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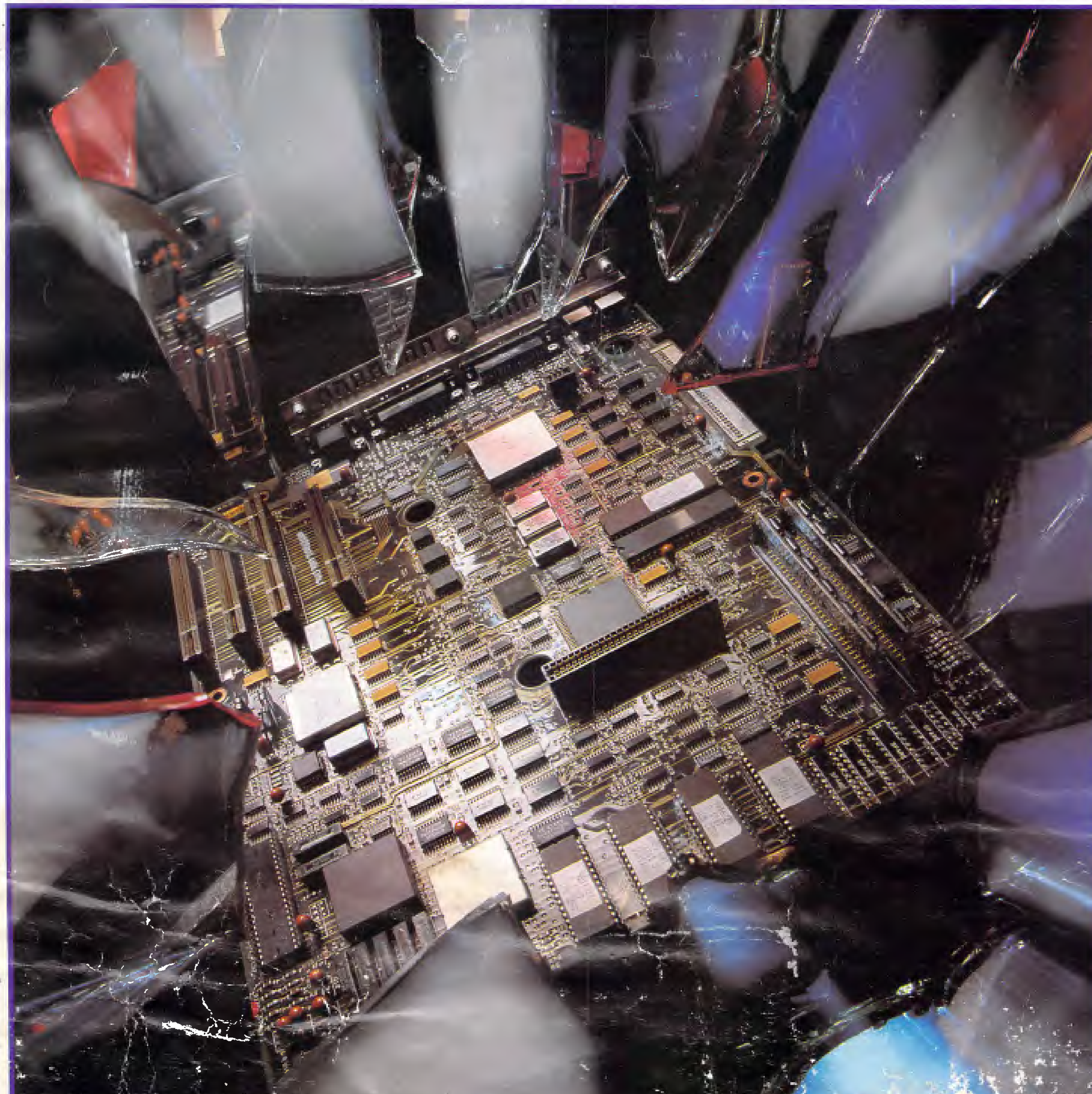
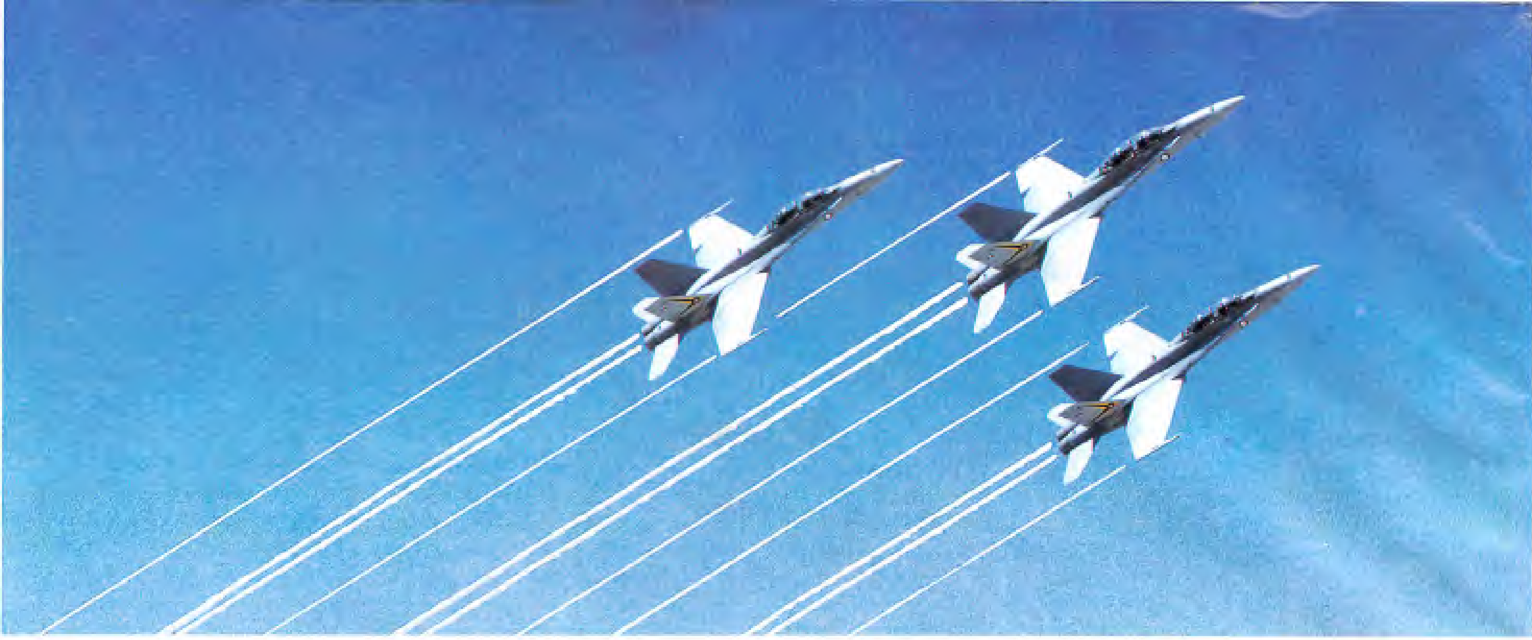


TANDY SHATTERS IBM'S PS/2 MONOPOLY

Micro Channel explained — plus DeskJet and Multi-sync monitor comparison



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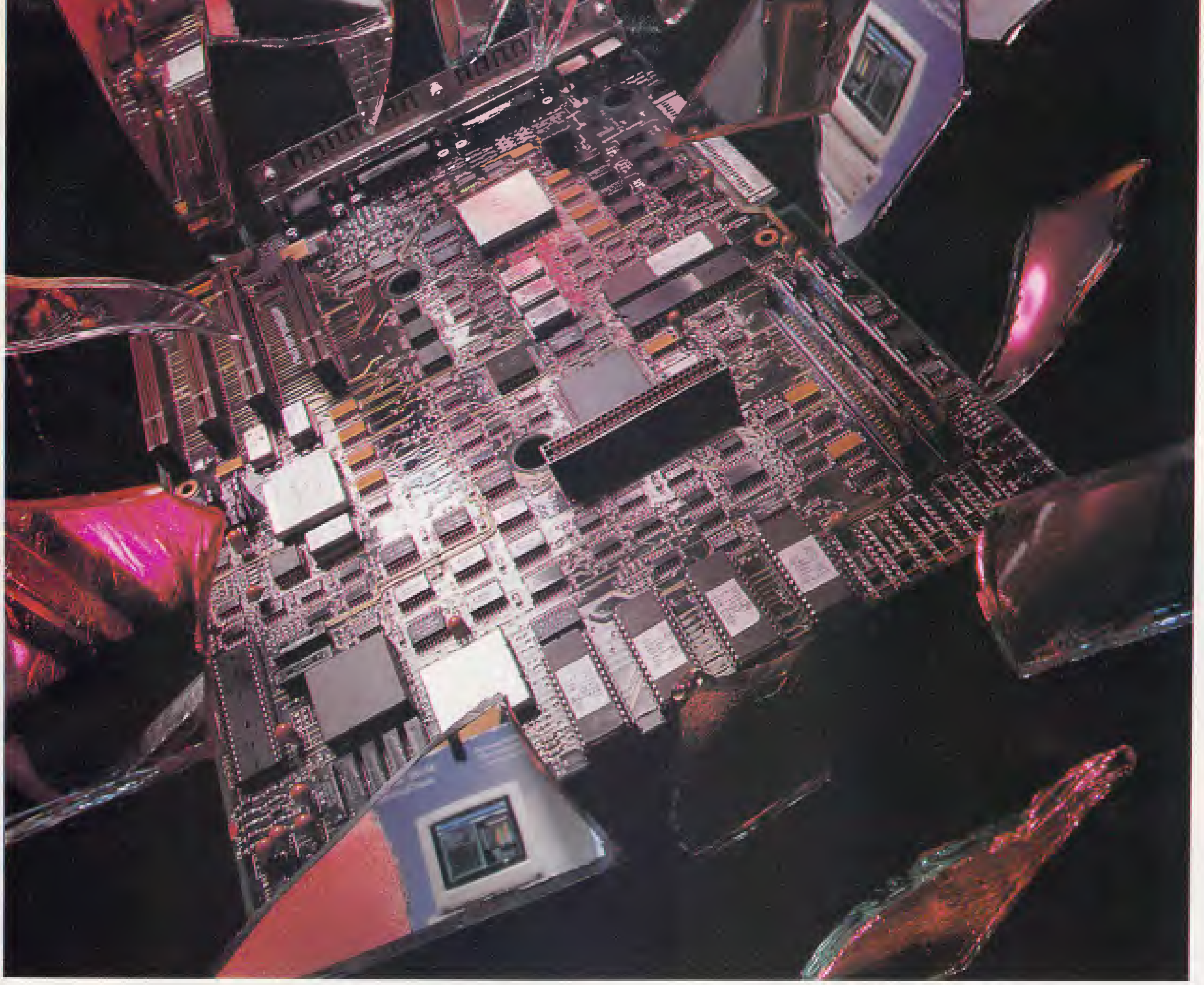

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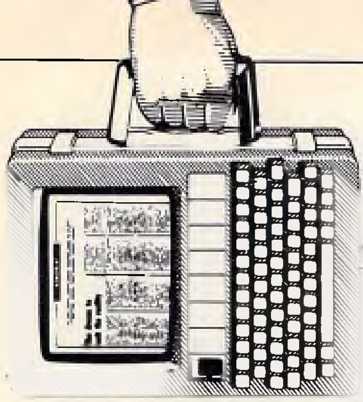

Guy Kewney and our US correspondent, Tim Bajarin, report on the month's micro news, including details of the first PS/2 clone, super-fast processors from General Electric, specifications of Apple's troubled laptop and significant language upgrades from Microsoft.

PS/2 clones from Tandy and Dell

Just over a year after IBM originally unveiled its new generation PS/2 range, featuring the all-singing, all-dancing Micro Channel architecture, the first clones have finally appeared.

Taking line honours was Dell Computers, which unveiled its System 400 (Model 50 clone) and System 500 (Model 80 clone) on April 18, closely followed by Tandy on April 21, with its 5000 MC (Model 80 clone).

More important than the arrival of the machines themselves was the fact that IBM is licensing these companies to go ahead and clone its PS/2s. This way, IBM gets to see the Micro Channel market blossom (resulting in more expansion boards and software); it also pockets substantial royalties with every clone sold; and it makes more money when the less well-heeled companies (such as Ferranti) badge the IBM models as their own. Who said profitability had gone out of the PC market?

Both the Dell and Tandy systems are based on a specialised Intel Micro Channel clone chip set — no systems have so far been released that are based on either the Western Digital or Chips & Technologies clone chip sets.

There has been no indication from InterTan Australia as to the pricing and availability of the Tandy 5000 MC (though it is expected to be released in the US by July), while Dell Computer says it is still making arrangements for an Australian distributor.

Stacey will live on at Atari

A laptop Atari ST should be available by Christmas, at a price of under $1700 — or so Sam Tramiel assures me.

The machine is currently in the final stages of prototyping at UK company Perihelion, which is best known for another Atari project — the Abaq, based on the Transputer.

Sam Tramiel spilled the beans on 'Stacey', as the laptop is code-named, when we met at the Hanover Fair in March.

There really isn't very much to say about it, from a design point of view: it's an ST design squeezed into a portable box.

The only surprise is likely to be an alternative to the normal Atari mouse — the designers reckon that somebody with a computer on their lap is unlikely to find a level surface to run the mouse around on. "You might be lucky and find somebody wearing a tight skirt sitting next to you on a plane," mused Sam Tramiel, "but otherwise it wouldn't work. So we're probably going to put in a tracker ball."

Tandy's PS/2 clone — it could be here by July

The main design problems are based on power consumption. The Motorola 68000 chip uses very little power, but all the associated electronics are rather greedy. So Perihelion has taken all the peripheral chips and has designed one large and complex, but miserly, gate array, which replaces them.

Final details of the machine depend on what silicon is available next month when first working prototypes will be shown to the trade.

At this moment, the plan is to have a full megabyte of memory, a hard disk as well as a floppy disk, and a full-screen LCD for display. But memory shortages mean that, quite possibly, the first models will be 512k machines. Also, if memory is expensive, the price will be kept down by dropping the hard disk. On the other hard, there are some spectacular new liquid crystal displays just coming onto the market at around $2500 per screen — and if these drop in price, they may be available as a super option.

Interestingly, Atari is now very close to another new machine, also in the 68000 family — its Unix ST.

This is described by Jack Tramiel, owner of Atari, as "the machine which will bring Unix to the consumer — well, to the personal user."

He reckons (quite correctly) that there is a market for Unix machines with people who'd like some of the multi-user accounting software that runs under Unix, but can't afford the normal prices. His machine, based on the 68030, will be cheap — under $10,000. And it will include the latest Unisoft version of Unix V.

The bright idea in the package is the decision to use an industry standard bus, called the VME bus. The company's technology boss, R&D vp Shiraz Shivji, points out that there are many similarities between this bus and IBM's new Micro Channel — but that the VME bus has several advantages.

The advantages: there are a very great many VME boards doing a very great many things, already in the market. It is also (said Shiraz) quite a bit faster, and more flexible on timing.

The Atari machine won't be the first VME-bus Unix machine in the world, but it will be one of the cheapest, and it will be well-promoted if Atari does go ahead and sell it.

Few would argue with Tramiel's theory that far. But when he goes on to talk about selling this to personal users as a high-power alternative to things like the PC or the ST or the Amiga or so on, he's talking about testing a concept that has been restricted to saloon bar discussion, until now.

The question is: can an ordinary, untrained user without the support of a programming department learn to use and love Unix?

I've read a lot of learned argument about this, none of which sounded remotely comprehensible. The gist of it is that Unix is much more powerful than DOS, and probably more powerful than OS/2, but that this power comes at a cost.

Most users I know find DOS more complex than they like. I'm not going to stick my neck out very far, but seriously, I do doubt that Unix is going to become a fad.

Guy Kewney

Perhaps the most surprising element of Tandy's recent PS/2 clone launch was the bonus unveiling of a CD-ROM-like technology that Tandy claims will allow compact discs to be erased and recorded over. The new technology will have major ramifications for the compact disc and CD-ROM field, as products developed with the technology could replace or augment such storage devices as WORM (write once/read many times) drives, tape-backup units and high-capacity hard disks.

When released, the Tandy THOR-CD (Tandy High-Intensity Optical Recorder Compact Disc) audio drive will cost "less than $700," according to Tandy officials. Promising a late 1989 delivery, they emphasised that THOR-CD is an optical-storage medium that can work transparently with disks and drives that adhere to current CD standards.

"THOR-CD looks just like a regular CD or CD-ROM," a Tandy spokesman said. "It can record, play back, store and erase music, data or video on a disk that can be used on any CD audio or CD-ROM player." The main difference between THOR-CDs and regular CDs, he said, is that the tracks and pits written to by the THOR-CD laser beam can be re-written at least "a million times."

No longer will CD fans have to fork out masses of money for the latest discs — they can simply pop round to a friend's place with their erasable CD and record it. Likewise, they can now pirate more software in one hit than ever before.

Corporate online databases now on CD-ROM

CD-ROM is proving a more cost-effective medium for massive corporate databases than online services. The latest release of CD/Corporate from Lotus, for example, contains data on more than 12,000 publicly-listed US companies, including financial statements, annual reports, investment analyst reports, stock prices and trading data, and abstracts from key business publications.

Lotus picked up the rights to CD/Corporate following its acquisition last year of Datext, and the product has since been absorbed into the Lotus One Source CD-ROM range. While CD/Corporate costs $US18,500 for monthly updates, customers still find it a more convenient option than online searching.

Melbourne-based Disctronics, currently the world's third largest replicator of compact discs, is preparing a similar corporate CD-ROM with Australian data, according to business development manager Peter Phillips. Disctronics (which operates two CD plants in the US and one in the UK as well as its Melbourne facility) is working with clients on a corporate CD-ROM financial database, that will eventually be available to customers on a subscription basis. While the price has not yet been determined, it is likely to also be "several thousand" dollars per year.

New date set for launch of NeXT workstation

The computer industry's favourite vapourware box — Steve Jobs' NeXT workstation — has had its proposed launch date amended from late 1987 to February 1988, then March, then May, and now mid-June is rumoured to be the date. This follows the arrival of several prototype models at beta test sites and universities recently.

NeXT founder Steve Jobs will be accompanied at the launch by representatives from several major software developers, according to sources close to NeXT. Word processors, spreadsheets, graphics and databases are believed to be ready for the NeXT workstation, as is a multi-processing variant of the Unix operating system, with a custom graphical user interface developed by UK company IXI.

Only the monochrome version of the NeXT workstation is expected to be debuted in June, with a high-resolution colour graphic version due before the end of the year. Like Apple, which Steve Jobs co-founded before setting up NeXT, the new systems will be assembled at a highly-automated factory in California.

Add-in converts mouse from serial to bus

MicroSpeed's PDA (Pointing Device Adaptor) is the first PC-compatible add-in card to allow mouse users to convert a serial mouse to a bus mouse, according to Timothy

Barry, Microspeed's president.

"Many users want a mouse, but since they already have a modem, laser printer or scanner in use on their two serial ports, they simply don't have the necessary extra port," Mr Barry explained. "We developed the PDA to let users change from a serial to a bus mouse without the expense of replacing existing equipment," he said.

Distributed by Bryte Software Services of Sydney, the Microspeed adaptor is claimed to work in all PCs and compatibles and can convert Microsoft, Logitech, and Mouse Systems mice (and other compatible serial mice) to a bus interface. The PDA, priced at around $120, will be available in a few weeks.

Mitac International, one of Taiwan's largest PC manufacturers, has unveiled its Paragon 386E model, based around the 20MHz 80386 processor, and the MPS1000L PS/2 Model 30 clone. Distributed locally by Keller Automation, the new Mitac models will be officially debuted at PC '88 in Melbourne next month, according to Keller's national manager Nick Sikiotis.

The $11,895 Paragon 386E features 2Mbytes of RAM (expandable onboard to 8Mbytes), SCSI adaptor, 100Mbyte 3.5in hard disk, 1.2Mbyte 5.25in floppy disk and a socket for an optional 80387 numeric coprocessor. With the SCO Xenix/386 operating system, the Paragon 386E can be used in multi-user mode with up to 50 terminals.

The $1995 MPS1000L is claimed to be superior to IBM's PS/2 Model 30, as it uses a faster 10MHz 8086 (compared to IBM's 8MHz processor), and can be fitted with VGA graphics capability (rather than MCGA).

Mitac is experimenting with emulation chip sets from Chips & Technologies and Western Digital, and claims that future Mitac systems will offer "complete PS/2 compatibility and support for OS/2 and the Micro Channel bus."

Apple tries to break windows

It will be interesting to see how IBM reacts to Apple's lawsuit against Microsoft and Hewlett-Packard. Apple is claiming that Microsoft's Windows 2.03 and H-P's New Wave product infringe the copyright of the Mac's desktop or Finder.

When Apple first started throwing its legal muscles around the computer industry, Digital Research and Microsoft gave in with little fight. DR agreed to change the look of its desktop, which means that we now have a Gem without resizable windows and without its original 'trash can' to delete files. Microsoft gained a 'licence' from Apple for Windows 1.03, but the latest release — version 2.03 — in Apple's words 'goes beyond that licence'.

Comparing the two versions of Windows, it's hard to imagine that Apple is getting upset about the only noticeable visual differences between the two versions — resizable windows and movable icons.

Where IBM comes in, is that Presentation Manager, the windowing front-end to OS/2, is based heavily on Windows, and I can't really see IBM giving in to Apple. If nothing else it certainly has a larger legal department as many clone-makers have experienced first hand.

So what is the fuss about? My guess is that Apple is clearing away barriers to its selling Macs into the major corporate environments. Its connectivity deal with DEC, announced two months ago, could mean Macs acting as front ends to minis and mainframes. And Apple is probably worried that it may be competing with IBM's own machines presenting a very similar interface under OS/2. Hewlett-Packard is also a mini and mainframe manufacturer which could build on NewWave to produce a windowing icon-based, front end to its own large machines. That would be the end of Apple's opportunities in that market.

The whole matter smells for a number of reasons.

Apple has always billed the Mac as 'the computer for the rest of us'. But Apple's pricing of the Mac has put the machine well above the means of most of us. This is no accident. Apple consciously prices the Mac to be 'a product that people aspire to'. The machine's interface is wonderfully friendly, easily customisable, and hides you from the complexities of DOS. But there is a fear within Apple that the machine will be seen as a toy and so be shunned by the corporate buyers who hold the real buying power.

Apple intends to develop its high-quality, high-performance profile. Its new connectivity strategy — with the acronym OASIS (Open Architecture System Integration Strategy) emphasises the company's commitment to link in with the main connectivity standards — OSI, Token-Ring, LU6.2, DECNet and the like. But Apple wants it both ways. It wants an open architecture; it wants easy-to-use graphic interfaces on terminals; but it doesn't want anyone to get too close to its own standard.

Apple's chairman John Sculley isn't worried about icons or windows or mice. He believes that it is possible to innovate and develop using these desktop metaphors without infringing Apple's copyright in its operating system. But does he really think Microsoft's making its windows resizable will make or break his chances with the corporates?

Personally, I blame Digital Research and Microsoft for giving in so lightly in the first place. Gem in its version 2 and 3 still looks more like a Mac desktop than Windows ever did. Microsoft Windows doesn't even use icons for most of its operations. By not fighting Apple originally,

Microsoft now has a harder time defending its interface.

Ultimately, all these desktops are copies of the original ideas developed by Xerox. Xerox's Smalltalk and its descendants, such as the Sun Tools interface reviewed last month, still work better than the Mac. Why hasn't Xerox sued Apple?

The answer is that Xerox isn't threatened by Apple while Apple is threatened by the IBM/Microsoft alliance and by Hewlett-Packard iconising its customers first and locking out Apple.

What amuses me most is the fair-minded facade that Sculley puts on the whole thing. Microsoft is an Apple developer and Sculley does not want to sever his good relationship with Microsoft chairman Bill Gates. "Bill and I talked about it and we agreed that we should not let this complaint escalate to the point that it affects our other relationships," Sculley told me just a couple of days after the writ was issued.

Considering Microsoft's Excel is reckoned to be one of the reasons why many corporate users ever gave the Mac a second look, Sculley is wise not to risk his relationship with Microsoft just yet.

Gates' version of the story is slightly different. He had been talking with Sculley just a couple of days previously and Sculley had not mentioned the writ. "It came as a complete shock," he said.

Derek Cohen

Commodore's slow lift-off

Commodore has officially entered the Transputer stakes, with the announcement that it had a product nearly ready, at Hanover Fair. More significantly, it has also announced its Amiga 2500, which has the 68020 chip, and offers a 1008 by 1024 graphics screen.

The Transputer system is not to be taken too seriously as yet. Essentially, Commodore has two projects under its wing: one has yet to work, and the other is very unambitious, using the Transputer as an add-in card on the PC side of an Amiga. Neither is seriously intended as a rival to the Atari Abaq.

At Hanover, one of these was available for inspection, but not working. The other was said to be "working, but stuck in an elevator somewhere."

Migent: the sequel

It wouldn't be quite right to say that Migent, with Emerald Bay, has launched a new database product that has it running hard in the opposite direction from the rest of the database world.

But it would come close, because the whole world is going after one 'standard' of database handling, SQL, and Migent has decided to produce a rival.

The idea seems to have a lot of merit, because all databases that use SQL are costly. And SQL is definitely the wave of the future. What Migent is offering is a low-cost alternative, but one which has the same advantages.

The snag is that no-one else will be able to use the Emerald Bay alternative unless they buy something from Migent.

Micro data storage, normally, has a whole bunch of information on a central disk, and when one user wants to search through it, it gets copied across to that user's PC (usually on a network).

The SQL concept, shared by Migent, is that central data ought to be analysed centrally. Only the results of the central search ought to be sent down to the user.

This may sound like a minicomputer concept (or even a mainframe concept) but there is more to it. Tomorrow's machines will have multiple applications running together, and they will definitely have serious problems when they try to access the same data. For ex-

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Not copy protected. Site licensing available. * (plus sales tax) ample: on a '386 micro with DESQview, I can run two copies of WordStar, and each can edit the same file. Which version is the correct one? Two versions of Lotus 1-2-3, and which is the 'final' version? Or a copy of a spreadsheet, fed over in a special format to a database manager, searched, and fed back into the spreadsheet — which may still be altering the data. Which one do you save?

Migent has already put together a product called Summit, which will give Lotus 1-2-3 users an in-built database (along the lines of Paperback's VP Planner). It has also built a 'C' language compiler which generates code to interrogate its own Emerald Bay database. And there is another language, called Eagle, which can be used by people who know Ashton-Tate's dBASE products.

Other people are writing other bits for it. Someone is doing an Emerald Bay interface for the Macintosh. Someone else is doing the Unix version. There will be Pascal, Basic, and other languages. There will even be an SQL version.

The problem is that Emerald Bay is proprietary — no one is allowed to know how to design a network database server which emulates it.

Programmers, typically, don't like writing in proprietary databases. A major obstacle to the success of the Ansa Paradox database (Migent will do an interface to this, too) has been Ansa's refusal to release details of how the data is structured.

Almost certainly, sometime in the next two years, Migent will have to reverse this decision, and allow other people to write Emerald Bay engines — or resign itself to seeing Emerald Bay remain a small and pretty corner of the database world — as Emerald Bay itself is a small and pretty corner of Lake Tahoe, Nevada.

Ashton-Tate is having a few problems, it seems, with its forthcoming incarnation of dBASE. At last count, 3770 bugs were known to exist in the product, over 400 of which caused the system to totally crash. The report preparation facility (pictured here) is especially plagued by bugs.

Unlike Lotus, which last month admitted it would have to delay the release of version 3.0 of 1-2-3, Ashton-Tate is keeping tight lipped about alledged development problems.

It does seem, though, that the company may have to postpone its planned July release date for dBASE IV.

There is speculation in the US that it will not be released until later this year.

New releases from Microsoft

Even before the ink was dry on last month's review of Microsoft C version 5, Microsoft had announced a new release of all its language compilers. The new releases not only improve the compilers but also add the ability of producing code for both MS-DOS and OS/2. Also announced at the same time was the long awaited OS/2 Developers' Toolkit.

Each language now comes with the new Microsoft program editor. This is a multi-file, multi-window and multiple language editor, which will run in real or protected modes. It can be configured to emulate WordStar, the QuickC editor, the QuickBasic editor or many other popular program editors. This will greatly aid people who use more than one of the Microsoft languages as there is now only one user interface to learn.

Each language now includes the latest version of CodeView, Microsoft's source debugging program. This program allows compiled code to be run incrementally while viewing the registers, variables and the source code. This new version will debug both MS-DOS and OS/2 code and includes the new features of data browsing and the ability to follow multiple processes and threads in OS/2 applications.

The compilers themselves have been simplified and will all run directly from the new editing environment. The problems of inter-language calling have been simplified, making the inclusion of assembler in high-level languages much easier. The assembler now supports 80386/7 and compiles the source code up to 15 per cent faster.

The OS/2 Developers' Toolkit should increase dramatically the rate at which new utilities are written for OS/2. The Toolkit, which works with all the languages, will improve a programmer's productivity significantly because there is only a single set of OS/2 calls to learn. Each piece of code makes use of OS/2's facilities through the application program interface (API) and this will support virtual programs of up to one gigabyte.

The Developers' Toolkit also contains the OS/2 Programmer's Learning Guide. This explains exactly how to get the most from the less familiar concepts contained in OS/2, such as multithreaded applications and dynamic linked libraries.

Also shipped with the Developers' Toolkit are two new useful utilities.

BIND allows a single program to run under either OS/2 or MS-DOS. My heart leapt when I read this, thinking that at last DESQview's power would be provided in OS/2 for old DOS applications. No such luck. Bill Gates must still believe that DESQview's power is unreliable. BIND will only work with programs compiled with new compilers, so your old DOS programs will still have to run in the compatibility box.

ILINK is an incremental linker which only links in the modules which have changed. This will encourage people to program in a modular fashion and will improve the compile time dramatically if they do.

This all sounds wonderful to those who understand what is going on, but will only serve to confuse even more the people who don't. Programming under OS/2 will be easy. Programming under DOS isn't too bad either. Programming in both at the same time is going to be very confusing. I really feel Microsoft has done the power users of its programming languages a big favour with these releases.

Andy Redfern

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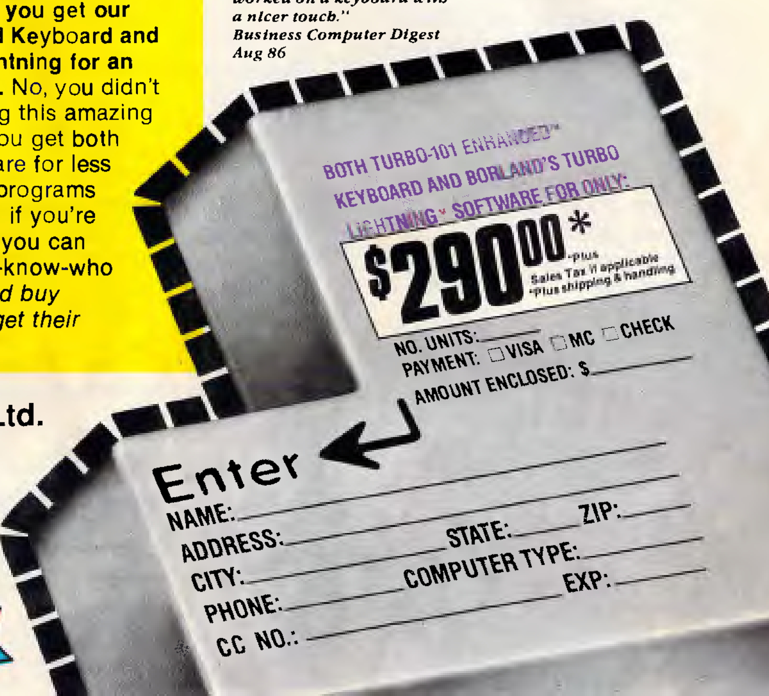

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Back to the drawing board

In mid-February, a 160-page document from Apple Computer got into the hands of a local trade journal which quickly became big news in Silicon Valley. The document listed in detail Apple's previously rumoured design for its laptop Macintosh — codenamed Laguna.

Apple had contended for some time that current flat panel display technology did not meet its desired goals for high resolution. According to the document, Apple has chosen the new 'Active Matrix Display' technology which lights each pixel via its own transistor, rather than just a block of pixels — thus giving it a very high resolution. The 9.8in screen has a resolution of 640 x 400. In fact, if you tried to use a mouse with conventional LCD technology, you would not even be able to see the pointer on the screen. With active matrix displays, however, the pointer is clear and crisp. Apple's laptop reportedly uses the new Motorola 68HC000 chip, a CMOS version of the 68000 series.

The major difference between the portable and the standard SE architecture lies in three ASIC chips codenamed Normandy, Omaha and Utah. These 2-micron, 84-pin CMOS ICs control most of the Laguna's function. Normandy, also dubbed the Power Manager, is an 8-bit microprocessor that replaces the real-time clock and Apple Desktop BUS transceiver. As a result, the memory expansion interface resides in Normandy. Omaha generates the video signal and screen refresh and Utah operates the serial port communications functions.

Another interesting feature of the portable Mac is a trackball-type device that is built into the keyboard. This sits where you would normally find a 10-key numeric pad and is convenient as it does away with a mouse cable. A mouse is still available, however, as an optional extra. Although the Laguna's primary power source is AC-driven, there is an optional external battery system. The 2.4kg battery fits into a recessed cavity and extends the machine's portability.

The document also explains that Apple uses SLIM (Slim Line IC Modules) cards to expand the RAM and ROM. These manually-inserted cards are similar to the credit cards used for font delivery on some Asian printers and measure 85.6mm x 54.0mm x 3.4mm.

The main system memory is 1Mbyte of static RAM which is arranged in a 512k by 16-bit array. Mass storage is two 3.5in double-sided drives that can read and write on a 3.5in disk in three modes: Group Code Recording and Modified Frequency Modulation (MFM) on a 1Mbyte disk and MFM on a special 2Mbyte (1.6Mbyte formatted) floppy disk. Also available will be an optional, low power, one-third height 10Mbyte hard disk.

The Laguna is not short of external ports either. The serial communications controller, a 4MHz CMOS Z8530, drives two mini DIN-8 ports and, in addition, there is a SCSI port, a db-19 external floppy connector, a mini DIN-4 Apple Desktop Bus port, an external video connector, a 96-pin Euro DIN Mac SE-style expansion connector and a stereo audio phone jack. The machine also uses the Apple Digital Sound Chip with Sony sound chip support. The machine has some very nice features, but the document points out it will have a selling price in the region of $US6000.

Apple's official comment on the document is that: "Apple will introduce no new CPUs in 1988." It is rumoured that Apple has already shown the Laguna to some industry leaders who felt that the ergonomic design and weight of the machine would hinder its acceptance as a true laptop even though they liked the basic specifications of the machine. As a result, it is believed Apple has opted not to release the machine this year but taken it back to the drawing boards to tweak it for a January 1989 release.

• Apple is not the only big company with a laptop in the wings. According to a former company official, Compaq had actually signed an agree-

The methods used by Melbourne-based Terran Computers to manufacture customised gate arrays in Motorola's specialised US facility are an example to other local developers. Using a PC-based chip design CAD package, Terran engineers prepare the original schematic plans for the internal layout of the chip. They then perform complete logic testing, based on just the software design file, before a single chip is manufactured.

After subsequent debugging and re-arranging, the gate array design is finalised as a 'pattern file', which can be transmitted electronically, directly to the US fabrication plant. Using a 2400 baud modem, the Terran engineers directly control the final stages of design, by remotely driving the CAD system at the US facility. This control is facilitated by Motorola's dedicated international leased line from Australia to the US.

Using this technique, Terran will soon be producing the world's first custom chip set for small-footprint PCs based around Intel's new 25MHz 80386 processor. The three-chip CS8231 set incorporates the functionality of around 25 conventional components, reducing the number of chips required for an 80386-based AT-compatible to around half.

This will be Terran's first such project, following the recent announcement by Motorola that Terran has been appointed as its first Australian independent design centre.

Sample quantities of the CS8231 set should be available within 12 to 16 weeks, and the first prototype 25MHz 80386 systems based on the chip set are expected before the end of the year. The CS8231 is claimed to be unique in its use of a fully-associative 256-byte cache, allowing near-zero wait state operation.

Terran engineers initially designed the chip set so that the company's small-footprint T20 AT-compatible motherboard could be easily upgraded to an 80386-based system. The T20 is based on a similar chip set from US company Chips & Technologies, known as the New Enhanced AT (NEAT) chip set, specifically designed for 16MHz 80286-based systems.

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WYSE

If we weren't better, we wouldn't bother.

ment to have a modified version of the Toshiba T3100 under the Compaq label for release last year but decided to pull it at the eleventh hour. Sources close to Compaq say that it opted for a similar design, but chose to "do it in-house" and will release it mid-year.
Tim Bajarin

Chips, chips and yet more chips

At a recent Dataquest Semiconductor Conference, participants discussed the growing prices and increased market demand for DRAM chips.

DRAM chips are the memory chips used in all computers, and the market will come under increased pressure as memory-hungry applications such as OS/2 and Presentation Manager come onstream. Memory prices have nearly doubled in the last year and the prices and production of these chips are almost exclusively controlled by Japanese manufacturers. One major industry vendor at the Conference felt that this tight Japanese control was a direct retaliation by the Japanese for the restrictions imposed by the US over earlier chip-dumping in the US.

But, American ingenuity is responding with a new memory-chip technology that could make DRAMs obsolete, along with just about all types of memory chips. This new technology is based on the 'ferro-electric effect'.

It has been known for some time that certain materials change polarity when an electric current is applied. Two start-ups, Krysalis Corp of Albuquerque, New Mexico, and Ramtron Corp in Colorado Springs, Colorado, claim that they have developed special ceramic materials and techniques for fashioning ferro-electric microcircuits on silicon, gallium arsenide and other semiconductor materials.

The ferro-electric memories (FRAMs) seem to promise the best of all possible worlds. Unlike DRAMs, they don't forget when the power is turned off. When compared to EPROMS, FRAMs are both faster and longer-lasting.

Dataquest predicts that FRAMs could sprout into a $500 million business by 1992. If these firms can prove that their chips can come to market quickly, it could put serious pressure on the Japanese to drop their prices on DRAMS.
Tim Bajarin

Larry, Moe and Curly go hi-tech? Not quite. These three gentlemen have reportedly stumbled across a cost-effective way to connect remote PCs to a Melbourne-based System/38. The solution comprises a Wall Data DCF11 18-port protocol converter from Tech Pacific (being helpfully pointed at by the fellow on the left), along with 'expertise and co-ordination' from Powerhouse Communications (the sharp-looking chap in the middle) and a stack of NetComm Trailblazer modems. The man on the right is from Pacific Dunlop's Consumer Goods division, which requested the project in the first place. He is smiling because the new solution, which allows up to 18 PCs to communicate through one host port, is much cheaper than international leased lines.

Create your own special effects

A product that has garnered a lot of attention in the Apple II world is Fantavision, an animation and special-effects generator. In fact, when originally introduced, it received Best Entertainment product of the year award for the Apple II. Now, Broderbund, the San Rafael, California-based software firm, has just released this product under the IBM PC/Tandy and Amiga platforms.

(Broderbund's products are distributed locally by Imagineering — Ed.)

With Fantavision, any user, from beginner to professional animator, can create smoothly animated cartoons and 'movies' — the secret: special tools called 'tweening' and 'transformation'. These Fantavision tools can instantly generate dozens of intermediate images for every one that the user draws.

This does away with the need to redraw shapes constantly as in traditional cell animation. Instead, the computer creates smooth, fluid motion from one drawing to the next. In addition, the new versions include a library of digitised sounds and music.

The program also allows users to create special self-running show disks for viewing by others, even if they don't have Fantavision.
Tim Bajarin

General Electric chips in

Another hot development in chip technology comes from General Electric. A prototype of a 32-bit microprocessor with reported peak performance rates up to 40 mips has been developed by GE's Electronic Labs in Syracuse, New York.

Furthermore, the CPU has a 25 nanosecond cycle time and runs at speeds of up to 40MHz. The chip itself contains only the central processor and the integer arithmetic units and is designed to be a component in a multi-chip microprocessor unit.

The CMOS chip has 92,000 transistors configured on a 7 by 7mm die, according to David Lewis, a member of the design team. The GE chip uses an 8-member instruction set and provides 21 general-purpose registers and a 32-bit program counter. It automatically handles exceptions and interrupts.

If you compare this chip with an 80386 20MHz that runs at approximately four mips, you can see its potential power, especially in systems where parallel processing is called for.

Company officials did not say when the chip might be in commercial use, but they did confirm that many major computer vendors are looking at it for future integration.

END

In the July issue of APC, we will be presenting a full user group listing.

Would club secretaries please advise us of the user groups' activities, including contact name, address and telephone number for parties interested in joining. Notice of venues for regular meeting should also be included.

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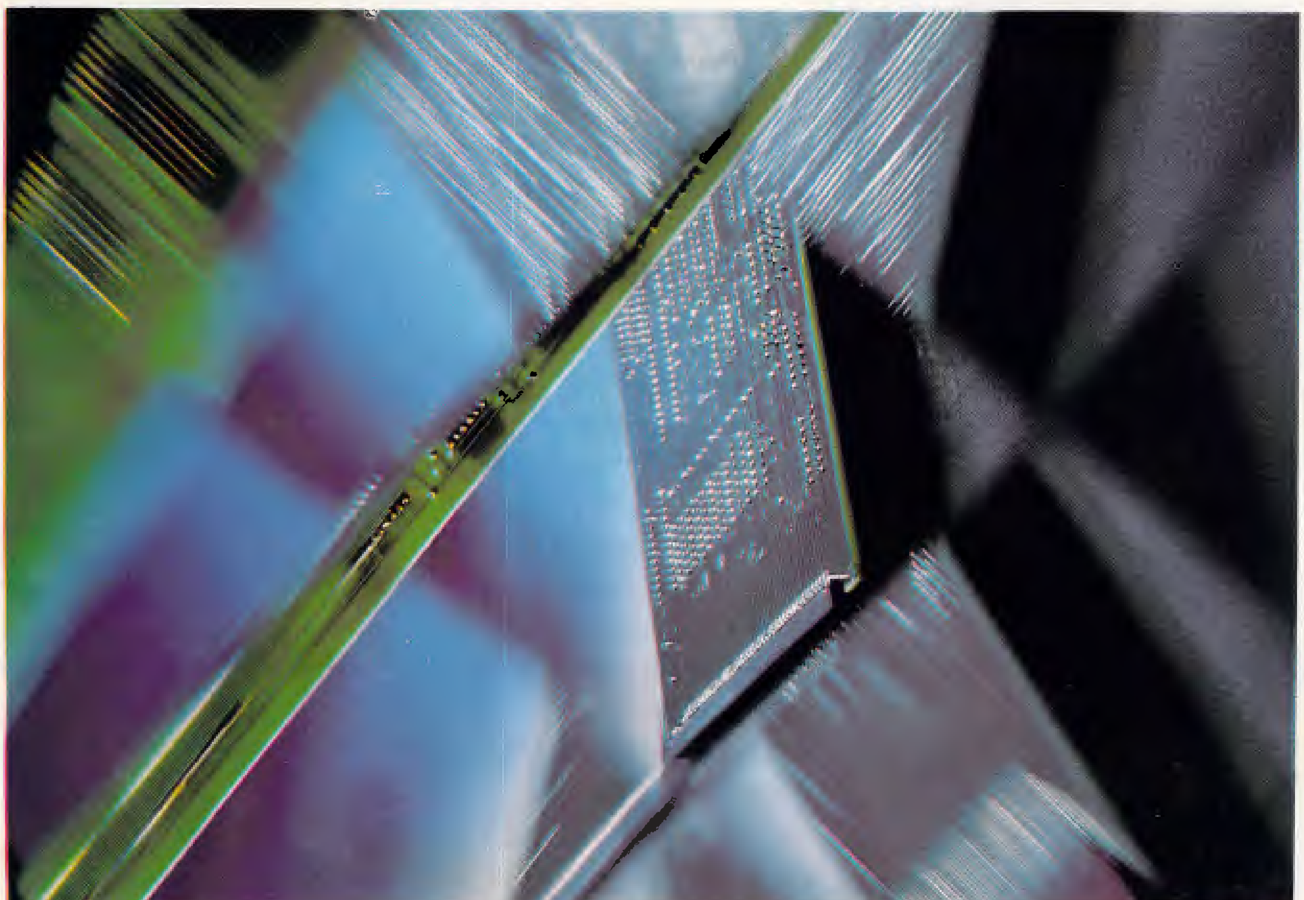
IBM's Micro Channel

The method of power sharing provided by IBM's Micro Channel Architecture is not limited to OS/2 systems: many PCs can benefit from this CPU bypass operation. Pat Moran explains how.



In April, 1987, IBM announced a new series of personal computers — the PS/2 range. At the heart of this range was a new hardware architecture, the Micro Channel (MCA), which linked the central processor, memory and peripherals of the PC in an intelligent rather than a passive manner.

At the same time, IBM and Microsoft jointly announced a new multi-tasking operating system, OS/2. Immediately, speculation arose that OS/2 would only run on machines which were based around the MCA. IBM did little to dispel this myth, although Microsoft has continued to claim, and manufacturers other than IBM have demonstrated that OS/2 will run on most existing 80286 and 80386-based PCs without the MCA.

Nonetheless, the Micro Channel is more than a new bus slot design for add-in cards and a pretty set of tracks on the motherboard. It is in fact a powerful, intelligent method of sharing processing control between devices on the PC's bus. This power sharing can be used to improve the performance of multi-tasking operating systems such as OS/2 or Unix by bypassing the bottleneck of the CPU.

What is the Micro Channel?

The Micro Channel is a combination of several buses (address bus, data bus, transfer control bus, arbitration bus) and multiple support signals. The channel architecture uses asynchronous protocols for control and data transfer and provides several new features. These include:

- level-sensitive interrupts;
- arbitration between devices with different priorities;
- multiple masters; and a
- programmable option select.

The programmable option select (POS) was introduced to simplify the installation of adaptor cards in a PS/2 by eliminating switches and enabling card clashes to be detected automatically and resolved where possible. When clashes cannot be resolved, one of the adaptor cards is automatically disabled to enable the system to continue to function.

Although the POS is directly of interest to the end user, the other new features are of much greater interest to system designers and programmers who are considering how to exploit the new systems.

This article, therefore, concentrates on the aspects of the Micro Channel Architecture (MCA) which need to be understood in order to exploit its versatility, reliability and performance features. The MCA incorporates many features aimed at improving the reliability of the system, and at least detecting — if not automatically recovering from — transient or non-transient error conditions.

Multi Device Arbitration Interface

The Multi Device Arbitration Interface has been designed to support both Direct Memory Access (DMA) features and multiple masters, and to prioritise their access to the channel while providing burst capability with fairness and pre-emption features.

The aim of a DMA controller is to reduce the cost to the system processor of handling a peripheral. Without a DMA controller, the central processor has to be interrupted each time a byte is to be transferred to or from a device. Such an interrupt can be expensive since the processor has to save the registers and its state before servicing the device, and then it has to restore its state so that its interrupted activity can be resumed. The device is serviced either by reading data from the device and storing it in a buffer, or obtaining it from a buffer and sending it to the device. Consequently, the processor also has to maintain a count of the number of bytes transferred and update the buffer pointers as each byte is transferred.

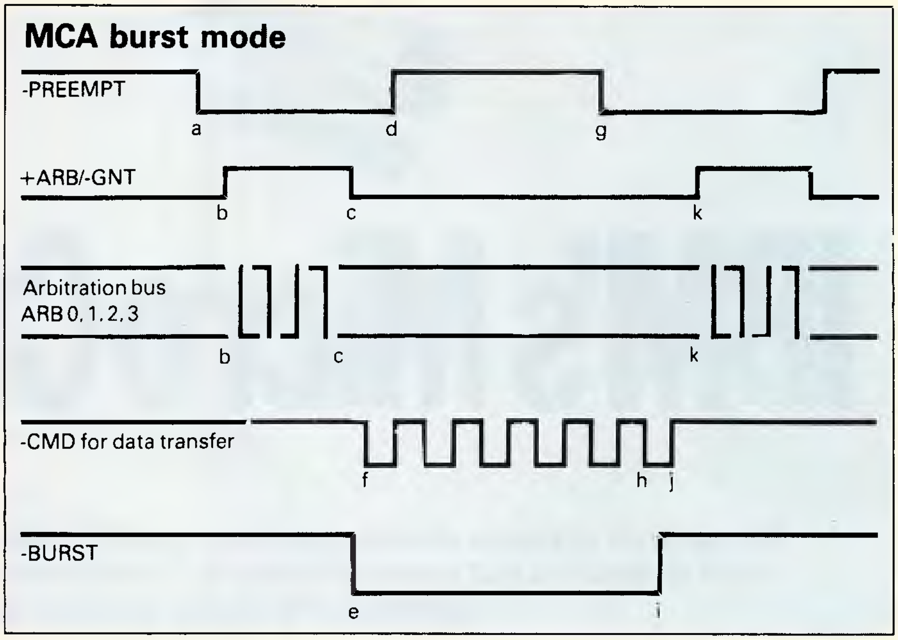


Fig 1

> *'The design of the Micro Channel enables the PS/2 systems to be inherently more reliable than the previous PCs or ATs, even in complex environments with a multi-tasking operating system such as OS/2. The support for multiple masters lays the groundwork for providing powerful systems . . .'*

A DMA controller can be regarded as a very limited processor whose only function is to oversee the transfer of a block of data either to or from a device. The main processor simply has to inform the DMA controller of the device to be handled, the number of bytes to be transferred and the location of the buffer in memory, and the DMA controller will relieve the main processor of the burden of transferring individual bytes between the device and the buffer. The processor is only directly involved when the entire transfer has been completed.

Both the PC bus and the AT bus support DMA controllers, but the MCA provides support for more controllers and gives much greater flexibility in using them. The DMA controllers on the MCA bus are effectively masters and are assigned unique priority levels.

Although the MCA supports multiple masters or devices, only one device can use the interface at any one time. The Central Arbitration Control Point (CACP) is the logic on the main processor board which controls access to the interface. The main system processor is the lowest priority device, and is the normal or default user of the interface. The other devices have a higher priority and can temporarily take over the interface.

Whenever one or more of these other devices requires access to the interface, it is the function of the CACP to initiate the arbitration sequence which is used to determine which device is to obtain access to the interface. The interface comprises seven signal lines on the channel.

+ARB/—GNT

This is the arbitration/grant output signal from the Central Arbitration Control Point (CACP) which notifies the devices if the interface has been granted to the highest priority device, or if the devices are to bid for use of the interface since an arbitration cycle is being initiated. Normally, this signal is the grant state

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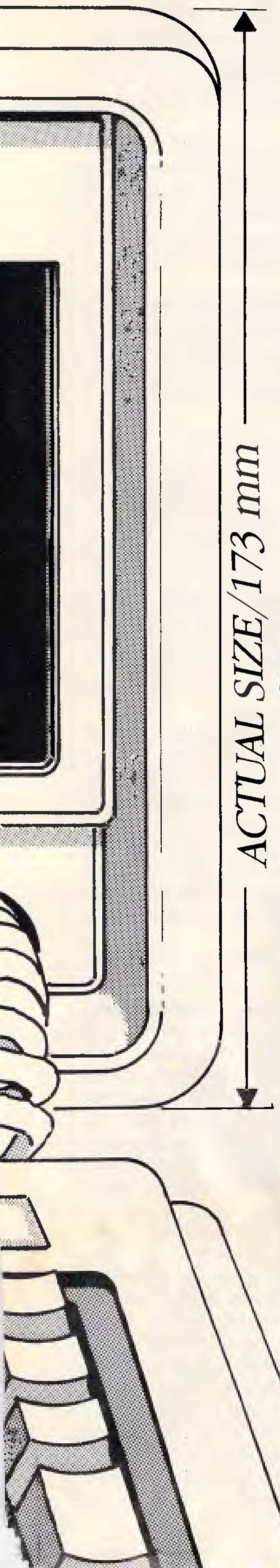

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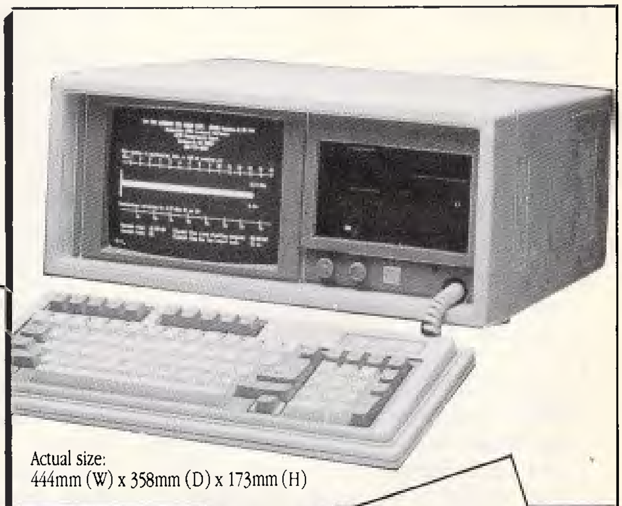

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and the bus is used by the highest priority device which bid at the last arbitration cycle. Whenever the CACP makes the signal active — that is, places it in the arbitrate state — data is not transferred over the interface but each device bids for the right to use the interface once the signal has reverted to the grant state.

—ARB0—3

When the +ARB/—GNT line goes to the arbitrate state, each device that wants the channel places its assigned arbitration level on the arbitration bus (which consists of the four signals —ARB0, —ARB1, —ARB2, —ARB3) and then monitors the arbitration levels placed on the bus by other devices. The higher value (that is, lower priority) device removes the lowered order bits of its bid, so the highest priority device is left with its arbitration level on the bus. The CACP which raised the arbitration signal times out after 300 nanoseconds, and automatically returns the +ARB/—GNT signal to the grant state which informs the highest priority device left on the arbitration bus that it is the controller and that it can utilise the channel. The device normally only owns the channel for one transfer on the bus and, after that cycle completes, the ownership of the channel is returned to the default owner which is the system board processor.

—PREEMPT

When a device requires access to the channel, it makes the —PREEMPT signal active and keeps it active until it has been granted control of the channel. When the CACP sees the —PREEMPT signal becoming active it initiates a new arbitrate/grant cycle, and the highest priority device requesting control will obtain it.

—BURST

Some devices normally transfer data in bursts that are separated by long, quiescent periods: for example, a disk file is such a device. Typically, such devices incorporate a buffer which is used to hold a chunk of the data which is then transferred a byte at a time across the channel. Burst mode attempts to enable such devices to transfer entire blocks directly to storage without the need to store the data in an internal device buffer.

Such a mode also reduces the amount of time spent in arbitration mode since there is no need to enter arbitration for each transfer (byte or word) across the channel.

A device which wishes to operate in burst mode activates the burst line and holds it active until it completes the transfer of the block. The CACP will not produce arbitration cycles when another device requests the channel during burst mode. The burst mode device is responsible for monitoring the —PREEMPT line and, if it becomes active, it will terminate the transfer tidily and relinquish control of the channel by removing the burst line. The bursting device does not, however, participate in the arbitration cycle which will immediately follow.

Figure 1 shows the timing relationship between the signals described above when burst mode occurs. The sequence of actions is as described below:

1) The —PREEMPT signal goes active to indicate a device is requesting control of the channel.

2) The +ARB/—GNT signal goes to the arbitrate state and the arbitration procedure starts to determine the highest priority.

3) After the time-out period which allows the arbitration bus to settle, the CACP changes the +ARB/—GNT signal to the grant state.

4) The device granted to the channel makes its —PREEMPT signal inactive to clear its request for control.

5) As a burst mode device, it then makes the —BURST line active to enable it to keep the channel for more than one transfer.

6) It then transfers data with each cycle of the —CMD signal.

7) If another device requires the channel, it makes the —PREEMPT line active. Since there is a burst transfer in progress, the CACP takes no immediate action.

8) The controlling device can do some more transfers to enable it to suspend its actions tidily.

9) The —BURST line is released after the leading edge of the last —CMD pulse in the transfer.

10) On the trailing edge of the last —CMD pulse, the CACP will action the outstanding —PREEMPT signal (as there is no longer a burst occurring).

11) The CACP makes the +ARB/—GNT signal go to the arbitrate state and the process begins again.

As described above, a high-priority bursting device would in fact only relinquish the channel for one cycle and then grab it back again. The simple algorithm above runs the risk of a high-priority high-bandwidth device 'hogging' the channel. To prevent this, each device which implements burst mode must also implement the fairness algorithm which guarantees each device a share of the channel in a priority determined sequence. When a bursting device relinquishes control, it is placed in the 'hogpen' (known more formally as the Inactive State Queue) and must wait until the common —PREEMPT line goes inactive before it competes for the channel again.

The common —PREEMPT line will only go inactive once all competing devices have had access to the channel. When —PREEMPT does go inactive, all the 'hogs' are released and will participate in the immediately following arbitration cycle.

Since a burst-mode device can utilise all of the available bandwidth if there are no other competing devices, the use of the burst mode can produce significant increases in the effective transfer rate of a device.

Each device on the channel must use a unique arbitration level or the above arbitration system would result in two devices, each thinking it had control of the channel, and the uniqueness of the arbitration levels is checked during POST (Power On System Test). Each adaptor must allow its arbitration level to be program-selectable to any of the available arbitration levels (0-15). In practice, the configuration utilities will never select level 15 as this would clash with the system processor.

This requirement means that there can never be more than 15 active on the channel at any one time. The POST will disable some cards if more than 15 are active on the bus on power-up.

DMA ports 1,2,3,5,6,7 have a fixed matching arbitration level, but DMA ports 0 and 4 have a programmable arbitration level. The allocation of arbitration levels is shown in Fig 2.

As can be seen, memory refresh has the highest priority and is initiated from the CACP, and the system board processing has the lowest priority (excluding the hogpen). The reason that the processor is allocated the lowest priority is that it continually uses the channel to fetch instructions and the data manipulated by the instructions. Input/output devices only need sporadic access to the channel since their data rate is often very low (for example, a 9600-baud serial link only needs to transfer a byte over 1000 microseconds). Even adaptors which need to transfer data at a high rate do not do so continuously but in short bursts (for example, an Ethernet adaptor sends and receives data at more than 1Mbyte per second but may only process 50 packets every second).

Since the processor is the lowest priority device it can retain the channel once it has control without the overhead

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of arbitration requests, until one of the other devices signals that it needs to use the channel by activating the —PREEMPT signal. This means that an arbitration cycle is only required when a device other than the system board processor requires the channel.

The performance benefits of using burst mode on the new Micro Channel are such that a disk, for example, can transfer data twice as fast across the channel as it could across the AT bus.

MCA reliability

In the description of the Multi Device Arbitration Interface, it was stated that the central arbitration control point will not initiate an arbitration cycle while a device is asserting the —BURST signal. If a burst-mode device were to gain control of the channel and then refuse to release control, memory refresh operations would be impeded which would cause soft-memory errors.

To protect the system from such devices the CACP implements a time-out, which is started when —PREEMPT goes active and gives the bursting device 7.5 microseconds to release control. After the time-out period has passed, the CACP will place the +ARB/—GNT line in the arbitrate state and therefore remove the grant from the bursting device. The memory refresh activity has the highest possible arbitration level and will set —PREEMPT every 15.6 microseconds to enable a refresh to occur.

Any memory card or device which detects an error that threatens the correct continued operation of the system must drive the channel check (—CHCK) signal active, and it must remain low until the —CHCK interrupt handler resets it. In addition, the card must set the channel check bit in the card's option select address space. This bit is interrogated by the —CHCK handler for each card position until all reporting cards have been identified.

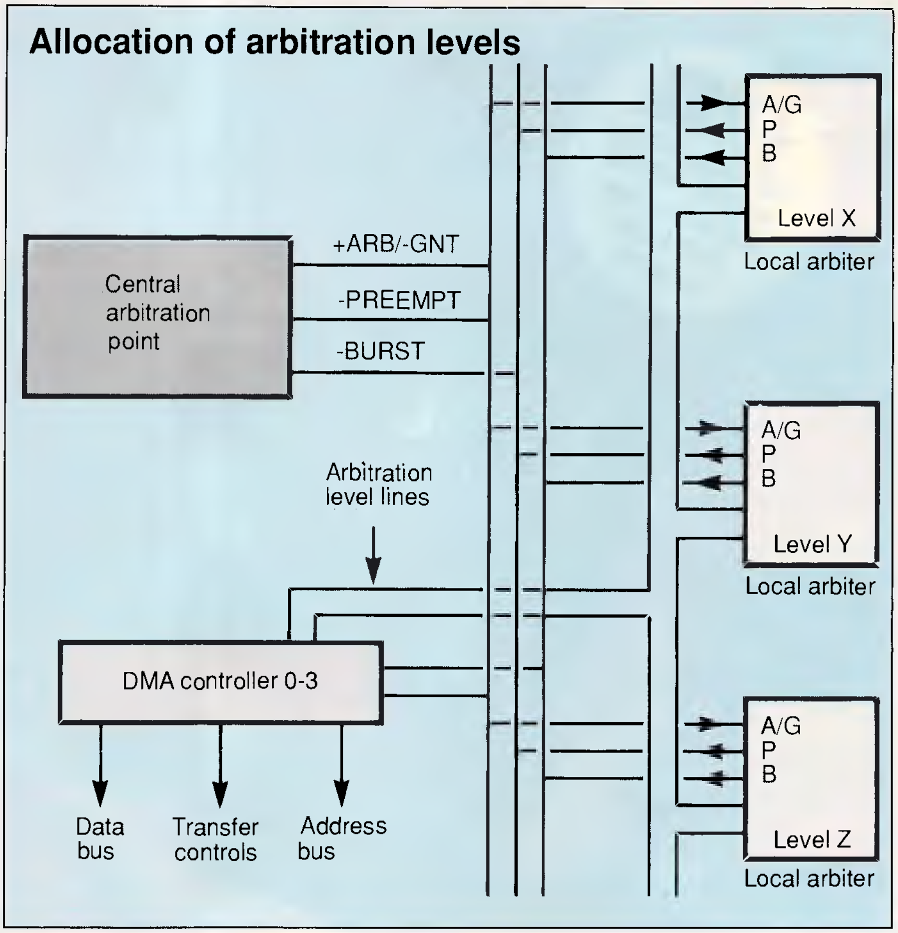

Fig 2 Central arbitration point, 8 DMA channels and diskette arbiter are all one chip!

Level-sensitive sharing interrupts

All the Micro Channel system board features and channel attached devices employ the same level-sensitive mechanism for interrupting the processor. Each card must also implement an interrupt pending indicator which is reset by the normal servicing of the device. Each card must hold the level-sensitive interrupt active until it is reset as a direct result of servicing the interrupt. The advantages of the new structure are as follows.

Phantom or lost interrupts should be less frequent and more easily identified as there is an interlock between the hardware and software that supports the interrupt service. With the previous PC bus, interrupts were 'edge sensitive' which meant that it was the change from inactive to active state which caused the interrupt request into the processor. With a level-sensitive interrupt, the interrupt request into the processor remains pending until the device makes the signal inactive in response to the normal servicing of the interrupt.

With edge-sensitive interrupts an inter-

Arbitration level assignments

Level	Primary Assignment	
−2	Memory refresh	
−1	Error recovery	
0	DMA port 0	(but programmable to other arbitration levels)
1	DMA port 1	
2	DMA port 2	
3	DMA port 3	
4	DMA port 4	(but programmable to other arbitration levels)
5	DMA port 5	
6	DMA port 6	
7	DMA port 7	
8-14	Spare	
15	System board processor	
ISQ	Hogpen or Inactive State Queue	

Fig 3

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□ Files can be left open between pop ups.

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Because many of the subprograms are video oriented, we've built in a few routines from our **Mach 2** assembly language library in order to speed up your programs.

Since all the subprograms and functions are written in QuickBASIC, and you get all the QB sourcecode, you can modify them to your heart's content. We even suggest specific modifications in the huge, easy-to-use, fully indexed manual.

In addition to the manual, you get diskettes containing: QB source code, a prebuilt User Library for QB 2 and 3, a Quick Library for QB 4 and BASCOM 6, plus four LINK libraries (BCOM and BRUN for QB 2/3 and QB 4). We also include .MAK files and declarations for QB 4 as well as batch files for maintaining and rebuilding libraries

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rupt could be lost if it occurred while a previous interrupt was still being serviced, as the interrupt signal was already in the active state. The second interrupt could not cause the inactive-to-active transition and, therefore, the processor was not notified of the second interrupt. With level-sensitive interrupts, each interrupt request will be notified to the processor.

The importance of this change to the reliability and flexibility of the system is underlined by the fact that IBM has built circuitry into the system board which prevents any attempt to re-program the interrupt controller to operate in edge-sensitive mode.

Each interrupt level can be used by a mixture of sharing and non-sharing hardware. An interrupt handler which is to be used in a shareable environment

'The channel architecture uses asynchronous protocols for control and data transfer and provides several new features.'

must follow certain rules to enable the system to operate. When the interrupt handler is set up, it must note the address of any existing handler for the interrupt level. When the interrupt level handler is invoked to process an interrupt, it must check that the adaptor that it is handling has an outstanding interrupt request by accessing the interrupt pending bit on the adaptor. If the adaptor is in the process of interrupting, it is serviced normally and the interrupt controller is reset.

If any other card on the same level still requires service, then the interrupt request line will still be active and cause the chain of interrupt handlers to be re-entered. If the handler finds that the adaptor does not have an interrupt pending, then it passes control to the previously-existing interrupt handler. In this way, control is passed down the chain of interrupt handlers until all requesting devices are serviced.

An interrupt level can in fact be shared between a device on the system board and a device attached to the channel service system board as long as the devices conform to the standard rules. It should be noted, however, although many devices can share an interrupt level, the time between the interrupt being raised and the appropriate interrupt handler processing the interrupt increases as the number of devices increases.

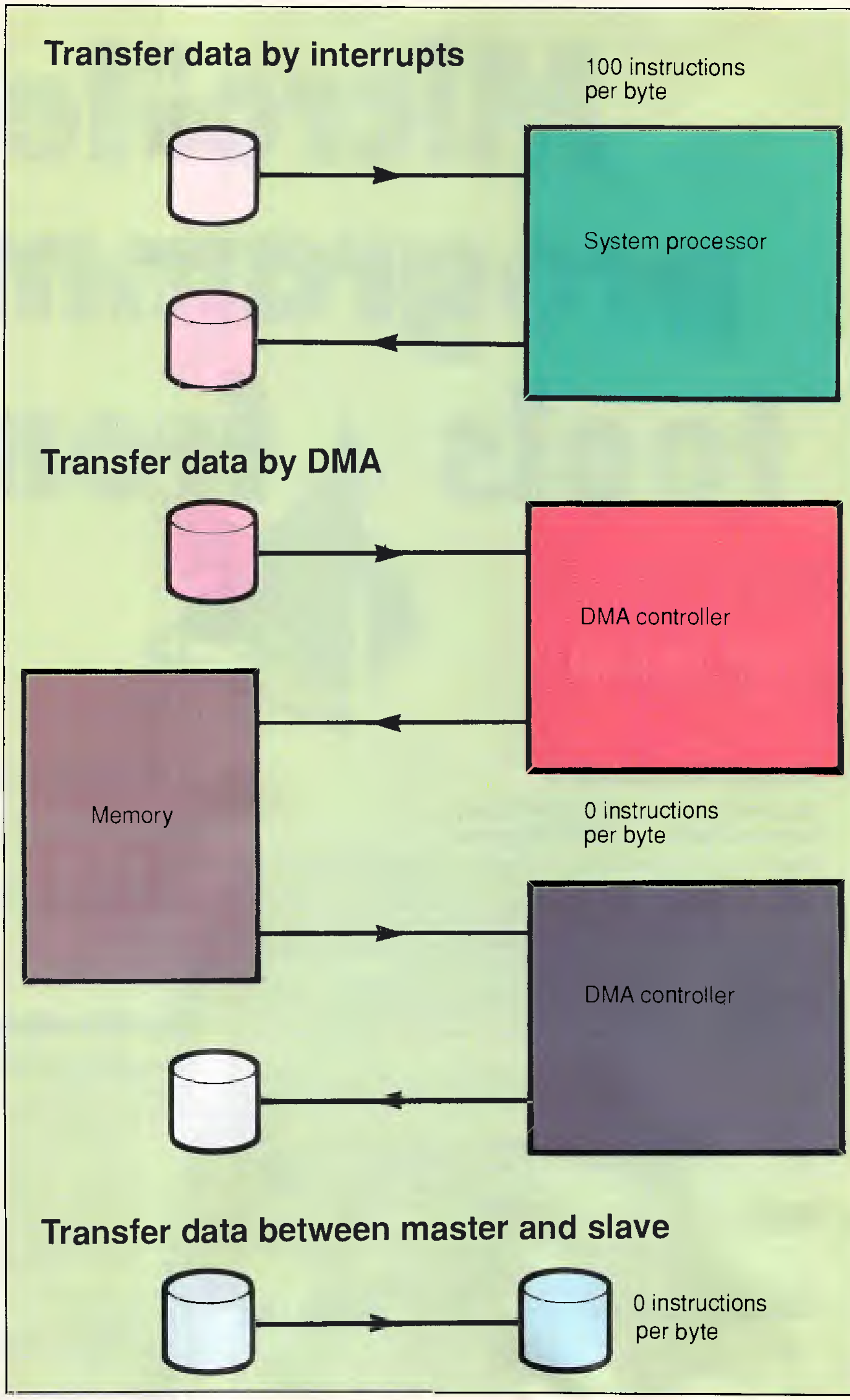

Fig 4

Multiple masters

To understand the benefits which can be gained from the use of an additional master on the channel, we need to understand the actions of the system board processor and the DMA controller when transferring data to and from a device. It should be noted that each port of the DMA controller on the system board is in effect a master but one with very limited abilities.

We will consider what is involved in the case where some data is being transferred from one device on the channel to a second device on the channel — for example, when a file is being copied from one disk to another.

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In the case where the processor is directly handling each device we would have the situation where the processor would be interrupted for each incoming byte, and would then execute code to identify the source of the interrupt as well as transfer the data from the device to the processor. It would then have a similar set of actions to write the data out to the destination device. Hence, each byte crosses the channel twice and there is a significant processor overhead servicing the devices (which will involve further memory accesses across the channel). Servicing each interrupt and organising the transfer to or from the device can cost at least 100 processor instructions to be executed for each byte transferred. This is shown in Fig 4.

The DMA controller can be used to transfer a block of data with a greatly reduced processor overhead. The processor would instruct the DMA controller to transfer a block of data from the input device but would not be involved in the

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transfer of each byte. The use of the DMA controller means that the byte would be transferred across the channel from the device to the DMA controller, and then again across the channel to the memory area specified by the processor. The same double transfer would occur when the data is being transferred to the output device. Therefore, the use of the DMA controller would cause each byte to transfer across the channel four times (but would still be more effective because of the greatly-reduced system processor overhead). This, too, is shown in Fig 4.

In the case where one of the devices is a master it can control the other device directly as a slave, and the master can process interrupts from the slave directly off the channel without involving the system processor. If, for example, the input device is the master, it can directly transfer each received byte to the output device with each byte being transferred across the channel only once, and the cost to the system board processor of setting up the master is probably less than the cost of setting up the two DMA operations. This is shown in Fig 4.

From the above example, it can be seen that the use of a master device can require only 25 per cent of the channel transfers that are needed by a DMA controller while requiring no additional processor overhead.

Enter OS/2

The real power of multiple masters will only be really exploited when the master becomes capable of providing a significant amount of functions for each request from the system board (or, indeed, some other master).

One possible such master would be a complete file system with internal disk drive(s) and controller which would respond to OS/2 or DOS level file access requests. Such a master would carry out the directory searches and the maintenance activities (such as updating the FAT) with no channel accesses, and only the requested data being transferred across the channel. It would support multiple simultaneous transfer requests and use various techniques to optimise access to the integral disks. In the case of the example presented here, the file copying could be achieved without any data being transferred across the MCA interface and with no interference to the operation of the system board processor.

Such intelligent masters cannot be fully exploited or cost-justified when PC-DOS is being used since DOS waits for each transfer to complete before continuing with the application. Under DOS, such masters would provide very little obvious performance benefit since the elapsed time to access the data is likely to be approximately the same and DOS is unable to utilise the processor savings. With OS/2, however, the situation is completely different. While one application is held waiting for its data to be processed by the master device, OS/2 will be able to schedule other activities and so fully utilise the processor time which is made available by the use of the intelligent master.

We are accustomed to and familiar with changes which improve the performance of our PC-DOS systems, such as when we upgrade the clock speed from 4.77MHz to 8MHz, or change from an 8088 to 80286 processor, or move from a floppy disk to a hard disk. Such changes speed up each individual activity noticeably. With OS/2 and MCA, however, we will have to become accustomed to changes which increase the overall power of our systems but which will not necessarily make any single activity operate any faster. One of the main benefits of MCA is that it gives IBM and other suppliers a platform on which such total system improvements can be built.

It is possible that at some point in the future the database and comms manager services for IBM's OS/2 extended edition will be offered by separate masters which have been optimised to provide the required high-performance service with minimum impact on the main system processor.

Conclusion

IBM has always stated that its reason for changing to MCA was to support fully and exploit a multi-tasking system such as OS/2. We have seen how MCA provides support for simultaneous transfers over the interface, and this is paralleled within OS/2 by the advanced BIOS also providing support for such concurrent activity. The availability of intelligent masters on the MCA interface further enhances the ability of the complete system to deliver a significant increase in total power when OS/2 is being used.

The design of the Micro Channel enables the PS/2 systems to be inherently more reliable than the previous PCs or ATs, even in complex environments with a multi-tasking operating system such as OS/2. The support for multiple masters lays the groundwork for providing powerful systems in which the major subsystems can be partitioned to operate in separate processors communicating over the Micro Channel. It is obvious that what IBM has currently announced is only the tip of a very large iceberg.

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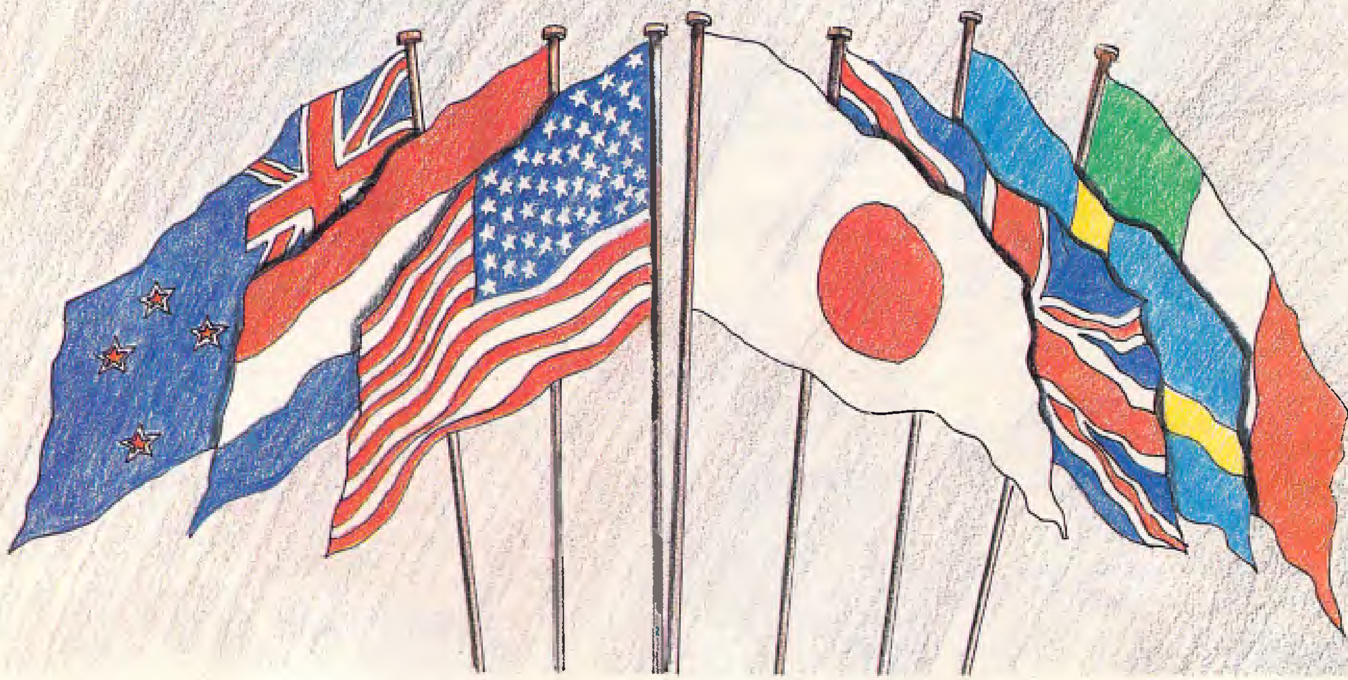

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NE016

HP DeskJet

Hewlett-Packard's DeskJet ink-jet printer provides laser-quality lettering and simple graphics at an affordable price for the small-business user. Derek Cohen was impressed by the performance of this machine, which is due for release next month.

With the increasing interest in graphics and desktop publishing, many computer users are looking disparagingly at their dot matrix printers and lusting after the sort of quality output that laser printers offer. For most users, however, laser printers are far beyond their means.

In addition, while many 24-pin printers offer good-quality text and graphics output, they are limited in typefaces and are often not supported by more sophisticated applications.

It is frustrating, for example, to find that Xerox Ventura Publisher will support 9-pin dot matrix printers, and laser printers, but not 24-pin devices which for many would provide adequate originals.

The final problem is that of printer drivers. Most software applications now support laser printers, and it has been

obvious for quite some time that there was room for a low-cost, non-laser printer that recognised, for example, the HP LaserJet set of instructions.

Hewlett-Packard has now filled this breach with its DeskJet, which will retail for around $2000. The unit is HP LaserJet compatible, is based on ink-jet technology, and produces text and graphics of a quality comparable with laser printers. It uses ordinary bond paper, and font cartridges give access to typefaces up to 18pt in size with italics and bold available.

If things were so simple, however, the laser market would collapse overnight, and as we will see, price does have its penalties.

Hardware

Having narrowly avoided slipping a few discs moving a bunch of newly-delivered laser printers around the office last month, it is gratifying to find the DeskJet a small, lightweight box. Dimensions are 37cms deep by 44cms wide by 20cms high — about half the size of a standard laser printer. And at just over 6kgs, it is about one-third the weight. Compactness is an integral part of the design, with the 'in' and 'out' paper trays lying on top of each other and forming part of the unit's 37cm depth.

Both serial and parallel interfaces are provided as standard and these, together with the power input, are recessed in the middle of the bottom plate of the printer. This means that the printer can be situated almost flush against a wall or partition.

The ink-jet printing mechanism consists of a removable cartridge containing both the two rows of 30 ink nozzles forming the print head, the ink-jet electronics and the ink reservoir. One head- cartridge should last about 500 sheets, depending on the balance of text to graphics and the quantity of heavy black areas of graphics. Hewlett-Packard works to a guide of 525,000 characters or double that in draft mode. Replacement cartridges will cost around $30. This works out at around 5.5c per copy. In terms of consumable costs this is comparable to many laser printers. However, 'typical laser printers' cost upwards of $3000. At the other end of the quality scale, 5.5c per copy is considerably more expensive than the cost of ribbons for a standard impact printer.

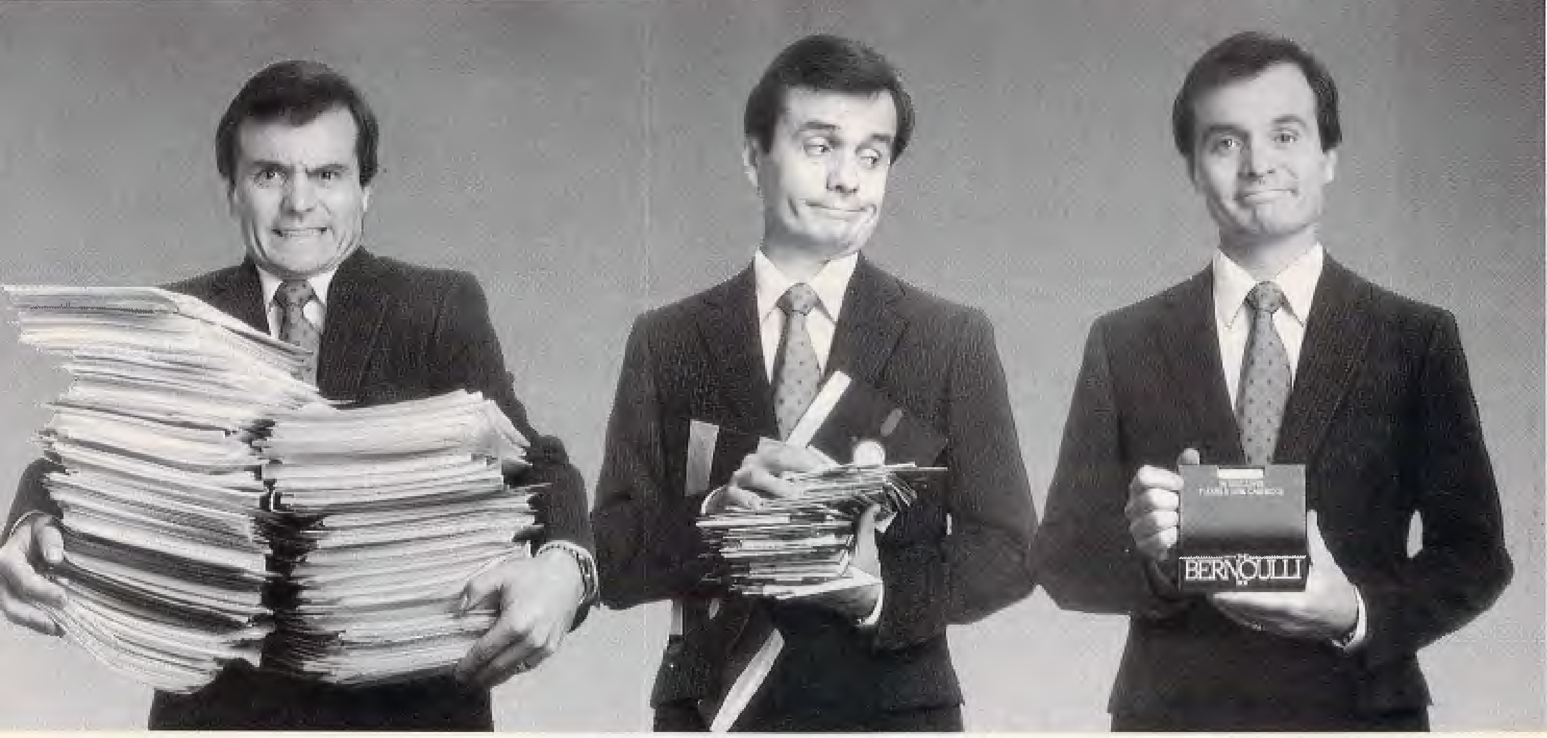
Next to the paper trays are two slots which take font cartridges, two sets of buttons and a series of LEDs. The font cartridges are different from the standard HP LaserJet cartridges because the format in which the fonts are held is different. As we will see later, this also means that standard HP downloadable fonts cannot be used.

The machine as standard comes with Courier as a built-in font and all other fonts must be purchased separately on cartridges.

The top of each cartridge shows the name and point sizes of the fonts it contains. Alongside each combination is an LED which glows when that particular font is in use. Fonts can be selected either by software, or manually using the buttons, and in either case the LEDs glow on and off as the fonts are selected.

The review machine was supplied with three cartridges. One each for Helvetica and Times Roman, and a demonstration cartridge which prints a sample text and graphics page on power-up. Font cartridges will cost between $80 and $200 and an Epson emulation cartridge will also be available.

Each of the supplied cartridges provided 8pt and 10pt text in Roman (upright) and italic fonts. Compression from the standard 10cpi to 16.67 and 20cpi, expansion to 5cpi and bold effects are performed 'algorithmically'. This means that the faces are calculated rather than stored, and the results can look pretty grim. Bold is achieved by doubling the number of dots per character and you soon realise why people like Adobe make a fuss about people buying proper fonts. I found the Helvetica bold



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far less objectionable than the Times or Courier bold.

Other buttons place the printer on and off-line, perform a form feed, change between letter-quality and draft mode, and allow for the hand-feeding of envelopes. In draft mode the DeskJet only prints every other dot, which saves ink and cuts printing time by about one third. For people who want to have fine control over the paper position before printing, two buttons produce micro feed movements of the paper.

The paper tray can hold up to 100 sheets of paper up to US legal size. An adjustable gripper holds the narrow edge of the paper in place while a lever adjusts a side bar to accommodate A4 or wider paper. The output tray holds only 25 sheets and each printed page is suspended by two bars above its predecessors for a few seconds, to allow the ink to dry before it is released onto the stack. HP recommends that standard bond paper is used, and on test I found no difficulty using ordinary photocopier paper or laid Conqueror, which has a surface texture that rubs against the head and smears the ink on some ink-jet printers.

Pages are stacked face up in the output tray which means that a multi-page document is stacked in the wrong order.

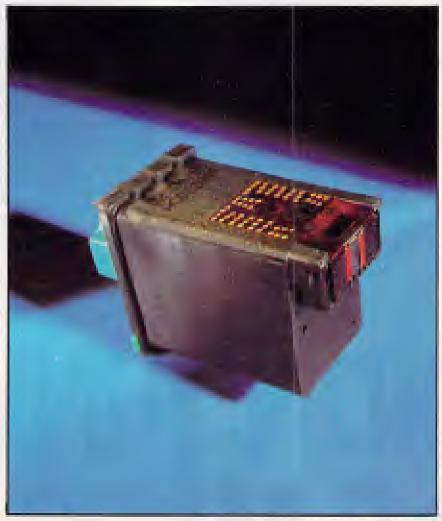
Software compatibility

The DeskJet is compatible with the original HP LaserJet printer. This compatibility is referred to as PCL III+. Current LaserJet Series II printers use PCL IV. It is important to understand the differences in order to realise why 'HP compatibility' is not a single standard. PCL III+ supports fonts up to a maximum of 18pt (about twice the height of a standard printer output) whereas PCL IV goes up to 48pt. Both offer up to 300 x 300 dpi resolution in text and graphics.

The HP control language is totally different from that used for Epson or IBM emulations. Instead of the computer saying 'now use font 3', the HP language is more like a bargaining statement — 'I'd like a bold serif face in 24pt with the international character set, what have you got? I'd prefer Century if you have it'. If the printer can't match the request exactly it provides the next best thing. So, you may get Times Roman in 18pt US-ASCII only. The very long strings of escape sequences to make such requests are frightening to say the least, so it is good that the DeskJet will work, as a default, with the LaserJet drivers provided with most software these days.

However, there are two major cautions. The DeskJet does not have any internal memory in which to assemble a page. In this respect it is closer to a serially-printing dot matrix or daisywheel printer — it processes one line of data at a time rather than accepting a page at a time like a laser printer with its 1Mbyte of RAM.

To give an example, consider a tinted



The removable print head also contains the Ink reservoir. The large gold plate is the electrical contact, the small one underneath contains the ink nozzles

box containing text. On a page printer, a virtual page is made up in RAM. The software in the computer will send the printer a series of instructions such as 'draw a box at these coordinates, fill it with a tint, now move to the top corner and write this text in this preferred font which I have just downloaded'. The printer assembles the components and then prints the page.

On a serially-driven printer (serially as in data not interface), there is nowhere to make up this page and the printer has to 'lay down' the data as it arrives. It needs some trial and error to discover whether the LaserJet printer driver provided for a given piece of software sends its data serially or to a virtual page. GEM Output works fine, but GEM-derived Ventura does not.

In the long term, Hewlett-Packard expects that DeskJet drivers will be available for all major software packages. In the short term, the company recommends using a LaserJet or LaserJet+ driver if no DeskJet one is available. I was provided with a DeskJet driver for Microsoft Windows which worked perfectly.

The other major difference is that the DeskJet will not accept standard HP downloadable fonts. Partly this is because the standard machine does not have the memory to store them. The other reason is that the DeskJet stores the bit-map for its fonts in a vertical pattern (that is, it reads one vertical line of dots at a time) rather than horizontally as with standard HP fonts. In addition, the DeskJet's basic 'dot' is round whereas that of a laser printer is oval.

Nonetheless, Hewlett-Packard will be supplying a memory cartridge to accept special downloadable fonts. And no doubt some enterprising hacker will write a utility to convert LaserJet fonts to DeskJet ones.

Performance

The DeskJet was run with a number of software packages. Apart from those running under Windows, all were configured for a standard HP LaserJet+. In operation the machine is almost silent and presents none of the environmental problems of smell, noise or bulk of a laser printer.

It is obvious, looking at any of the print samples, that the output quality of the DeskJet is very close to that of a laser printer. In fact, when printing solid black areas and tints in graphics mode, the DeskJet showed less streaking than a laser printer. In text mode the results are very impressive, with only occasional slight spidering revealing that a wet process has produced the text.

Using PC-Write, I selected the LaserJet+ printer driver with what was referred to as 'Soft R8 new Helv-AD' fonts. This set includes a 24pt Helvetica not contained on the cartridge, but the standard, bold and italic fonts reproduced correctly. I tried various other font cartridge drivers and most produced satisfactory results for some of the font letters.

Fontasy also reproduced its fancy text and graphics correctly, showing that this package sends its graphics data serially rather than as page commands. The HP fonts available for Fontasy printed out correctly, though again, these are transmitted as graphics streams.

Pictures were printed from GEM packages Draw and Davrelle, using the standard LaserJet+ driver. These printed perfectly with the grey tints actually printing finer than on a Kyocera 1200 laser printer. The LaserJet+ driver for GEM sends lines only one bit high to the printer which makes for very slow printing. The DeskJet can handle lines 12 dots high and, when a GEM driver becomes available, printing will be speeded up considerably.

Though it is possible to print from GEM, it is not possible to drive the Desk-

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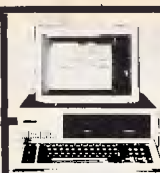

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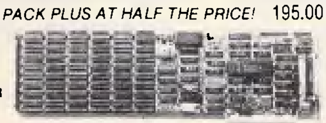

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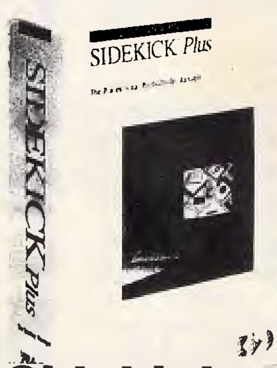

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TIPS & TECHNIQUES

With the increasing interest in graphics and desktop publishing, many computer users are looking disparagingly at their dot-matrix printers and lusting after the sort of quality output that laser printers offer. For most, however, laser printers are with laser printers. It uses ordinary bond paper and font cartridges give access to typefaces up to 18pt in size with italics and bold available. If things were so simple, however, the laser market would collapse overnight, and as we will

Graphics and solids reproduce quite well when the DeskJet driver is used with Windows. The Times typeface leaves something to be desired, though

Jet from Ventura Publisher at present. This is because Ventura sends the printer numerous positioning commands which cannot be acted upon. Hewlett-Packard is currently in the process of writing a Ventura driver.

Using the supplied driver for Microsoft Windows I printed out a page from PageMaker. The sample above shows how well it can produce text and graphics, but how uneven the tinted area is. The Type menu only allows access to fonts on the installed cartridges.

Conclusion

If the DeskJet's print quality is as good as I have made out, what are the drawbacks?

The main one is speed. A typical laser printer will output text pages at anything between six and 12 pages per minute. The DeskJet is rated at two pages per minute. When printing graphics, you do have to sit and wait while the head draws each line separately.

However, for many users speed is not a problem; and the ability to output at laser quality without the capital cost of that type of machine will be a great advantage. The consumables cost is also on the high side, but I found it reassuring rather than wasteful that every 500 sheets or so I was getting a new, clean set of ink jets.

As an ink-jet printer, performance is very good. The quality of output and software compatibility ranks the printer well ahead of other ink-jet printers and at a cost below many less capable machines.

The DeskJet is clearly aimed at the small-business or discerning personal user who wants laser-quality lettering and simple graphics without the capital cost. So far these users have been buying 24-pin printers as a compromise between quality and cost.

The printer is not aimed at the heavyweight desktop publishing market, though it will work with PageMaker. It will certainly appeal to those using either low-end DTP packages or the new breed of 'graphics with text' word processors such as MicroPro's Pagesetter or WordPerfect 5.

Given Hewlett-Packard's position in the laser printer standards market, it is likely that DeskJet drivers will start appearing on most printer menus in the near future.

Overall, the printer and the quality of its output impressed everyone who saw it in action, and I'd certainly recommend anyone thinking of buying either a 24-pin printer or a laser printer to consider whether the DeskJet is more suited to their needs.

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Serving the System

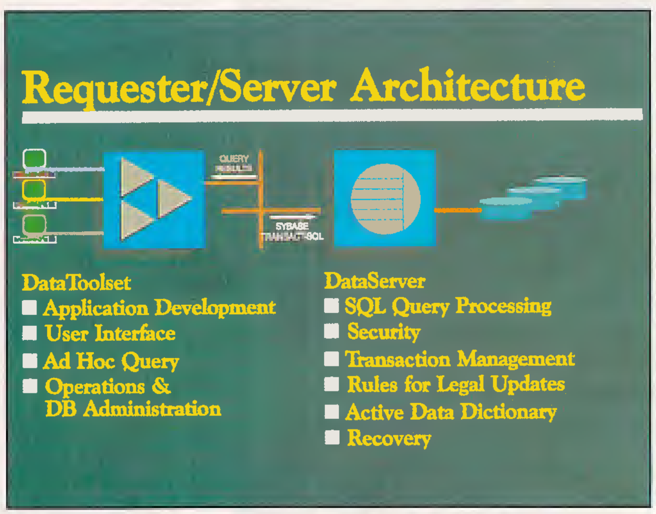
The long-term use of the SQL programming language on mainframe database systems has prompted its acceptance in the micro field — not least by IBM and Microsoft in OS/2. Kathy Lang assesses its importance at all levels of computing power.

Many PC users already know how hard it is to transfer themselves or their data from one package to another. Many word processors initially adopted their own file formats so that most text files were far from plain, but contained scatterings of control codes and other formatting information. In the database and spreadsheet worlds there have also been few attempts to standardise on particular files or interfaces, and most moves have come from manufacturers with vested interests.

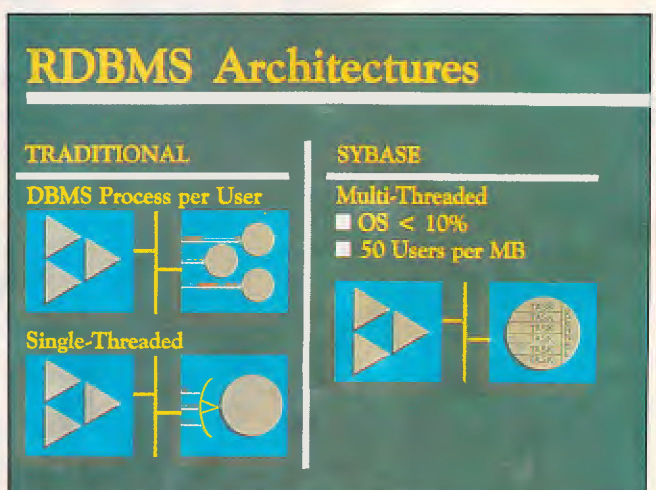
For users of databases, file incompatibility can have more serious consequences than in other fields because the information structures and the programs which handle them tend to be more complex. With no standard method of storing information in a database, there can be no standard method for inputting or extracting information from a file.

On larger systems, where many different applications may be trying to access the same information, the problem is much worse. One step towards solving it on large systems has been the creation of centralised databases, with generally agreed data structures being supervised by a database administrator.

In order for this to work, the data structures have to be appropriate for a wide range of applications which must be written in such a way that data is not duplicated. The history of these developments is covered in the accompanying box, and they have now reached the point where there is a defined standard



Any suitably-configured application can act as a front-end to the SQL data server, which acts in the same way as a network file server except that the whole of the server is dedicated to one database



Three approaches to multi-user access: one process per user; the data server running a single task and users queuing for access; and many users at different points in the same re-entrant data server routine

for specifying both data structures and the way they can be interrogated.

Data protection

Even on single-user systems, there is an obvious need to check the accuracy and internal consistency of data. For example, you should not be able to create an invoice for a customer who does not appear in your customer file. If you design, build and use your own systems, you may look after this yourself, but where a system is built by one person or group and used by another, formal checks on data integrity should be built in.

And, users must be prevented from circumventing the checking by updating the database directly. The more people use the system, the more important this becomes.

Again, all the major packages, and the compilers for programs such as dBASE III, have facilities to allow you to build in such checks, but few make it easy. If several applications can update the same database, all must include their own error-checking (though some programs help in this by allowing the use of a shared library of subroutines). Such checking can sometimes involve significant overheads, both in system performance and in programming.

For example, where several files are being updated in sequence, it is possible that an error in user input will not be discovered until the last update is tried. Then all the preceding changes must be 'undone', repeating all the file access in reverse order. And if the system should hang in the middle of either phase, good luck!

That last example highlights one of the most error-prone aspects of PCs: what happens to your data if your system crashes, or someone pulls the power plug before data has been saved properly and files closed?

And how does the system cope if a task goes berserk and steps over the border into an area of memory being used by another task running on the same processor? Some of these problems, notably the problems of multitasking, require operating system facilities not yet available but promised, for IBM PC systems, in the full version of OS/2.

To facilitate some sort of standardisation among databases, many manufacturers are adopting SQL (Standard Query Language) as their interface. SQL has been used on mainframe databases for some time, and with the growing interest in micro/mainframe connectivity, it makes sense for micro database publishers to also adopt SQL as their standard. This move was reinforced last year by the decision of IBM and Microsoft to support the language as a part of OS/2.

SQL may seem just another programming language like dBASE. But, its existing acceptance within many parts of the computer industry, and the fact that it is not linked to any proprietary product, will mean that increasing numbers of database manufacturers at all levels of computing power will include SQL support in their packages.

In this review I will look at some database situations and discuss why a standard like SQL is necessary. I will also give some examples of SQL in operation, though thankfully, it can be implemented as a 'black box' with users being shielded by existing friendly front-end applications from the nitty-gritty of raw code.

Batch facilities

In systems which take instructions entirely interactively, using menus and question-and-answer, it is difficult to provide a simple way to automate repetitive tasks. Some systems try to do so by allowing the recording of a sequence of keystrokes; others by using equivalents for keyboard characters which can be stored in a file and edited. But such systems are notoriously difficult to use. And, for systems which make heavy use of the mouse without providing keyboard equivalents for all operations, they are virtually impossible to implement.

The alternative approach, used by most powerful database systems, is to use commands, either as an alternative or as a substitute for menus. This may allow, as it does in dBASE, the option of using commands interactively; it will certainly permit storage of a batch of com-

Landmarks in the SQL story

(SQL is officially pronounced by its initials, as Ess-Queue-Ell, but it is almost universally known as Sequel.)

1970: EF Codd, at that time working at the IBM Research Laboratory, published his now classic paper on the relational model for large databases. This paper laid the foundation for all subsequent work on developing the relational model, from which stemmed the implementation work needed to produce workable relational systems, including relational languages.

1974: Creation of the relational language, Structured English Query Language, by DD Chamberlin and others at the laboratory. This language formed the basis of the first IBM prototype system, SEQUEL-XRM, in 1974-5.

1976-77: Revised version, called SEQUEL/2, developed; a large subset of this language, subsequently renamed SQL for legal reasons, was implemented by IBM as System R. This became operational in 1977, and was subsequently installed on a joint study basis at a number of customer sites, as well as undergoing trials within IBM itself.

1981: First commercial version of SQL announced by IBM for its mainframe operating system DOS/VSE, followed by a version for MVS called DB2, the major SQL product now supplied by IBM. The long gap between tests beginning on System R and the release of a viable product allowed other vendors to develop SQL implementations, and that from the company which is now Oracle Corporation preceded IBM in the market.

1982-88: Many other implementations of SQL were launched, either as standalone products (including Sybase — see under 'The Ashton-Tate/Microsoft SQL server'), or as interfaces to existing products such as Ingres. On micros, the command language used in the Open Access database module is based on SQL, while dBASE IV promises an SQL implementation alongside the current dBASE command language.

1986: The importance of SQL in the market as a whole was recognised by the ratification of an ANSI standard for SQL. The initial standard was essentially the IBM dialect of SQL, and has been criticised for leaning too much towards protecting existing vendors' implementations and not being sufficiently concerned with the need for a solid foundation based on formal language principles. Substantial revisions of the standard have been proposed.

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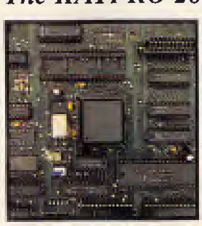

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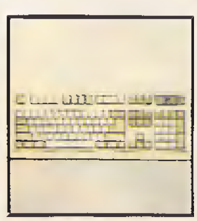

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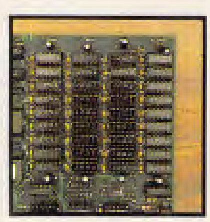

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mands in a file to be run regularly. It also opens up the possibility, as has been done with many systems, of adding commands which are only appropriate in a batch setting, or where interaction is permitted only indirectly, thus developing a programming language specifically for database handling.

Standards exist for conventional programming languages such as Basic, Fortran, C, Cobol and so on. In the micro world, as I have mentioned, there are no standards yet for database languages. And while many language standards are more honoured in the breach than the observance, at least they offer a minimum to which all conform. The desirability of a standard is one of the reasons for the continuing popularity of dBASE products through periods when competitors have provided demonstrably better facilities more cheaply — most people being of the opinion that an ad hoc standard is better than none, and a widely-accepted ad hoc standard is better than an unpopular pukka standard.

There is, then, a certain irony in Ashton-Tate being the first supplier of database systems for PCs to recognise the desirability of an external standard for command languages. The reason is the popularity of the chosen language, SQL, on larger systems, which means that many dBASE users and potential users are asking to have the same language available across all their database systems.

The use of a standard command language also opens up the possibility of simple inter-program communications. For example, a series of changes made to a database on a micro, using one database program, could be propagated on a mainframe using another database program simply by means of a task initiated on the micro, communicated to the mainframe and executed there, all without user intervention.

'For users of databases, file incompatibility can have more serious consequences than in other fields . . .'

So, there are three main areas in which we might hope to see significant improvements in database systems soon, and where SQL and its implementations might help: a standard language interface for interactive and batch use and for inter-program communication; improved data protection, by separating integrity checking and failure precautions; and the efficiency of access to databases on multi-user systems.

The first of these should come from implementing SQL itself. The other two depend on software developments which, in their turn, rely on the use of an agreed standard for accessing databases, so that many applications can work together harmoniously. One example of such a development, the SQL server announced jointly in January by Ashton-Tate and Microsoft, is explored here. There will doubtless be others, but the pedigree of this system, and its backing from the leading DBMS supplier and the operating system vendor, makes it likely to be of extreme importance on IBM PC and PS/2 systems.

What is SQL?

SQL is a language for the manipulation of relational databases. Any language sufficiently powerful to need an ANSI standard is far too complex to be described fully in a few paragraphs, but some idea of the language and its facilities can be given.

Assuming a single table of suppliers, each with an identifying code and a column recording their city of origin, a simple SQL statement, intended for interactive execution might look like this:

```
SELECT S.CITY FROM S WHERE
S.SNO="S4"
```

This would result in the display of the city in which supplier S4 is located. The prefix S before each column name is the name of the table; this is optional where no ambiguity about the source of the data is possible.

SQL includes a set of commands for the creation of tables, the insertion, amendment and deletion of rows, and the selection of data using one or more sets of criteria. Further control is exercised by adding more parameters: for example, sorting is accomplished by adding the parameter 'ORDER' to the 'SELECT' command, while 'DISTINCT' inhibits the display of rows which would duplicate those already displayed. Some built-in functions are provided to allow, for example, totalling of a numeric value across the range of rows valid for the SELECT command. A 'JOIN' facility, as befits a relational system, is provided to permit the selection of information from more than one table in a single SELECT command.

Even interactive dBASE is more friendly and less wordy than the rather primitive user image of SQL. SQL is, in many applications, used as a hidden language rather than being displayed to the user in all its gory detail.

Indeed, in its standard specification, it is largely intended to be invoked from within a programming language. The effect is to provide people writing programs in languages like Cobol with a set of database-specific commands to speed up and standardise the handling of database functions. It may well be that ordinary users will never need to know any more about SQL than is covered here; dBASE developers will merely use it to communicate with other programs if they need to, and shield their users from its antediluvian user image.

Given that caveat, SQL could well be the means of providing many features which developers have long sought. The most obvious is the transaction facility, which allows you to define a group of amendments as a single transaction which will only be implemented when the 'COMMIT' instruction is given, and only then if all aspects of the amendment process can be completed successfully. If problems arise, the program can issue a 'ROLLBACK' command which will cancel all updates putatively made by the transaction.

Security can also be provided through SQL, either to prevent individuals without authorisation viewing a complete table, or to restrict the operations they can perform — for example, to prevent them changing information but allowing them to view it. The basic language also provides some elementary facilities for data checking, such as specifying that a cell must never have a null value.

So far, I've simply referred to 'SQL', but in fact all the implementations are dialects of SQL without one conforming precisely to the standard, and all are different. As with some programming languages, for example, notoriously difficult areas such as input and output commands have been left undefined. While there is a family of programs based on SQL, you cannot rely on them being fully compatible even at the language level. This may give the vendors of PC implementation some headaches when they try to introduce direct communication with mainframe systems — for example, to go and collect information for processing on the PC. Ashton-Tate has already said that this facility will not be implemented in the first version of dBASE IV.

The Ashton-Tate/ Microsoft SQL server

Two of the three advantages we might hope to gain from a standardised database language cannot be gained wholly and directly from SQL, but only from implementations of the language. One of its major advantages is that its design permits the separation of the application from database handling.

For example, where several applications all access the same database, each one could, with the right hardware and SQL software, handle its own interaction with the user, but leave the checking of data integrity to the SQL 'backend'. This facility is offered by the SQL server recently announced by Ashton-Tate and Microsoft, the fruits of a tie-up with Sybase which has its own complete DBMS based on SQL for the DEC VAX and other mini systems.

The way in which networked applications work at present, contrasted with the way they would interact with the SQL server, is shown in the screentest on the first page of this article.

Separating the functions common to all applications from those specific to each application should result in substantial savings in development time, and also lead to fewer errors both in program code and in data. Some saving in processing time can also be expected from this rationalisation of application code, but a further significant improvement should be possible because of the way this particular server works. Most current database packages on micros require each user to be running a separate copy of the program (either the full package, or a compiled program).

But in that situation there is no possibility of, for example, intelligent queuing of data requests to speed up overall throughput. Nor is it easy to prevent users — often unwittingly — from making retrieval requests which will lead them and others to sit around waiting for the results. The multi-threading approach used by Sybase shown on the first page of this article should answer these problems, leading to faster response times and much greater capacity on existing physical networks in which one server can be dedicated to database work.

Two types of relationships will be possible between dBASE IV programs and the server. SQL commands can be embedded directly in dBASE IV programs; because there is some syntactic overlap between the two, you will first have to use a 'SET TO' SQL command to show that the following commands are indeed raw SQL. It will also be possible to program using dBASE IV commands which can then be passed directly to the server, undergoing translation to SQL on the way, with the results being translated back into dBASE IV format on the way back.

Conclusion

The relationship between Sybase, and Ashton-Tate and Microsoft, will be interesting to watch. As we have seen, this SQL server allows many different applications — not necessarily written in the same front-end language — to access the database through the same channels. It is certain that other companies will follow Ashton-Tate's lead in offering SQL facilities within existing products, and the agreement makes it clear that the server facilities will be made available to other front-end products.

But Sybase already has a front-end system, called DataToolset, implemented on the DEC VAX and other systems. The company has just announced that a version of DataToolset, fully compatible with its minicomputer implementation, will be produced for OS/2, providing direct competition for dBASE IV.

END

Real-World RISCs

You can't operate faster than zero wait states — or can you?

It's not important how you play the game; what matters is how you design the playing field. The speed and type of memory in a computer no longer play a big role in determining that system's performance. The configuration of its memory interface has become the key factor.

To achieve maximum benefit from the ultrafast internal CPU architectures of modern microprocessors, it is essential that the external hardware (RAM, ROM, and peripherals) keep the internal CPU execution pipeline supplied with an instruction stream and data flow at the CPU's clock speed. In the case of a 25MHz reduced-instruction-set-computer (RISC) processor like Advanced Micro Devices' Am29000 (see the accompanying box 'The Am29000 Chip Set'), this means making a new 32-bit word available to the CPU every 40 nanoseconds (ns).

Linking CPUs to memory has historically generated a great many techniques. But, as RISC microprocessors usher in another CPU era, the time has come to create still newer designs.

Implementing a conventional zero-wait-state static RAM (SRAM) interface (see Fig 1) at 40ns speeds requires an access time of better than 40 (one clock cycle) — 14 (address delay) — 5 (data-setup time), or 21ns (see Fig 2). Even this number allows for no delay in any address or data interface buffers. Such access speeds are really not practical, especially if the SRAM is part of a cache memory, where control logic and additional buffers may introduce more delays.

So why would a manufacturer produce a processor that cannot operate at full speed with the fastest available RAM? The answer lies in the basic precept of the memory access-speed calculation — conventional memory-design techniques. Although conventional memory technology has served the microcomputer industry well during its first 20 years, a new, more complex technology must be developed to meet the challenge of the 1990s.

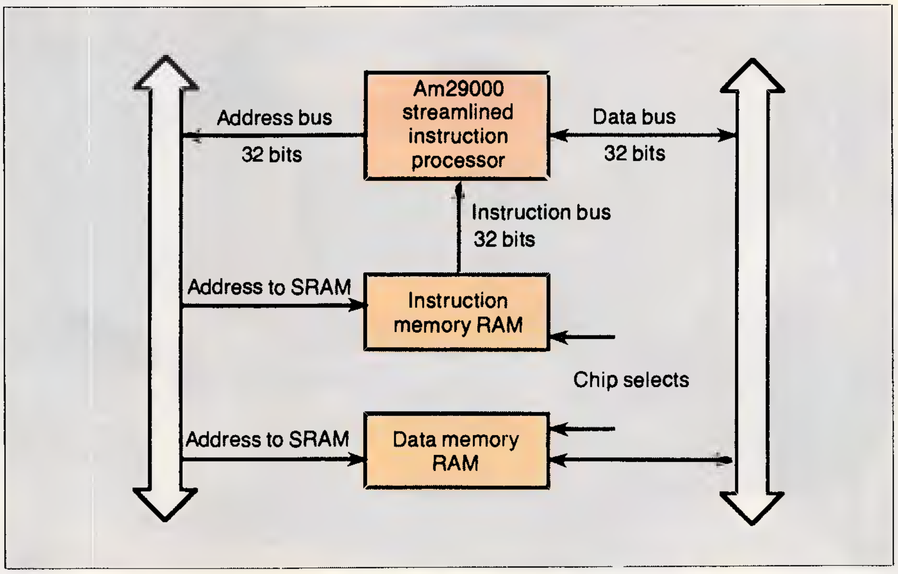


Fig 1 A conventional zero-wait-state SRAM interface design for the Am29000 microprocessor. Notice the separate instruction and data buses with the common address bus

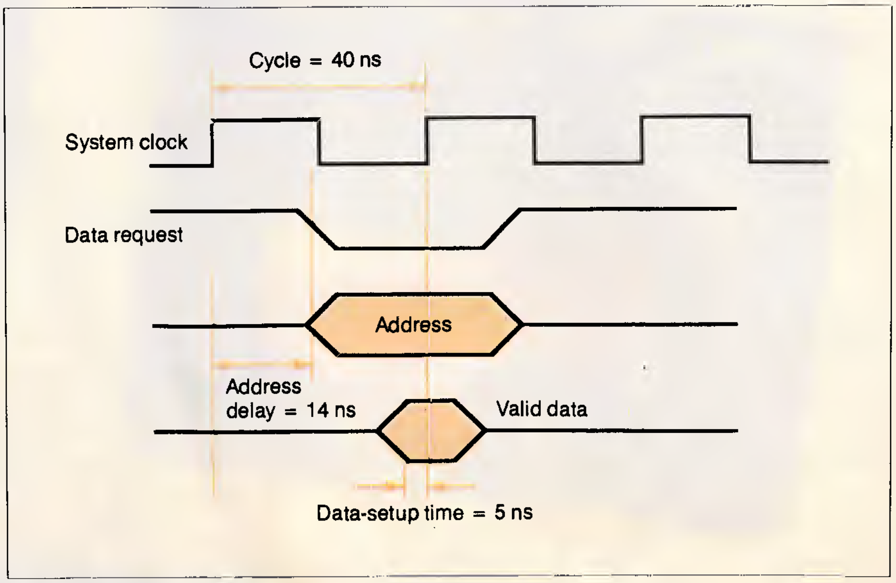
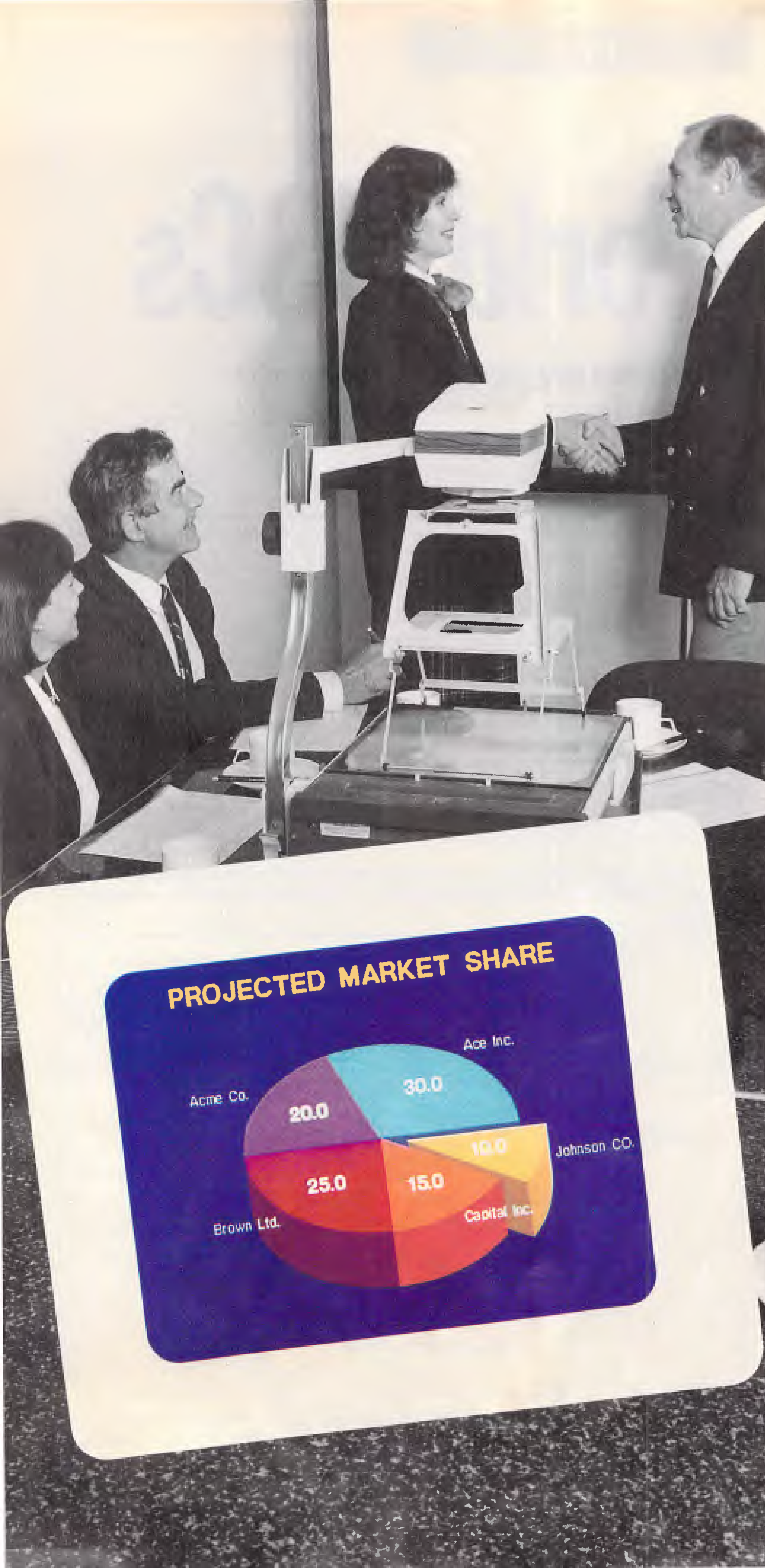


Fig 2 The timing diagram for the interface design in Fig 1. To implement the design at a 40ns speed, you need an access time of less than 21ns (clock cycle — address delay — data-setup time)



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New-generation microprocessors, like the Am29000, the MC88000 (see the accompanying box 'The MC88000 RISC'), and even the Intel 80386, use techniques such as interleaving, pipelining, and burst mode to get maximum efficiency from modern memory devices, such as static column dynamic RAM (SCRAM).

New memory-interface techniques are able to achieve mostly zero-wait-state system performance with these new high-speed CPU engines, even with low-cost memory.

Simulating RISCs

To test the performance of a variety of interface architectures without needing to actually assemble any hardware, AMD has released an MS-DOS-based simulator for the Am29000 streamlined

```
Dhrystone time (in cycles) for 50 passes = 31487
This machine benchmarks at 39698 dhrystones/second
Loading Am29000 Memory from file: mw_dhry.bin.
loading section " at address 00002000 [228 bytes of type data]
loading section " at address 00001000 [1924 bytes of type text]
loading section " at address 00003000 [10632 bytes of type bss]
loading section " at address 00000000 [564 bytes of type data]
loading section " at address 00001784 [1568 bytes of type text]
Entry at Address: 00001784


Advanced Micro Devices Am29000 Simulator Ver 4.21-PC -
               Copyright 1987
Sim complete -- successful termination
------------------------------------------------------------

Environment of "mw_dhry.bin" simulation:

Instruction Memory:
1 Cycles for a Simple access. (0 Wait States)
No Burst accesses are allowed and no Pipelined accesses are
               allowed.
(0 Cycles To Decode an Address)
Instruction ROM Memory:
1 Cycles for a Simple access. 0 Cycles To Decode an address.

Data Memory:
1 Cycles for a Simple access. (0 Wait States)
No Burst accesses are allowed and no Pipelined accesses are
               allowed.
(0 Cycles To Decode an Address)
Statistics of "mw_dhry.bin" simulation:

User Mode:            32404 cycles         (0.00129616 seconds)
Supervisor Mode:        189 cycles         (0.00000756 seconds)
Total:                32593 cycles         (0.00130372 seconds)

Instructions Executed:          27006

Simulation speed: 20.71 MIPS (1.21 cycles per instruction)
---------- Pipeline ----------
 17.14% idle pipeline:
      12.70% Instruction Fetch Wait
       2.50% Data Transaction Wait
       0.00% Page Boundary Crossing Fetch Wait
       0.83% Unfilled Cache Fetch Wait
       0.00% Load/Store Multiple Executing
       1.54% Load/Load Transaction Wait
       0.38% Pipeline Latency

---------- Branch Target Cache ----------
Branch cache access:          13511
Branch cache hits:             8197
Branch cache hit ratio:       60.67%
```

Continues . . .

Fig 3 Simulator output for the interface design in Fig 1. Note the Dhrystone (second line) and mips (last line, this page) predictions

```
---------- Translation Lookaside Buffer ----------
TLB access:                        9433
TLB hits:                          9426
TLB hit ratio:                   99.93%

---------- Bus Utilization ----------
Inst Bus Utilization:            71.44%
       23285 Instruction Fetches

Data Bus Utilization:            18.11%
        3380 Loads
        2523 Stores

---------- Instruction Mix ----------

      3.24% Calls
     14.41% Jumps
     12.52% Loads
      9.34% Stores
      6.49% No-ops

---------- Register File Spilling/Filling ----------
           0 Spills
           0 Fills


(Simulator Performance:      592.60 cycles per second)
```

Ends

instruction RISC processor. The simulator is available on Microtex (see page *6663#), or by sending an IBM PC-formatted 5.25in floppy disk and reply-paid, self-addressed packet to 'Real-world RISCs', *APC*, 124 Castlereagh St, Sydney 2000.

Consequently, I will use this simulator to examine Am29000 memory-interface technology, although the techniques are equally applicable to other devices.

The Am29000 execution unit uses a four-stage pipeline, allowing a peak execution rate of one instruction every clock cycle (40ns). It has three nonmultiplexed 32-bit buses (see Fig 1): separate buses for instruction and data transfers, and a common address bus. Simultaneous instruction and data transfers can be achieved using pipelined and burst-mode transfers.

No waiting

The conventional memory design shown in Fig 1 shows a zero-wait-state SRAM design. Fig 3 shows the simulator output (using the Dhrystone program as the test code) for this condition. The simulator predicts a rating of 20.71 million instructions per second (mips) and 39,698 Dhrystones per second. Although these numbers may seem exceptional, this is a normalised performance of only 94.7 per cent when compared to the peak performance possible with this processor.

If we used instruction burst mode with this zero-wait-state SRAM, we could obtain 41,290 Dhrystones and 21.83 mips. But how can this be? How can anything improve on zero-wait-state performance?

Bursting through

To understand what's happening, we need to look at how the CPU's four-stage execution pipeline operates. Instruction fetches overlap with data fetches; thus, they can occur simultaneously. Although the data and instruction buses are separate, they share a common address bus; thus, occasionally, they will both need the address bus at the same time. Burst mode allows sequential accesses to occur when only the first (starting) address has been placed on the address bus.

Fig 4 shows the timing of a short burst-mode instruction-fetch access. The address of the first data word is placed on the address bus for only the first cycle. It then becomes the responsibility of the RAM control hardware to provide incrementing addresses to RAM for every clock cycle in which the burst-request signal (*IBRQ) is active. Thus, the address bus is freed for data accesses. Most instruction-stream fetches tend to be sequential, so burst mode effectively speeds up RAM instruction access. However, if a 'BRANCH' instruction takes execution to a new area of the

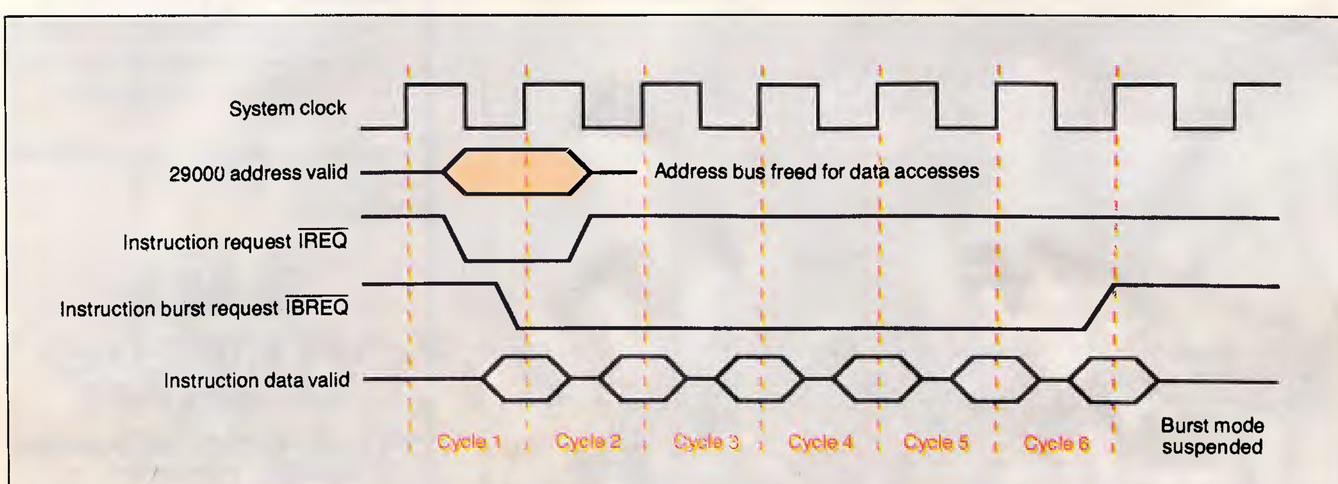


Fig 4 The timing of a short burst-mode instruction-fetch access. Notice that the instruction fetch overlaps with the beginning of each cycle except the first

code, the sequential fetch will be interrupted.

The Am29000 has a 'branch-target cache' that keeps the four instructions immediately following each branch in internal CPU memory. After executing a branch instruction once, you don't need to access external memory on its second and subsequent executions. This leaves the burst sequencer four cycles in which to terminate and start fetching instructions from the new (non-sequential) address.

Waiting for memory

Large memory systems with access times of 20ns just aren't practical. If you simulate the system in Fig 1 with one-wait-state RAM — access time is 80 (two clock cycles) — 14 (address delay) — 5 (data-setup time) = 61ns, not including buffers — you get 26,907 Dhrystones and 14.08 mips — only 64 per cent of peak performance.

Simulating performance with three wait states (approximately the best dynamic RAM (DRAM) cycle time currently available) gives 14,104 Dhrystones and 7.42 mips, or 34 per cent of peak performance.

Clearly, much of the advantage of these faster processors is lost unless they are matched by unusually high-speed memory systems.

This explains why the performance of the current generation of RISC computer systems is often so disappointing. If the test software has good locality of reference (it works well with conventional SRAM cache technology), its speed of operation approaches that of the SRAM simulation. If it doesn't, then performance leans toward that of the DRAM (main memory).

The benchmark performance of RISC machines using conventional technology is usually excellent, since the benchmarks are small enough to fit entirely within the SRAM cache. When actual applications software using matrix algebra or data in large arrays is assessed, however, the cache becomes much less effective and performance drops. We need to adopt new computer system architectures to realise the real performance potential of RISC technology.

Speeding things up

Interleaving uses two banks of memory instead of one. One bank handles even addresses, and the other handles odd addresses. If we assume that an instruction-fetch sequence occurs at sequential addresses, then only one bank is active at any one time; the other bank can be in its row-address strobe (RAS) precharge cycle (for DRAM) or getting the next data ready (for SRAM).

This process achieves its peak efficiency with the instruction-burst-access mode of the Am29000. When the Am29000 requests an instruction-burst access, the first bank of RAM is addressed (see Fig 5). It has approximately 60ns to get its data ready. The next word of data, however, comes from the second bank of memory. If the system design is such that the next address is placed on the second bank at the start of the cycle (using an external incrementer), then that bank has approximately 100ns to prepare its data.

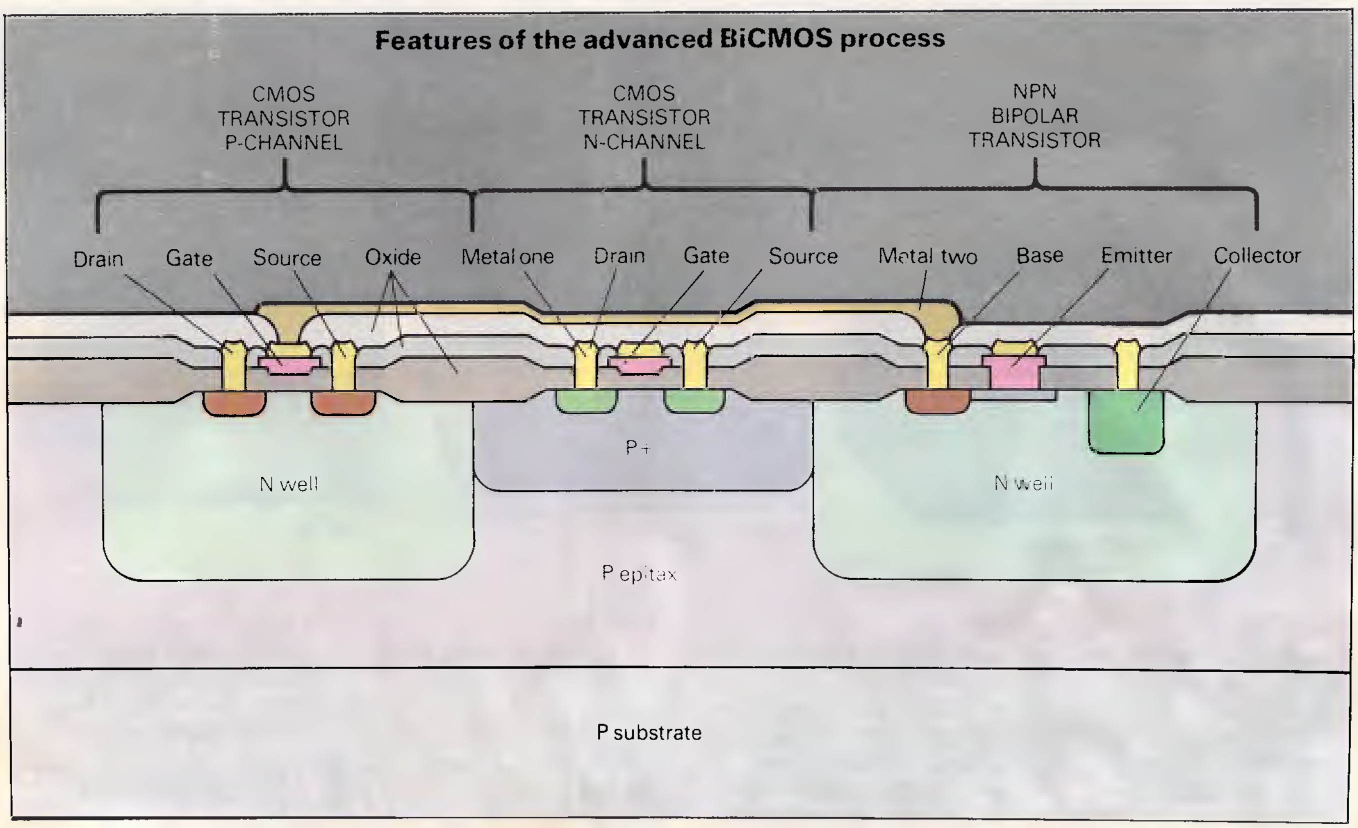
Furthermore, the second bank can present its data to the CPU only 40ns, or one cycle, after the first bank does. Similarly, while the second bank is being accessed, the first can be preparing to present its next data word to the CPU just 40ns later.

Continued on page 115

The best of both worlds

Although still in its infancy, BiCMOS technology (the fusion of the high-speed bipolar integrated circuit and CMOS) has immense potential in the design of fast processors for the commercial world in general and the PC world in particular. Nick Hampshire explains.

In 1947 three researchers at Bell Research Laboratories — Messrs Shockley, Bratain and Bardeen — made a discovery which changed the world. That discovery was the transistor. In the 41 years following that discovery there were two other important developments. The first was the bipolar integrated circuit in the early 1960s which was followed about 10 years later by the CMOS integrated circuit. Now we are witnessing the birth of a third integrated circuit tech-



A cross-sectional diagram of a BiCMOS chip showing how the two different types of CMOS transistor are combined with a bipolar transistor on the right of the diagram using polysilicon fabrication techniques

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nology which combines the best features of both the earlier technologies — this is known as BiCMOS.

This fusion of the two older technologies, bipolar with its high speed and CMOS with its high component density and low power consumption, is creating a great deal of excitement among both chip designers and electronic and computer system designers. In the last few months virtually every major chip manufacturer has announced plans to invest in both research and actual production of BiCMOS chips. At the recent International Solid State Circuit Conference in San Francisco, developments in BiCMOS were one of the conference sensations.

The reason for this excitement is that at last electronic chip designers will be able to produce very fast, densely packed chips with a low power consumption. But even more exciting than this is the fact that BiCMOS will allow large-scale analogue and digital circuits to be combined on the same chip — in the past these two types of circuit had to be placed on separate chips. BiCMOS technology thus looks set to increase the speed and power of integrated circuits as well as giving rise to a whole new generation of applications chips. In both areas, BiCMOS will have a considerable impact on personal computers in the years ahead.

To understand the excitement and appreciate the potential of BiCMOS technology, it is necessary to understand something about semiconductor technology, and the reasons why bipolar and CMOS technologies are different.

The semiconductor

An understanding of semiconductor technology is firmly based on the principles of quantum mechanics and its application to the energy levels within an atom. An atom is primarily made of two components — a central nucleus which is positively charged, and an outer cloud of negatively charged electrons. These electrons do not form a random cloud around the nucleus, but are organised as a series of concentric shells. Each shell contains electrons with a similar energy level.

What quantum theory states is that the energy of an electron has to be at one of a set number of energy levels. It is the existence of these energy bands which is crucial in both the conduction of electricity and in the properties of semiconductors. For a material to act as an electrical conductor some of the electrons must be excited above their normal levels. This excitation pushes the electron into a shell further away from the nucleus and thus frees the electron and allows it to pass from one atom to another.

When the outer shell of electrons in an element is only partially filled, it is very easy to move electrons from one atom to another. Such materials are usually good electrical conductors since very little energy is required to raise an electron to a higher energy level and thereby convert it into a charge carrier. Materials where the outer shell of electrons is entirely filled are usually insulators since they require a considerable energy input to move electrons from one atom to another.

There are, however, some insulators which do not require large amounts of energy to create charge carrier electrons. Since these elements lie between the true conductors and the total insulators they are referred to as semiconductors. Normally at room temperature the thermal vibration of atoms is sufficient to generate charge carriers within a conductor, but in a semiconductor this is usually not quite enough to make the material a conductor.

When an electron in a semiconductor becomes a charge carrier it leaves a space in the electron shell of the atom, and consequently this atom acquires a positive charge. Such positively charged atoms can also act as carriers of an electrical current in exactly the same way as an electron, and they are referred to as 'electron holes'. In a normal semiconductor the number of charge-carrying electrons is always equal to the number of electron holes.

A semiconductor can be made conductive by inputting energy over and above the normal ambient thermal energy. This could be in the form of additional heat, light or electricity. All these sources of energy are utilised by different semiconductor devices. Thus a semiconductor such as cadmium sulphide becomes a conductor when exposed to ordinary light, a feature which is utilised in the construction of photographic light meters.

With semiconductors like silicon and germanium, their electrical properties can be changed by adding very small quantities of another element, such as arsenic or phosphorus. The effect of these doping elements is to create an electrical imbalance between the number of charge-carrying electrons and their opposite equivalent electron holes. Thus the addition of arsenic to silicon produces an excess of electron carriers over electron holes. The doped silicon is therefore known as N-type material. Adding phosphorus has the reverse effect and creates a deficiency of electrons — in this case the material is referred to as P-type material.

Semiconductors which have an excess of either conducting electrons or electron holes are known as 'doped semiconductors'. All semiconductors used in integrated circuits and discrete transistors use this sort of material. Just simply doping a piece of silicon with either arsenic of phosphorus does not make the semiconductor useful. That happens when a junction is created between a P-type piece of silicon and an N-type piece. A P-N type semiconductor junction of this sort creates a one-way electrical valve called a diode. Connecting the positive lead of a battery to the P-type side and the negative terminal to the N-type side will allow current to flow through the device, the semiconductor acting as a conductor. Reversing the battery leads will result in the P-N junction acting as an insulator.

A transistor is constructed in a similar manner, only instead of using just two pieces of doped silicon it uses three. A transistor is not only a one-way valve, it is one which can be electrically turned on or off. A typical transistor would thus consist of a sandwich of P-type silicon between two pieces of N-type.

If a battery is connected across the two N-type pieces no current will flow whichever way the battery is connected. However, by connecting the central P-type piece of silicon to the negative terminal of the battery it is possible to use this source of electrons to fill all the holes in the P-type and so enable it to conduct electricity between the two N-type layers. The amount of electrical current flowing through a transistor is thus dependent upon the voltage applied to the central layer of the transistor semiconductor sandwich.

The three-layer transistor and the two-layer diode form the basis of all semiconductor devices. It is from these simple devices that the bipolar integrated circuit has been developed. The difference between these and CMOS integrated circuits lies in the design of the transistor. CMOS uses what are known as Field Effect Transistors (FETs). These do not rely on the PNP or NPN junction but instead control the flow of current through a channel of P or N-type silicon by means of an electric field. This field is produced by a metal 'gate' placed over the semiconductor channel and insulated from it by a layer of silicon oxide. Hence the term Metal Oxide Semiconductor (MOS). The C in CMOS stands for 'complementary' which simply means that both P and N-type doped silicon are used in the device.

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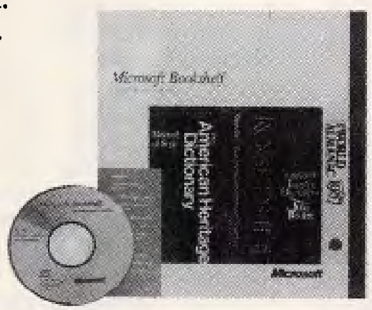

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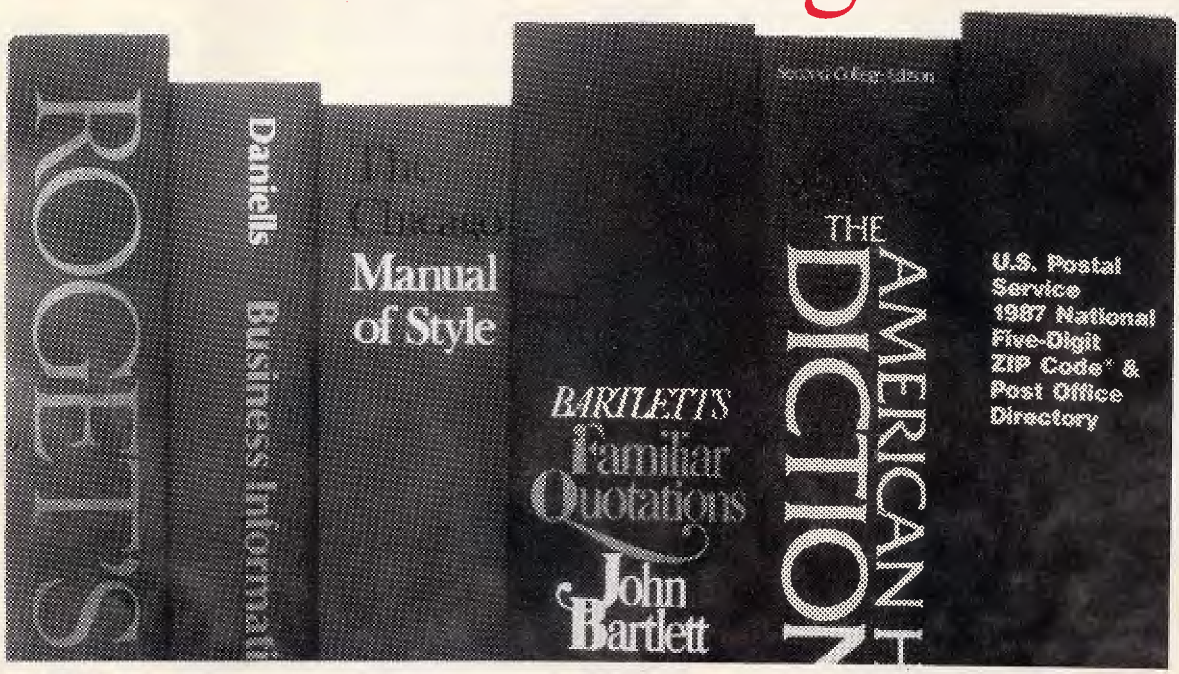

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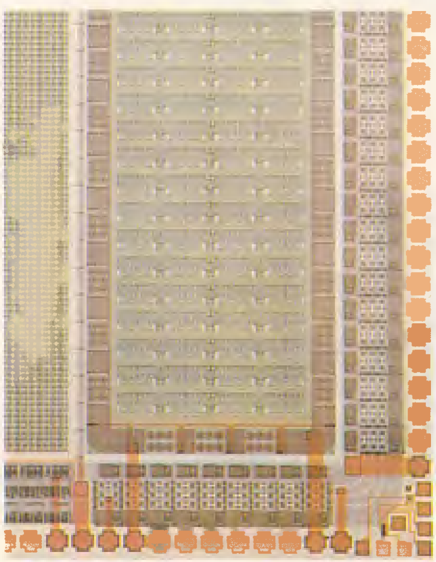
Bipolar chips

All the earliest integrated circuits used bipolar technology. This was a logical extension of the fabrication process for both transistors and diodes. This process involved taking a slice from a large crystal of silicon and selectively doping different areas of the slice with either P-type or N-type dope. This had the effect of printing a pattern of different electrical properties into the silicon slice.

This doping process was performed by placing the silicon slice into a furnace,



heating it up and then introducing the dope chemical into the furnace atmosphere in the form of a gas. The dope molecules would then diffuse into the surface of the red hot silicon thereby creating a doped surface layer. By masking out areas of the silicon slice it was possible to dope only selected areas of the slice.

In this way bipolar integrated circuits were formed from a number of transistors and diodes 'printed' on to the surface of the silicon slice. The undoped silicon has a very high resistance and virtually behaves as an insulator. Connections were made between the components on the chip by depositing a thin layer of metal over the surface of the chip and then etching away unwanted portions to leave a pattern of interconnections between components.

The virtue of the bipolar transistor is that it is able to switch very rapidly between acting as an insulator and as a conductor. Consequently, bipolar integrated circuits are also very fast devices, typically with clock speeds of several hundred megahertz. Bipolar transistors also have a good linear response, which simply means that the amount of current flowing through the transistor is directly related to the voltage applied to the central slice in the transistor sandwich. This means that bipolar circuits are ideal for use in any application where variable voltages are being handled — in other words, analogue circuits.

Another virtue of bipolar transistors is that it is very easy to construct devices which can handle target currents. Increasing the dimensions of the transistor will allow it to switch larger current loads. Again this is a frequent requirement in many analogue circuits.

Against the undoubted virtues of bipolar technology for constructing integrated circuits there are also severe limitations. The first is that bipolar chips cannot be made very dense — the bipolar transistor requires an area of the chip surface which cannot be reduced beyond certain limits. The other main problem is that bipolar circuits require substantial power to drive them — the electrical energy put into the central slice of the transistor to make it conductive. This energy input is dissipated as heat, and excessive heat production can cause problems in an integrated circuit. Overheating can cause the entire component to fail, and limits the maximum size of the chip. Thermal stress in large chips can also lead to failure. As a result, bipolar technology has been confined to use on relatively small integrated circuits.

The excellent analogue properties of bipolar devices means that virtually all analogue integrated circuits are fabricated using this technology. Their potentially high speed and high power output means that they are often used as the 'glue' between large CMOS chips. This very important application area includes such vital functions as bus drivers, clock generators, I/O drivers, and so on. Without these bipolar 'glue' chips, it would be impossible to construct any of the fast current generation of PCs.

CMOS chips

The MOS integrated circuit family, of which CMOS is a member, is based around the concept of the field effect transistor or FET. This type of transistor was first invented in 1961 but was not employed in the construction of integrated circuits until the end of that decade. The principles behind this type of transistor are totally different to those used in the bipolar transistor. Instead of directly injecting electrons into a normally insulating area of doped silicon, the FET induces an electric field in a channel of silicon. This induced electric field will then convert the silicon channel from being an insulator to a conductor.

This technique for constructing a transistor has many advantages as well as a few disadvantages. A major advantage is that the electrical input to the gate — the area of metal above the silicon conduction channel — is electrically isolated from the silicon channel itself. This contrasts with the bipolar device where the central 'base' layer of silicon is directly connected to the conductive layers.

This means that in bipolar transistors there is always a leakage of current from the base into the conductive layers. In contrast, the gate area of a FET transistor is insulated from the rest of the transistor, which means that in comparison to bipolar devices it requires much less current to switch the transistor on and off. Less drive current means less heat, and therefore the ability to construct larger chips without fear of thermally induced failure.

The absence of any leakage of current from the gate area of a FET transistor to the channel also means that when the transistor is in its non-conducting mode, it has a very high resistance.

However, the use of an induced current in the conduction channel means that the FET is inherently much slower than the bipolar transistor. Indeed, there is a direct relationship between power consumption and speed in MOS circuits which does not exist in bipolar circuits. There is also a far less precise relationship between gate voltage and the amount of electricity allowed to flow through the conduction channel, which means that MOS technology is not ideal for constructing analogue circuits.

MOS technology is, however, ideal for constructing large-scale digital integrated circuits. Not only is power consumption lower and the consequent heat generation much reduced, but the properties of the FET enable chip designers to greatly reduce the chip area needed, not just for single transistors, but also for that key component of all digital circuits, the memory cell.

In bipolar circuits a memory consists of a 'flip flop' circuit. This is a digital circuit which can exist in one of two states. It requires four transistors and a couple of resistors, and this type of memory cell is still used in the so-called 'static' memory chips. The low leakage of electricity across a FET transistor allowed designers to create a new form of memory cell which only requires a single transistor and a capacitor. Data is stored in this form of memory cell by charging the capacitor to represent a '1' or leaving it uncharged to represent a '0'.

The only problem with this type of memory is that sooner or later the charge stored in the capacitor leaks away and the data in the memory is lost. This problem is overcome by regularly reading each memory cell and then rewriting its contents, a process which simply recharges the contents of the capacitor. This form of memory is now the most widely used and is called 'dynamic memory'.

All the large integrated circuits (IC) in use today are fabricated using one of the three different sorts of MOS technology. These are N-MOS and P-MOS, where the N and P simply indicate the type of doping used for the base slice of silicon.

CMOS is a slightly more sophisticated product which uses silicon with both N and P doping. This means that CMOS has the advantage of requiring far less power than either of the other two MOS technologies. Most of the large chips in a PC will be fabricated in either N-MOS or P-MOS, while CMOS is exclusively used in low-power applications such as portable computers, calculators and wrist watches.

Bipolar + MOS = BiCMOS

The current situation is, therefore, that bipolar technology is used to create fast integrated circuits — in particular those for applications involving analogue or high-power functions. However, for densely-packed, large, complex digital functions, especially those where low power consumption is important, then MOS technology is the natural choice.

In the past this division between the two main semiconductor technologies has not been particularly important. Improvements in MOS technology has resulted in enormous improvements in speed, component density and size of integrated circuits over the past 10 years. The number of components within an IC has leapt from just a few thousand to hundreds of thousands and — in some cases — even millions. Operating speed has increased from one or two megahertz to 20 or even 30MHz, while actual component sizes are now only about 10 per cent of what they were.

Further improvements in MOS technology in terms of speed and component size are now beginning to show signs of impending physical limitations. Up to now designers have been able to make chips faster by making the component size smaller and reducing the distance between connected components. The laws of physics dictate this process cannot go on forever.

However, in a complex circuit such as a microprocessor chip, not all portions of the chip need to operate at the same speed. In fact, the maximum operating speed of such a chip is dictated by a relatively few components such as 'data and address bus controllers'. Implementing these in a higher-speed technology would dramatically increase the overall speed of the chip. After all, a large mainframe computer is not architecturally very different from a processor like the 80386 or 68020 — it is simply constructed using a far higher-speed technology, such as ECL or gallium arsenide, in critical areas of the circuit.

At present, processors such as the 80386 and 68020 are limited to operating at between 20 and 25MHz. If it were possible to implement the speed-critical areas of the processor circuit in a high-speed semiconductor technology capable of running at 200 or 300MHz, then the whole performance of the chip would be boosted to twice or three times its current rating.

Further improvement in the performance of microprocessor-based computers can be obtained by integrating as much as possible of the circuit into as few chips as possible. Again, chip speed as well as chip function is the current problem. If you look at a PC circuit board you will find that a considerable number of bipolar integrated circuits are required in its construction. Some of these are required to perform operations at speeds in excess of that normally available on MOS circuits. These are usually related to parts of the circuit like the address and data bus or the clock drivers.

Another area where bipolar circuits are required in a PC is in the video board. If you look at an EGA or VGA board you will find that about 30 per cent of the chips are bipolar devices. Some of these are high-speed digital control devices, others are analogue devices which create the variable voltage signal which drives the colour monitor or TV.

The last area where bipolar devices are required is the I/O board. MOS circuits are not good at delivering a lot of power, and that is one thing that an I/O circuit needs to do. A lot of electrical power is dissipated down a 3-meter printer cable. Consequently, I/O drivers are usually bipolar devices.

Thus, there are a lot of bipolar integrated circuits used in the construction of a device such as a personal computer. In chip-count terms they probably comprise about 25 per cent of the chips, but in terms of actual circuit complexity they account for just a fraction of one per cent. This is not a desirable situation since the greater the number of chips, the more expensive the device is to construct, the more error-prone it is and the slower its operating speed.

Manufacturers have sought to overcome some of these problems by using special chips known as Applications Specific Integrated Circuits (ASICs) which are simply a means of putting a number of bipolar chips into a single package without having to design a special semiconductor circuit. These have reduced the package count considerably in many PCs. However, it would be infinitely preferable to be able to put many

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of these bipolar components directly on to large MOS ICs.

This need to integrate high-speed digital and analogue bipolar circuits with high-density MOS circuits on the same chip has been the driving force behind the development of BiCMOS. The problem with combining the two technologies has essentially been a manufacturing problem. It was possible to put both technology devices on the same chip, but it required a vastly increased number of manufacturing steps. This made the process very expensive and also lowered the yield of usable devices to an uneconomic level.

The application of BiCMOS

The STC development of an efficient BiCMOS process relies on the use of polysilicon-emitter technology which has been used to create high performance bipolar elements plus non-compromised CMOS technology. With this and a combination of devices, it is possible for designers to address many different applications areas which involve the integration of complex digital functions and demanding analogue functions on the same chip, in order to improve speed and reduce assembly costs. It also allows the construction of purely digital chips with compact CMOS circuitry and bipolar components, such as output buffers for better line driving.

This polysilicon-emitter technology has not compromised the behaviour of either of the two constituent technologies and above all, is relatively easy and cheap to fabricate. It can be made in a conventional bipolar or CMOS fabrication facility and can be designed with any ratio of CMOS to bipolar. The CMOS components can be used to construct highly complex and compact digital circuits.

Already the CMOS components are being constructed with a standard 2µm technology and STC will be lowering this to 1.25µm in the very near future. This very small component size is comparable to that currently being employed on standard pure MOS and CMOS devices. The other performance ratings of the STC BiCMOS CMOS components is equally comparable to that pertaining to conventional CMOS technology.

The BiCMOS bipolar devices have a minimum fabrication feature size of 1.5µm for any bipolar device, which is a small feature size. These BiCMOS bipolar devices have a maximum clock rating of well over 300MHz and are potentially capable of at least doubling this speed as the technology develops. They are also able to function at voltages between the normal operational five volts and 20 volts, and development should improve this rating further.

The initial products are all quite small devices, and mainly directed at the telecommunications industry. This is an area where the ability to integrate both analogue and digital functions on the same chip is causing great excitement, particularly when the resulting devices are also able to operate at speeds of 100MHz or more.

As manufacturers develop the BiCMOS process, so they will start to use it on larger chips. One of the largest announced so far was described at the International Solid State Circuits Conference in San Francisco by National Semiconductor. This is a very high-speed 256k static memory chip which has been designed in BiCMOS for use in supercomputers. Industry analysts are expecting a flood of such announcements over the next 12 months.

Chips of this size using BiCMOS are

still very rare, and most manufacturers are adopting the same approach as STC and another company, LSI Logic — to gain experience in the technology by constructing small devices before designing much larger circuits. In fact, one of the principal initial applications to which LSI Logic is applying BiCMOS technology is in the fabrication of a mixed digital/analogue ASIC.

Conclusion

The technology of BiCMOS is still very much in its infancy, and it will take at least another three or four years before it reaches any reasonable level of maturity.

With BiCMOS a whole range of applications become both economically and technically possible — for example, digital radio, high-definition digital TV, and miniature portable phone systems. In the personal computer field BiCMOS will enable manufacturers to create much faster processors. It will also enable designers to construct cheap voice and image input systems.

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Analysing your RAMdisk needs

RAMdisks can be a PC user's dream or a memory-hogging nightmare. RECORDER gives you a painless way of checking disk file accesses so you can optimise RAMdisk use.

PC users are always looking for ways to squeeze just a little more speed out of their computers. Often, today, the limiting factor is the time spent waiting for the disk drive. Its mechanical operations just can't keep up with the speedy silicon of the microprocessor. A RAMdisk is one good answer to the problem of disk delays, since it provides a level of performance that can't be matched by the fastest hard disk in town. Another technique involves organising the physical ordering of the sectors in such a way as to minimise head movement.

If you're not careful, however, these advanced techniques can sometimes do more harm than good. Your efforts to speed up the disk may slow down other operations, for example. Memory assigned to a RAMdisk is unavailable for executing programs. When usable memory is reduced, large programs often run inefficiently or (the worst case) not at all. Tuning the system for optimum performance thus requires precise balancing of your resources. And to do this, you've got to know exactly what your individual processing needs are.

RECORDER.COM will help you decide how to distribute your available resources. It measures your usage of disk I/O by keeping track of how many times each of your files is accessed. With this information in hand, you can select the specific files that will benefit most from being kept on the speedy RAMdisk. Moreover, if you use one of the disk optimisation programs that let you locate files so as to minimise head movement, RECORDER will show you which files should be located closest to the FAT.

```
RECORDER 1.0 (c) 1987 Ziff Communications Co.
PC Magazine - Tom Kihlken

   File Name  Total    Read  Write    EXEC

RECORDER.ASM     88      88      0       0
   SETUP.ASM     69      65      4       0
   SETUP.COM     43      16     27       0
   SETUP.TMP     40       2     38       0
RECORDER.COM     17       3      9       5
RECORDER.EXE     13      13      0       0
 COMPILE.BAT     12      12      0       0
    EDIT.EXE      5       0      0       5
AUTOEXEC.BAT      4       4      0       0
    LINK.EXE      3       0      0       3
   DEBUG.COM      3       0      0       3
 EXE2COM.EXE      3       0      0       3
    MASM.EXE      2       0      0       2
```

Fig 1 The report from RECORDER shows the number of times each file was read from, written to, or executed. The specific files shown on your display will differ

The easiest way to get a copy of RECORDER.COM is to download it from Microtex on Telecom's Viatel (see page *6663#). Alternatively, you can create the .COM file either by assembling its source code, RECORDER.ASM, or by loading and running the RECORDER.BAS program. Both these listings are printed here and are also available for download from Microtex. And lastly, you could send a blank formatted 5.25in disk with a stamped, self-addressed package to RECORDER, c/- *APC,* 124 Castlereagh Street, Sydney 2000.

Using RECORDER

To begin logging your file activity, just

```
                Page 60,132
;---------------------------------------------------------------------
; RECORDER.ASM - A resident program which counts file operations.
; Run it once to install and initialize it.  Run it again later to
; view a list of files which have been accessed.  The table
; shows how many disk accesses have been made while reading and
; writing to the file.
;
; SYNTAX:   RECORDER  [n] [/R]
; USE   n to specify the maximum number of files (default=200)
; Use  /R to reset the file table.
;---------------------------------------------------------------------
CSEG            SEGMENT
                ASSUME  CS:CSEG,DS:NOTHING
                ORG     100H    ;Beginning for .COM programs
START:          JMP INITIALIZE  ;Initialization code is at end

;---------------------------------------------------------------------
; Data area used by this program
;---------------------------------------------------------------------
COPYRIGHT       DB      'RECORDER 1.0 (c) 1988 Ziff Communications Co."
PROGRAMMER      DB      13,10,"PC Magazine ",254," Tom Kihlken$",1AH

FULL_MESS       DB      "*Table is saturated*$"
OLDINT21        DD      ?       ;Old DOS function interrupt vector
OLDINT13        DD      ?       ;Old BIOS disk I/O interrupt vector
NUM_FILES       DW      200     ;Default size of the table
FILE_TABLE_END  DW      ?
LAST_FILE       DW      ?
LAST_HANDLE     DW      ?

;--to help count spaces-01234567890123456789012345678901234567890l-----
HEADER          DB      "   File Name  Total   Read  Write   EXEC$"

CURRENT_FILE    DB      11 DUP (?)
CURRENT_HANDLE  DW      ?
FUNCTION_ID     DW      ?
BUSY_FLAG       DB      0
BIOS_IO_COUNT   DW      0       ;Counts disk accesses made by BIOS

HANDLE_TABLE    EQU     OFFSET INITIALIZE
FILE_TABLE      EQU     HANDLE_TABLE + NUM_HANDLES * 4
NUM_HANDLES     EQU     30
ENTRY_SIZE      EQU     20

;---------------------------------------------------------------------
; Interrupt 13 (Diskette I/O) This routine counts disk sector accesses.
;---------------------------------------------------------------------
NEWINT13        PROC    FAR
                ASSUME  DS:NOTHING, ES:NOTHING
                CMP     AH,2            ;Is function lower than 2?
                JB      DONT_COUNT      ;If yes, then ignore it
                CMP     AH,4            ;Is function higher than 4?
                JA      DONT_COUNT      ;If yes, then ignore it
                INC     CS:BIOS_IO_COUNT;Add sectors count to total
DONT_COUNT:
                JMP     CS:OLDINT13     ;Continue with disk interrupt
NEWINT13        ENDP


;---------------------------------------------------------------------
; Interrupt 21 (DOS functions)  This routine counts file accesses.
;---------------------------------------------------------------------
NEWINT21        PROC    FAR
                ASSUME  DS:NOTHING, ES:NOTHING

                PUSHF                   ;Save callers flags
                STI                     ;Get interrupts back on
                CMP     CS:BUSY_FLAG,0  ;Are we busy now?
                JNE     OLD_DOS         ;If busy, just pass it to DOS
                CMP     AH,4BH          ;Is it the EXEC function?
                JE      EXEC            ;Handle EXEC specially
                CMP     AH,0EH          ;Is it below 0EH?
                JBE     OLD_DOS         ;If yes, ignore it
                CMP     AH,31H          ;Is it TSR function?
                JE      OLD_DOS         ;Dont intercept this call
                CMP     AH,45H          ;Is it above 45H?
                JB      INTERCEPT_IT    ;If yes, then ignore it
OLD_DOS:
                POPF                    ;Recover callers flags
                CLI
                JMP     CS:OLDINT21     ;Allow interrupt to proceed
EXEC:
                PUSH    AX              ;Save these registers
                PUSH    BX
                PUSH    CX
                PUSH    SI
                PUSH    DI
                PUSH    DS
                PUSH    ES
                MOV     CS:BUSY_FLAG,1  ;Set the busy flag
                MOV     SI,OFFSET PARSE_STRING ;Point to parse routine
                CALL    ENTER_FILENAME  ;Search file table for the file
                JC      EXEC_CONTINUE
                INC     WORD PTR DS:[SI+12[
                INC     WORD PTR DS:[SI+18]
EXEC_CONTINUE:
                MOV     CS:BUSY_FLAG,0  ;Not busy any more
                POP     ES              ;Restore the registers
                POP     DS
                POP     DI
                POP     SI
                POP     CX
                POP     BX
                POP     AX
                JMP     OLD_DOS
INTERCEPT_IT:
                MOV     BUSY_FLAG,1     ;Ignore any other calls
                MOV     FUNCTION_ID,AX  ;Save the function ident.
                MOV     BIOS_IO_COUNT,0
                CLI
                CALL    CS:OLDINT21     ;Do the DOS function
                STI                     ;Reenable interrupts
                PUSHF                   ;Save DOS result flags
                PUSH    AX              ;Save these registers
                PUSH    BX
                PUSH    CX
                PUSH    DX
                PUSH    SI
                PUSH    DI
                PUSH    DS
                PUSH    ES
                JNC     CHECK_FUNCTION  ;If no error, continue
                JMP     POP_RET         ;Otherwise just return
CHECK_FUNCTION:
                MOV     CX,FUNCTION_ID
                SUB     CH,0FH          ;Is it 0Fh?
                JZ      READ_FCB
                DEC     CH              ;Is it 10h?
                JZ      WRITE_FCB
                SUB     CH,4            ;Is it 14h?
                JZ      READ_FCB
                DEC     CH              ;Is it 15h?
                JZ      WRITE_FCB
                DEC     CH              ;Is it 16h?
                JZ      READ_FCB
                SUB     CH,0BH          ;Is it 21h?
                JZ      READ_FCB
                DEC     CH              ;Is it 22h?
                JZ      WRITE_FCB
                DEC     CH              ;Is it 23h?
                JZ      READ_FCB
                SUB     CH,4            ;Is it 27h?
                JZ      READ_FCB
                DEC     CH              ;Is it 28h?
                JZ      WRITE_FCB
                JMP     SHORT NOT_FCB_FUNCTN
READ_FCB:
                MOV     BX,14           ;Index for the read column
                JMP     SHORT INC_FCB_COUNT
WRITE_FCB:
                MOV     BX,16           ;Index for the write column
INC_FCB_COUNT:
                MOV     SI,OFFSET PARSE_FCB
                CALL    ENTER_FILENAME  ;Search file table for the file
                JC      JUMP_POP_RET    ;Quit if file not in table
                MOV     AX,BIOS_IO_COUNT;This many disk operations made
                ADD     CS:[SI][BX],AX  ;Add it to the indexed column
                ADD     CS:[SI+12],AX   ;Add it to the total
                JMP     POP_RET

; If it was not a FCB function, see if it was handle I/O

NOT_FCB_FUNCTN:
                SUB     CH,14H          ;Is it 3Ch?
                JE      NEW_HANDLE
                DEC     CH              ;Is it 3Dh?
                JE      NEW_HANDLE
                DEC     CH              ;Is it 3Eh?
                JE      WRITE_HANDLE
                DEC     CH              ;Is it 3Fh?
                JE      READ_HANDLE
                DEC     CH              ;Is it 40h?
                JE      WRITE_HANDLE
                SUB     CH,2            ;Is it 42h?
                JE      READ_HANDLE
                SUB     CH,2            ;Is it 44h?
                JE      IO_CONTROL
                JMP     POP_RET
NEW_HANDLE:
                CMP     AX,5            ;Is it a standard handle?
                JGE     GOOD_HANDLE     ;If not, then record it
JUMP_POP_NET:

                JMP     POP_RET         ;Jump to the return
READ_HANDLE:
                MOV     CX,14           ;Index for the read column
                JMP     SHORT INC_DEV_COUNT
IO_CONTROL:
                CMP     CL,2            ;Is it a read request?
                JE      READ_HANDLE     ;Treat it as a read
                CMP     CL,3            ;Is it a write request?
                JNE     JUMP_POP_RET    ;If not read or write, ignore it
WRITE_HANDLE:
                MOV     CX,16           ;Index for the write column
INC_DEV_COUNT:
                CMP     BX,5            ;Is it a standard handle?
                JB      JUMP POP RET    ;If it is, then ignore it
                PUSH    CX              ;Put index on the stack

; Now search the handle table for the handle in BX.

                CALL    ADD_PSP         ;Add in the current PSP segment
                MOV     DI,HANDLE_TABLE ;Point to the handle table
                MOV     CX,NUM_HANDLES  ;Search the entire table
HANDLE_LOOP:
                CMP     BX,CS:[DI]      ;Is it a match?
                JE      HANDLE_MATCH    ;If it is, we've found it
                ADD     DI,4            ;If not, look at next entry
                LOOP    HANDLE_LOOP
                POP     BX              ;Restore the stack
                JMP     SHORT POP_RET   ;Return if handle was not found

; If the handle is being closed, then the entry is deleted.
```

continues . . .

RECORDER.ASM: *The assembly language source code for RECORDER.COM*

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A

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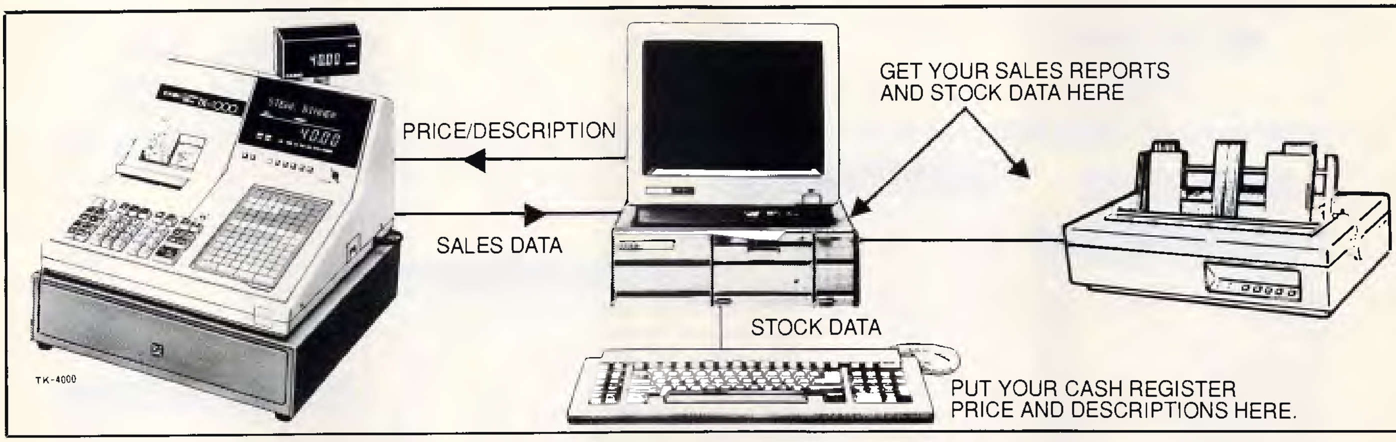

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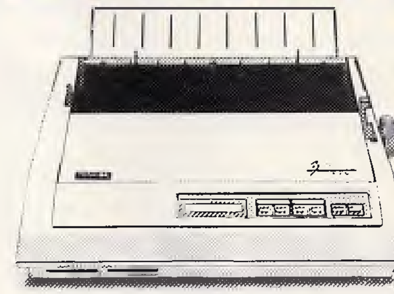

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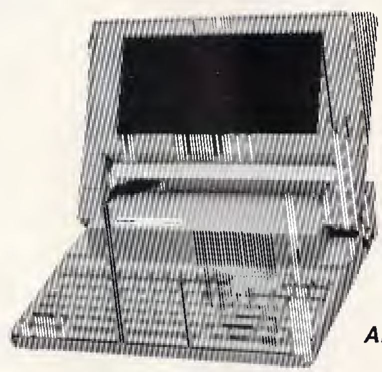

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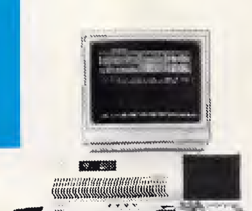

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```
HANDLE_MATCH:
        CMP     BYTE PTR FUNCTION_ID+1,3EH ;Closing this file?
        JNE     NOT_CLOSE
        MOV     WORD PTR CS:[DI],0
NOT_CLOSE:
        MOV     DI,CS:[DI+2]      ;Get pointer to file table entry
        POP     BX                ;Get the index back
        MOV     AX,BIOS_IO_COUNT  ;Get the sector count
        ADD     CS:[DI][BX],AX    ;Add it to selected column
        ADD     CS:[DI+12],AX     ;And also to the total column
        JMP     SHORT POP_RET
GOOD_HANDLE:
        MOV     CURRENT_HANDLE,AX        ;Save the handle
        MOV     SI,OFFSET PARSE_STRING   ;Point to parse routine
        CALL    ENTER_FILENAME    ;Add the file to the table
        JC      JUMP_POP_RET      ;If table is full, return
        MOV     AX,BIOS_IO_COUNT;Get number of sectors
        ADD     DS:[SI+12],AX     ;Add to the total column
        ADD     DS:[SI+14],AX     ;Add to the read column

; Now enter this new handle to the handle table

        MOV     DI,LAST_HANDLE    ;Get location of last entry
        ADD     DI,4              ;Advance it one position
        CMP     DI,HANDLE_TABLE+NUM_HANDLES*4
        JNE     KEEP_GOING
        MOV     DI,HANDLE_TABLE
KEEP_GOING:
        MOV     LAST_HANDLE,DI     ;Now this is the last handle
        MOV     BX,CURRENT_HANDLE ;Get handle back

        CALL    ADD_PSP           ;Add in the current PSP segment
        MOV     CS:[DI],BX        ;Store the handle
        MOV     CS:[DI+2],SI      ;Store location in file table
POP_RET:
        MOV     CS:BUSY_FLAG,0    ;Not busy any more
        POP     ES                ;Restore all registers
        POP     DS
        POP     DI
        POP     SI
        POP     DX
        POP     CX
        POP     BX
        POP     AX
        POPF                      ;Recover DOS result flags
        STI                       ;Return with interrupts on
        RET     2                 ;Return with these flags
NEWINT21        ENDP

;------------------------------------------------------------------------
; ENTER_FILENAME adds the file at DS:DX to the table.
; It returns with DS:SI pointing to the entry.  If CF=1, then the name
; was not in the table and no more entries could be added.
;------------------------------------------------------------------------

        ASSUME  DS:NOTHING, ES:CSEG
ENTER_FILENAME  PROC    NEAR
        CLD                       ;String moves forward
        PUSH    CS                ;Set up the ES register
        POP     ES

        MOV     DI,OFFSET CURRENT_FILE
        MOV     AL," "            ;Fill with blanks
        MOV     CX,11             ;11 letters in name
        REP     STOSB

        CALL    SI                ;Call the parse routine

; Now search the file table for the current filename
        CLD
        PUSH    CS
        POP     DS                ;Set DS to this segment
        ASSUME  DS:CSEG
        MOV     CX,NUM_FILES      ;Try all entries
        MOV     SI,FILE_TABLE     ;Setup for a string compare
SEARCH_LOOP:
        MOV     DI,OFFSET CURRENT_FILE
        PUSH    CX                ;Save the loop counter
        PUSH    SI                ;Save the source also
        MOV     CX,11             ;Compare 11 characters
        REPE    CMPSB             ;Do they all match?
        POP     SI
        POP     AX                ;Recover loop counter
        JCXZ    CLEAR_RETURN      ;If matched, return CF=0
        ADD     SI,ENTRY_SIZE     ;Point to next name in table
        MOV     CX,AX             ;Get loop counter back to CX
        LOOP    SEARCH_LOOP
        MOV     DI,LAST_FILE      ;Get location of last entry
        CMP     DI,-1             ;Is table saturated?
        JE      TABLE_FULL        ;If yes, then return

        MOV     CX,NUM_FILES      ;Loop through file table
FIND_OLDEST:

        ADD     DI,ENTRY_SIZE     ;Point to next entry in table
        CMP     DI,FILE_TABLE_END
        JB      NO_WRAP
        MOV     DI,FILE_TABLE
NO_WRAP:
        MOV     AX,[DI+12]        ;Get total for this record
        CMP     AX,1              ;Is it less than one?
        JBE     FOUND_OLDEST      ;If it is, then we'll use it
        LOOP    FIND_OLDEST       ;Search entire table for a space
        MOV     LAST_FILE,-1      ;If none found, table is full
TABLE_FULL:
        STC                       ;Carry flag indicates table full
        RET

; At this point ES:DI points to newest table entry

FOUND_OLDEST:
        MOV     LAST_FILE,DI
        PUSH    DI
        CLD                       ;String moves forward
        MOV     SI,OFFSET CURRENT_FILE
        MOV     CX,11             ;Copy the filename to table
        REP     MOVSB             ;Move the string in
        XOR     AX,AX
        INC     DI                ;Point to the totals column
        STOSW                     ;Set total column to zero
        STOSW                     ;Set open column to zero
        STOSW                     ;Set read column to zero
        STOSW                     ;Set write column to zero
        STOSW
        POP     SI
CLEAR_RETURN:
        CLC                       ;Indicates sucessful return
        RET
ENTER_FILENAME  ENDP

;------------------------------------------------------------------------
; This subroutine parses a filename from the FCB at DS:DX
;------------------------------------------------------------------------
        ASSUME  DS:NOTHING, ES:CSEG
PARSE_FCB       PROC    NEAR
        INC     DX                ;Point to filename in FCB
        MOV     SI,DX             ;Get address in index register
        ADD     SI,8              ;Point to file extension
        MOV     DI,OFFSET CURRENT_FILE+8 ;DI Points to extension
        MOV     CX,3
COPY_EXT_1:
        LODSB                     ;Get a letter of the extension
        CALL    UPPER_CASE        ;Make it upper case
        STOSB                     ;Store it in current file
        LOOP    COPY_EXT_1
        SUB     SI,3
        JMP     SHORT COPY_NAME ;Finish copying the name
        RET
PARSE_FCB       ENDP

;------------------------------------------------------------------------
;This routine parses an ASCII filename from DS:DX and places it at
; CURRENT_FILE
;------------------------------------------------------------------------
PARSE_STRING    PROC    NEAR

        ASSUME  DS:NOTHING, ES:CSEG
        MOV     SI,DX             ;Get address in index register
LOOK_FOR_DOT:
        LODSB                     ;Next letter of name
        OR      AL,AL             ;Is it the last letter
        JZ      COPY_NAME1 ;If yes, begin to copy the name
        CMP     AL,"."            ;Is this the dot?
        JNE     LOOK_FOR_DOT
GOT_THE_DOT:
        PUSH    SI                ;Now SI points to the extension
        MOV     DI,OFFSET CURRENT_FILE+8 ;DI points to extension
        MOV     CX,3
COPY_EXTENSION:
        LODSB                     ;Next letter of the extension
        OR      AL,AL             ;Is it the last letter?
        JZ      END_COPY
        CALL    UPPER_CASE        ;Convert letter to upper case
        STOSB                     ;And store it
        LOOP    COPY_EXTENSION
END_COPY:
        POP     SI                ;Recover location of name
COPY_NAME1:
        DEC     SI
COPY_NAME:
        DEC     SI
        STD                       ;Copy name right to left
        MOV     CX,8              ;Eight letters in filename
        MOV     DI,OFFSET CURRENT_FILE+7 ;Point to end of name
NAME_LOOP:
        CMP     SI,DX             ;At start of name yet?
        JB      PARSE_DONE        ;If yes, then quit copying
        LODSB                     ;Get letter of name
        CMP     AL,"\"            ;At path specification?
        JE      PARSE_DONE        ;If yes, then quit copying
        CMP     AL,"/"            ;At path specification?
        JE      PARSE_DONE        ;If yes, then quit copying
        CMP     AL,":"            ;At drive specification?
        JE      PARSE_DONE        ;If yes, then quit copying
        CMP     AL," "            ;Is this letter a space?
        JE      SKIP_SPACE        ;Don't copy any spaces
        CALL    UPPER_CASE        ;Convert letters to upper case
        STOSB                     ;Store the letter
SKIP_SPACE:
        CMP     SI,0FFFFH         ;Did SI wrap around segment?
        JE      PARSE_DONE        ;If yes, then quit copying
        LOOP    NAME_LOOP ;Loop through entire name
PARSE_DONE:
        RET                       ;Done parsing the name
PARSE_STRING    ENDP

;------------------------------------------------------------------------
; This subroutine converts the letter in AL to upper case.
;------------------------------------------------------------------------
UPPER_CASE      PROC    NEAR
        ASSUME  DS:NOTHING, ES:NOTHING
        CMP     AL,"a"            ;Is it lower case?
        JB      NO_CHANGE         ;If not, don't change it
        CMP     AL,"z"            ;Is it a letter?
        JA      NO_CHANGE         ;If not, don't change it
        AND     AL,11011111B      ;This convert to upper case
NO_CHANGE:
        RET
UPPER_CASE      ENDP
```

continues . . .

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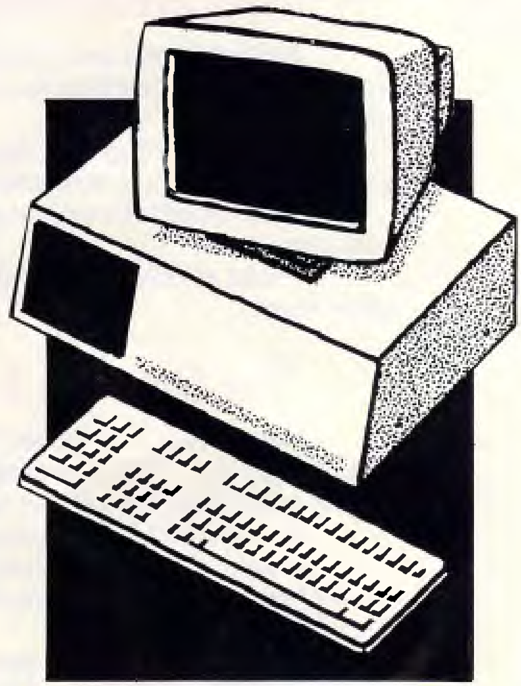

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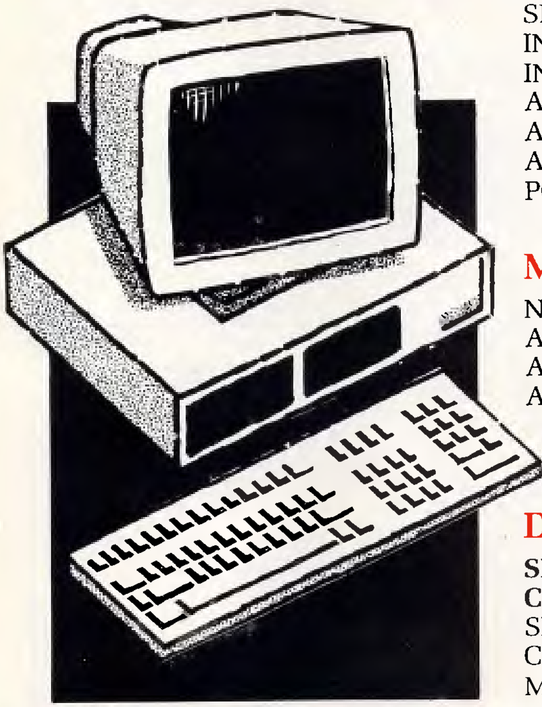

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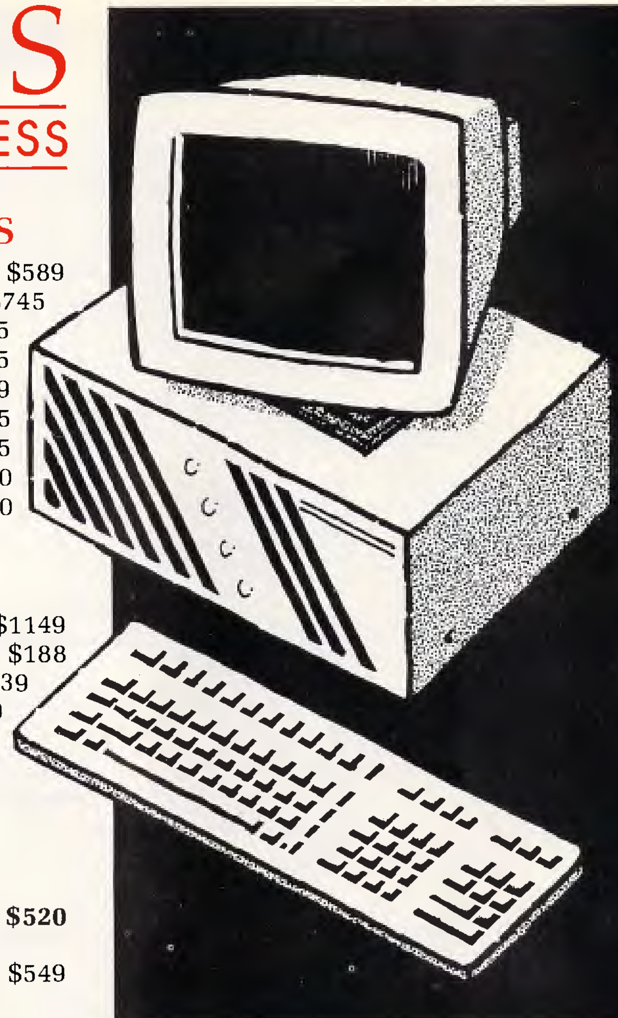

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```
;--------------------------------------------------------------------------
; This subroutine adds the current PSP segment address to the handle
; in BX.  This creates a unique number for each open handle.
;--------------------------------------------------------------------------

ADD_PSP         PROC    NEAR
                ASSUME  DS:NOTHING, ES:NOTHING
                PUSH    BX                      ;Save the starting handle
                MOV     AH,51H                  ;Get current PSP
                INT     21H
                POP     AX                      ;Get back starting handle
                ADD     BX,AX                   ;And add it to the PSP
                RET
ADD_PSP         ENDP

;--------------------------------------------------------------------------
; This subroutine zeros out the file and handle tables.
; on entry DS points to the tables segment.
;--------------------------------------------------------------------------

RESET_TABLE     PROC    NEAR
                ASSUME  DS:NOTHING, ES:NOTHING
                PUSH    DS
                POP     ES
                MOV     DI,FILE_TABLE
                MOV     CX,DS:NUM_FILES
                XOR     AX,AX
ZERO_FILES:
                STOSW                           ;Erase the old filename
                ADD     DI,10
                STOSW                           ;Zero the total count
                ADD     DI,ENTRY_SIZE-14
                LOOP    ZERO_FILES
                MOV     DI,HANDLE_TABLE ;Point to the handle table
                MOV     CX,NUM_HANDLES  ;Number of entries in it.
ZERO_HANDLES:
                XOR     AX,AX
                STOSW
                MOV     AX,FILE_TABLE
                STOSW
                LOOP    ZERO_HANDLES    ;Zero the handle table entries
                MOV     LAST_FILE,FILE_TABLE
                MOV     LAST_HANDLE,HANDLE_TABLE
                RET
RESET_TABLE     ENDP

;--------------------------------------------------------------------------
; To install, store existing interrupt vectors and replace them with the
; new ones.  Then exit and remain resident.
;--------------------------------------------------------------------------

INSTALL:
                ASSUME  CS:CSEG, DS:CSEG, ES:NOTHING
                CALL    LOAD_PARAMS
                JCXZ    NO_DIGITS
                XOR     AX,AX                   ;Clear AX for the total
GET_DIGIT:
                MOV     BL,DS:[SI]              ;Get next letter
                SUB     BL,30H                  ;Convert ascii to integer
                JC      NOT_A_DIGIT             ;Was it below a 0?
                CMP     BL,9                    ;Was it above a 9?
                JA      NOT_A_DIGIT             ;Ignore if not 0-9
                MOV     BH,10
                MUL     BH                      ;Times 10 for next digit
                XOR     BH,BH
                ADD     AX,BX                   ;Add in the new digit
NOT_A_DIGIT:
                INC     SI
                LOOP    GET_DIGIT               ;Look at all characters
                OR      AX,AX                   ;Did we get anything
                JZ      NO_DIGITS
                CMP     AX,2000                 ;Above the upper limit?
                JBE     SIZE_OK
                MOV     AX,2000
SIZE_OK:
                MOV     NUM_FILES,AX
NO_DIGITS:
                MOV     AX,3513H                ;Get BIOS disk I/O vector
                INT     21H
                MOV     WORD PTR [OLDINT13]  ,BX
                MOV     WORD PTR [OLDINT13+2],ES
                MOV     DX, OFFSET NEWINT13
                MOV     AX, 2513H

                INT     21H                     ;DOS function to change vector
                MOV     AX,3521H                ;Get DOS function vector
                INT     21H
                MOV     WORD PTR [OLDINT21]  ,BX
                MOV     WORD PTR [OLDINT21+2],ES
                MOV     DX, OFFSET NEWINT21
                MOV     AX, 2521H
                INT     21H                     ;DOS function to change vector

;--------------------------------------------------------------------------
; Deallacote our copy of the enviornment.
; Exit using INT 27H. Leave code and space for the tables resident.
;--------------------------------------------------------------------------

                CALL    RESET_TABLE             ;Clear out the file table
                MOV     AX,DS:[002CH]           ;Get segment of enviornment
                MOV     ES,AX                   ;Put it into ES
                MOV     AH,49H                  ;Release enviornment segment
                INT     21H
                MOV     AX,NUM_FILES            ;Get number of files
                MOV     BX,ENTRY_SIZE           ;Times size of each entry
                MUL     BX
                ADD     AX,FILE_TABLE           ;Add in beginning of table
                MOV     FILE_TABLE_END,AX
                ADD     AX,15
                MOV     CL,4
                SHR     AX,CL
                MOV     DX,AX                   ;Leave this much resident
                MOV     AX,3100H
                INT     21H                     ;Terminate and stay resident

;--------------------------------------------------------------------------
; Here is the code used to initialize RECORDER.COM.  First determine
; if RECORDER is already installed.
;--------------------------------------------------------------------------

                ASSUME  CS:CSEG, DS:CSEG, ES:NOTHING
EVEN                                            ;Align to an even byte boundry
INITIALIZE:
                ASSUME  DS:CSEG, ES:NOTHING
                MOV     DX,OFFSET COPYRIGHT
                CALL    STRING_CRLF             ;Display the string

; Search for a previously installed copy of RECORDER

                NOT     WORD PTR START  ;Modify to avoid false match
                XOR     BX,BX                   ;Start search at segment zero
                MOV     AX,CS                   ;Compare to this code segment
NEXT_SEGMENT:
                INC     BX                      ;Look at next segment
                CMP     AX,BX                   ;Until reaching this segment
                MOV     ES,BX
                JNE     NOT_FOUND
                JMP     INSTALL
NOT_FOUND:
                MOV     SI,OFFSET START ;Setup to compare strings
                MOV     DI,SI
                MOV     CX,16                   ;16 bytes must match
                REP     CMPSB                   ;Compare DS:SI to ES:DI
                OR      CX,CX
                JNZ     NEXT_SEGMENT            ;If no match, try next segment

; When all 16 bytes match, an installed copy already exists and
; ES points to resident code segment. Display the file table

                PUSH    ES
                POP     DS                      ;DS also points to table
                ASSUME  DS:NOTHING, ES:NOTHING

                MOV     DI,FILE_TABLE   ;Point to the table
                MOV     CX,DS:NUM_FILES ;Number of entries in table
ZERO_LOOP:
                MOV     BYTE PTR [DI+11],0 ;zero the displayed byte
                ADD     DI,ENTRY_SIZE   ;Move to next entry
                LOOP    ZERO_LOOP       ;Do entire table

                CALL    NEW_LINE
                MOV     DX,OFFSET HEADER;Point to header text
                CALL    STRING_CRLF     ;Display the string
                MOV     CX,DS:NUM_FILES ;Number of entries in table
FILE_LOOP:
                PUSH    CX
                MOV     DI,FILE_TABLE   ;Point to the table
                XOR     AX,AX
                MOV     CX,DS:NUM_FILES ;Number of entries in table
FIND_BIGGEST:
                CMP     [DI+12],AX
                JBE     NOT_BIGGER
                CMP     BYTE PTR [DI+11],0
                JNE     NOT_BIGGER
                MOV     SI,DI
                MOV     AX,[DI+12]
NOT_BIGGER:
                ADD     DI,ENTRY_SIZE
                LOOP    FIND_BIGGEST

                CMP     BYTE PTR [SI+11],1
                JE      LAST_ONE
                MOV     BYTE PTR [SI+11],1
                MOV     DX,SI
                ADD     SI,12
                CMP     WORD PTR [SI],0
                JZ      LAST_ONE
                MOV     AH,40H
                MOV     BX,1
                MOV     CX,8                    ;8 letters in name
                INT     21H
                PUSH    DX
                MOV     AL,"."                  ;Display a dot
                CALL    DISPLAY_CHAR
                POP     DX
                ADD     DX,8                    ;Now point to extension
                MOV     AH,40H
                MOV     CX,3                    ;3 letters in extension
                INT     21H
                LODSW
                PUSH    AX                      ;Save the total
                CALL    NUMBER_OUT              ;Display the totals column
                LODSW
                CALL    NUMBER_OUT
                LODSW
                CALL    NUMBER_OUT
                LODSW
                CALL    NUMBER_OUT
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MODEMS

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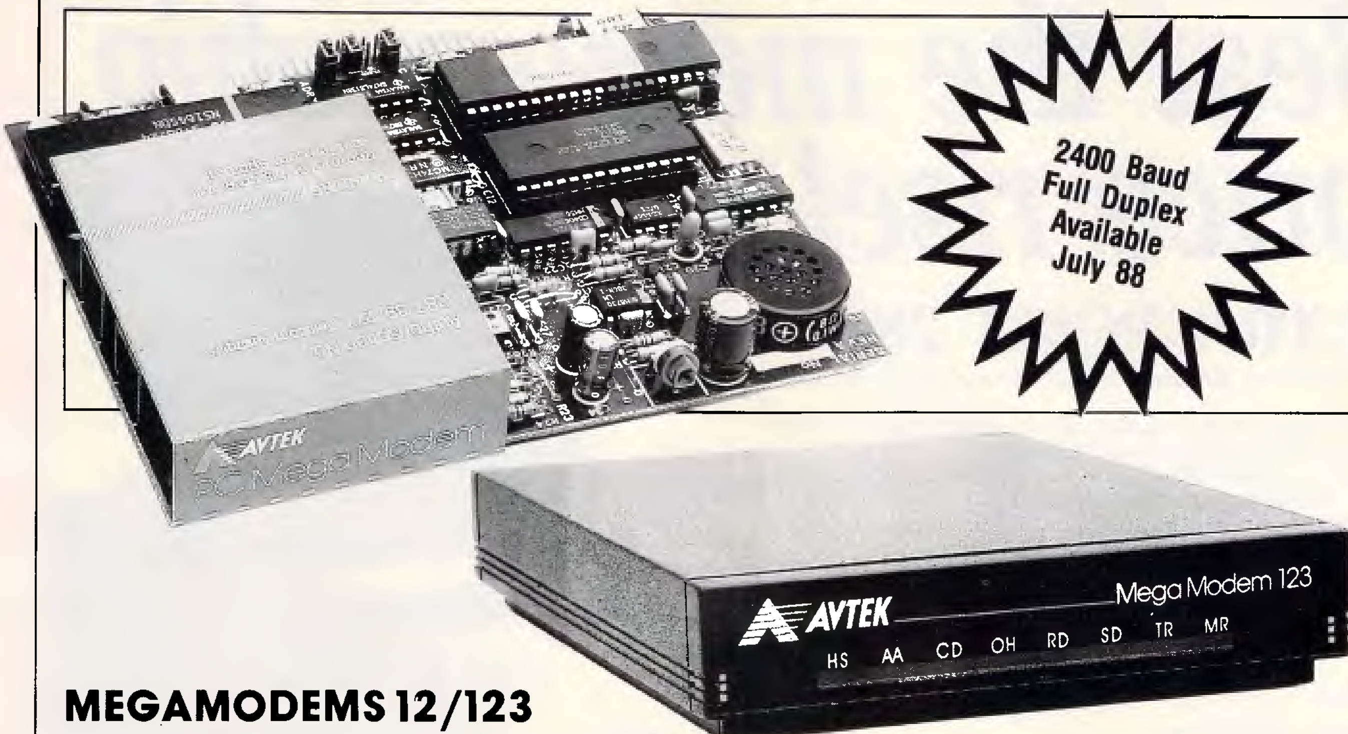

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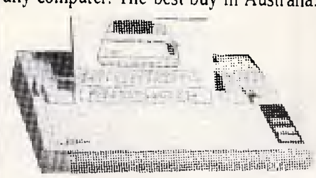

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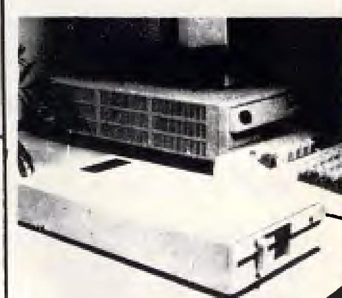

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```
                CALL    NEW_LINE
                POP     AX              ;Recover the total count
                POP     CX
                LOOP    FILE_LOOP
                CMP     AX,2            ;Was the last total less than 2?
                JB      LAST_ONE        ;If yes, table is not full yet.
                CALL    NEW_LINE
                MOV     DX,OFFSET FULL_MESS
                CALL    STRING_CRLF     ;Display the string
LAST_ONE:
                CALL    LOAD_PARAMS
                JCXZ    NO_PARAMS
SCAN_PARAMS:
                MOV     AL,CS:[SI]
                OR      AL,32           ;Convert it to lower case
                CMP     AL,"r"          ;Is it the R parameter?
                JE      SLASH_R         ;If yes, then reset the table
                INC     SI
                LOOP    SCAN_PARAMS     ;Look at all parameters
NO_PARAMS:
                MOV     AX,4C00H
                INT     21H
SLASH_R:
                CALL    RESET_TABLE
                JMP     NO_PARAMS

;----------------------------------------------------------------------
; NUMBER_OUT Outputs the number in AX to the standard output device
;----------------------------------------------------------------------
NUMBER_OUT      PROC    NEAR
                PUSH    AX              ;Save the number
                MOV     AL," "          ;Send a space
                CALL    DISPLAY_CHAR    ;Write the character
                MOV     AL," "          ;Send another space
                CALL    DISPLAY_CHAR    ;Write the character
                POP     AX
                XOR     CX,CX           ;Indicates no digit yet

                MOV     BX,10000        ;Get 10000's digit

                CALL    DIVIDE_OUT      ;Display it
                MOV     BX,1000         ;Get 1000's digit
                CALL    DIVIDE_OUT      ;Display it
                MOV     BX,100          ;Get 100's digit
                CALL    DIVIDE_OUT      ;Display it
                MOV     BX,10           ;Get 10's digit
                CALL    DIVIDE_OUT      ;Display it

                ADD     AL,30H          ;Get 1's digit
                CALL    DISPLAY_CHAR    ;Display the last character
                RET
NUMBER_OUT      ENDP

;----------------------------------------------------------------------
; This divides AX by BX and displays the result. Remainder is in AX.
;----------------------------------------------------------------------
DIVIDE_OUT      PROC    NEAR
                XOR     DX,DX
                DIV     BX              ;Divide to get this digit
                PUSH    DX              ;Save the remainder
                OR      CX,AX
                OR      CX,CX           ;Any digits yet?
                JNZ     NOT_A_SPACE
                MOV     AL," "-30H
NOT_A_SPACE:
                ADD     AL,30H          ;Convert it to ASCII
                PUSH    CX
                CALL    DISPLAY_CHAR    ;Write the character
                POP     CX
                POP     AX              ;Get the remainder back
                RET
DIVIDE_OUT      ENDP

;----------------------------------------------------------------------
; DISPLAY_CHAR outputs the character in AL to the standard output device
;----------------------------------------------------------------------
DISPLAY_CHAR    PROC    NEAR
                MOV     DL,AL           ;Get the character into DL
                MOV     AH,02           ;DOS string output function
                INT     21H
                RET
DISPLAY_CHAR    ENDP

;----------------------------------------------------------------------
; STRING_CR displays a string followed by a CR and LF
; Entry point NEW_LINE displays only the CR and LF
;----------------------------------------------------------------------
STRING_CRLF     PROC    NEAR
                MOV     AH,9            ;Display string function
                INT     21H
NEW_LINE:
                MOV     AL,13           ;The carriage return
                CALL    DISPLAY_CHAR    ;Send it
                MOV     AL,10           ;The line feed
                CALL    DISPLAY_CHAR    ;Send it
                RET
STRING_CRLF     ENDP

;----------------------------------------------------------------------
; This subroutine sets DI to the command line and CX to the byte count
;----------------------------------------------------------------------
LOAD_PARAMS     PROC    NEAR
                MOV     SI,80H          ;Point to parameter area
                MOV     CL,CS:[SI]      ;Get number of chars into CL
                XOR     CH,CH           ;Make it a word
                INC     SI              ;Point to first character
                CLD                     ;String searchs forward
                RET
LOAD_PARAMS     ENDP

CSEG            ENDS
                END     START
```

Ends

load up RECORDER with the following command:

RECORDER [*n*] [/R]

The optional *n* parameter is used to specify the maximum number of filenames RECORDER will hold in its table. The default value, 200, is enough to handle a normal day's work, but you can increase the table size to a maximum of 2000 filenames, if necessary. Each additional entry requires 20 more bytes of RAM. The optional /R switch resets the table if it becomes filled. When you reset the table, all entries are erased and recording starts all over again. The /R is always ignored on the initial installation.

Once RECORDER is in place you just proceed with your normal PC work. Each time a file is accessed, it will be entered appropriately in a table similar to that shown in Fig 1. You can view this table any time you're at the DOS prompt simply by entering RECORDER again.

The data contained in the file table will allow you to optimise your disk operations. You'll notice straight away, for example, that batch files generate a lot of disk activity. When DOS runs a batch file, it opens it, reads one line, closes it, then executes the line. This process is repeated until the entire file is processed. Since most batch files are small in size but disk-intensive in use, they're ideal candidates for placement on a RAMdisk.

Chances are your program data files will also be at the top of RECORDER's list. It's a common practice to put them on the RAMdisk, as well. If you use this technique, however, you must be extra careful to copy these files back to your hard disk at reasonably frequent intervals and especially at the end of a session. Everything in RAM — including everything on a RAMdisk — disappears as soon as the machine is turned off or rebooted. If the system should crash with your latest masterpiece on the RAMdisk alone, you'll wish you'd never heard of such 'time savers' as RAMdisks.

Interpreting the table

The operating system assigns a series of numbered clusters to each file it stores. Each cluster is made up of one or more smaller units known as sectors. The sectors are the smallest unit of storage found on the disk. Sectors are arranged in groups called tracks, each track forming a ring. When a file is read, DOS figures out which sectors are needed and requests them from the disk controller. Each request requires the controller to position the head over the selected track. One request can read from one up to an entire track's worth of sectors. When the required sectors are scattered about on many tracks, multiple requests must be issued. The time required to complete the data transfer is largely a function of the number of individual requests made.

The numbers in the file table columns represent how many read or write requests were made to the device's controller. Every file that has been used since RECORDER was installed is listed. The read column is used each time a file is created, opened, or read from. The write column is used when a file is written to or closed.

The EXEC column is a little different. It shows the number of times a program was executed. Depending on its size, running a .COM or an .EXE program may require more than one actual disk access, though RECORDER increments the EXEC column by one regardless of the file size. The totals column is simply the sum of the other three.

You'll notice the filenames listed lack any drive and path designation. To keep RECORDER simple, all files with the

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CSS: Fast hierarchical menus; the entire user interface is optimised to limit the number of keystrokes necessary to perform an analysis; fast selection of individual variables or lists of variables; previous variable selections are "remembered" (and can be edited) across consecutive analyses; batch processing is also supported.	**SPSS/pc+:** Command language; some commands are several lines long (in case of a typo, e.g., a misspelled variable label, the entire command has to be re-typed): commands can also be submitted via batch files.
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CSS: Yes (on line selection of cases via "include if" or "exclude if" selection conditions that remain in effect for the entire CSS session or until cancelled; the selection conditions can be saved for repeated use)	**SPSS/pc+:** Yes (via logical "select if" conditions
SCREEN DISPLAY OF OUTPUT	
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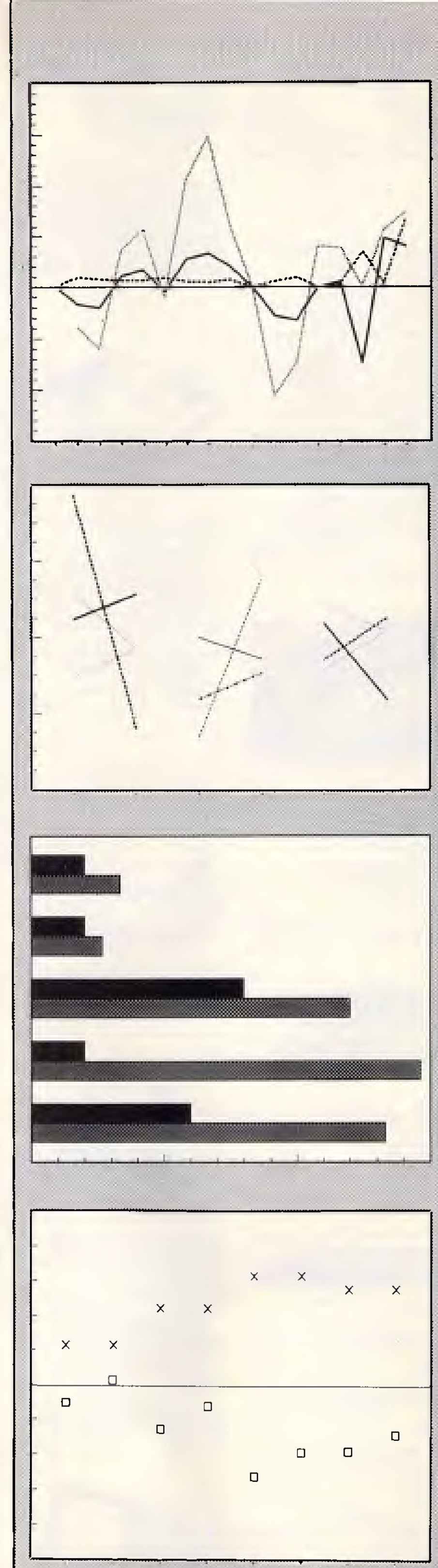
SUBMITTING OUTPUT FROM ONE ANALYSIS AS INPUT FOR ANOTHER	
CSS: In addition to matrices (corr., cov., etc.) and scores that are calculated for each case (e.g., residuals, factor scores), all other numbers generated with CSS analyses can be converted into the CSS data file format.	**SPSS/pc+:** Only matrices (corr., cov., etc.) and scores that are calculated for each case (e.g., residuals)



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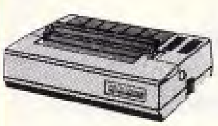

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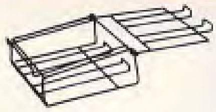

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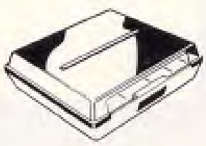

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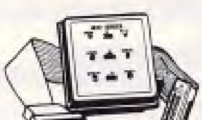

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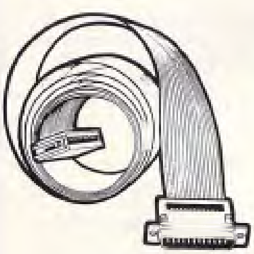
$2.50/m **$1.95/m**

CIC12 12 conductor computer interface cable. Colour coded with mylar shielding. 12 x 7/0.16mm.
1-9 metres 10+ metres
$2.70/m **$2.50/m**

CIC16 16 conductor computer interface cable. Colour coded with mylar shielding. 16 x 7/0.16mm.
1-9 metres 10+ metres
$3.90/m **$3.40/m**

CIC25 25 conductor computer interface cable. Colour coded with mylar shielding. 25 x 7/0.16mm.
1-9 metres 10+ metres
$4.90/m **$4.40/m**



5 1/4" FLOPPY DISK DRIVE EXTENSION CABLE

- IBM* compatible
- DB37 Male to 34 way edge connector
- Length 0·5 metres

P19045 .... $99.95

3 1/2" FLOPPY DISK DRIVE EXTENSION CABLE

- IBM* compatible
- DB37 Male to 34 IDC connector
- Length 0·5 metres

P19046 .... $99.95

36 WAY CENTRONICS CABLES

- Male to male connections.
- All 36 pins wired straight through.

P19042 2 metre $19.95
P19040 6 metre $29.95

PRINTER LEAD FOR IBM*

- Suits IBM* PC XT and compatibles
- 25 pin D" plug (computer end) to Centronics 36 pin plug

Cat.P19029 1.8 metres . $14.95
Cat.P19030 3 metres . $19.95

2 & 4 WAY RS232 DATA TRANSFER SWITCHES

If you have two or four compatible devices that need to share a third or fifth, then these inexpensive data transfer switches will save you the time and hassle of constantly changing cables and leads around.

- No power required
- Speed and code transparent
- Two/Four position rotary switch on front panel
- Three/Five interface connections on rear panel
- Switch comes standard with female connector

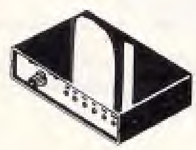
2 WAY Cat.X19120 only $59
4 WAY Cat.X19125 only $99

2 & 4 WAY CENTRONICS DATA TRANSFER SWITCHES

Save time and hassles of constantly changing cables and leads around with these inexpensive data transfer switches. These data switches support the 36 pin centronic interface used by Centronics, Printronics, Data Products, Epson, Micronics, Star, and many other printer manufacturers.

- No power required
- Speed and code transparent
- Two/Four position rotary switch on front panel
- Three/Five interface connections on rear panel
- Switch comes standard with female connector
- Bale locks are standard

2 WAY (X19130) ...... only $59
4 WAY (X19135) ...... only $99



RS232 DATA SWITCH WITH TESTER

- No power required
- Ideal for 1 computer to 2 peripherals or 2 computers to one peripheral.
- 25 pin RS232 "D" connectors,
- Six dual coloured LED indicators showing certain flow status:

T.D. Transmit Data
R.D. Receive Data
R.T.S. Request To Send
C.T.S. Slear To Send
D.S.R. Data Set Ready
D.T.R. Data Terminal Ready

- Size: 200(W) x 68(H) x 150(D)mm

Cat.X19110 .... R.R.P. $169
Our Price $149

CPF CONTINUOUS POWER FILTER SPIKE ARRESTOR

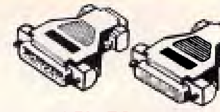
The Fortron CPF Filtered Electronic Spike Protector provides a protective electronic barrier for microcomputers, printers, telephone systems and modems electronic typewriters, audio and stereo systems and other sensitive electronic equipment.

The CPF provides protection from dangerous electrical spikes that cen cause anything from obvious damage (like immediate equipment failure) to less obvious harm that can drastically shorten a system's life.

CPF's superior circuitry design and semi conductor technology responds instantly to any potentially damaging over-voltage, ensuring safe trouble free operation.

Additionally, CPF's filtering capability helps eliminate troublesome and annoying interference, general hash created by small motors, fluorescent lamps, and the like that threaten the performance and shorten equipment life of unprotected electronic components.

SPECIFICATIONS:
Electrical rating: 220-260 volts (AC) 50Hz 10 Amp
Spike/RFI Protection: 4,500 amps for 20m/second pulses.
Maximum clamping voltage: 275V differential mode.
Cat.X10088 .... $69.95



9 PIN TO 25 PIN CONNECTOR ADAPTORS

NEW! The ideal solution! Features gold plated pins.
X15668: DB9 Plug to DB25 Socket
X15669: DB9 Socket to DB25 Plug
.... each $10.95

NEW!

U.S. TO AUSTRALIAN TELEPHONE ADAPTOR

- Australian plug to U.S. socket

Y16008 .... $8.95

UV EPROM ERASER

Erase your EPROMs quickly and safely. This unit is the cost effective solution to your problems. It will erase up to 9 x 24 pin devices in complete safety, in about 40 minutes (less for less chips). High UV intensity at chip surface ensures EPROMS are thoroughly erased. (Dimensions 217 x 80 x 68mm)

WITHOUT TIMER
Cat. X14950 .... Normally $97
Special, $79

WITH BUILT-IN TIMER
Cat. X14955 .... $139
Special, $99

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COPY HOLDER (YU-H32)

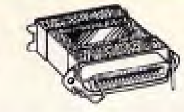
- Adjustable arms allows easy positioning.
- Copy area 9 1/2" x 11"
- Sliding line guide
- Clamp mounting

C21062 .... $39.95

COPY HOLDER (YU-H33)

- Copy area 9 1/2" x 11"
- Sliding line guide
- Fiat metal base

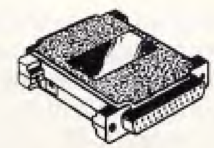
C21060 .... $39.95



CENTRONICS GENDER CHANGERS

- Female to Female
- Saves modifying or replacing non-mating Centronics cables.
- All 36 pins wired straight through.

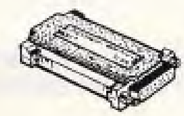
Cat. X15663 **Male to Male**
Cat. X15661 **Male to Female**
Cat. X15664 **Female to Female**
Normally $33.95,
Only $24.95



RS232 GENDER CHANGERS

- Saves modifying or replacing non-mating RS232 cables.
- All 25 pins wired straight through

Cat. X15650 **Male to Male**
Cat. X15651 **Male to Female**
Cat. X15652 **Female to Female**
Normally $14.95 each
Only $9.95



DB15 GENDER CHANGERS

- Saves modifying or replacing non mating DB15 connections
- All 15 pins wired straight through

X15645: Male to male
X15646: Male to Female
X15647: Female to Female
.... only $14.95

DB9 GENDER CHANGERS

- Saves modifying or replacing non mating DB9 connections
- All 9 pins wired straight through

X15640: Male to male
X15641: Male to Female
X15642: Female to Female
.... only $14.95

RS232 WIRING ADAPTOR BOX

- Male to female
- 25 Detachable plug on leads
- 2 mini jumpers
- Ideal for experimenting or temporary connections

Cat. X15665 ...... **Normally $49.95**
Only $44.95

SAVE $7

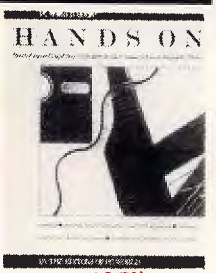
RS232 MINI TESTER

- Male to female connections
- All pin wired straight through
- Dual colour LED indicates activity and direction on 7 lines
- No batteries or power required

T.D. Transmit Data
D.S.R. Data Sat Ready
R.D. Receive Data
C.D. Carrier Detect
R.T.S. Request to Send
D.T.R. Data Terminal Ready
C.T.S. Clear to Send

Cat. X15656 ...... **Normally $39.95**
SPECIAL, ONLY $32.95

BOOKS



HANDS ON

Practical tips and useful programs for IBM PC's from the editors of PC World

A collection of the best tips, programs, and routines for IBM computers from the popular "Hands on" and "." columns. Covering both hardware and software, the book is organised so that you can quickly find information on virtually everything you need to know.

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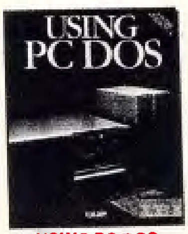

USING PC DOS

"Using PC DOS" is the only combination of a beginning tutorial, advanced guide, and lasting reference that gives you ultimate control over your PC's most important software: the operating system!

Beginners will learn how to...
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- Manage DOS directories
- Erase, rename, and copy files
- Print what appears on your screen
- Avoid disastrous errors

Advanced users will learn...
- Master path names
- Maneuvering through directories
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- Create AUTOEXEC.BAT files

Regardless of your level of expertise, you can use the Command Reference section to...
- Gain quick access to 63 most frequently used DOS commands
- Recognize valid DOS command phrasing
- Cope with frustrating DOS error messages

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UNDERSTANDING UNIX

-James R. Groff, Paul N. Weinberg

The exploding popularity of the UNIX operating system is one of the most important trends in computing in the 1980's. UNIX is available on hundreds of different computers, ranging from personal computers to mainframes and supercomputers. *Understanding UNIX* offers an overall perspective on UNIX, including a discussion of where UNIX fits in the worlds of computing, business, and education. Individual chapters address the UNIX structure, file system, multiuser capability, specific applications tools, and more.

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An introduction to the operating system, Basic programming, and applications.

-Larry Joel Goldstein

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GETTING STARTED WITH THE IBM* PC* AND XT*

-David Arnold

An authoritive guide from the PC World Library to using the PC* and its more powerful cousin, the XT*. If you're new to computing, you'll appreciate their tutorial approach, as you become familiar with keyboard, disks, and operating system (DOS 1-10 and 2-00). You'll learn to set up and handle electronic files, evaluate your software needs, and program in BASIC.

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-Dr. Marvin L. De Jong

- Teaches assembly language programming at the beginning level - no prior knowledge of 6502 assembly language needed.
- Directs you in hands-on-computer exercises and experiments, with both software and hardware.
- Enables you to interface the Apple II to outside devices, eg: a/d and d/e converters, timers, etc.
- Provides interfacing circuits and programs that can be used on the Apple II without modification.
- Enhances your power as a programmer in your use of the Apple II.
- Gives you a more general understanding of how microcomputers work than can be obtained by programming in BASIC or any other high level language.

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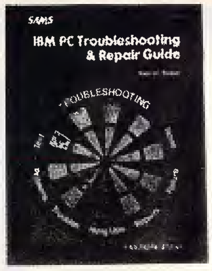

IBM PC TROUBLESHOOTING & REPAIR GUIDE

-Robert C. Brenner

Keep your IBM PC in top operating condition with this handy reference book. Inside you will find pages of schematics, photos and block diagrams to help you identify problems. Simple instructions tell you what's wrong and how to fix it fast.
- Make most repairs with few or no tools
- Quickly zero-in on a malfunctioning component
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- Pays for itself many times over in repair savings
- Easy to understand circuit diagrams.

The IBM PC Trouble Shooting and Repair Guide will make even the computer novice feel comfortable with the complex world of electronic trouble shooting. This fully illustrated book is recommended for anyone who uses an IBM PC.

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DISKS, FILES AND PRINTERS FOR THE APPLE II

-Brian D. Blackwood,
-George H. Blackwood

Learn how to create and use text files while running a computer program, and to make hard copies of the results on a printer. Covers Apple II, II+, IIe, and Franklin Microcomputers. You will discover:
- Using the system includes booting DOS master, initializing disk, backup disk, accessing the drives, verifying, saving programs, and loading programs.
- DOS commands enable you to operate the disk drives and printer from the keyboard and to change languages (Integer BASIC to Applesoft or vise versa).
- Sequential files include creating, updating, reading, extending, refining, and multisection.
- Random access files are faster and take less memory
- Executive files can be used to control a series of steps that do not require the operator to make keyboard inputs.
- Deficiancies of TAB and SPC can be overcome in 80 characters per line printers.

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INTRODUCTION TO BASIC

-Jeffrey B Morton

This book is lucidly written, and is in two parts. The first teaches BASIC, and the second consists of a dozen carefully constructed projects. These are wide-ranging and set the language into the context of solving real-world problems. Each project is laid out with a set of variables to give the reader insight into the practical applications of the language. Any version of BASIC can be used to solve the projects and the other excellent examples scattered throughout the book.

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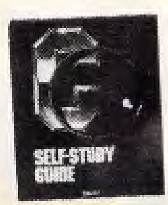

"C" SELF STUDY GUIDE

-Jack Purdum

Learn at your own pace as this self directed study guide takes you through the basics and into advanced areas of the C programming language. The unique format allows you to advance quickly or proceed slowly. The book is divided into two parts:

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Answers: that include many complete programs for testing new functions and for illustrating tips, traps, techniques and short cuts.

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CP/M PROGRAMMER'S ENCYCLOPEDIA

-Bruce Brigham

The CP/M Programmer's Encyclopedia is a time saving, comprehensive reference for serious CP/M users. Covering all the commands and syntaxes for CP/M 2.x and CP/M 3.0, this encyclopedia gives you the information you need in an easy-to-use format especially designed for programmers. The CP/M Programmer's Encyclopedia is the only major compilation of CP/M commands and syntaxes. If you use CP/M extensively, you should not be without this important reference guide.

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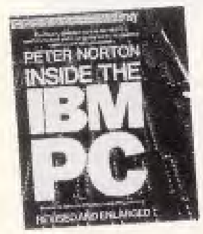

INSIDE THE IBM PC

(Revised and expanded edition)

-Peter Norton

The widely acclaimed guide to the IBM PC's inner workings. The latest edition now covers every model of the IBM micro: PC, XT and AT, and every version of DOS from 1.1 to 3.0

B20080 .... **$44.95**

HARD DISK MANAGEMENT

For IBM PC XT, AT & compatibles

-Thomas Cain and Nancy Woodard Cain

Now you can use a hard disk to its fullest advantage with this guide to managing your hardware using DOS, batch files, and menu systems. It introduces you to various disk management concepts you need to know, while providing step by step techniques for dealing with them. Key topis include partitioning, formatting, the TREE command, sub-directory usage, and file/memory capacity. It also offers extensive information about DOS along the way: how it fits in, and how hard it can't work for you.

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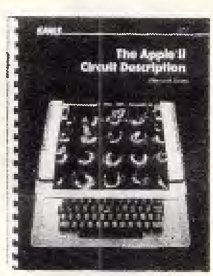

APPLE II CIRCUIT DESCRIPTION

-Winston D. Gayler

- Covers all Apple II motherboard and keyboard versions.
- Helps you learn about microcomputer hardware in general and Apple II hardware in detail.
- Provides you with accurate schematics and verified waveforms to rely on for servicing and repair.
- Explains the advanced concepts of daisy chains, interrupts, direct memory access, and the ready line.
- Gives you many valuable hints for successful interfacing.
- Contains tutorials on video signals, memory IC's and the 6502 microprocessor, as well as full explanations of advanced concepts.
- Each chapter contains an overview for the beginner and a detailed section for the more adventurous.
- Ideal for students, technicians, hobbyists, engineers, and others who need Apple II technical information.

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INTERFACING TO THE IBM PERSONAL COMPUTER

-Lewis C. Eggebrecht

This book describes the interfaces, resources, and functions of the Personal Computer. While not presenting specific interface designs or projects, it provides information and techniques that can be used in various projects.
- Describes the components of the Personal Computer.
- Examines the processor card and its functions.
- Reviews the 8088 microprocessor.
- Discusses fully the PC bus system, its signals, its timing, its characteristics.
- Examines the system interrupts and the modes of operation of its timers and counters.
- Looks at the PC memories and describes its methods of data transfer.
- Describes interface signal conditioning and some BASIC interfacing commands.

Essential reading for everyone who owns or uses an IBM PC!

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PASCAL PRIMER

-Mitchell Waite, David Fox

If you are learning programming or have dabbled in the popular language BASIC and wish to learn the capabilities of Pascal, this book is definitely written for you. Written and illustrated with a touch of humour, the informative text describes Pascal program structure, Pascal variables, Pascal procedures, and many other features. There are chapters on decision making statements, numeric functions, string functions, arrays and sets, and much more. The eight appendices present facts about the advantages and disadvantages of Pascal, components of a Pascal system, interfacing assembly language routines, and other useful information.

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1-2-3 TIPS, TRICKS & TRAPS

-Dick Anderson, Douglas Cobb

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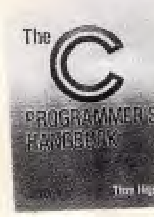

THE C PROGRAMMER'S HANDBOOK

-Thom Hogan

While other books will tell you how to learn C, this one shows you how to use it. It's a literal encyclopedia of the information you'll need to get it to work for you, efficiently and effectively. Handy and well organized, it gives you quick access to the things you need, when you need them, plus a clear definition of C language with examples and explanations of restrictions and defaults. You won't find an approach this understandable and objective anywhere else.

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-Steve Lambert

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-Patrick Plemmons

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B20090 .... **$34.95**

INSIDE MICROSOFT OS/2

-Gordon Letwin

A rare and exciting technical examination of the philosophy, key development issues, programming implications, and future of the MS OS/2 operating system. Gordon Letwin, Chief Architect for MS OS/2, provides a true behind the scenes view of the process of merging Microsoft's vision of an automated office system with the realities of software development. Here is revealing information every MS OS/2 programmer, as well as high tech and office automation specialists, will find invaluable.

Letwin discusses:
- The powerful graphics, true multitasking, hardware and software protection, and program "encapsulation" features that were incorporated into MS OS/2
- The restrictions of the microprocessor and the constraints of upward and downward MS DOS and MS OS/2 compatibility
- The software architectural details from a design and programming perspective
- Central issues for the future: a new MS OS/2 file system, a fully protected environment, and an enhanced network support.

This book will be a cornerstone book in the library of anyone interested in MS OS/2. You can't get a more "inside" view. (352 pages)

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- Manual
- 6 Months Warranty
- Dimensions: 360(W) x 175(H) x 405(D)mm

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WITH 20 M/BYTE HARD DISK **$2,595**
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IBM* compatible, plugs straight in to your computers bus connectors!

SPECIFICATIONS:	20 MB	30 MB
FORMATTED CAPACITIES:		
Sectors Per Track*:	17	17 (26)
Bytes Per Sector:	512	512
Transfer Rate:	5 M/bits	5 M/bits
ACCESS TIMES:		
Track to Track:	15ms	15ms
Average:	68ms	68ms
Maximum:	152ms	152ms
Average Latency:	8·33ms	8·33ms
RELIABILITY FACTORS:		
Meantime Between Failures:	20,000 hours	
Meantime to Repair:	30 minutes	
Service Life:	5 years	
Soft Read Errors:	1 in 10^{10} bits	
Hard Read Errors:	1 in 10^{10} bits	
PHYSICAL CHARACTERISTICS:		
Number of Surfaces*:	4	4 (4)
Number of Cylinders*:	615	940(615)
Height:	127mm	127mm
Depth:	350·5mm	355mm
Width:	43·2mm	43·2mm
Weight:	1·04 kg	1·04 kg
POWER:	+5VDC 0·9A max +12V DC 0·8A (1·5A 3 sec max) Overall 13W typ.	

X20020 20 M/BYTE... **$995**
X20030 30 M/BYTE **$1,095**

*Reference to the 30 M/Byte product reflect logical and (Physical) formatts respectively.
*Datalife is a registered trademark of Verbatim Australia Pty. Ltd.

XT* MOTHERBOARD
(WITHOUT MEMORY)

- 4·77MHz
- 8088 Processor
- Expandable to 640K on board.
- Provisions for up to 6 x 2732 EPROMs on board.
- Keyboard connector
- 8 Expansion slots

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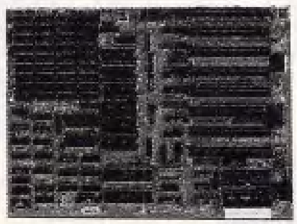

XT* TURBO MOTHERBOARD

- 8MHz
- 8088 Processor
- Expandable to 640K on board.
- Provisions for up to 6 x 2732 EPROMs on board
- Keyboard connector
- 8 Expansion slots

X18030 (excl. RAM) **$169**
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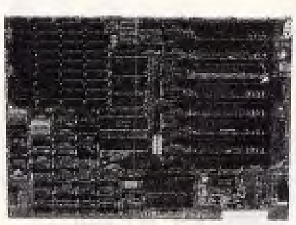

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Increase the performance of your sluggish XT* approximately four times with this super fast motherboard.

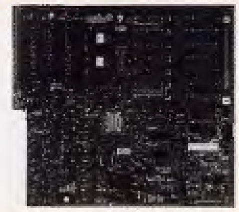
- 8088-2 running at 10 MHz, no wait state
- Turbo/Normal selectable
- 640K fitted
- 8 Expansion slots
- 4 Channel DMA
- Keyboard port

Excluding RAM .. **$249**
Including RAM) .. **$579**

BABY AT* MOTHERBOARD
(WITHOUT MEMORY(

- 6/10 MHz system clock with sero wait state.
- 80286-10 Microprocessor
- Hardware and software switchable
- Socket for 80287 numeric data co-processor
- 256K, 512K, 640K, or 1,024K RAM
- 64K ROM
- Phoenix BIOS
- 8 Expansion slots

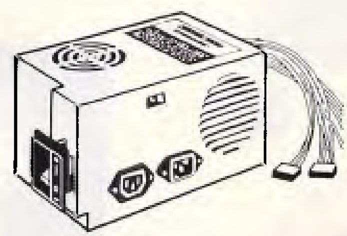
X18200 (excl. RAM) **$689**
X18201 (incl.640K RAM) **$1,019**



6/10 MHz AT* MAIN BOARD

- 6/10 MHz system clock with zero wait state
- Hardware and software switches for alternative system clock.
- Rechargeable battery backup for CMOS configuration table and real time clock.
- 80286-10 microprocessor
- Socket for 80287 numeric data co-processor
- 256K8, 512K8, 640K8, or 1,024K8 RAM
- 64K8 ROM, expandable to 128K8
- 8 Input/Output slots
- Hardware reset jumper
- Power and turbo LED connector
- Phoenix 8IOS

X18100 (Excl. RAM) **$689**



150W SWITCH MODE POWER SUPPLY FOR IBM* PC*/XT* & COMPATIBLE

DC OUTPUT: +5/13A, -5V/0.5A
+12V/4.5A -12V/0.5A

Cat. X11096 .... **$145**

200W SWITCH MODE POWER SUPPLY FOR IBM* AT* & COMPATIBLE

DC OUTPUT: +5/16A, -5V/0.5A
+12V/5A -12V/0.5A

Cat. X11097 .... **$199**

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"IBM* XT* TYPE" COMPUTER CASING

Give your kit computer a totally professional appearance with one of these "IBM* style" casings. Includes room for 2 x 5¼" disk drives, connection ports and mounting accessories etc.
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IBM* XT* COMPATIBLE CASE AT* STYLING

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Size: 490(W) x 145(H) x 400(D)

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- 100% I8M* PC*, XT* compatible.
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- Status displays, Power, Cap Lock and Numeric Lock

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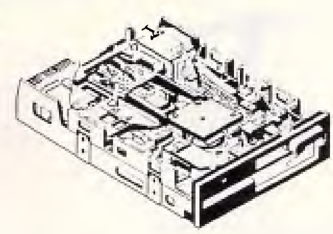
IBM* COMPATIBLE EXTENDED KEYBOARD (101 KEYS)

These new keyboards are both XT* and AT* compatible!

- 20 Dedicated function keys
- Enlarged "Return" and "Shift" key
- Positive feel keys
- Low Profile Design, DIN standard
- Separate Numeric and Cursor control keypads

Cat.X12022. **only $109**



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Top quality at an incredibly low price! Double sided, double density. Switchable 1·2 M/Byte to 720K formatted capacity. I8M* AT* compatible.

C11906 .. **ONLY $269**

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A top quality double sided, double density drive at an amazing price!
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C11905 .. **ONLY $255**

MITSUBISHI 4851 DISK DRIVE

Slimline, 360K, Double sided, double density

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20 M/BYTE HARD DISK

Tandon, including DTC controller card, 12 month warranty. I8M* compatible.

X20010 .. **ONLY $595**

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I8M* compatible.
- For technical details phone Mark Stevens on (03) 543 7877

.... **ONLY $795**

80 M/BYTE HARD DISK

Seagate, 12 month warranty.
IBM* compatible.
- For technical details phone Mark Stevens on (03) 543 7877

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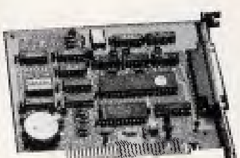

RS232 & CLOCK CARD
(WITHOUT CABLE)

This RS232 card supports 2 asynchronous communication ports. Programmable baud rate generator allows operation from 50 baud to 9600 baud. Fully buffered. Clock includes battery back-up and software.

Cat. X18028 .... **$89**

RS232 (SERIAL) CARD
(WITHOUT CABLE)

This RS232 card supports 2 asynchronous communication ports. Programmable baud rate generator allows operation from 50 baud to 9600 baud. Fully buffered. Second serial port is optional.

Cat. X18026 .... **$49**

CLOCK CARD

Complete clock card including battery back-up and software.

Cat. X18024 .... **$55**

GAMES I/O CARD

Features two joystick ports. (DB15).

Cat. X18019 .... **$37**

I/O PLUS CARD

Provides a serial port, a parallel port and a joystick port, and even a clock/calendar with battery backup!

Cat. X18045 .... **$119**

768K MULTIFUNCTION I/O CARD

(Includes cable but not 41256 RAM)

- Serial port
- Parallel port
- Games port
- Clock/Calendar with battery back-up
- provision for second serial port

Cat. X18050 .... **$194**

MULTI I/O & DISK CONTROLLER CARD

This card will control 2 x double sided, double density drives, and features a serial port, a parallel port, and a joystick port or games port. It also has a clock/calendar generator with battery backup.

Cat. X18040 .... **$145**

MULTI SERIAL CARD

- 4 RS232C asynchronous communication serial ports. One fitted 3 optional.
- NS16450 Asynchronous communication elements (ACE)
- COM1/COM/2 COMPATIBLE
- DTE/DCE Selectable
- Drive support for PC*/AT*, XENIX*
- Interactive installation procedure available.

X18154 .... **$139**

148 PAGE CATALOGUE FREE WITH EACH ORDER!

16 BIT FLOPPY DISK DRIVE CONTROLLER CARD

These cards will control up to 2 or 4 double sided 360K IBM* compatible disk drives.

X18005 (2 Drives) . **$52**
X18006 (4 Drives) . **$55**

1·2 M/BYTE/360K FLOPPY CONTROLLER CARD

The ideal solution for backing up hard disk, archiving etc. Suitable for 1·2 M/Byte and 360K drives. XT* and AT* compatible

Cat. X18008 .... **$124**

640K RAM CARD (SHORT SLOT)

- 640K memory installed
- User selectable from 64K to 640K
- DIP switches to start address

X18014 .. **ONLY $229**

2 M/BYTE RAM CARD

Plugs straight into BUS ports on mother-board. XT* compatible. RAM not included.

X18052 (Excl.RAM) **$194**

386 MAIN BOARD

- Intel 80386 CPU (16MHz)
- Socket for 80387 Math co-processor
- 32 bit BUS system, 1 M/Byte or 640K on board memory
- Built-in speaker attachment
- Battery backup for CMOS configuration table and real time clock.
- Keyboard controller and attachment
- 7 Channel DMA
- 16 Level interrupts
- 3 Programmable timers
- 8 System expansion I/O slots:
  5 with a 36 pin and a 62 pin expansion slot 2 with only the 62 pin expansion slots 1 with two 62 pin expansion slots (32 bit BUS)

IN STOCK!

X18101 without RAM **$2,489**
X18103 1 M/Byte RAM **$3,495**
X18105 2 M/Byte RAM **$4,495**

COLOUR GRAPHICS CARD

This card plugs staight into I/O slot and gives RGB or composite video in monochrome to a monitor.

Colour graphics: 320 dots x 200 lines.
Mono graphics: 640 dots x 200 lines.

Cat. X18002 .... **$107**

GRAPHICS CARD

- Hercules compatible
- Interface to TTL monochrome monitor
- One Centronics parallel printer port
- 2K-Static RAM, 64K Dynamic RAM
- Display Mode: 720 dots x 348 lines

Cat. X18003 .... **$139**

PRINTER CARD

This card features a parallel interface for Centronics printers such as the Epson RX-80, 100, and other similar printers. Included is printer data port, printer control port, and printer status port.

Cat. X18017 .... **$35**

COLOUR GRAPHICS & PRINTER CARD

This combination card features printer and monitor interface. It has 1 parallel printer port, RGB CTTC outputs.

Colour:
Text Mode: 40 columns x 25 rows.
Graphics: 320 x 200

Monochrome:
Text Mode: 80 columns x 25 rows.
Graphics: 640 x 200

Cat. X18010 .... **$124**

ENHANCED GRAPHICS ADAPTOR CARD

- 256K display RAM
- Handles monochrome, CGA Hercules and E.G.A.
- Paradise* compatible
- Up to 16 colours
- Standards: 320 x 200, 640 x 200, 640 x 348, and 720 x 348.

X18070 .... **$279**

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```
100 REM -- BASIC PROGRAM TO CREATE RECORDER.COM
110 OPEN 'RECORDER.COM" AS #1 LEN = 1
120 FIELD #1,1 AS A$
130 CHECKSUM = 0
140 FOR I = 1 TO  164
150    LINESUM = 0
155    PRINT ".";
160    FOR J = 1 TO 8
170       READ BYTE
180       CHECKSUM = CHECKSUM + BYTE
190       LINESUM = LINESUM + BYTE
200       IF (BYTE < 256) THEN LSET A$ = CHR$(BYTE)
210       PUT #1
220    NEXT J
230    READ LINECHECK
240    IF LINECHECK <> LINESUM THEN PRINT "Error in Line";280 + 10 * I
250 NEXT I
260 CLOSE
270 IF CHECKSUM = 131824 THEN PRINT 'Successful Completion!" : END
280 PRINT 'COM file is not valid!" : END
290 DATA    233,   227,     3,    82,    69,    67,    79,    82,   842
300 DATA     68,    69,    82,    32,    49,    46,    48,    32,   426
310 DATA     40,    99,    41,    32,    49,    57,    56,    56,   430
320 DATA     32,    90,   105,   102,   102,    32,    67,   111,   641
330 DATA    109,   109,   117,   110,   105,    99,    97,   116,   862
340 DATA    105,   111,   110,   115,    32,    67,   111,    46,   697
350 DATA     13,    10,    80,    67,    32,    77,    97,   103,   479
360 DATA     97,   122,   105,   110,   101,    32,   254,    32,   853
370 DATA     84,   111,   109,    32,    75,   105,   104,   108,   728
380 DATA    107,   101,   110,    36,    26,    42,    84,    97,   603
390 DATA     98,   108,   101,    32,   105,   115,    32,   115,   706
400 DATA     97,   116,   117,   114,    97,   116,   101,   100,   858
410 DATA     42,    36,     0,     0,     0,     0,     0,     0,    78
420 DATA      0,     0,   200,     0,     0,     0,     0,     8,   200
430 DATA      0,     0,    32,    32,    32,    70,   105,   108,   379
440 DATA    101,    32,    78,    97,   109,   101,    32,    32,   582
450 DATA     84,   111,   116,    97,   108,    32,    32,    32,   612
460 DATA     82,   101,    97,   100,    32,    32,    87,   114,   645
470 DATA    105,   116,   101,    32,    32,    32,    69,    88,   575
480 DATA     69,    67,    36,     0,     0,     0,     0,     0,   172
490 DATA      0,     0,     0,     0,     0,     0,     0,     0,     0
500 DATA      0,     0,     0,     0,     0,   128,   252,     2,   382
510 DATA    114,    10,   128,   252,     4,   119,     5,    46,   678
520 DATA    255,     6,   171,     1,    46,   255,    46,   102,   882
530 DATA      1,   156,   251,    46,   128,    62,   170,     1,   815
540 DATA      0,   117,    20,   128,   252,    75,   116,    22,   730
550 DATA    128,   252,    14,   118,    10,   128,   252,    49,   951
560 DATA    116,     5,   128,   252,    69,   114,    49,   157,   890
570 DATA    250,    46,   255,    46,    98,     1,    80,    83,   859
580 DATA     81,    86,    87,    30,     6,    46,   198,     6,   543
590 DATA    170,     1,     1,   190,   215,     3,   232,    83,   895
600 DATA      1,   114,     6,   255,    68,    12,   255,    68,   779
610 DATA     18,    46,   198,     6,   170,     1,     0,     7,   446
620 DATA     31,    95,    94,    89,    91,    88,   235,   207,   930
630 DATA     46,   198,     6,   170,     1,     1,    46,   163,   631
640 DATA    168,     1,    46,   199,     6,   171,     1,     0,   592
650 DATA      0,   250,    46,   255,    30,    98,     1,   251,   931
660 DATA    156,    80,    83,    81,    82,    86,    87,    30,   685
670 DATA      6,   115,     3,   233,     3,     1,    46,   139,   546
680 DATA     14,   168,     1,   128,   237,    15,   116,    41,   720
690 DATA    254,   205,   116,    42,   128,   237,     4,   116,  1102
700 DATA     32,   254,   205,   116,    33,   254,   205,   116,  1215
710 DATA     24,   128,   237,    11,   116,    19,   254,   205,   994
720 DATA    116,    20,   254,   205,   116,    11,   128,   237,  1087
730 DATA      4,   116,     6,   254,   205,   116,     7,   235,   943
740 DATA     30,   187,    14,     0,   235,     3,   187,    16,   672
750 DATA      0,   190,   190,     3,   232,   213,     0,   114,   942
760 DATA     53,    46,   161,   171,     1,    46,     1,     0,   479
770 DATA     46,     1,    68,    12,   233,   178,     0,   128,   666
780 DATA    237,    20,   116,    29,   254,   205,   116,    25,  1002
790 DATA    254,   205,   116,    44,   254,   205,   116,    25,  1219
800 DATA    254,   205,   116,    36,   128,   237,     2,   116,  1094
810 DATA     16,   128,   237,     2,   116,    16,   233,   144,   892
820 DATA      0,    61,     5,     0,   125,    80,   233,   136,   640
830 DATA      0,   185,    14,     0,   235,    13,   128,   249,   824
840 DATA      2,   116,   246,   128,   249,     3,   117,   238,  1099
850 DATA    185,    16,     0,   131,   251,     5,   114,   230,   932
860 DATA     81,   232,    94,     1,   191,   230,     4,   185,  1018
870 DATA     30,     0,    46,    59,    29,   116,     0,   131,   419
880 DATA    199,     4,   226,   246,    91,   235,    98,    46,  1137
890 DATA    128,    62,   169,     1,    62,   117,     5,    46,   590
900 DATA    199,     5,     0,     0,    46,   139,   125,     2,   516
910 DATA     91,    46,   161,   171,     1,    46,     1,     1,   518
920 DATA     46,     1,    69,    12,   235,    59,    46,   163,   631
930 DATA    166,     1,   190,   215,     3,   232,    68,     0,   875
940 DATA    114,   164,    46,   161,   171,     1,     1,    68,   726
950 DATA     12,     1,    68,    14,    46,   139,    62,   112,   454
960 DATA      1,   131,   199,     4,   129,   255,    94,     5,   818
970 DATA    117,     3,   191,   230,     4,    46,   137,    62,   790
980 DATA    112,     1,    46,   139,    30,   166,     1,   232,   727
990 DATA    248,     0,    46,   137,    29,    46,   137,   117,   760
1000 DATA     2,    46,   198,     6,   170,     1,     0,     7,   430
1010 DATA    31,    95,    94,    90,    89,    91,    88,   157,   735
1020 DATA   251,   202,     2,     0,   252,    14,     7,   191,   919
1030 DATA   155,     1,   176,    32,   185,    11,     0,   243,   803
1040 DATA   170,   255,   214,   252,    14,    31,   139,    14,  1889
1050 DATA   106,     1,   190,    94,     5,   191,   155,     1,   743
```

continues . . .

RECORDER.BAS: *A BASIC program that will automatically create RECORDER.COM*

same name are counted on the same line. If you have files in several directories with the same name, the table won't differentiate between them; this may be a good reason to get organised and get rid of the duplicates.

When looking through the table, don't be surprised to see some filenames you've never heard of before. Many applications programs create temporary files. They're normally deleted when the program terminates so you never know about them, but they don't escape RECORDER's watchful eye. Some programs, such as LINK.EXE, let you specify a drive letter for this type of scratch file. Your RAMdisk would be a perfect place for them. It's a shame more programs don't provide this feature.

The output table is normally sorted by descending order of the totals column, but you can easily sort it by any other column. For example, to sort by the EXEC column, just enter

```
RECORDER | SORT / +34
```

This command sequence uses piping and the DOS SORT utility to sort the table beginning with the 34th character. (The read column begins with character 20, and the write, with 27.) After using piping to sort the output, you'll notice still another strange file the next time you list the table. When DOS pipes output, it creates a temporary file in the root directory of the default disk. Different versions of DOS use different temporary filenames. Versions 2.x use names such as %PIPEn.$$$. Beginning with Version 3.0, the name consists of eight digits (such as 42621836). Although the names may seem random, they're actually derived from the system time.

> *'FCB functions were made obsolete with DOS 2.0. Since they're still used by older software, RECORDER must be able to work with them.'*

The file table maintained by RECORDER isn't limitless. Should the message "*Table is saturated*" appear at the end of the listing, the table is filled. When this happens, no more entries can be added. although current entries will continue to be updated. Before continuing, you'll probably want to save the current table entries. The easiest way to do this is to redirect its output into a file, thus:

```
RECORDER /R > FILES.LOG
```

This creates a copy of the table in the file FILES.LOG. At the same time, the /R option resets the table so you can start again. If you find yourself filling the table frequently, just specify a larger table size the next time you load RECORDER.

After studying the list, you're ready to begin tuning your disk. Files with the highest totals are prime candidates for RAMdisks. If you're not already familiar with using a virtual disk, the accompanying box 'Shifting into High Gear with VDISK' will show you how it works. Other often-used files (especially those too large to keep in RAM) should ideally be located on the outermost sectors. When selecting files for this prestigious perch, choose only those that won't be modified, such as executable programs. When a file is copied or deleted its sectors get reallocated by DOS, destroying the continuity you're trying to achieve. The reason the outer sectors are fastest

```
1060 DATA   81,   86,  185,   11,    0,  243,  166,   94,  866
1070 DATA   88,  227,   73,  131,  198,   20,  139,  200, 1076
1080 DATA  226,  235,  139,   62,  110,    1,  131,  255, 1159
1090 DATA  255,  116,   32,  139,   14,  106,    1,  131,  794
1100 DATA  199,   20,   59,   62,  108,    1,  114,    3,  566
1110 DATA  191,   94,    5,  139,   69,   12,   61,    1,  572
1120 DATA    0,  118,   10,  226,  234,  199,    6,  110,  903
1130 DATA    1,  255,  255,  249,  195,  137,   62,  110, 1264
1140 DATA    1,   87,  252,  190,  155,    1,  185,   11,  882
1150 DATA    0,  243,  164,   51,  192,   71,  171,  171, 1063
1160 DATA  171,  171,  171,   94,  248,  195,   66,  139, 1255
1170 DATA  242,  131,  198,    8,  191,  163,    1,  185, 1119
1180 DATA    3,    0,  172,  232,   81,    0,  170,  226,  884
1190 DATA  249,  131,  238,    3,  235,   32,  195,  139, 1222
1200 DATA  242,  172,   10,  192,  116,   23,   60,   46,  861
1210 DATA  117,  247,   86,  191,  163,    1,  185,    3,  993
1220 DATA    0,  172,   10,  192,  116,    6,  232,   46,  774
1230 DATA    0,  170,  226,  245,   94,   78,   78,  253, 1144
1240 DATA  185,    8,    0,  191,  162,    1,   59,  242,  848
1250 DATA  114,   28,  172,   60,   92,  116,   23,   60,  665
1260 DATA   47,  116,   19,   60,   58,  116,   15,   60,  491
1270 DATA   32,  116,    4,  232,    9,    0,  170,  131,  694
1280 DATA  254,  255,  116,    2,  226,  224,  195,   60, 1332
1290 DATA   97,  114,    6,   60,  122,  119,    2,   36,  556
1300 DATA  223,  195,   83,  180,   81,  205,   33,   88, 1088
1310 DATA    3,  216,  195,   30,    7,  191,   94,    5,  741
1320 DATA  139,   14,  106,    1,   51,  192,  171,  131,  805
1330 DATA  199,   10,  171,  131,  199,    6,  226,  246, 1188
1340 DATA  191,  230,    4,  185,   30,    0,   51,  192,  883
1350 DATA  171,  184,   94,    5,  171,  226,  247,   46, 1144
1360 DATA  199,    6,  110,    1,   94,    5,   46,  199,  660
1370 DATA    6,  112,    1,  230,    4,  195,  232,  169,  949
1380 DATA    1,  227,   40,   51,  192,  138,   28,  128,  805
1390 DATA  235,   48,  114,   13,  128,  251,    9,  119,  917
1400 DATA    8,  183,   10,  246,  231,   50,  255,    3,  986
1410 DATA  195,   70,  226,  233,   11,  192,  116,   11, 1054
1420 DATA   61,  208,    7,  118,    3,  184,  208,    7,  796
1430 DATA  163,  106,    1,  184,   19,   53,  205,   33,  764
1440 DATA  137,   30,  102,    1,  140,    6,  104,    1,  521
1450 DATA  186,  173,    1,  184,   19,   37,  205,   33,  838
1460 DATA  184,   33,   53,  205,   33,  137,   30,   98,  773
1470 DATA    1,  140,    6,  100,    1,  186,  193,    1,  628
1480 DATA  184,   33,   37,  205,   33,  232,  115,  255, 1094
1490 DATA  161,   44,    0,  142,  192,  180,   73,  205,  997
1500 DATA   33,  161,  106,    1,  187,   20,    0,  247,  755
1510 DATA  227,    5,   94,    5,  163,  108,    1,    5,  608
1520 DATA   15,    0,  177,    4,  211,  232,  139,  288,  986
1530 DATA  184,    0,   49,  205,   33,  144,  186,    3,  804
1540 DATA    1,  232,   23,    1,  247,   22,    0,    1,  527
1550 DATA   51,  219,  140,  200,   67,   59,  195,  142, 1073
1560 DATA  195,  117,    3,  233,  104,  255,  190,    0, 1097
1570 DATA    1,  139,  254,  185,   16,    0,  243,  166, 1204
1580 DATA   11,  201,  117,  232,    6,   31,  191,   94,  883
1590 DATA    5,  139,   14,  106,    1,  198,   69,   11,  543
1600 DATA    0,  131,  199,   20,  226,  247,  232,  230, 1285
1610 DATA    0,  186,  114,    1,  232,  220,    0,  139,  892
1620 DATA   14,  106,    1,   81,  191,   94,    5,   51,  543
1630 DATA  192,  139,   14,  106,    1,   57,   69,   12,  590
1640 DATA  118,   11,  128,  125,   11,    0,  117,    5,  515
1650 DATA  139,  247,  139,   69,   12,  131,  199,   20,  956
1660 DATA  226,  235,  128,  124,   11,    1,  116,   79,  920
1670 DATA  198,   68,   11,    1,  139,  214,  131,  198,  960
1680 DATA   12,  131,   60,    0,  116,   65,  180,   64,  628
1690 DATA  187,    1,    0,  185,    8,    0,  205,   33,  619
1700 DATA   82,  176;   46,  232,  142,    0,   90,  131,  899
1710 DATA  194,    8,  180,   64,  185,    3,    0,  205,  839
1720 DATA   33,  173,   80,  232,   60,    0,  173,  232,  983
1730 DATA   56,    0,  173,  232,   52,    0,  173,  232,  918
1740 DATA   48,    0,  232,  122,    0,   88,   89,  226,  805
1750 DATA  154,   61,    2,    0,  114,    9,  232,  110,  682
1760 DATA    0,  186,   77,    1,  232,  100,    0,  232,  828
1770 DATA  112,    0,  227,   12,   46,  138,    4,   12,  551
1780 DATA   32,   60,  114,  116,    8,   70,  226,  244,  870
1790 DATA  184,    0,   76,  205,   33,  232,  123,  254, 1107
1800 DATA  235,  246,   80,  176,   32,  232,   60,    0, 1061
1810 DATA  176,   32,  232,   55,    0,   88,   51,  201,  835
1820 DATA  187,   16,   39,  232,   24,    0,  187,  232,  917
1830 DATA    3,  232,   18,    0,  187,  100,    0,  232,  772
1840 DATA   12,    0,  187,   10,    0,  232,    6,    0,  447
1850 DATA    4,   48,  232,   23,    0,  195,   51,  210,  763
1860 DATA  247,  243,   82,   11,  200,   11,  201,  117, 1112
1870 DATA    2,  176,  240,    4,   48,   81,  232,    3,  786
1880 DATA    0,   89,   88,  195,  138,  208,  180,    2,  900
1890 DATA  205,   33,  195,  180,    9,  205,   33,  176, 1036
1900 DATA   13,  232,  240,  255,  176,   18,  232,  235, 1393
1910 DATA  255,  195,  190,  128,    0,   46,  138,   12,  964
1920 DATA   50,  237,   70,  252,  195,    0,    0,    0,  804
```

ends

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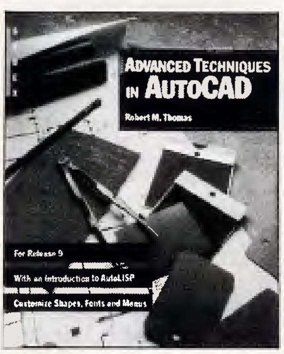

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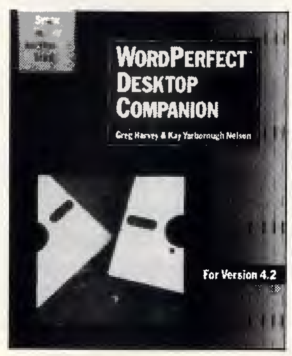

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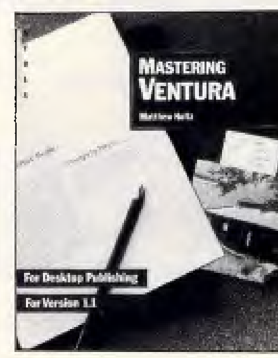

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Shifting into high gear with VDISK

If you've never used a RAMdisk, you really ought to give it a try. Everyone will DOS 3.0 or higher already has it available, and most memory expansion boards come packaged with similar software. If you haven't yet expanded to 640k, now may be the time. With a full megabyte you'll be able to allocate 384k for a RAMdisk while maintaining 640k for your DOS applications.

VDISK is a device driver that is loaded when DOS is initially started. It then steals some RAM and configures it like just another drive. To use it, make sure the file VDISK.SYS is on your boot disk. Then you'll need to add a line to your CONFIG.SYS file. If you don't already have this file, you can create it with any ASCII text editor. CONFIG.SYS should be in the root directory of your boot disk. The syntax for VDISK is

```
DEVICE=C:\DOS\VDISK  [/E]
[n]
```

This example assumes that the VDISK driver is located in the DOS subdirectory. The *n* parameter specifies the size of the disk in kilobytes. If you're using a machine with extended memory installed, the /E parameter will instruct VDISK to utilise it.

The drive letter for your newest disk will be one greater than DOS assigned to your last physical drive. For most users, who have one hard disk, this will be 'D:'. If you create multiple drives with VDISK, each will automatically use the next available letter. Don't try formatting the virtual disk; DOS does that by itself when installing VDISK. Likewise, don't try to use the DISKCOPY command with VDISK.

How much memory should you allocate to the RAMdrive? Well, everyone's needs are different. RECORDER provides you with a clue as to which files should (if possible) be stored on the RAMdrive, and your job is to save just enough ordinary free memory to run your largest program without losing speed. You could run CHKDSK to show how much you've got left and then dig through your program manuals to determine their requirements. In most cases, however, it's easier just to keep increasing the VDISK size until you get the 'Insufficient memory' error when running your largest program. Most users with 640k can spare around 196k. Of course, if you load a lot of other TSRs (print spoolers and disk caches also fall into this category), you may want to use a smaller virtual disk.

Load the new disk by copying your most-used files to it. Putting the necessary COPY commands in your AUTOEXEC.BAT file makes this step painless. Then adjust your path statement so that the RAMdisk is the first drive listed.
For example:

```
PATH=D:\;C:\DOS;C:\UTIL
```

This ensures that files copied onto the RAMdisk will be read from there rather than from the slower drive C:
Tom Kihlken

DOS file functions

Functions for file control blocks

Function	Purpose
0Fh	Open file
10h	Close file
14h	Sequential read
15h	Sequential write
16h	Create file
21h	Random read
22h	Random write
27h	Random block read
28h	Random block write

Functions for file handles

Function	Purpose
3Ch	Create file
3Dh	Open file
3Eh	Close file
3Fh	Read file
40h	Write file
42h	Move pointer
44h	I/O control

These DOS file functions are counted by RECORDER to determine the extent of file activity.

is because the file allocation table is also located there. Files located closest to the FAT can be read with the least amount of head movement.

Rearranging a hard disk is best done with one of the specialised disk management utilities. As an alternative, you can copy all your files to floppies, reformat the hard disk, then copy the files back in the order of highest utilisation. Since you'll be replacing the files one by one, be sure to keep an accurate record of the directory structure. If you take this approach, this would be a good time to get rid of all your duplicate and obsolete files as well. Directories full of unnecessary files slow the operating system as it searches for good files. Before reformatting the disk, be sure to make a second, complete backup as double insurance against lost files.

DOS file handling

The Disk Operating System is king when it comes to putting data on the polished platters. Although some programs (such as The Norton Utilities) are smart enough to write to disk by themselves, most are not. The DOS services (including file I/O) are accessed by software interrupt 21h. The location of the interrupt 21h service routine is located at address 0000:0084h. By modifying this vector, RECORDER can monitor every DOS function request. The functions available with this powerful interrupt are well documented in the DOS *Technical Reference* manual. RECORDER watches for those that concern file I/O and extracts the vital information it needs from the registers. These functions are summarised in the table 'DOS File Functions'.

As the table indicates, DOS uses two different systems in handling files. The first is somewhat old-fashioned and dates back to the time when DOS was evolving from the CP/M operating system. It uses a system of file control blocks (FCBs) and data transfer areas (DTAs). The FCB is a block of information in memory that DOS needs to locate the required file sectors. A separate FCB is needed for each open file.

The layout for an FCB is shown in the diagram 'File Control Block Fields'. Some of the data (such as the name and extension) for the FCB is provided by the requesting program. The remainder is supplied by DOS when the file is opened. The only part of interest to RECORDER is the filename and extension. The DTA is a chunk of memory into which and out of which the disk controller transfers information directly. Its location is always controlled by the requesting program.

FCB functions don't support subdirectories and so were made obsolete with

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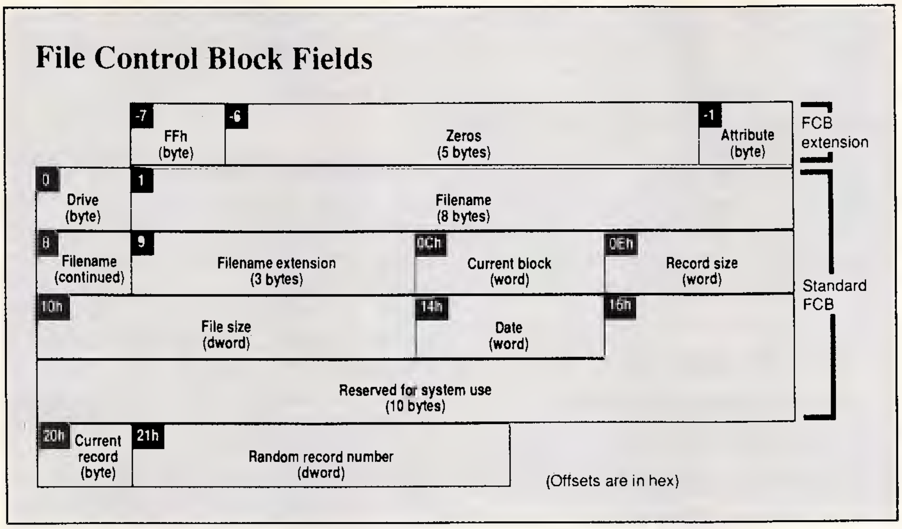

The layout of the FCB showing the size and placement of the file information maintained by DOS

DOS 2.0. Since they're still used by older software, however, RECORDER must be able to work with them.

Newer programs use identifiers known as handles to refer to files. Each time a file is opened, a 16-bit binary value is assigned to it. The handle is then used to refer to the file for reading and writing. Handles make it easy to have many files open at once. DOS maintains a data area for each one, relieving the application program of the task. In addition, DOS provides the following standard handles for input and output to the console.

```
0 - Standard Input

1 - Standard Output

2 - Standard Error
3 - Standard Auxiliary
4 - Standard Printer
```

Since these last don't require disk activity, however, RECORDER ignores them.

Recorder Record Format

Byte	Function
0-7	Filename (right justified and padded with blanks)
8-10	Extension (left justified and padded with blanks)
11	Byte, used for sorting the table
12-13	Word, integer for total column
14-15	Word, integer for read column
16-17	Word, integer for write column
18-19	Word, integer for EXEC column

RECORDER stores the information needed to track each file in a 20-byte field arranged as shown.

Understanding RECORDER

RECORDER uses two major data structures to keep track of file activity. The file table already mentioned contains the information displayed each time you run the utility. The handle table is used internally to keep track of which handles are in use. First let's look at the file table. It consists of a series of records, one for each file. Each record is 20 bytes long and contains the information as shown in the table 'RECORDER Record Format'.

To ensure that filenames will be matched correctly, they must always be stored in exactly the same format. All characters are converted to uppercase and all embedded spaces are removed. In addition, any names with less than the full eight letters are padded with spaces. The file extension is treated similarly. By following this rule, names such as 'Data.Dat' and 'DATA.DAT' will be matched.

To facilitate entering new names in the table, a pointer is used to mark the most recent entry. This pointer is advanced to the next record each time a name is added. When the table fills, the pointer is set back to the first entry. Additional entries can then be made by bumping an entry that has a total of only one. When every entry has a total of two or more, the table is considered saturated and no more entries can be made. This algorithm prevents a new file entry from bumping out an older entry that has already accumulated a high total. At the same time, the oldest entries with only one access are the first to go as new files are added.

The second data structure is the handle table. Its purpose is not so obvious. Recall that when handles are used to access files, the file's name is specified only when it is created or opened. The handle table provides the logical relationship between handles and filenames.

Each time a new file is encountered, its name is entered into the file table and its corresponding handle is put in the handle table. The handle table contains two words for each entry: the 16-bit handle and a pointer to the matching record in the file table. Whenever a handle is referenced, you simply look it up in the handle table to determine the corresponding filename. You then increment the appropriate columns in the matching record of the file table.

When the file is closed, its entry is deleted from the handle table. Up to 50 handles can be accommodated at any one time, which is more than any program would normally use. A pointer in the handle table is used to mark the latest entry, and entries are made sequentially in a first-in, last-out manner.

This simple scheme has one additional refinement. It would be possible for several programs to execute concurrently. The print command is an example of this. Each program could have handles open with the same 16-bit identifiers but different names, and RECORDER must be able to distinguish between them. To do this, each handle is encoded by adding the current program segment prefix (PSP) to it before it is inserted into the table. The current PSP is obtained by using the undocumented DOS function call 51h. Thus, even in this situation, each handle of each process can be uniquely identified.

'Not all read and write requests require accessing the disk. Many can be handled by DOS's buffers.'

Snooping around INT 21h

Like most resident programs, RECORDER helps itself to the interrupt vector table. An integral part of the Intel family of processors, this important table holds the locations of the most-critical system routines. During RECORDER's installation, the interrupt 21h vector is set to the procedure NEWINT21, which maintains the utility's two internal tables. Each time it is called, it does its own work and then makes a far call to the address that was found in the original interrupt table. This technique ensures that RECORDER remains transparent to the operating system.

The first step in NEWINT21 is checking its busy flag. BUSY_FLAG is set each time a function is intercepted and cleared when it completes. NEWINT21 needs local memory to store function parameters, so it can't handle more than one function at a time. If a recursive call is made, it must be ignored by jumping directly to the original DOS vector. Since

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most DOS functions are nonreentrant, this bypass is seldom required. Because of this limitation, however, RECORDER may fail to include in its list all the files accessed by such background processes as the PRINT command.

The next step is to weed out irrelevant function calls. Functions numbered below 0Fh and above 44h don't involve files and are always allowed to pass undisturbed. In addition, function 31h (TSR) is not intercepted. Another special case is function 4Bh (EXEC), and it's worth explaining how it works.

Each time you run a .COM or an .EXE program, the EXEC function call is used to load the program into memory and begin its execution. Before this is allowed to happen, RECORDER notes the file's name. This is easily located since the protocol for EXEC specifies that the DS:DX register pair points to it. The procedure ENTER_FILENAME parses the name and searches the file table for it.

The EXEC and total columns of the file table must then be incremented. The base plus displacement addressing mode is used to find these words. The base address for the record is returned by ENTER_FILENAME in register SI. The appropriate displacements are 12 for the total and 18 for the EXEC column. After incrementing these two words, the EXEC function is allowed to proceed. The busy flag is cleared and a far jump is made to the original DOS interrupt vector.

If by chance the table has reached saturation, ENTER_FILENAME returns with the carry flag set to indicate the error. When this happens the increment instructions are skipped and the function is simply allowed to proceed.

The busy flag is set and register AX is stored when file functions are performed. AX contains the function code that we'll need later. Next, we make a far call to DOS to process the request. When DOS finishes its job, we first examine the carry flag to determine whether the function completed successfully. If an error occurred, DOS return with CF=1. Since there is no point in recording errors, we restore the stack and just return. Otherwise, a series of conditional jumps is used to sort out the various functions.

Functions of the FCB variety are categorised at this time as either a read or a write. As far as we're concerned, the only difference among FCB functions is which columns of the file table will be affected. Register BX is set to the appropriate displacement of the column to be modified. With these FCB functions, DS:DX points to a control block containing the file name. Again ENTER_FILENAME is called to locate this name in the file table (or, if necessary, to add it).

The number of disk operations can then be added to the correct columns. Remember, we put the column displacement in BX (either 14 or 16). The offset of the correct file table record is now in register SI. These base and index registers are combined to form the effective address for the appropriate column. Naturally, the totals column must also be increased by the same amount. To access this column, a displacement of 12 is used. Lastly, all registers that were modified are restored, and a far return instruction passes control to the requesting program.

Things get a little more difficult when the handle functions are used. These functions are divided into three classes: those that read, those that write, and those that require a new entry in the handle table. Reads and writes are processed similarly to the FCB functions. The main difference here is simply how

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the correct record of the file table is located.

Each time a file is opened or created, it must be added not only to the file table but to the handle table as well. To do this, the name is obtained from the DS:DX pointer. A search is made of the file table to determine whether the name is already there.

If not, it is entered and the four corresponding columns (totals, reads, writes, and EXECs) are zeroed out. Next, a new entry is made in the handle table. This handle table entry will provide the relationship between the handle and file table record. Before entering the new handle, however, it is first encoded by adding the PSP of the calling program. With the new table entries made, the number of disk interrupts is added to the read and total columns.

When RECORDER is reading or writing from a file, only the handle is specified. The handle table must be consulted to determine the file's name. As mentioned earlier, the caller's PSP is obtained and added to the handle. Then the handle table is searched for this entry. When a match is found, the corresponding file table entry can be retrieved. From here on, it's treated the same as an FCB function. Handles with numbers lower than five (the 'standard' handles) are not considered.

When a handle is closed, it is treated like a write, with one exception. The handle table entry is zeroed to prevent it from incorrectly matching a later read or write.

> *'RECORDER uses two data structures to track file activity: the file table and the handle table.'*

Parsing filenames

I've mentioned the procedure ENTER_FILENAME several times. Its job is to search the file table for the filename being used by the current function. The current file is passed to it by the DS:DX register pair. On return, it sets register SI to the matching entry in the file table. When ENTER_FILENAME encounters a new file (one not yet in the table), it attempts to add it. Should the table be full, the procedure returns with the carry flag set to indicate the full condition.

The interesting thing about this routine is that it can work with either FCBs or with the newer handle type of function. While the basic principles are the same, FCBs pass the name differently from the handle functions. To handle the difference, there are two parsing routines. FCBs use the routine PARSE_FCB, while handles use PARSE_STRING. How does ENTER_FILENAME know which one to use? The answer is easy: the address of the correct one is passed to it in register SI.

These two parsing routines transfer the name into a temporary holding area in which any missing letters are replaced with spaces and all letters are converted to uppercase. At the same time, any drive and path information that may have been included is stripped off.

The current file is then compared against each entry in the table. The string compare instruction, with a repeat count of II, makes this quick and easy. If a match is found, the appropriate location is returned. Otherwise, the table is again searched for an empty slot.

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This time the search is begun with the last filename entered. We'll be looking for an entry with a value of one or less in the totals column. If there aren't any left, we mark the table as saturated and return with the carry flag set. If space is available, the new name is copied from its temporary holding area to the table. The four columns (total, read, write, EXEC) are then set to zero. Lastly, the pointer to the last file entered is set to this location.

Counting sectors

Not all read and write requests require accessing the disk. DOS maintains internal buffers that hold the sectors most recently used, and many small I/O requests can be handled by the buffers alone. This buffered I/O is lightning fast compared to the time required for the drive head to reach the correct sectors. RECORDER is intended to reflect only the time required for disk operation. To accurately meter this, a count of the number of disk interrupts is maintained. A function may require zero, one, or many disk operations depending on the amount of data being transferred. After each function, the count is added to the appropriate columns of the file table.

The counter intercepts the BIOS disk interrupt. Whenever DOS needs to do physical I/O, it delegates that task to the basic input/output system, which is located in read-only memory (ROM-BIOS). The disk interface is provided by interrupt 13h. RECORDER steals this vector and points it to the procedure NEWINT13. Thus, when a disk is accessed, the counter BIOS_IO_COUNT is incremented. Each interrupt can handle anywhere from one sector to an entire track. Interrupt 13h provides functions other than reading and writing. Two of the other functions (formatting a track and resetting the controller) are never counted. The final function is used to verify the integrity of the disk data. If you've set VERIFY=ON, this process will require additional disk accesses, which RECORDER faithfully counts.

Since only devices that use interrupt 13h will affect the counter, some storage devices are neglected. For example, the Bernoulli box uses its own device driver instead of interrupt 13h. Similarly, most RAMdisk software doesn't issue interrupt 13h, so virtual disks are also ignored.

The information gathered by RECORDER would be useless if you couldn't see it. Converting binary encoded data to a readable format is so common, most people take it for granted. But it doesn't happen by itself. It involves finding the table, sorting it, and displaying the names with the sector information.

Each time RECORDER is run from the command line, it first searches through the computer's memory for the program's copyright notice (a hoary technique, but effective). If it's not present, then the program hasn't been loaded yet. In this case the initialisation routine takes over and no display is needed. If the copyright notice is found, then the program is already installed, and the existing table is retrieved and displayed.

The usual method of sorting a table involves rearranging the entries from highest to lowest. But sorting the file table is different. The order of the entries must not be changed, since they are to be kept in a chronological order. Instead, a search is made for the entry with the highest total and that file is displayed. This entry is then marked as completed and the next highest total is sought. This loop is completed until all entries get written out. If you're wondering how files are marked as complete, the answer lies in the 11th byte of the table entry. This byte is initially cleared. As each file is displayed the byte is set to one, indicating the file should be excluded from subsequent searches.

Copying the filename to the screen is fairly straightforward. Notice that I've used DOS output services, so redirection of output will work. Although DOS output is somewhat slower than more direct methods, its versatility makes it worth the wait in this case. Converting the numbers for each column to character data is done by the procedure NUMBER_OUT.

It first outputs two spaces to separate the columns. Next, the simple algorithm of dividing by 10,000, 1000, 100, etc, is used to isolate each digit. The result of each division is converted to ASCII by adding 30h. The character is then displayed to the standard output device. Leading zeros are suppressed by using register CX to indicate when the first nonzero digit is encountered. As long as CX is zero, any zero digits are displayed as spaces.

RECORDER by itself can't do much for your system. But teamed with RAMdisk software, a disk organiser, and your careful scrutiny, it can squeeze that extra ounce of performance from your system. And what can be more cost effective than making the most of your existing equipment? You'll also get the satisfaction of knowing your hardware is being used to its full potential.

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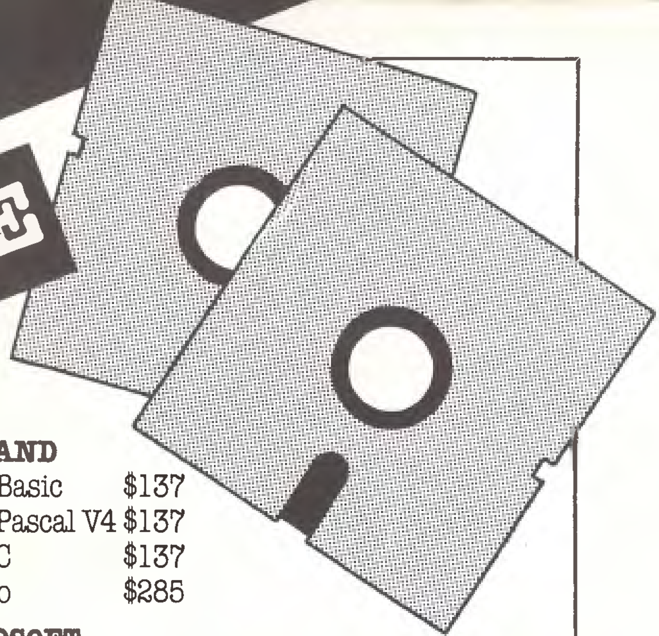

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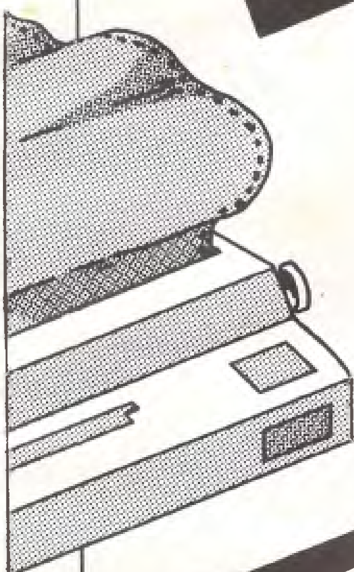

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APC 4/88

Continued from page 59

Thus, interleaved burst access with practical SRAM could take just one wait state to set up the burst, then zero wait states within it. Simulating this combination yields 35,760 Dhrystones per second and 18.67 mips (85 per cent of peak). The use of the instruction burst-mode configuration improves performance by 21 per cent.

The simulator output also shows that the CPU pipeline had 25.3 per cent idle time, split mainly into 10.2 per cent instruction-fetch waits and 12.3 per cent data-transaction waits.

There was also a 1.8 per cent 'load/load' transaction wait due to the wait states on the data RAM, and to CPU pipeline holds when switching from a write to a read cycle.

Compared to peak performance, the interleaved burst-instruction memory with real SRAM gives only 2.8 per cent more instruction latency than perfect zero-wait-state memory using this Dhrystone code. Thus, little is to be gained from further improvements (or complications) to the instruction memory design.

Pipelining

In pipelining, the address of the next instruction is placed on the address bus prior to the completion of the current cycle. External hardware latches this address, freeing the bus for the other channel (either the instruction bus or the data bus). Performance improvement is minimal, two per cent to six per cent typically, and can be easily examined with the simulator.

The Am29000 chip set

To quote from the Am29000 user's manual, "The Am29000 Streamlined Instruction Processor is the result of a design philosophy which recognises that processor performance must be considered in the light of the processor's hardware and software environment." Thus, the Am29000 draws on system concepts not only from early RISC technology, but also from the bit-slice and interface technologies that Advanced Micro Devices has pioneered.

The Am29000 has 192 internal general-purpose registers and a full 32-bit architecture, and it currently operates with a 25MHz clock, giving a 40ns cycle time (the most ambitious for any of the currently released RISC chip sets). Instructions are of three-address architecture; that is, of the form 'ADD Ra,Rb,Rc, where the source operand in register a is added to the operand in register b, and the result placed in register c.

The CPU includes demand-paged memory management (on-chip), a timer, and, like the MC88000, master/slave redundancy checking.

For floating-point operations, the Am29027 Arithmetic Accelerator supports not only the IEEE floating-point data formats but also the DEC D,F,G, and IBM 370 formats. The Am29027 has an 8-deep 64-bit register file that can be programmed in flow-through (for scalar computations) or pipelined (for vector operations) mode.

The floating-point speed predicted for the Am29027 is exceptional. AMD predicts a LINPACK rating of three million floating-point operations per second (MFLOPS), single precision, before the end of 1988. Although three MFLOPS represents a tenfold speed increase over 1987's technology, the MC88000 is also expected to deliver this order of performance. For reference, the CRAY-1S supercomputer achieves 13 MFLOPS.

The Am29000 chip set is rounded out with the Am29041 Data Transfer (DMA) Controller. It attaches the high-performance local data bus of the Am29000 to asynchronous peripherals and includes DMA buffering to more effectively utilise the Am29000's burst-transfer modes.

SCRAM is becoming prominent as the memory of choice for low-cost, high-speed computer systems. Even the 80386 clone on which I am writing this article uses it.

SCRAM is just like normal DRAM with RAS and column-address strobe (CAS) cycles, except that the column address is not latched on the falling edge of CAS, but can be changed while RAS and CAS are held low. In this mode, the RAM looks just like a 256kbit (64kbitx4) SRAM. Thus, for minor address changes within the same row of the RAM array, SCRAM has the fast access times of SRAM (typically 40 to 55ns).

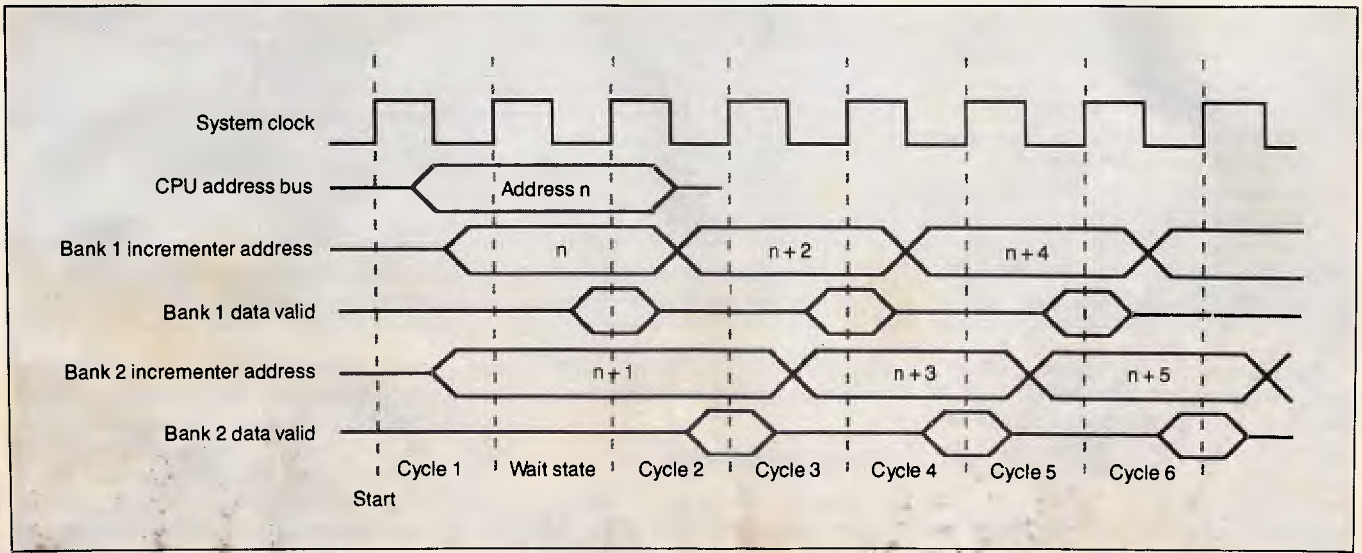

Fig 5 The timing for an interleaved instruction-burst access. Notice that the access switches back and forth between the two data banks. This process avoids the wait between accesses on a single bank

The MC88000 RISC

The MC88000 is the first RISC processor from Motorola. Although the part number might seem to indicate some relationship with the MC68000 family of complex-instruction-set computer (CISC) processors, nothing could be further from the truth. The MC88000 shares no common instructions, architecture, or pin-outs with its CISC predecessors.

Like the Am29000, instruction and data memories are accessed through separate ports. Unlike the Am29000, however, the MC88000 has two completely separate address buses for the two memory spaces, thereby preventing the possibility of contentions. As a result of the 32 extra interface pins, the MC88000 comes in a larger pin-grid-array package, totalling 182 pins and measuring 1.8in square. It supports both big-endian and little-endian byte orderings. Fig A shows a block diagram of the system.

The MC88000 has 32 general-purpose 32-bit registers. It uses register-to-register addressing for all data manipulation instructions. Registers are written to or read from memory only by load and store operations.

The internal floating-point capability is a unique feature of the MC88000. The floating-point unit is actually organised as separate adder and multiplier units that can operate concurrently.

Integrated within the MC88000 family are the MC88200 cache/memory management units (CMMUs); there is one for use with each of the instruction and data spaces. The cache is 16k of 4-way set-associative SRAM that can achieve one-cycle pipelined access on cache hits and can be used in write-through or write-back modes.

It is not mandatory to use these CMMUs, although the level of technology implemented in them certainly makes their use attractive. For interfacing to main memory, they use the Motorola M-Bus, a multiplexed, multi-master protocol. A single read cycle on the M-Bus interface takes two CPU clock cycles. Although the burst-mode read improves the data transfer rate to four words every five cycles, burst mode is unlikely to be of much use in data memory applications. Nevertheless, the M-Bus is an excellent compromise between the requirements of a bused memory system and the performance of a high-speed, closely coupled memory system.

By contrast, the MC88000 CPU P-Bus timings make it quite easy to operate high-speed SRAM with no wait states. The P-Bus is a pipelined protocol, with the reply signals not being required until the cycle subsequent to the access. This gives a peak transfer rate of 80Mbytes per second at the 20MHz CPU clock rate of the current MC88000 family. The worst-case access time is 50 + 5 - 5 = 50ns (no buffers) from address valid to data setup. No Dhrystone performance figures are available at this time.

Motorola says that the MC88000 is scheduled for production in the first quarter of 1989.

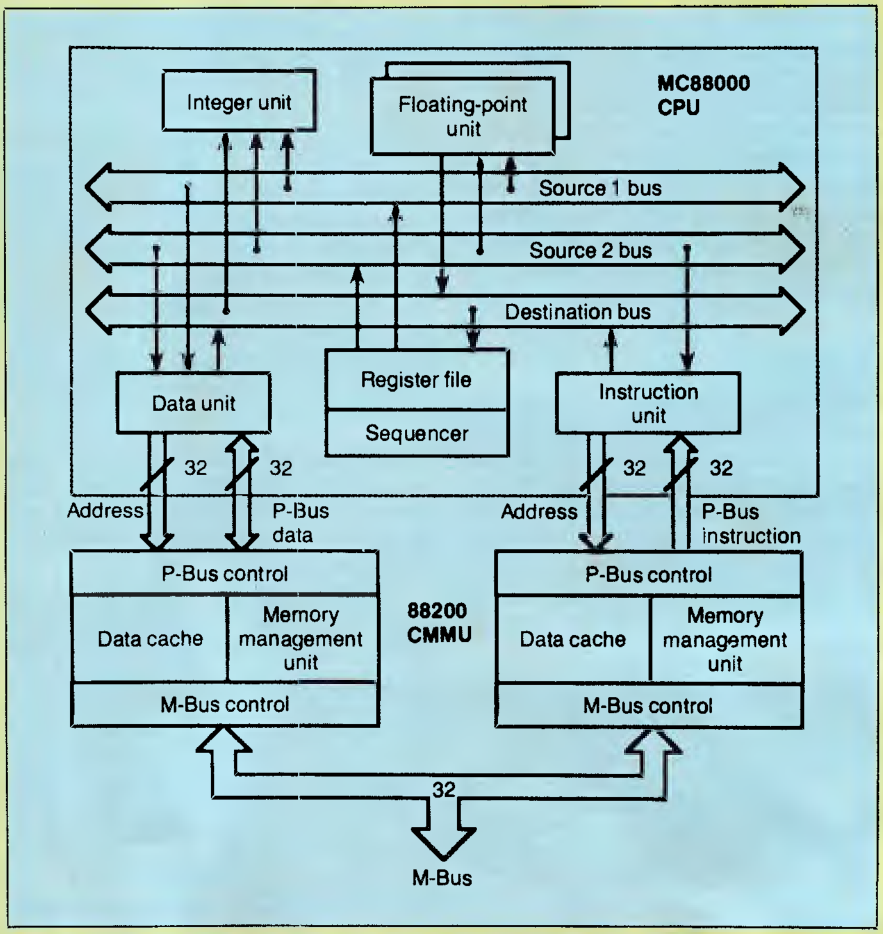

Fig A The Motorola MC88000 RISC processor and support chip block diagram

There is a problem, however. When a new row address needs to be latched, the RAS precharge interval plus a normal access time must elapse. This typically leads to extra wait states at the beginning of a burst sequence. The simulator has been designed to estimate additional SCRAM penalties.

Since the instruction stream only rarely (less than 10 per cent of the time) goes outside the current page, interleaved burst-mode SCRAM instruction memories can be very effective.

It really works

I recently designed a Macintosh II coprocessor board using the Am29000. It is typical of the designs that you can achieve using these memory interface architectures.

Possibly the most important factor you need to determine in a design is how much space you have available to hold it. This is usually the prime determining factor in choosing between SRAM and SCRAM and between extemally bused and closely coupled (nonbused) systems.

Deciding to go with an external but (eg, the VME bus) for your memory interface immediately sets an upper bound on the performance of memory-intensive applications. Buses have considerable

overhead when they have to match 40ns cycle times. You just can't use interleaved burst mode in a bused system and achieve anywhere near the zero-wait-state performance of a closely coupled configuration, even when the bus is combined with an SRAM local cache. Thus, the necessity for a memory bus structure must be carefully balanced against the need for performance.

Conversely, there is a limit to the amount of memory that can be closely coupled to a CPU. This limit is determined not only by loading the CPU address and data outputs to capacity but also by the available space on the CPU board itself. At the moment, loading 512k of SRAM (256kbit technology) or 2Mbytes of SCRAM (1-megabit technology) to capacity would fully load each internal bus of the Am29000.

In my case, I elected to use the Macintosh NuBus for access to peripherals, keeping the memory closely coupled to the CPU. I chose SCRAM for instruction memory, but due to the performance penalty incurred by SCRAM page-miss cycles, I selected SRAM for data memory. Size considerations then led me to choose 512k of 64kbitx4 chips in both technologies. It's interesting to note that the 512k of SRAM costs almost 10 times what the same amount of SCRAM costs.

The performance simulation shows that the penalty for using SCRAM in the instruction memory was about 10 per cent in this case. Although that may seem quite high, if you run the simulation for the same parameters using a 512-word page size (which is what you would get with 1-megabit SCRAMs), the penalty is only 2.3 per cent.

'The usefulness of these new memory designs is intimately interwoven with the sophistication of the software they will execute.'

The usefulness of these new memory designs is intimately interwoven with the sophistication of the software they will execute. It's obvious that the early version of the MetaWare C compiler (and associated run-time libraries) that I used makes frequent branches or calls that are not within the current page of 256kbit SCRAMs. The real performance potential of these new architectures will require further development of compiler and linker technologies. For example, placing small subroutines in-line rather than calling them makes a major difference in the performance of SCRAM-based systems.

Pushing beyond

In 1985, the performance of microcomputers rivaled that of minicomputers. When the DSI-32 achieved 1500 Dhrystones (August 1985 *Byte* magazine), it was cause for celebration; yet today's high-end personal computer is capable of much greater performance.

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* **Olivetti-AT&T CGAII 640 x 400**
* **CGA 640 x 200, Hercules,** MDA
* **IBM 3270** (Models 2, 3, 4 & 5)
* **PAL/NTSC** Composite Video/Audio

FULL HOUSE ♠™ by	TVM	NEC	TAXAN	SONY
CRT Size (True)	**14"**	13"	14"	14"
Dot Pitch mm	**.31**	.31	.31	.26
Horizontal Res.	**910**	800	800	900
Vertical Res.	**620**	560	600	560
Horz. Scan KHz	**15-39**	15.7-35	15.7-37	15-34
Vert. Scan Hz	**45-75**	50-60	50-60	50-100
Video Band	**32**	30	30	30
MONO Version	**YES**	NO	NO	NO
CGA Card	**YES**	YES	YES	YES
Hercules Card	**YES**	NO	YES	YES
EGA Card	**YES**	YES	YES	YES
PGA Card	**YES**	YES	YES	YES
800 x 600 Card	**YES**	NO	NO	NO
VGA (IBM PS/2)	**YES**	NO	NO	NO
Apple MacII, SE	**YES**	NO	NO	NO
132c x 45r Text	**YES**	NO	NO	NO
3270 (2,3,4,5)	**YES**	NO	NO	YES
PAL/NTSC Video	**YES**	NO	NO	YES

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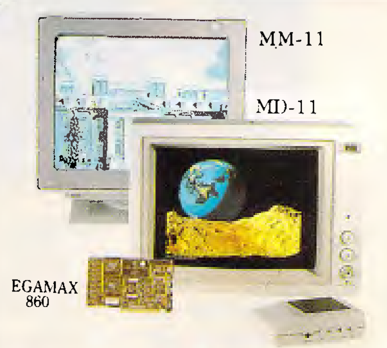
Optional **PAL/NTSC** Composite Video & Audio Signal Decoder (TVMouse) for using the MD-11 as Superhigh resolution **Monitor for VCR,** TV, Video Disk, Camera, Teletext or external video Games.



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Synchronising standards

Adaptable-sync monitors answer the needs of today's diverse graphics standards while looking to the future standards.

In the world of PC computer graphics today, there is no such thing as an enduring standard, much less an endearing one. The safest claim that a vendor can put forth is that its display is the most versatile one available on the market. Many of the graphics-board manufacturers admit, however, that fixing on a single standard is like trying to freeze the electron beam that flies across the shadowmask of a monitor.

The adaptable-sync monitor provides a partial solution to the elusive PC graphics standard. These monitors not only synchronise with the existing graphics standards — the IBM Monochrome Display and Printer Adaptor, Colour Graphics Adaptor (CGA), Enhanced Graphics Adaptor (EGA), Video Graphics Adaptor (VGA) and Professional Graphics Controller (PGC) — but they also will be able to accept signals from future graphics boards that exceed the current standards.

Earlier monitors, such as IBM's Monochrome Display and Colour Display, were designed to be used only in tandem with their associated display board. The IBM Enhanced Colour Display provided the added flexibility of allowing either the CGA or the EGA to be attached. Now, with an adaptable-sync monitor the user can change or upgrade his display system without having to buy a different monitor.

Nippon Electric Corporation (NEC) led the way in the field with its Multisync monitor, introduced in 1985. Since then several competitors have entered the market. For this article *APC* examined eight of them and Table 1 compares the specifications of these monitors.

Existing standards

The IBM monochrome display adaptor has a resolution of 80 characters by 25 rows with each character being 9 by 14 dots. This gives a dot resolution of 720 by 350. The monochrome display accepts a transistor-transistor logic (TTL), digital, horizontal synchronisation pulse at 18.432kHz with a 50Hz refresh rate. The signals from the display adaptor are

Monitor	Horizontal sync Frequency (kHz)	Vertical sync Frequency (Hz)	Maximum horizontal resolution (pixels)	Maximum vertical resolution (pixels)	Shadow-mask pitch	Price
Logitech Autosync TE5155	15.5 — 35	45 — 80	800	560	0.31	$1354
Eizo Flexscan 8060S	15.7 — 35	50 — 80	820	620	0.28	$1423
NEC Multisync XL	21.8 — 50	50 — 80	1024	768	0.31	$5500
Princeton Ultrasync	N/A — 35	45 — 120	800	600		$1170
Sony Multiscan CPD 1402E	15 — 34	50 — 100	900	560	0.26	$2088
Thompson Ultrascan 4375M	15.6 — 35	45 — 75	800	560	0.31	$1740
Teco TE5155	15.5 — 35	45 — 80	800	560	0.31	$1272
TVM Multifunction/2 MD-11	15 — 38	47 — 75	800	600	0.31	$1350

Table 1 The adaptable-sync monitors can accommodate the analogue signal of the VGA and digital inputs from the TTL display adaptors

the vertical sync pulse, the horizontal sync pulse, and the video pulse. The bandwidth of the monitor, the maximum dot frequency it can display, is 16.257MHz at a –3-decibel level.

The IBM CGA can display two colours from a palette of 16 at its maximum pixel resolution of 640 by 200. Its display is non-interlaced like the monochrome adaptor; RGBI signals are sent as TTL digital signals along with the horizontal and vertical sync pulses. The refresh rate on the CGA is 60Hz; the horizontal sync frequency is 15.75kHz.

Of much higher resolution is the IBM PGC, an analogue board with a display resolution of 640 by 480 that can display 256 colours from a palette of 4096. The PGC requires a high-resolution analogue display, such as the IBM Professional Graphics Display, in which the colour signals are sent in analogue form and are translated into RGB components within the monitor itself.

This means that the monitor cannot be used with other types of display adaptors; however, the PGC does emulate the CGA, thus allowing CGA-compatible software to be run. The Professional Graphics Display has a horizontal scan frequency of 30kHz with a refresh rate of 60Hz and A bandwidth of 25MHz. Despite its high resolution and more extensive range of colours, the PGC has not gained popularity because of the high cost of the controller and monitor — over $5000. Applications software for the PGC requires a custom device driver to use the facilities of the display system. Many CAD companies have opted to write drivers for slightly more expensive display systems that give resolutions around 1024 by 1024. These display systems then can be sold as OEM products.

The more reasonably priced EGA has emerged as the most popular standard for graphics applications, primarily because of its backward compatibility. Existing applications that run on the CGA can function without modification on the EGA, and vendors can upgrade their software to use the EGA.

The IBM EGA has a maximum resolution of 640 by 350 pixels, displaying 16 colours from a palette of 64. This requires a horizontal scan frequency of 21.8kHz and refresh rate of 50Hz. When in this 16-colour mode, the signals sent to the monitor are two red, two green, and two blue signals (RGBrgb). These colour signals, along with the horizontal and vertical sync pulses, enable a larger range of colours to be obtained than is possible with the CGA.

The latest from IBM, the VGA, also uses a high resolution analogue colour display. Since all the hardware is bundled with PS/2s (Model 50 and above), users find themselves obliged to adopt the new standard.

Performance limits

Adaptable-sync monitors have theoretical maximum performances. Using the specifications supplied by the manufacturers provides some insight into the possible life span of these units. As an example, NEC claims its Multisync can display up to 800 pixels horizontally and 560 vertically and the Sony Multiscan monitor is specified as being able to display up to 900 by 560 pixels. This provides room for the standard to grow while still accommodating previous standards, by being able to attach either an analogue or a digital display adaptor. The new monitors allow users to take advantage of the evolving standards without knowing what the next major standard will be.

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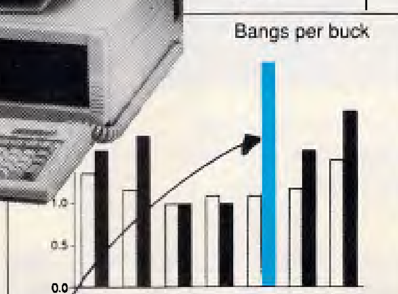

'Bangs per buck' — just one way of comparing the relative merits of these seven ultra-cheap clones. The lighter shading denotes price (in thousands of dollars) and the darker shading a performance index. See Table 3 for more details. (Machines in order from left to right are ... Atlantis, Rod Irving, MicroDOS, Commodore, Uni-x, ...onics and Techn...

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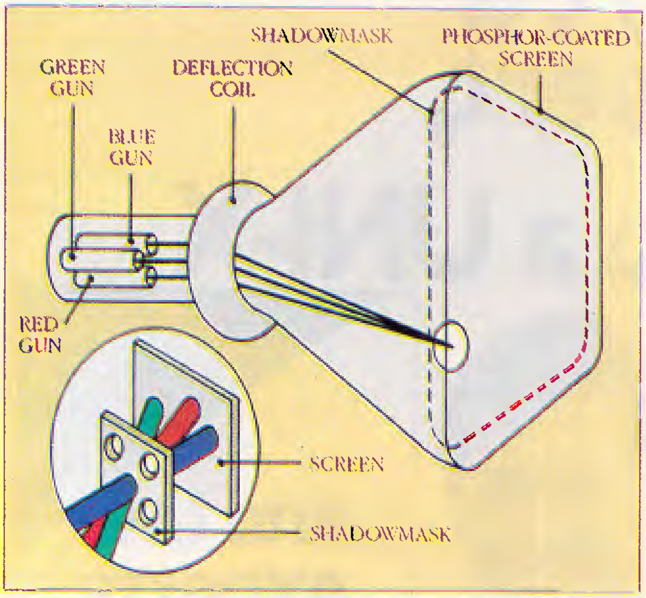

Fig 1 The three-gun CRT. The three guns at the rear of the cathode ray tube emit a beam of electrons toward the front of the tube. They converge at the shadowmask and pass through onto the screen, causing their respective phosphor dots to glow as the pixel

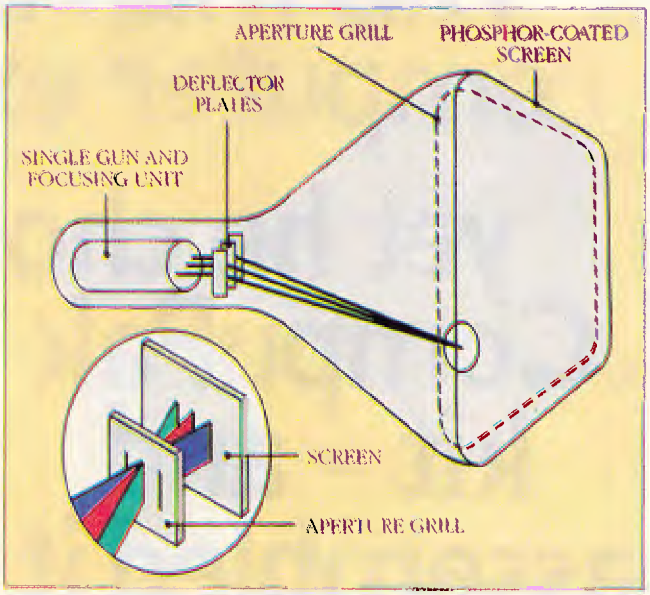

Fig 2 The Single-gun colour CRT. The single-gun assembly within the Sony Trinitron tube emits three beams of electrons side by side that make up the pixel. This design enables the convergence setting to be simpler because the three beams are on a single axis

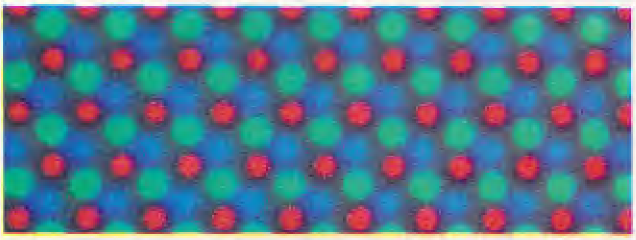

Photo 1 A triangle of three dots makes up a single pixel. The actual colour of the pixel is determined by the brightness of the combination of the three phosphor dots

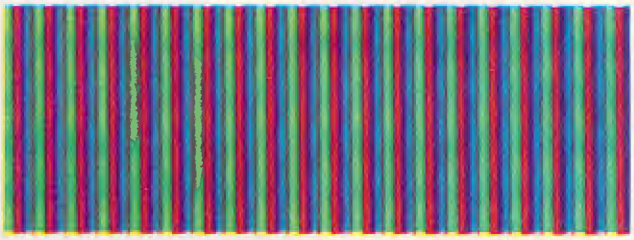

Photo 2 With a Sony aperture grill, the pixel is made up of the three slots side by side. The pitch of the Sony mask is 0.26mm

monitors can be appreciated by an understanding of their various limiting specifications. A monitor consists of a cathode ray tube (CRT) that has an electron gun in the rear. This gun transmits a beam of electrons from the rear of the tube to the front phosphor-coated screen that is seen by the user. The electron beam is moved from side to side by the deflection coil using the horizontal sync pulse and from top to bottom by the deflection coil using the vertical sync pulse.

With a colour display the operation is expanded. A CRT can have either three guns (see Fig 1), one each for the red, green, and blue signals, as with the NEC monitor; or it can have one gun, as with the famous Sony Trinitron system (see Fig 2).

For a three-gun system a beam of electrons is sent from the rear of the tube from each gun. The beam passes through a shadowmask (a precision-drilled plate with holes) before reaching the screen. Each pixel consists of a triangle of three phosphor dots — one red, one green, and one blue (see Photo 1). The size of the pixel is sufficiently small that the human eye is tricked into seeing a colour that is a combination of the red, green, and blue components rather than the individual dots themselves. The size of the holes in the shadowmask and the pitch of the mask (the distance between adjacent holes) affect the clarity of the pixel.

In the single-gun Sony Trinitron system the pixel consists of three strips side by side as the gun transmits three beams of electrons side by side (see Photo 2). The equivalent of a shadowmask for this type of monitor is an aperture grill with vertical slots, rather than circular holes.

The signals from the monochrome display, CGA, EGA, and high-resolution EGA boards are digital. The video signals contain the on/off information about a particular pixel that is to appear on the screen. For the monochrome display, the information is in the video pulse that is transmitted from the adaptor to the monitor. In the colour displays the red, green, and blue information for each pixel is sent individually. Once it is received by the monitor, this information is converted to analogue form and sent to the colour guns.

The video signal transmitted from the PGC and VGA are analogue; it is used more directly by the monitor. Because the display adaptor is supplying the colour information, the adaptor and monitor need to be in the tune with each other.

Adaptable-sync monitors do not accept just one type of input. Fig 3 shows a functional block diagram of an adaptable-sync monitor. A switch on the monitor enables the user to select either analogue or digital input. The incoming signals are synchronised and used to

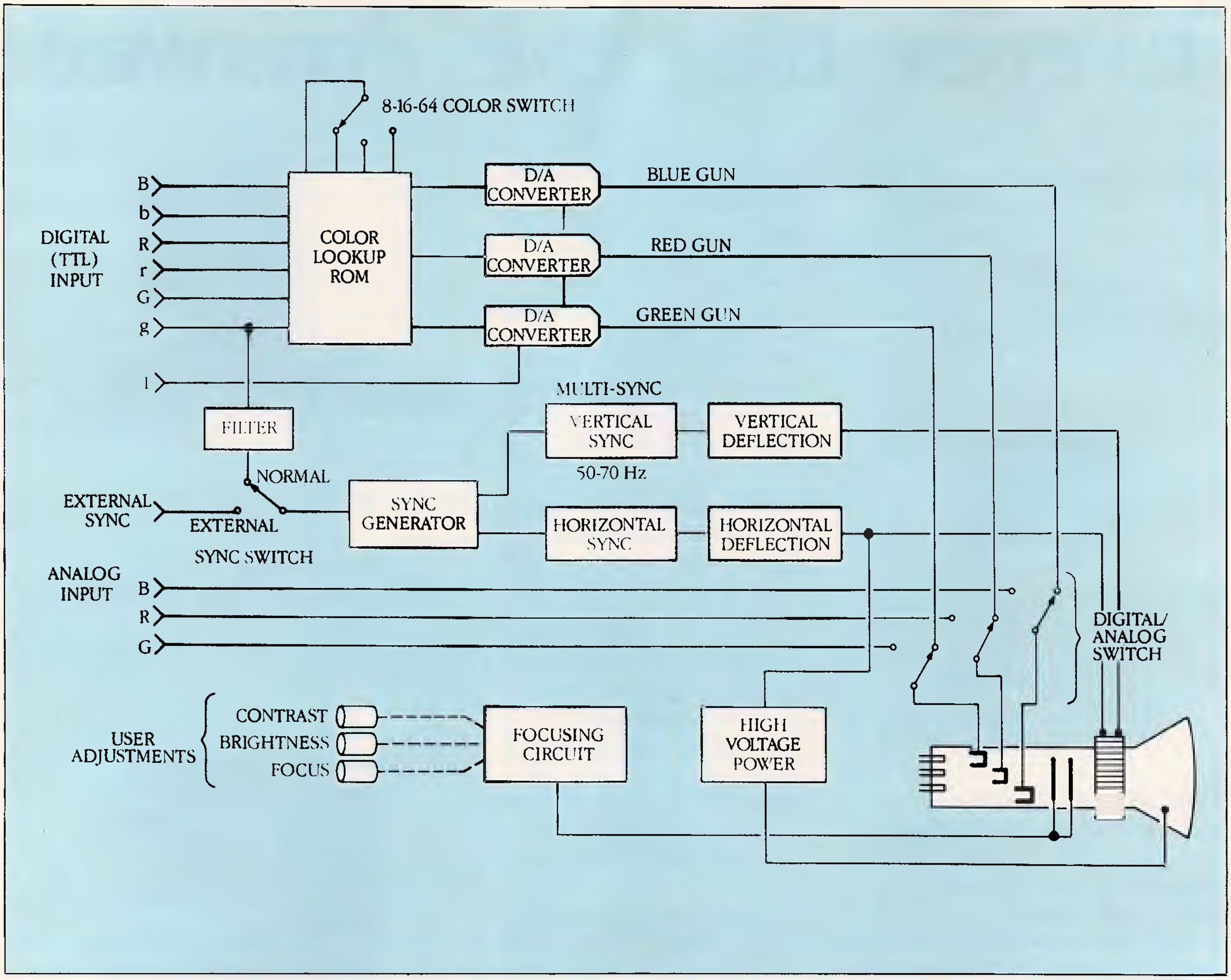

Fig 3 Functional Block Diagram. The analogue display adaptor has a separate input to the monitor. The monitors cannot be damaged by incorrect switch settings

create the display. The horizontal and vertical sync frequencies vary among adaptors. Adaptable-sync monitors can accept these variations and produce a satisfactory display with a variety of resolutions and colour ranges.

The maximum horizontal sync frequency limits the number of horizontal lines that can be displayed per second, and vertical sync frequency affects the refresh rate for the screen. The bandwidth of the monitor is the limiting factor of a display. Its value gives an indication of how many dots per second can be displayed without blurring the image. Blurring results from the colour information being fed to the guns faster than the monitor can move to the next hole in the shadowmask. For the PC market the limits for the monitor need to be translated into pixels in order to judge the highest future standard that an adaptable-sync monitor can support. The bandwidth and the maximum horizontal and vertical sync frequencies, including the horizontal and vertical retrace times, are used to calculate the maximum number of pixels that can be displayed on a monitor.

The adaptable-sync monitors on the market translate the horizontal and vertical sync frequency limits into horizontal and vertical pixels (see Table 1). Depending on the future designs of the display-adaptor manufacturers, these numbers mean that a new graphics standard can appear on the order of 800 by 600 without requiring a new monitor.

A variety of adaptable-sync monitors is available. They each vary ergonomically and visually with the colours that they produce, but they all have similar functional specifications. Most of the monitors examined here are major contenders in this emerging market. Their individual descriptions below reveal some of the variations among the units.

The selection of a monitor requires some experimentation before purchase. One consideration should be the monitor's particular environment, including ambient light and glare, which may affect individual requirements. The monitor must be tested with the display adaptors that are to be used with it, and the colours produced by the monitor should be examined.

The choice of monitor depends on the individual taste and needs of the end user. For CAD applications the clarity of the colours may be the most important feature to consider. In other applications, such as the use of prepared slide shows, it may be more essential to have colours that are identical to those on an IBM monitor. The colour produced on the adaptable-sync monitors varies among the different models. For example, some of the monitors display brown (which is

really intense yellow) as a true brown representation as the IBM monitors do, whereas others display it as intense yellow or a mustard colour.

The adaptable-sync monitors have several adjustment controls, such as vertical hold, horizontal hold, vertical size, and horizontal size. Not all of these are available on board-specific monitors. For example, the IBM Enhanced Colour Display has brightness and contrast controls and two vertical size controls, but no horizontal controls.

The actual size of the display window varies on an adaptable-sync monitor whenever different display adaptors are installed. However, the various monitor controls, such as the vertical size and width, can be used to adjust the picture for the particular adaptor in use. The amount of adjustment that is necessary depends on the specific monitor design and set-up as it was shipped from the manufacturer.

Most units degauss, or demagnetise, the screen during a warm reboot. This feature prevents any colour smears caused by residual magnetism that may remain from the previous display. These adaptable-sync monitors are also forgiving; they will tolerate the switches being set incorrectly without causing damage to the unit. This characteristic is different from the earlier, board-specific models.

Additional features may be available on the individual monitors. The NEC Multisync monitor allows the display of text to be a colour that is specified by the monitor instead of by the applications software. The monitors may require separate cables for use with different display adaptors. For example, the Sony Multiscan requires a different cable for the analogue than it does for the TTL display-adaptor boards.

Teco TE5155

This 14in diagonal screen monitor features a flip top cover on its right side al-

The Teco TE55155 features four LED indicators on the front-panel

The TVM multifunction/2 MD-11 is also available in a monochrome version

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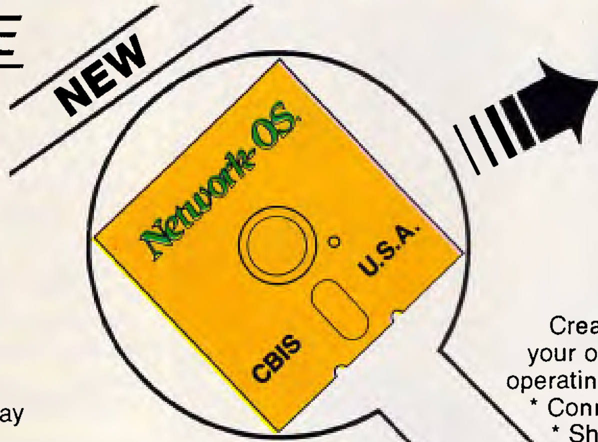

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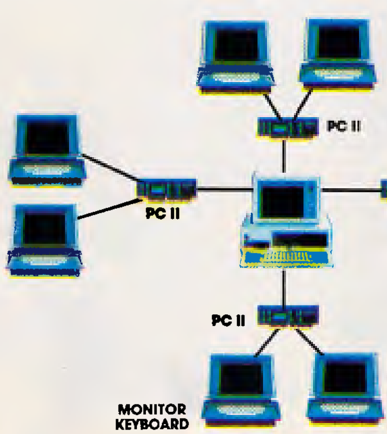

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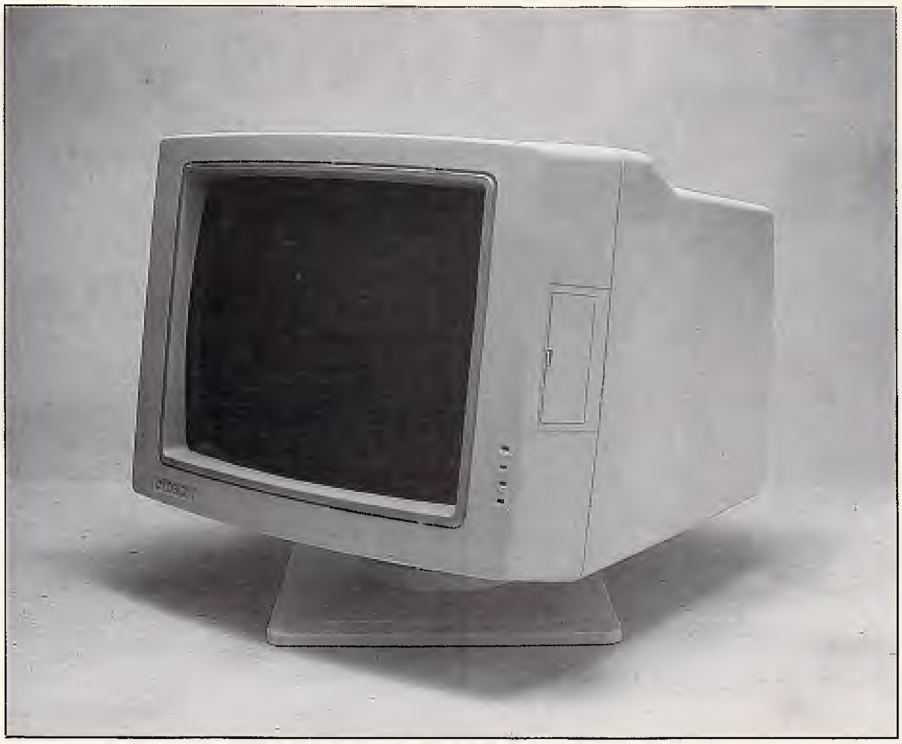

The Logitech Autosync TE5155 has its controls located behind a flip-open cover on the side

lowing access to contrast and brightness controls, text mode, size and positioning adjustments and width. Four mode indicator LEDs on the front panel are provided, with additional controls on the rear to select colours, manual over-ride, and TTL/analogue selection.

The Teco TE5155 and the Logitech Autosync TE5155 are actually the same monitor — we're not sure who came first, but it is a definite job of badge engineering.

The only major difference is the price — and that isn't major. The Teco version costs $1272, while the Logitech model will cost you $1354.

The second best shadowmask pitch is provided by the Eizo Flexscan 8060S, just 0.28mm

TVM Multifunction/2 MD-11

The TVM MD-11 front panel features only a single LED power indicator, accompanied by three knobs providing control over power, brightness, contrast and colour suppression. A flip top instrument recess on the top provides access to controls covering vertical and horizontal positioning, size, hold and width.

Further controls on the rear set the colour mode, and select between TTL or analogue input. A 9-pin D-shell input connector is also positioned on the rear.

Most unusually, the TVM features a 'mouse' connector next to the video input. This is not a mouse in the conventional sense (although it does slightly look like one), but a video signal adaptor which allows you to interface the monitor to TV tuners, VCRs, video disks and cameras. The mouse comes complete with a speaker, volume, brightness and contrast controls, and is an optional extra.

The 'mouse' is a great idea. The only criticism we have is its name. Everybody in the *APC* office was rushing past and asking how a mouse could be connected to a monitor, and then being slightly confused by the explanation, "it only says it's a mouse — it's not really a mouse." We might suggest 'hard disk controller' to be a better name, but really, it isn't one of those, either.

The monitor itself supports horizontal scanning of 15 to 8kHz with a maximum resolution of 800 by 600, with a dot pitch of 0.31mm. The unit weighs 33 pounds, and comes complete with a 27 page instruction manual covering installation, usage, specifications and a troubleshooting guide.

Logitech Autosync TE5155

This monitor has overall dimensions of 13 by 15 by 15ins and weighs 31 pounds. Its 13in screen is polished. The bezel is deep, and overhead lights throw a shadow on the top edge of the screen.

All the commonly-used controls are conveniently located on the side panel behind a flip-open cover. These controls include switches for text mode (on/off)

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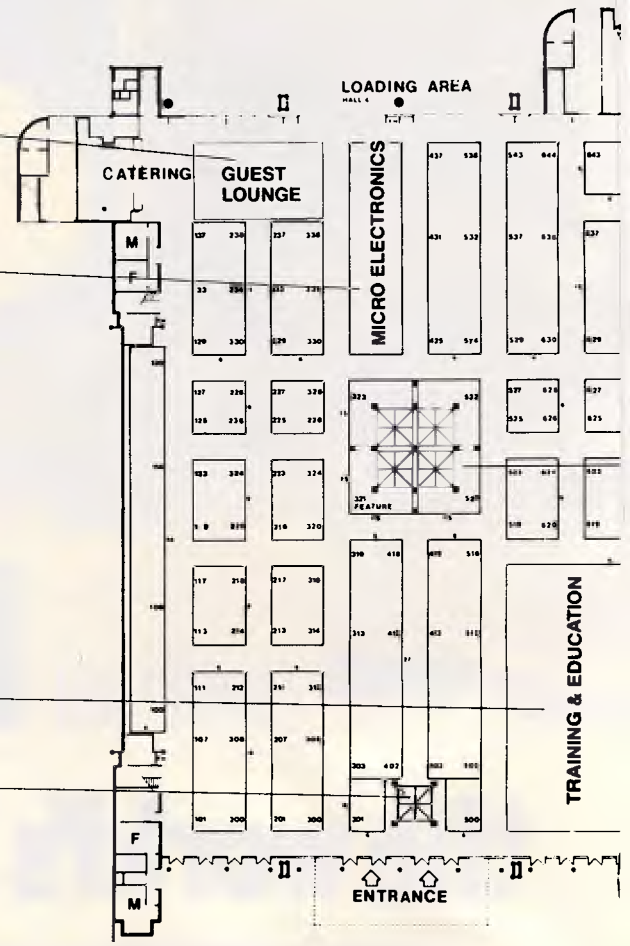

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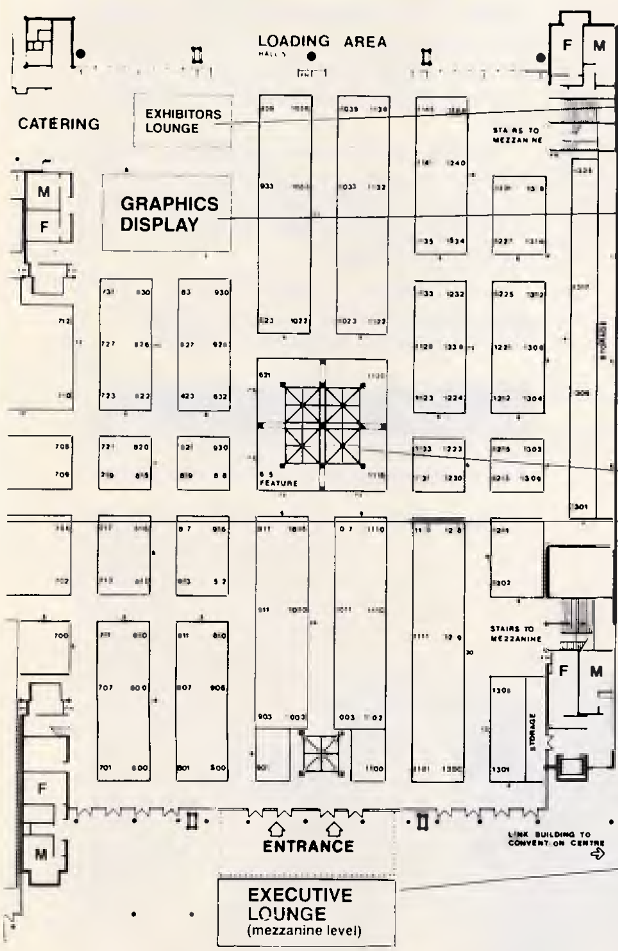

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FARWAG! 7551

Top of the line; the NEC Multisync XL is the largest, highest resolution and most expensive

The Princeton Ultrasync is the cheapest of the eight monitors reviewed

and horizontal width (on/off); and adjustments for contrast, brightness, horizontal and vertical position, and horizontal and vertical size. The size and position of controls close to the front make it easier to adjust the picture.

On the rear panel you'll find additional controls to select the scan mode and analogue/digital input. A set of micro-switches selects the colour to be used in text mode; any of eight colours may be selected. Additional micro-switches let you adapt the monitor for use with various non-IBM colour adaptors, and a single 9-pin D-shell plug accepts analogue and digital inputs.

Video bandwidth is 40MHz and the maximum resolution is 800 by 560. The horizontal scanning rate is up to 35kHz; vertical, 45 to 80Hz.

The picture shifted positions in certain modes of a diagnostic test, requiring additional setting of the horizontal position and size controls. Colours were very close to those on the PS/2 display, with reds a little deeper and whites not quite so white.

The documentation we received with the unit was a very complete user's manual, including pin-outs and a troubleshooting guide. Warranty is one year parts and labour.

EIZO Flexscan 8060S

This monitor has a dot pitch of 0.28mm, which is very small compared to the 0.31 pitch of most of the other monitors we tested. The unit has a 13in etched screen, measures 13 by 14 by 16in, and weighs 29 pounds. The bezel is fairly deep, limiting the effects of nearby light sources.

Most of the adjustments are conveniently located on the front panel: brightness (adjusts all colours), contrast (adjusts all but high-intensity colours), horizontal size, vertical size, amber/colour/white (the amber and white positions are for use with monochrome adaptors), and power. The power-on LED glows orange when the unit is set for digital operation and green when the unit is set for analogue operation.

Rear panel controls include vertical position, horizontal position, colour mode (automatic preset or manually set to 8/16/64 colours), and analogue/digital. The signal input is a single 9-pin D-shell plug.

The Eizo's bandwidth is greater than 30MHz, according to specifications, and its maximum resolution is 820 by 620. Horizontal scanning rate is up to 35kHz; vertical, 50 to 80Hz.

The 13-page manual provides brief operating instructions, pin assignments, timing diagrams, and specifications.

NEC MultiSync XL

This $5500 unit measures 19 by 19 by 21ins and weighs 57 pounds. Its screen measures 19in and has a medium bezel; it shows sharp reflections that are attenuated so as not to be distracting.

Front-panel controls include power,

At 0.26mm, the Sony Multiscan CPD 1402E has the best shadowmask pitch

The unit we received did not come complete with documentation.

Sony Multiscan CPD 1402

This $2088 monitor measures 12 by 14 by 17ins and weighs 32 pounds. Its cylindrical 13in screen gives sharp reflections. The shallow bezel accepts light from nearby sources but does not cause shadows from overhead lights. The dot pitch on this monitor is 0.26mm, the finest of all we included in this review.

Side panel controls (not visible while looking at the screen) are for power, contrast (adjusts all but intensity), and brightness (adjusts all). On the rear panel are controls for analogue/digital select and horizontal/vertical position and size. Also on the rear panel is a mode switch for digital operation, selecting eight, 16, or 64 colours. A single 9-pin D-shell plug accepts digital and analogue input.

Bandwidth of this monitor is 25MHz. Maximum resolution is 900 by 560. Horizontal scanning rate is up to 34kHz; vertical, 50 to 100Hz.

The 25-page English/French operating instruction booklet included brief instructions for setup and use of controls, plus specifications and timing charts.

brightness, contrast, horizontal and vertical size and position, text mode, text colour (green, amber, or white), input BNC/D-shell, and a degauss button. Back-panel controls include an automatic/manual colour set switch, a digital/analogue switch, an 8/16/64 switch for manual colour setting, and an input voltage selector. For signal input, the unit has a 9-pin D-shell plug (analogue or digital signals) and four BNC plugs (analogue signals). A tilt-swivel stand is included.

The NEC MultiSync XL's bandwidth is 65MHz, and resolution is up to 1024 by 768. Horizontal scanning rate is up to 50kHz, and vertical scanning rate is 50 to 80Hz.

The Thompson Ultrascan 4375M has most common controls on the front-panel, with more on the rear

Princeton Graphic Systems Ultrasync

This monitor has a 12in etched screen and measures 12 by 13 by 14ins. The unit weighs 26 pounds. It comes with a tilt-swivel base.

Side panel controls are for brightness, contrast, text mode (green on black, amber on black, white on blue, or normal colour display), and power. Rear panel adjustments are for horizontal/vertical size and position; switches are for underscan and overscan, 16/64 colours for use in digital operation, and digital/analogue. A single 25-pin D-shell plug accepts digital or analogue inputs.

Bandwidth of the Ultrasync is 30MHz, and maximum resolution is 800 by 600. Scanning rate is up to 35kHz horizontal and 45 to 120Hz vertical.

Thompson Ultrascan 4375M

This monitor measures 13 by 14 by 15ins and weighs 28 pounds. The 13in screen is tinted and etched to reduce glare and diffuse reflections. The bezel is fairly deep, reducing the effects of nearby lights but also allowing shadows on the screen.

Front panel controls include power, brightness (changes all but high-intensity colours), and contrast (changes all colours). Rear panel controls include switches for selecting analogue/digital/composite video, normal/monochrome, and underscan/overscan, as well as adjustments for tint and colour (for use with composite colour video input) and vertical/horizontal position and size. Separate inputs are provided for digital signals (9-pin D-shell plug), analogue (25-pin D-shell plug), and composite video (BNC plug).

Bandwidth of the 4375M is 30MHz, and maximum resolution is 800 by 560. Horizontal scanning rate is up to 35kHz; vertical, 45 to 75Hz.

The 34-page English/French operating instructions included detailed instructions for connection and use of controls, specifications, special features (eg, superimposition of images), a troubleshooting guide and timing charts.

END

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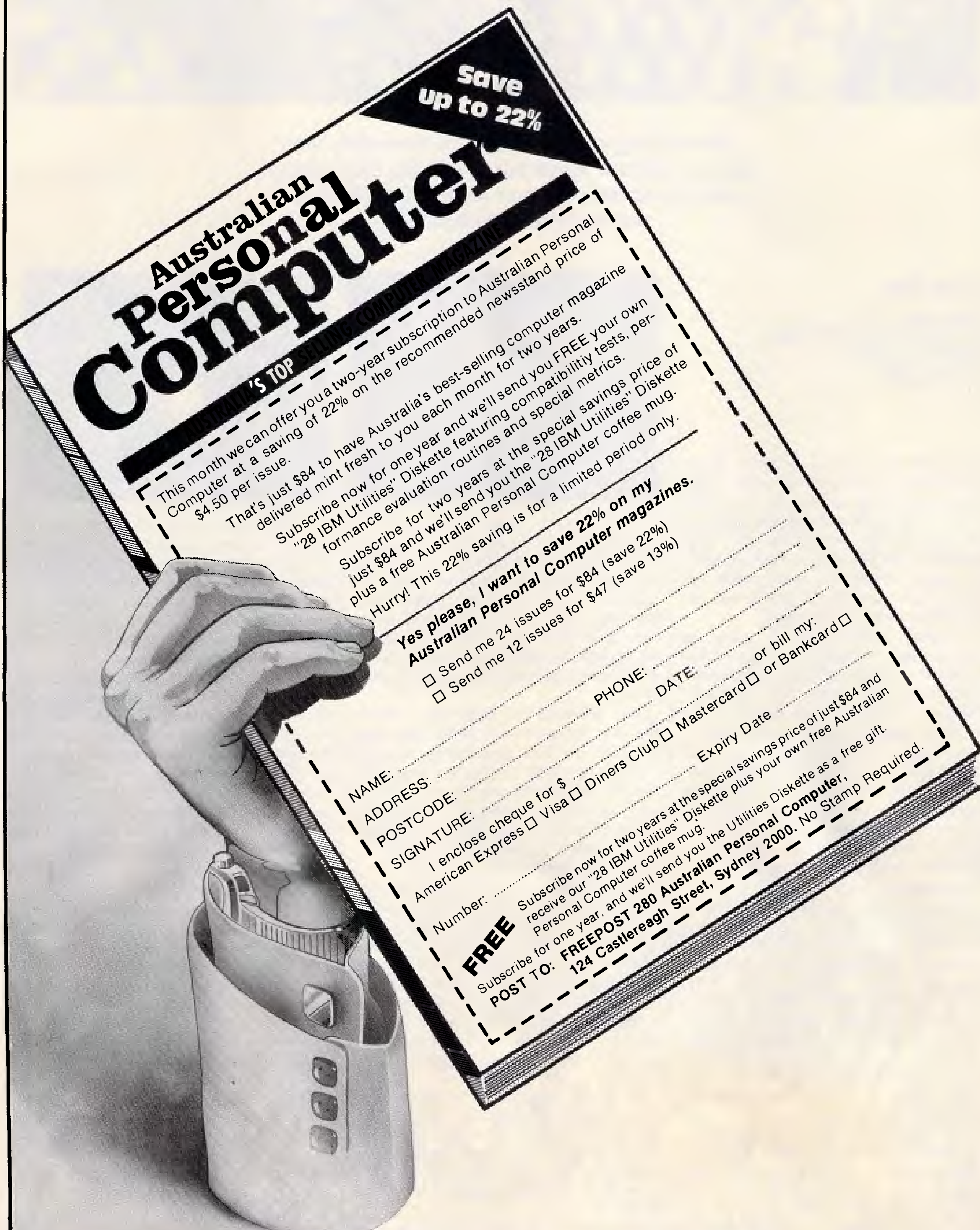
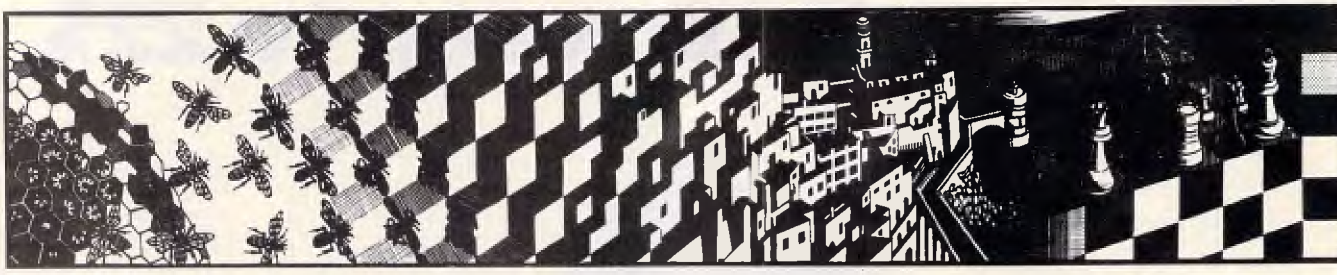




After diving to the depths of humanity last month, Steven Applebaum shoots into space aboard Apollo 18, then returns to Earth for some leisurely mutating.

Low life

Title: Eco
Computer: Atari ST; Amiga
Supplier: Ozisoft
Format: Disk
Price: $69.95

The survival of our species is not something many of us have much cause to think about in our daily lives. With food and shelter available in abundance, we pass our days almost mechanically, worrying neither about where the next meal will come from nor about where we will stay after leaving the office.

Imagine, then, what it would be like to live in a world without all the material things we have surrounded ourselves with over the centuries. Imagine, in fact, what it would be like to be a creature fighting for survival in a world where animal life is divided simply between predator and prey. If you were one of the latter, would you be able to survive? Moreover, do you think you could survive long enough to evolve into the dominant species, hunter of all creatures and prey to none?

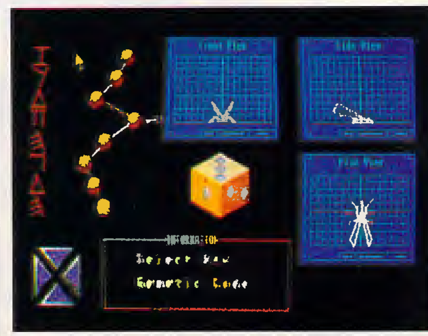
These rather intriguing, if inadequately hypothetical, questions are the basis for Eco, an intelligent, and brilliantly conceived and executed program from Ocean. Unlike anything you have seen before, Eco is a stunning, if highly stylised, simulation of a world inhabited by a large variety of fauna and flora representing almost every level of the food chain. Starting from the lowest form of life — say, a fly or a worm — you must eat, mate, and develop more complex offspring, with the aim being to develop so far that you are able to hunt *anything* without fear of being hunted yourself.

Eco opens with a beautifully-presented and thought-provoking extract from Darwin's *Origin of Species* that effectively galvanises one's imagination into overdrive. Having created the right atmosphere, the program then goes on to select randomly an ecosphere based on one of several different worlds, each with its own climate.

The diversity of plant and animal life that subsists in a world depends entirely on the prevailing climatic conditions. For instance, only the likes of scorpions can live in arid desert conditions, while a lush equatorial region gives rise to a large variety of creatures, including simple insects and hominids.

During play, the display divides horizontally into two halves. The top half forms a window on to the world chosen by the computer; and the bottom half contains a number of icon controls to move your assigned creature along the ground in any one of eight directions — to send it on a search for food or, alternatively, for a mate — and, if it is a winged beastie, to make it take off and land.

A small radar feature tracks the movements of other creatures, allowing you to keep an eye out for possible sources of food and, rather more important, for predators who may be planning to make you their next meal.



In the top window, you can see not only your own creature but also any others in the vicinity. This part of the display is testimony to the skill of the programmers at Denton Designs, a name that disappeared from these pages a long time ago but has re-emerged triumphant.

All the creatures are depicted as fully-animated vector graphic figures which run, bound, scuttle, fly or wriggle across the screen without the hint of a flicker. The most impressive of all the animals is the seemingly indefatigable hominid, which runs and walks with immense grace and stops only to pick up a bite to eat, whether it be a hapless insect or a large quadruped.

Using the Atari's arrow, home and insert keys, you can pan around the landscape as though you were in control of a camera able to move in any direction. Via this option, you can move around your creature and examine it from virtually any angle. And, when another animal runs by, you can spin round so that you can watch it run towards you and then away in the opposite direction.

The most important thing to do when the game begins is to find food. Depending on the climate, this can be either super-abundant or scarce; but, no matter where you are, it is always in the form of stubbly grass.

Finding food is simple: all you do is move around the world until you come across a blade or two of green, and then click on the 'eat' icon to start your creature munching. Alternatively, you can click on the eat icon from the outset, in which case your creature will search for food of its own accord.

As your creature eats, a skull, with its jaws chomping, rises on a spine-like stalk in the bottom right-hand corner of the display. When it has risen to its full height, a fire, symbolising death, flickers at the spine's base. As your creature ages, the flames rise until,. at the point of death, the skull is engulfed.

When you have successfully fed your creature, you can send it off to look for a mate. After it has found one, the display changes to reveal an ingenious little item called the 'gene designer'.

The gene designer allows you to play either God or Frankenstein, depending on how you look at it; for this is where new and, perhaps, better life is created. Down one side of the designer runs a line of eight hieroglyphs, beside which are eight corresponding orange balls representing the eight genes that make up your creature's DNA.

Each time your creature mates, you can 'unlock' one of the genes: you can drag the unlocked gene to various positions either left or right of its original one. Each time you move the gene a certain distance, its corresponding hieroglyph changes, indicating a change in the overall DNA structure. The effect this has on the physical characteristics of your creature are shown on a blueprint lying alongside the DNA filament. A gene unlocked in this way remains unlocked, and can be moved in combination with others whenever your creature mates.

Learning what each gene controls is a major part of the game. Sometimes you may unlock one and find that the only effect it has is to give your creature a bigger nose or longer arms. At other times, however, a single displacement can turn your animal from a hominid into a large chicken, or even a slug. But, being a slug is not as bad, believe it or not, as being a plant. Become one of these and your chances of survival are zilch.

When you return to the main screen from the gene designer, the first thing you notice is that your creature is much smaller than all the others roaming about. This is because it is but an infant and, therefore, must be fed to enable it to grow to maturity. Having fed, it can then look for a mate.

One thing you must avoid when creating a new species is making it too exotic. Although giving it wings, a massive proboscis and legs might have seemed a good idea at the time, you will soon find that it becomes extinct through not having another creature even nearly like itself to breed with.

Eco is one of the most unusual, and certainly inventive, games to have appeared on the scene in the past year or so. Its graphics and gameplay make it instantly appealing, though some people, particularly those who go in for shoot-'em-ups, will perhaps find it rather too pedestrian for their tastes.

One small step

Title: Apollo 18
Computer: Commodore 64/128
Supplier: Ozisoft
Format: Disk; cassette
Price: Disk, $39.95; cassette, $29.95

If you are old enough to remember the Apollo space missions, you will no doubt remember the thrill of watching Man's first tentative steps on the moon. And, when Neil Armstrong spoke those immortal words: '... one small step for man, one giant leap for mankind', who but the most blasé could fail to feel a degree of pride at the enormity of the achievement.

Sadly, those pioneering days are gone, at least for now. Not even the Space Shuttle managed to affect the world's collective consciousness in the same way as the Apollo project.

If you yearn to relive the days of lunar landings and heart-stopping splash-downs, Electronic Arts' Apollo 18 is probably as close to the real thing that you can get without actually leaving your front room. It is not a precise simulation as such, but the atmosphere that it creates sure sends a shiver down your spine.

Apollo 18 puts you in the driver's seat, so to speak, of an Apollo rocket. Your mission is to blast off, dock with an orbiting space station, land on the moon, drive around the lunar surface, take off and re-dock with the command module, perform a space-walk, capture a satellite, and then, finally, re-enter the earth's atmosphere and splash-down. Easy, huh?

The blast-off is viewed from inside what I suppose is meant to be the control room at Cape Canaveral. In front of you are a number of controls, beyond which are ranged various monitors manned by control staff members. In the distance, through a window on the far wall, you can see the rocket.

Prior to take-off, it is imperative that you make a number of pre-flight checks via what is called the 'telemetry screen'. There are a number of telemetry screens in the game, each corresponding to one of the mission phases. It is almost impossible to do anything without first of all programming something or other in the telemetry screen.

After making the necessary pre-flight checks, a very clear, very serious, extremely American voice advises you to begin the count-down by pressing the joystick fire button. From here on, success depends entirely on hand/eye coordination.

As the rocket rises from its pad the scene in the far window zooms in on the action, so that you get a view rather like that in the now famous film taken from a camera placed looking down the sleek body of an Apollo rocket as it pulls away from its moorings. Although not nearly as impressive, the game's graphics and roaring engine sound effects are good enough to evoke in one's mind the experience of watching the actual event on television.

AFTER DARK

To clear the first stage safely, you must watch a red strip which moves horizontally across the screen. When it gets to a specific point, you must press the fire button with the aim of stopping the strip as close to said point as possible. When you press the button, a time in 1000ths of a second appears in a small onscreen readout. If, after performing this procedure several times during the first phase, your cumulative time is 148 or greater, the mission is automatically aborted.

Okay, this doesn't sound too bad. But, as well as making sure that the red line does not overshoot the critical point, you must simultaneously keep the craft from over-rotating by moving the joystick left and right. Phew! If you think this sounds difficult, it is; or at least it is until you get the hang of it.

Once out of the earth's atmosphere, you go into a quick orbit before heading off for the moon. From now on, you see things through the eyes of the astronaut manning the craft.

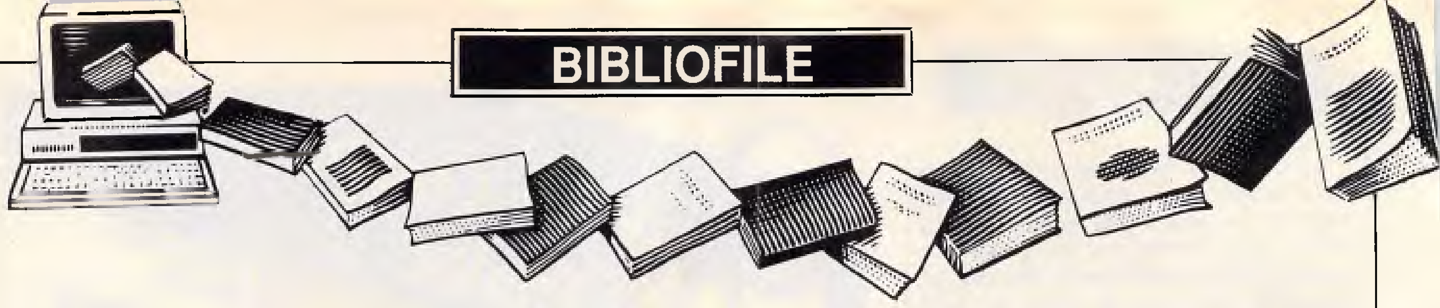
On the way to the moon, a number of course corrections have to be made via the onboard telemetry system, as must a routine docking procedure with an orbiting space station. Once again, a steady hand is required to guide your craft into the docking section of the space station.

One of my favourite phases in the game is the space walk, in which you practise capturing a satellite launched from your craft. The idea here is to guide an astronaut figure towards the satellite, hook it, and drag it back in. This section, like everything else in the game, is scored on the time/number of attempts taken for the satellite to be recovered.

My one gripe about the cassette version of Apollo 18 is that each phase has to be laboriously loaded in separately. If you fail halfway through a mission, this means having to rewind side A and then re-play the tape until the beginning of the load code is found.

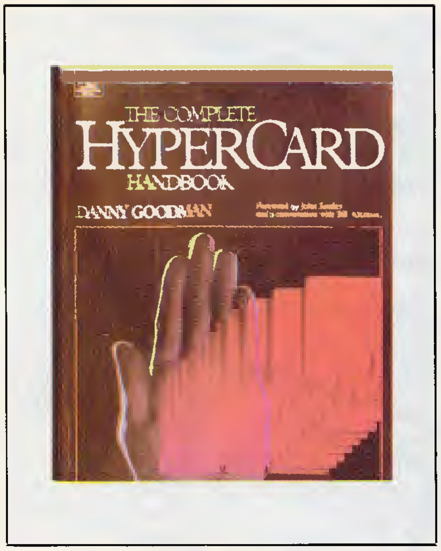
Electronic Arts could make this less tiresome by starting the code near the beginning of the tape instead of what seems nearly a quarter of the way through.

Apollo 18 is a fairly simple but extremely effective evocation of the ethos of the Apollo project. Its graphics are, on the whole, good, as are the sound effects. If you were, or are, fascinated by what was an historic achievement, Apollo 18 will certainly liven up your game-playing.



BIBLIOFILE

With OS/2 breaking new ground in the operating system arena, this month our book reviewers assess current offerings ranging from DOS to Apple's HyperCard.



The Complete HyperCard Handbook

Author: Danny Goodman
Publisher: Bantam Books
Distributor: Transworld Publishers
ISBN: 0-533-34391-2
Price: $70

I am always very suspicious of computer books that are published a matter of weeks after their subject is launched. It usually means one of two things: either the book is no more than a rewrite of the manual, or the author has been commissioned by the manufacturer to write an accompanying book. In the first case, the book is rarely worth the paper it is printed on; in the second, it is often a dull and biased read. *The Complete HyperCard Handbook* is a hefty 700-page tome that arrived at practically the same time as HyperCard itself. I was prepared for the worst.

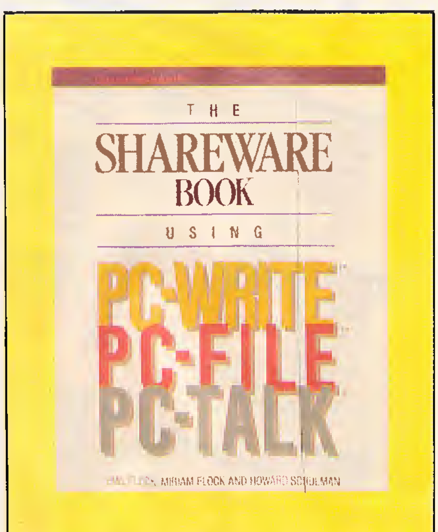
By page 5 if was obvious that this book is different. Author Danny Goodman has been involved with HyperCard for the past year and a half, since the time it was little more than a few MacPaint pictures. By page 10 I'd fired up my Macintosh and was busy following a guided tour of HyperCard concepts. *The Complete HyperCard Handbook* is not a reference book; it is a book to be worked through page by page with a Macintosh in front of you all the way.

The book is basically divided into four sections: Browsing through HyperCard, HyperCard's Authoring Environment, HyperCard's Programming Environment and Applying HyperCard & HyperTalk.

The section on HyperCard's programming environment is where the book really excels, for me totally replacing the official Apple documentation. I particularly recommend this section for those with no previous programming experience, as the author purposefully steers clear of making analogies with existing programming languages. One chapter which lists the properties of every element in HyperCard is now incredibly dog-eared after less than one month's use.

HyperCard is a wonderful piece of software. *The Complete HyperCard Handbook* is a wonderful book.

Barbara Gaskell



Mastering DOS

Author: Judd Robbins
Publisher: Sybex Computer Books
Distributor: Methuen Publishers
ISBN: 0-89588-400-3
Price: $49.95

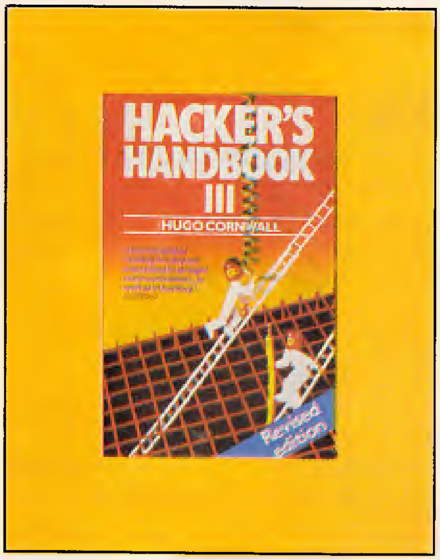
This large (500+ pages) book is both a tutorial introduction and a user's guide to the principal IBM PC/XT/AT operating systems PC-DOS and MS-DOS, covering versions 2.0 through 3.3. As with most books of this genre, it starts from first principles with an introduction to hardware and software concepts and how to back up disks before moving on to elementary DOS operations. The next section is a tutorial-based guide aimed at introducing elementary file manipulation and setting up suitable directory structures for running different application packages.

From the halfway stage in the book, the emphasis shifts from a tutorial approach to a more advanced text covering DOS usage for power users and system programmers. Unlike many DOS books, this section is not merely a catalogue of DOS features but clearly explains the use of such features through well-documented examples. Many of these examples are available on a disk which you'll have to obtain from the publisher in the US as the Australian distributor, Methuen Publishers, is not making the disk available to Australian customers.

It is a measure of the quality of this book that the same clarity of description found in the introductory sections is maintained in the highly technical advanced section. This advanced section covers virtually every aspect of DOS including keyboard customisation, sophisticated batch file usage and connecting multiple disk drives into a single DOS directory structure. The last chapter looks at a range of utility software available for DOS machines and gives an even-handed assessment of their capabilities and limitations.

I very much liked *Mastering DOS*. It is clearly written, authoritative and, for once, succeeds in taking the reader from elementary DOS through to the design and application of sophisticated utilities. Either as a tutorial introduction or as a reference book for more advanced users, this book is one of the clearest and most authoritative guides to DOS that I've read.

Dr Simon Jones



Hacker's Handbook III

Author: Hugo Cornwall
Publisher: Century Hutchinson
Distributor: Century Hutchinson
ISBN: 0-7126-11479
Price: $19.95

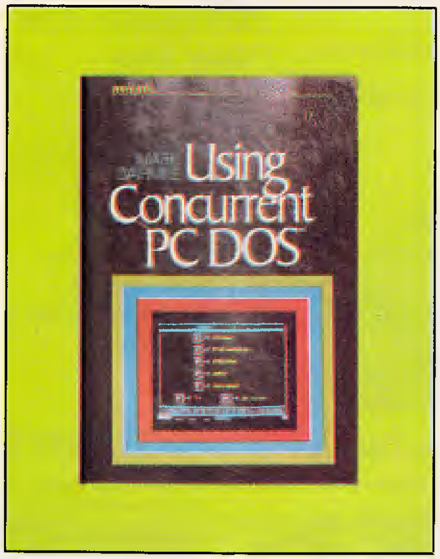
This latest incarnation of *The Hacker's Handbook* from the UK looks, in places, like the computer enthusiast's version of *Spy-catcher*. There is a very impressive chapter (around 40 per cent of the book has not appeared in previous versions) about how two English journalists discovered details of the computer installation used by M15. The actual details include the make and model of the machine, the number of terminals, the operating system and the communications protocol. However, the (fairly simple) method which allowed the journalists to gather this information is probably more useful to amateur sleuths than the eventual results.

The chapter on UK Government installations is just one of the additions in *HH3*. Another is the updated information on previously reported hacks, including the Prince Philip Prestel hack. The report on this one in particular now includes details of the acquittal in the High Court. Thankfully, the chapter on radio hacking has been trimmed, as I always felt that such information was slightly out of place. While many computer users have modems, few have RTTY (radio teletype) receivers.

As before, the book contains full details of the events leading up to a number of 'unauthorised accesses' to computer systems. Some people are bound to criticise the author for explaining the tricks. However, my personal feeling is that the only way to protect computer information is by employing experienced security managers. Knowing how to spot the early stages of a hack — and how to prevent them happening altogether — requires some knowledge of the way a hacker thinks and operates, and this is what the book is trying to provide. As such, I feel it should be required reading for anyone involved in upholding the security of a computer.

And, if you're not already into computer communications, prepare to be amazed.

Roger Dalton



Using Concurrent PC-DOS

Author: Mark Dahmke
Publisher: McGraw-Hill
Distributor: McGraw-Hill Australia
ISBN: 0-07-015073-7
Price $49.95

Concurrent PC-DOS is Digital Research's alternative to Microsoft's Windows and provides the multi-tasking facilities that MS-DOS lacks. The reader that this book is aimed at, therefore, will be emigrating from MS-DOS and would probably want an overview of the new system plus some discussion of the special features provided. I am not sure, however, if Dahmke's book exactly fits the bill. It is insubstantial (150 pages) and greatly overpriced, offering a very quick canter through the subject (I read the whole book in one evening) and glossing over any area which threatens to require a fuller treatment.

Yet is is useful. The introductory chapters provide a concise overview of the history of PC operating systems in general and Concurrent PC-DOS in particular. The concept of concurrency itself is also explained quite clearly, and Dahmke provides numerous illustrations of the various screen displays to clarify the textual explanations of individual Concurrent PC-DOS functions. There is also an appendix of Concurrent PC-DOS commands in quick-guide format which would be useful once one was fairly familiar with the system.

Nevertheless, the book is disappointing. The chapter which I found particularly frustrating was the one entitled 'Customising Your Personal Computer'. This is just nine pages long whereas it really should have been as long as all the other chapters put together. There are no examples of batch files which would exploit the Concurrent PC-DOS multiple window environment, merely a few airy references, in the book's usual throwaway style, to possibilities which are not explored. Certainly, Dahmke does not attempt to convey the idea that working within a multi-tasking environment might involve different disciplines from single-tasking.

All in all, this is a book to skim through in a quiet hour in a book shop before buying something else!

Jeff Wells

END

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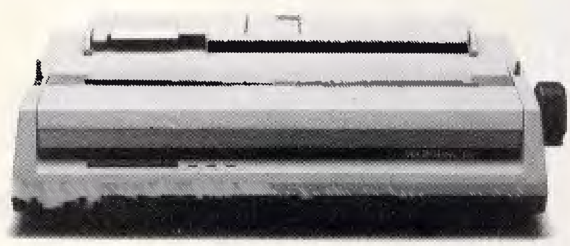

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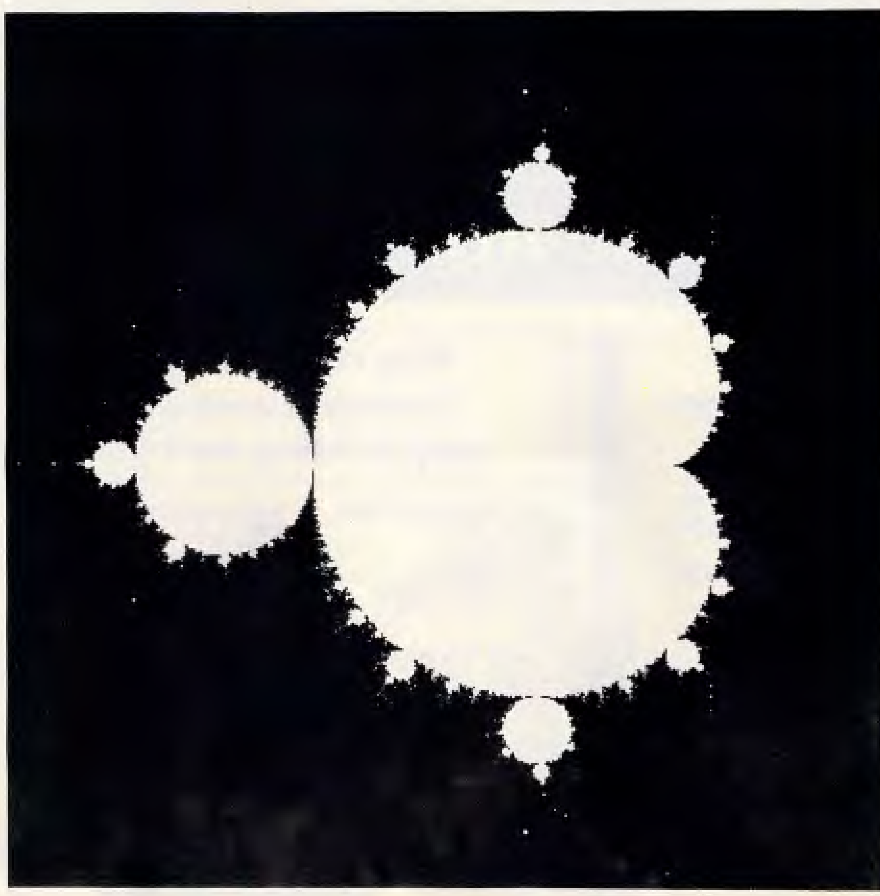
INK

First–class Postscript

Attractive printout need not be the exclusive preserve of Macintosh users! Julian Dow takes you through the rudiments of the arcane but powerful language, PostScript, and shows you how to drive the Apple LaserWriter from any micro.



The calculations for this Mandelbrot set took 48 hours and were done in PostScript

Desktop publishing is the growth area in microcomputing. Increasingly, people are discovering that it is no longer necessary to choose between dot-matrix output and the jobbing printer's beautiful but expensive product. The desktop publishing (DTP) empire is founded on the middle ground. You want your work to look crisp, neat and professional, but without having to go out-of-house to achieve it. The Apple Macintosh shot to fame for its obvious talents in this field as much as any other. The page description language (PDL), PostScript, developed by Adobe Systems, became the industry standard overnight when Apple adopted it for its LaserWriter printer.

Computer phototypesetting, the process by which text is converted to camera-ready bromides for plate-making, used to be much like any other kind of computer printing. The printer was connected via a data cable, and the text to be printed was sent as ASCII. If a change in font size or style were required, control codes were sent, and the subsequent text was interpreted differently. This was easy to understand and cheap to implement, although the equipment was hardly cheap to purchase. Computer phototypesetters were good at handling text, awful at handling graphics, and totally unable to integrate the two.

The PostScript language, another product to have been nurtured at the Rank Xerox Palo Alto laboratories, is owned by Adobe Systems. It takes a revolutionary approach to phototypesetting. What is sent down the data cable to the printer is not a stream of text, punctuated by control codes, but an ASCII listing of a computer program written in PostScript with the text interspersed as data statements. The program is then executed by a Post-

Script interpreter inside the printer.

This implies considerably more sophistication at both ends of the data cable, both in parcelling up the data to be sent, and in building up the image of the desired page at the receiving end. However, the enormous benefit is that text and graphics can be freely mixed on the same page, and can even interact. In PostScript, text can easily be fitted around an arbitrary object, like a circle. In the past, such an effect would have been impossible without recourse to Letraset and a skilled graphic artist.

The PostScript standard is accordingly becoming established. Even Hewlett-Packard compatible laser engines are starting to include PostScript interpreters. The Sun workstation (reviewed in *APC* last month) operates as a series of PostScript windows. More importantly, the new generation of Linotronic computer phototypesetters are driven in PostScript. This may seem an unimportant point when the output of a LaserWriter seems so impressive, but rest assured that, for professional purposes, 300 dpi (dots per inch) is simply not good enough. A resolution of 900 dpi is considered adequate; the Linotronic L300 phototypsetter delivers 2540 dpi! Additionally, a full typesetter provides greatly superior justification facilities and a wider range of fonts — but at $60,000 or more, it's just as well.

The lovely thing about PostScript is its device independence. Precisely the same PostScript code can be used to drive a LaserWriter or a typesetter, and the result will look identical on both (apart from differences in resolution). The Apple LaserWriter is thus seen by the industry as an inexpensive proofing tool before the final bromide run on the typesetter.

Why learn PostScript?

At one level, you may be curious as to how typesetting works. At another, you might be keen to write a desktop publishing (DTP) program yourself. Or you may simply want to achieve effects which are unavailable to you using proprietary software, even on machines like the Mac.

There is a two-volume bible for experimentation in this field, published by Adobe Systems. Both the *PostScript Language Tutorial and Cookbook* and the *PostScript Language Reference Manual* are highly lucid and informative. If you want a few more examples to peruse, try the article by Pelli, *Programming in PostScript (Byte,* May 1987, 185-202).

Perhaps the most important reason for learning PostScript is that, like me, you find yourself in a mixed computer environment where you don't have a Macintosh computer but do have access to a LaserWriter. In that case, you must have dreamed of getting your computer talking to the LaserWriter, and getting high-quality output.

There are solutions, of course, you can buy an IBM card which allows you limited access to the Appletalk network, and you can then use the LaserWriter as a basic Diablo-compatible printer. Alternatively, read on. This article will tell you how to send both graphics and text, in fonts of your choice, to the LaserWriter, all for the price of a home-made cable.

Connecting your micro to a LaserWriter

At the back of the LaserWriter, there are two D-connectors (9-pin and 25-pin) and a rotary switch. The selected connector and its behaviour depend on the switch setting. These can be one of:

Appletalk Input is taken from the 9-pin connector, according to the Appletalk protocol. The Macintosh is connected to this socket.

Special Diablo 630 emulation mode. Serial input is taken from the 25-pin socket at 9600 baud, parity ignored. The LaserWriter pretends to be a reliable, quiet, fast and expensive Diablo daisywheel printer. Only a typewriter font is available, but if speed and quietness are important to you, you could consider using a LaserWriter as your normal office printer. Note that this mode accepts text, not PostScript commands!

1200 PostScript batch mode: accepts input from either the 9 or 25-pin connectors at 1200 baud (parity ignored).

9600 PostScript batch mode: accepts input from either connector at 9600 baud (parity ignored). The baud rate and parity for this setting, however, can be reconfigured.

The connection for the IBM PC to the LaserWriter is shown in Fig 1. You should disconnect the AppleTalk connector from the LaserWriter while running it from the 25-pin port, otherwise the network will behave strangely and you may become unpopular with the official users of the printer!

Communication

The PostScript interpreter expects to receive only printable ASCII characters. Control codes are not approved of. This is good, because it means that you can use almost any text-processor and any comms program to send your output. Under some circumstances (for example, with bit-mapped images), you will need to send binary data to PostScript. In this case, you should send an ASCII hexadecimal version of each byte: hex 255 would be sent as the two-character string 'FF'. In this way, there's never any need to send weird ASCII codes to PostScript except for communications protocols.

PostScript is an interpreted language: that is, lines are interpreted from the source code that you supply, when the program is run. Like Basic, there is a speed penalty to pay; but it is generally rather easier to work with an interpreter than a compiler. The PostScript interpreter sits in the printing device, so you don't need any special PostScript program for your computer, only the ability to send ASCII files through your serial port.

So, any micro with a text editor and a comms program is ideal. As to the

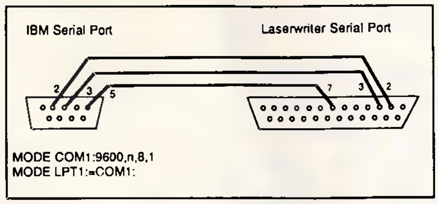


Fig 1 Connections on the LaserWriter

protocol, the default baud rates are 1200 and 9600. You are advised to set up communications using 1200 baud. However, once you transfer bit-map images to the printer, you'll be unlikely to get results on a reasonable time scale without using 9600 baud.

The PostScript interpreter can be stunningly slow, so it's important to make sure that you don't hang the system by sending data faster than the LaserWriter can handle it. Your communications link must be able to support the XON/XOFF protocol. Put simply, your computer must listen as it sends to the LaserWriter, and stop whenever it hears XOFF (ASCII character 19). It can resume transmission when it gets XON (ASCII 20). In theory, the protocol works the other way round too, allowing your computer to stop itself from being swamped by diagnostic messages from the LaserWriter. In practice, though, these are both rare and terse, so (provided your computer empties its input buffer occasionally) there should be no need to worry. Most terminal emulator programs will support XON/XOFF. Sending ASCII 4 at the end of your text file is wise. If you've written bad code, it tells the PostScript interpreter to ditch the job.

If you're using a comms program, and you're curious as to what the LaserWriter's doing, type Control-T. This causes the LaserWriter to send back a one-line status message describing its progress — idle, busy, printing, no paper tray, and so on. Programs could perform this task automatically every few seconds to warn of any problems.

Nature of the language

PostScript is a fully-fledged computer programming language. Only about a third of its commands directly handle imaging. However, it is extremely well-suited to the task of image specification. There are two points which must be understood clearly before you dip into the language. PostScript uses a post-fix notation, and is stack oriented.

If you're a Forth programmer this will probably come as great news, but if you're a mortal like myself, you'll already be wondering if it's worth the effort coming to grips with the language at all. If these terms mean nothing to you, then here's an example. In Basic, to add 2 and 3, you'd say something like:

```
A=2+3
```

Whereas in PostScript, you'd say:

```
2 3 add
```

This means: (a) put 2 on the stack; (b) put 3 on the stack; and (c) take the top two numbers from the stack, add them, and return the result to the stack. Note that the result is not normally stored as a variable, so to program competently in PostScript, you need the kind of mind that can keep track of what has gone on the stack, and in what order.

If you're the kind of person who can remember what cards have gone down in a game of poker, or if you write compilers for a living, then this will be second nature. If not, then draw some consolation from the fact that it is possible to store to named variables in PostScript using the slightly cumbersome DEF construct (of which more below).

The question of the superiority or otherwise of post-fix notation has enlivened the letters page of more than one computer journal. The important things in its favour are its compactness and ease of implementation while against it weighs the fact that relatively few people can ever obtain an intuitive grasp of what's going on. In selecting this style for the PostScript language, Adobe has ensured that the limited processors in PostScript printers can perform quite impressively for their size, but has rendered the language difficult for any but systems developers to spend time on. This is a shame as PostScript repays some effort in understanding.

The ideal page

The PostScript 'ideal page' is like a sheet of graph paper, with the origin in the bottom left-hand corner. Unlike graph paper, however, the page is ruled in divisions of 1/72 inch. This corresponds to the printing industry's 'point' scale, which is great for some things (like specifying the size of type you want), and lousy for others (like specifying where on the page to put it).

Fortunately, there are simple ways to specify chosen co-ordinate systems, and an example will be given shortly. Another point to note is that the default origin is the physical corner of the paper, although the printable area is not so large (for A4 paper, it's a 7.41in x 10.86in size, centred on the 8.25in x 11.66in page).

Moving around on the screen will be immediately familiar to anyone who has programmed points directly to a video screen. You can either move the origin and co-ordinate systems with the trans-

```
% The simplest of all programs
/Times-Roman findfont
18 scalefont
setfont
72 72 moveto
```

Listing 1 The 'Hello World' program

Hello World

Fig 2 Output of program

late, rotate and scale operators, or move relative to your co-ordinate system with the MOVETO command.

PostScript can handle three major groups of pictures: text, paths and images. Text is handled as strings (enclosed in brackets rather than the more common quotes), and placed on the page at the current co-ordinates with the SHOW command. A path is a series of points, specified by (for example) a series of MOVETO and LINETO commands, and is placed on the page by the STROKE command. An image is a 2-D greyscale bit-map which is plotted onto a unit square by the IMAGE command. Any or all of these commands can be used to build up the printer's notional representation of the page, which is then committed to the physical page of paper by the SHOWPAGE command. No SHOWPAGE, no output! Because of this emphasis on pages, PostScript is known as a 'page description language'.

By general convention, the first example in any computer language tutorial is a program to print the words 'Hello World'. Listing 1 begins with a descriptive comment, specifies a resident font, scales it to 18-point size, moves one inch up from the bottom-left corner of the page, prints 'Hello World', and commits the image to paper (Fig 2).

Hello World

However, even this program merits detailed study. First, the comment line: any text following '%' until the next newline is considered as a comment and ignored by the interpreter. A newline in PostScript is the 'linefeed' character (ASCII 10). However, carriage return (ASCII 13) or combinations of carriage return and linefeed are automatically interpreted as newline.

The second line is interpreted as follows: put the name Times-Roman on the stack as a 'literal' (something not to be interpreted) as it is prefixed by '/'. Then execute the 'findfont' procedure, which expects to take a font-name from the top of the stack, find the font, then put it on the stack. Note that the entire font constitutes a single object in PostScript, and so can be dumped on the stack just like an integer or a literal.

The 'scalefont' function requires two arguments — the font, and the scale required. At the end of line two, the font is at the top of the stack. Line three puts the desired scale (18) on the stack, executes scalefont, which removes the font and the scale from the stack, and replaces them with the scaled font. This scaled font is then selected as the current font by 'setfont', which also clears the font from the stack.

The next line puts 72 and 72 on the stack, then executes 'moveto' which takes them off the stack and uses them as x and y co-ordinates to move to. The brackets surrounding 'Hello World' are in fact PostScript's version of string delimiters, so this line puts 'Hello World' on the top of the stack as a string, then prints it as the current position on the 'ideal page'. Note, though, that this is only written on a notional page; to commit yourself to paper, you must issue the command SHOWPAGE which starts the LaserWriter's motors churning.

Specifying a path

The second class of PostScript object is the 'path'. This is the path (or locus, if

```
% examples of boxes
  /box { 0 72 rlineto
    72 0 rlineto
    0 -72 rlineto
    closepath } def
% main program
  newpath                 % draw outlined box
  144 432 moveto
  box
  .5 setgray
  5 setlinewidth
  stroke
  newpath                 % draw filled box
  144 288 moveto
  box
  .5 setgray
  fill
  newpath
% draw filled AND outlined box, using gsave
  144 144 moveto
  box
  gsave
  .5 setgray
  fill
  grestore
  0 setgray
  5 setlinewidth
  stroke
  showpage
```

Listing 2 Program to draw boxes

Fig 3 Output of program

you're a mathematician) of an imaginary paintbrush, described by a series of MOVETO, LINETO or ARC commands. Once a path has been defined, it can be drawn with the STROKE command, with a line of variable width (using 'setlinewidth') or grey value (using 'setgraylevel'). Alternatively, if the path is

```
% use path operator to specify a polar plot:
% r = 1.5 - sin(9.theta).cos(12.theta)
  /inch (72 mul) def
  /doleaf {               % define our path
  newpath
  0 1 360 {
% --- store loop variable  as theta:
  /theta exch def
% --- calculate r according to formula
  /s theta 9 mul sin def
  /c theta 12 mul cos def
  /r s c mul 1.5 exch sub def
  1 rotate
  r inch 0 inch
% --- if theta=0 move, otherwise draw
  theta 0 eq {moveto} {lineto} ifelse
  } for
  closepath
  } def
% --- main program
  4 inch 5 inch translate   % move origin
  0 0 moveto
  doleaf
  gsave
      .5 setgray fill
  grestore
  0 setgray 3 setlinewidth stroke
  showpage
```

Listing 3 Program to draw leaf pattern

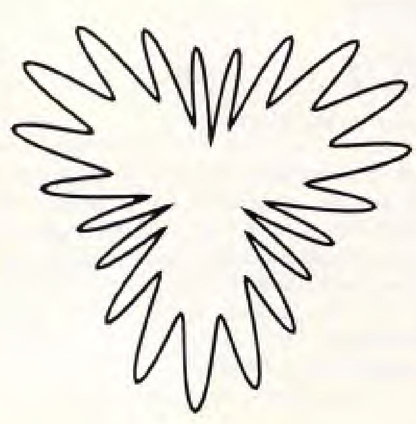


Fig 4 Output of program

closed (you can force this with 'closepath'), it can be filled with 'fill'. Listing 2 shows an example of the 'path' operator. This defines a path to draw a square box, then strokes it.

This is really three examples in one. First, the box-drawing procedure is defined.

As the procedure is in curly braces it is not interpreted immediately, but is stored in the 'userdict' stack of user-defined variables and procedures, to be called by name from the main program. Three boxes are then drawn at the current co-ordinates (specified by MOVETO). The first is outlined with the 'stroke' operator, the second filled with the 'fill' operator, and the third both filled and outlined.

There is an important point to note in this last example. The fill and stroke operators both erase the current path from the stack while drawing, so you can't use both on the same path. To get around this, we save the current graphics state of the machine by calling 'gsave' before the first operation. After the box has been filled, 'grestore' restores the previous graphics state in which the box was the current path so that it can also be stroked.

The gsave and grestore pairing are widely used to allow you to alter the origin and co-ordinate transformation system rather promiscuously, to make some special effect rather easier, and then return to a more sanitary state.

Of course, specifying the co-ordinates making up a path individually (as we did for the box) is a pretty tedious pastime for all but the simplest shapes. We can simply evaluate a formula to obtain successive points on our path. (This is what we learned at school as 'plotting the locus of a point'). Unfortunately, laser printers weren't commonplace in my school-days or my career might have taken a different path, so to speak.

The third line of the simple example shown in Listing 3 shows the promised trick for converting from your desired measurement units to points. The procedure 'inch' is defined as something which multiplies the top item on the stack by 72. The curly braces indicate that this is a procedure for storage on the userdict stack and not for immediate execution. In use, a line like:

```
1.5 inch 2.5 inch moveto
```

is interpreted by the LaserWriter as

```
108 180 moveto
```

saving you the bother of making the conversion. Another point in the program is the use of a conditional clause, the IF...ELSE construct. A logical test is performed, in this case comparing two values with the EQ command, which leaves a Boolean (true or false) on the stack. The IF...ELSE takes a Boolean and two procedure names off the stack and executes the first procedure if it finds true, the second procedure otherwise. There is also an example of a DO loop. In PostScript, these take the form:

```
startvalue increment endvalue
{procedure} for
```

The loop variable is put on the top of the stack for each iteration, so be sure to get rid of it (using 'pop') if you don't use it within the loop, or the stack will overflow.

Another point is that, rather than use trigonometry to calculate x,y co-ordinates from my polar co-ordinates, I simply rotated the co-ordinate system repeatedly. As the co-ordinate system went around all 360 degrees, it wasn't too important to bother with gsave and grestore, although they would have been stylish.

Of course, most fonts are defined as paths. There are two types of font: bitmap (in which each letter is specified as a series of pixels), and analytic (in which each character is stored as a path). Analytic fonts are greatly to be preferred as they scale up much better. Bitmapped fonts in large sizes look terrible compared with analytic fonts (like Times). If you fancy your hand at specifying your own fonts, or just special single characters, then delve into the PostScript language tutorial and reference volumes.

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```
% Clipping Path demonstration
% --- define your parameters
   /left 72 def
   /top 720 def
   /bottom 72 def
   /linespacing 12 def
/clipshape   % --- specifies the clipping path
   {
   /Helvetica-Bold findfont 156 scalefont setfont
   newpath
   100 400 moveto
   (APC) true charpath clip
   }  def
/background  % --
   {
   /Helvetica-Bold findfont 12 scalefont setfont
   bottom linespacing top {
        left exch moveto
        0 1 3 { (Australian Personal Computer) show
      } for
    } for
    } def
% --- main program starts here
   clipshape
   background
   showpage
```

Listing 4 Demo of clipping path

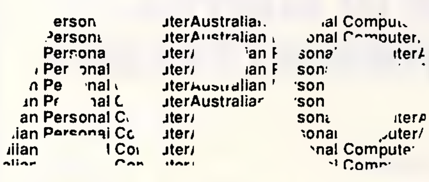

Fig 5 Output of program

through which other patterns can be seen. They are known as clipping paths, as they clip the outlines of other components of the picture. In the example below, we set up a clipping path made of the outlines of a huge (156 point) *'APC'*, then filled the page with repeats of a tiny *'Australian Personal Computer'*. Only those that are within the clipping path reach the paper (Fig 5).

'Charpath' takes a string and produces a path according to one of two algorithms (governed by the selection of true/false). 'Clip' then takes the path and uses it to clip the ideal page. The page is then filled with two nested DO loops.

Stopping startup!

The Apple LaserWriter is notorious for wasting a sheet of paper, every time it is switched on, by printing a 'startup page'. Rooms in which LaserWriters are situated are readily identifiable by the sheaves of scrap paper littering all available surfaces and covering the place where the wastepaper basket was once rumoured to be. In fact, there is a way of turning the startup page off, described in the *PostScript Language Reference Manual.* Not only does it save paper, but it cuts the machine's warm-up time from 50 to 25 seconds! So even if you aren't too interested in PostScript programming in general, this little trick will make you a local hero.

Send the program shown in Listing 5 to the LaserWriter (from a Macintosh, use a comms program or the PostScript facility of CricketDraw). The zero in the first executable line is, in fact, the default system administrator password for the interpreter. Issuing the password takes you to a privileged level where the printer operation can be reconfigured permanently and a warning to that effect is sent back to the terminal.

The password can be reset in a similar way to the startpage, using the 'setpassword' operator. In fact, several of the persistent parameters for the LaserWriter can be changed using programs such as this; the only one that everyday Mac users may have come across is the renaming of the printer, using the 'setprintername' operator.

Beware, though, when playing with such programs. The first line of the program exits from the server environment, making your changes permanent. You could stop the printer from working permanently if you did something silly, so read the *PostScript Language Reference Manual* before experimenting. Note the equals sign in the lines:

dostartpage = flush

'Dostartpage' puts a Boolean value onto the stack, according to whether the machine is set to produce a startup page. The equals sign is an important way of interrogating the stack. It sends the value at the top of the stack to the terminal. 'Flush' is used to empty the terminal output buffer, to make sure you get the information immediately. This type of construct is very useful in getting information back from the machine when a program is running. In this case, the messages returned are true then false.

The startup page on the LaserWriter is more interesting than it might appear. As well as the number of pages printed so far and the name of the machine, several operating parameters are encoded into the picture. For example, the number of ticks on the left-hand graph shows the rotary switch setting: 0=1200 baud, 1=9600 baud, 2=Special, 3=Appletalk. The height of the bars in the centre graph shows the baud rates of the 9-pin and the 25-pin connectors, and the colour encodes the parity setting.

As a precaution, perhaps it may be useful to keep the startup page under some circumstances.

The image operator

If you can wait long enough for the serial data to be transferred, the LaserWriter makes an excellent and easily customised graphics screen-dump engine. The key to this is the image operator, which acts on a 2-D greyscale bit-map of an image. This allows you to use the LaserWriter as an excellent multipen plotter, or as a printer of digitised video images.

```
% stop startup page by changing the
% setdostartpage persistent parameter
   serverdict begin 0 exitserver
   statusdict begin
   dostartpage = flush
   false setdostartpage
   dostartpage = flush
   end
```

Listing 5 How to turn off the LaserWriter startup page

All you have to do is scan your computer screen with a pair of nested DO loops, and send the pixel values sequentially to the LaserWriter! By default, data is sent as successive rows from left to right, and starting from the bottom. Even this, however, is readily altered with a scaling matrix. The general format of an image-dumping PostScript program is shown in Listing 6.

The key point to note is the format of the data stream. As PostScript only recognises printable values of ASCII, you must send binary data as a hexadecimal version of the value, as described above. So, 255 would be sent as the two ASCII characters 'FF'. A simple Basic function to do this conversion would look like:

```
a$="0123456789ABCDEF"
DEF FNbin_hex (n) = MID$
(a$,n DIV 256,1) = MID$(a$,n
MOD 256, 1)
```

The program as it stands expects 256-greyscale data, whereas few micro displays have such resolution. The simple answer is to scale each pixel to occupy the full range. For example, if in your dialect of Basic, POINT-(x,y) returns a greyscale value from zero to seven, you want

FNbin_hex(POINT(x,y) * 32)

Of course, this rather slow to calculate but nothing like as slow as the serial data transmission, as each pixel is being represented by one byte and two characters. An alternative is to tell the PostScript interpreter that you are sending 4-bit data, by changing the line:

x y 8 to **x y 4**

Then each character corresponds to one pixel. For large screendumps, it is a bad idea to load all the pixel data onto the printer's stack before calling the image operator to unload it. The stack has a limit of a few hundred items, so the program will crash. Instead, put a procedure in the braces, which produces one line of data at a time. 'Image' will call the procedure repeatedly until the right

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```
% dumps x by y pixel by 8-bit grey level
/inch 72 mul def
1 inch 1 inch translate
3 inch 2 inch scale % set size of picture
x y 8      % dimensions of image to be read
[x 0 0 y 0 0] % transform matrix for scaling
{<your hex data>}  image
showpage
```

Listing 6 General format for a screen-dump program

number of pixels has been read.

A powerful application of the image operator is to plot a mathematical function. If you wished to plot z=f(x,y) for a range of x and y values, you could set the computer calculating each value in turn and sending the results to the LaserWriter; or you could simply program the LaserWriter to calculate the points directly. The image operator needs a 2-D array of greyscale value, but doesn't care where it comes from. So, instead of an array of data, you need only provide a procedure which generates the data. Shown on the first page of this article is a printout of the Mandelbrot set, which enthralled so many people after that classic 1986 *Scientific American* article — be prepared to wait for your output, though.

END

```
% calculates the Mandelbrot set
%--- define variables
/maxcycles 255 def    % - number of iterations
/xmin -1.7 def        % - left edge
/ymin -1.3 def        % - bottom edge
/pixels 512 def       % - image resolution
/interval .005 def    % - pixel spacing
/j ymin interval sub def  % - starting y-value
/rowarray pixels string def
% - string to hold 1 row of pixels
/mandel  {               %   --- calculates 1 row
  /j j interval add def % - increment row number
  0 1 pixels 1 sub      % - for each x-value
    { /indx exch def        % - calculate x-value
    /i indx interval mul xmin add def
    cycle                     % perform iterations
    rowarray indx n cvi put
              % - result in correct element
    } for
    j = flush
        % - info to terminal, so you know OK!
    rowarray
        % - return string to calling routine
} def
 / cycle {                     % - does iterations
    /n -1 def
    /x 0 def
    /y 0 def
    {
       /y2 y y mul def
       /x2 x x mul def
       /y 2 x y mul mul j add def
       /x x2 y2 sub i add def
       /n n 1 add def
       n maxcycles ge x2 y2 add 4 ge or {exit} if
         } loop
   } def
/doimage {          % - sets up and calls image
pixels pixels 8 [pixels 0 0 pixels 0 0] {mandel}image
        } def
% ---main program
   100 200 moveto
   512 512 scale
   doimage
   showpage
```

Listing 7 Program to calculate the Mandelbrot set

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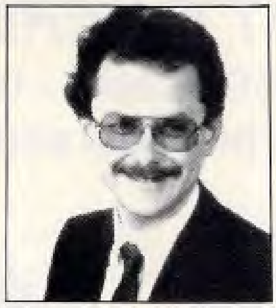

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Mystery tour

The myriad mysteries of the many modem standards are unravelled this month, as Peter Tootill and Steve Withers simplify the main points.

There are two major hurdles to overcome in connecting a computer to a telephone line. The first is that computers use 'parallel data' — that is, data carried on a lot of wires (usually 16) simultaneously. Telephone lines have only two. Furthermore (and here's the second problem) it is 'digital data'. The signal is either on or off: 5 volts or 0 volts, there is nothing in between. Telephone systems use 'analogue data', which means that the signal is continuously variable. Many technical and computing books will explain the differences between parallel and serial, and digital and analogue data.

The first of the problems mentioned above is dealt with by the computer's serial interface. It takes the parallel data from the computer's data bus and converts it into serial data — that is, data where bit follows bit. The modem's job is to deal with the second problem. It converts (modulates) digital data into analogue data and back again (demodulates); hence the name MODulator/DEModulator.

The serial interface is often called an RS232 or V.24 interface after the two standards that specify it. The first is American in origin, but is widely used now. The second is the international standard set out by the CCITT (the Consultative Committee on International Telegraphy and Telephony) which is part of the International Telecommunications Union, a UN body. The two standards are functionally the same.

Standards comparison

Modem type	Data rate (bps)	Transmission technique	Modulation technique	Transmission mode	Line use
Bell System					
103	300	asynchronous	FSK	Half, Full	PSTN[1]
202	1200	asynchronous	FSK	Half	PSTN[2]
212	0–300	asynchronous	FSK	Half, Full	PSTN
	1200	asynchronous/ synchronous	PSK	Half, Full	PSTN[3]
CCITT					
V.21	300	asynchronous	FSK	Half, Full	PSTN
V.22	600	asynchronous	PSK	Half, Full	PSTN/Leased
	1200	asynchronous/ synchronous	PSK	Half, Full	PSTN/ Leased
V.22 bis	2400	asynchronous	QAM	Half, Full	PSTN[4]
V.23	600	asynchronous/ synchronous	FSK	Half, Full	PSTN[2]
	1200	asynchronous/ synchronous	FSK	Half, Full	PSTN
V.26	2400	synchronous	PSK	Half, Full	Leased[5]
	1200	synchronous	PSK	Half	PSTN[5]
V.26 bis	2400	synchronous	PSK	Half	PSTN[5]
V.26 ter	2400	synchronous	PSK	Half, Full	PSTN[5]
V.27	4800	synchronous	PSK		
V.29	9600	synchronous	QAM	Half, Full	Leased[6]
V.32	9600	synchronous	QAM	Half, Full	PSTN

Notes
PSTN — Public Switched Telephone Network
1 Not compatible with V.21
2 Rarely used
3 This mode compatible with V.22
4 Also used in North America
5 Rarely used with PSTN
6 Half-duplex variations for switched lines exist

Synchronous & asynchronous modems

When the computer's serial port is decoding incoming data, it needs timing information so that it can tell where one bit stops and the next one starts. With a synchronous modem, accurate timing circuits are used (these are usually built into the modems themselves, but may occasionally be provided externally — for example, by the computer itself). The modems synchronise their timings by means of occasional special characters called SYN characters.

Asynchronous modems, however, start and end every character with what are called start and stop bits. As these are 0 and 1 respectively, it means that the start of every character is identified by the transition from a 1 to 0 bit. Thus, the modem only needs to work out timings for a relatively short period (one character length). No expensive timing circuits are needed, and synchronisation is

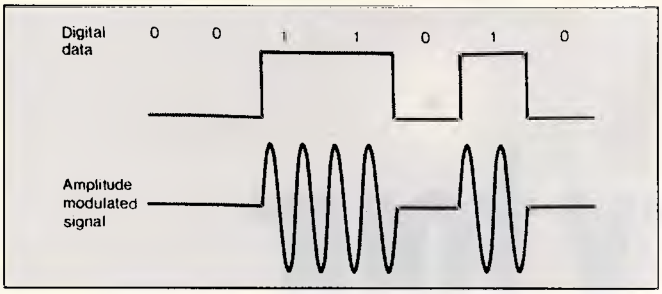

Fig 1 Amplitude modulation

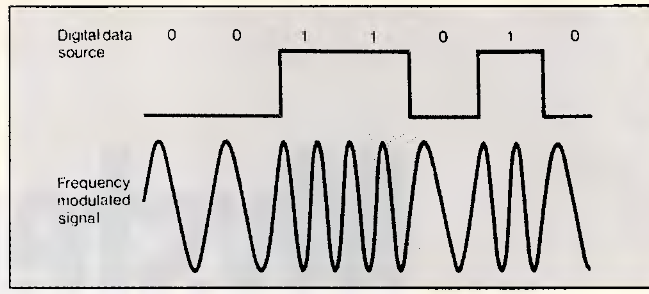

Fig 2 Frequency modulation

automatic. It does mean that two extra bits are added to each 8-bit character, making 10 in all. That's why 300 bits/sec is only 30 chars/sec, and not 300 divided by 8 (37.5).

Modulation methods

The three basic methods of modulation are:

Amplitude modulation The strength (or amplitude) of the signal is changed to convey the information. This is used in AM radio (Fig 1).

Frequency modulation The frequency of the signal is changed to convey the information. This is the method used in FM radio, and the simplest version is used in 300-baud modems. Two frequencies are used: one to represent 0, and one to represent 1. In this context, it is usually called frequency shift keying (Fig 2).

Phase modulation The phase of the signal is changed. Usually referred to as phase shift keying (Fig 3).

Some modems combine two of the above methods, but I'll consider that when I look at higher-speed modems later.

Bits & bauds

Bits per second (bps) and bauds are both methods of measuring the speed of data transmission. Many people use the terms interchangeably, but there is a significant difference. I'll do my best to explain it.

As we have seen, the data being sent consists of a number of bits. So, the speed of transmission can be measured in bits per second. If you look up the word 'baud' in a data communications book, it will probably refer to modulation rates or some such thing. In fact, a baud is the unit used to measure the speed of change of the signal on the telephone wire itself, which is not necessarily the same as the speed of the data that is being sent.

This is where the difficulty arises. You

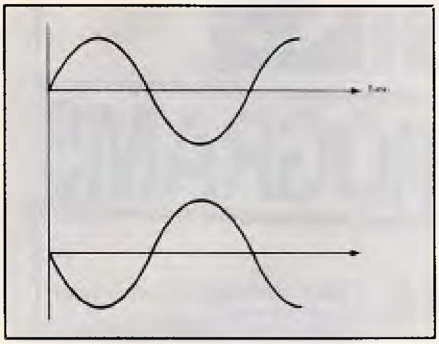

Fig 3 Phase modulation. Phase is the position of the wave form with respect to the origination of the carrier cycle. In this illustration, the bottom wave is 180 degrees out of phase with a normal sine wave illustrated at the top

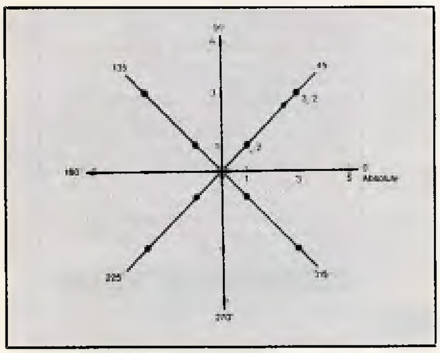

Fig 4 The signal constellation pattern for a 9600 bps modem contains phase and amplitude modulation (QAM)

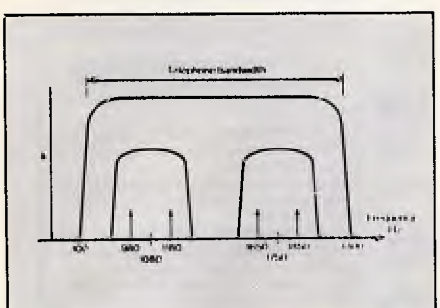

Fig 5 V.21 frequency spectrum showing both transmit and receive channels

have to divorce the two in your mind: the rate of change of the data signal on the phone line is not necessarily the same as the speed of the data it contains. Read on: it will become clearer.

Using a 300 bps modem, as we have seen, there are two different signals: one for 1 bits and one for 0 bits. Each signal level represents one bit so here the baud rate is 300, the same as the data rate. However, if we use a different signalling method — say, for example, we have

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four different signal levels — then each level can represent two bits (there are only four possible combinations of two bits: 00, 01, 10 and 11). If we keep the same baud rate (remember, baud measures the rate of change of the signal) we could send twice as much data — 600 bits per second at 300 baud.

As I'll describe later, the newer V.22 and V.22bis modems actually transmit and receive at 600 baud, but by encoding two and four bits respectively, the data is sent at 1200 and 2400 bits per second. A two-bit combination is called a 'dibit' and a four-bit one a 'quadbit'.

You may be wondering why we need these different signalling techniques. Why not just send data at 2400 baud if we want to transmit at 2400 bits per second — it sounds much simpler. Well, it would be, but the problem is with the telephone line. It can only handle frequencies between about 300Hz and 3300Hz, so we have a bandwidth of 3000Hz available which is fine for speech but not so good for data.

The theoretical limit for the baud rate on a phone line with a bandwidth of 3000Hz is 3000 baud (based on a formula derived by a gentleman called Nyquist in 1928, and which is sometimes called the Nyquist Limit). That sounds fine — 2400 is less than 3000, after all. True, but the problem is that we normally want full-duplex transmission transmitting data in both directions at once.

Furthermore, the closer we get to the limit, the more difficult it becomes to keep the signals clean and to avoid errors being introduced by line noise. Modern high-quality modems do use baud rates of 2400 and even slightly higher, but normally only in one direction at a time.

The most common modems available for use on the ordinary public switched telephone network, or PSTN (usually referred to as 'dial-up' lines) operate at speeds up to 600 baud full duplex. The main exception to this rule is the V.23 modem which works at 1200 baud (and 1200 bps) in one direction and 75 (bits and baud) in the other.

Which is which?

Most modems found in Australia comply with a range of standards specified by the CCITT. These standards begin with the letter V — V.21, V.22, and so on. In the US, modem standards used to be set by the Bell telephone company, but now there is a move towards using the international CCITT standards.

Bell standards are not usually compatible with CCITT ones. In the high-speed area (above 2400 bps) there are also variants of CCITT standards. The 'Standards comparison' box summarises the main modem standards commonly used on dial-up lines.

Medium-speed modems

Until recently, 300 bps was the normal operating speed for modems. However, this is rather slow (around 30 chars/sec) and the introduction of IC technology has meant that modems operating at higher speeds can now be made at reasonable cost.

V.22 (1200 bps full duplex) looks like becoming the standard for Australian users. It gives good performance over dial-up lines without requiring error correction (such as MNP) in the modem itself; and — most importantly — prices have fallen to a level that any serious user can afford.

V.22bis is twice as fast (at 2400 bps full duplex) but needs good phone lines to work satisfactorily. However, it is expensive. There are probably good reasons for it (like economies of scale), but US prices are much lower. There, V.22bis

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modems can be bought for under $US200 (say $270). In Australia, expect to pay $400 or more.

High-speed modems

9600 bps modems are the latest thing to appear on the comms scene, but there are, unfortunately, several incompatible standards covering them (see the 'Standards comparison' box).

The main CCITT standard (also used in the US) is V.32. This uses a complex modulation method with quadbits (4 bytes per baud) at 2400 baud, and a combination of amplitude and phase modulation called quadrature amplitude modulation (QAM) (Fig 4). It also transmits over the whole bandwidth in both directions at the same time for full duplex working. So, to avoid mixing up incoming transmissions with outgoing ones, sophisticated echo cancellation techniques are needed to filter out the outgoing transmissions and leave just the incoming signal for demodulation.

Error correction is built into the signal by adding extra bits in a pre-determined pattern (called trellis code modulation — TCM). The receiving modem knows what these bits should be, and that helps it to make allowances for line noise and sort out the original signal.

This system has the advantage of allowing the receiving system to correct most errors without having to ask for a block of data to be sent again (unlike other systems such as MNP) so there is no reduction in throughput. However, TCM is not perfect, and an ARQ (Automatic Repeat on reQuest) system such as MNP is still desirable.

V.32 modems are expensive, at around $5000. This is about the same price as UK buyers face, but in the US $2500 is the going rate.

Another CCITT standard for 9600 bps is V.29. However, this was primarily designed for use on leased lines where there are four wires — two for the transmit and two for the receive channel. Hence, when it is used on ordinary telephone lines, it has to be used in half-duplex mode — alternatively transmitting and receiving data on the same frequency.

Hayes and US Robotics in the US, produce 9600 bps dial-up modems using V.29 methods, and they get round the half-duplex problem by using FPPS, which we are told stands for 'fast ping-pong system'. Basically, the modems bounce back and forth between transmit and receive modes. They do this with clever internal software, and present what appears to the computer to be a full-duplex system. This is good enough for most purposes and avoids the need for expensive echo cancellation.

The main problem is that Hayes and US Robotics modems don't work in quite the same way and they currently cannot 'talk' to each other, although the two companies are co-operating in an effort to sort this problem out.

A new way?

Until now, all modems have transmitted data on one basic frequency or channel. This is often referred to as a carrier. Even the V.32 modems use one basic frequency which is modulated in a complex manner to carry the data.

The people at Telebit (a US modem company) went back to square one and looked at the problem of achieving high-speed data transmission. They came up with the idea of using a number of carriers, each much narrower than previous ones and each carrying a part of the signal.

The Trailblazer uses 512 separate carriers and allows data transmission at speeds of up to 18,000 bps. It uses a form of QAM that Telebit has christened DAMQAM — dynamic adaptive multi-carrier quadrature amplitude modulation (no comment!). The adaptive bit is there because it monitors line conditions and gradually slows down if they are poor until it finds a speed they can support. CCITT standards also have what is called fall-back capabilities, but they tend to halve the transmission speed: 9600 falls back to 4800, and so on. The Trailblazer will wring every last bit out of the phone line.

The Trailblazer is available in an Australian version from Netcomm. The price of this technology? Around $3500, giving a better price/performance than V.32 modems.

Dangerous downloads

We recently saw a Usenet news item that listed some 'contaminated' programs that are known to be circulating. We believe that some of them are genuine public domain or shareware programs that have been hacked to cause damage (like erasing disks) as a side effect, while others are single-minded attacks on the unwary. The article suggested that the following files should be avoided:

```
ARC.*
ARC513.*
ARC600.*
BALKTALK.*
DISKSCAN.EXE
DOSKNOWS.EXE
EGABTR.*
FILER.EXE
LIST60.*
QMDM110.EXE
QMDM110A.ARC
QUIKBBS.COM
SECRET.BAS
STRIPES.EXE
VDIR.COM
```

Experienced bulletin board users and operators know that detailed reports of such nasties are in circulation, making it easier to identify the offending files. The reason for raising the issue here is to warn newcomers that it's not all sweetness and light in the world of PC communications.

Computer viruses and trojan horses have been given much publicity this year. Some pundits have suggested that you can protect your system from 'infection' by using only licensed software from official distributors.

Unfortunately, this is not true. Viruses have been reported on commercial software for the Macintosh and the Amiga. There might be a bigger risk with

downloaded software, but if you only use your computer for recreational purposes and take care with backup procedures, you may decide it's worth taking a chance. If you do, you'll be in good company.

System news

It's not at all unusual for a user group to start a BBS, but we've just heard that the opposite process has occurred in Melbourne's northern suburbs. For more details, log on to the Zoist BBS — the number is given below in the 'Updates' section.

This month our thanks go to Jeff Campbell, John Fisher, Larry Lewis, and Ann Matthews for the information they provided.

New listings

NSW

2000 And Beyond (02) 522 6514. MV. Greg Kuhnert. V21, V22, V23, Bell 103, 212.
Amiga Zone (02) 771 6351. MV. Richard Duffy. 9pm-7am daily. V21, V22, V23, Bell 103, 212.
Aquarius (02) 686 2798. MV. Glen Harvy. V21, V22, V22bis V23, Bell 103, 212. FidoNet node 713/608.
Arknet (02) 868 4836. M. Andrew Khoo. V22, V22bis, Bell 103. Log on as guest, and mail user admin for access.
Arrow (02) 451 2660. MV. Mark Sinclair. V21, V22, V23.
Black Hole (02) 81 4253. MV. Ken Thompson. V21, V22, V23, Bell 103, 212.
Bramblebush (02) 829 1809. MV. Ken Allan. V21, V22. 24 hours Mon-Sat.
Cesspit (02) 543 7204. 'Moby Disk'. V21, V22, V23, Bell 103.
CoCo Arena (02) 646 5573.
Cursor Contact (02) 637 8131. MV. 'Infiltrator'.
Dharruk (02) 625 3246. Punternet node 10.
Kiwi Konektion (02) 439 6178. MV. Robert Earle. 6pm-8am weekdays, 24 hours weekends. V21, V22, V22bis, V23. FidoNet 711/410.
Midnight Quest (02) 519 3579. P. Peter Pride. 5pm-9am weekdays, 24 hours weekends. V21, V22, V23. Astronomy.
Mirage Arcane (02) 665 5970. MV. Jeremy Nysen. 10pm-7am daily. V22, V22bis, Bell 103. FidoNet 712/621.
Nightmare (02) 545 1132. Todd Wright. V21, V22, V22bis. FidoNet 712/503.
Raucous (02) 261 5329. P. Mark Weegen. 9am-6pm daily. V21, V22, V23.
SBA (02) 411 1850. MV. Bob Wilson. V22, V22bis. FidoNet 711/406.
Trantor (02) 543 6899. Matthew Geier. V21, V22, V22bis, Bell 103, 212. A ringback system.
VIP (02) 319 3207.
Yet Another Bulletin Board (02) 804 6837. MV. Jonathan Chin. V21, V22, V22bis, V23, Bell 103, 212.
Steel City (042) 83 7247. MV. Craig Sinclair. 6.30pm-11.30pm daily. V21, V22, V22bis, V23. FidoNet 712/420.

Vic

Alpha Centauri (03) 874 3559. M. David & Kim Nugent. V21, V22, V22bis, V23. FidoNet 632/348.
Cave 76 (03) 882 9197. 'Avatar'. 10pm-8am daily.
Entropy (03) 583 9747. P. John Hardy. V21, V22, V23. FidoNet 632/344.
Krime Philes (03) 743 0324. 'Renegade'. V21, V22, V22bis, V23.
Livewire (03) 399 9077. P. 24 hours daily. V21, V22, V22bis.
MACE-Atari (03) 899 6203. MV. Stuart Szabo & John Burgess. V21, V22, V23.
Mercury (03) 221 3612. P. John Fisher. 7.30pm-6am weekdays, 24 hours weekends.
Pegasus (03) 725 4948. Lee Gordon-Brown. FidoNet 630/309.
Southern Mail (03) 725 1621. P. Maurice Halkier. V22, V22bis. FidoNet 631/320.

Qld

Sunshine Coast Connection (071) 44 2889. P. 'Brian'. 8pm-8am daily. V21, V22.
TurboLink Australia (07) 262 1414.
Youth Extension Service (Toowoomba) (076) 39 1790. P. Wayne Bucklar. V21, V23. FidoNet 640/302.

SA

Burning Bush (08) 272 8405. Douglas Carthew.
Sorcerer Users Group (08) 260 6576. MV. Steve Fraser.

WA

Bit-Board (09) 417 3706. P. John Hamill. V21, V22, V22bis, V23, FidoNet 690/909.
Kardinya (09) 331 1695. P. Tony Salmeri. V21, V23.
Lightning Line 1 (09) 275 8225. MV. Simon Blears. V22, V22bis, Bell 212, Trailblazer. FidoNet 690/903.
Treasure Island (09) 271 0471. Gloria Platt. V21, V22, V23.

Updates

NSW

Augur (02) 311 3052. MV. Mark James. V21, V22, V22bis, V23. FidoNet 712/302.
Commodore 64 (02) 664 2334. MV. Graham Lee. 24 hours daily. V21, V23. Punternet node 4.
Dream Time (02) 93 5225. MV. Chris Geddes. 9pm-7am daily. Previously known as Fantasy.
First Nice MIDIline (02) 868 4347. P. Andrew Khoo. V22, V22bis, Bell 103, Trailblazer. FidoNet node 711/805.
Idiom Offline.
Landover (02) 319 1793. MV. Lance Lyon. V21, V22, V22bis, V23, Bell 103, 212.
Manly (02) 977 6820. MV. V21, V22, V23. Requires Ultraterm or Rterm on C64.
Micro Design Lab (02) 663 0150, (02) 663 0151. MV. Kevin Lowton and Lindsay Gorrie.
Milliway's (02) 357 7027. MV. David Coucke. 9.30pm-7.30am daily. V21, V22.
Nebula (02) 407 2729. MV. Sean Craig. V21, V22, V22bis, V23.
Night Shift (02) 635 8175. P. 'Binky'. 8.30pm-5am daily. V21, V22, V23, Bell 103, 212.
Omen Offline.
Paragon (02) 597 7477. MV. Jennifer Allen. V21, V22, V22bis, V23. FidoNet 712/502.
Phantom Connection (02) 399 7716. MV. Bob James. 24 hours daily. Punternet node 5. Formerly known as Phantom Land.
Playground (02) 53 9688. MV. Brett Selwood. V21, V22, V22bis, V23. FidoNet 712/504.
RCOM (02) 667 1930. MV. V21, V22, V23, V23 ORG, Bell 103 212. Requres Ultraterm on C64.
Sorceror Users Group (02) 626 8020. MV. John Cepak. V22, V22bis, Bell 103. FidoNet 711/405.
Tesseract Offline.
Comm-Link (043) 413 135. MV. 'Nuggets'. 24 hours daily. V21, V22, V23, Bell 103, 212. Punternet node 9.
Griffith Computer Association Offline.
Matrix Newcastle (049) 29 5279. MV. Andrew Pike. V21, V22. Punternet node 3.
Newcastle Micro Club (049) 68 5289. MV. Tony Nicholson. 5pm-8.30am weekdays, 24 hours weekends. V21, V22, V22bis, V23.
Palantir (060) 40 1284. MV. Steve Sharp. V21, V22, V22bis, V23, Bell 103, 212. Punternet node 1.
Sorcim Micros (065) 59 8854. M. John Caine. 9pm-8am daily. V22, V22bis, Trailblazer. FidoNet 711/405.

ACT

Canberra KBBS Offline.
Commodore User Group. (062) 810 847. MV. James Hacker. 24 hours daily. Punternet node 2.
Datalink Offline.
MICSIG Offline.

VIC

Anzugs (03) 887 0678. MV. Miklos Bolvary. V22, V22bis, Bell 103, 212. FidoNet 631/326.
Compusoft (03) 386 6019. P. George Tsoukas. 24 hours daily. V22.
Crystal Symphony (03) 874 4176. MV. Greg Jones. 10pm-7am daily. FidoNet node 632/346.
Cycom Offline.
Dreamscape (03) 562 0489. Michael White. 7am-midnight daily. V21, V22, V22bis, V23. Formerly known as Prodergy.
Duncan Offline.
East Suburb Eighty User Group (03) 819 3115. Martin Axford. V21, V22, V23, V23 ORG.
Eastcomm (03) 288 0775. P. Keith Haslam. V21, V22, V23, V23 ORG. FidoNet 630/312.
Electronic Cross-Over (03) 367 5816. Stephen Paddon. 24 hours daily. V21, V22, V22bis, V23.
Info-Source Offline.
Maxitel (03) 882 6188. P. Jos Van Der Sman.
MESA (03) 754 5081. MV. David Woodberry. 24 hours daily. V21, V22, V23. Formerly known as SCUA.
Yarra Valley (03) 736 1814. MV. Grahame Mitchell. 10am-8am daily. V21, V22, V23. FidoNet 630/350.
Zoist (03) 467 2871. M. Bob Fletcher. "4 hours daily.

QLD

CCUG (07) 344 1833. Ray King. 24 hours daily. V21, V22, V22bis, V23, Bell 103, 212. Punternet node 6.
ConComp Offline.
HiTech (07) 300 5235. Clyde Smith-Stubbs. 24 hours daily. V21, V22, V23.
Midnight Express (07) 350 2174. MV. Lloyd Ernst. 24 hours daily. V21, V22, V22bis, V23.
Missing Link (07) 808 3094. MV. Mike Barber & Gernot Rosche. V21, V22, V23. User Works node 3. Punternet node 7.
Comtel (077) 891 655. MV. Warren Mason. 24 hours daily. Punternet node 8.

COMMUNICATIONS

SA

Aquarium (08) 270 4341. MV. 'Bream LeFish'. V21, V22, V22bis, V23. FidoNet 680/807.
Club (08) 263 5181. P. John Pride. V22, V22bis, V23. FidoNet 680/802.
Midnight Magic Offline.
IDN (08) 352 2252. MV. Dave Winfield. 5.30pm-9am weekdays, 24 hours weekends. V21, V22, V22bis. FidoNet 680/806.
Oracle PC-Network (08) 260 6222. MV. Don Crago & Grayham Smith. 24 hours daily. V21, V22, V22bis, V23. FidoNet 680/804. Formerly known as Electronic Oracle.

NT

Telepack Offline.

WA

Amiga Mouse (09) 310 3998. MV. Martyn Bate. 10.30pm-8am daily. V21, V22, V22bis, V23. Formerly known as Meeting Place.
Lightning Line 2 (09) 275 7900. MV. Simon Blears. V21, V22, V22bis, V23, Bell 103, 212. FidoNet 690/903.
Oasis Offline.
Omen III (09) 276 2777. MV. Greg Watkins & Mark Dignam. 24 hours daily. V21, V22, V23.
Omen Mini (09) 279 8555. Grey Watkins. V21, V22, V23.
Programmers Exchange Offline.

END

Submissions

The material in this column is presented in good faith, but as it is collated from material provided by readers, *APC* cannot take responsibility for its accuracy. New information and corrections are always welcome (but please mention whether or not you can vouch for accuracy of the material provided), and should be sent to:

Steve Withers, C/- Computer Publications, 47 Glenhuntly Road, Elwood, Vic 3184 or to Viatel mailbox 063000030.

Acknowledgements will normally be made through this column. You may also like to send a copy of the information to the Australian PAMS Coordinator at one of these addresses:

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TJ'S WORKSHOP

APC's monthly pot-pourri of hardware and software productivity tips. APC will pay between $100 and $200 for each tip published. Write to TJ's Workshop, APC, 124 Castlereagh Street, Sydney 2000.

Using a mouse in Basic

QuickBASIC has an advantage over Borland's Turbo Basic in that it allows external object files to be linked with compiled code. Along with its mouse, Microsoft provides an object library (MOUSE.LIB), but there's no way to combine it with programs written in Turbo Basic.

I have written a set of routines in Turbo Basic that will get around this limitation. By using Turbo's Call Interrupt command, any of the mouse services may be accessed from within a Turbo Basic program.

The demo program MOUSEDEMO.BAS (Fig 1) shows how these various subprograms may be called to turn the mouse cursor on or off and to change its shape in graphics mode.

H Chow

Using Mr Chow's subprogram as a foundation, I added an example to the demonstration that shows how to detect when a button is pressed. There are quite a few other mouse services that Turbo Basic can access using these routines.

Particularly interesting in this collection of routines is the service to alter the shape of the mouse cursor in graphics mode. The cursor may occupy an 8 by

```
'******** MousDemo.Bas

If FNMouseInstalled% Then
   Screen 0 : Cls
   Print "Text mode cursor . . . move the mouse, then press any key"
   Call MouseOn
   While Inkey$ = "" : Wend

   Screen 9
   Cls : Print "Default graphics cursor . . . press a button to continue"
   Call LoadCursor
   Call MouseOn

WaitButton:
   Call Mouse(3, Mouse%, X%, Y%)
   If Mouse% = 0 Goto WaitButton

   'Mouse% is zero if no button is pressed,
   '  1 if left button, 2 if right button,
   '  3 if both buttons


   Cls : Print "Hand cursor . . . press any key"
   Call LoadCursor
   While Inkey$="":Wend

   Cls : Print "Hour Glass cursor . . . press any key"
   Call LoadCursor
   While Inkey$="":Wend
   Call MouseOff
Else
   Cls
   Print "Mouse Driver Not Installed"
   Stop
End if

Screen 0
Cls
Print "Program Over"
End


'--------------------------------------
'returns -1 if mouse installed, 0 if not

 Def FNMouseInstalled%
     Local X%
     Reg 1, X%
     Call Interrupt 51
     FnMouseInstalled% = Reg(1)
 End Def

'--------------------------------
'similar to Microsoft's mouse call

 Sub Mouse(M1%, M2%, M3%, M4%)
    Reg 1, M1%          'AX
    Reg 2, M2%          'BX
    Reg 3, M3%          'CX
    Reg 4, M4%          'DX
    Call Interrupt 51
    M1% = Reg(1)
    M2% = Reg(2)
    M3% = Reg(3)
    M4% = Reg(4)
 End Sub

'---------------
'shows the cursor

Sub MouseOn
   M1% = 1
   Call Mouse(M1%, M2%, M3%, M4%)
End Sub

'---------------
'hides the cursor

Sub MouseOff
   M1% = 2
   Call Mouse(M1%, M2%, M3%, M4%)
End Sub

'-------------------------------------
'load a graphics cursor from Data items

Sub LoadCursor
   Local Cursor%()
   Dim Cursor%(0:15,0:1)

   For X% = 0 To 1
       For Y% = 0 To 15
           Read Pattern$
           Cursor%(Y%, X%) = Val("&H" + Pattern$)
       Next
   Next

   Reg 1, 9                         'AX
   Reg 2, 0                         'BX
   Reg 3, 0                         'CX
   Reg 9, VarSeg(Cursor%(0,0))      'ES
   Reg 4, VarPtr(Cursor%(0,0))      'DX
   Call Interrupt 51

   'defines the arrow cursor (graphics mode only)

    Data 3FFF, 1FFF, 0FFF, 07FF, 03FF, 01FF, 00FF, 007F
    Data 003F, 001F, 01FF, 10FF, 30FF, F87F, F87F, FC3F
    Data 0000, 4000, 6000, 7000, 7800, 7C00, 7E00, 7F00
    Data 7F80, 78C0, 7C00, 4600, 0600, 0300, 0300, 0180

    'defines the hand cursor (graphics mode only)
    Data E1FF, E1FF, E1FF, E1FF, E1FF, E000, E000, E000
    Data 0000, 0000, 0000, 0000, 0000, 0000, 0000, 0000
    Data 1E00, 1200, 1200, 1200, 1200, 13FF, 1249, 1249
    Data F249, 9001, 9001, 9001, 8001, 8001, 8001, FFFF

    'defines the hand cursor (graphics mode only)
    Data 0000, 0000, 0000, 0000, 8001, C003, E007, F00F
    Data E007, C003, 8001, 0000, 0000, 0000, 0000, FFFF
    Data 0000, 7FFE, 6006, 3C3C, 1FF8, 0FF0, 07E0, 03C0
    Data 0660, 0C30, 1998, 37EC, 6FF6, 7FFE, 0000, 0000

 End Sub
```

Fig 1 These routines allow Turbo Basic programs to access the mouse

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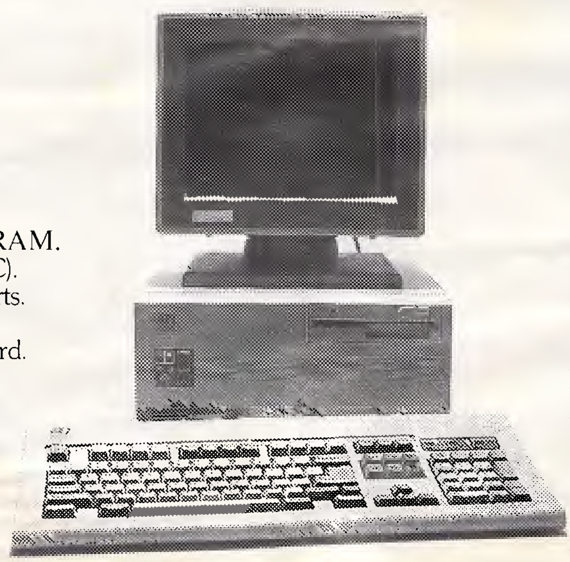

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16-pixel box, and the various bits in each Data item determine which pixels will be turned on or off — EW.

Accelerating slow chips

I have installed an accelerator board in my IBM PC but find that the increase in speed is limited by the speed of my memory chips. I can easily replace my memory with faster chips except for the lower 64k, which is soldered in. I understand that I can fill the lower 64k to prevent access. Can you suggest a patch or a Pascal program to accomplish this?

R Sommers

A memory-resident program to 'fill in' memory up to a certain address boundary is very simple to construct.

However, it may not speed up the operation of your machine as much as you would hope. Examining the DOS memory allocation plan will help you understand why.

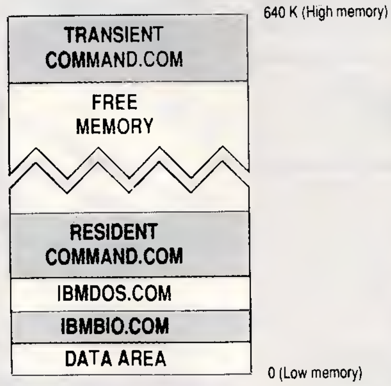
DOS is a single system that actually consists of three separate parts. The low-level BIOS interface program, IBMBIO.COM, works with the ROM BIOS to control the actual hardware of the PC. The DOS program itself, IBMDOS.COM, provides the familiar (to programmers) Int 21h interface and handles the device interface for disk and other peripherals. Finally, the command processor, COMMAND.COM, is itself divided into three portions: a resident portion, an initialisation portion, and a transient portion. The initialisation portion is thrown away after it processes the AUTOEXEC.BAT file, leaving memory looking something like the diagram 'DOS Memory Allocation After Running AUTOEXEC.BAT'.

The length of each portion of DOS varies with the version used, with 3.3 taking the largest amount of RAM. On my computer, booting with a 'small system' (no CONFIG.SYS file and no AUTOEXEC.BAT file), the free memory begins at about the 54k level. The next program to be loaded would begin there and have approximately 10k of itself in the lower 64k.

Once I add my normal CONFIG.SYS file, which allocates space for additional buffers and files and loads device drivers for two RAMdisks, a mouse, and a disk cache, the start of free memory has already been pushed up past the 64k boundary. Since no TSR program can get control early enough to lock out the 'slow' memory in the first 64k, the effort would be wasted.

In addition, the interrupt vector tables and ROM BIOS data areas must (by convention) be located in the lower 64k.

DOS Memory Allocation After Running AUTOEXEC.BAT



If these were to be moved, no program, including DOS, would function. Since most programs access these areas and go through DOS to perform file manipulation, a good proportion of the normal execution time is actually expended in the slow RAM anyway.

Note that some accelerator boards have the ability to 'backfill' memory, allowing them to substitute on-board RAM for system board RAM. Because the on-board RAM is usually accessed with a 16 or 32-bit-wide data bus and is run at a higher clock speed, performance is improved.

Rather than worry about blocking out the first 64k, why not fill it up with something useful? Many of the resident utilities published in this magazine aren't speed-critical and can made good use of small amounts of RAM. Loading them will satisfy your need to fill memory while increasing your productivity — RH.

Macintosh Word 3.0x and Excel

You're allowed to 'personalise' your master disk with Word or Excel by entering your name and/or organisation into a dialog box.

But once you've done that, all future backup copies display this information in an Info box when you open the application. The documentation states your disk will be 'permanently marked'. If you desire to change what was entered, here's the solution.

Using a file editor such as Fedit, display the application's data fork. Pull down the Options menu and select SET EOF or SET END OF FILE. Then select ZERO, which eliminates the application's data fork. The next time you run the application, it prompts you

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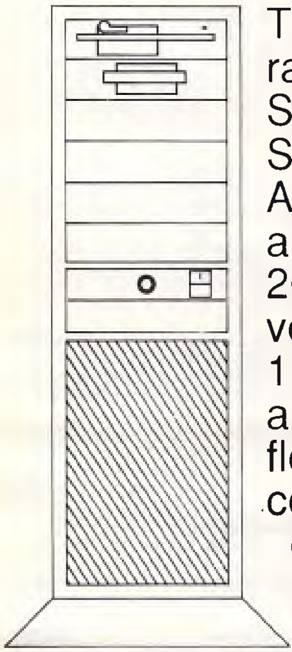

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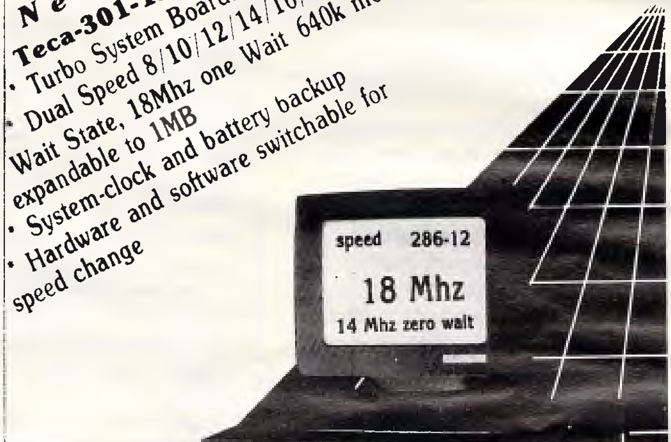

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to enter the 'personal' information again, as if you had a virgin master.
D Allain

Finder

When using the Macintosh Finder to copy a disk, you can avoid typing the new disk name. Simply click on the icon of the original disk and select COPY from the Edit menu (COMMAND-C), then click on the icon of the disk you want to name or rename and select PASTE (COMMAND-V). You will have to add to the name or move the duplicate file to another folder since you can't have files with identical names in the same folder.
W Sacco

Jazz

When using Jazz or other programs on the Mac that don't let you delete files from within the program, the following technique helps you purge obsolete versions of files.

For the files you want to delete, use SAVE AS and add a '-T' (short for Trash) to the end of the file name. When you QUIT the application and return to the Finder with BY NAME chosen for the View, every file that should be deleted now appears twice, once with the original name and once with the '-T' suffix. Just carry both copies to the trash.
J Zarkin

Snapshots on the Mac II

In order to get COMMAND-SHIFT-3 (the System utility that creates MacPaint-type snapshots of the screen) to work on a Macintosh II, configure the video card to use only two shades of grey. If the card is configured for 4 or 16 shades, the COMMAND-SHIFT-3 combination won't work.
G Mushlin

Drive select

When presented with a Save or Open dialog box on the Macintosh, pressing the Tab key is a short cut to clicking on the Drive button. It selects the next available disk drive.
J Haslup

Triplets

By setting BELOW and DOUBLE borders on the paragraph menu of Word for the Macintosh, you can obtain a double line beneath a paragraph.

Then, on the paragraph directly below that one, set the borders for DOUBLE and ABOVE. The result is an interesting group of three horizontal lines, as shown

take in figure

M Elenko

Macintosh System

There's an easy way to have all your cdev resources appear in the order you want. The cdevs appear in alphabetical order following the General cdev when you select the Control Panel. To put them in the order you want, simply rename the cdev files; what I do is place numbers in front of the original names.

In order to rename the cdev files, you have to duplicate them, rename the copy, then throw away the original.
P Pudaite

Mac menu bar interference

One problem with Word 3.0x on the Macintosh is that Microsoft's choice of long menu titles, such as Document and Window, plays havoc with the length of the menu bar especially when desk accessories add their own menus to the menu bar.

You can't change Word's menu titles to something less verbose with a utility such as ResEdit, because Microsoft

didn't use menu resources. So, use a file editor such as Fedit. Perform an ASCII Search for the capitalised word 'Document'. This reveals the program area where the names of menu titles are stored. Each title is preceded by the length of the title. For example, change the 8 in front of 'Document' to 3, then issue the command WRITE SECTOR. That's it. Using this technique, you can completely rename or shorten Word's menu titles. If you rename titles, make sure your new titles are no longer than Word's old ones.
N Ransom

Total check

I use Microsoft Word on the Macintosh. Generally I need to spell check an entire document, but I don't like going to the beginning of a document before running the spelling checker. If I don't start at the beginning of the document, then I get a 'Continue Check from Beginning' dialog from Word.

In order to check the entire document without moving the cursor to the beginning, select the entire document by moving the cursor to the left margin, where the cursor changes to an arrow, then click the mouse while pressing the Command key. Now run the spelling checker. The entire document will be checked in one pass.
D Meza

Usable 'auto date'

While setting up a template for memos in Mac Word, I stumbled across the fact that the 'auto date' from the headers or footers can be copied and pasted anywhere in a document. It continues to change automatically each time you start a new document. An 'auto date' can be distinguished from text containing the date by using the SHOW PARAGRAPH command (COMMAND-Y), which displays a dotted outline around 'auto dates'. This also works for the time and page numbers. You can also paste 'auto date' into the glossary and add it to your Work menu.
L McArthy

ImageWriter, part I

Here's a way to obtain the fastest and best print quality from your ImageWriter II. You can access the ImageWriter II's built-in proportional fonts from within MacWrite or Microsoft Word. Certain fonts when printed with the 'draft' quality access the printer's internal proportional fonts.

These internal proportional fonts are: Boston II 10 and 12 point, Toronto 12 point, Chicago 12 point, Venice 14 point, London 18 point, Athens 18 point, and San Francisco 18 point. Other fonts, such as Geneva, use a monospaced font in draft mode that produces awkward spacing.
D Harten

ImageWriter, part II

Here's a foolproof way to deal with the Imagewriter II's frustrating tendency to crunch up paper as its paper-advance teeth lose track of the perforated edge. First, place the printer on a table top with the back of the printer about 20cms from the edge. Then put a phonebook (about 8cms thick) between the edge of the table and the printer. Next, thread the paper from below the table, over the phonebook, into the printer, and out again. Whenever you print, start on the second sheet of paper. Attach a heavy paper clip to the paper and let it gently pull the paper over the phonebook be-

hind the table. Leave at least another 20cms between the table and the wall for gathering the printed output. This costs you extra space and paper, but the printer will finally stop crunching up your paper.
E Keller

PageMaker

When using PageMaker on my Mac, I often need to nudge an object just a small distance. Dragging with the mouse rarely provides precise control. Easy Access, and INIT that comes with the new System, is useful for this situation. Just press COMMAND-SHIFT-CLEAR to turn on the Mouse Keys. Press the 0 key to lock the mouse button down, then use the numeric keypad to move the pointer (press 8 to move up, 6 to move right, etc). To move the pointer one pixel on the screen, tap the key once. For longer movements, hold down the key. Pressing the decimal point unlocks the mouse button, and pressing the Clear key turns off the Mouse Keys.
K Fong

Macintosh Excel, part I

In Page Preview in Excel I discovered that while in the Blow Up mode, the arrow pointer turns into the hand scrolling tool when the Option key is pressed. An Option allows you to scroll to any part of the document without going back to the Full Page mode, moving the magnifying glass, and then clicking on the other part of the document.
C Smith

Excel, part II

Using Excel's FIND command (the one under the Formula pull-down menu, not the FIND under the Data pull-down menu) with nothing in the 'Find What:' field finds unoccupied cells. With this command you are restricted to the actual size of the worksheet (ie, the worksheet area you have highlighted). If you try to execute FIND from the keyboard with COMMAND-H, Excel bypasses the Find window and selects the next occurrence of the search string, (ie, the next blank cell). If you want to open the Find window from the keyboard, just type COMMAND-J.
D Weber

Excel, part III

You can create a cell with a blank numeric format. In other words, you can enter a value into the cell and it won't show. I use this and the LOOKUP function in an entry area of the spreadsheet for my company billing template. The blank format cell is the entry area for a code number that corresponds to the Town, State, and Post Code in the Lookup table. The code number itself is never displayed. Here's the technique:

1) Select the cell to format.
2) Choose NUMBER from the Format menu.
3) Hit the Backspace key, then the Space bar.
4) Press the Enter key to return to your worksheet.

D Smith

Excel, part IV

In Excel, when you want to copy a formula from one cell to another but still keep the reference absolute, you normally add a dollar sign ($) before the reference, and then Copy and Paste.

There is another way. By copying the formula from the formula bar instead of copying the cell itself and pasting it as usual you end up with the same cells being referenced in the new location. The procedure goes like this:

1) Select the cell that you want to copy.
2) Select Formula from the formula bar.
3) Press COMMAND-C or choose COPY from the Edit menu.
4) Click on X in the formula bar.
5) Select the cell that you want to paste and press COMMAND-V.

You now have exactly the same formula in the new cell.
M Topete

HyperCard

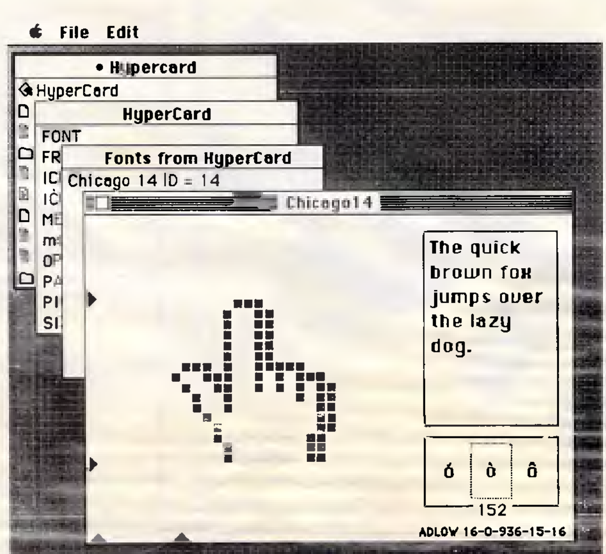
If you want to expand the cursors of HyperCard, make the ones you need with ResEdit, and call them from HyperCard by indicating the ID Number. The browse tool and all other HyperCard icons and cursors are in the FONT resource of HyperCard, shown as a strange '12 ID 31756'. You may not be able to open a resource with the ID number set so high. You can change the ID number, temporarily, to a lower number using GET INFO from the menu bar. Now you can open the resource, make your changes, then reset the ID number to the previous value. Be sure to save the changes.
M Lafortune

• If you need HyperCard to select a tool or pattern from the Tool menu or the Patterns menu but you're not sure what it's called, follow this procedure:

1) TEAR-OFF the menu that has the item in question.
2) Select the tool or pattern that you plan to use.
3) Type 'get the tool' or 'get the pattern' into the Message Box and press Return.
4) Type 'it' into the Message Box and press Return.

The Message Box should contain the exact name (or, for patterns, a number) that HyperCard needs to identify that item.
A Moore-Smith

• Showing the time in a stack is nice, but it becomes a pain in the mouse if



HyperCard cursor and other Icons are kept in the HyperCard FONT resource. Use ResEdit if you want to make alternate icons. To access these icons, HyperCard will need to know their ID numbers the stack is used for keyboard input. At the end of each minute, HyperCard updates the time. If you happen to be typing when the clock strikes, HyperCard abandons the text field to update the Time field, and your keyboard turns into a pumpkin. One way to ensure uninterrupted keying is to have HyperCard only refresh the time when you are not keying. The following lines in your stack script will do just that (assuming a field named 'Time' is in the background):

```
on openField
   set lockText of field"Time" to false
end openField

on mouseLeave
  set lockText of field "Time" to true
end mouseLeave

on idle
  if lockText of field "Time" =
    true then put the time into
      field "Time"
end if
```

B Swagerty

Writing TSRs

I have a problem with a TSR program I'm writing as an experiment. I'm using MASM 5.0, DOS 3.3, and an IBM PC XT. My program hooks interrupt 09h (keyboard interrupt) and checks for a hot-key (Ctrl-~) to pop up. If the key is detected, a message appears on the screen. My problem is writing the message. I tried to use DOS interrupt 21h, function 09h, but it hangs every time. I got the program to work using BIOS calls, however. I can get interrupt 21h calls to work in the initialisation part of my program, but once I'm inside my interrupt handler, it goes off into outer space when it tries to return.

J Ratti

The basic problem lies not in your code but in the fact that MS-DOS was designed to be a single-tasking, single-user operating system. The majority of the MS-DOS kernel is not 're-entrant'. That's to say, it cannot be called by an interrupt handler if it was already executing at the time the interrupt occurred.

For example, imagine that an application has called MS-DOS to perform a file function, the file operation is in progress, an interrupt occurs, and a program that is invoked by the interrupt also calls DOS to request a file function. Instant disaster! DOS's stacks and internal variables get bashed, the context of the original file operation function call is lost, and a crash is almost certain to follow.

There are a variety of ways to get around these re-entrancy problems, most of which involve use of semidocumented or undocumented MS-DOS function calls and internal flags. Most or all of the necessary techniques have been presented in the body of the source code for the various 'pop-up utilities' that have appeared in APC's productivity section over the past six months. The new MS-DOS Encyclopaedia *(Microsoft Press, 1987) contains a detailed chapter on writing TSRs, complete with a working example. Also, you might find* Performance Programming Under MS-DOS, *by Michael Young (Sybex Books, 1987, ISBN O-89588-420-8) which contains extensive information on writing TSRs — RD.*

Less is more

I recently ran across a program that would not run properly on an IBM PC in which more than 512k was installed. Although this sounds strange, I've run

```
TITLE    'MEM512 - limit memory size to 512K

 ;  This program will limit the amount of RAM known to the operating system
 ;  to 512K bytes.
 ;
 ;     If more than 512K is installed in the system, the memory size variable
 ;     is set to 512(K) and the system is rebooted without ROM diagnostics
 ;     or memory re-sizing.
 ;
 ;     If the amount of RAM installed is less than or equal to 512K bytes,
 ;     a message is displayed informing the user of the amount of RAM in the
 ;     system.  No further action is taken.

MEMSIZE EQU      512                            ;Limit of memory size (in K)

 ;
 ;  Macro to print a string of text end by '$'
 ;
PRINT   MACRO    STRING
        MOV      DX,OFFSET STRING
        MOV      AH,9
        INT      21H
        ENDM

 ;
 ;  Macro to delay so user can read message on screen
 ;
DELAY    MACRO
         LOCAL   DELAY_1,DELAY_2
         MOV     AL,5
DELAY_1: MOV     CX,0FFFFh
DELAY_2: LOOP    DELAY_2
         DEC     AL
         JNZ     DELAY_1
         ENDM

 ;
 ;  Code segment starts here
 ;
CSEG    SEGMENT
        ORG      100H
        ASSUME   CS:CSEG,DS:CSEG

INIT:   PRINT    STRTMSG                        ;Display the "start" message

        MOV      BX,40H                         ;DS:BX <= ptr to mem size variable
        MOV      DS,BX
        MOV      BX,13H
        MOV      AX,WORD PTR [BX]               ;AX <= memory size value
        CMP      AX,MEMSIZE
        JBE      MEM_OK                         ;Jump if memory size LE 512K
```

Continues . . .

Fig 2 MEM512.ASM assembly language code to create MEM512.COM program, which will trick DOS into thinking you have only 512k RAM. You may substitute other Runts by changing the number following MEMSIZE EQU and fixing the other text references

across other commercial and public-domain programs that have this problem.

One possible cause is the program's use of a signed compare and jump where an unsigned compare and jump in checking memory size is appropriate. You can address up to 512k with 19 address bits and need a 20th bit to go any higher. A signed comparison will interpret this as a negative value and report insufficient memory.

To fix this, I wrote the MEM512.COM program created by the MEM512.ASM assembly language code in Fig 2 or the Basic MEM512.BAS program in Fig 3. It looks at the memory size variable set by the diagnostic code during boot-up. If this variable says your system has more than 512k installed, the program sets it to indicate that only 512k is available. It then performs a special reboot (INT 19) that bypasses system diagnostics to avoid the memory-sizing routine. The system will load normally except that it will think it has only 512k RAM.

If you run MEM512.COM on a system with 512k or less, it will display a message indicating the amount of RAM and then quit without rebooting.

The equate MEMSIZE is currently assigned the value 512. If you want to reduce the amount of memory even further, change the number there.

B Herbert

It's true that even some commercial software (like the Version 3.3 of WordStar's installation program) had problems with more than 512k, but these days, with so many programs needing 600k just to say hello, you probably won't need this utility much. Still, if you're developing software, you have to make sure it runs on small-

memory systems, and this program makes it easy to simulate them all.

If you do create several versions, change both the value after MEMSIZE EQU and all the text references to 512k — PS.

```
;
;  Memory size is greater than 512K - set the memory size variable to 512(K)
;    and reboot the system without re-sizing memory
;
        MOV     WORD PTR [BX],MEMSIZE   ;Set memory size to 512K
        PUSH    CS                      ;Restore DS to "CSEG"
        POP     DS
        PRINT   REBTMSG                 ;Tell user we're rebooting
        DELAY
        INT     19H                     ;Read bootstrap from disk; pass control

;
;  Memory size is less than or equal to 512K - tell user the current amount
;    of memory and take no further action.
;
MEM_OK: PUSH    CS                      ;Restore DS to "CSEG"
        POP     DS

;  Move ASCII value of mem size to output string.  Mem size is in AX.

        DIV     BYTE_10
        OR      AH,30H
        MOV     KBYTES[2],AH
        AAM
        OR      AX,3030H
        XCHG    AH,AL
        MOV     WORD PTR KBYTES,AX
        PRINT   SIZEMSG                 ;Display the message

        INT     20H                     ;Exit to DOS

;-----------------------------------------------------------------------------

REBTMSG DB      'Rebooting to set memory size to 512K',13,10,'$'
SIZEMSG DB      'System memory size is currently '
KBYTES  DB      3 dup ('0'),'K',13,10,'$'
STRTMSG DB      10,13,'MEM-512 tricks DOS into thinking '
        DB      'system has 512K or less of RAM.',13,10,'$'

BYTE_10 DB      10                      ;Used by Divide instruction in MEM_OK

CSEG    ENDS
        END INIT
```

Ends

```
100 ' MEM512.BAS program to create MEM512.COM -- Barry Herbert
110 E=4:CLS:PRINT "Checking DATA; please wait..."
120 FOR B=1 TO 15:FOR C=1 TO 16:READ A$:T=T+VAL("&H"+A$):NEXT
130 READ S:IF S<>T THEN PRINT "ERROR IN LINE";B*10+180:END
140 T=0:NEXT:RESTORE:OPEN "MEM512.COM" AS #1 LEN=1
150 FIELD #1,1 AS D$:FOR B=1 TO 15:FOR C=1 TO 16:READ A$
160 LSET D$=CHR$(VAL("&H"+A$)):PUT #1:IF B=15 AND C=E THEN 180
170 NEXT:READ F$:NEXT
180 CLOSE:PRINT "MEM512.COM CREATED"
190 DATA BA,9E,01,B4,09,CD,21,BB,40,00,8E,DB,BB,13,00,8B,1729
200 DATA 07,3D,00,02,76,1A,C7,07,00,02,0E,1F,BA,50,01,B4,914
210 DATA 09,CD,21,B0,05,B9,FF,FF,E2,FE,FE,C8,75,F7,CD,19,2651
220 DATA 0E,1F,F6,36,E3,01,80,CC,30,88,26,99,01,D4,0A,0D,1516
230 DATA 30,30,86,E0,A3,97,01,BA,77,01,B4,09,CD,21,CD,20,1739
240 DATA 52,65,62,6F,6F,74,69,6E,67,20,74,6F,20,73,65,74,1560
250 DATA 20,6D,65,6D,6F,72,79,20,73,69,7A,65,20,74,6F,20,1463
260 DATA 35,31,32,4B,0D,0A,24,53,79,73,74,65,6D,20,6D,65,1173
270 DATA 6D,6F,72,79,20,73,69,7A,65,20,69,73,20,63,75,72,1544
280 DATA 72,65,6E,74,6C,79,20,30,30,30,4B,0D,0A,24,0A,0D,1003
290 DATA 4D,45,4D,2D,35,31,32,20,74,72,69,63,6B,73,20,44,1208
300 DATA 4F,53,20,69,6E,74,6F,20,74,68,69,6E,6B,69,6E,67,1528
310 DATA 20,73,79,73,74,65,6D,20,68,61,73,20,35,31,32,4B,1316
320 DATA 20,6F,72,20,6C,65,73,73,20,6F,66,20,52,41,4D,2E,1275
330 DATA 0D,0A,24,0A,00,00,00,00,00,00,00,00,00,00,00,00,69
```

Fig 3 Basic MEM512.BAS program to create MEM512.COM program, which will trick DOS into thinking you have only 512k RAM

Disappearing act

I've read comments in several magazines complaining about new software installation programs that alter existing AUTOEXEC.BAT or CONFIG.SYS files. One way to avoid these unwanted modifications is to change the attributes of the two files to Hidden. DOS will still access both files without complaint during boot-up, but it will not allow any programs to modify or delete them.

B Stephenson

Changing the file attributes to 'hidden' or 'read-only' will prevent programs from overwriting them. The SCRIPT file shown in Fig 4 will create four files called HIDE.COM, UNHIDE.COM, RO.COM, and UNRO.COM. Type this SCRIPT file using a pure-ASCII word processor. Be sure to leave the blank line above RCX and to press the Enter key at the end of each line, especially the last one. Then make sure DEBUG.COM, Version 2.0 or later, is handy and type

```
DEBUG < SCRIPT
```

To hide CONFIG.SYS, just type

```
HIDE CONFIG.SYS
```

To unhide it later, type

```
UNHIDE CONFIG.SYS
```

To make AUTOEXEC.BAT read-only, type the command

```
RO AUTOEXEC.BAT
```

and to bring it back to normal, type

```
UNRO AUTOEXEC.BAT
```

These four files use function 43h of INT 21 to first check the existing attribute byte and change only the bits that need modification. ORing the existing value with 1 makes it read-only; ORing it with 2 makes the file hidden. ANDing it with FE takes away the read-only attribute; ANDing it with FD unhides the file. Other attributes (system or archive) remain as they were.

Unfortunately, you can't use function 43 to change the attribute byte of subdirectories or volume labels, so this won't let you meddle with those. Be careful when hiding files en masse. If you issued a command such as

```
FOR %A in (*.*) DO HIDE %A
```

you'd end up with a whole directory of hidden files. You won't be able to use a similar command to unhide them, since DOS won't see any files to unhide. You'll have to unhide all your files individually, since wildcards don't work with hidden files. The safest thing to do if you hide lots of files is first to create a

```
N HIDE.COM
A
MOV BX,80
INC BX
CMP BYTE PTR [BX],20
JZ 103
MOV DX,BX
INC BX
CMP BYTE PTR [BX],D
JZ 116
CMP BYTE PTR [BX],0
JNZ 10B
MOV BYTE PTR [BX],0
MOV AL,0
MOV AH,43
INT 21
OR  CX,2
MOV AL,1
MOV AH,43
INT 21
INT 20

RCX
2B
W
E 120 E1 FD
N UNHIDE.COM
W
E 120 C9 01
N RO.COM
W
E 120 E1 FE
N UNRO.COM
W
Q
```

Fig 4 SCRIPT file to create HIDE.COM, UNHIDE.COM, RO.COM, and UNRO.COM. Type it in using a pure-ASCII word processor. Make sure you leave a blank line above RCX and that you press Enter at the end of every line, especially the last one

master file listing all the filenames, and then to put this master file in some other directory or on some other disk. If you're on drive C: you could use a command like

```
DIR > B:C-HIDDEN.LST
```

Making all your root directory files hidden may look interesting, but it can confuse other people who try to work with your system. Making them read-only will prevent other programs from changing (or deleting) them, but you'll still see them in normal DIR searches.

Some awful installation programs change things as they proceed. They may rename a driver file on the original disk or delete files once they've copied them to a hard disk. If the installation process is interrupted, or if it's so dumb that it doesn't know when something's gone wrong, you may have trouble reinstalling things later.

A safer way is simply to create a \ROOTBACK subdirectory one level down from the root and copy all your important root directory files into it. When something changes the files in the root directory, or if you somehow erase them, you can log into the root directory and type

```
COPY ROOTBACK
```

If you do try this, make sure that if you ever change your AUTOEXEC.BAT or CONFIG.SYS files, you copy the new versions into \ROOTBACK — PS.

Another approach

Another clever way to prevent having software packages replace or otherwise modify AUTOEXEC.BAT files was submitted by William Dixon:

The AUTOEXEC.BAT file on my disk contains just one real line (after an initial ECHO OFF):

```
ECHO OFF
SETPATH STARTUP
```

All it does is execute another batch file called SETPATH.BAT:

```
SET NORMPATH=C:\DOS;C:\UTIL;C:\
PATH %NORMPATH%
%1
```

SETPATH.BAT sets the path, then executes the STARTUP.BAT file, since its %1 replaceable parameter refers to the word STARTUP in the last line of the AUTOEXEC.BAT file.

The STARTUP.BAT file contains all the commands I normally would have placed in an AUTOEXEC.BAT file:

```
PROMPT $P$G
PRINT /D:PRN /Q:32
CARDFILE C:\UTIL\CARDFILE.TXT
DOSKEY
CTYPE /MA
SPEEDUP
```

There are several advantages to this technique:

(1) The AUTOEXEC.BAT file is easy to re-create if it is destroyed or inadvertently modified.

(2) The PATH command is in its own separate batch file, making it easy to change if directories are added or removed.

(3) The SETPATH.BAT file makes it easy to restore the default path if it has been changed.

(4) By creating a batch file like ADDPATH.BAT,

```
PATH %NORMPATH%; %1
```

it's easy to add a new directory to the path temporarily, and then restore it later with SETPATH.BAT.

(5) If all memory-resident programs are removed by utilities such as MARK/RELEASE or INSTALL/REMOVE, running STARTUP.BAT restores those programs as they were at power-on time.

W Dixon

Warm booting from Basic

The BASICA program listing (Fig 5) will cause a warm boot when added to a program and then run. A cold boot is even easier to do, although it will cause a longer delay due to the PC's memory check. To convert this routine to perform a cold boot, remove lines 30 through 130, change the ARRAY(7) in line 20 to ARRAY(2), and then change the FOR counter in line 200 to FOR I = 0 TO 4.

Dr T Burnakis

To convert this routine for use with QuickBASIC or Turbo Basic you will have to use CALL ABSOLUTE, which is equivalent to BASICA's CALL command. CALL ABSOLUTE is built into Turbo Basic directly; however, you must first use

```
DEF SEG = VARSEG (ARRAY (0))
```

before the POKE and CALL statements, to make the array's segment the current default.

In QuickBASIC 2.0, ABSOLUTE is an external routine contained in the file USERLIB.OBJ, though in later versions it is in its own file named ABSOLUTE.OBJ. Regardless of which version of QuickBASIC you're using, this object module must be linked to your program after it has been compiled — EW.

Compressing with bitmaps

When the elements of a large array are going to be used as flags to indicate yes/no or on/off status, the individual bits of each byte can be used to reduce memory overhead.

On IBM PC-class machines, a byte is 8 bits, which means a character array can track eight times as many elements (or be eight times smaller, depending on

your needs). Each element of a list can be represented by a single bit, with every 8 bits stored in a single array element. When an element is to be set (turned ON), the position of the character containing the bit is found and the bit set to 1. Resetting the bit (turning it OFF) requires the bit to be set back to 0.

BITTEST.C is a small program that demonstrates the use of these bit manipulation routines.

S Manipoopathy

Bitmaps and bit manipulations are not new. But C makes bit manipulation so easy that it's a sin not to take advantage of it, as Mr Manipoopathy's program, shown in Fig 6, so aptly demonstrates. I can think of a lot of times bitmaps would have gone a long way in improving the memory requirements of one of my programs: tracking previously asked questions in a trivia game program or a list of record numbers from a database selection, for example. In fact, a small model program (limited to 65,535 bytes of data space) can easily track over 250,000 elements of a list using a 32k bitmap.

Whenever you use bitmaps, make sure that the maximum number of elements being tracked does not exceed a value eight times the number of bytes in the bitmap; otherwise, you're sure to get 'unpredictable results' — a program crash. I did this, and the 'bug' disappeared once I realised my error and increased the size of the bitmap.

```
10 ' Machine language warm reboot procedure
20 DEFINT A-Z: P=0: I=0: J=0: DIM ARRAY(7)
30 DATA &HB8              :REM This is the hex code
40 DATA &H40              :REM for the warm reboot.
50 DATA &H00              :REM It first goes to the
60 DATA &H8E              :REM memory address 0040
70 DATA &HD8              :REM and places 1234 (hex)
80 DATA &HC7              :REM into memory.  Then it
90 DATA &H06              :REM branches to FFFF:0000,
100 DATA &H72             :REM the address where the
110 DATA &H00             :REM CPU begins to execute
120 DATA &H34             :REM instructions after a
130 DATA &H12             :REM power on.  From here
140 DATA &HEA             :REM the PC's BIOS jumps
150 DATA &H00             :REM to the start of its
160 DATA &H00             :REM diagnostic routines.
170 DATA &HFF
180 DATA &HFF
190 REM
200 P=VARPTR(ARRAY(0)): FOR I=0 TO 15: READ J: POKE(P+I), J: NEXT
210 SUBRT=VARPTR(ARRAY(0)): CALL SUBRT
```

Fig 5 Running this subroutine in a Basic program will force the PC to do a warm boot

```
/* bittest.c
 * tests bit-map routines
 */

#include<stdio.h>
#include<mem.h>
#include"PcMag.h"                          /* standard definitions    */

#define BITMAP_SIZE 1024
#define NUM_BITS    8
#define MAXVAL   (BITMAP_SIZE*NUM_BITS)
#define Bmap_init(bitmap,size)   memset(bitmap,0,size)

unsigned char bitmap[BITMAP_SIZE];         /* can track 8000 elements */

main()
{
    int n,i;
    char    linebuffer[100];

    Bmap_init(bitmap,BITMAP_SIZE);        /* initialize the bitmap to 0   */

    while(TRUE)
    {
        printf("\nEnter a number to put in the list & <RETURN> (^Z to go
on):\n");
        if(!gets(linebuffer))
            break;
        i = atoi(linebuffer);
        if(i < 0 || i > MAXVAL)
            printf("\nOnly numbers from 0 to %d are valid in this demo",MAXVAL)
        else
            setbit(bitmap,i);
    }

    while(TRUE)
    {
        printf("\nEnter a number to EXCLUDE from the list & <RETURN> (^Z to go
on):\n");
        if(!gets(linebuffer))
            break;
        i = atoi(linebuffer);
        if(i < 0 || i > MAXVAL)
```

Continues . . .

Fig 6 BITTEST.C demonstrates the use of bitmaps and bit manipulation routines to reduce memory overhead

BITTEST.C uses a 1k bitmap to track over 8000 elements. You can adjust this if you wish, but remember that data space in a small model program is limited, and most compilers require the 'Huge' memory model to be used to create an array larger than 64k. You can also declare a 'Huge' pointer and allocate over 64k from the far heap.

The Bitmap initialisation routine (a macro call to memset) should always be called before commencing calls to bitmap routines. This ensures that the bitmap is properly initialised to all zeros.

The setbit() function turns on a specific bit in the bitmap. To do this, it first calculates which byte in the bitmap contains the bit to be set, by dividing the bit number by 8 (the divide operator ignores any remainder). For example, bit number 7 (starting with 0) would be in byte 0, and bit number 24 would be found in byte 3 — the quotients of (7/8) and (24/8), respectively.

Next, setbit() finds the individual bit in the selected byte via the C modulus operator, which returns the remainder of a division operation. Calculating the remainder of 7 divided by 8 (7 % 8 in a C modulus) returns 7, or the seventh bit of byte 0; bit number 24 would be the zeroth bit of byte 3 (24 % 8). Fortunately, setbit() performs this automatically for us.

Finally, setbit() must turn that particular bit ON. It does this by taking the value of 1 (or 00000001 in binary) and shifting it left by the bit number. Bit 7, for in-

```
            printf("\nOnly numbers from 0 to %d are valid in this demo",MAXVAL)
        else
            resetbit(bitmap,i);
    }

    printf("\nThe included numbers are:\n");

    for(i = n = 0; i < MAXVAL; i++)
        if(isbitset(bitmap,i))
        {
            n++;
            printf("%3d %c",i, ((n % 13) ? ' ' : '\n') );
        }
    printf("\nThat\'s it");
}

    /* setbit() - turns ON bit n in bitmap       */
setbit(bitmap,n)
char    *bitmap;
int     n;
{
    bitmap[n/8] |= (1 << (n % 8));
}

    /* unsetbit()  - turns OFF bit n in bitmap  */
resetbit(bitmap,n)
char    *bitmap;
int     n;
{
    bitmap[n/8] &= (~(1 << (n % 8)));
}

/* isbitset() - returns TRUE if bit n is ON in bitmap, else returns FALSE */

isbitset(bitmap,n)
char    *bitmap;
int     n;
{
    return (bitmap[n/8] & (1 << (n%8)));
}

    /* End of bittest.c ****************************/
```

Ends

stance, results in 10000000 (1 shifted left seven times). Note that the bits are referred to here on a right-to-left basis, so that bit 7 is the seventh bit from the right side of each byte (beginning with 0).

This creates a mask that is used to turn on the appropriate bit via the bitwise OR operation. An OR operation always returns TRUE (or 1) if at least one of the two operands is TRUE. So, ORing a bit set to 1 (10000000) with a bit set to 0 (00000000) will always result in a 1 (10000000).

The table 'Turning On Specific Bits' shows the first 32 bits of a bitmap before and after bits 7 and 24 have been set.

To reset a bit in the bitmap (ie, to turn it OFF), the same steps are taken in resetbit() with the exception of the OR operation. Instead, a logical AND is used (which returns FALSE unless both operands are TRUE). To ensure that the appropriate bit is turned OFF without affecting the other bits in a byte, a mask must be created that contains a 0 in the appropriate bit. In other words, to turn off bit 7, we must create a mask the opposite of 10000000 — that is, one that looks like: 01111111.

ANDing a byte with this mask will turn bit 7 OFF without affecting the remaining bits. Other bits that are ON will stay ON, while bits that are OFF will remain OFF. That's the nature of the AND operation and this particular mask.

To create this second mask, the complement of the first mask is used. Designated by the tilde (~), the complement operator reverses all of the values of the bits in a byte. So while ORing a bit with a 1 will force it ON, ANDing the bit with the complement of 1 (or 0) will force it OFF.

The remaining function, isbitset(), returns TRUE or FALSE depending on whether the appropriate bit is ON or OFF. It accomplishes this by ANDing the bit with the original mask and returning the result of the AND operation. This will only return TRUE if the bit has been set.

To test these functions, BITTEST.C prompts you for a series of numbers to include in the list, which are added to the list via setbit(). Then it prompts for numbers to be excluded from the list and resets them via resetbit(). Finally, it uses isbitset() to print the list of included numbers on the screen.

Bit manipulation routines can also be written as macros, too, depending on how much 'in-line' code you want scattered all over your program.

Either way, the functions in BITTEST.C can reduce your list tracking data overhead considerably — RS.

Turning on specific bits

Byte number	0	1	2	3
Bit number	76543210	76543210	76543210	76543210
Before	00000000	00000000	00000000	00000000
After setbit(bitmap,7)	10000000	00000000	00000000	00000000
After setbit(bitmap,24)	00000000	00000000	00000000	00000001

7 (bit 7 of byte 0) (bit 0 of byte 3) 24

The first 32 bits of a bitmap before and after bits 7 and 24 have been set.

Turbo Pascal clarifying inline listings

Using hex constants in INLINE code destroys the readability of the code and invites errors if you type in a wrong number.

The solution is to use named constants to represent the instruction mnemonics. As an example:

```
INLINE ($8B/$86/stack_var);
```

loads the value of the parameter 'stack_var' into the AX register. If you declare a CONST MOV_AX__BPdisp = $868B, you can write this instead:

```
INLINE (MOV_AX__BPdisp /
  stack_var);
```

(By my convention, a single underscore separates the portions of the instruction, and a double underscore indicates indirection.)

Note that integer words in the 8088/8086 are stored in byte-reversed order, so $1234 would appear as $3412. Also, in Version 2 of the compiler, references to constants generate a two-byte value even if the constant defines only one byte.

That is the reason for the value of the ES override instruction being $2690. The $90 is a NOP (no operation), to pad the constant out to 2 bytes. Under Version 3 you may simply use $26.

The listing in Fig 7 demonstrates this technique as used to create a set of routines for incrementing and decrementing a pointer, and adding to and subtracting bytes from a pointer.

D Selesky

When I write INLINE code, I often have to get out an 8088 reference manual or leave Turbo Pascal and use DEBUG. In DEBUG I assemble the instructions I need and note the actual bytes that represent them.

Either way makes writing INLINE tedious. Mr Selesky's method makes so much sense, it's a wonder we haven't seen it before. Just create an $Include file of constants for common opcodes and then refer to them by name in your ONLINE code. Remem-

```
CONST
  ES_override     = $2690; {ES Override of instruction}
  LES_DI__BPdisp = $BEC4; {load addr on stack into ES:DI}
  MOV_AX__BPdisp = $868B; {move integer on stack to AX}
  ADD__DI_AX     = $0501; {add AX to [DI] }
  SUB__DI_AX     = $0529; {subtract AX from [DI] }
  INC__DI        = $05FF; {increment [DI] }
  DEC__DI        = $0DFF; {decrement [DI] }

  PROCEDURE ptr_incr(VAR Pntr);
  (* increment a pointer *)
  BEGIN
    INLINE(LES_DI__BPdisp/Pntr); {load addr of variable in ES:DI}

   INLINE(ES_Override/INC__DI); {increment variable ES:[DI] }
 END;

 PROCEDURE ptr_add(VAR Pntr; bytes : Integer);
 (* add a number of bytes to a pointer *)
 BEGIN
   INLINE(LES_DI__BPdisp/Pntr);   {load addr of variable in ES:DI}
   INLINE(MOV_AX__BPdisp/bytes);  {mov length to AX}
   INLINE(ES_Override/ADD__DI_AX);{add AX to ES:[DI] }
 END;

 PROCEDURE ptr_decr(VAR Pntr);
 (* decrement a pointer *)
 BEGIN
   INLINE(LES_DI__BPdisp/Pntr); {load addr of variable in ES:DI}
   INLINE(ES_Override/DEC__DI); {increment variable ES:[DI] }
 END;

 PROCEDURE ptr_sub(VAR Pntr; bytes : Integer);
 (* subtract a number of bytes from a pointer *)
 BEGIN
   INLINE(LES_DI__BPdisp/Pntr);   {load addr of variable in ES:DI}
   INLINE(MOV_AX__BPdisp/bytes);  {mov length to AX}
   INLINE(ES_Override/SUB__DI_AX);{subtract AX from ES:[DI] }
 END;
```

Fig 7 Demonstrating the use of named constants for INLINE opcodes

ber, untyped constants don't take up any code space. They're strictly for your benefit — NR.

Drive sniffer

The DRIVES.SCR script in Fig 8 will create DRIVES.COM, which scans the entire alphabet to report all valid drives on an IBM PC, logical and physical, while ignoring the gaps. Type it in using a pure-ASCII word processor (omit the semicolons and the comments following them).

Be sure to leave the blank line above RCX, and press the Enter key at the end of each line, especially the last one (with the Q). Then make sure DEBUG.COM is handy and enter the command

```
DEBUG < DRIVES.SCR
```

Instead of using the save/change/check drive technique, DRIVES, like COMMAND.COM, employs the esoteric DOS interrupt 21 function call 29h to check valid drives.

G Monroe

SUBST is a terrific keystroke saver, reducing complex pathnames down to manageable single letters. And if you have trouble remembering which of your programs are on which of your many drives, SUBST lets you use mnemonic labels (such as W: for the drive that holds WordStar). DRIVES.COM will report all the drives you've currently nicknamed. But so will just typing SUBST. However, DRIVES.COM will report both logical and physical ones, something DOS can't do — PS.

Fooling COMMAND.COM

If you want to use batch files and/or programs that have filenames identical to internal DOS commands, just prefix them with drive letters. DOS will recognise them as files and search the PATH for them.

For example, to execute a customised DIR.COM program, type C:DIR. This saves you from having to patch COMMAND.COM.
Dr Z Barak

You shouldn't really have to patch COMMAND.COM, since you can almost always come up with a name that's slightly different from the actual internal DOS command. However, if you really need to duplicate the names of commands and filenames, this technique will work (in Versions 3.x). You may also prefix such a command with a pathname. And if you want to execute a file like this in the current directory, you can stick a .\ in front of it. So, typing the command

```
.\DIR
```

would run the DIR.COM or DIR.EXE or DIR.BAT program stored in the current directory — PS.

USEing blank filenames

Software written in the dBASE language offers no built-in password security system, and if you have databases with sensitive information you may not want everyone to be able to edit, append, delete, or zap the data.

A simple solution is to insert CHR(255), which appears to be a CHR(32) space, as part of a filename or program. Then, for example, if you change the filename PAY_RATE.DBF to PAY RATE.DBF, the ordinary user will attempt to enter a space between the Y and the R and won't gain access to the file.

To create the CHR(255) character, hold down the Alt key and enter 255 on the numeric keypad. This method of file security can be useful with other types of files, too.
C Cohen

While this technique won't stop a sophisticated snooper for long, it certainly has the advantage of simplicity, and it requires no programming whatever.

Many subtle variations can be played on this theme. For example, if you add the CHR(255) at the end of the filename, your snooper can take a DIR of files, see what appears to be a perfectly normal filename, and be completely unable to USE it. Or you could name your file with a single CHR(255); when a DIR is taken, all that appears for this file is a blank filename, and the unauthorised user may not realise that it even exists.

Still another variation is to create a subdirectory named CHR(255). Inside this subdirectory, you can keep any number of normally named databases and programs and an ordinary user will never perceive their existence at all. Incidentally, ProKey users must enter Shift-Alt-255 rather than Alt-255; in all cases, remember to use the numeric keypad — BS.

END

```
N DRIVES.COM
A
NOP
MOV     SI,5C                       ; put dummy command line in PSP
MOV     DI,149                      ; destination of drive text
MOV     BYTE PTR [SI],40            ; hex value for "@"
INC     BYTE PTR [SI]               ; raise it to next letter
MOV     BYTE PTR [SI+0001],3A       ; put a colon after it
MOV     AX,2906                     ; parse dummy command line
INT     21
MOV     SI,5C                       ; point SI to output text
CMP     AL,FF                       ; AL = FFh if invalid drive
JZ      121                         ; jump if it is
MOV     CX,3                        ; queue up three characters
REPZ
MOVSB                               ; and move 'em
MOV     SI,5C                       ; set up SI for next pass
CMP     BYTE PTR [SI],5A            ; have we reached Drive Z?
JNZ     109                         ; loop back if not
MOV     AX,240A                     ; otherwise terminate string
STOSW
MOV     AH,9                        ; print it
MOV     DX,136
INT     21
INT     20                          ; and exit
DB      0D 0A "Valid drives are "
DB      "$"

RCX
4A
W
Q
```

Fig 8 DRIVES.SCR file to create DRIVES.COM. Type it in using a pure-ASCII word processor (omit the semicolons and the comments following them). Be sure to leave the blank line above RCX, and press the Enter key at the end of each line, especially the last one (with the Q). Then make sure DEBUG.COM is handy and enter: DEBUG < DRIVES.SCR

'All right, you lot, which one of you programmed a dead rat onto Miss Pringle's computer?'

DIARY DATA

Exhibitions

May

31 **Comsoft** This exhibition/seminar to be held at the Adelaide Hilton Hotel from May 31 to June 2 will be demonstrating and explaining software, software and more software! *Enquiries, Ray Goldie, tel: (08) 363 1757*

June

6 **The Annual Exhibition of Engineering Software** An exhibition for users by users incorporating structural and civil engineering software. To be held at Clunies Ross House, 191 Royal Pde, Parkville. *Enquiries, ACADS, tel: (03) 51 9153*

7-10 **2nd Australian International Tech Exhibition** This exhibition attracts widespread interest, generating business opportunities for 114 participating companies. To be held at Darling Harbour. *Enquiries, tel: (02) 436 3266*

7 **Technology and Computer Productivity Awards** Come and applaud the achievers of significant productivity gains through the use of advanced technology from all levels of government at Canberra's Hyatt Hotel. *Enquiries, Colin Archer, tel: (02) 552 1166*

Conferences/Meetings

May

16-18 **Microelectronic Advances** Conference to feature microelectronic advances will be held at the University of Sydney. *Enquiries, tel: (02) 327 4822*

16 **Turbo Pascal SIG Meeting** To be held at 7.30pm, St Mark's Anglican Church, cnr Canterbury and Bourke Rds, Camberwell.

17 **NSW SAS Users Group Meeting** This half day meeting will begin at 9.00am and conclude at 1.00pm. To be held at the NRMA head office, 151 Clarence St, Sydney. *Enquiries, tel: (02) 260 8787*

17 **PostScript SIG Meeting** To be held at 6.30pm at Peak, Marwick and Mitchell, 18th floor, 500 Bourke St. Melbourne.

18 **Tech SIG Meeting** To be held at 7.30pm at the Physics Department of Melbourne University. *Enquiries, Patrick Kearney, tel: (03) 344 5465*

19-21 **5th World Computer Security Conference** IFIP is expected to draw around 400 international experts for this conference which will be held on the Gold Coast. Organised by the International Federation for Information Processing. *Enquiries, Bill Caelli, tel: (075) 56 0911*

23-26 **Management Renaissance in a Brave New World** This conference explores the challenges facing managers up to the turn of the century and beyond and underlines the key roles managers must play to initiate this renaissance. *Enquiries, AIM, tel: (07) 832 0151*

24 **Public Domain SIG Meeting** To be held at 7.30pm, St Mark's Anglican Church, cnr Canterbury and Bourke Rds, Camberwell. *Enquiries, Leon Cohen, tel: (03) 520 6414*

24 **Low Cost CAD Shootout Seminar** All CAD-crazy users should attend this seminar from 1.30pm to 7.30pm at the Metropole Hotel, 287-305 Military Rd, Cremorne. *Enquiries, ACADS, tel: (02) 929 8097*

25-26 **Australian Status Users Group** Australian Status Users Group 1988 Conference and Annual General Meeting will be held at the South Park Motor Inn, Adelaide. *Enquiries, Lorraine Gerdes, tel: (08) 274 7531*

25-26 **A/E/C Applications '88** Computer applications in architecture, engineering and construction. Four half-day seminars to be held at the Metropole Hotel, 287-305 Military Rd, Cremorne. *Enquiries, ACADS, tel: (02) 929 8097*

25 **A/E/C Applications '88** Applications for mapping, surveying and mining will be held in the morning and those for civil, road and water will be in the afternoon. So wander down to the Metropole Hotel, Cremorne. *Enquiries, ACADS, tel: (02) 929 8097*

25 **Geelong Regional SIG Meeting** to be held 7.30pm at Geelong Amateur Radio Club room, 4 Storrer St, Geelong. *Enquiries, Ron Vahland, tel: (052) 75 6813*

26 **A/E/C Applications '88** This time we have structural in the morning and architectural and plant layout in the afternoon. To be held at the Metropole Hotel, Cremorne. *Enquiries, ACADS, tel: (02) 929 8097*

27 **Retired Persons SIG Meeting** To be held at 10.00am, at St John's Church, Virginia St, Mt Waverley. *Enquiries, Keith Bower, tel: (03) 277 1666*

31 **Australian Paradox Users Group** The formation of this latest SIG should be of great interest to many readers out there. Why not go along and see for yourself. Meetings to be held the last Tuesday of every month. *Enquiries, Gordon Castle, tel: (03) 563 1037*

31 **Paradox Users Group** Remember, this newly formed users group will hold its meetings on the last Tuesday of every month at Bird Cameron, 316 Queen St, Melbourne. *Enquiries, tel (03) 563 1037*

June

5-9 **The Enterprise Networking Event '88** The Enterprise Networking Event has called for papers. The conference is planned for the Baltimore (Maryland) Convention Centre. *Enquiries, tel: (313) 271 1500*


MICROTEX 666

Mike Mudge introduces readers to the elementary concepts of cryptology in this month's 'not-so-secret' Numbers column.

The need for secret communication in diplomacy and military affairs is readily appreciated. Now that electronic mail, electronic banking and other computer-based business transactions are part of everyday life, the need for security of information is clear to us all. The purpose of this article is to indicate certain aspects of number theory which are the foundations of elementary ciphers (or codes), to display examples of their use, and to invite readers to submit a working coder and decoder package with a specimen message.

It must be emphasised that the types of cipher discussed are elementary and bear little relation to those used in an ultimate security environment; however, they can form part of a challenge among, for example, computer club members: 'How do you go about cracking (even an elementary) code?' This aspect will not be considered here, but may form the subject of a future column, depending upon the response to this article.

Character ciphers

Stage 1 Translate the letters of the alphabet into their numerical equivalents 0-25.

Stage 2 Transform the numerical equivalent, m, of each letter in the message into another number, c, using an 'affine transformation' of the type: $c = am + b$ (modulo 26) where a and b are integers having no common factor. Note that since modulo 26 means retain only the remainder after division by 26, it follows that c lies between 0 and 25 inclusive.

Stage 3 Return each c to its equivalent letter using the reverse process to that described at stage 1 and group into convenient, ordered sets, say, of five to yield the code.

The particular affine transformation in which $a = 1$ is called a 'shift transformation' and clearly corresponds to replacing each letter of the message by that found by shifting b places through the alphabet.

For example, under the affine transformation $c = 7m + 10$ (modulo 26), the message 'PLEASE SEND MONEY' becomes the code 'LJMKG MGXFQ EXMW'!

Block ciphers

Stage 1 Group the letters of the message into convenient, ordered sets — say, for example, pairs. For example: 'PLEASE SEND MONEY' becomes 'PL EA SE SE ND MO NE Y'.

Stage 2 Transform the numerical equivalent, m_1m_2, of each pair in the message into another number pair, c_1c_2, using a pair of affine transformations of the type: $c_1 = a_1m_1 + b_1m_2$ (modulo 26).

Stage 3 Return each c_1c_2, to its equivalent letter pair using the inverse translation process. For example: 'STOP PAYMENT' block ciphered in triples using the affine transformations:

$c_1 = 11m_1 + 2m_2 + 19m_3$ (modulo 26)
$c_2 = 5m_1 + 23m_2 + 25m_3$ (modulo 26)
$c_3 = 20m_1 + 7m_2 + m_3$ (modulo 26)

becomes 'ITN NEP ACW ULA'.

Exponentiation ciphers

Invented in 1978 by S Pohlig and M Hellman (see IEEE Transactions on Information Theory (vol 24,1978, pp106 - 110) this begins by translating the letters of the message into numerical equivalents, using A,B,C, . . . Y,Z becomes 00,01,02 . . . 24, 25. The resulting numbers are then grouped into blocks of '2s' digits; where 2s is the largest positive even integer, such that all blocks of numerical equivalents corresponding to s letters (viewed as a single integer with 2s decimal digits) is less than an odd prime p. Associated with p is the *enciphering key* k, a positive integer which has no common factors with $p — 1$.

For each message block M, which is an integer with 2s digits, form a code block C using the transformation:

$C = M^k$ (modulo p), O C p.

For example, if $p = 2633$ and $k = 29$, then to encipher:

'THIS IS AN EXAMPLE OF AN EXPONENTIATION CIPHER', first convert to two-digit numerical equivalents, then group in blocks of size four: 1907 0818 0818 . . . 0704 1723. The final 23 being an X added to complete a block of four.

Now use $C = M^{29}$ (modulo 2633) to obtain the code:

2199 1745 1745 . . . 1841 1459.

Readers are invited to send an encoder, a decoder and a specimen message to Mike Mudge, c/- *APC*, 124 Castlereagh St, Sydney 2000 by June 17, 1988.

It would be appreciated if such submissions contained a brief description of the enciphering theory and any peculiarities of the programming, in a form suitable for publication in *APC*. These submissions will be judged using subjective criteria, and a prize will be awarded to the 'best contribution' received by the closing date.

Please note that submissions can be returned only if a suitable stamped addressed envelope is provided.

Factorisation of Fermat Numbers, Review, October 1987

The factorisation of fermat numbers, $F_m = 2^{2^m} + 1$, proved to be a very difficult exercise even with the assistance of Theorem 3.

The table shown here is due to Professor Wilfrid Keller of the University of Hamburg and summarises the state of the art at 1980. This table accompanied the then new results that $1985 \times 2^{933} + 1$ is a factor of F_{931}, $19 \times 2^{6838} + 1$ is a factor of F_{6835}, while $19 \times 2^{9450} + 1$ is a factor of F_{9448}.

Values of m	Character of F_m
0, 1, 2, 3, 4	Prime
5, 6, 7, 8	Composite and completely factored
12*	Four prime factors known
10*, 11*, 19, 30, 36, 38, 150	Two prime factors known
9*, 13*, 15, 16, 17, 18, 21, 23, 25, 26, 27, 29, 32, 39, 42, 52, 55, 58, 62, 63, 66, 71, 73, 77, 81, 91, 93, 99, 117, 125, 144, 147, 201, 207, 215, 226, 228, 250, 255, 267, 268, 284, 287, 298, 316, 329, 416, 452, 544, 556, 692, 744, 931, 1551, 1945, 2023, 2456, 3310, 4724, 6537, 6835, 9448	Only one prime factor known
14	Composite but no factor known
20, 22, 24, 28, 31, 33, 34, 35, etc.	Character unknown

*Cofactor known to be composite

Subsequently GB Gostin and PB McLaughlin (Math Comp, vol 18, No 158, April 1982 pp645-649) published a new prime factor for each of F_{29}, F_{36}, F_{99}, F_{147}, F_{150} and F_{201}. It is certain that further results exist in the literature and readers are invited to comment on any which they can locate.

Using the flexibility of the 'subjective criteria' this month's prizewinner is Andrew Slodkiewicz of 25 Taylors Road, St Albans, 3021.

Andrew uses string handling routines in Turbo Pascal to manipulate numbers up to 256 digits. Unfortunately his hardware is undefined; however, the calculation of Euler Number E_{152} having 238 digits (for definitions see *APC*, February 1987) took in excess of four hours to calculate. 'String division is performed using multiple subtractions, then shifting the numerator to the left, and so on. It takes about three seconds per unit in each decimal place'.

Readers may like to write to Andrew with advice or obtain further details of his work in this area.

END

Mike Mudge *welcomes correspondence on any subject within the areas of number theory and other computational mathematics. Particularly welcome are suggestions, either general or specific, for future Numbers articles; all letters will be answered in due course.*

LAZING AROUND

Brainteasers courtesy of JJ Clessa

Quickie

No answers, no prizes for this one.

What number must be added to both the numerator and the denominator (top and bottom) of the fraction 2/5 to give a result of 3/4?

Prize puzzle

The sequence of numbers 1,1,2,3,5,8,13,21,34 is known as a 'Fibonacci' series, since each number in the series after the first two is formed by adding the preceding two. Thus,

2=1+1
3=1+2
5=2+3
8=3+5
and so on.

In our example we started with 1 and 1, but we could have started with any two numbers.

If we wanted to include the value of one million — that is, 1,000,000 — in our series, what are the two smallest positive (non-zero) numbers that we could have used to start off the series? We define the smallest two numbers as the two numbers whose sum is the least. (Note that the second number cannot be less than the first, although it may be equal.)

Answers on postcards only please, to arrive not later than 31 May 1988.

Send you entry to: Lazing Around May, *APC*, 124 Castlereagh St, Sydney 2000.

February prize puzzle

This was much harder than usual. Only 15 entries were received, of which six were incorrect.

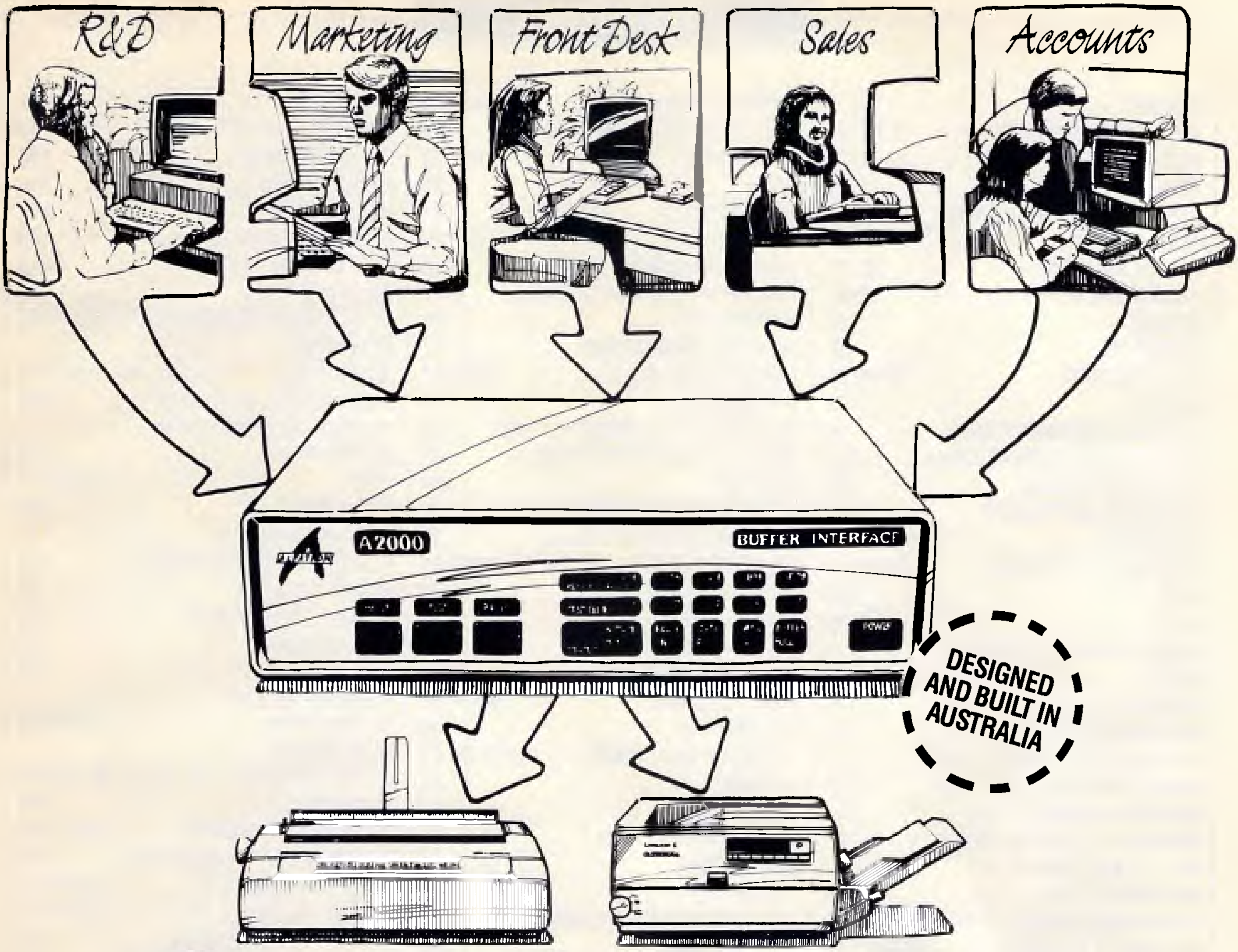
The winning card, drawn at random, came from Mr A Fieldus of Surrey Hills.

The winning solution is:

96 x 8745231 = 839542176

Congratulations Mr Fieldus, your prize is on its way. To all the others — keep trying.

END



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Working with the A2000 could hardly be simpler. On power-up or reset, the A2000 connects all devices to one port such as a printer. To connect to another device, the user has only to key in another port. That's all there is to it. Several personal computers or work stations can conveniently share printers or work stations can conveniently share printers as well as transfer data or files amongst themselves. Menu set up is available as an option.

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Up to eight independent channels can be operated simultaneously, using the basic memory size of 256K which is expandable to 1M. What's more, a dynamic memory allocation algorithm ensures that each channel only uses as much memory as it needs, leaving the remaining memory free for other channels.

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The A2000 is very flexible. User controlled configurations range from simple serial/serial, serial/parallel or parallel/parallel conversion to an intelligent networking interface. The two parallel ports can be either input, output, Centronics or Data Products and the six serial ports are RS-232. If desired, units can be cascaded to increase the number of input channels to suit the application.

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For information on any of the Alfatron A-series converters, please ask for the comprehensive literature. Dealer enquiries welcome.

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AD INDEX

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