 3).

The design was published in 1963 but construction was beset with problems and it never worked at all well. Had the project been completed, the performance of ILLIAC III would have considerably exceeded any contemporary machine, such as Solomon, but apparently it was destroyed by fire.

The Solomon and ILLIAC machines were very expensive and were attempting to use the most advanced technology of the sixties. Other projects, however, were pursued which implemented the logic of a cellular array in a serial, or ‘slightly parallel’ manner.

The first, CELLSCAN, was built in 1960. It processed a picture element (pixel) and its eight neighbours sequentially, and was intended for the analysis of white blood cells. Further (continued on next page)
(continued from previous page)

development led to the Golay logic processor (GLOPR) which was incorporated in a commercial machine for white blood cell analysis.

That machine used the concept of "Golay surrounds" which are based on hexagonal connectivity. There are 14 combinations of the six neighbours of a given pixel, ignoring surrounds which are identical under rotation. That approach allows for the topological analysis of an image so that the type and form of a white blood cell can be found.

After GLOPR, the binary image processor (BIP) followed. It could perform Boolean operations between corresponding pixels of two images, the cross-correlation of two images over a 3 x 3 window producing nine correlation counts - and analysis of a shift registers, each four bits wide and 4,096 bits long. An image is processed sequentially, one 3 x 3 neighbourhood at a time.

Unlike GLOPR and BIP, PICAP has memory per PE so only 16 binary images can be stored. The small size of the array meant that although parallel algorithms could be investigated, real images could not be processed. CLIP 3 was constructed from SSI and MSI TTL and fitted into a 5 ft. x 20 in. x 18 in. cabinet. That meant that an array suitable for practical image processing would be very large - and expensive - if TTL were used. The solution adopted was the commissioning of a custom-made integrated circuit. This chip will be used in CLIP 4, which will be a 96 x 96 array processor in a single 7 ft. x 20 in. 18 in. cabinet.

As an interim measure between CLIP 3 and CLIP 4, a scanned array was built, using CLIP 3 as the parallel processor. The 12 x 16 array is used in 48 positions to simulate a 96 x 96 array. The loss of speed is considerably greater than 48 times - in fact, 1,000-3,000 times - since the overheads of data shuffling are immense; but the machine is still much faster than an implementation on a minicomputer. The basic CLIP 4 cell is shown in figure 5.

**Threshold gates**

The cell is little changed from that of CLIP 3. The threshold gate at the neighbour inputs is replaced by an OR gate, and a few gates and a flip-flop have been added to make it into a full-adder. The threshold gate produced a T output only when a specified minimum of neighbours produced a 'neighbour' output.

The function was little used and not considered worthwhile implementing on the CLIP 4 chip. The provision of a full-adder in each processor speeds arithmetic processing by CLIP 4. Additionally, there is an increase in memory to 32 bits in CLIP 4.

The CLIP 4 integrated circuit is made in MOS on a chip 0.168 x 0.177 in. It contains eight processing elements. The chip design began about seven years ago and has been dogged by setbacks. The situation now looks brighter and CLIP 4 should be working shortly. For the 96 x 96 array, 1,151 chips will be required. Each will cost about £12 because of limited production. The basic chip should be useful in building future array processors of different and larger configurations.

The CLIP 4 computer is interfaced to a PDB-11/10 minicomputer which runs the operating system. It will handle I/O assignment, image display, error traps, etc.

---

**Figure 3. Hexagonal and square connectivity.**

- **Connectivity Types:**
  - 6-connected hexagonal
  - 4-connected square
  - 8-connected square

**Binary outputs**

There are two binary inputs to the Boolean processor, one of which is the logical image value - in the A register - and the other is derived from any combination of the neighbouring cells and the B register. The B register can be loaded with data from another image and can be used for two purposes.

If no neighbour inputs are allowed, the images in the A and B registers can be combined in a Boolean manner. If neighbour inputs are allowed, the contents of the B register can act as a "label" to put-out a specific object in the array of A registers - this will be explained in detail later.

The two binary outputs from the Boolean processor are independent. One is the new image value (the D output) and the other is routed to the immediate neighbours (N output). Either square or hexagonal connectivity for the array can be specified under program control.

On CLIP 3 there are only 16 bits of data processing and storage.

---

**Figure 2 (refer also to figure 3).**

(a) A single set of (black) connected points. The "link" instruction on Unger's machine used a special array to mark the position of vertical, horizontal and diagonal connections between adjacent points of the object.

(b) A paradox of 8-connectivity. Does the 8-connected line divide the array into separate regions?

---

**Figure 2 (b).**

A paradox of 8-connectivity. Does the 8-connected line divide the array into separate regions?

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**Figure 2** (continued from previous page)

single image with a 2 x 2 window. BIP was again essentially a serial machine but cross-correlation was performed in a pipeline, giving a processing time of 20nS per pixel. The machine is now incorporated in a commercial system for alphanumeric data processing and storage.

The machines mentioned previously were all built in the United States. PICAP was built in Sweden. The heart of PICAP is a 3 x 3 array processor having nine processors of different and larger configurations.
image transfer between CLIP and PDP peripherals, and interactive debugging. There is provision for the user to allow control to pass between the PDP-11 and CLIP so that a program can utilise serial and parallel processing.

The machines will not run concurrently. A development system has been written which allows CLIP to be programmed interactively. To the user it seems like an interpreter but it is an on-line editor and linker run by the PDP for CLIP 4 code generation.

A schematic of the overall CLIP 4 system is shown in figure 6. The basic form of image input is from a standard faster scan monochrome TV camera, but it can be taken from a VTR — analogue recording. The image is digitised into 64 levels (6 bits) in about 20mS (one TV scan) and an additional 24mS is required to input the whole grey image into the array. The basic instruction time of CLIP 4 is about 10 S and so a great many operations can be performed in the time it takes to input an image.

For many processing applications the input time could be the limiting factor in throughput. For this reason other forms of visual input are being considered. A CCD camera can provide serial data at a rate of 20mS faster than a standard TV system at up to 10 million picture points per second, compared to the 5 MHz rate used by the CLIP TV camera.

There are no systems on the market which provide a completely parallel output of picture data and, anyway, CLIP 4 could not handle a 96 × 96 data bits. The array is organised as 96 shift-registers of length 96 bits for data input and so the fastest system for CLIP 4 would be a camera providing a 96-bit-wide data stream.

CLIP is orientated specifically towards the manipulation of binary data. For the processing of grey pictures, however, arithmetic is required. The grey value of a pixel is stored as an integer with each bit in a different storage plane (figure 7). Integer addition, subtraction and multiplication have been implemented in bit plane arithmetic. Division is not feasible, since too many bits are required to achieve reasonable accuracy.

Even holding a few grey images in memory can use a considerable proportion of the storage available. Thus, judicious data manipulation is required if several images must be dealt with together.

CLIP 3 processors can act only as half-adders but additional circuitry in the CLIP 4 cell allows full-adder operation when performing bit plane arithmetic. Setting the R bit (figure 5) allows the C register to save the carry resulting from the addition of bits in the A and B registers — they are bits from the corresponding planes of two-bit plane numbers.

Setting the C control on the input gating passes the previous carry in the C register to the processor input, where it is added to the A and B registers which have been loaded with the next most significant bits of the numbers being added. The new carry is stored again in the C register and the process is reiterated to complete the addition of the two numbers.

The full-adder capability is also useful for executing sideways arithmetic on a single grey-level image. Such operations as adding and subtracting a pixel from a neighbour in a specified direction allow the implementation of a certain class of digital filters — binomial filters. They can be used for image smoothing, edge finding and enhancement.

An alternative representation of numbers is the binary column mode. Here, a single storage plane can hold 96 numbers, each of up to 96 bits. Floating point numbers can now be used and since any operation is performed on all 96 numbers at once, the time per number process is small, even though the CLIP processor handles arithmetic rather crudely.

For example, the simultaneous multiplication of 96 pairs of 16-bit integers would take about 800μS on CLIP 4, giving an effective time of less than 10μS per pair. For the addition of two 96 × 96 arrays of 16-bit integers (9,216 pairs) using bit plane arithmetic, the estimated processing time on CLIP 4 is about 170μS, giving an effective time of only 18μS per addition.

First operations

The operation of the CLIP computer with regard to a specific image processing application will now be considered. In the automatic analysis of blood, one of the first operations is to distinguish the white and red cells. The former have nuclei while the latter do not have, and this fact can be exploited for separating the cells. For extracting a nucleated cell from an image containing nucleated and non-nucleated cells and various "blobs", the input

Dr M J B Duff.
image is binary; some pre-processing would be required to achieve this from a real input. The first step in the segmentation process is to extract the inner white areas of all cells. This is done by initiating a signal from the edge of the array — not visible in the figures — which is passed on only by white pixels. The white pixels in the middle of the cells are surrounded by black and so do not receive this “propagation” signal, and so can be separated from other white pixels.

This is an example of “global propagation” and takes 1.29 $S$ for each pixel crossed in CLIP 4. A test on the overall array is made to discover when the process settles and the propagation signals disappear. The next instruction can then be executed.

All nuclei are then extracted, in much the same way as the inner white areas. They can now be used to extract the nucleated cells by a process known as “labelling”. If the nuclei are expanded by one layer of pixels, they overlap the inner white areas of the nucleated cells. If the original image is loaded into the A register of CLIP and the expanded nuclei into the B register, propagation through white pixels can be initiated from the expanded nuclei.

Once the propagation signal reaches the cell wall it ceases and hence only the inner white areas of nucleated cells are extracted. The inner areas of nucleated cells can be expanded by one pixel layer and used as a label on the original image to extract the nucleated cells.

Of course, the algorithm can be altered easily to extract only the non-nucleated cells. The overall cell segmentation program consists of only six CLIP operations, each taking about $10^4 S$, plus time for the propagation signal to circulate, giving an execution time of around $100K S$. The same program was run on a simulation of CLIP 4 — but only a $32 \times 32$ array — on an IBM 360/651 mainframe and took 12 seconds to execute.

That is $10^4$ times slower than CLIP 4 but comparison of a simulation with hardware is not really fair. CLIP 4, however, is expected to be about one thousand times faster than the 360 performing picture processing operations on a $96 \times 96$ array. Since the instruction time for CLIP 4 is $10^4 S$, the effective time for each pixel is $1K S$, far shorter than any serial computer can manage. The TTL of CLIP 3 is five times faster than the MOS of CLIP 4 but since the array is 50 times smaller, the time per pixel operation is reduced to $10^5 S$.

To many, image processing conjures ideas of image enhancement like that performed on space photographs by NASA. That, however, is only a very small part of the subject. The range of medical applications continues to grow. As mentioned previously, a cellular computer is now available commercially for the automatic analysis of blood smears. Automatic biopsy is also being pursued for detection of cancer and liver disease. The problems, however, are considerably greater than blood analysis, since the variation in input image is much greater. Work has also been done on the analysis of X-ray photographs, which will be very useful for mass screening.

Fingerprint matching is an obvious candidate for an image-processing computer, and it is anticipated that a commercial CLIP machine will be used eventually by the police for that purpose. Other applications for CLIP which have been investigated include lay-planning, egg inspection, texture analysis and cell analysis.

Minimum length

Lay-planning is the process of laying-out patterns on a width of cloth so that the minimum length is used. That is a skilled job in the tailoring industry. A program operating on the scanned CLIP array processor takes 20 minutes to fit 12 pieces, but on CLIP 4 the execution time would reduce to about one second.

Egg inspection may seem a trivial problem but is a skilled and tiring task. Humans can inspect eggs at a rate of about five per second. A machine which could replace humans would need to be fast and CLIP 4 can provide that speed. The faults an egg can exhibit can be very subtle and considerable computing is required to enhance fine cracks or to pick out the mis-shapen eggs. The amazing power of human visual discrimination is always apparent when an attempt is made to replace a human inspector.

A study of texture analysis was instigated with the hope of applying it to LANDSAT photographs. Land areas exhibit different visual textures and so land-use analysis can be performed by texture discrimination. Texture analysis is also important in the field of metallurgy. Microscope images of the crystalline structure of a metal tell much about its strength and weakness and can be processed under a texture discrimination regime.

Real time

The cell study has involved the analysis of the movement of a single-celled amoeba. It is hoped that CLIP 4 will provide a system for real-time measurement of amoeboid movement. The problem is really one of image segmentation, important in many image-processing applications. The source images are of varied type, have very poor contrast, and the desired object is usually rather fuzzy. Completely successful segmentation of the image is proving difficult to achieve.

A version of CLIP 4 eventually will be marketed commercially and should make available to industry many areas of image processing. Its speed and price — around £40,000 — will give CLIP a place on the production line for automatic inspection, and possibly a derivative machine will provide the image analysing power for the much-mooted industrial robot.

Acknowledgment: Appreciation to Dr M J B Duff and all members of the image processing group of University College, London.
Modern technology showing its hand

PREHISTORIC spinning tops and throwing balls are familiar to many archaeologists, so it should not be much of a surprise to find that today's toys reflect today's technologies, with electronic toys more and more in the limelight. It is no great surprise, either, to find that many of them are sold on the strength of their ability to shoot, bomb and zap everything from submarines to Klingons.

Even the so-called 'educational' kits are not entirely immune. The Electronikit Ex System is a modular electronics kit, using discrete components packaged individually with common connectors. It can build, at various levels, doorbells, radios and logic gates. It is thoroughly 'educational', yet it has to be dressed in military green in an imitation diecast package to appeal to the customer.

To prepare this article, I wrote to 10 toy manufacturers asking for details of their latest offerings and it is interesting to see that all the material could be fitted fairly easily into one of three main categories — educational, intellectual/strategic, and inevitably, war; war being a term covering all forms of guns, bombs, and combat, whether 20,000 leagues under the sea or in the remote corner of a space pirate's empire.

In agreement with a number of educationalists, I would be very suspicious of the first category. Very few toys are more educational than another; man does most of his learning through play. His ability to handle real objects, and concepts, stems directly from his play experience with toys and by this criterion all toys, from a radio-controlled helicopter to a matchbox floating down the stream, must be classed as educational.

I suppose many of the 'less acceptable' items — although still among the most popular — such as guns, 'realistic' hand grenades, war games and the like can really be distinguished from chess or bridge only on the grounds of personal taste. Then, if one were still feeling philosophical, chess, too, would have to be re-considered in the light of other aggressive games.

So, to business. There can be no doubt that electronics has arrived in the toy market in a very real way. No more of the half-hearted radio-controlled tanks which fail on Boxing Day. Now here is the infra-red-controlled tank with a microprocessor heart, as sophisticated in many ways as the real thing. Lesney's new Super car can respond to instructions from a calculator-style keyboard, carried by a single infra-red beam and allowing up to nine kinds of movement.

The beam decoding and motor control is carried-out by a Texas Instruments calculator chip with 2,000 bytes of ROM,
allowing for an absolute minimum of electro-mechanical parts.

George, the voice-operated delivery van, has a rather smaller repertoire of instructions, but will, in response to verbal commands, move forwards or backwards, turn right or left. At the same time he is built robustly enough to withstand a fair amount of abuse. How he does it, I'll leave you to try to discover.

Also from Actionable, and probably containing much the same electronics as George, is Ben, a voice-operated dog which walks, stops, barks and wags his tail in response to your claps. He is complete with an 'acoustic hammer' for those who can't whistle; there are no prizes for guessing what he does not do, no matter how much you give him to drink.

On the same fun level as George, are Electronik-Kit Mechanimals. Meccano-like but rather more modular, the constructed walk, hop, crawl and jump their sci-fi way across almost any surface. They are not really electronic, since their electrical involvement ends at the level of motors, but they are well worth mentioning, since they serve as supermob mobile bases for robot builders.

Moving further into the field of modern electronic toys, we find the variants on pocket calculators, synthesizers and even computers. Lil Genius has the format of a very simple pocket calculator, dressed-up with garish printing to look like a schoolteacher and with flashing eyes which signal approval or disapproval at your attempts to answer the arithmetic problems it poses.

For music

That mini synthesiser, the Stylophone, is still going strong under Rolf Harris' wing with a big brother now on the market. Pure-a-Tone goes a stage further with the ability to recall your compositions, arrange them to a given tempo and add effects like echo and note mixing. A few years ago this instrument was the dream of many a rock group.

There are a number of simpler musical instruments, described variously as electronic organs or pianos, based on a simple tone generator with either electronic or manual keyboards. Many of them can provide cheap but acceptable music for the child starting on a musical career.

Then there are television games, where the field is now so big that nothing short of a full review would suffice, and even that would be hopelessly out-of-date by the time it was published. Those games are becoming more sophisticated, more adaptable and more complex every few weeks, and the ubiquitous micro is there more and more.

Toys have always been used in the imitation of the adult or 'real' world, possibly nowhere more blatantly than in the field of weaponry. From the Ideal Toy Company, Tin Can Alley has a beam of light from a rifle which causes a row of spring-loaded tin cans to hurl themselves around the room whenever they are 'shot'.

From Harrods there is the Sonic Fazer Computer Gun which, according to the literature, uses a 'computer chip' to produce sounds including 'Anti Gravity', 'Ion Transport', 'Radiate' and the even more innocuous 'Mass Invert'. To round it off the American manufacturers have included what they call an 'inter-space voice projecter'.

There are variations on this theme and I would not be too surprised to see them kitted-out with infra-red sights or laser rangefinders before long.

Serious in intent

Often disguised as military games but nevertheless much more serious in intent are the games of strategy. Into this category falls by far the largest number of games and there are big inroads from the electronic industry. Initially, electronics is being used for scoring purposes, often programmed to add a few special effects from time to time but still relying largely on traditional materials and schemes.

Interceptor from Action Games is described as a 'Search and Destroy' game, with one player manipulating an attack jet through a battlefield to bomb an airbase. Sam missiles, interceptors, flashing lights and a host of whistles, bangs and flashes bring it to life.

MB Electronics offers Computer Battleship, another hybrid using a complex game board covered in plastic ships and pegs with a built-in computer to model the field of battle, keep track of the scores, and supply a stream of assorted sonar 'pings', missile whistles and, of course, the game sound.

The Waddington Sonic UFO is a strange combination of board game and beeping-emitting-UFOS In which the players have to identify a position entirely on the level of sound being emitted. The same firm's Code Name: Sector has the participants hunting a very strong-willed submarine over a traditional board but with the addition of a complex console full of electronic strategy, scoring and sound.

Along slightly more traditional lines run various chess and backgammon players, complemented by the runaway success of the Invicta Mastermind — again with many copies around under different names — and the arrival of variants like BlackJack from Actionable; a pocket calculator with the ability to deal hands of blackjack when not engaged in pocket calculating; and Bridge Challenger from Computer Games Ltd, a box of tricks which can play from one to four hands under most of the common systems, reading the specially-encoded cards as they are dealt to it. This game, incidentally, uses two microprocessors and has 168KB of ROM and 851KB of RAM.

While on the subject of the para-military, it is worth mentioning that walkie-talkie sets have progressed a very long way since the days when I tied together two tin cans with a piece of string and tried to discover whether we were hearing the message over the string or through the air. The Inter-Galactic Communicator from Harrods may not live up fully to its name but it uses modern low-cost electronics to give the kind of clarity and power one expects from the real thing.

To my mind, realism in its most addictive form is heralded most clearly in Mark Blaster from Spectrum. A hand-held plastic moulding contains a small display screen and a fire button, together with a three-way selector switch and various odds and ends. Periodically at a slow setting a flying saucer screams, literally, down the display and you have to select the correct track for an air-to-air miss or hit. You do not which you launch, with full sound effects, and which hopefully blows up the invader, again with much audio accompaniment. If you miss, you blow up.

We find that our information reaches us via electronic links. Many electronically-operated children's toys can produce strong emotional and psychological reactions — the doorbell, the telephone or even Orson Welles on the radio warning us of the landing of the Martians. All these and many other inputs can be simulated, synthesised or copied electronically and it seems likely that some of the toys and games of the next decade will be able to simulate them and other effects to give us a co-ordinated and very real experience — for example, the complete launch of a moon rocket from the astronaut's point of view or the flying of an aircraft or an invasion from Mars.

Displays

Perhaps the biggest problem in the development of computerised adult toys is still the business of displays. While electronic dials, lights and sounds could well go a long way towards creating a realistic atmosphere, the fact that many of the strategy games still rely on cardboard playing areas and much shuffling of plastic bits must be a source of annoyance to games manufacturers.

The imagination leaps to animated holograms: Middle Earth, Dungeons and Dragons and other fantasy games in which participation can become so realistic that it might seem real for the players. Fantasy games were quick to respond to the arrival of the personal computer, used largely to keep track of the convoluted scoring systems used in this field, but given the possibility of ever more ingenious use of ever more powerful micros, the business of boys and games may be set for a major change of direction.
Computer paymasters have to be convinced

If you are in the unfortunate position of wanting to start computing studies in your school but find it hard to convince people that it is a good idea, there are no easy answers, but what follows might provide you with some ideas.

The worst thing about a computer is that it is costly and, as anyone in any school will tell you, that is a disadvantage. Even a second-hand terminal will cost £200 and the service contract on that will probably be another £150 a year.

If you manage to wring that meagre sum from the bureaucrats you still have the cost of an acoustic coupler — to link your terminal to some remote computer; and the telephone bills — you will use telephone lines. Not least, there is the computer time to buy. Trying to justify the expenditure is, to put it mildly, difficult. If the controllers of the purse-strings know nothing about computing, you may feel like giving-up the idea and investing what you have in slide rules.

You are short of money and talking to a headmaster who has a BA in Ancient Greek history. He knows nothing about computers and hopes microprocessors will go away. What do you do? The answer is simply to make the computer do something really useful. There are two obvious options, Computer Assisted Learning and administration — see his eyes light up at that last suggestion.

Computer Assisted Learning is a process by which the computer instructs and tests individual pupils. It is limited by the accessibility of the machine and the number of terminals available — so forget it. Except perhaps as a one-off demonstration program teaching English-French translation or multiplication tables — or Ancient Greek history. It is a method of instruction which is bound to grown as the cost of computer hardware falls but at the moment it is probably not for you.

On the other hand, administration provides endless scope for the computer and something the headmaster will understand immediately. Time tabling springs to mind as an immediate application but it presents major problems for the programmer, and even commercially-available programs cannot produce successful timetables from simple raw data. So put it aside.

The creation of a databank of facts and figures about the pupils in the school might also suggest itself.

Sandbach High School has been involved in the field of computer education for more than four years. We have an on-line terminal linked to the computer at the South Cheshire College of Further Education at Crewe. It is used extensively as a teaching facility and it is also employed as an administrative workhorse. For three years, it has handled the sorting and collating of the fourth-year option scheme and has more than earned its place, and its keep.

More recently the school has acquired its own machine, an 8080-based micro with 48K of RAM and twin floppy discs designed for the school by Real Time Computer Systems of Crewe. It meant that the system, developed originally at the college had to be re-written in Microsoft Basic for use in the school.

Fast printer

Both machines are well suited to data processing use. At the college there is a 16-bit Data General Nova 2 configured with six on-lines, disc operating system, disc backing store and a fast printer.

Our machine is designed to handle a number of slave terminals but has no fast printer. It is slower than the 16-bit Nova 2 but has ample file space on the discs. The sample outputs shown are printed on an Olivetti TE300 terminal from the school micro.

Fortunately, both the Data General and Microsoft versions of Basic allow for sophisticated data processing — arrays of (continued on next page)
choose the examination subjects they will follow in their fourth and fifth years. The subjects offered can vary considerably from year to year but the system used to organise the choices remains constant. Each child chooses five option subjects, one from each of five groups A-E. The programs allow for a maximum group size of 20 subjects. In addition, the pupil chooses a leisure option (L) and is placed in an English and a mathematics group (G and H — no choice here).

The information is recorded for use by the computer in the form of an ordered data file. Each record contains the name, sex and form of the child, followed by eight numbers denoting the option choices. A typical record might be:

J. SMITH (G) 3L, 1, 4, 3, 6, 2, 8, 4

A the girl in 3L has chosen option subjects A1, B4, C3, and so on. Another data file stores the titles for each option described in some detail. SAISJHSORT is a classical bubble sort; although fairly slow in sorting a completely disordered file, it is extremely fast in sorting a partially-ordered file. It is used whenever new data is added to the file.

SAISJHMP6L produces a listing of the (ordered) data file. A copy is kept in the school office; if any child needs to be found within the school, the list can be used to locate his or her classroom by comparison with the master timetable.

**SAISJHMP6L**
This program is concerned with the organisation and collation of the data file. During operation, the user is asked for certain command keywords:

**LIST:**
The program allows the user to type-in the option group and number of any option subject for example, 'D4'. An alphabetically-ordered listing by forms, boys before girls, is then made on the printer.

**NUMBERS:**
The program scans the data file, counting the numbers of children in each option subject. Results are obtained for total numbers and for numbers of boys and of girls. The program requests the identifiers of any number of option subjects and merges the groups to produce an ordered listing within which coincidences have been eliminated — useful where a subject occurs in two option groups.

**MERGE:**
The program requests the identifiers for two option subjects. It then searches for numbers denoting children in each option subject. Results are obtained for total numbers of boys and of girls. The program requests the identifiers of any number of option subjects and merges the groups to produce an ordered listing within which coincidences have been eliminated — useful where a subject occurs in two option groups.

**COINCIDENCE:**
The program requests the identifiers for two option subjects. It then searches for numbers denoting children in each option subject. Results are obtained for total numbers of boys and of girls. The program requests the identifiers of any number of option subjects and merges the groups to produce an ordered listing within which coincidences have been eliminated — useful where a subject occurs in two option groups.

**LIST ALL OPTIONS:**
The program prints-out automatically the contents of each option file from A1 to H20. It is a repeated and automatic application of the LIST facility.

**SAISJHTED**

With children leaving or entering the school or, worse, altering their option choices, it is necessary to have some system to edit the data file. This program, acting on the following command keywords, performs this function:

**FIND:**
The program requests a name and then scans the data file looking for that name. When located, the name and all associated option choices are output to the terminal.

**DELETE:**
The program requests a name, scans the file, and deletes the record.

**AMEND:**
The program again requests a name and finds it; the user then edits the record. The program asks if the record is to be saved; if saved, the record is stored with the data file. If not saved, the record is deleted.

Those are the main programs within the package. Other programs are, of course, necessary. There are programs to create the data files, to append the files and to
produce copies of the files. In addition, there is one program which has proved particularly useful — SAISJHPPPLS. At the beginning of the fourth year all fourth-year form teachers are issued with a printout from this program. It produces a listing of all option choices for each pupil organised by form. So the form teacher of form 4R, for instance, knows which options each of the children in his class should be following.

The most recent addition to the package is a program which prints out individual timetables for each child. The master timetable is built into the program, which accesses the data files to produce the output.

The usefulness of the programs detailed must be self-evident. They have been used extensively and their superiority over any manual system of data processing is obvious. Information is available more quickly and it is presented well and more of it is available. For example, a program has been written to identify the relative popularity of all combinations of three subjects chosen from five, a task which takes the computer minutes but would require many man-hours of human processing.

Although the Sandbach programs undoubtedly saves a great deal of time in the construction of lists and statistics, they also make great demands in terms of data preparation. Someone has to type in all the names and option choices and all the data has to be checked before it can be used. The data has to be prepared only once, though, and it can be achieved in a reasonable time, perhaps an hour and a half for 200 names.

A word of warning. Anyone who decides to write any kind of administrative package must be prepared to spend a good deal of time programming and debugging. The exercise is probably not cost-effective for those whose programming skills are only slightly better than those of the children.

Having decided to use the machine in this way, however, be prepared for an avalanche of requests for additional facilities and even a computer thrust on you by a classicist tired of data processing by hand.

Finally, my thanks to those who have helped to make these systems operational, especially Don Grimsditch and Dave Pugh at SCCFE for allowing me to use their computer — and miles of paper.

Overall schematic.
Startraders can keep you busy for six hours

STARTRADERS may not be the biggest game in the world but it is certainly the longest we have published. It concerns the economies of starships trading between primitive and developed solar systems.

Dealing in software, uranium and other goods of a futuristic character. Copes with two to 12 players. Allow at least six hours for a game; if you have to stop, there is a subroutine to save the variables for the next session.

The program is in two parts: Trades sets up the game; Sedrat runs it. Trades needs 7.4KB, Sedrat 17.5KB in Research Machines Extended Disc Basic.

To adapt the program to other machines, the main problem will probably be with lines like 3290: "OPEN* 10, "TRDU", etc stores the values of the matrices $S$, $T$... in the file TRDV to be read back by Sedrat. To adapt the program to languages without that command, one would have to read each variable from each matrix with a FOR loop and then store it in a sequential file, and vice versa.

The last line of Trades is LOADGO 'SEDRAT' which will load and run the second program of the game. Failing that, you can do it manually.

660 INPUT AF
670 IF AF="H" THEN GOTO 1000
680 IF AF="E" THEN GOTO 1000
690 "The date is Jan 1, 2070
700 "Flight has existed for 17.5KB years. There are several star systems that have been colonized. Some are on the frontier."
710 "Systems, others are older and more developed."
720 "Each of you is the captain of two starships. You will travel from star system to star system."
730 "Buy and sell merchandise. If you can make large profits,"
740 "you can keep them."
750 "Your ships can travel in light-years per day."
760 "Slowly grow, and it's needs will change."
770 "A star system that now is selling much uranium and raw metals cheaply may not."
780 "Have enough for export in a few years."
790 "Your ships can travel for two star systems have"
800 "Now tons of cargo. Only class"
810 "Class II star systems have"
820 "Banks on them. They pay 5% interest and"

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(continued on next page)
2750 *X=-Y
2750 *X=0
2730 ON H GOTO 2840,2800,278
2760 RETURN
2850 IF SQR(X-S(11,J))f2+(Y
2840 FOR J=1 TO S1-1
2830 REM SECOND,TEST PROXIMITY
2820 Y=2
2810 X=Y
2800 2=X
2790 GOT02840
2780 Y=-Y
2770 GOT02840
2760 Y=7.

(continued from previous page)

2950 REM MODEL #1
2910 S(12,51)=INT<Y)
CTR
DS AND INCREMENT HALF -BOARD
2890 REM FINALLY, ENTER CO -OR
2880 NEXT J
2860 F=0
2850 IF (S(12,J))t2)>=D9 THEN 2880

3030 NEXT XX
3020 NEXT YY
3010 T(XX,YY)=0
7000 FOR YY=0 TO 12
7010 FOR XX=0 TO 12
7020 NEXT YY
7030 NEXT XX

2900 DATA -.5,.5,1.5,-.5
5,-1,-1.5
75,-.75,-.75,-.75,-.50-1.5,.
2970 DATA 1,1.5,.5,.75,.75,.

3000 LOADGO"SEDRAT"
3360 WRITe #10,W,D9,K9,X9,D1
3350 NEXT
3340 WRITE #10,T$(1),N$(1)
3330 FOR I=1 TO 12
3320 MAT WRITE #10,S,T,B,M,C
3290 OPEN #10,"0"0"TRDV"
3280 ERASE"TRDO"
3270 RETURN
3260 FNEND X
3250 IF X<Y THEN FNRETURN Y
3240 DEF FNM(X,Y)
3230 END
3220 RETURN
3210 NEXT
3200 INPUT N$(I)
3190 FOR I=1 TO P9
3180 ?
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PRACTICAL COMPUTING December 1979
PRACTICAL COMPUTING December 1979
(continued from previous page)

2680 GOSUB 5570
2670 ?TAB(5);
2660 IF S(7,S1)<10 OR T(11,7)
2730 S(11,S1)=S(I1,51)-T(7,T1)=T(7,71)-X*(I1<5
2720 T(I1,T1)=T(I1,T1)+X
2710 ?TA8(5);"Sold!"
2690 IF Y>T(11,T1) THEN 2600
2590 NEXT K1
2580 P(I1)=.8*P(I1)+2*Y/X
2570 NEXT I
2560 J=J+S(7,I)
2550 FOR I=1 TO 59
2540 J=0
2530 IF S(I)=15 THEN 1040
2520 GOSUB 6140
2510 NEXT I
2500 "**
2490 FOR J=1 TO 6
2480 S(7,51)=S(7,51)+.02*RND
2470 PRINT "What is our next for
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10 FOR S=7 TO 9 
10 IF S7=1 THEN 3900 
920 S7=S7-1 
910 S7=S7+1 
900 IF S7=0 THEN 8900 
8900 NEXT J 
880 ?"Local holiday soon";
870 PRINT "...";"J1." Week delay."
860 D2=D2+1 
850 GOTO C9,T(9,T1)+2 
840 IF T(9,T1)<536 THEN 43 
830 GOTO C9,T(9,T1)+2 
820 C9,T(9,T1)=T(9,T1)+2 
810 M=INT((C9,T1)-1)/20)
In this document, there is a mix of code snippets, financial calculations, and some natural language text. It appears to be a mix of programming code and financial statements. The code includes variables, mathematical operations, and some English text. The document seems to be a part of a financial or banking simulation program, possibly written in COBOL or a similar language.
The Paper Tiger is here.


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Unbeatable capability.
The Paper Tiger prints just about any paper form you need. From address labels to multicopy invoices and legal-size reports.

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Teleprinter Equipment Ltd.,
70/82 Akeman Street, Tring, Herts.
Telephone: (044282) 4011 (20 lines)
Telex: 82362 BATECO G

Comparison data from manufacturers' current literature for 60 Hz operation.

<table>
<thead>
<tr>
<th>Feature</th>
<th>Lear-</th>
<th>Seigler</th>
<th>Texas Instruments</th>
<th>Integral</th>
<th>Data</th>
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<th>Lear-Seigler</th>
<th>Texas Instruments</th>
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<td>105</td>
<td>Data not available</td>
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Unit Price + VAT, P & P

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<th>Lear-Seigler</th>
<th>Texas Instruments</th>
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<td>£1500+</td>
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<td>£995</td>
<td>£21</td>
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</table>

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TELEPRINTER EQUIPMENT LTD

PRACTICAL COMPUTING December 1979
Getting to grips with the MK-14

Where those traps lurk for the unwary

If you haven’t built your MK14 yet, stop. Buy a load of IC sockets — you will need them. If you’ve built your machine but it doesn’t work, check your soldering again; about 90 percent of faults are due to duff soldering. A jeweller’s eyeglass is very useful for checking joints. Look for solder which has not wetted the conductors properly, and for ‘whiskers’ of solder shorting two adjacent conductors together.

Most of the rest of the faults are due to wrongly-inserted components. Check that ICs are the correct way round — on the MK14 they should all have their pin 1 code at the top — the same way round as the keyboard. An IC may be the proper way round but have one pin folded up under it. Again, a thorough check with the eyeglass is worth the trouble.

If you’ve used sockets so that your ICs are unlikely to have suffered heat-death, the problem may be in the power supply. Have you checked the fuse?

Drawing current from a supply causes its voltage to drop, so a nominally sufficient supply may drop below the required 7V under load, especially if it has to cope with extra RAM, a cassette interface, and other add-ons. The ripple from mains power supplies also worsens under load and can appear as keyboard bounce. Cure is a larger smoothing capacitor — C2 on the circuit board. If you buy a bigger supply, for which the cure is a heatsink — rule of thumb; if it’s too hot to touch, it’s too small — and/or a resistor between power supply and regulator. Should the instruction book leave you baffled, try 4.7 ohm rated at least 1.5 W. If necessary, add more of them nose-to-tail. A heatsink is a good idea in any case, since the cooler any component the longer it will last.

If you use batteries, for example, as a portable power source, it is still worth putting in C2. It provides a small reservoir of current in case of momentary power loss and also eliminates the risk of HF instability, which can affect regulation.

To round-off the subject of hardware, what can one do about the keyboard? When keyed-in entries start producing garbage on a previously well-behaved machine, the most likely culprit is the rubber sheet sticking to the PCB.

Temporary relief can be gained by turning-over the sheet or making a paper spacer to aid the transparent one. If you haven’t yet started building your kit, don’t peel the spacer from its backing. A new keyboard, however, is almost essential. A set of push-keys will cost £5, but old pocket calculators provide an excellent alternative. The 16-way edge connector is satisfactory for the job.

Numbers game

The newcomer to machine-code programming often finds negative numbers and complements confusing. Even the revised instructions supplied by Science of Cambridge leave something to be desired. Perversely, perhaps, I shall start with binary addition — and by the way, section 7 of the instruction book is incorrect; the third rule of addition is ‘1 + 1 = 0 with carry’, like adding 5 + 5 in decimal.

When large numbers are added, they can overflow available storage and leave behind a number smaller than either original. Take this four-bit addition:

```
 1010
+ 0111
-----
 0011
```

In decimal it would appear as 10 + 9 = 3, which is patently incorrect. 10-7 = 3 would be more like it:

```
 1010
- 0111
-----
 0011
```

Computers cannot store plus and minus signs, only 0s and 1s, so storing negative (continued on page 87)
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Note that the most significant bit contains the sign -0 for negative numbers and 0, 1 for positive numbers.

The memory reference and jump instructions of the SC/MP assume that address displacements are in two's complement form. All numbers with the MSB (bit 8) set to 1 are assumed to be negative. So bit 8 is used as a sign indicator, leaving only seven bits to give the actual size. Which is why maximum displacement is 127, or 2^7 - 1, or Hex 7F.

Relative addressing

There are two more traps lurking for the unwary. In relative addressing, memory reference instructions count from the second byte of the instruction. So instruction 0F36 at location OF30 means 'LD from OF31-IA = OF18'.

Jump instructions increment the PC again after jumping, so displacements are calculated from the following instruction. Thus 90E6 at location OF30 means 'JMP to OF32-1A = OF18'. Similarly with indexed addressing, memory reference instructions count from the index address and jump instructions from the next one.

Logic functions appear very strange to many of us. The computer compares the same bit from each of two numbers - in AC and EA - and sets that bit in the result according to a table of values called a truth table, invented by philosophers. Here are the tables for the SC/MP:

<table>
<thead>
<tr>
<th>AC</th>
<th>EA</th>
<th>AND</th>
<th>OR</th>
<th>XOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>

For example, 11010011 OR 00011001 becomes 110110110, XOR is 000000011. The eight segments of each display digit are coded as in figure 2, so the text code for A is 01111110, or 7E.

Debugging aid

Another aid to debugging is the use of XPPC 3 to stop your program in mid-flight and display the next byte. You can then look at registers and the like. Return to where you left off, hit GO, and the program continues.

Some of you may have tried the 'Message' program from the official guidebook, which I found somewhat agricultural. Here is a more comprehensible version; it allows text up to 128 characters to be entered forwards, and caters for spaces. No characters need repeating. In addition, any part of a larger text may be displayed.

To run, enter text address in OF12 and OF13 with length in OF14. If length is entered as 00, the program will substitute as a sign.

The memory is no better than mine.

The eight segments of each display digit are coded as in figure 2, so the text code for A is 01111110, or 7E.
Exidy Sorcerer users seem to be neglected, partly because we seldom receive manuscripts, but here is a collection to compensate.

How to use those graphics capabilities

The two manuals with Sorcerer, A Guided Tour of Personal Computing and A Short Tour of Basic, leave a few things unexplained. At least for those Sorcerer owners who are new to computing, it requires detective work and experimentation to find some of the capabilities of the machine. This is particularly true of the graphics, so here is an explanation which should save a good deal of effort for those owners who have not yet worked out how to use them.

Printing and Poking

There are three ways of making a particular character, let us say a Z, appear in a chosen position on the screen. For the first two, the cursor has to be in that chosen position. They are:

- PRINT "Z" POKE -3500,90
- PRINT CHR$(90) PRINT "Z"

It saves trouble to enter the first two as ?"Z" or ?CHR$(90), 90 is the ASCII character code for Z. Appendix G of the Basic manual gives the complete list of standard characters. We shall reach the non-standard Sorcerer graphics characters in a moment. The -3500 is a memory address in the part of the memory containing the display screen space. Since there are 64 characters on a line and 30 lines, there are 64 x 30 = 1,920 such addresses. They run from -3968 through -2049, corresponding to the top left and the bottom right positions on the screen. So POKE -3968,43 will put a + in the top left position.

Ready-made characters

The Sorcerer also has 64 ready-made graphics characters, which one can print by using the appropriate key with the SHIFT LOCK and GRAPHIC keys depressed. Some, but not all, of those characters are marked on the keys. The complete set of them is shown at the bottom of page 23 of the Personal Computing manual.

Since neither manual indicates the character codes for those characters, you can have the machine tell you what they are by using the following program:

```
10 FOR J = 127 TO 187 STEP 4
20 FOR K = 1 TO 4
30 PRINT "CHR$(1): J+K:"; CHRS(J+K); "";
40 NEXT K
50 PRINT: PRINT
60 NEXT J
```

It enables you to see most of the 64 at once. Now it is clear why POKE -2049,153 will put a heart at the bottom right of the screen. POKE -2049,32 will remove it, since 032 is the ASCII code for a blank space.

Returning to the 128 ASCII character codes, 000 to 032 are for giving instructions to Teletype machines and are of no use if your Sorcerer is hooked to a video display. There are two important

```
(continued on next page)
```

Useful tips for Basic functions

There are no instructions on using the USR(X) function. In the Basic interpreter it is a section which places a CALL instruction in memory location 0103 HEX, to use the USR function you must first enter the address of the subroutine into locations 0104H (Low order) and 0105H (HIGH ORDER). This should be done with a poke command before the call, i.e.

```
10 POKE 260,16
20 POKE 261,00
```

This means your routine starts at 0010H. Now you can insert your USR call anywhere in the program like below.

```
200 A = USR(0)
```

A is a dummy variable and its value will be altered.

0 is a dummy argument.

Any letters can be used instead of a & O.

To return to Basic, a C9H should be

```
In order to use any non-standard Sorcerer graphics characters, they must be altered.
```

```
BANK 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
1 STOP CLEAR X C F B M R , / \ - + 0 . not
2 GRAPHIC REPEAT Z D R V I L . @ RETURN X 1 2 used
3 CTRL SPACE A S E G H J O ; ? LINE FEED 4 5
4 SHIFT LOCK Q V 4 T I U 9 P C ^ A = 8 6 =
5 SHIFT (SEL) 1 2 3 5 6 7 8 0 : - NOT USED 7 9 3
```

See pages 65-66 of Guided Tour and following. The Sorcerer keyboard is software scanned. It is arranged into 16 banks of FIVE keys. The bank is selected by sending a number between 0 and 15 to Port No: FE. The key pressed is returned on bit 0 to 4 of input Port No: FE. Care must be taken to force bits 5 to 7 to a zero value to obtain a number in response to a key pressed. The keys are shown below.

```
BITS 0 - 4 of FE are normally LEVEL ONE and go low only if a key of the selected bank is pressed.
```

```
Numbers obtained with bits 5-7 RESET to 0
NO KEY PRESSED = 31
KEY IN ROW 1 = 30
2 = 29
3 = 27
4 = 23
5 = 15
```

```
PROGRAM TO SCAN THE "0 - 9" & "=" & ";" keys on the number pad.
```

Basic part

```
10 POKE 260,16: POKE 261,00
```

Ralph Turvey

```
looks into Sorcerer graphics.
```

PRACTICAL COMPUTING December 1979
The subroutine

START MANIPULATING

PRESS

OPTIONAL IF YOU WANT TO

VARIABLE

TRANSFER

routine is

then 20

40

30

20

10

- - - - - -

60	84

50	78

40	62

30	56

20	50

10	44

00	38

- - - - - -

THE SUBROUTINE

used in real-time programs like "STOMP".

Examples of the ready-made characters, like the do-it-yourself ones, occupies eight memory addresses. Character number x is in the eight addresses starting with -2048

ADD

ADDR

000H - F5 C5 D5 E5 - PUSH REGISTER TO STACK

001H - CD 18 E0 - CALL E0 (KEYBOARD ENTRY TO MONITOR)

0014H - 520 00 - LD ADDR (0000) FROM REG A

001AH - EI DI CI FI - POP REGISTER FROM STACK

001EH - C9 - RETURN TO BASIC

This program uses the Monitor Program to scan and decode the keyboard so you gain access to all ASCII codes and graphics.
Wizardry with Sorcerer

(continued from previous page)

+ 8*Y. Thus a question mark, which is character number 63, is in addresses -1544 through -1537. The routine: FOR J = -1554 TO -1537 : PRINT PEEK (J): NEXT will yield the numbers shown on the right of each of the binary numbers:

```
 00111000 = 56
 00111100 = 60
 00111101 = 61
 00111110 = 62
 00111111 = 63
 00100000 = 24
 00100001 = 33
 00100010 = 34
 00100011 = 35
 00100100 = 44
 00100101 = 45
 00100110 = 46
 00100111 = 47
 00101000 = 56
 00101001 = 57
 00101010 = 58
 00101011 = 59
 00101100 = 60
 00101101 = 61
 00101110 = 62
 00101111 = 63
 00110000 = 48
 00110001 = 49
 00110010 = 50
 00110011 = 51
 00110100 = 52
 00110101 = 53
 00110110 = 54
 00110111 = 55
 00111000 = 64
```

One can change the 64 ready-made graphic characters in the same way as one can create 64 of one's own. Beware of the fact, if changing any of them, that PRINT CHR$(I2) will not only clear the screen but will also change them back to their original shape.

Blinking

The techniques described can be combined to create some elaborate graphic effects. You can fill the screen with some pattern of characters and make them all change at once into some other character and then back into the first one. If you do this with character 192, for example, and use:

```
FOR U = 0 TO 600 : NEXT
```

as a Delay subroutine, the routine would be made up of the following components:

- Clear screen and show a pattern consisting of, or including, a dot-it-yourself character, e.g. 192.
- Generate character 192 — e.g. a hollow square.
- Delay.
- Generate a different character 192 — e.g. a solid square.
- Delay.
- Go to (b).

All the squares in the pattern will then blink simultaneously from hollow to solid and back for as long as you can let the machine run. This is somewhat boring but the technique probably has all kinds of useful and amusing applications. It would be interesting to hear about them.

How to represent your characters

The Sorcerer has great merit in that you can define your own graphic characters but the procedure detailed in the Sorcerer manuals, whereby hexadecimal code is placed into successive memory addresses using the monitor, is somewhat tedious. The equivalent Basic program listed makes the defining of graphic characters an easy process, so that each one can be done in a few seconds.

The first stage is to work out how to represent the desired character by an eight-column, eight-row arrangement of dark and light squares. One way is to use quarter-inch or similar graph paper and fill-in the squares which need to be dark with pen or pencil.

I find it more convenient to use a set of 54 pieces of graph paper, 2cm by 2cm — which are white on one side and black on the other. They are arranged in an 8 by 8 matrix on a tray and I can turn over individual cards and change the arrangement until it represents the graphic character I want.

The second stage is to decide where on the keyboard the new graphic is to be.

Make a copy of the keyboard template and write your new character in the place where you would most likely look for it when you want to use it. For example, the Greek letter delta would go on the D key, while the mathematical symbol not greater than would go on the greater than key.

Then we are ready to use the Basic program listed. When run, it first prompts with "Key NAME?". That is not strictly necessary but is helpful when you are faced with a mass of similar-looking numbers later, to distinguish one set from another more easily.

The second prompt is "Which KEY?". There you press the graphic key, the shift key, and the key of your choice. At first it will show a rectangular block but when the program is finished it turns into the character you want.

After printing "Column: 12345678", the third prompt is "Row 1?". You then type-in a string of eight characters, each of which is either one or other of those you use in the data statements of lines 300 to 315. I use the graphic characters on the graphic 192 — (minus) and 7 (seven) keys of the numeric keypad. My Anadex printer prints them as 1 and 2. Note that Sorcerer does not understand a space as the start of a line.

With a finger of the left hand on the graphic button, your right thumb on the return button, and your first and second fingers on those numeric keys, you will soon be entering graphic characters at great speed.

Should you make a mistake, you can press return after an 8-character row, then we are ready to use the Basic program:

```
READ M
FOR K = 1 TO 64
READ N
POKE (-1024 +8x(M-128)*R-1), N
NEXT R
NEXT K
```

These programs will also work with the standard graphic keys but unless your keyboard program is made at the start of your main program, your graphics will be replaced by the standard graphic if a RUN command is given. This does not apply to the user-definable graphics, which remain in the keyboard memory until the power is switched-off.

John Martin deals with the theme of user-defined characters in greater detail.
Saving disc space with control programs

THE FLEXIBILITY of large or small disc-based systems can be determined solely by
the methods used to store and retrieve information. In any system which will
become more complex in terms of storing data, a significant saving of disc space and
memory overhead can be achieved by starting with a powerful file control program.

Part one covered the basic concepts of assessing files, linking records according to
their logical sequence, and so on. By using those concepts we can now discuss some
typical and very useful file-management techniques used in industry and commerce. They are not as difficult
to implement or understand as they may at first appear and after a time will become instinctive as you design your future systems.

The technique of partially-linked files

stores information on a secondary file in "chains" of information, which each relate to one record on a main file. Each record in the main file contains pointers to the first and last record in the secondary file — figures 1(a) to 1(e).

This shows the initial set-up before use. The free chain of the secondary file is initialised, with the first free record pointer (FFRP) set to the first record on the file. The pointers on the main file are initially set to nulls, since the secondary file is empty.

This shows how the file may be structured after a little use. Customer A has three transactions outstanding, customer B has only one. Customer C has none and therefore does not use any disc space on the secondary file.

The last record in every chain in the secondary file has its "link" pointer set to a null to indicate to the processing programs that all transactions for the current main file record have been encountered.

The main advantages of using this storage technique are:

(a) For most processing applications the record access times can be as fast as those for direct files.
(b) Since each chain relates to only one

main file record the search time for, say, a particular invoice number is minimised.

c) New records can be inserted quickly and deleted records are released to the free chain for future use.

(d) If the physical location of the main file record is changed — e.g., a customer is transferred to another slot on the main file or is re-organised (see index-sequential) — the sec-

Figure 1(a).

ondary file remains intact, since the FRP and LRP are held on the main file.

(e) By monitoring the number of live records — held on the file directory — on a regular basis, the size of the secondary file can be "tuned" to a minimum.

This shows how partially-linked files may be cascaded for a typical production control system. For each product the sequence of departments through which it must pass is held on a secondary file and the sequence of operations within each department is held on yet another secondary file.

That method of cascading files may be repeated ad infinitum, thus enabling programs to 'hop' from file to file, collecting or searching for information very rapidly and with the minimum number of disc accesses. When inserting or deleting partially-linked records the new LRP must be returned to the only free chain — and that all LRP pointers are either null or point to a record containing a null.

When deleting a record which contains pointers to other files the program should check that the pointers are "nulls". For example, if in figure 1(c) the 'Dept 1' record is deleted and released to the free chain, then two records on the process file will be left unusable and inaccessible by "file hopping".

All records in a partially-linked file should be "accounted for" in terms of the FRPs, LRPs and the record chains, leaving the FFRP to account for the remaining free chain. Self-checking programs become invaluable in complex systems to verify that files are intact before taking security copies of discs.

A good example of this technique can be described with the file structures in figures 1(a) and 1(b). Suppose that a customer's balance is held on the main file; it can be verified by the algebraic sum (debits and credits) on the transaction file.

Indexed files are used when the physical position of a record cannot be calculated by manipulation of the desired method of reference. Names and addresses, catalogue numbers, product descriptions and the like fall into this category.

Imagine a product file to be referenced by a seven-digit code of the form 123/4567 where the first three digits are the product type and the last four are the size.

A direct file would require a file length

(main file record for disc update, or the logical chaining will be lost, leaving a 'cobweb' of meaningless pointers which may be impossible to unscramble.

A small program which checks all linked files is worth writing, especially for program development when 'bugs' are liable to corrupt pointers. The self-checking program should verify that all FFRP pointers on the directory eventually reach the end of the file — i.e., follow
of 9999999 records which is clearly impracticable unless you wish to make the floppy manufacturers very rich. By using the seven-digit code as a "key" to a

main file.

The program needs to know the key length, the key position within the main file, the index density and the file names or file numbers of the main and index files. The program starts reading from the

seven-digit code as a "key" to a floppy manufacturers very rich. By using impracticable unless you wish to make the of 9999999 records which is approximate position on the main product separate index file we can find the holding the key to the index file for every copy the key value and the slot number ascending integer values. We can now physical and logical sequence with keys in number used to hold it. The file is now in sequential file, as described in part one, and is loaded initially with our product file in ascending key sequence — figure 2(a).

Do not confuse the record pointers with the key, or the key value with the slot number used to hold it. The file is now in physical and logical sequence with keys in ascending integer values. We can now copy the key value and the slot number holding the key to the index file for every nth record on the main file, where n is the index density which will determine the FRP on the main file and writes a record to the serial (index) file every nth access. The first record on the main file should be an nth record otherwise slots 1 to n-1 will not be accessible. The program should also check that the keys ascend for all records and that none is repeated.

The link pointer in every record should be equal to the current slot number + 1, except for the last one read, which ought to contain a null and its slot number should be equal to the LRP. Those checks will ensure that the index can be created only on a file which is in physical and logical sequence. For reasons which will become clearer, each indexed record must be marked in some way to indicate that it is indexed; choose the next free byte after the key and set it to a recognisable pattern, but do not mark the pointer or the key in any way.

We now have an index sequential file as shown in figure 2(b) with an index density of 4.

Records on the main sequential file can now be accessed via the index file using the key to search both files quickly. Given a key value, the index file is searched until either the desired key is found — in which case the desired record can now be accessed directly — or until a key of a higher value is encountered.

The previous record on the serial file will direct the search to within n-1 records of the desired record, starting from the indexed record and following the record chain until the record with the required key is located. If a key of a higher value than the required key is found or an indexed marker ($) is discovered during the search, the required record does not exist on the file and that fact must be returned to the calling software — this failure is useful to prove the non-existence of a new record we wish to add to the file.

Once a record has been located via the index, all records up to the LRP can be accessed sequentially without further reference to the index file. If, for example, we wish to print all products from, say, type 23 to type 92 using our seven-digit code, the limits given to the print program would be 0230001 to 0929999 and only the record with a key of 0230001 would have to be read via the index; subsequent records can be read using the pointers in the record chain of the sequential file until a key value greater than 0929999 is read.

When printing or searching a range of an index sequential file, the first record in the range must be a valid record, otherwise the "chain" through to the last cannot be located.

The file size, the key size and the index density will determine the number of sectors required for the index file, which, if numerous, will decrease the response times for records with a high key value. For large index files, further "levels" of index can be created using the same technique — see figure 2(c).

I shall not explain this technique in great depth, since it should rarely be required in floppy environments. Level 1 is searched until "n" records on level 2 are located; they are scanned to give "n" records on the main file to search. Index searches can be very fast even with very large main files, typically 1.5 seconds on

Figure 1(c).

Figure 2(a).

Figure 2(b).
fast minicomputers with more than one million main file records.

New records can be added to the file without having to re-create the index each time. They will fall automatically into logical sequence. The file should be read using the new key, which does not yet exist on the file. The search will fail, proving that the insertion is permissible. During the search the records which will logically precede and follow the new record can easily be determined — they will normally be the last two accesses on the main file before the search fails. The new record is now written to the slot denoted by the FFRP and the record pointers are updated in the normal manner for sequential files — see figure 2(d).

The index file remains unchanged and on sequential reading of the file, records A, B and C will be read in that order. The new record (B) can also be found via the index as easily as any other record in the file by using its key. Insertion of records logically preceding the FRP or following the LRP are a little more complex, since the index file may also need updating.

The memory requirements for the software to do this will be hard to justify on small systems since “dummy” first and last records can be loaded with minimum and maximum possible key values to overcome this problem or if this is not practicable, a new index can be created after the file is re-organised into physical and logical sequence.

The removal of records which are not “indexed” i.e., do not have an entry on the index file — is as easy as for any sequential file. The deleted record is returned to the free chain and the FFRP is set to the slot deleted. The pointer in the logically preceding record becomes the pointer from the deleted record and the pointer in the new free slot becomes the old FFRP.

A record which is indexed cannot be deleted in this way since its physical position, pointer and key are still required for an index read to locate like records logically following it. The deleting software must check for the “indexed marker” ($) and change it to another pattern to be recognised, by software, as “indexed and dead”. It must then be ignored in sequential prints and searches.

Index sequential files tend to be relatively static — customer files, product files and so on; but after a number of insertions and deletions they will take longer to access, since the physical sequence is lost. Logically-adjacent records may be separated by many sectors or tracks, increasing seek times for the disc unit. File re-organisation for indexed files is as follows:

1. Copy the main file to a “scratch” file of equal length.
2. Re-initialise the free chain on the main file.
3. Read records logically from the scratch file — ignoring any marked as “dead” — and write them sequentially to the newly-initialised main file. Do not transfer any link pointers or index markers from the scratch file to the main file.
4. Re-create the index on the main file. We are now back to a file structure as in figure 2(b) with an (n-1) search time for any record.

As you can appreciate, index sequential files are an effective method of storing and retrieving information. Their speed and flexibility make them useful for a wide range of applications. They cannot be cascaded in the same way as partially-linked files, nor can any record be referenced from another file simply by a pointer, since records change their physical position after re-organisation.

All external references to records should be by the key value unless it is a temporary situation which I shall cover when discussing spooled output files.

A Pool File, as its name implies, is a collection of records which form a file containing information of different types. It is simply a dumping area, usually for relatively transient records of different formats like delivery addresses, descriptive text and so on. The software writing a record to the file is, in effect, saying “Here is a record. Store it on the pool file — I don’t care where — but tell me where you’ve put it, and don’t ‘free’ it until I tell you.”

The record is retrieved from the file as a direct access on the slot number returned by the writing software. The file initially is a linked file using only the FFRP. Records are written to the slot denoted by the FFRP which is then updated in the normal manner. The record written to the file does not form any chain within the file (continued on next page)
File handling techniques

and simply awaits its retrieval and subsequent deletion, after which it becomes linked to the free chain again.

For continuity and ease of explanation, I have assumed fixed-length records for all file types I have discussed. This restriction is removed to some extent with pooled files, since the format and use of space within a record is totally defined by the user, subject to the restriction that it must be large enough to hold the largest record to be pooled. The record pointer may be used as an information area, as it is not required during its existence and will be restored — to the old FFRP — upon deletion.

Considerable disc space can be saved using this pooling technique, since main file records need allocate space only for the pointers to the pool file slots rather than its contents, which can be "trimmed" to a minimum in volatile environments.

For example, if a customer file is, say, 2,000 records in length and, say, only 100 of them use separate delivery addresses, then space for 1,900 main file delivery address requirements are saved and the only unused space on the main file is 1,900 null pointers.

Figure 3 shows a typical pool file containing records required by different files.

Spooling techniques are a method of storing data on disc to be retrieved and passed to its destination at a later time. The destination is usually a printer but may be any form of output — for example, a modern link. A typical business system can generate output for different print layouts — invoices, credit notes, delivery notes and so on, each of which must be de-spooled separately.

Some large systems spool information in character format in the same sequence as they would appear at the printer with a separate file for each information "set". This can be efficient with very large discs and very fast printers, since the proportion of the available disc space used is low and time taken to "empty" it is fast. It is not needed on small systems where the volume and speed of printing are much lower, especially if the output device has its own internal buffer — as many matrix printers do — which, as it is emptying, allows the de-spooling program to access main files for the bulk of its output without stopping the printer.

Figure 4 shows a method of spooling up to four separate chains of information using one file. It is fairly simple but sufficiently effective for most micro systems.

The first "n" records of the file are reserved by the software for pointers to separate "spooled chains" of records, where "n" is the maximum number of spool chains allowed on the file. In the diagram, when the spool file is empty the FFRP will point to an empty free chain — records 1-4 will contain null points to indicate to the software that there is nothing to print.

When a spool chain is processed and deleted finally, each record in the chain is released to the free chain, until the previous record is in the range 1-4, in which case the FFRP is set to the slot number of the last record deleted — as usual — but record (1, 2, 3, or 4) has its link pointers set to null.

The contents of each spooled record can now be the minimum — just pointed to other files — required to access all information to be output. Pointers to slot numbers on index sequential files will save holding full-length key values on the spool record, and will allow a direct access on the file rather than an index search.

The only restriction is that any spool chains containing such pointers must be "emptied" before file re-organisation. Spooling techniques, of which this is only one method, allow processing to continue while the output device is not available, and in situations where remote printers are used can greatly reduce the cost of "connect time".

Most or all of the file types I have explained in this series are used in typical industrial and commercial applications, usually in multi-programming environments. The philosophy of storing and retrieving information remains essentially the same, but some problems can occur when more than one program accesses the same files.

This deserves a brief explanation. Figure 5(a) shows two programs attempting to update the same record on a file "simultaneously". Each program will have the same record in its buffer and can update it there. The first program to "re-write" the record will have the changes it made over-written by the second program to "re-write". To overcome this problem, the calling programs must inform the file control program that the record is to be "locked" until released or re-written to disc.

This now leads us to the second problem — figure 5(b) — where program 1 has read and locked RECORD A, and then needs to read and lock RECORD B, but program 2 has read and locked RECORD B and requires RECORD A. The solution, as textbooks have it, is left to the student.
Taking the tedium from data analysis problems

TEN HOUSEHOLDS were selected to test WYTO, a new super detergent — no counter-claims, please, since this is an imaginary example — and 10 others selected to test the well-known brand X. At the end of the tests they were asked to score on a scale from 0 to 5 for each of four features — washing whites, washing coloureds, grease-removal, convenience in use.

The four scores were added, so that the maximum score from any one household was 20 points. The scores obtained are shown in Table 1. Unfortunately, the washing machine belonging to household F broke down and the tests were not completed. When we calculate average scores it seems clear that ‘WYTO washes better’. Not only have it the higher average score, but it also has the highest individual score, 17.

![Table 1](data:image/png;base64,iVxOz...)

<table>
<thead>
<tr>
<th>Household</th>
<th>Score</th>
<th>Household</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>K</td>
<td>B</td>
<td>L</td>
</tr>
<tr>
<td>C</td>
<td>M</td>
<td>D</td>
<td>N</td>
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<td>O</td>
<td>F</td>
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</tr>
<tr>
<td>G</td>
<td>Q</td>
<td>H</td>
<td>R</td>
</tr>
<tr>
<td>I</td>
<td>S</td>
<td>J</td>
<td>T</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Total scores</th>
<th>142</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average scores</td>
<td>15.8</td>
</tr>
</tbody>
</table>

score (19), while brand X has the lowest individual score (9).

Now let us look at this data from another viewpoint. Suppose we had selected 20 households, given them all the same brand of detergent and then chosen a group of nine families to make the group we call WYTO, how easily could we have obtained results like those of Table 1? What are the chances of picking a group of households from those 19 purely at random, which would have an average score of 15.8 or even more?

If we can find a number of ways of doing this, the claims for the efficacy of WYTO are based on little more than good luck in the testing.

To simplify the thinking and to make the conclusions of more general applicability, we substitute ranks for the scores of Table 1. In Table 2 the rating by each household has been replaced by a rank, from one to 19 corresponding to the scores from 19 down to nine. Where two or more tests gave the same score, the ranks are tied, and we allocate the average rank to tests obtaining tied scores. For example, score 18 occurs places 2, 3, and 4 on the rank list, so the average rank is three. Score 17 occupies places 5 and 6 on the rank list, so the average rank is 5 1/2. In Table 2 it still appears that WYTO is better than brand X, even though it can be argued that ‘average rank’ does not have a great deal of meaning.

The results of Table 2 might have been obtained by taking 19 households, giving them all the same detergent — or two brands of equal washing powders — and then picking a group of nine households at random and calling them ‘the WYTO group’. Would this be unlikely to have the same average rank as the remainder, so almost always one group would be ‘better’ than the other?

The number of different ways of picking nines from 10 is 10!10!9! = 92378. How many such groups give rank totals equal to or less than the 69 obtained by WYTO? This is not an easy question to answer offhand, though an enthusiastic reader may like to compile a program to calculate the answer.

Random result

Calculations show that 95 percent of such groups have totals of 65 or more, and only five percent have totals of 64 or less. The WYTO total of 69 is thus not a particularly low one, for one can get a lower total in more than five percent of cases by picking scores at random from among 19 households with identical detergents. So much for the claim that ‘WYTO washes better’.

If WYTO had done a little better in its test and obtained a rank total of 64 we could say:

There is no difference between the detergents, and this is a lucky one in 20 chance which gives WYTO the lead or WYTO washes better — but remember there is a one in 20 chance it is a random result and we could still be wrong to enthuse about WYTO.

To become really convinced about the virtues of WYTO, we might demand an even lower rank total, say, 58 or less, which can be obtained only by random selection once in 100 times. Then we could believe in WYTO with only a one percent chance of being wrong.

The Wilcoxon Rank Test, which can deal with analyses of the kind outlined, is also known as the Mann-Whitney test. The data used can be actual measurements — weights of tomato crops from two sets of plants grown with different fertilisers; numbers — numbers of dental fillings required by two sets of children using different toothpaste; subjective scores — the WYTO data; or ranks — finishing positions of members of two teams of racing cyclists. The two groups can have different numbers of members. To perform the test we:

- Allocate ranks, allowing for ties.

Owen Bishop continues his series, showing how even the MK-14 can be astonishingly powerful with certain statistical routines.

- Total the ranks of the smaller group, and call it T. If groups are equal in size, total both and take the smaller.

- Calculate the conjugate total, T’, which is the rank total obtained by ranking the data in the reverse order. If the smaller group has n1 members and the larger group has n2 members, T’ = n2 (n1 + n2 + 1)-T.

Take the lesser of T and T’ and compare it with the table of critical values. The tables give values below which the lesser rank total must lie if the difference between the two sets of data is to be regarded as significant at the five and one percent levels. For n1 = 9, and n2 = 10, the five percent table gives the value 65, which is why we can set little store in the claims of the WYTO trials.

Figure 1 gives the flow-chart for the MK-14 program which calculates ranks and then derives the lesser of T and T’ — we will call this T’. The ranking part of the program can be used in conjunction with a modified version of the program for the Runs Test — see November issue — and its applications will be described in a later article.

This program can rank up to 30 items of data, entered in decimal — maximum value 99 — with n1 taking any value from two to 15. It is easy to modify it to deal with larger numbers of items, though it is unlikely that the facility will be required in

(continued on next page)
The operator enters \( n_1 \), then the total number of items \( n_1 + n_2 = N \), followed by the items, with then items of the smaller group, corresponding to \( n_1 \), entered first. Within each group order does not matter. The program is then run. First it converts \( n \) and \( N \) to hexadecimal. The data is not converted. Conversion is done by decrementing \( n \) or \( N \) decimally \((+99 \equiv -1)\), while incrementing a counter hexadecimally.

Allocation of ranks using pencil and paper is a time-consuming operation, fraught with possibilities of error, as any teacher working out end-of-term positions will agree. Though the microcomputer routine is a very inefficient one, the ranking of 30 items takes only a fraction of a second. A search value, \( s \), which is zero to begin with, is compared to each value of the data table in turn. If there is equality, a tie counter \( t \) is incremented. Final value

The final value of \( t \) is used for calculating the rank to correspond to the current value of \( s \). To make calculation simpler, ranks are computed at twice their correct value (they run 2, 4, 6, 8) and tied ranks such as \( 7/2 \) are ranked at 15. If the total number of items already ranked is \( p \) (= previous rank), the new rank is calculated from:

\[
r = p + t + 1
\]

As for most distribution-free tests, computation is simple and the tedious operation of sorting through the data and allocating ranks is only suited ideally to the abilities of a microprocessor. After all ties have been found — \( t = 1 \) if no ties — the data table is scanned a second time. When a datum equal to \( s \) is found, the corresponding location in the rank table is given the appropriate rank value.

A new value for \( p \) is then calculated — new \( p = p + 2t \) — and the program returns to scan the data table with an incremented value of \( s \). Thus it scans with \( s = 0, s = 1, s = 2 \) and so on until all items have been ranked and the rank table completely filled. At that stage, \( p = 2N \) and the program proceeds to its second stage.

The program first sums the first \( n \) ranks of the rank table to get \( T \); then it takes that value of \( T \) which, being based on doubled rank values, is double the true value of \( T \), and divides it by two. This is done by a simple 'rotate right' operation, causing each binary digit to move one place to the right, and the rightmost to the carry-link register (CY/L).

If the sum of ranks included an odd half-rank, it would have been odd when in doubled form, and a '1' would be rotated into CY/L. If this happens, \( T \) is incremented by one to round-up the odd half, as mentioned earlier.

Next the value of \( (n_1 + n_2 + 1) \) is calculated or, to be more specific, the equivalent quantity, \( n(N + 1) \). \( T \) is subtracted from that, giving \( T' \). If \( T' > T \), \( T' \) is replaced by \( T \) at address occupied previously by \( T' \) (OAA9, OA8A). Note the use of two addresses for each of \( T \) and \( T' \), since they can exceed 127 or FF16. If \( T' > T \), the contents of its
register are left unchanged. The contents of this register, the lesser of T and T', are now referred to as T" for but are still in hexadecimal.

The decimal conversion of T" is performed by decrementing the hexadecimal T" while incrementing the contents of addresses OA87 and OA88 decimally. When this process is complete, decimal T'" is held at OA87 and OA88; it is then transferred to the locations in RAM used by monitor for holding addresses to be displayed (ADH and ADL).

The program is then sent to the 'Display Address' sub-rotation (DISPA), causing the decimal value of T'" to be displayed. This may then be compared to the critical value from the tables.

The program could be extended to deal with more than 30 items of data. That would entail locating the data table in the basic RAM of the MK-14 from, say, OF80 onward. With more than 30 items of data, a special table of critical values is not necessary. The method of determining whether T is significant is described in Statistical Methods, by G W Snedecor and W G Cochran, Iowa State University Press.

The program does not calculate both Ts and T' by the conventional t-test but there are no objections to using the Rank Test. There are many distributions, for it is skewed towards the top end of the scale. There are many scores of high value, and a tailing-off in the number of scores of lower value. Such data could not be satisfactorily analysed by the conventional t-test but there are no such objections to using the Rank Test.

---

**Statistics on a micro**

Calculates and displays T or T', whichever is the lesser.

\[ T" = p, \text{ previous rank} \]
\[ T = r, \text{ rank} \]
\[ T = s, \text{ search value} \]
\[ T = t, \text{ number of ties} \]
\[ T = u, \text{ counter} \]
\[ T = H, \text{ sum of n ranks} \]
\[ T = H, \text{ lesser of T}, T' \]
\[ T = T', \text{ conjugate total} \]

\[ s, \text{ in decimal, rest in hex} \]

Enter data:

\[ OAB = n, \text{ number of items in smaller group, maximum 28 items entered in decimal.} \]
\[ OAB = N, \text{ total number of items, maximum 30 items entered in decimal.} \]
\[ OAB = \text{data table}, 30 items maximum, entered in decimal, maximum value each = 99. No entry required for unused memories.} \]

P1 to RAM (OAB0)
P2 to data table (OAB5), then to RAM (OFOO)
P3 to rank table (OFZ0), then to DISPA-1 (0159)

**INITIALIZE:**

\[ OAB = C40A, \text{ LDI'OA'} \]

\[ \text{OAAD 35 XPAH P1} \]
\[ \text{OAEE C480 LDI'80'} \]
\[ \text{OAB0 31 XPAL P1} \]
\[ \text{P1 pointed to RAM (OAB0)} \]
\[ \text{OAB1 C400 LDI'00'} \]
\[ \text{OAB3 C900 ST P1+00} \]
\[ \text{OAB5 C902 ST P1+02} \]
\[ \text{OAB7 C903 ST P1+03} \]
\[ \text{OAB9 C904 ST P1+04} \]
\[ \text{OABB C905 ST P1+05} \]
\[ \text{OABD C906 ST P1+06} \]
\[ \text{OABF C907 ST P1+07} \]
\[ \text{OAC1 C908 ST P1+08} \]
\[ \text{OAC3 C909 ST P1+09} \]
\[ \text{OAC5 C90A ST P1+0A} \]

Clear registers for p, s, t, T, T' and T'':

\[ \text{OAD7 C40A LDI'OA'} \]
\[ \text{OAEG 36 XPAH P2} \]
\[ \text{P2 pointed to OAXX (data), n decimal to n hexadecimal;} \]
\[ \text{OAQ A10B LD P1+0B n, dec} \]
\[ \text{OACC 02 A:OCL} \]
\[ \text{OACD EC99 DAI 99 decimal} \]
\[ \text{OAGF C90B ST P1+0B n-1} \]
\[ \text{OAD1 A904 ILD P1+04 u+1} \]
\[ \text{OAD3 C90B LD P1+0B n-1} \]
\[ \text{OAD5 CT55 JNZ to A,} \]

\[ \text{conversion not complete yet} \]
\[ \text{OAD7 C104 LD P1+04 u} \]
\[ \text{OAD9 C90B ST P1+08, u= n, in hexadecimal} \]
\[ \text{OADB C400 LDI'00'} \]
\[ \text{OADD C904 ST P1+04} \]

Clear counter

\[ \text{OAE1 02 B:DCL} \]

\[ \text{OAA2 EC99 DAI 99 decimal} \]
\[ \text{OAB4 C90C ST P1+0C N-1} \]
\[ \text{OAB6 A904 ILD P1+04 u+1} \]
\[ \text{OAB8 C10C LD P1+0C N-1} \]

Clear counter

\[ \text{OAE9 9CF5 JNZ to B,} \]

\[ \text{conversion not complete yet} \]
\[ \text{OAEC C90C ST P1+0C, u+N, in hexadecimal} \]
\[ \text{SCAN DATA FOR TIES:} \]
\[ \text{OAF0 C40C C:LDI'00'} \]
\[ \text{OAF2 C904 ST P1+04} \]
\[ \text{Clear counter} \]
\[ \text{OAF4 C48D LDI'8D'} \]
\[ \text{OAF6 32 XPAL P2} \]

P2 pointed to data table

\[ \text{OAF7 A904 D:ILD P1+04 u} \]
\[ \text{OAF9 C601 LD@ P2(+1) first item of data, then next etc} \]
\[ \text{OAFB E102 XOR P1+02 s} \]

\[ \text{Gives zero if x=N} \]
\[ \text{OAFD C902 JNZ to E, x=N} \]
\[ \text{OAFF A903 ILD P1+03 t+1,} \]
\[ \text{to count number of ties} \]
\[ \text{OB01 C10A E:LD P1+04 u} \]
\[ \text{OB03 E10C XOR P1+0C N} \]

\[ \text{Gives zero if x=N (last x)} \]
\[ \text{OB05 9C90 JNZ to D, to get next x} \]

**CALCULATE RANK:**

\[ \text{OB07 02 CCL} \]
\[ \text{OB08 C100 LD P1+00 p} \]
\[ \text{OB0A F103 ADD P1+03 t} \]
\[ \text{OB0C F101 ADDI'01' r=p+st+1} \]
\[ \text{OB0E C901 ST P1+01 r} \]
\[ \text{OB10 C400 LDI'C1} \]
\[ \text{OB12 C904 ST P1+04} \]

Clear counter

**SCAN DATA TABLE AND ENTER TIES AS RANKS IN RANK TABLE:**

(continued on page 101)
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<table>
<thead>
<tr>
<th>Item</th>
<th>Price (£)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acorn controller</td>
<td>35.00</td>
</tr>
<tr>
<td>Microcomputer</td>
<td>65.00</td>
</tr>
<tr>
<td>Assembled Microcomputer</td>
<td>79.00</td>
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<tr>
<td>Memory</td>
<td>95.00</td>
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<td>Memory assembled</td>
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<tr>
<td>V.D.U.</td>
<td>88.00</td>
</tr>
<tr>
<td>V.D.U. assembled</td>
<td>98.00</td>
</tr>
</tbody>
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Statistics on a micro

Continued from page 97)

```
OB'14 08BD LDI '80'
OB'16 32 XPAK P2
OB'C4 80 P2 pointed to data table
OB'17 8C PF LDI '01'
OB'19 37 XPAK P3
OB'A1 C41F LD1 '1F'
OB'10 33 XPAK P3
P3 pointed to rank table +1
OB'1D A900 F: ILD P1+04 u, to
count position in table
OB'1F 08DO LD P2 (+1) first
item of data, then next etc
OB'21 E102 XOR P1+02 s,
gives zero if x=s
OB'23 9C07 JNZ to G, x<s
OB'25 C104 LD P1+04 u, to
get position in data table
OB'27 01 XAE u to E
OB'28 C101 LD P1+1 r
OB'29 9C80 ST P3=S, at
corresponding position in
rank table
OB'2C C104 G:LD P1+04 u
OB'2E E10C XOR P1+0C N,
gives zero if xN (last x)
OB'30 8CEB JNZ ifT, to F
to get next position
OB'32 02 CCL
OB'33 C103 LD P1+03 t
OB'35 F103 ADD P1+03 t+t
OB'37 F100 ADD P1+00 p,
gives new p=pt+2
OB'39 9C00 ST P1+00 new p
stored
OB'3B 02 CCL
OB'3C C10C LD P1+0C N
OB'3E F10C ADD P1+0C N+N
OB'40 E10C XOR P1+00 p,
gives zero if p=N (last p)
OB'42 8C0C JZ to H ranking
completed
OB'44 C400 LDI '01'
OB'46 C903 ST P1+03 restore
to zero
OB'48 C102 LD P1+02 s
OB'4A E01D DA'I01'-1
OB'4C 9C02 ST P1+02
OB'4E 9A00 JMP to C, begin
next search, incremented s
SUM FIRST n RANKS to GET T:
OB'50 C420 H:LDI '20'
OB'52 33 XPAK P3
P3 pointed to rank table
OB'53 C400 LDI '00'
OB'55 C606 ST P1+04, restore
counter to zero
OB'57 02 I:CLC
OB'58 C106 LD P1+06 T(L)
OB'5A F701 ADDMP3(+1)
first rank, then next etc
OB'5C 9C06 ST P1+06 T(L)
OB'5E 06 CSA to find if
T(L) is 0 or 1
OB'5F 9A02 JP to J if no
carry over required
OB'61 A905 ILD P1+05 T(H)+1
OB'63 A904 J:ILD P1+04 u+1
OB'65 E10B XOR P1+OB n
Gives zero if n=un (last rank
is to be summed)
OB'67 9CEE JNZ ti un
DIVIDE T BY 2: ROUND UP:
OB'69 C705 LD P1+05 T(H)
OB'6B 02 CCL
OB'6C 1E RRL gives T(H)/2
with lowest digit to CY/L;
OB'6D C905 ST P1+05 halved
value of T(H) stored
OB'6F C106 LD P1+06 T(L)
OB'71 1F RRL gives T(L)/2
with lowest digit in CY/L;
OB'72 C906 ST P1+06 halved
value of T(H) stored
OB'74 06 CSA to test if
rank total had 'odd half'
OB'75 9F02 JP to K no 'odd
half' found
OB'77 A906 ILD P1+06 T(L)
rounded up for 'odd half'
CALCULATE T':
OB'79 C400 K:LDI '00'
OB'7B C904 ST P1+04 u
register to count to zero
OB'7D A90C ILD P1+0C N+1
OB'7F 02 L:CLC
OB'80 C10A LD P1+0A T'(L)
OB'82 F10C ADD P1+0C N+1
OB'84 C90A ST P1+0A T'(L);
register incremented by N+1
OB'86 06 CSA check for
carry-over
OB'87 9F02 JP to M, if no
carry-over
OB'89 A909 ILD P1+09 T(H)
incremented for carry-over
OB'8B A904 ILD P1+04 u+1,
counting additions of N+1
OB'8D E10B XOR P1+OB,zero
if un (last addition)
OB'8F 9CEE JNZ to L, to
continue addition
OB'91 03 SCL
OB'92 C10A LD P1+0A T'(L)
OB'94 F606 CAD P1+06 T(L)
OB'96 C906 ST P1+06 T(H)
OB'98 C109 LD P1+09 T(H)
OB'9C F605 CAD P1+05 T(H)
OB'9D C909 ST P1+09 T(H)
T' now stored
FIND GREATER OF T AND T':
OB'9E 03 SCL
OB'9F C106 LD P1+06 T(L)
OB'AC F60A CAD P1+0A T(L)
OB'AE C105 LD P1+05 T(H)
OB'AF C909 ST P1+09 T(H)
T' now replaced by T, as
it was less than T: if'T'
CALCULATE T" IN DECIMAL:
OB'B1 02 N:CCL
OB'B2 C108 LD P1+08 T'(L)
OB'B4 E01I DAI '01' carry
added to T'(H) decimally
OB'C0 C907 ST P1+07 T'(H)
OB'C2 02 O:CCL
OB'C3 C10A LD P1+0A hex
value of T'(L)
OB'C5 86 FF ADI 'FF' subtract
1 in hexadecimal scale
OB'C7 C90A ST P1+0A.
OB'C9 9802 JZ to P, if
hex T" reduced to zero
OB'CB 9E04 JMP to N, if not
yet reduced, for next cycle
OB'CD C109 P:LD P1+09 hex
value of T'(H)
OB'CF 9807 JZ to Q, hex to
decimal, conversion complete
OB'D1 02 CCL
OB'D2 86 FF ADI 'FF' subtract
1 in hexadecimal scale
OB'D4 C909 ST P1+09
OB'D6 9009 JMP to N for
next cycle
DISPLAY T":
OB'D8 C40F Q:LDI '01'
OB'DA 36 XPAK P2
OB'DC C400 LDI '01'
OB'DD 32 XPAK P2
P2 pointed to RAM (0F00)
OB'EB C107 LD P1+07 T'(H)
OB'ED C40E ST P2+08 (ADM)
OB'E2 C108 LD P1+08 T'(L)
OB'E4 C40C ST P2+06 (ADM)
OB'E6 C101 LD1 '01'
OB'EB 37 XPAK P3
OB'EC 4599 LDI '99'
OB'ED 33 XPAK P3
P3 points to Display
address routine in monitor
OB'EF 3F IFF P3
Ge to DISPA routine to
display T'
OB'EE = END
```
Fault-finding with aid of self-test programs

With a cunningly-designed program, a microprocessor can even test itself. The chip can fail but still 'work' and there is a way to generate a program to find such faults.

The microprocessor chip can fail in one of two ways. It can have a 'hard' failure, or a soft fault. A 100 percent test of a microprocessor will not necessarily find all faults. The system may well only when certain data is in the processor affect only certain instructions and then use - the system will not run at all. 'Soft' defects. With a hard failure, self-test is no way to generate a program to find such faults.

Of these, 26 (with IN and OUT) have 8-bit operands, and 35 have 16-bit operands. There are thus (195 + 26 x 256 + 35 x 2^16) possible instructions.

With an average instruction time of around 4 x 10^12 years, which is not very practical.

What we can do, though, is to check that we can read and write to every register in the chip, and that there are no bits stuck at '1' or '0'; and test every instruction at least once.

A test of this type will make sure that there are no major faults in the chip and will, in practice, detect the vast majority of soft faults.

How do we start to write a suitable self-test program and how do we continue? At the start, we must assume that a few basic instructions work, and use these to test others. As more and more instructions are checked, they can be used to bootstrap yet more. Finally, the initially 'assumed-good' instructions can be tested, using all the others.

Remember that there is no point to identifying the fault; if the micro is broken, all we can do is change it. Instructions can thus be chained together for testing, so long as the result can be monitored.

The order of trying the instructions is important. One method (1) is to give each one a score, which represents the proportion of the microprocessor it exercises. The scoring scheme I used for the 8080 was:

a. One point for each byte the instruction and operand take in the program (e.g. LXI, H, abcd — 3 points).
b. One point for each instruction operand take in the program (e.g. STA, abcd writes to address abcd — 1 point).
c. One point for each clock cycle needed by the instruction.
d. One point if only one flag is affected, two if more than one flag can be changed. Giving one point per flag seemed like over-reaction.
e. One point for each microprocessor control line affected by the instruction.

Table 2.

| Table 2. | **THIS PROGRAM ASSUMES THAT** | | **LXI A, ; LXI SP, ; JNZ: JC: JNC; JMP ALL WORK** | | **PROPERLY AT THE START. THEY ARE CHECKED LATER.** | | **A 'B' IN THE COMMENTS COLUMN SHOWS WHERE EACH NEW INSTRUCTION IS TESTED.** | | **A 'C' SHOWS WHERE EACH NEW RESULTING FLAG IS TESTED.** | | **A 'D' SHOWS WHERE EACH NEW RESULTING FLAG IS TESTED.** |
| --- | --- | --- | --- | --- | --- | --- | --- |
| | **LXI SP, STACK** | | **STACK IS ANY SUITABLE SP POSITION** | | | | |
| | **MVI A,FF** | | | | | |
| | **CMO** | | | | | |
| | **CPI D,0** | | | | | |
| | **JNZ FAULT** | | | | | |
| | **ON FAIL, CMA OR CPI WRONG.** | | | | | |
| | **ON FAIL, CMA OR CPI CORRECT.** | | | | | |
| | **CPI FF** | | | | | |
| | **SET Z AND CY FLAG.** | | | | | |
| | **JNZ LABEL 1** | | | | | |
| | **2 SET THIS TIME:** | | | | | |
| | **JMP FAULT** | | | | | |
| | **CPI OR JNZ DOES NOT WORK.** | | | | | |
| | | | | | | | |
| | **LABEL 1** | | | | | |
| | **CMO** | | | | | |
| | **@ CY = 0** | | | | | |
| | **JO FAULT** | | | | | |
| | **CMO OK?** | | | | | |
| | | | | | | | |
| | **STC** | | | | | |
| | **@ CY = 1** | | | | | |
| | **JC LABEL 2** | | | | | |
| | **STG OR JC DOES NOT WORK.** | | | | | |
| | | | | | | | |
| | **LABEL 2** | | | | | |
| | **MVI A,1** | | | | | |
| | **CMO D,A** | | | | | |
| | **A/CY = 0100 0011/1** | | | | | |
| | **E,A** | | | | | |
| | **0100 1100/0** | | | | | |
| | **N,E** | | | | | |
| | **0000 1100/1** | | | | | |
| | | | | | | | |
| | **RCL** | | | | | |
| | **0000 1100/0** | | | | | |
| | **RAR** | | | | | |
| | **0000 0110/0** | | | | | |
| | **RRC** | | | | | |
| | **0000 0011/0** | | | | | |
| | **CPI 03** | | | | | |
| | **JNZ FAULT** | | | | | |
| | **FAULT IN ROTATES WILL CAUSE FAIL.** | | | | | |
| | | | | | | | |
| | **TEST FOR ACCESS TO EACH REGISTER.** | | | | | |
| | **MVI A,01** | | | | | |
| | **MOV B,A** | | | | | |
| | **@ B=1** | | | | | |
| | **MVI C,A** | | | | | |
| | **MOV D,C** | | | | | |
| | | | | | | | |
| | **RAR** | | | | | |
| | **MVI D,A** | | | | | |
| | **MOV E,D** | | | | | |
| | | | | | | | |
| | **RCL** | | | | | |
| | **MVI E,A** | | | | | |
| | **MOV H,E** | | | | | |
| | | | | | | | |
| | **RRC** | | | | | |
| | **MVI H,A** | | | | | |
| | **MOV L,H** | | | | | |
| | | | | | | | |
| | **MAKE SURE THEY ARE OK.** | | | | | |
| | **MVI A,01** | | | | | |
| | **CMP B,A** | | | | | |
| | **JNZ JAULT** | | | | | |
| | | | | | | | |
| | **DOES CMP R REALLY WORK?** | | | | | |
| | **CMP C** | | | | | |
| | **@ SHOULD SET CARRY.** | | | | | |
| | **JNZ FAULT** | | | | | |
| | **CMP D,R** | | | | | |
| | **MVI A,01** | | | | | |
| | **CMP B,R** | | | | | |
| | **JNZ FAULT** | | | | | |

David Peckett suggests how a microprocessor can test itself.
to the normal PC action. (e.g. POP PSW — 2 points.)

This scheme, modified in detail, will work for any micro. The result is a set of scores for the instructions; the lower the score, the more 'reliable' the instruction. Table 1 shows the scores I produced for the 8080 instruction set.

Obviously, we try the 'most reliable' instructions first and use these to check on whether or not the appropriate flag is set. We now have a basic set of instructions:

```
<table>
<thead>
<tr>
<th>SCORE</th>
<th>INSTRUCTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>NOP</td>
</tr>
<tr>
<td>6</td>
<td>CMA: CM: CI; EI; ETC</td>
</tr>
<tr>
<td>7</td>
<td>DCX SP; INX SP; RAL;RAR; RLC; RRC</td>
</tr>
<tr>
<td>8</td>
<td>CMP r; DAA; DCX (B,D,H); HLT; INX (B,D,H); MOV r1, r2</td>
</tr>
<tr>
<td>9</td>
<td>ADD r; ADD r; ANA r; DCR r; INR r; ORA r; PCHL; SBB r; SPHL; SUB r; XCHG; XRA r</td>
</tr>
<tr>
<td>10</td>
<td>MVI r,</td>
</tr>
<tr>
<td>11</td>
<td>CPI</td>
</tr>
<tr>
<td>12</td>
<td>ACI; ADI; ANI; MOV r,M; ORI; SBI; STAX; SUI; XRI</td>
</tr>
<tr>
<td>13</td>
<td>CMP M; LDAX; MOV M,r; RST</td>
</tr>
<tr>
<td>14</td>
<td>ADC M; ADD M; ANA M; M; DAD H; INJ; JMP; LXI SP; ORA M; OUT; RET; SBB M; SUB M; XRA M</td>
</tr>
<tr>
<td>15</td>
<td>DAD SP; JC; JM; JNC; JNZ; JP; JPE; JZ; LXI (B,D,H), ; POP</td>
</tr>
<tr>
<td>16</td>
<td>DAD (B,D); MVI M</td>
</tr>
<tr>
<td>17</td>
<td>DCR M; INR M; PUSH</td>
</tr>
<tr>
<td>18</td>
<td>LDA; STA</td>
</tr>
<tr>
<td>19</td>
<td>LHLD</td>
</tr>
<tr>
<td>20</td>
<td>SHLD; XTHL</td>
</tr>
<tr>
<td>21</td>
<td>CALL</td>
</tr>
<tr>
<td>10/16</td>
<td>RC; RM; RNC; RNZ; RP; RPE; RE ) See</td>
</tr>
<tr>
<td>19/25</td>
<td>CC; CM; CNC; CNZ; Note. CP; CPE; CPO; CZ</td>
</tr>
</tbody>
</table>
```

Table 1. Instruction scores.

Note: conditional CALLS and RETURNS have two instruction cycle times, depending on whether or not the appropriate flag is set.

Instructions first and use these to check out the 'less reliable'. The initially 'assumed good' instructions must be chosen carefully to have scores as low as possible; there must also be as few of them as possible.

When we write the test program, the more we know about the detailed internal working of the chips the better. Unfortunately, the manufacturers are in no hurry to give this kind of information away, so we must combine careful reading of the data books with some reasonable assumptions.

For instance, the Intel 8080 has 49 data transfer instructions of the form MOV r1, r2. Do they all have to be tested? I have assumed not; if we know that we can access each register, we need to test only a few different combinations (e.g., MOV A, H; MOV B, A; MOV C, L) to prove the whole family of similar instructions. That kind of assumption can simplify the test program considerably.

Having ranked the instructions, I began

(continued from previous page)
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already in the accumulator; this shortens that all the way through each batch of the register/memory instructions. Note register operations, the program checks unlikely. be beaten by multiple faults but they are approach shortens the program; it could result of each stage is monitored. This register, and the like -- and only the final families all checked. The checks are grouped in arithmetic and logical operations can be -tions. Once the basic data transfer and arithmetic jumps and subroutines are added inevitable demonstrate yet more instruc- tions. They permit com-
Figure 1. Broad flow of program.

START

TEST 'COMPARE'

TEST ACCUM SHIFTS

SET DIFF. CODES IN EACH REG.

CONFIRM CODES AND REG. ACCESS

TEST 'JUMP' AND 'CALL'

CHECK REGS FOR STUCK BITS. EACH TO:
AA, 55, FF, 00

TEST IMMED. ARITH. AND LOGIC OPs

TEST REG-REG ARITH. AND LOGIC OPs

TEST 'FLAG SET' JUMPS AND CALLS

TEST 'FLAG CLEAR' JUMPS AND CALLS

TEST ALL FLAGS

LOAD SPECIFIC MEM. LOCNS

TEST ACC-MEM ARITH. AND LOGIC OPs

CHECK REGs TO DISCRETE CODES

TEST UNDEF UNDEFED

SET ALL FLAGS

STOP

(continued from page 105)

JM Fault

JPH Fault

JZ Fault

JNC LABEL11

INR A

LABEL11

INZ LABEL12

LABEL12

JPG LABEL13

INR A

LABEL13

JP LABEL14

INR A

LABEL14

MVI L,00

CLEAR L.

CNC SUB6

CNZSUB9

CPOSUB10

CP

'Sub 4 these 4 calls should be made.'

CM Fault

CM Fault

CPE Fault

CZ Fault

'These 4 catch errors.'

ADD

L SHOULD = OA

CPI 7C

'A SHOULD = 72.0A. 7C'

JNZ Fault

Check the remaining unused instructions.

LXI H,STACKA

MOV M,A

M = 7C

MOV B,A

B = M

XRA A

A = 00

LDA STACKA

 CMP B

LDA WORKED?

INR A

A = 7D

EQA (STACKA+1)

H, L = 707C

CMP H

H = 7D?

JNZ Fault

DCR A

A = 7C

LDA STACKA

L SHOULD = 0A

INR A

A = 7D

STA (STACKA+1)

LHLD (STACKA)

(H, L) = 71=

CMP H

H = 7D?

JNZ Fault

DCR A

A = 7C

CMP L

L SHOULD = 0A

LDA STACKA

H, L = 7E7D

SHLD STACKA

LDA

STACKA

L SHOULD = IN LOWER BYTE.

CMP L

JNZ Fault

INX H

L = 1C

MVI A,1C

MAYBE 1B already in A?

CMP L

JNZ Fault

* LHLD works.

INR H

H, L = 7E7D

EMD STACKA

L SHOULD = IN LOWER BYTE.

CMP L

JNZ Fault

LDA (STACKA+1)

H SHOULD = IN HIGH BYTE?

JNZ Fault

* Check so-far untested, but assumed good, operations:

MVI A, 20 SP

LXI H,001B

MVI A,1B

CMP L

JNZ Fault

INZ H

L = 1C

MVI A,1C

MAYBE 1B already in A?

CMP L

JNZ Fault

* MVI A, 20 IS OK.

LXI H,STACKA

BPLM

PUSH PSW

SAVE A, PSW.

INX SP

SP = STACKA-1.

IMM A

A = 00

LXI SP,(STACKA-2)

POINT TO PUSHED DATA.

POP PSW

RECOVERED CORRECTLY?

CPU 7C

JNZ Fault

* The test is over; chip is OK.

* Put a suitable stop and display result routine here.

* Subroutines, etc.

* Check that 'Call' works.

SUB1

MVI A,00

A = 00

RET

JMP Fault

Ret may fail.

* Set all the registers to A, and confirm.

SUB2

MOV B,A

MOV A,B

PUSH B

POP D

PUSH D

POP H

H SHOULD = 0A

If these fail, S/R will fail.

CPU 7C

MVI A,00

CLEAR A;

JNZ Fault

(continued on next page)

Figure 1. Broad flow of program.
instructions work but the vitally important conditional operations have to be checked. Each conditional command must be checked twice, once with the appropriate flag set, and once with it cleared. The tests emerge as a long string of jumps and calls, with traps at each possible failure point. The traps are either jumps to the fault routine, or changes to the accumulator which eventually will cause a CPI to fail.

To check the conditional instructions more thoroughly, we should set only one flag at a time and check for no false response to it. The test I have given here should detect most faults. Finally, the so-far-untested instructions are checked, as are those which were assumed to be satisfactory at the start.

The program of table one lacks two essential elements — a routine to show a 'GO', and a routine to show a 'NOGO'. How you write them will depend on your system and your preferences but the 'NOGO' must be as short as possible. Ideally, it will use only the 'assumed good' instructions to give the best chance of its working.

In testing 'IN' and the like I cannot offer any useful details for testing the interrupt instructions (El, DI, HLT and RST n). Those tests will depend far too much on what is in your system but they should follow the basic approach I have used. Table 3 is a short routine which could test IN and OUT but you will need to tune it to match your system.

The program I have described should detect most soft faults which might occur in an 8080. Its abilities will depend however, on the support chips. They must use the status bits correctly, particularly when testing IN and OUT, and interrupts. For example, an 8225 fault could appear, wrongly, as a microprocessor fault. It is possible to test the support chips, PIA's, and the like, but the program will depend on the system hardware; I cannot give a general test routine.

The program in table one, is less than 1K long. It could be loaded from tape, but if you have the option, it would be better to put it in a self-test PROM. That way, you could be confident that it was loaded properly.

Conclusions

- It is fairly straightforward to write a program a micro can use to find the majority of 'soft' faults within itself. Instructions are tested in ascending order of complexity, with simple ones being used as bootstraps to check more complex operations. Support chip faults can confuse things but it is normally possible to test round them in any particular system.


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RATHER than provide the normal kind of fiction, here is a program which will generate thousands of personally-configured Sci-Fi stories. It will write, for example, Earth is attacked by tiny Moon reptiles which are not radioactive and cannot be killed by the coast guard, but a little boy tells them about God and they leave; or Earth freezes and everybody dies; or, by way of variation, Earth falls into the Sun and almost everybody dies.

Adapted by Bennet and Adam Laurie from a flowchart published by Sam Lundwell in An Illustrated History of Science Fiction.

DIY Sci-Fi

560 GOSUB 1670
570 "WHICH(*)OH")
580 ON FNR(2) GOSUB 730,790.
590 "FIND ARE"
600 ON FNR(2) GOSUB 920,940
610 "AND"
620 ON FNR(2) GOSUB 960,990
630 "BUGS"
640 RETURN
650 "REPTILES"
660 RETURN
670 "MECHANICAL DEVICES"
680 RETURN
690 "SUPERPERSONS"
700 RETURN
710 "VIRUS"
720 RETURN
730 "DESTROYED"
740 RETURN
750 "REPTILES"
760 RETURN
770 "MECHAMICAL DEVICES"
780 RETURN
790 "SUPERPERSONS"
800 RETURN
810 "ICKY THINGS"
820 RETURN
830 "WANT OUR WOMEN"
840 RETURN
850 "WANT OUR LITTLE SCHOOL-BOYS"
860 RETURN
870 "ARE FRIENDLY"
880 RETURN
890 "ARE FRIENDLY BUT MIS-UNDERSTOOD"
900 RETURN
910 "UNDERSTAND US TOO WELL"
920 RETURN
930 "LOOK UPON US ONLY AS A SOURCE OF NOURISHMENT"
940 RETURN
950 "CAN BE KILLED BY"
960 RETURN
970 "TAKES A FEW AND LEAVE"
980 RETURN
990 "AND EAT US WITH A SIDE DISH OF FRENCH FRIES (HOLD THE ONIONS!)"
1000 GOTO 440
1010 "A CROWD OF PEASANTS WITH TORCHES."
1020 RETURN
1030 "THE ARMY"
1040 "THE NAVAL"
1050 "THE MARINE-CORPS"
1060 "THE COASTGUARD"
1070 "THE ATOMIC BOMB"
1080 RETURN
1090 "A BAG OF HIGH-VELOCITY JELLY-TOTS"
1100 RETURN
1110 "THE AIR-FORCE"
1120 RETURN
1130 "THE AIR-FORCE"
1140 "THE MARINE-CORPS"
1150 RETURN
1160 "THE NAVAL"
1170 RETURN
1180 "THE MARINE-CORPS"
1190 RETURN
1200 "THE COASTGUARD"
1210 RETURN
1220 "THE NAVAL"
1230 RETURN
1240 "THE AIR-FORCE"
1250 "THE MARINE-CORPS"
1260 RETURN
1270 "THE NAVAL"
1280 RETURN
1290 "THE AIR-FORCE"
1300 RETURN
1310 "THE MARINE-CORPS"
1320 RETURN
1330 "THE COASTGUARD"
1340 RETURN
1350 "THE NAVAL"
1360 RETURN
1370 "THE AIR-FORCE"
1380 RETURN
1390 "THE MARINE-CORPS"
1400 RETURN
1410 "THE NAVAL"
1420 RETURN
1430 "THE AIR-FORCE"
1440 RETURN
1450 "THE MARINE-CORPS"
1460 GOTO 440

(continued on next page)
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1470 "AND THEY LEAVE ";
1480 "AND SEND US POSTCARDS
AND FLOWERS ON OUR BIRTHDAY
FOR QUITE A LONG TIME AFTER
WARDS."
1490 GOTO 440
1500 "WHICH FAILS ";
1510 GOTO 1010
1520 "WHICH KILLS THEM.
"
1530 GOTO 440
1540 "WHICH TURNS THEM INTO
DISGUSTING LUMPS.
"
1550 GOTO 440
1560 "AND THEY GET MARRIED
AND LIVE HAPPILY EVER AFTER.
"
1570 GOTO 440
1580 RETURN
1590 "DON'T WANT OUR WOMEN
ON FNR(7) GOTO 1020,1670
DON'T ";
1600 GOTO 1030
1610 "BUT REALLY GO APE OVE
FORD CORTINAS AND MOVE TO
DAGENHAM ";
1620 GOTO 1020
1630 "WITH GREAT BIG PIMPLE
S ";
1640 GOTO 1020
1650 "WITH REPULSIVE WAXY E
ARS ";
1660 GOTO 1020
1670 "WITH FESTERING BOILS
ON THEIR ";
1680 GOTO 1020
1690 "WITH RIPPLING MUSCLEY
BITS ";
1700 GOTO 1020
1710 "WITH NOSES ";
1720 GOTO 1020
1730 "WITH BOTTOMS ";
1740 "YOU -KNOW -WHAT'S' ";
1750 "HOOD ORNAMENTS FOR TH
EIR ";
1760 GOTO 1020
1770 "ROLLS-ROYCE'S."
1780 "HONDA FIFTIE/S."
1790 "GLITTERING PUMPKIN CO
ACH."
1800 "MOTHERS' RELIANT ROBI
N'S."
1810 "ROLLS OF BRIGHT BLUE
FLOWERY CARPET."
1820 "GARDEN GNOMES."
1830 "PRACTICAL COMPUTING
December 1979

ACROSS
2 Opposite of 'stolen'.
3 Use packed for best arithmetic.
7 A Teletype is slow at 110.
A Both inputs true for this logic to work.
C An algebraic tongue.
E Specified organisation.
I A basic means of talking to your micro.
J Bits unite!
K First good colour graphics micro.
L Electricity lights three up.
17 Best to check data at this time.
19 Transfer from backing store to memory.
In HEX, —1 is FF,—2 is FE,—26 is EB
so —42 must be?
1D Results of arithmetic generally here.
22 Not even parity.
24 Assured to be bubbling soon.
25 To miss the next issue of Practical
Computing.
28 Selected for data transfer.
2A Same as 9 DOWN.
2B Jump to.
2C One in every home!
2D American ciphers.

DOWN
1 These crawl into your program when you are not thinking.
3 Change one to this by an arithmetic shift
left.
4 Food for a program.
5 Two-state system.
7 He invented the first for his lady to win on
the horses.
8 Arithmetical genius in the CPU.
9 Repeat in Fortran.
15 Meaningful abbreviation.
16 It was either true or false for him.
18 Chat over telephone with this.
20 When to miss the next issue of Practical
Computing.
22 End of text.
23 Large scale integration.

E Enclosed in a record.
F Same as 8 DOWN.
G You can program it only once.
H A hard one is started by a hole.
12 Get data from a list.
13 Meanings of sleeping.
14 Search text.
15 Signal a special condition.
16 Fill up the field.
17 CR1 forms its heart.
20 End of next.

(Acrosses on page 120.)
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Seeking pools draws by golden button route

FIVE YEARS AGO, Frank George was press-ganged into writing a program for football pools punters. "I was being nettled by the family. They were saying 'You're so clever, why don't you do something useful?'" So he did.

Since then the program has been rated an amazing success. Professor George is head of cybernetics at Liverpool. People then wrote to Topaz asking for a copy of the computer print-out to check form. An impromptu 'club' has grown from it; members pay 50p per week for the printout, which covers the cost of the extra print run and first-class postage.

There are now some 3,000 people in the club. Colin Rose of Topaz says: "We can't guarantee it works, but I don't think anybody in the club hasn't won something if they've used it for two months. We have tangible evidence that it works in some cases. Someone wrote to us saying that he was pleased with the system - he had won £5,400 one week and £730 the week before".

The system reduces the odds against you but they are still high. The club experienced a poor patch last season because of the bad weather, when the pools panel had to sit for many weeks. The form factor does not come into play; neither do the teams, for that matter.

Topaz hopes soon to implement George's horse racing system in the same way. Meanwhile, the pools program is run every Monday and produces a list of likely draws in order of priority. At present, the program is written in the high-level language Fortran and, runs on an ICL 1900 mainframe. But George maintains that it can be translated easily into any language, even machine code, so, in theory, it can be run on any machine. He explained how the system works: "The main effort of the program was directed to the treble chance and four considerations have to be borne in mind. "First, there is form. Football is dis-

(continued on page 115)

Comment on figure 1. Each of these outcomes has to be repeated 89 times for full account of league position when conjoined to the result of the last two matches (see figure 2) for each time, making up 324 outcomes, all of which fall into three categories - 1, home win; 2, draw; 3, away win, and then you may distinguish score-draw from scoreless draw by a further test.
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Industry standard dot matrix keyboard printers featuring 132 column upper and lower case printing on standard listing paper at printing speeds of continuous 30cps or 180cps. KR and RO versions available with a wide range of optional features.

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New low cost range of desk top serial printers, printing over 80 or 132 columns at 100 or 180cps on standard listing paper using a 7x7 or 7x9 dot matrix. Options include VFU, second paper feed mechanism, 9x9 matrix with italic or expanded printing, buffered serial RS232 interface.

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PRACTICAL COMPUTING December 1979
(continued from page 113)
tinguished from other forms of betting, such as horse and greyhound racing, lotteries or roulette, in that it is not entirely random. The betting, and therefore the odds, reflect the form.

"Not all football teams play to form, if they did, it would make a nonsense of the game and remove the gamble. It would also mean that the favourites would always win and individual punters would win nothing of any real value. So some random element must be brought to bear on the proceedings, and that leads to the second consideration.

**Random element**

"But let us stay with form for the moment. It depends on league position, last result, last-but-one result and perhaps the one before that. That leads to a Markov Net — a statistical technique of probabilistic sequential analysis — of the form a/b/c/p, where a, b and c are the last three results and p is the weighting in the light of the team's league position. The same is compiled for the other team in any fixture — d/e/f/q, for example — and then we compare p to q.

"If p > q, the home team will win. If p = q, it will be a draw, and if p < q the away team will win. One can, of course, adjust those inequalities slightly by using the condition where p and q are almost equal. By using the form method alone, you should be able to pick a high percentage of score draws each week.

"Now, the random element. The best approach is to select matches where no-one would forecast a draw and mix them on a 10 per cent basis with 90 per cent of the forecast draws — those which are expected, according to form. This means that a straight full permutation cannot be used; nor can any of the special plans.

"This is where the third consideration comes into play — how to sort the forecast to put them into the correct "lines" or columns.

"The sort factor forces us to decide how much money we want to bet each week. If all things are equal, the more you spend the better the chance of winning. To illustrate this, let us assume that the bet will be £2.25 per week.

"You want a sort which includes only 10 percent of the unexpected plus 90 percent of the expected. In the following table A to R are expected and x1 to x2 are unexpected; this shows that you have to replace the letters by game numbers each week.

In this table, you have to make sure that no two columns are identical. More than seven letters in common. Each of A to R occurs equally often — five times; x1 to x2, the unexpected draws, each occur twice.

"You could plump for fewer than the 18 expected draws and that would give better coverage over a smaller number of forecast draws. That decision has to be made mainly in the light of evidence as to the forecasting ability of the system and the average distribution of score draws. You can have any number of such arrays, all different, according to how much you can afford to spend.

**Tests to apply**

"You now perm eight from 10 in each column. You then find you have 450 lines in all, 45 for each column of the sort. At a state of 1½p per line, that amounts to £2.25, hence our choice of this weekly amount.

"The fourth consideration is choice. Apart from choosing how much money you stake each week, you must also look at the sort you prefer. There are also other tests to consider, such as the historical test, where you look at the history of a club and see how it fared against a certain team at a certain ground. Often one finds a similarity in the score when two particular clubs meet on one or the other's ground.

"The other test you can apply is for a local derby. Those tests are not built into the program but there is some evidence that results between two teams, especially when they are local rivals, tend to form a pattern; and, in the case of a local derby, matches will often lead to a draw". Microcomputers are well-suited to the computerisation of the program and the two flowcharts show the sort of structure you will obtain. The base data is available in the press, or obtained easily from other sources.

**Does not bet**

Once you have decided how many score draws you need for your sort, you write them in order of priority — very likely, likely, possible and the like and apply the goal difference test if you choose to include it in your program. Then, of course, you follow the other procedures, deciding how much to invest, choose a sort of the kind described and then make further tests, such as local derby, if you wish to do so. Finally, don’t forget to fill in your coupon — and post it.

Surprisingly, George does not bet on the pools. He leaves that to his wife. Using his method, she won more than £2,000 last year. The program is successful but George is working to improve it all the time: "I’m always doing a little bit of fine-tuning".

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The same simple problem tackled in three ways

In this article we will be looking at three scientific programming languages. The first, Basic, is already available widely on anything from micros to mainframes. The second, Fortran 77, offers many improvements over its predecessor, Fortran 66, and without doubt will be just as successful. The third, Pascal, is gaining rapidly in popularity and, with more implementations over its predecessor, Fortran 66, and without doubt will be just as successful.

The problem chosen to illustrate a typical histogram and give data is input sequentially and converted into a series of counts representing the histogram columns. Secondly, we compute the height of the histogram. Finally, we print the histogram with the correct layout.

Important points

- This problem can be broken-down into three distinct sections. In the first, the raw data is input sequentially and converted into a series of counts representing the histogram columns. Secondly, we compute the height of the histogram. Finally, we print the histogram with the correct layout.

- Let us define a problem for our languages to tackle. A company has a text file containing the ages of its employees. The ages are represented as integers in the range (0 . . . 99) and the file is structured so that there is one integer per line (record). It is required to print a histogram showing the distribution of the ages into the 10 percentiles (0 . . . 9), (10 . . . 19), . . . , (90 . . . 99).

- No assumptions can be made about the data or their distribution. Figure 1 illustrates a typical histogram and gives the required layout. To keep the programs reasonably short we will assume that the data file has been validated and is therefore not empty, and that all the ages are within the specified range.

- The control variable of a FOR statement must match the identifier in the corresponding NEXT statement. There is a default step size of 1 and both the step and limit values are evaluated once on entry to the loop. Although we have not done so, some implementations allow the keyword LET to be omitted. If your implementation does not support an end-of-file test (IF END . . . ) it will be necessary to append the data with some number outside the specified range and thereby do the same simple problem.

Michael Farmer compares three scientific languages by making them do the same simple problem.

100 DIM S(9)
110 PRINT "HISTOGRAM PROBLEM"
120 PRINT "------------------"
130 FOR J=0 TO 9
140 LET S(J)=0
150 NEXT J
160 INPUT X
170 IF END THEN 210
180 LET J=INT(X/10)
190 IF S(J)<S(J)+1
200 GOTO 160
210 LET M=S(J)
220 FOR J=0 TO 9
230 IF S(J)>M THEN 250
240 LET M=S(J)
250 NEXT J
260 FOR I=1 TO 1 STEP -1
270 PRINT I; TAB (4); " ";
280 FOR J=0 TO 9
290 IF S(J)>I THEN 320
300 PRINT ";";
310 GOTO 290
320 PRINT "!";
330 NEXT J
340 PRINT "!"
350 NEXT I
360 PRINT "-";
370 PRINT ";";
380 END

Figure 1

Figure 2

(continued on next page)
Figure 3
(continued from previous page)
the irritating quirks of its predecessor
Fortran 66, which is almost a proper subset, and the enhancements make for a
cleaner programming style. In fact, many
Fortran 66 implementations included such
extras. Fortran 77 allows a variable to be
declared implicitly by its occurrence, at
which point its type is determined by the
initial letter of the identifier — I to N are
integer, the others are real.
Again, explicit declarations make the
program easier to read and modify. The
lower bound of the CHARACTER array
is declared to be 0 — the default would be
1 — and the length of each element is also
specified. Input and output is record
(line)-orientated with FORMAT state-
ments controlling the layout. An asterisk
instead of a unit number in READ or
WRITE statement specifies that the
system defaults for I/O are to be used.
The first character of each output
record is interpreted as a carriage-control
character. Although this is meant for
controlling paper movement on a printer,
multiple implementations also use it as a
cursor-control character for VDU screens.
The meaning of the various carriage-
control characters is given in figure 4.
Note that the output line has to be built-
up internally before it can be printed out.
The label present in the DO statement
determines the range of the loop and
once again there is a default step size of 1.
The step and limit values are evaluated
once on entry to the loop. This is an
incompatibility with Fortran 66 in which
any DO loop was performed at least once,
because the test for completion was
executed at the end of the loop rather than
at the beginning.

Aids readability
If present, END = . . . specifies the
label to which control is to be transferred
when end-of-file is detected. Division of
two integer operands produces a
truncated integer result. The CONTINUE
statement, labelled 250, is mandatory, as
DO loops cannot finish on an IF state-
ment whereas any number of statements
may be enclosed between REPEAT and
UNTIL. This inconsistency is a minor
drawback to an otherwise excellent
language. We have all achieved the same objective
— producing a histogram — in much the
same way. That is for two reasons. One,
they are scientific languages and as such
are capable of manipulating simple data
items in similar ways. Two, our initial
problem involved one data type — some
people may argue that we used two — one
except that writeln (and also readln) will
terminate the current line of text.
Again, the first character of every
output line is interpreted as a carriage-
control character. If no file name is
present in read or write calls, it is assumed
that the text files 'input' and 'output'
respectively are being used. No step size
may be specified in FOR loops. The limit
value is evaluated once on entry to the
loop and either TO or DOWNTO speci-
ifies the direction.

Similarity
The Boolean function eof() returns the
value ‘true’ if we are at the end of the file.
Note that we did not attempt to read past
the end-of-file before testing as we did in
Basic and Fortran. In fact, the program
would, or should, abort if we did. As with
other block-structured languages we can
group a number of statements and form
them into one compound statement by en-
closing them between the symbols BEGIN
and END. This is essential in some cases
as the FOR loop controls only one state-
ment whereas any number of statements
may be enclosed between REPEAT and
UNTIL. This inconsistency is a minor
drawback to an otherwise excellent
language. They have all achieved the same objective
— producing a histogram — in much the
same way. That is for two reasons. One,
they are scientific languages and as such
are capable of manipulating simple data
items in similar ways. Two, our initial
problem involved one data type — some
people may argue that we used two — one

Control Meaning character
--------- ---------------
0 : Advance two lines
1 : Advance next page
+ : Overprint (no advance)
(Space) : Advance one line
Any other character is usually
treated as if it were a space.

Figure 4

data structure — the array — and only
simple program control structures.
Even so Basic is already showing a lack
of conditional statements. Later in this
series we will introduce problems
requiring richer data and control
structures. Then we will see more contrast
between the languages and also between
the other languages we have yet to
introduce. If one exists, the moral is that
you should choose your programming
language to suit your problem, but how
many of use have access to the correct
language at the right time?
In the next article we will be presenting
three more candidates to be the language
of your choice.
Disc system
A new disc operating system, called
Newdos+, is being made available by A J
Harding. The company has prepared its
own manual for Newdos+ and claims the
following features for the system:
- All errors, reboots and similar crashes
  which occurred with TRSDOS 2.1 are
  eliminated and the TRS-80 disc system
  is now a viable entity as a safe storage
  medium.
- Basic programs and commands can be
  entered from DOS.
- All DOS commands can be entered
  from Basic with an automatic return to
  Basic.
- A return to DOS from Basic, except in
certain exceptional circumstances,
leaves the Basic program intact and it
may be accessed on return to Basic.
- A Renumber utility is included, with
  the added facility of checking of Basic
  program for validity of line numbering.
- A Reference utility is included whereby
  one can check whether or not variables
  have been used and, if so, in what
  line(s). It will also check for and
display the line number in which any
stipulated five digits appear. Excellent
for checking branching origination.
- A Disassembler is included which will
disassemble from memory or disc
contents.
- An Editor Assembler is included.
- Level 1 is included. The user therefore,
  now has the full range of the Tandy
  Basics available on one machine.
- Disc Directories are not only listed but
  are also checked and any errors are
displayed. Even the EOF byte number is
given.
- A fairly extensive shorthand entry is
  provided, allowing for single key
  entries of a number of commands.
- The contents of a section of memory of
disc may be offset and loaded to disc
with a new location.
- An entirely new utility by the name of
  "Superzap" is supplied on the disc. It is
  an extremely wide application
program which is best described as a
tool by which complete surgery may be
carried out on a disc. It is possible to
get into the disc and change even a
single byte. Discs which would not
back-up under TRS-DOS 2.1 will back-
up under Superzap.
- By use of a special command, a line
  printer may fulfill the function of a
  screen printer. This is more useful
  than it sounds. For instance, one can
  now have hard copy of a disc
directory. This command seems to
over-ride other commands and may be
used at any time, even while the
machine is looping. Graphics and
other representations can therefore be
printed-out without the ubiquitous
"Ready" prompt.
- In addition, there are many small
features such as automatic keyboard
debounce, the ability to add to
sequential files, and corrections to
make the Append command work.

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 make this page to become
a market-place for TRS-80 information.

Battle game
ADRIAN RUFF of Newcastle-on-Tyne sent
this game. We have not been able to try it
but it sounds fun.
The program simulates a battle between
two opposing laser bases. The bases are
place on opposite sides of a board which
the computer "draws" on the computer
graphics unit. The version of the program
presented is for the TRS-80 Level II but
can be modified easily for most computers
with either a graphics unit of a memory
mapped VDU. As high definition is not an
essential requirement.
The object is to destroy your opponent
as many times as possible and gain as
many points as possible. This is achieved
by firing your laser across the screen
and hitting him — easier said than done
while he is trying to dodge and fire back.
To make things a bit more interesting,
the laser bases are in constant motion and
the only direction control possible is
reverse. This is achieved by hitting one of
the command keys at which the relevant
laser base reverses its direction.
Each player has two command keys,
one for reversing his laser base and one
for firing his laser. The keys used are "Z" and
"X" for one player and "Y" and "W" for
the other.
The key functions are:
- "Z" — reverse left laser base.
- "Y" — fire left laser.
- "X" — reverse right laser base.
- "W" — fire right laser base.
There is one restraint. Only one laser
burst may be "in the air" at any one time;
the program sees to this i.e., any "fire"
keys hit while a laser burst is on its way are
ignored.
One interesting feature is the ability to
control, slightly, the trajectory of a laser
burst. This is achieved by hitting the
reverse key for the laser base. This
changes the vertical position of the laser
burst. Thus hitting the reverse key more
than once at a time produces zig-zagging
laser fire and is hard to avoid.
The game can be varied for beginners or
experts. The program as given is intended
for faster play but can be made easier by
changing the width of blocks on the board
by altering the inner loop count in line 30
from 3 to 5. TO "Y=O TO 6", and
by slowing the laser propagation speed by altering the step count in lines
1020 and 2020 from 12 and -12 to 6 and -6,
respectively.

```
10 CLS
30 PRINT TAB(9):"LASER BATTLE"
35 FOR X=O TO 47 STEP 1:FOR Y=O TO 47: NEXT Y: NEXT X
40 P=30: D=30:1=O:D2=-1
50 S=1: P2=1
60 SET (0,P): SET (127,P3)
70 CSUB 80: GOTO 70
80 AS=INKEY$:IF AS="X" THEN 120
90 IF AS="Z" THEN 95
92 RESET (P,D1): DI=D1+1: IF F THEN RETURN
95 IF (P+D1)<0 OR (P+D1)>47 THEN RETURN
94 RESET (X,P). P=P+D
95 IF AS="X" AND P THEN 120
97 RESET (127,P2): D2=D2+1: IF F THEN RETURN
98 IF (P+D2)<0 OR (P+D2)>47 THEN RETURN
99 RESET (X,P). P=P+D: RETURN
100 IF AS="Z" AND P THEN 100
101 IF AS="Y" AND P2 THEN 200
110 RETURN
120 REM MOVE
130 RESET (P,D1): RESET (P+DI+D1): IF (P+DI)>46 OR
(F+DI)>46 DI=DI-1: THEN D=DI+1)
140 P=1: P=DI: SET (P,DI): SET (P+D1)
150 RESET (127,P2): RESET (127,P2+D2): IF (P2+D2)<
46 OR (P2+D2)<46 THEN 200
170 RETURN
190 REM FILE
1000 IF POINT (2,P1) THEN RETURN
1001 F=0: P=P+0
1010 P=FI
1020 FOR X=1 TO STEP 12: SET (X,P): CSUB 80: RESET
(X,P): NEXT X
1030 IF NOT POINT (127,P) THEN RETURN
1040 FOR A=1 TO 100: RESET (127,P): SET (127,P): NEXT A
1050 S=1: P=PRINT 
1060 REM FILE 2
2000 IF POINT (127,P) THEN RETURN
2010 P=P-2
2020 FOR X=12 TO STEP -12: SET (X,P): CSUB 80: RES
2030 IF NOT (X,P): NEXT X
2051 F=1
2060 IF NOT (P,DI) THEN RETURN
2070 FOR A=1 TO 100: RESET (P,DI): SET (P,DI)
2080 NEXT A
2090 S=2: S=1: P=PRINT (9,8,5,2)
2100 RETURN
```
Microelectronic revolution: Implications for Education.

Microprocessing, industrial applications. Kensington

3-Primary Basic. Excelsior, Glasgow. Teaches fundamental programming skills, as well as the Basic programming language and enables participants to write software for a range of peripheral devices. Fee, £300 + VAT. Blecads Computer Systems Ltd, 7 Church Path, Merton Park, London, SW19. Tel: 828 6661.

High-level language programming course of Pascal. London. Includes the use of a robot. The course teaches languages and emphasises their application in real-time control and enables the participants to write software for a range of peripheral devices. Fee, £300 + VAT. Blecads Computer Systems Ltd, 7 Church Path, Merton Park, London, SW19. Tel: 828 6661.


Microcomputers for non-electronic engineers. London. Designed for potential middle management staff and senior analysts and programmers. It covers management concepts, analysis techniques, communications, project control and management development. Fee, £255 + VAT. Compower Training School, Cannock, Staffs, WS11 3HZ. Tel: Cannock 2511.

Management in project development. Cannock, Staffs. Designed for potential middle management staff and senior analysts and programmers. It covers management concepts, analysis techniques, communications, project control and management development. Fee, £255 + VAT. Compower Training School, Cannock, Staffs, WS11 3HZ. Tel: Cannock 2511.

APL programming course. Cannock, Staffs. Enables staff with some experience to program in this powerful and increasingly-utilised language. Fee, £245 + VAT. Compower Training School, Cannock, Staffs, WS11 3HZ. Tel: Cannock 2511.


Data communications. London. Four-day course on digital techniques and system design. Covers fundamental principles of signal conversion, encoding/modulation, data transmission and error control. Fee, £470 + VAT. ICSP (U.K.), Pebblecombe, Tadworth, Surrey, KT20 7PA. Tel: 03723 79211.

JCL/Utilities for operations staff. Cannock, Staffs. Operations training course for all operations staff including control/set-up and planning staff. Fee, £215. Compower Training School, Cannock, Staffs, WS11 3HZ. Tel: Cannock 2511.

ANSWERS to crossword (page 111)

4-8 Breadboard exhibition. London. Royal Horticultural Hall. Features extensive range of prototyping boards and accessories for circuit designers and several new ranges of low-cost digital trouble-shooting and test aids for the development, production or service environment. Continental Specialities Corporation, Shire Hill Industrial Estate, Saffron Waldon, Essex, CB11 3AQ.

5 Microprocessor seminar. St Albans. Designed for the businessman. It gives a general introduction to the basic logic and basic technology with demonstration of micro-computers, showing their use in commercial applications. Naomi Buhai, Birklords Management Centre, 330, London Road, St Albans, AL1 1ED. Tel: St Albans 66661.


12 3800 printing subsystem. Cannock, Staffs. Operations training seminar; introduces operators to the concepts and mode of operating a 3800 subsystem. Fee, £50. Compower Training School, Cannock, Staffs, WS11 3HZ. Tel: Cannock 2511.

10-14 Advanced microprocessor design. London. Advanced course for engineers with a good understanding of microprocessors and the aspects of software, how it works, and how it is produced. Deals with advanced hardware and software design techniques. Fee, £300. Blecads Computer Systems Ltd, 7 Church Path, Merton Park, London, SW19. Tel: 828 6661.

10-14 Interactive testing (CMS). Cannock, Staffs. This course enables programmers to use a terminal to develop, edit, compile and test their Cobol programs. Fee, £245 + VAT (includes accommodation); Compower Training School, Cannock, Staffs, WS11 3HZ. Tel: Cannock 2511.

10-14 Microelectronics for non-electronic engineers. London. For engineers with no previous experience of electronics and who are faced with the problem of designing microprocessors into their products. The course gives the participants an appreciation of the hardware of a microprocessor system and how to construct microprocessor-based systems. Fee, £250 + VAT. Blecads Computer Systems Ltd, 7 Church Path, London SW19. Tel: 828 6661.

10-14 System control language. Cannock, Staffs. Operators' training course, designed for all data processing staff, to enable them to write and understand elementary job control programs. Fee, £250. Compower Training School, Cannock, Staffs, WS11 3HZ. Tel: Cannock 2511.


11-14 Distributed processing and computer networks. London. Introduction to distributed processing and computer network system design techniques. Fee, £470. ICSP (U.K.), Pebblecombe, Tadworth, Surrey, KT20 7PA. Tel: 03723 79211.
Top drawer

C B LAKE of Huddersfield was fascinated by the drawing program in the May Pet Corner and decided it could form the basis of a comprehensive program to draw anything on the screen of a Pet. His criteria for an enlarged program included the following:

- Diagonal lines should be able to be drawn easily.
- The drawing character should be able to be changed without re-starting the program.
- The program should cater for the printing of reverse characters.
- It should be possible to move the drawing bodily on the screen.

The original innovation of routing from the keyboard using PEEK (515) is still there at line 1150; this enables continuous movement of the cursor by looping, something which cannot be achieved using the GET instruction. Not having a printer he removed the X = USR(R) instruction from the original program. As for the modifications outlined, they were achieved as follows:

- Diagonal lines: lines 1240-1270. Lines 1390 and 1395 change each time the RVS key is pressed. The delays in those lines are to stop D$ changing back and further if RVS is pressed too long.
- Moving the drawing: the routine between lines 1320 and 2040 is entered when 'S' is pressed during drawing. Lines 1720-1780 set up the direction of the loop in line 2000. D is the distance each character has to move in screen units; and CR$ is the direction the cursor is to move, depending on the direction of movement requested.
- CRS is required because although the POKE statement of line 2010 moves the white square, the cursor must be moved by a PRINT statement. The FOR/NEXT loop is short-circuited in line 2005 if the position is a blank; otherwise the character found is POKEed into the new position and the old one blanked-out. Line 2030 checks to see if sufficient movement has been made; if it has (GS > 5) drawing can continue.
- Line 1180 is a delay to slow the speed of drawing; this delay could be programmable if desired. The instruction at the beginning of the program should be sufficient to give a good idea of how you use it.
- The program apparently can become addictive as you see what you can draw. The program is also useful for the development of games and other graphics programs. You can experiment with any shapes beforehand, including large letters and numbers on the screen. In conclusion, here are some open questions from Lake:

- Why can't S = PEEK(SC) POKE (SC + D),S be written as POKE(SC + D),PEEK(SC)?
- How do you print a " without using POKE?
- Can anyone devise a method of rotating the drawing?
- Can anyone produce a machine code routine — with explanation — to replace lines 2000-2040 to speed the movement? This could possibly include the rotation. Bear in mind that moving a drawing from the bottom of the screen makes it re-appear, offset, at the top; POKEing to locations greater than 33767 still affects the screen. This could be eliminated from the existing method using IF statements but it would slow the routine even more.

Keyboard

A member of IPUG has tried the add-on keyboard from Northend Office Supplies, obtained with the intention of typing-in copy for the IPUG newsletter ready for word processing and production of masters for printing. He says that the unit is sound enough but does not provide a different output when the shift key is pressed, so it can be used only for input of upper-case characters. This seems a pity, especially in the light of the claims by Northend that the unit offers full "typewriter facilities".

Copyright

There has been a great deal of discussion recently on copyright as it affects computer software. Various methods have been tried to make it impossible for dishonest individuals to copy and sell other people's programs. The difficulty is that this also makes it impossible for you to take back-up copies of software. We have all had unsatisfactory cassettes and we are all now finding more and more programs organised so that taking a back-up copy is impossible.

Let us be very clear about what copying means. Any copy made for the purpose of giving or selling it to someone else is illegal if the original is subject to copyright. The restriction applies to many other items — books, records, TV programs. In those cases, though, a copyright declaration is normally made — in the case of a record it is printed on the paper disc in the middle of the record — and the rest is left to the law. Anyone in breach of copyright may be sued by the copyright owner.

Suppliers of computer software do not seem to be content with this arrangement. All the tricks of the trade are used to make copying impossible. We are therefore faced with a problem. Many are quite capable of finding out how all the tricks work, since we want to know all there is to know about our machines and how they operate.

The problem comes when we communicate the information to other users. Are we thereby encouraging them to break the law and make illegal copies? If you teach someone how to use a shotgun and he or she then proceeds to rob a bank with it, are you guilty of armed robbery?

Anyone who copies computer software in contravention of copyright should be punished; after all, copyright is the only protection under the law for those who write software but the legal protection seems sufficient.
Two Apples Newton would have been proud of

The Pascal System
A complete system for the development and use of applications programs in Pascal, Basic or Assembly language.

48K APPLE II PLUS
Apple II Plus, with extended (Applesoft) Basic in ROM, 48K of RAM, High-resolution Black and White graphics on a matrix of 280 x 192 individually addressable points, Auto-start ROM with on-screen editing, power-on books to application programs, and reset key protection. 2K system monitor, fast 1500 baud cassette interface, hand controllers.

Disc System
This consists of an intelligent interface card, a powerful D.O.S. and one mini-floppy drive.

Features
* Storage capacity of 116K Bytes/Diskette (140K with language card installed)
* Powered directly from the Apple
* Fast access time - 600 m sec (max) across 35 tracks.
* Random or sequential file access.

Pascal Language System
Includes
The Language Card — 16K Bytes of RAM memory which replaces Apples ROM firmware in the memory map.
Auto-start ROM.
5 Discs containing the Pascal compiler editor, macro assembler, linker, loader and runtime utilities, Applesoft and Integer Basic interpreters.
The language system provides the most powerful set of software development tools available to the microcomputer programmer.

Apple II Plus 48K
Disc System with Controller
Pascal Language System
£1662.00
£296.00
£1911.30

The Graphics System
A complete, hi-resolution colour graphics system using the ITT 2020

ITT 2020
48K RAM, PALSOFT Basic on ROM high resolution graphics on a matrix of 360 x 192 points. Low resolution graphics in 15 colours on a matrix of 40 x 48 points. Fast 1500 baud cassette interface to normal domestic cassette recorder.

ITT 2020 16K Colour Board £822.00
32K RAM £128.00
Plus 15% V.A.T £143.25
Total £1098.25

Peripherals

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* Circle No. 201

PRACTICAL COMPUTING December 1979
(continued from page 121)

**Business packages**

THE ERA of professional programs is now the era of PETACT. It has now announced its new business package, accounting, sales and purchase accounting. It is a complete system that is available from PETACT and is system-compatible. All output is provided for printers, and is also available from PETACT and is system-compatible. All output is provided for printers, and is also available from PETACT and is system-compatible. All output is provided for printers, and is also available from PETACT and is system-compatible. All output is provided for printers, and is also available from PETACT and is system-compatible. All output is provided for printers, and is also available from PETACT and is system-compatible. All output is provided for printers, and is also available from PETACT and is system-compatible. All output is provided for printers, and is also available from PETACT and is system-compatible. 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Not all Apples

ANDY WITTERICK, of the Apple Users' Group, is concerned about a number of computer retailers importing Apples, among others, into this country, bypassing the usual distribution network.

Those Apples are not exactly the same as those on sale from officially-appointed dealers and require certain, albeit straightforward, modifications. Not only are those Apples being sold cheaply, but some, it would appear, are not being modified.

If you have experienced similar problems write to me with full details—serial numbers, proof of purchase, name of dealer and history—if it concerns an Apple. If it concerns another micro, write to the Computer Retail Association, giving the same information.

Speeding discs

IT APPEARS that a fault is occurring in a number of disc drives purchased recently. It occurs during long periods of disc drive usage as the interior warms-up. The heat build-up can cause certain components to change values and the result is a speeding of the motor and disc errors. Microsense believes that fault effects only about 1,000 drives and traced it to a glass capacitor of a value of 0.015 microfarad, 50V.

The component is located on the small vertical board at the rear of the drive, with one end going to pin 2 on LM2917. To cure the fault, the capacitor should be replaced by one of the same value but made of 10 percent polystyrene.

They can be obtained from Microsense but a word of warning—the modification should be carried out only by a qualified engineer. Don't attack your disc drive with a hammer and soldering iron—you will cause more problems and invalidate the warranty.

Motor-boating clock

THOSE with a clock card may be experiencing a peculiar problem which results in your system going down and 'motor-boating' from the area of the power supply—a rising and falling hum. The cause is unknown, except that the symptoms occur when the clock card is placed in a slot which is numerically one higher than a serial interface card.

So long as the serial interface is in a higher-numbered slot than the clock, all is well, or if the serial card is placed with at least one slot between it and a clock card in a higher-numbered slot, again all is well.

Wang Basic

A NUMBER of users have asked for information on converting some of the published listings written in Wang Basic into a form suitable for use with the Apple.

It is perhaps unfortunate that Wang Basic is the most advanced Basic around and converting to Apple Basic may not be easy. The main features of Wang Basic which cause problems are:

- PRINTUSING
  e.g. 10 PRINTUSING 110, A, B, C, 110% B----. A--- C
  This means PRINT USING line 110 as a format statement. The numbers will fit the format as indicated by the #. You will have to use tabs.

- HEX (03)
  The HEX codes used are numerous and are control codes for the computer. If you print a code it may affect the screen, e.g. PRINT HEX (03) Equivalent of HOME.
  PRINT HEX (01) Equivalent to HTAB1; VTAB1 Incidentally, A$=HEX (10) in Wang is equivalent to A$=CHR$(16) in Applesoft. Applesoft uses decimals, whereas Wang Basic uses Hexadecimal.

- PACK AND UNPACK
  These are used to reduce the amount of storage required by arrays of numbers by packing them into alphanumeric arrays in binary coded decimal format (BCD).

- The matrix commands are a built-in matrix algebra. They will have to be substituted using subroutines.

- DEFFN'11(A,B,C)
  GOSUB'B(A,B,C), The ability exists to pass parameters to subroutines as arguments. They are not returned, however, and the following two equivalent routines should explain what is happening:

Wang
  10 GOSUB '2(4,5,A,B,)
  20 END
  100 DEFFN'2 (X,Y,Z,Q)
  10 S=X+Y+Z+Q
  120 RETURN
Apple
  10 X=4: Y=5: Z=A: Q=B
  20 GOSUB 100
  30 END
  100 S=X+Y+Z+Q
  100 RETURN

There is another feature which allows the user to enter a program at a point using a special function key. If for the above program we pressed special function 2 we would effectively have typed directly on to the keyboard, GOTO 100. This would have failed because the Wang could expect values for X,Y,Z,Q, and so we would have to type:

4,5,6,7. (special function 2)

This would be equivalent of

X=4: Y=5: Z=6: u=7; GOTO 100.

Clearly there is no equivalent feature in Apple.

- AND, OR NOT, XOR
  These are handled in a different way on different Wangs. Early models use:

  20 AND (L5, L28) and later ones 20 L5=L28 AND L28

A significant difference is that Wang logic algebra operates on STRINGS and Apple operates on REALS. This can make life difficult. Apple logic is very good but recent Wang Basics are more flexible in many ways.

- Notes on conversion
  Wang is incapable of accepting variables other than one letter and one number. Any variables you introduce can be double letters, e.g. AB or PZS and will not interfere with the variables already assigned.

There is no equivalent of A% in Wang Basic. The cumbersome PACK command is used often to economise on storage of integer arrays. This is automatic using A% ( ) with the Apple.

The worst disadvantage is that Wang assumes a 64-character display, so event if you run a program you may get errors if it may appear jumbled on the screen. Screen-handling is more sophisticated on the Apple and a long string of HEX codes may be alleviated by one simple VTAB command.

Music machine

K HOWTON of Southport offers an Apple II music machine. He writes: No doubt many of you have been intrigued by the prospect of using your Apple II to generate music. The Apple II reference manual gives a suggestion for a simple tone routine. The Best of Micro Vol 1 contains three pieces of tone and music generation, and in particular the article by Richard Suitor makes fascinating reading—but it looks to be heavy weather for those of us not experienced in machine code work.

Nick Hampshire's article in Practical Computing, May, 1979, explains how it works in principle but it will not get your Apple making music.

Apple Inc has foreseen the headache. Included in the Programmers' Aid No. 1
is a music generation program — only one of several utility programs in this ROM and strictly light entertainment by comparison with some of the other material. The Programmers' Aid, incidentally, is now becoming widely-available here.

The music feature is run from within Apple Integer Basic. It is necessary to tell the computer only three things to generate a note — pitch, duration, and timbre. A CALL will then play the note.

Pitch, duration and timbre are set by examining the score and putting all identical notes together.

Apple can produce 50 notes, numbered 1 to 50. The statement PITCH, 32 will produce Middle C; increments — or decrements — of 1 will shift the note by a semitone — so, POKE PITCH, 33 will produce C sharp. The range 1 to 50 gives just over four chromatic octaves.

Whenever I have transcribed music, I have always indexed the notes and durations from a common base. So let C = 32, approximately middle C; then for C sharp you can POKE PITCH (C + 1). I have found this very useful; in fact, it is almost a necessity, for when there is a wide range of notes an improvement in quality can be made by shifting C up or down a few semitones.

It is good practice to lay-out the treble and bass clef staves with the scale written in code for rapid fault-free encoding. This is worth the effort. Figure 1 shows the values in absolute code: but Figure 2 shows the same notes in code relative to Middle C, and it does not take any great genius to see just how easy it is to encode using the relative mode.

The same principle applies when setting the duration of the note: examine your music to find the shortest duration note that you will want. The tempo of the music will decide the best value, and this determined by trial and error.

Following are the first few bars of The British Grenadiers, where the shortest note is a semi-quaver and the value I have assigned to this it 22, (S = 22). Most of the notes are coded in BCD.

QUAVER = 1
CROTCHET = 2 x QUAVER = 2
MINIM = 2 x CROTCHET = 4
SEMICREVE = 2 x MINIM = 8

Watch for the dotted notes which are 1½ times the note value.

Another tip to make life a little easier — examine the score and put all identical bars into subroutines; if there are repeated sets of bars use a few conditional jumps.

Apple claims it can manage five timbres — of almost a necessity, for when there is a difference between them, and I am hard put to tell any difference, but I do not have a particularly musical ear. A wide range of notes an improvement in entertainment by

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South Yorkshire Personal
Computing Group
Tony Rycroft
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WE CONCLUDE our series of articles on how to program in Basic, probably the most widely-used programming language for small computers. For the series, we obtained the serialisation rights for one of the best books on the subject, Illustrating Basic by Donald Alcock.

Each month, we have published a part of the book, so by now you should 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.


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SYNTAX

This is a summary of the syntax of BASIC as described in this book. Your version probably differs, but if it has a definition of syntax set out like this one then most differences should be easy to spot by comparison.

A bastardized "Backus-Naur" notation is used for the summary. Many such bastards have been created for defining the syntax of BASIC and some are very awkward to read. I have tried to make this one as readable as possible without loss of rigour but even so you may find it hard going.

Symbols in the definitions:

- \( \Rightarrow \) says "is defined to be".
- \( \Rightarrow \) says "or".

\[ \text{square brackets enclose anything that may appear once or not at all for the definition to hold good.} \]

\[ \text{braces enclose anything that may appear once or several times or not at all for the definition to hold good.} \]

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- Capitals are used for letters, digits and symbols which must be copied as they stand to create a valid example of the thing being defined.

- Italics are used to give names to the things being defined.

Comments & Examples:

- "shadow" brackets enclose comments & examples which are not part of the definitions.

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<th>Definition</th>
</tr>
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<td>one of the digits 0 to 9</td>
</tr>
<tr>
<td>letter</td>
<td>one of the letters A to Z</td>
</tr>
<tr>
<td>sign</td>
<td>+, -</td>
</tr>
<tr>
<td>operator</td>
<td>( \Rightarrow )</td>
</tr>
<tr>
<td>separator</td>
<td>,</td>
</tr>
<tr>
<td>comparator</td>
<td>( \Rightarrow )</td>
</tr>
<tr>
<td>text</td>
<td>any characters except quotation marks</td>
</tr>
<tr>
<td>line</td>
<td>an integral line number from 1 to 9999</td>
</tr>
<tr>
<td>function</td>
<td>( \Rightarrow )</td>
</tr>
<tr>
<td>constant</td>
<td>( \Rightarrow )</td>
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</table>

First the Elements of BASIC:

<table>
<thead>
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<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>integer</td>
<td>digit {digit}</td>
</tr>
<tr>
<td>number</td>
<td>integer {integer}[exponent]</td>
</tr>
<tr>
<td>letter</td>
<td>numerical {letter}</td>
</tr>
<tr>
<td>term</td>
<td>function (expression)</td>
</tr>
<tr>
<td>expression</td>
<td>index [expression]</td>
</tr>
<tr>
<td>statement</td>
<td>variable = (expression)</td>
</tr>
<tr>
<td>adjustment</td>
<td>(expression, expression)</td>
</tr>
</tbody>
</table>

### ELEMENTS OF BASIC

<table>
<thead>
<tr>
<th>Category</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Digit</td>
<td>0, 1, 2, 3, 4, 5, 6, 7, 8, 9</td>
</tr>
<tr>
<td>Sign</td>
<td>+, -</td>
</tr>
<tr>
<td>Operator</td>
<td>( \Rightarrow )</td>
</tr>
<tr>
<td>Separator</td>
<td>,</td>
</tr>
<tr>
<td>Comparator</td>
<td>( \Rightarrow )</td>
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### COMMENTS & EXAMPLES

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Illustrating BASIC Page 128
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- Says "or".
- Square brackets enclose anything that may appear once or not at all for the definition to hold good.
- Braces enclose anything that may appear once or several times or not at all for the definition to hold good.

PRINTING STYLE:

Small letters are used to give English descriptions where the matter is obvious or where the special notation can't reasonably cope.

Capital letters are used for letters, digits and symbols which must be copied as they stand to create a valid example of the thing being defined.

Italics are used to give names to the things being defined.

COMMENTS & EXAMPLES:

"Shadow" brackets enclose comments & examples which are not part of the definitions.

Illustrating Basic Page 128

FIRST THE ELEMENTS OF BASIC:

digit = one of the digits 0 to 9

letter = one of the letters A to Z

sign = + | -

operator = + | - | * | /

separators = ;

comparator = = | > | < | < | <

text = any characters except quotation marks

line = an integral line number from 1 to 9999


constant = :RND | :FN | letter

(THIS DEFINITION ALLOWS BOTH RND AND RND(X); ALSO FNA & FNAL)

NEXT THE COMPOUNDS (ARBITRARILY DISTINGUISHED FROM ELEMENTS):

integer = digit [digit]

number = [: sign ]integer [integer | sign | integer]

variable = letter [digit | letter | text | expression ]

numeric = letter [digit | letter | text | expression ]

lexical = text | textual

expression = [sign | term ]{operator | term }.

declaration = letter (integer [, integer]) | letter (integer)

textable = expression | expression | expression

printable = expression | expression | expression

adjustment = expression | expression | expression

Illustrating Basic Page 129
### D M E N S I O N S O F A R R A Y S

<table>
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<td>DIM</td>
<td>DIM declaration {, declaration}</td>
</tr>
<tr>
<td>LET</td>
<td>LET numerical = expression</td>
</tr>
<tr>
<td>LET</td>
<td>LET textual = textual</td>
</tr>
<tr>
<td>DEF</td>
<td>DEF FN letter [letter [digit]] = expression</td>
</tr>
<tr>
<td>DATA</td>
<td>DATA datum {, datum}</td>
</tr>
<tr>
<td>READ</td>
<td>READ variable {, variable}</td>
</tr>
<tr>
<td>RESTORE</td>
<td>RESTORE</td>
</tr>
<tr>
<td>INPUT</td>
<td>INPUT [integer] variable {, variable}</td>
</tr>
<tr>
<td>RESET</td>
<td>RESET integer {, integer}</td>
</tr>
</tbody>
</table>

---

### A S S I G N M E N T

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<th>Line</th>
<th>Statement</th>
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<tr>
<td>LET</td>
<td>LET numerical = expression</td>
</tr>
<tr>
<td>LET</td>
<td>LET textual = textual</td>
</tr>
<tr>
<td>DEF</td>
<td>DEF FN letter [letter [digit]] = expression</td>
</tr>
<tr>
<td>DATA</td>
<td>DATA datum {, datum}</td>
</tr>
<tr>
<td>READ</td>
<td>READ variable {, variable}</td>
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<tr>
<td>RESTORE</td>
<td>RESTORE</td>
</tr>
<tr>
<td>INPUT</td>
<td>INPUT [integer] variable {, variable}</td>
</tr>
<tr>
<td>RESET</td>
<td>RESET integer {, integer}</td>
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### I N P U T

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<td>DATA datum {, datum}</td>
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<td>READ variable {, variable}</td>
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<tr>
<td>RESTORE</td>
<td>RESTORE</td>
</tr>
<tr>
<td>INPUT</td>
<td>INPUT [integer] variable {, variable}</td>
</tr>
<tr>
<td>RESET</td>
<td>RESET integer {, integer}</td>
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<td>PRINT [integer] variable</td>
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<tr>
<td>DATA</td>
<td>DATA datum {, datum}</td>
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<td>READ variable {, variable}</td>
</tr>
<tr>
<td>RESTORE</td>
<td>RESTORE</td>
</tr>
<tr>
<td>INPUT</td>
<td>INPUT [integer] variable {, variable}</td>
</tr>
<tr>
<td>RESET</td>
<td>RESET integer {, integer}</td>
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### M A T R I C E S

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<tr>
<td>MAT</td>
<td>MAT letter = letter</td>
</tr>
<tr>
<td>MAT</td>
<td>MAT letter = letter + letter</td>
</tr>
<tr>
<td>MAT</td>
<td>MAT letter = letter - letter</td>
</tr>
<tr>
<td>MAT</td>
<td>MAT letter = (expression) + letter</td>
</tr>
<tr>
<td>MAT</td>
<td>MAT letter = TRN(letter)</td>
</tr>
<tr>
<td>MAT</td>
<td>MAT letter = ZER [adjustment]</td>
</tr>
<tr>
<td>MAT</td>
<td>MAT letter = IDN [adjustment]</td>
</tr>
<tr>
<td>MAT</td>
<td>MAT letter = CON [adjustment]</td>
</tr>
<tr>
<td>MAT</td>
<td>MAT letter = letter * letter</td>
</tr>
<tr>
<td>MAT</td>
<td>MAT letter = INV(letter)</td>
</tr>
<tr>
<td>MAT</td>
<td>MAT READ letter [adjustment] {, letter [adjustment]}</td>
</tr>
<tr>
<td>MAT</td>
<td>MAT INPUT [integer] letter [adjustment] {, letter [adjustment]}</td>
</tr>
<tr>
<td>MAT</td>
<td>MAT PRINT [integer] letter {separator letter} [separator]</td>
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### S U N D R Y

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<td>REM</td>
<td>REM {any character}</td>
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<tr>
<td>END</td>
<td>END</td>
</tr>
<tr>
<td>GO TO</td>
<td>GO TO line</td>
</tr>
<tr>
<td>GO SUB</td>
<td>GO SUB line</td>
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<tr>
<td>RETURN</td>
<td>RETURN</td>
</tr>
<tr>
<td>ON</td>
<td>ON expression GO TO line</td>
</tr>
<tr>
<td>IF</td>
<td>IF expression comparator expression THEN line</td>
</tr>
<tr>
<td>FOR</td>
<td>FOR letter [digit] = expression TO expression [STEP expression]</td>
</tr>
<tr>
<td>STOP</td>
<td>STOP</td>
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<tr>
<td>RUN</td>
<td>RUN</td>
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<tr>
<td>LIST</td>
<td>LIST</td>
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<tr>
<td>CATALOG [UE]</td>
<td>CATALOG [UE]</td>
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<tr>
<td>SAVE</td>
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<tr>
<td>UNSAVE</td>
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<tr>
<td>OLD file</td>
<td>OLD file</td>
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<tr>
<td>NEW file</td>
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### C O M M A N D S

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<td>NEXT letter [digit]</td>
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<td>STOP</td>
<td>STOP</td>
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<td>RUN</td>
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<td>CATALOG [UE]</td>
<td>CATALOG [UE]</td>
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<tr>
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<td>SAVE file</td>
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<td>REM {any character}</td>
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<td>END</td>
<td>END</td>
</tr>
<tr>
<td>GO TO</td>
<td>GO TO line</td>
</tr>
<tr>
<td>GO SUB</td>
<td>GO SUB line</td>
</tr>
<tr>
<td>RETURN</td>
<td>RETURN</td>
</tr>
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<td>ON</td>
<td>ON expression GO TO line</td>
</tr>
<tr>
<td>IF</td>
<td>IF expression comparator expression THEN line</td>
</tr>
<tr>
<td>FOR</td>
<td>FOR letter [digit] = expression TO expression [STEP expression]</td>
</tr>
<tr>
<td>NEXT</td>
<td>NEXT letter [digit]</td>
</tr>
<tr>
<td>STOP</td>
<td>STOP</td>
</tr>
<tr>
<td>RUN</td>
<td>RUN</td>
</tr>
<tr>
<td>LIST</td>
<td>LIST</td>
</tr>
<tr>
<td>CATALOG [UE]</td>
<td>CATALOG [UE]</td>
</tr>
<tr>
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<td>SAVE file</td>
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<tr>
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<td>NEW file</td>
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SYNTAX (CONTINUED)

Now the Statements of BASIC

DIMENSIONS OF ARRAYS:
- Line DIM declaration {, declaration} 62

ASSIGNMENT:
- Line LET numerical = expression 11
- Line LET textual = textual 13
- Line DEF FN letter ([letter [digit]]) = expression 26

INPUT:
- Line DATA datum {, datum} 16
- Line READ variable {, variable} 16
- Line RESTORE 17
- Line INPUT [integer] {, variable} 18, 120
- Line RESET integer {, integer} 121

OUTPUT:
- Line PRINT [integer] {, variable} 34, 120
- Line /* structure of image line too varied for definition */ 34 - 37
- Line PRINT [integer] {, integer} 38-32,
  /* avoid using a comma after TAB */ 120

MATRICES:
- Line MAT letter = letter 76
- Line MAT letter = letter + letter 78
- Line MAT letter = letter - letter 80
- Line MAT letter = (expression) * letter 82
- Line MAT letter = TRN(letter) 84
- Line MAT letter = ZER [adjustment] 86
- Line MAT letter = IDN [adjustment] 87
- Line MAT letter = CON [adjustment] 87
- Line MAT letter = letter + letter 88
- Line MAT letter = INV(letter) 90
- Line MAT READ letter [adjustment] {, letter [adjustment]} 94
- Line MAT INPUT [integer] {, letter [adjustment]} 96
- Line MAT PRINT [integer] {, letter [adjustment]} 98

SUNDARY:
- Line REM {any character} 8
- Line END 7

CONTROL:
- Line GO TO line 39
- Line GO SUB line 40
- Line RETURN 52
- Line ON expression GO TO line {, line} 46
- Line IF expression comparator expression THEN line 41
- Line IF lexical comparator lexical THEN line 41
- Line "GO TO" is common in place of "THEN" 48
- Line FOR letter [digit] = expression TO expression [STEP expression] 48
- Line NEXT letter [digit] 48
- Line STOP 42

FILE MANAGEMENT:
- Line /* too diverse for definition here */ 119

COMMANDS:
- Line RUN 114
- Line LIST 114
- Line CATALOG[ue] 115
- Line SAVE [file] 117, 119
- Line UNSAVE File 116
- Line OLD file 116
- Line NEW file 117
- file -> file name with syntax local to the installation
- /* commands differ widely in number and syntax among installations offering BASIC */
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**Possum on the Pet**

This is part two of the article on the Possum system to turn the Pet into an aid for the disabled.

In part one we went into some detail about the design of a microprocessor-based aid for the disabled. In addition to some photographs from a Commodore Pet screen of the program in operation, a listing of part of the code, complete in itself, was presented.

At the same time it was promised that part two will continue to the matter of 'Hands-on experience' and will provide information about the whole system and about how to use the best effect. Anyone reasonably knowledgeable about computer equipment should have little difficulty with this system; once the switch was placed in their hands it was only minutes before most of the people who were invited to try the program were busy constructing text in the buffer area at the top of the screen.

Once prompted to try the various 'Functions' boxes at the bottom of the screen, good familiarity with the whole set-up was soon achieved. Initially, frequent reference to the 'Help' box was made, a practice which soon fell into disuse as the relatively self-evident effects of most selections became apparent.

While the program was being tested, a simple lever-type microswitch was connected to channel seven of the user port to provide the interface. Most of us found that the air-pressure switches usually supplied to the disabled required somewhat more skill in use, due to the delays in their operation.

For those less used to electronic and computerised equipment, a longer period of introduction and familiarisation will almost certainly be necessary. In any case, the 'Help' system allows this process to continue in a more relaxed manner.

The program is a fairly complex piece of code, nearly 500 lines long, and anyone who intends to use it will almost certainly wish to modify it to personal requirements. If the individual is not interested in computing, the 'Programming' frame could be omitted.

To facilitate modification and to assist anyone trying to understand and follow the coding, a series of tables, one to five, has been drawn-up. Table one shows the use of the 20 or so numeric variables included in the program. Most are either flags to indicate the status of some aspect of the program execution — HP, the 'Help' flag, M the 'frame' flag, or UC the 'upper/lower-case' flag — or counter variables in FOR loops used to initialise, access or modify arrays and step the cursor across the screen (I, J, K and L), or to act as time delays — PD and PQ.

Some are program constants, needed to increase speed. Basic variables are accessed more rapidly than constants can be converted and then used — such as UX and UP. Other constants are chosen for convenience, such as MC and PR. In

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**Table one — The variables used in the program, their use and the meanings of some of the values they may assume.**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ED</td>
<td>Special edit mode flag; would be used for adding and deleting text from the middle of AS (not implemented).</td>
</tr>
<tr>
<td>FM</td>
<td>Help mode flag; normally zero, if 1, 'select any box for help', if 2, jump to help routines.</td>
</tr>
<tr>
<td>HP</td>
<td>Help mode flag; normally zero, if 1, 'select any box for help', if 2, jump to help routines.</td>
</tr>
<tr>
<td>I, J, K, L</td>
<td>Loop counters.</td>
</tr>
<tr>
<td>M</td>
<td>Used to calculate which variable or function has been chosen from the values of various loop counters.</td>
</tr>
<tr>
<td>MC</td>
<td>Frame flag; 0 for text mode, 1 for programming mode (see DAS and TAS).</td>
</tr>
<tr>
<td>NV</td>
<td>If greater than zero, then in variable delete mode.</td>
</tr>
<tr>
<td>PD</td>
<td>Cursor down speed (70).</td>
</tr>
<tr>
<td>PQ</td>
<td>Cursor across speed (50).</td>
</tr>
<tr>
<td>PR</td>
<td>File channel number for I/O to printer (5).</td>
</tr>
<tr>
<td>SS</td>
<td>Used to calculate selected function from loop counter values.</td>
</tr>
<tr>
<td>TV</td>
<td>If zero, convert letters being added to the buffer into lower-case; if one, leave upper- and lower-case letters unaffected — text is stored in upper-case; if three, the next letter only is set to upper-case for SENT.</td>
</tr>
<tr>
<td>UP</td>
<td>User port address (59471).</td>
</tr>
<tr>
<td>UX</td>
<td>Value to be ANDed with UP to leave input switch status (128).</td>
</tr>
<tr>
<td>VN</td>
<td>Number of variables currently defined in use, out of a possible 21.</td>
</tr>
</tbody>
</table>
Table Two — The string arrays, their use and dimensions.

DAS(19) Contains all the fixed letters and words as they will be displayed on the screen directly below the 'HOME' location. Each of the 70 strings is five characters long — padded out with spaces — formed into a 10 x 7 matrix, the second and third dimensions of the array. M specifies the 'frame', zero for text, letters and words and one for programming in Basic.

DFS(2,6) Contains the function name strings to be displayed on the screen in a 3 x 7 matrix, zero to two down and zero to six across.

DVS(20) Stores the first four characters of each of the 21 variables to be displayed on the screen; they are always padded out to five spaces. A currently-unused variable location will contain five spaces.

TAS(19) Contains the actual strings which will be added to the buffer and then printed corresponding to the representations stored in DAS.

TVS(20) Contains the actual variable strings which will be added to the buffer when a particular variable is selected. They correspond to the display representations stored in DVS. A currently-unused location in TVS is set to the empty null string.

(continued from previous page)

Table two shows the five string arrays which hold all the information appearing on the screen. DAS and TAS form a pair; the first contains what is displayed on the screen in the 70 boxes, and the second contains what will be added to the buffer — and they may or may not be the same.

In the present example both frames — 'text' and 'programming' — follow the same format; the second and third dimensions are the rows and columns of the display. The first dimension is controlled by the M flag. If it is zero, any reference to an element is from the 'Text' set; if M is one then it comes from the 'programming' set. If it is zero, any reference to an element is from the 'Text' set; if M is one then it comes from the 'programming' set.

Table three shows the various string variables used in the program. Most are concerned with 'housekeeping', and some are not used, although their presence makes certain improvements to the text buffer editing facilities much easier. A5 is by far the most important of the strings, since it is the buffer string which is added to by selecting any 'text', 'programming' or 'variable' box, and modified, printed or sent to the second microprocessor with the 'function' boxes.

It is displayed normally at the top of the screen and if for any reason the screen must be changed temporarily, such as going to the USER frame, or printing some HELP information, it must be restored unchanged when you return to the more usual mode.

Tables four and five show some of the more significant points and areas of code. Because of the length of the program, it is not possible to give full flow charts. Instead, table four will permit anyone wanting to know how it works to locate major portions of the program text, and table five shows all the code specific to the functions is to be found.

Locations in table four which are underlined are those which have special significance. All the tables should be used in conjunction with the program listings, those given last month and those in this issue.

Starting at the beginning of last month's listings — this month's can be added to the end — only four statements
Figure 1. Connections for Pet user port.

The next section, lines 10 to 999, are the data areas which contain all the strings to appear on the screen and all to which they will correspond, as in table two. The functions first; note how each of the 21 strings is exactly five characters long. Next, the display portion of the text frame, followed by the strings. Next comes the display and strings for the programming mode. If one wished to add another mode, perhaps utilising the Pet graphics capabilities, in conjunction with the Commodore 2020 printer, a third, or another mode, perhaps utilising the Pet graphics. The third statement defines lower-case letters rather than upper-case generator ROM to display upper- and lower-case letters rather than upper-case and graphics. The third statement defines the printer to be channel five on the IEEE port communications system and the second microprocessor to be channel six.

Between 1000 and 1220 the program reads in these data areas: first DFS, then the 'text' frame DA8 (O,J,K) and TA8 (O,J,K), followed by DA8 (I,J,K) and TA8 (I,J,K) the second time around the outer loop, 1170 and 1190 are two special cases.

Because it is impossible to read in the double-quote symbol "" the two elements — one in the 'text' and the other in the 'programming' frame which must contain this character — are set to CHR$ (34), which is equivalent. The variable arrays are cleared, the display array to five spaces and the actual to the null string. Finally, in this section, some of the integer variables are initialised.

The code between 2000 and 3000 prints out the 'text' frame on the screen if M is zero, as it is at the beginning of a program run.

The start of the main action loop is 3000. It is between 300 and 3200 that any additions to the buffer are made. It also checks to see if the HELP function box has just been selected, in which case HP will equal one — normally it would be zero. When HP is one the message ""ADVICE SELECT ANY BOX FOR HELP."" is shown in the appropriate place.
will jump into the Help subsystem and nothing else will happen.

Statements 3040 and 3050 check that the combined length of the current buffer contents and those to be added do not exceed the largest size which can be fitted into the buffer area, currently four lines or 160 characters. Printers usually have a width of between 72 and 120 positions and it might be more sensible to limit the buffer size to that of the printer.

Moreover, the user will be unable to add anything to the buffer until something has been deleted, or the contents of the buffer have been transferred to a printer or similar device. This condition is heralded by the advice line reading **"WARNING PRINT STRING — NOW"**.

Statements 3070 to 3143 are concerned with checking the upper/lower-case flag and converting letters to lower-case if the UC function has been selected more recently than the UC one. To do this, each character to be added to the buffer is separated from the string NS, converted, if need be, by its ASCII value three, the next letter only is set to be appropriately and then added to the buffer string AS. If UC had been set to capital; the value two in UC is only an intermediate stage in this process.

The ED flag will allow the user to edit the buffer in the middle, and not, as at present, only at the end.

One character directly after the edit point would be reversed to show the current edit position (Y8 at statement 3170), and then the remainder would be printed on the screen (Z8).

To indicate that the program is ready to accept cursor control commands via the switch input it reverses the **"HOME"** message (also 3200). Statement 3205 waits by looping round to itself if the switch is pressed and then 3210 waits if the switch is released. In this way the program waits until the switch has been released before it will continue.

This is particularly noticeable if the cursor is allowed to wrap round from the bottom or right-hand edge of the screen with no box having been selected. When the switch is pressed again it will clear the advice line (3215), to remove any redundant advice from the last cycle. Unless, of course, the HP, ED or NV flags are set, in which case the advice is still valid and useful (3212, 3213 and 3214).

Next the **"HOME"** line is restored to its former, unreversed, self (3220). Statements 3240 to 3290 form a loop which counts down the 16 rows of boxes. For each row a pointer is printed in the five clear positions to the left of the row (3250) and it waits there for about half a second (3260-3265). If during that time the switch is released, the code jumps to 3400. Otherwise the pointer is wiped-out (3270) and moves down to the next line — two to jump over the lines **"VARIABLES"** and **"FUNCTIONS"** (3280). If all 16 rows have been scanned and the switch has not been released it

(continued on next page)
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Listing 1. The user-frame subsystem.
7300 REM USER MODE
7310 GOTO30000
READY
30000 REM USER FRAME
30010 PRINT*AS *** SELECT FUNCTION ***
30020 PRINT
30030 PRINT* T. V. ON*
30040 PRINT* T. V. OFF
30050 PRINT* B. C. 1*
30060 PRINT* B. C. 2*
30070 PRINT* I. U.
30080 PRINT* RADIO ON*
30090 PRINT* RADIO OFF*
30100 PRINT* LAMP ON*

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30110 PRINT" LAMP OFF"
30120 PRINT" DOWN FASTER"
30130 PRINT" DOWN SLOWER"
30140 PRINT" ACROSS FASTER"
30150 PRINT" ACROSS SLOWER"
30160 PRINT" RETURN"
30170 PRINT" END *"
30180 IF PEEK(UP) AND UX)=0 GOTO 30180
30190 IF PEEK(UP) AND UX) GOTO 30190
30200 PRINT" * * *
30210 FOR I=1 TO 14
30220 PRINT "A0*"
30230 FOR L=1 TO PD
30240 IF PEEK(UP AND UX) GOTO 30300
30250 NEXT I
30260 PRINT" 1"
30270 NEXT I
30280 GOTO 30170
30300 PRINT" * *
30310 IF GOTO 30340
30320 ON I GOTO 30400;30500;30600;30700;30800;30900;31000
30330 ON 1-7 GOTO 31100,31200,31300,31400,31500;31600,31700
30400 REM TURN TV ON
30410 POKE UP;PEEK(UP) AND 251
30420 GOTO 30170
30500 REM TURN TV OFF
30510 POKE UP;PEEK(UP) OR 4
30520 GOTO 30170
30600 REM BBC1
30610 POKE UP;PEEK(UP) OR 3
30620 GOTO30170
30700 REM BBC2
30710 POKE UP; (PEEK(UP) OR 3) AND 254
30720 GOTO30170
30800 REM ITV
30810 POKE UP; (PEEK(UP) OR 3) AND 253
30820 GOTO30170
30900 REM RADIO ON
30910 POKE UP;PEEK(UP) AND 247
30920 GOTO30170
31000 REM RADIO OFF
31010 POKE UP;PEEK(UP) OR 8
31020 GOTO30170
31100 REM LAMP ON
31110 POKE UP;PEEK(UP) AND 239
31120 GOTO30170
31200 REM LAMP OFF
31210 POKE UP;PEEK(UP) OR 16
31220 GOTO30170
31300 REM DOWN FASTER
31310 PD=PD-10 IF PD>30 THEN PD=30
31320 GOTO30170
31400 REM DOWN SLOWER
31410 PD=PD+10
31420 GOTO30170
31500 REM ACROSS FASTER
31510 PD=PD-10 IF PD<30 THEN PD=30
31520 GOTO30170
31600 REM ACROSS SLOWER
31610 PD=PD+10
31620 GOTO30170
31700 REM RETURN
31710 GOTO2400
READY.

Listing 2. The help subsystem.

1500 IF HP=20 THEN 40000
1501 GOTO 240000
1600 IF HP=2600 THEN 40000
1601 GOTO 240000
1700 IF HP=2600 THEN 40000
1800 REM HELP WITH LETTERS
1900 POKE "BY SELECTING ',' AND ','
2000 IF LEN(AKI(M.I,J)) THEN PRINT"' BY SELECTING '="A(K(M.I,J))."
2001 IF LEN(AKI(M.I,J)) THEN PRINT"' THE CHARACTER '="A(K(M.I,J))."
(continued on next page)
Computech for Apple System. Applications Software

Professional business software packages now available are turnkey systems with comprehensive manuals, built-in validity checks, interactive enquiry facilities, user options, satisfying accountancy, Inland Revenue and Customs and Excise requirements on diskette with DOS 3.2 and space utility.

Not adaptations, written specifically as packages for the Apple System applications software from £295 ea.

Constable

The post offers a top salary and prospects leading to a junior partnership for the right person.

Initial MICROS. proven experience of programming

A Senior BASIC programmer with

memory £1,300.

£150.

ASSEMBLER £420 four weeks. Also

AIM 654K CASED POWERED BASIC

CHALLENGER -1 £300 complete with

Also PET peripherals.

Full technical support. Write or call for

own modification as necessary.

We import direct from U.S.A. and our

Also other S100 products.

Seawell memories etc. S100 memory 16K

range TI 99/4 £690.

RF convertor. Also CHALLENGER -2

32K £620.

PETS 4K £400, 8K £450, 16K £535,

32K £620.

Delivery ex-stock to three weeks.

32K £620.

PETS 4K £400, 8K £450, 16K £535,

32K £620.

Delivery ex-stock to three weeks.

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PETS 4K £400, 8K £450, 16K £535,

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Delivery ex-stock to three weeks.

32K £620.
The Buyers' Guide is a summary of low-cost computers available in this country. It appears each month; we add new computers and amend existing information, as required, to keep it up-to-date. Systems are listed by manufacturer.

**ACORN COMPUTERS**

Acorn. Single Eurocard-sized microcomputer with 6520 processor, 1KB RAM, 16-way I/O. Max size, a second Eurocard adds hex keypad and CUPS cassette interface. Monitor and machine-code programming now. Basic and disk 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.

**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 application. Maintenance contracts offered. Microsense Computers is the sole U.K. distributor and has a national dealer network. Tel: (0442) 41191/48151 (24-hour answering service).

**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. floppy, video screen. Disc Basic; business applications produced by Moncoland, the sole U.K. agent. Distributors include Koen, GBH, Alba, and Lion.

**BRUTECH ELECTRONICS**


**BYTRONIX MICROCOMPUTERS**

Megamicro. 8080A/2-80 processor. 64K. Double-sided discs, two-page addressable VDU, 140 cps printer. Software includes Basic, Fortran, Cobol and Pascal, all running under CPM. Applications include automatic letter writer, sales ledger and stock control, payroll and bought ledger, Self-diagnosis utilities. Aimed at business and university use. Available from Bytronix (0252) 726814.

---

**APPLE II IN SCOTLAND**

At New Low Prices

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<th>Apple II Nascom</th>
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**APPLE II**

Apple II 16K £750
Apple disk complete with controller £938
16K Memory add on £69

Supercolor allows Apple to drive three colour guns of television separately. Fantastic performance. Send for details.

Clock Card £140
Serial Card £110
Parallel Card £110
Hobby Card £20
Analog Input Card 16-channel £170

**PASCAL**

Full fantastic language system complete with c/w documentation to usual high Apple standard. Too many features to detail here. £296

Dolphin BD80 printer 1122 char/sec, tractor fed £595.
Hitachi monitors in stock

---

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Vets for Pets
Anita Electronic Services (London) Ltd., are specialists in the repair and service of Commodore Pets. We offer a fast on-site service, or alternatively repairs can be carried-out at our workshops should you wish to bring in your Pet. Pet maintenance contracts are available at very competitive prices. Trade inquiries welcomed.

For further information tel. or write to: John Meade Anita Electronic Services, 15 Clerkenwell Close, London EC1 01-253 2444

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).

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.

Kim-1, processor (6502 chip); small calculator-type keyboard, LED display, built-in interfaces for audio-cassette and Tele-type; 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.)

COMPELEC ELECTRONICS

Series I. Z-80 processor 512K 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 (01-560 6296), which is also sole supplier of Altair systems.

COMPCOLOR

Compucolor II. Packaged system including 13in. eight-colour display with alphanumeric 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.)

COMPUCORP

610: desk-top unit using Z-80 and incorporating screen, 150KB floppy, 48KB. Up to 60 KB memory, four floppies, printers. Basic, Assembler, DOS, text editor, file manager, business packages. Nine dealers.

COMPUTER CENTRE

Mini kit: Z-80 CPU, CTC, USAR, serial and parallel I/O, 16 bytes memory. Western Digital disc controller, SA400 8in. drive plus CP/M, cables and connectors. Maxi kit: As above but with DRI 7100 8in. drive instead of 8in. 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 (0251 29507).

COMPUTER WORKSHOP

System 1. Typical size: 40K memory; dual 8in. floppy disc, total storage capacity 1.2MB, Rich daisywheel printer. System 1, £5,000 plus

System 2. Typical size: 24K memory; dual mini-floppy discs of 80K bytes each, Centronics 779 dot matrix printer, VDU. System 2, around £3,000

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 serious hobbyist. Twenty-five dealers.

PRACTICAL COMPUTING December 1979
CROMEMCO

**Single-card computer.** 4MHz Z-80 CPU, S100 bus, 4KB RAM, sockets for 8K ROM, 20mA/RS232 serial interface and parallel bidirectional 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.)

Z-2. Min size: chassis, 31A power supply, motherboard, Z-80 processor, 16KB memory. Max size: 512KB, 21 sockets, three minifloppies or four 8in. floppies. Basic, Fortran, Cobol, assemblers. For serious hobbyists, OEMs, educational applications, and industrial/scientific users.

**System Two.** Min size: factory-assembled system with 32KB, dual 90K minifloppies, dual printer interface, serial interface. Max size: two additional floppies, 128KB, up to seven terminals, CPM-compatible operating system (CDOS), Fortran, Cobol, Basic, assemblers, word processing, database manager. Multi-user system for software development, or scientific/industrial/business users.

**System Two/64.** New configuration featuring min-diskette drives and 64K bytes memory. Software and applications as System Two.

**System Three.** Min size: 32KB, dual 256KB floppy, dual printer interface, 20mA/RS232 serial interface, Z-80 processor. Max size: two additional discs, 128KB, seven terminals, multi-channel A/D and IVA interface, PROM programmer. Software as for System Two. Designed as appropriate for small to medium business, scientific and industrial users — "rivals minicomputers at more than twice the price." Multi-user Basic. Prices quoted by EDP Computer (031-225 2022).


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).

EXIDY

**Sorcerer:** based on Z-80, 16K and 32K; cartridge and cassette interfaces; 79 key keyboard, 256-character set, 1.2in. video monitor, expandable with Micropolis floppy discs. Basic, Assembler and Editor; games, word processor. Other pre-packaged programs plus EPROM Pack. Factor One is sole distributor for U.K. (Reviewed March, 1979.)

HEATH SCHLUMBERGER

**H83.** 8080 CPU, 46564K RAM. Serial/cassette I/O; optional parallel I/O; optional parallel I/O; serial multiprot; breadboard I/O and disc system. Basic, Ext Basic, Microsoft Basic, HDOS, CPM.

**WH83.** All-in-one computer. Z-80 processor plus Z-80-controlled VDU. 16K expandable to 48K, user-accessible. Two RS232 I/O ports. Operating system includes Benton Harbour Basic, two-pass absolute assembler, text editor, utility programs, Microlit Basic and Fortran word processor package. Heath Schlumberger (0452 29451).
**MAPP1-3Z**

- Operates the Z80 as a 40-bit floating point arithmetic processor with decimal input and output.
- Unlocks the Z80 registers to form two 40-bit floating point registers and a 16-bit symbol register.
- Is user-programmed by 39 instructions
- Links the Z80 registers to form two 40-bit
- Operates the 280 as a 40-bit floating point

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- and full ancillary equipment.
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For further details ring (0482) 23146

**MICOSTRATEGY**

For 8K Pet on C60 cassette

- Multi-player games:
  - War of the East £5.00
  - Empire £5.00
  - Solitaire games:
    - Nuclear Missile Attack £5.00
    - Cave Quest £5.00
  - A must for wargamers

**HEWART MICROELECTRONICS**

**Mini 6800 Mix II**
- 1K monitor, 1K user RAM, 1K VDU RAM, CUTC.
- Upper- and lower-case VDU with graphics option. 128-byte scratchpad, decoder/buffer, power supply. Basic in ROM, monitor command summary. SWTPC programs, Newbeir 6800, Scoib 6800 Cookbook. Markets are small business, education and home user.
- Cash with order to Hewart. (0625) 22030.

**6800S**
- 16K dynamic RAM, 1K 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 CUTC test tones, test message and games with kit.

**DIGITAL MICRO SYSTEMS**

**DSC-2**
- Min size: 32KB, but 64K standard. 2-80, over 1MB floppy disc on two single-sided 8in. drives; four programmeable 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 (0992 399591) is sole U.K. distributor, dealers being appointed.

**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.

**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 Micros is U.K. agent and is looking for distributors.

**MICHONICS**

**Micro**
- Typical size: 1K 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).

**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, accountability type system. Price includes a reporter language generator, imported by a Data Efficiency subsidiary. MicroEase Computers, Microsolve is London agent, other distributors being arranged.

---

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Business, process control, education.

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Including:
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- Compec 201
- and full ancillary equipment.
- Microprocessor Services, 139 Beverley Road, Hull
- Hull HU8 1HE

For further details ring (0482) 23146

**Circle No. 232**

**MICOSTRATEGY**

For 8K Pet on C60 cassette

- Multi-player games:
  - War of the Last £5.00
  - Empire £5.00
  - Solitaire games:
    - Nuclear Missile Attack £5.00
    - Cave Quest £5.00
  - A must for wargamers

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**Circle No. 232**
**MIDWEST SCIENTIFIC INSTRUMENTS**

**MSI 8600.** Min size: 16K memory Act I terminal; cassette interface. Max size: three disc systems — mini floppy drive 80 bytes each and 32K memory, large floppy system with up to four 312K-byte discs and 56K of memory mounted on 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 Strunech (SEED) (05433 4321) but a distributor network is being established.

**NASCOM MICROCOMPUTERS**

**Nascom I.** Min size: CPU, 2K memory; parallel I/O interface; disc interface. Max size: CPU, 64K memory, up to 16 parallel I/O ports. Mostly games, but also a dedicated text editor system written by ICL Dataseal. 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.)

**NATIONAL MULTIPLEX**

**Pegasus.** Min size: 48K, Z-80; double-density floppy (320KB); S100 bus, 12in, CRT, 58-key keyboard, two serial and one parallel interfaces, bidirectional printer. Options: 8MB drives, 1MB additional drives, digital recorder 9,600 baud. Assembler, Cobol, Fortran, 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.

**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).

**Explorer 85:** Min size: 4K, Max size: 64K. 8080A, 128KB, VDU board, ASCII Keyboard, S100 expansion. Cassette, RS232, TTY interface on board. I/O ports, programmable timer. Disc software, Microsoft Basic on cassette, RS20 and Z-80 software can be used. Aimed at hobbyist, OEM and small business. Available from Newtronics (computer division of HL Audio).

**NEWBEAR**

**7786.** CPU board, 4K memory, cassette and VDU interfaces. Range of cassette tape. Basic kit £79.95. From £165 exc VAT. From £2,700 exc VAT.

**OHIO SCIENTIFIC**

**Ohio Superboard II.** Min size: 6502 processor, 8K Basic in ROM; 2K monitor in ROM; 4K RAM; Cassette 1/2, full keyboard, 32 x 32 video 1/2, 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.)
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Calcot, Reading,
Tel: 0734 414751 (Ansaphone service)

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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 Complete Altair systems is from Pertec but the software is Anglo-Dutch. Sole distributor Complete (01-580 6296).

£3,000—£5,000

POWERHOUSE MICROPROCESSORS
Powerhouse 2: desk-top unit using Z-80 with 5in. built-in VDU and built-in mini cassette. 16K or 32K RAM, full keyboard, real-time clock, two spare slots. RS232 interface. Software: Disc and cassette operating system, programmable keyboard, 16K PROM, extended Basic. Options: 14K Basic, X-Y graphics, 2K monitor, larger screen, discs. Compatible with all computers. Aimed at OEMs and expert users such as scientists or researchers. Applications include real-time process control, engineering calculations. Availability: Powerhouse only (0442) 42002. Reviewed, September 1979.

£1,480—£1,760

PROCESSOR TECHNOLOGY
Sold: 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; 1MB 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 routine; CPM, DOS, text processor; Basic, Fortran, Algol, Pilot, Cobol. CPM 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 £396; 32KB for £722

ROCKWELL
Am-85. Kim-compatible with full keyboard and on-board printer. 1K or 4K RAM. The 4K version is described as a development system rather than a personal computer. Assembler, editor. Basic. Available from Pelco, Microdigital and Portable Microsystems (Reviewed July, 1979)

1K — £249.50
4K — £315

SCIENCE OF CAMBRIDGE
Mik 14. SCIMP processor, 256 bytes user memory, 512-byte PROM with monitor program; hex keyboard and expandable screen; display; interface circuitry; 5V regulator on board. To this can be added: 16K RAM (£3.60); 16 I/O chip (£7.80); cassette interface kit

£39.95 basic
Buyers' Guide

PRACTICAL COMPUTING December 1979

**Buyers' Guide**

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<tr>
<td>SDS 100.</td>
<td>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.</td>
<td>From £3,750</td>
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**SEMEL**

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A PRACTICAL GLOSSARY

Continuing the terminological gamut with P

Parameter
Much-used buzzword meaning an item of data, which can be changed according to what you want to do. Or if you want a heavy definition, it's a constant with variable values. For instance, you might have a parameter called 'height' and you might try giving it a succession of values.

Parity
A clever way of checking each character as it is moved around the electronic internals of a computer system. Remember binary encoding? One character is made up of a group of Os and Is, so if one bit is altered accidentally, somehow it's bad news. Such accidents can happen — the computer is shifting around many bits at very fast speeds with all kinds of electrical interference possible.

Parity checking is a way of making reasonably sure that the character hasn't changed in getting from A to B, usually from memory into the processor, though sometimes to and from tape, cassette or disc. What happens is that an extra bit is tacked on to the character — the 'parity bit' set to 0 or 1 according to whether the character has an odd or even number of Is in its bit pattern. Odd parity means that the parity bit is set to 1 when there's an odd number of Is. Given that information, you should have no difficulty guessing even parity.

At the end of some operations the computer makes sure the parity bit is still set appropriately; if it isn't, there is clearly an error and the computer will tell you. It's generally your job to correct it.

There's one obvious problem with parity checking. Clearly one troublesome bit will show as a parity error but equally, a two-bit error will appear as a perfectly good parity check. Still, single-bit errors are much more common. If there is one chance in a million of a single-bit error, there is something like a one in a billion chance of a two-bit error.

Partition
Check multiprocessing again. Some operating systems organise the computer's memory into distinct areas, called partitions, and have different programs running in different partitions. Several micros allow you to run a foreground partition with one interactive program at the same time as another program, typically a batch job, runs in a background partition. They are not running at the same time; the computer gives most of its attention to the foreground partition, occasionally snatching a few nanoseconds to execute some interpretative languages like Basic, though that also applies to any worthwhile compiler language.

The big problem with Pascal is that its impenetrably cryptic notation and syntax rules means a hefty learning task before you can start using it.

Password
This one is obvious. It's a string of characters which allows you to run restricted programs or to read restricted files. Handling passwords is a function of the operating system and not all of them have it; usually a computer, or rather its operating system will request your password, you type it in, it is checked and access is either granted or denied.

Patch
A patch is a correction, usually a group of instructions added to correct a mistake in a program.

PC
Printed circuit, as in PCB, or sometimes program counter — that is a memory location inside the computer which keeps track of where you are in the program being executed.

PCM
Plug-compatible manufacturer: Someone who makes plug-compatible equipment. In practice, the term is used most often to refer to people who make IBM-compatible peripherals.

PDP-11
The world's best-selling minicomputer family from the world's top mini manufacturer. The PDP-11 has more or similar internal all the way from the LSI-11 microcomputer to the six-figure VAX-11/780.

In fact, that is somewhat simplistic; there are distinct subdivisions along the way, with significant developments in the basic architecture producing four or five family groups. At one end there is the LSI-11, which is called the PDP-11/03 when it's in a box. The 11/23 is a bigger micro, a bridge between the LSI-11 and the 11/24, the latter is the company's mainstream mini. It has its own line of development, with the small 11/04 at one end and the big 11/60 at the other. The bigger 11/70 and the forthcoming 11/44 are another group, and the VAX system — a 32-bit mini, unlike the rest — is also out on its own.

PE
Phase-encoded. A way of storing data on mag tape. Forget it. Some people use PE as an abbreviation for parity error, but not many.

PEEK
Most Basics have a handy statement which allows you to read the contents of a specified memory address. A companion statement is POKE to put a value into a specific memory address. David Lien's BASIC Cookbook quotes this example:

X = PEEK 18370 assigns the numeric value stored in memory address 18370 to the variable X.

Parallel
A type of interface. Generally a specific plug-and-socket connection between two parts of a computer system, like a printer and the processor. Interfaces are in two varieties, serial and parallel.

A serial interface moves data one bit after another, serially. A parallel interface uses cable containing enough wires to carry each bit in a character simultaneously; so if the computer uses an eight-bit pattern to encode one character, the parallel interface will contain eight wires, each carrying one bit.

Within the two groups, however, there are several philosophies about which wire carries what, and so on. Parallel interfaces are faster because they deliver eight bits at a time instead of one. Parallel interfaces tend to be specific to one computer manufacturer. Phrases you might hear include:

Centronics-compatible: Centronics has for some time been the leading supplier of matrix printers and because many of the U.S. minicomputer makers brought their printers from this company, its parallel interfaces became another de facto industry standard. It was adopted by several computer vendors and it is also offered by

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several printers can attach directly to Dataproducts in inference being that several
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encountered occasionally.

and common; Perkin-Elmer (Interdata) manufacturers.

table options which may be offered with interfaces printers claim very carefully. IBM has so many
PDP-11. Equipment. That also applies to many PDP-11

The 'standard' interface. Check carefully.


circles 152

Other popular Digital-compatible: Again, RS 232: Sometimes known in ICL
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Glossary
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several printer suppliers, the inference being that it is a simple matter to replace a Centronics unit with another.

Dataproducts-compatible: Dataproducts has been the top independent vendor of line printers and a similar situation obtains.

Digital-compatible: Again, several printers can attach directly to the parallel interface socket on a PDP-11 minicomputer from Digital Equipment. That also applies to many of the systems incorporating a PDP-11.

IBM-compatible: Check this claim very carefully. IBM has so many printers attached via so many interfaces to so many types of computers. Other popular parallel interface options which may be offered with printers broadly follow the league table of minicomputer manufacturers. Compatibility with Data General and Hewlett-Packard minis is common; Perkin-Elmer (Interdata) and General Automation are encountered occasionally.

RS 232: Sometimes known in ICL circles as V24 - is yet another 'standard' interface. Check carefully.

The 'data in', 'data out' and 'common return' pins usually are standard, but others, like 'printer busy', - very useful for stopping the flow of data while a printer gets on with things - can vary.

Parallel interfaces are used generally for printers, in fact. This is largely because the electro-mechanical printer can often be the bottleneck in a system which otherwise operates at electronic speeds. Anything which optimises the performance of the printer, like presenting it with eight data bits at a time rather than once, is a good thing.

Pet
Be thankful that nobody calls it the Personal Electronic Transactor 2001 any more. The clever Commodore piece of consumer electronics is probably the world's best-selling personal computer. It is a pioneering, table-top design with graphics, a good clear screen, a very good Basic, and the 6502 processor among its better-liked attributes.

The calculator-style keyboard on Commodore's and the idiosyncratic use of the IEEE interface are probably its least-respected qualities. The newer business-oriented version has a more reasonable typewriter-type keyboard and no built-in cassette. Commodore, which makes Pet, also sells pocket calculators and digital watches. It used to sell office furniture, too, but that is past now. Commodore also make peripherals for the Pet, notably a plug-in floppy disc unit and some printers.

Peripheral
Almost anything connected to a computer. Generally a peripheral is a discrete and physically separate 1/0 or storage device of some kind attached by cable to the processor. Some people legitimately use the term for almost anything which isn't the processor, including internal, invisible parts of the computer system. You will be safe if you use the term to mean disk units, VDUs and printers.

Petal printer
Some people use this phrase instead of 'daisywheel'. They are correct, really, since it refers to impact printer mechanisms where the characters are formed on the end of a kind of stem attached at the other end to a central boss of sorts, not unlike petals on a flower. Daisywheels are just one example.

Others you might encounter are the Perkin-Elmer Carousel mechanism - more like a roundabout than a daisy; and the DRI/NEC Spinwriter, which has a print element which looks like a thimble.

All petal printers deliver reasonably good quality printing for word processor use.

Philips
Giant Dutch conglomerate in electronics and electronics. Philips also makes smallish office computers and word processors. It owns a Californian microprocessor company, Signetics; and it has a minicomputer line called the P800, which is used principally by other Philips divisions for incorporation into its products.

Picoprocessor
What is smaller than a microprocessor? The term picoprocessor, however, should be reserved for an LSI element Computer Automation puts into some of its interface cables, that company thought of the word first. What they do in the cables is organise the data moving along them so that the computer doesn't have to do it.
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<td>T. PITMANS short course in programming manual (full VAT)</td>
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<td>RCA 1820 users manual (Nil VAT)</td>
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<td>On cassette Text Editor: Ascsembler, Diaggsembler, Each</td>
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<td>SAVE 10% AND BUY ALL THREE TOGETHER</td>
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The EXPLORER 85 is inexpensive with all the advantages of a powerful board plus potential for "infinite" expansion.
- Uses New Fast INTEL 8085 cpu, 100% compatible w/ 8080A software but 50% faster than 8080A cpu.
- Powerful 2 K monitor.
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- Provision for 8K PROM or EPROM,
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- And lots of other great features.
- Send SAE for Full Specification.

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<td>LEVEL 'C'</td>
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<td>S100 main frame expander kit</td>
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<td>Increases the number of S100's to 6</td>
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| Includes all slot metal, 5 slot extension board, board-guides & brackets.
- Fits into EXPLORER cabinet, (less $10 pin connectors). | 2.00           |     |      |
| LEVEL 'T''                                  |                |     |      |
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| EXPLORER 85                                | 35.50          |     |      |
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| POWER SUPPLY IN STEEL CABINET              | 25.00          |     |      |
| GOLD PLATED S100 BUS CONNECTORS            | 4.00           | Free|      |
| SF MODULATOR 8kHz required when using TV set serial socket.                | 8.00           | Free|      |
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The characters can be any of the 96 ASCII alphanumerics and any of the 32 special characters in addition to upper/lower case capability it has scroll up features and full X-Y cursor control. All that is required from your microcomputer is 300 baud RS232 or 20ma loop, I/O. 64 or 32 to baudot output, selectable baud rate, RS 232 or 20ma loop serial data plus a power source of 8v DC 6.3v AC. The steel cabinet is finished in IBM Blue-Black. And if that is not enough the price is only £135.55 + VAT as a Kit, or £175 + VAT assembled and tested. Plus £2 P&P (Monitor not included).

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ELF 11's VIDEO OUTPUT makes it unique among computers selling at such a modest price. The expanded ELF 11 is perfect for engineers, business, industry, scientific and educational purposes.

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<td>To Newtronics 138 Kingsland Road London E2 9YB Dept PVC Tel: 01-739 1582. SOLE UK AGENTS.</td>
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PRACTICAL COMPUTING December 1979

179
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Professional audio mixer that you can build yourself and save over £100.
6 into 2 with full equalization and echo, cue and pan controls.
All you need for your own recording studio is a stereo tape or cassette recorder.
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• Reliability Solid state circuitry using an IC and silicon transistors ensures high reliability.
• 500 lines horizontal resolution Horizontal resolution in excess of 500 lines is achieved at picture center.
• Stable picture Even played back pictures of VTR can be displayed without jittering.
• Looped video input Video input can be looped through with built-in termination switch.
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Our charges are £7 per hour plus parts.
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FULL RANGE OF PET/SOFT SOFTWARE NOW AVAILABLE

THE NEW ITT APPLE (2020)
Apple IIc with keyboard and monitor. The Apple IIc is the 8-bit microcomputer that has been developed from the successful Apple IIe. It has a full colour, high resolution display, a full size keyboard, and a built-in printer.

THE TRS80 (Special Scoop)
Low priced, ready to go (B999 + VAT).

PLUGS INTO YOUR OWN TV
Use your own cassette
LEVEL II BASIC WITH 16K USER RAM provides you with possibly the most powerful micro around. All our TRS80s are fully converted to English Television Standard and include a U.K. Power Supply, Cassette Leads, Sample Tape, Level I & Level II programming manuals, and special lead that enables you to connect direct into your own television. Special features of Level II Basic enable you to:
- Set or reset any point on the screen
- Test for the presence of a point on the screen (these features enable easy animation)
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- Graphics blocks as standard
- Design your own pictures and many more features for only £399 + VAT.

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SORCERER SPEAKS YOUR LANGUAGE
For personal or business use. The best value for money around.
- 152 by 256 point resolution
- 16K or 32K User RAM
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- RS232 Serial Port
- Composite IV peak to peak video
- Centronics compatible TV output supplied as extra
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- 64 standard PET graphics
- 79 key keyboard including 16 key numeric keypad
- Expansion bus for connection to 5100 Expansion Box
16K Sorcerer — £590.00 + VAT
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Combines complete interface to Centronics parallel standard. Switchable golfball heads makes this the most versatile golfball printer around. Fits the Sorcerer, TRS80 Exps. Interface, Apple & ITT2030 (with parallel card extra), Pet (with special connector extra) and any machine that has Centronics compatible parallel output. Control buttons to enable you to suspend printing while changing paper. Recognizes control codes to switch printer on or off. Only £690 + VAT complete with Interface and manual. Limited supply of converted typewriters only.

TOP QUALITY RS232 SERIAL PRINTER FOR YOUR BUSINESS
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- Full colour
- UHF output
- Audio cassette tape interface
- Up to 64K RAM on board
- BASIC in ROM (graphics commands include COLOUR = VLIN, HLIN, PLOT and SCRN)
- Built in loudspeaker
- Buckets of software available
- Disk System (110K byte per drive — includes controller)
- 512 by 256 point screen
- Port
- Composite IV peak to peak video
- Centronics parallel standard. Switchable bi-directionality to print in 9 X 9 matrix on multiple copy, pin-fed plain paper.
- This model accepts RS-232 or current loop serial data at baud rates switchable from 110 to 9600 and Parallel Bit data input and output at over 1000 characters per second.
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- Standard storage capacity of 256 characters
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OCTOBER 1979

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- high
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- Disk controller. (Ohio Scientific compatible).
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life sound effects. With special circuits to protect your TV.

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variables

EXPRESSIONS

STATEMENTS

COMMANDS

CONT LIST STATEMENTS

NEW NULL RUN

CLEAR DATA DEF DIM END FOR

GOTO GOSUB IN GOTO LET

NEXT ON GOTO ON GOSUB POKE PRINT REAC

RESTORE RETURN STOP

OPERATORS

NOT AND OR > < + - RANGE 10 32 to 10 32

FUNCTIONS

ABS ( ) ATN ( ) COS ( ) EXP ( )

LOG ( ) PEER ( ) POS ( ) RND ( )

SIN ( ) POP ( ) TAN ( )

CR

FUNCTIONS

USR ( )

PRE ( ) INT ( )

SGN ( ) TRUNC ( )

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Send large S.A.E. for our free '79 catalogue.
Another Case History

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You start by designing your document. Look at this one—a classic example of how to cut down paper-handling. It acts as:

INVOICE STATEMENT GOODS RECEIVED NOTE CASH RECEIPT CASH POSTING SLIP

The filing system is based on the principle of one file per customer which allows the detailed breakdown of any account balance to be easily checked. All entries are made in answer to easily followed prompts on a visual display terminal. The clerk works from an order form/picking list which has had the customer’s account number, the product numbers and quantities to be invoiced filled in when the order is taken. The system responds by showing the customer’s name and address or the product description on the screen in an average of approximately 2 seconds: this from a total file size of 1,000 customers and 5,000 product items. The invoice or credit note is prepared on the screen and then printed when all the lines have been accepted. If a customer is on ‘hold’ because of an overdue balance this can be reported on the screen before producing the invoice. The system allows complex discount rules to be used with no effort by the clerk. Lists of customer balances, full customer details, and product lists can be produced in full or by selecting parts, such as all balances over £200.

For an appointment with an SWTU Authorised Distributor to discuss your system requirements, contact us at:

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