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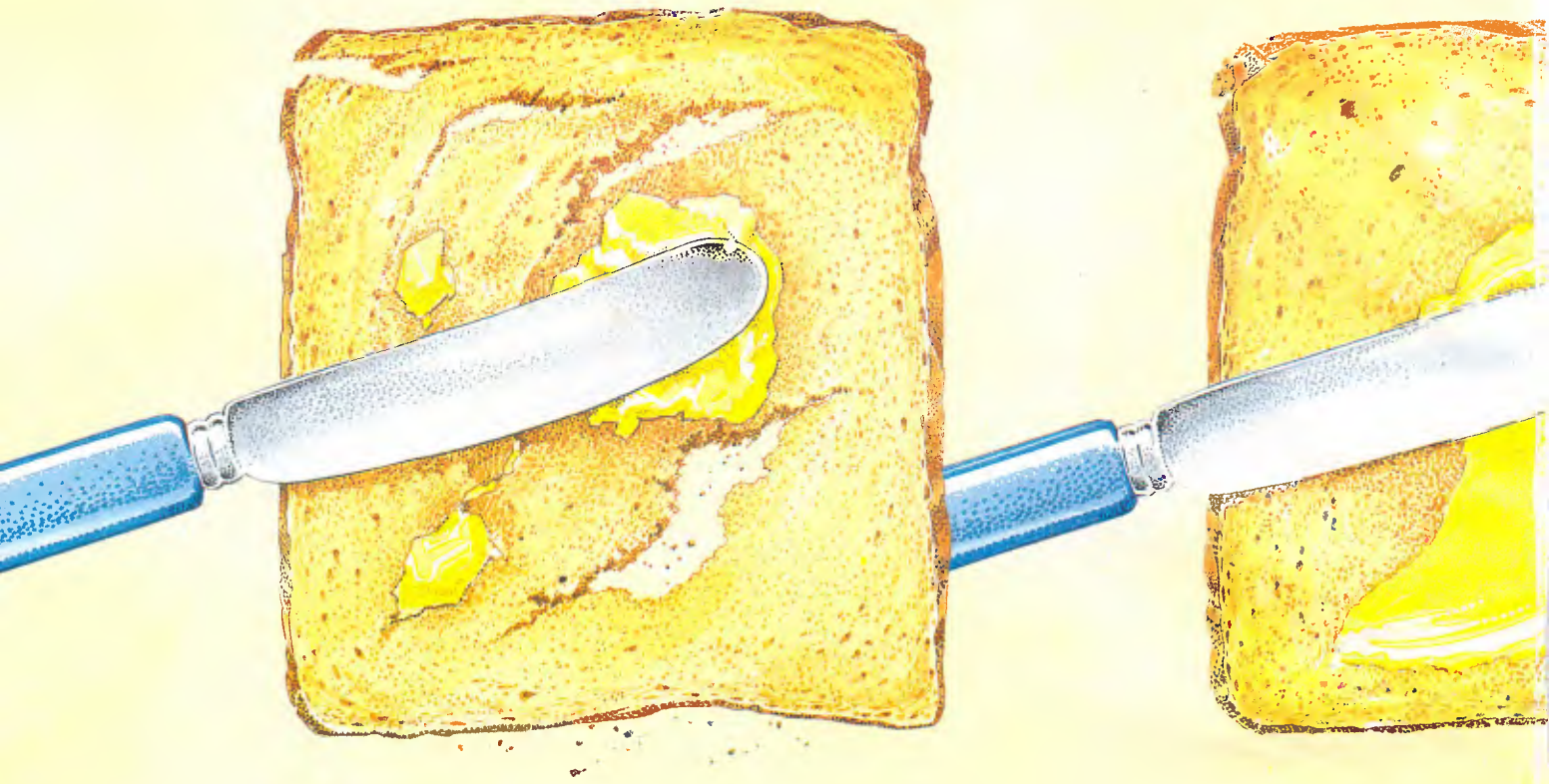

*BUTTER USED TO BE HARD TO USE.*

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*You're probably quite happy with your current word processing software. Then again, you were probably quite happy with hard butter. Certainly, hard and soft butter look and taste similar. But when soft butter came about, it made life a lot easier. Which is exactly what would happen should you use Microsoft Word 4 for IBM PS/2 P.C.'s and compatibles.*

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An exciting addition has made Word 4 a fully programmable word processor.

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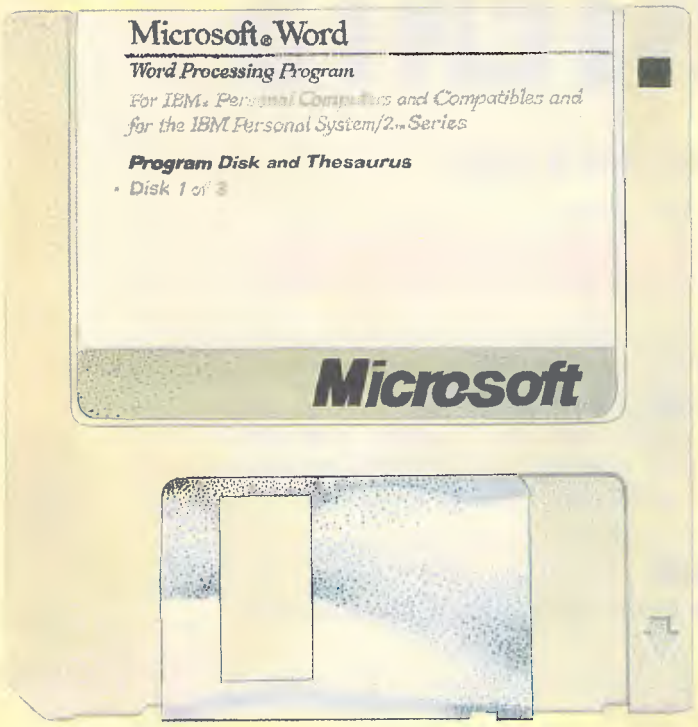


*IT MORE VERSATILE.*

*THE SAME HAS HAPPENED TO W.P. SOFTWARE.*

Word has document management and retrieval. This feature is designed to make it easy to search for and locate documents and manage large directories.

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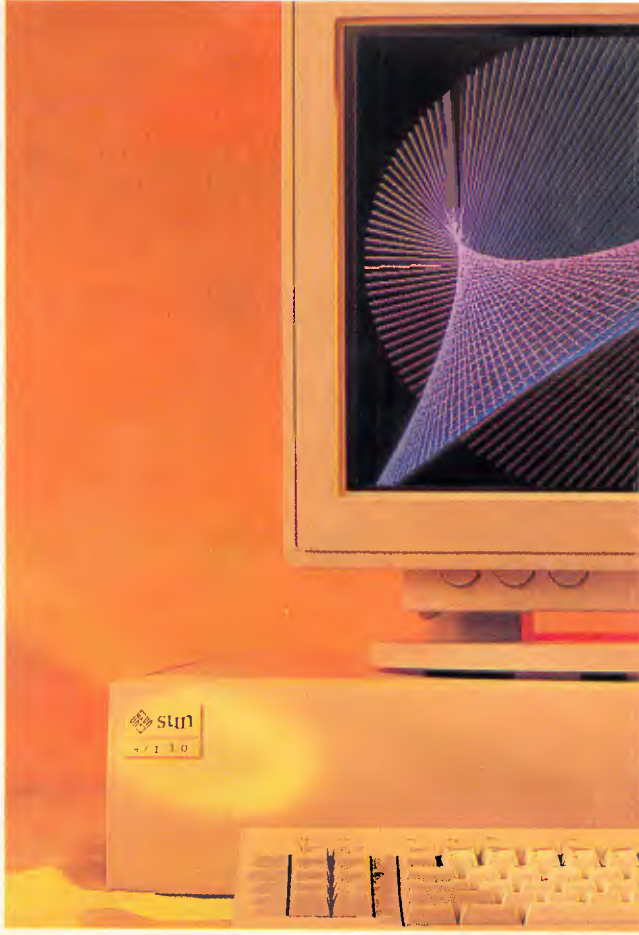

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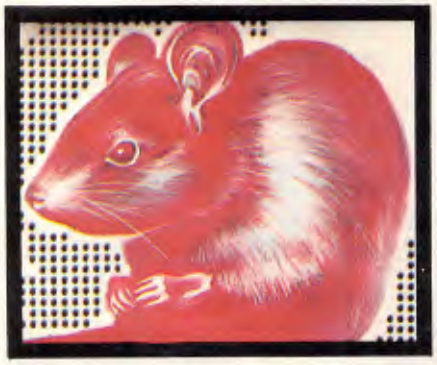

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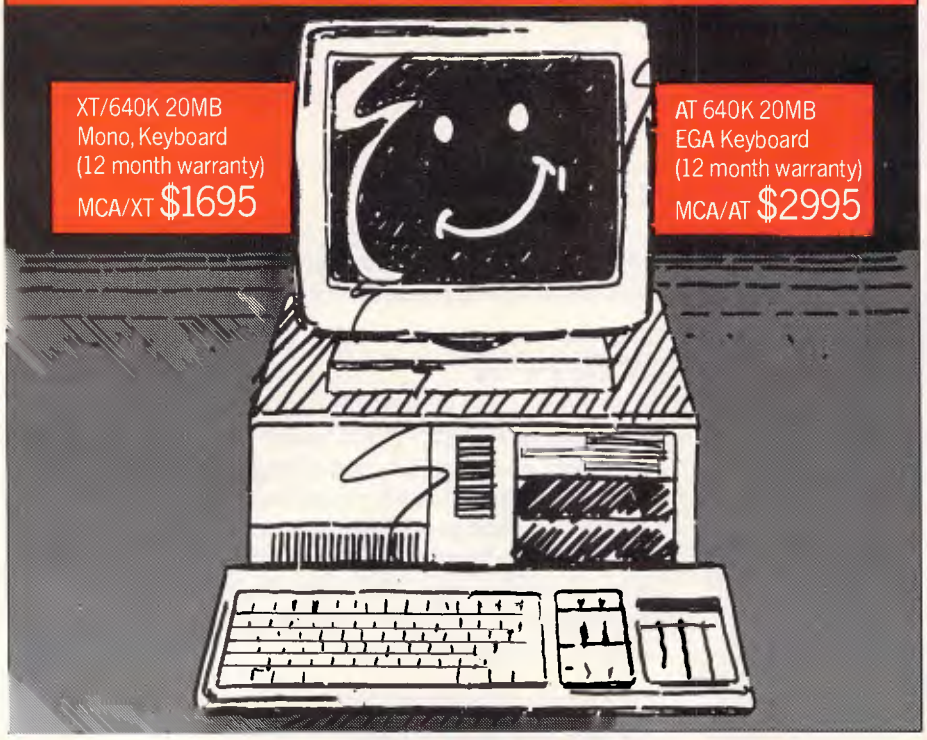


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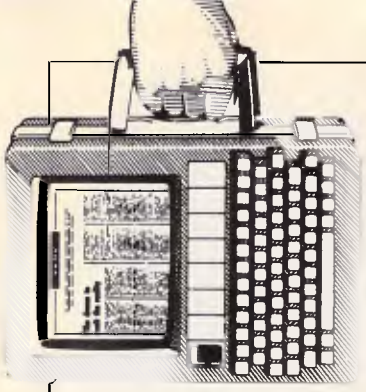


***Guy Kewney, and our 'West Coast correspondent' in the US, Tim Bajarin, round up the month's micro news from around the world, and what a month it's been!***

# Lotus 1-2-3 Release 3.0 slips back

Development on Lotus 1-2-3 Release 3.0 has slipped back, according to users designated as beta-version testers of the product. According to Lotus officials, the release of the beta version has been pushed back to sometime this month, but this should not further delay the arrival of the new spreadsheet, which is scheduled for release late this year.

By holding the release of the beta-test version back to April, Lotus has introduced a four month delay in the eventual release of the product, according to its would-be beta-testers. Lotus, however, has denied this and instead claims that the beta-version does not have to be released until April now because of "increased efficiencies" in its beta-test program.

Rumour has it the real reason behind the delay is that, at the last minute, Lotus decided to add the features found in its HAL add-in to the new version.

## The wizards of transputerdom

The first 50 Atari Abaq machines have been built — complete with ultra-fast Inmos Transputer chips — and several are already in the hands of developers writing software. Initial response of these wizards to the new Helios operating system is sufficiently confused to make it seem likely that some months will go by before we see any interesting applications.

In the meantime, other Transputer suppliers are moving prices down in anticipation.

The pioneer of Transputerdom on the Atari ST is Tim Moore of Kuma. His K-Max development system is down to $1750, roughly half of what it cost when first launched.

Inmos itself has announced a new board family called Trams (Transputer Modules) — the idea looking strangely similar to Leon Heller's design, with a low-cost motherboard, into which you plug modules.

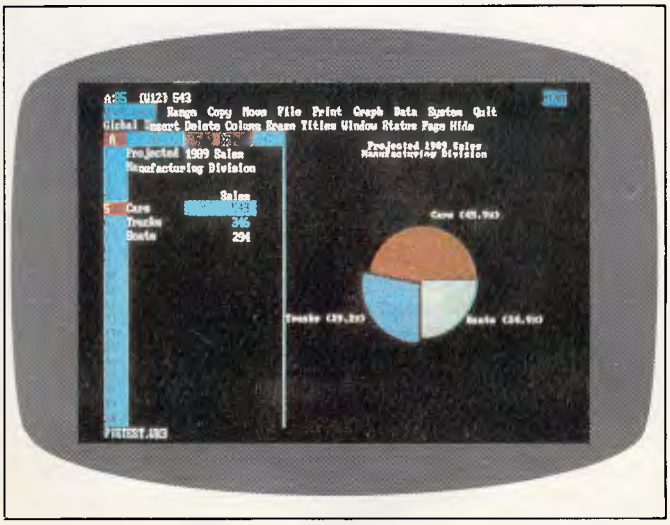
The Transputer really is catching on. I recently visited the Micro Development Systems show in the UK, where normally you can get to play with strange machines that will never grace an office — machines with control interfaces for machinery, machines with VME bus or STE bus or Futurebus connections, and operating systems like OS/9.

Amidst the normal crowd of 68000 and 32032 and Z80-based systems (oh, and 8086 as well!) the common factor was Transputer development systems.

Cambridge Risc Machines was showing a system running Helios, with a PC as the keyboard, disk and screen interface. They said Helios was still 'more flaky than usable' but better than nothing.

There was the enormously powerful 32-transputer module for the Sun — built by Niche Technology. A four-player flight simulator was being demonstrated on 64 Transputers (gross waste of processing power!) on Rapid Recall's exhibit. And a new company — 3L of Livingston — was offering an alternative 'C' language compiler for parallel systems, parallel C.

***Guy Kewney***



***Long awaited and now delayed, Lotus's 1-2-3 version 3.0 promises spreadsheet users improved graphics and more powerful functions***

## Getting to know the AmigaDOS manual

This month's informed comment: the Amiga 2000 is a nice pig. Taking their corporate courage by the scruff of the neck, the folks at Commodore finally decided that the Amiga 2000 was in solid enough shape to risk letting me have one to play with.

At the end of a couple of months living with the beast, I can't honestly think of anything to say that would prevent anybody buying one. But I can think of an awful lot of warnings.

First, you will definitely need the manual. No, strangely enough, you don't get the manual with the machine. You get a slim volume called a user guide, which frankly you can do without. If you aren't clever enough to work out what to do with an Amiga just by plugging in the Workbench (startup) disk when it says 'please put the Workbench disk in' then you won't be bright enough to understand this 'extract from'

the AmigaDOS manual.

But without the full manual, you're virtually stuck. You need it, for example, if you have a hard disk and want to persuade the machine to look on the hard disk for ordinary AmigaDOS commands.

Take a simple command like 'dir' to find the directory of files on a disk: before the Amiga can do this, it has to look in a special directory to find out what the 'dir' command is.

That directory is on the floppy 'Workbench' disk. What that means is awesome: every time you try to use a command, like copy, or makedir, or run, or execute, or rename, or delete, or type, or list — and several other essential instructions — you have to have the 'Workbench' disk in the floppy drive.

This is a poor idea, even allowing for the fact that the Amiga has one of the slowest floppy disks I know. You end up with 'Macintosh elbow' from putting new disks in and out of the drive.

Oh, of course you can change this! But not without the manual.

And as for persuading the machine to change this itself, by writing your own startup sequence, well, you really need to be a programmer. The AmigaDOS manual explains how, and you will get there in a couple of weeks.

And the AmigaDOS manual is sold separately, published by Bantam Amiga Library and usually available from technical bookshops for over $50. Clever, eh?

You will also need the Fred Fish disks.

The Fish disks cover an enormous amount of free, public domain, and shareware software, much of which is a torment to understand and use and generally contain the essential extra programs that you can't use an Amiga without.

To get them, you join any of the major Commodore user groups, which will solve several of the other problems you will have. For example, you can download 'shareware programs' from bulletin boards. But they will arrive on your system with an extra few bytes on the end, because the Xmodem protocol downloads blocks of 128k.

Try to run a file which is longer than it ought to be, and the Amiga will inform you that this 'is not an object file'. You need a shareware program, called fixobj, to chop off the extra bytes.

There are other surprises. For example, for somebody accustomed to the Atari ST or the Mac, it seems obvious that if you have a file on the disk, you can point to it with the mouse.

Not on the Amiga. A file can be there, but it will only have an icon if you know how to make one. Without an icon, there's nothing to point to — not even the silly list of filenames that Microsoft Windows gives you. I'm told that one of the Fish disks has a program that will make icons . . . haven't found it yet.

Now, what is nice about the Amiga 2000 is the fact that it has a multi-tasking operating system. You really can run two tasks at the same time.

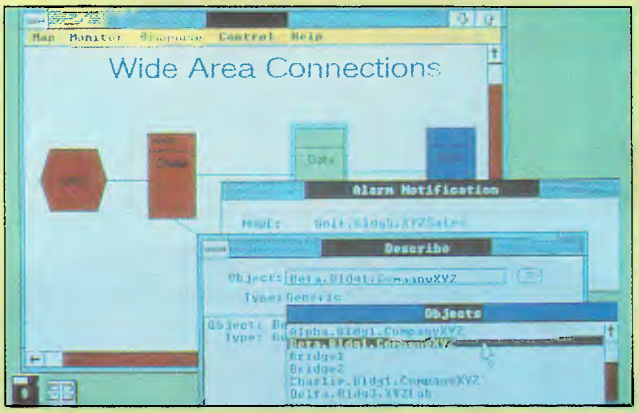
And one of these can be a straightforward IBM PC-DOS task, because Commodore does sell the Bridge board — a complete PC clone on a card — which fits inside the Amiga.

With the bridge board, you get only an ordinary 8088 chip running at 4.77MHz. That's very, very slow — slower than an Apple II. As a way of giving somebody a PC, it stinks.

However, I don't use it as a PC. I use it as a way of getting PC information into the Amiga (and back). Also, quite importantly, it can be a way of plugging cheap IBM accessories into your Amiga.

I have a Tandon Businesscard disk drive — 20Mbytes on a PC expansion card. Inside the Amiga, 10Mbytes of that are formatted as a PC drive, the other ten as an Amiga drive. I couldn't help noticing that it took ten times longer to format the Amiga portion than the PC bit, but that's by the way.

The idea is pretty good. It would be even better if the engineers who designed the internal PC card had found a way of leaving it free to use the bottom couple of hundred interrupts, so that you could




***Development work on Presentation Manager for OS/2 may be hindered yet further by Apple's recent shot at Microsoft. Apple has charged, in the US District Court in California, that Microsoft's Windows 2.03 (a forerunner to the Presentation Manager), and Hewlett-Packard's New-Wave (pictured above) operating system shells are imitations of the user interface on the Macintosh.***

***The suit proposes that both Microsoft and Hewlett-Packard have deliberately copied elements of an interface that Apple claims to have the copyright to. Apple's lawyers are currently pleading with the court to order both companies to immediately stop manufacturing and selling the offending products.***

***Microsoft is surprised for at least two reasons by Apple's attack. Firstly, Microsoft signed an agreement with Apple over two years ago which allows it to share the Macintosh graphical interface. Secondly, as Microsoft is one of the leading developers of Macintosh software, Apple risks fouling up an important, and mutually beneficial, business association.***

***Industry analysts suggest that Apple's attack is motivated by a fear that it will soon lose share in the graphical user interface market. The Presentation Manager for IBM's PS/2 range is scheduled to arrive in October and, over the next few years, is expected to dramatically increase the number of PC users who adopt the graphical interface.***

***The last straw, though, appears to be the fact that Microsoft has licensed its Windows 2.03 interface to Hewlett-Packard in the form of NewWave. Hewlett-Packard has approached Apple on a number of occasions for a licence to distribute NewWave, but Apple has steadfastly refused to grant its hardware-competitor such authority.***

***Litigation of this variety is typically very costly, running into several million dollars. One has to wonder whether Apple has the wherewithal to legally outsmart opponents as financially mighty as Microsoft, Hewlett-Packard, and (through the PS/2 Presentation Manager connection) ultimately IBM. If Apple's funds were to run out before its opponents, perhaps it could raise a little extra by selling someone the licence to televise the court proceedings. Correctly edited, such a trial would be anything but dull.***

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plug more accessories into the system.

For example, it's impossible to run Transputer chips that work quite happily in a normal PC bus system. And other programs behave oddly at times.

The Amiga's main reputation is a games machine. As a games machine, the 2000 suffers by comparison with the cheaper 500 model.

For a start, the 2000 is a business machine, and tends to come with 3Mbytes of RAM. Wonderful, but when you run many games, you have to turn this off, because the games must talk to the bottom half of one megabyte — the area which those super-chip video and sound controllers can access.

Some programs won't stand for that, because (for copy protection reasons) they won't let you run the program that turns off fast memory. You have to put the game disk in the drive and turn the machine on. Crash!

There are other differences between the 2000 and the 500, which have resulted in frustrating calls to software suppliers. "Why won't *Time Bandit* read the keyboard?" I asked. "Are you using a model 2000?" came the reply.

They're working on it.

The claim that "there's no good business software for the Amiga" won't stand up. There is lots.

But still, after all this time, I have to say I do worry about Commodore itself.

What is it doing for money? What is it doing about a successor to the Amiga? What about a truly high-resolution screen driver for the current model? Will the company really be around in a year's time?

I suppose we ought to be more optimistic. After all, it's already a couple of years since I felt sure the company would die inside six months. Maybe it can carry on working the same survival trick. I hope so.

***Guy Kewney***

***When a new Tandy 80386 PC compatible arrived in the office, I decided it was perhaps time to upgrade from my old 80286 machine.***

***After opening the 80386 packaging and finding the machine only had a 1.44Mbyte 3.5in floppy drive, I decided the aggravation of copying all my data from one format to another wasn't worth it. Fortunately, at this point a copy of DeskLink arrived and I realised that perhaps it wouldn't be so hard after all.***

***DeskLink is the latest product from the US software house Travelling Software and is really an upgrade of its laptop computer file transfer program, LapLink.***

***Within half an hour I had the 80286 machine working as a file server for the 80386 machine and suddenly MS-DOS had three new virtual drives E, F and G, which were physically A, B and C on the file server. Then with some judicious use of the DOS XCOPY command my 80386 had its full complement of software and only a single 3.5in disk used — the one DeskLink arrived on.***

***DeskLink actually works through the RS-232 port of both machines and achieves a bit transfer rate of 115,200 baud. The server software is simple to use and allows the sharing of printers and disk drives on either machine.***

***The machines can be up to 30 metres apart and support a chat mode, so both users can interactively communicate. The package comes with 3.5in and 5.25in disks and the necessary RS-232 transfer cable. Also included is a free copy of LapLink. DeskLink is distributed in Australia by Micro Support Systems, telephone (02) 439 7773.***

***Guy Kewney***

## *Apple comes of age with Claris*

Time was when Apple, like a little boy with a bullying father, was far too scared of the consequences to dream of challenging Microsoft in the software business. You may recall that when Apple launched the Mac, it quoted Microsoft (with Software Publishing and with Lotus) as the software house which would make some enormous part of its revenue from this new machine. And it has depended on Microsoft in many ways since — the spreadsheet, Excel, for example, sold thousands of Macs into the business community.

But Apple is a big boy now, and dream it can, with the launch of a new software brand name — Claris. This is a new 'independent subsidiary' of Apple, a software publishing company.

The software itself isn't that new. Claris has rights to all the old Macintosh favourites, and a few old Apple II favourites. For example, it can sell MacWrite and MacDraw. Two new titles are the obviously mega products, SmartForm Designer and SmartForm Manager.

Despite the laid-back Californian lilt to their voices, these Claris chaps are pure bureaucrats at heart. The SmartForm products form part of Claris' and Apple's strategy to link into the mainframe and mini world. "We grow up filling forms, so we're all familiar with them" is their theory. So when you want to access a mainframe database from your Mac-based terminal, you just fill in a form.

Claris also wants to develop the idea of software slots. Just as you can plug in peripherals to hardware, they want to encourage developers to produce add-ins to their products in a fashion similar to products such as What's Best for Lotus 1-2-3. An example is an add-in for an architectural application based on MacDraw. You just point at the various objects, specify what they are made from and, hey presto! — a bill of materials.

***Guy Kewney***

## *Snags in the Presentation Manager*

According to sources inside Microsoft, not only is work on the Presentation Manager behind schedule, but also the graphical user interface will be a poor performer when finally released. Officially, Microsoft claims that Presentation Manager will start shipping this October, but would not deny the allegation that it was having trouble with it.

Last September, Microsoft advised third-party developers that beta-test code for the Presentation Manager would be included in its December release of the MS-OS/2 Software Development Kit. The promised code did not appear and now Microsoft

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Q&A Version 3 comes with over 100 improvements. But it's uniquely comprehensive yet affordable network support is the big bonus for the business user. And you don't have to take our word for it. To quote Novell, *"Q&A Version 3 fully utilises the record locking capabilities that LANs offer today's business"*.

**Comprehensive LAN facilities built into Q&A 3.0 include:**

☐ record locking support to allow multiple users to simultaneously access the same database
☐ five levels of password protection to preclude unauthorised entry into databases
☐ levels of protection can be set so that a user may read or read/write records, change form designs or change report designs

**Q&A Version 3, first with Appleshare support**

Q&A Version 3 supports the Appleshare network including record locking of databases. Apple are delighted – *"It is very exciting to see PC users sharing a Q&A database from a Macintosh II file server using the AppleTalk network with our AppleShare PC software"* says Peter Friedman, Manager of Business Systems Marketing at Apple Computer. *"Q&A Version 3 is the first MS-DOS file manager to offer such impressive record-locking support on an AppleShare network."*

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A Q&A Network Pack allows additional users to simultaneously operate a single copy of Q&A from a LAN. This offers an inexpensive way of extending Q&A throughout an organisation. Diskless workstations are fully supported. Installation takes a only a few minutes.

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claims that it should be ready this month.

On the other hand, sources within Microsoft predict that a beta- copy will not be available until August at the earliest, and possibly not until as late as December. The reason given was that, in its current state, the Presentation Manager is too slow to be of any real use.

## NeXT killers about to pounce

For Atari and Commodore, 1987 was a difficult year. Although Atari succeeded in making a profit, it had little success in getting the ST accepted by serious computer dealers. The company just cannot shake off its games computer image.

Atari also went through three vice presidents of marketing. This is still holding the company back, even when there seems a chance of it advancing.

Commodore also had a turbulent year: there was a major management shake-up in which the president was fired and the company started 1988 with almost totally new management.

But 1988 will be particularly important for Commodore, and perhaps even Atari. This year the personal graphics workstation will be born. And its father will be none other than Steven Jobs, the computer visionary who has already given us two computer standards — the Apple II and the Macintosh.

His NeXT machine will be a personal computer that can also function as a graphics workstation. For lack of a better term, I call it a personal graphical workstation. Although few details are known about the machine, it does seem clear that it will be truly graphical, and will fit into an office automation environment. Consequently, this machine could set the technical standards for desktop computing for years to come, especially if it is priced at $10,000-$20,000.

Those close to the company say this machine will be Unix-based with a custom-built windowing environment. It will be multi-tasking and have very sophisticated graphics chips, probably a subset of the Pixar chips used in the Pixar commercial graphic workstations.

But there is an astonishing irony in this. Commodore's Amiga is a windows-based system that is multi-tasking. It also has sophisticated graphics chips. And the Amiga 2000, priced at under $3000, has already achieved its own unique position as a graphics workstation in many money-conscious firms.

The Atari machine, although less graphically sophisticated, can also claim to be part of this next generation. In fact, Silicon Valley sources say that Atari has developed a new set of graphics chips that are even more powerful than the new generation of Amiga chips. The story has it that there are four key developers who defected there from the original Amiga chip program at Commodore.

Consequently, Atari is rumoured to be releasing its own 'NeXT Killer' soon. This will be a 68030-based machine with the new graphics chips and 4Mbytes of RAM, with a 1280x960 colour monitor and an 80Mbyte hard disk for about $12,000. Although this may be just vapourware like so many other things Atari has talked about, it's clear the company has its sights set on the emerging workstation market. Whatever the final specification of Steve Jobs' NeXT machine, it will have a dramatic impact on many vendors, especially Atari and Commodore. What is significant is whether or not Commodore and Atari use their new generation machines to make their presence known in the market.

Of the two, Commodore could be in the stronger position. It has gone out to find strong industry talent with a lot of connections. The entire Commodore team is now filled with seasoned veterans who know the distribution channels and can manoeuvre the company to make the most of these market developments. On the other hand, Atari still has its original staff, headed by Jack Tramiel and his offspring.

And while they are also seasoned veterans, they still have to cope with the stigma of Tramiel's war with the dealers in his Commodore

***A data virus is a program which poisons your own programs, and spreads itself throughout your system. One has been discovered which was benign — on a certain date, it printed a message of peace and love and destroyed itself. Most, however, are designed maliciously, simply to destroy the data on somebody's computer.***

***A UK company, Sophos, thinks it has found a cure. It calls its product Vaccine. Naturally, in fact, it's more of a leprosy vigilance campaign.***

***It runs on a system known to be clean, and notices the 'fingerprints' of data and programs. If they change subsequently, you get a warning.***

***AT nearly $500 (converting from English pounds), you have to be sure you need it and I suppose most people will doubt it. Theoretically, you can guard against it by doing backups. But you have to keep them all, because the typical 'virus' program does nothing at first, and only starts misbehaving when it has been on your disk so long that it has infested all the backups too.***

***I had a strange insight into the mind behind this sort of program recently on BIX, where a lunatic praised the people who produced them as 'discouraging software piracy'. His idea was that if it became unsafe to copy programs for fear they were infected, people would only use software they had bought in a store, with cellophane wrapper still on.***

***Sophos is in the UK on (865) 853668.***

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days. And Commodore has made some serious strides in the business market channels, while Atari is still floundering in the consumer markets.

***Tim Bajarin***

## Apple goes for presentation techniques

One of the companies in which Apple invested recently is Mirus. 'Mirus' is the Latin word for 'remarkable': the company has a digital imaging system that Apple believes is a critical part of its desktop presentation range. Computer-aided slides have come a long way. Computer-generated slide-making is still a very open market.

Polaroid's Palette video imaging system could be likened to the dot-matrix printer of the normal printing world. Presentation Technologies' Imagemaker uses opto-mechanical technology and could be likened to the daisywheel printers of our day. But the Mirus film recorder is digital imaging technology and is much more like the increasingly popular laser printers.

The heart of the Mirus system is its Precision Digital Technology. Similar digital imaging techniques can be found in larger ($25,000-$150,000) film printers typically used by 35mm slide service bureaux. The Mirus device sells for less than $10,000 and is a true desktop unit. An average slide from a service bureau can cost at least $10 but a slide made on the Mirus machine costs an average of only 70 cents.

One of the main attractions of the machine is that its resolution (from 512 to 8000 lines per inch) is software switchable. And 2000-line resolution is about all you need for most presentation slides.

The one drawback is speed. At 2000-line resolution, each slide can take anything from two to eight minutes to produce, depending on the complexity of the graphics. But considering you get the control and flexibility of doing it in-house, this can be well-justified. The Apple Mac version will be shipped by June, and the PC version should be close behind. Apple will go all out for desktop presentations this year, and the Mirus machine will be the laser printer in this strategy. Although Apple owns only 20 per cent of this company, Mirus can't lose; it is destined to become another Silicon Valley success story.

Mirus is at 445 South San Antonio Road, Los Altos, California 94022, telephone (415) 949 5544.

***Tim Bajarin***

## Live wires

Later this year, IBM and Sears will roll out their videotex online service — to be known as Prodigy. Together, Sears, IBM and CBS set up Trintex, the company behind Prodigy, although CBS pulled out late last year to concentrate on a major business reorganisation.

Although Trintex is more than two years old, it is only just getting off the ground. It spent those two years doing the background research and setting up the system — no small task. In fact, when Prodigy arrives towards the middle of the year, its market will be limited and it will be perhaps late 1990 before it covers the rest of the US market.

While very similar to Telecom's Viatel service, this new service will be totally consumer-orientated. The cost for accessing Prodigy will be about $15 a month with unlimited log-on time. You can use a standard PC, Mac or Apple II with 256k of memory.

Most actual revenues of Trintex will come from the advertising that is displayed at the bottom of the screen. The service will have the traditional information such as Associated Press and USA Today wire services, as well as financial news from Dow Jones. You can also have online access to brokers Dean Witter and Donaldson, Lufkin and Jenrette for instant trading of stocks. Through the shopping feature, you can buy directly from more than 70 retailers, advertisers and direct marketers who have already signed up to use Prodigy to market their products.

An agreement with American Airlines allows the user to have direct access to its EAASY Sabbre system to book air tickets, hotels and hire cars. A unique feature called 'ask the experts' allows the user to ask questions of Jane Fonda on fitness, Sylvia Porter on finance and Howard Cosell on sports, and he will get an answer from these experts in 72 hours. A consumer reports section gives the user information on products and evaluates almost anything you could want to buy.

It will also feature educational programs and games for anyone to play, and you can even order your groceries through the system. There is an extra charge for only one service — home banking, connected to local banks all over the US.

The interface to the software is the same throughout the system, which makes it very easy to use. And you can even buy a pocket-sized 1200-baud modem for it for less than $US100.

Most video text systems, particularly the one from Knight-Ridder, failed miserably, but they were much harder to use and more business-oriented. The Prodigy system has some tough hurdles ahead, but if its target market (the baby boomers with discretionary incomes) understand its true value, and see that it is actually easy to use, IBM and Sears could have a real winner on their hands.

***Tim Bajarin***

## Drive disk

A recent magazine advertisement for Ford motor cars proclaimed that for $US4.95 the company would send you a PC disk holding a simulation program.

The program contains a driving game that supposedly mirrors the driving capabilities of several 1988 model Ford, Lincoln and Mercury cars. It also contains a handy program that lets you figure out how much you'd have to pay for one of these cars if it were equipped the way you want it. You can even print out a price sticker and use a mini spreadsheet to help you find out how much your monthly payments would be.

The simulation uses animated graphics to explain basic automotive engineering concepts. These screens cover rack and pinion steering, front wheel drive, air bags and anti-locking brake systems.

Although Ford is just testing this idea and placing the ad in a few US PC-related magazines, the company hopes its demos will develop into a full blown ad campaign some day.

The company behind the design of these ads is the Soft Ad Group, of Sausalito, California. It has also produced disk advertisements for Chase Manhattan Bank's home banking service and is just finishing a two-disk project for Buick.

Even though the Ford disk costs $US4.95, it is expected to end up on bulletin boards and be copied generously. As PCs find their way into more and more homes, this concept of disk-based advertising might really catch on.

***Tim Bajarin***

## IBM PS/2s get re-badged

In an effort to gain broader market acceptance of its ever-expanding PS/2 product line, IBM recently signed an agreement with UK-based Ferranti International. Ferran-

## Borland's Turbo Lightning™ FREE

# Here it is...DATADESK'S TURBO-101 ENHANCED KEYBOARD for the 10 million PC users IBM just ignored!

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*To really turbocharge your productivity, we are including, free-of-charge, Borland's red-hot Turbo Lightning software with each keyboard.* Now, when using SideKick, WordPerfect, Microsoft Word, 1-2-3 or most popular programs, our Turbo-101 Keyboard will check your spelling *as you type*, gives you instant access to Random House's 80,000-word Concise Dictionary and 60,000-word Thesaurus and much, much more!

***"Lightning's good enough to make programmers and users cheer, executives of other software companies weep,"*** **says Jim Seymour of PC Week. Sold separately, Turbo Lightning retails for $99.95!**

### *The Turbo-101 is the best data entry tool since the pencil!*

For users of spreadsheets like 1-2-3, the Turbo-101's *separate* cursor controls and numeric keypad makes entering numeric data into cells and moving from cell to cell as natural as moving your fingers. And for *word-processing*, the *'Selectric'* typewriter layout makes the Turbo-101 as easy to use as a pencil; and with the extra large Enter, Shift & Control Keys, you'll make so few mistakes, you won't even need an eraser!

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### Up to now, DataDesk International may be one of the best kept secrets, but here's what's being said about our first *end-user* Keyboard/Borland software bundle:

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***John C. Dvorak, InfoWorld Mar 86***

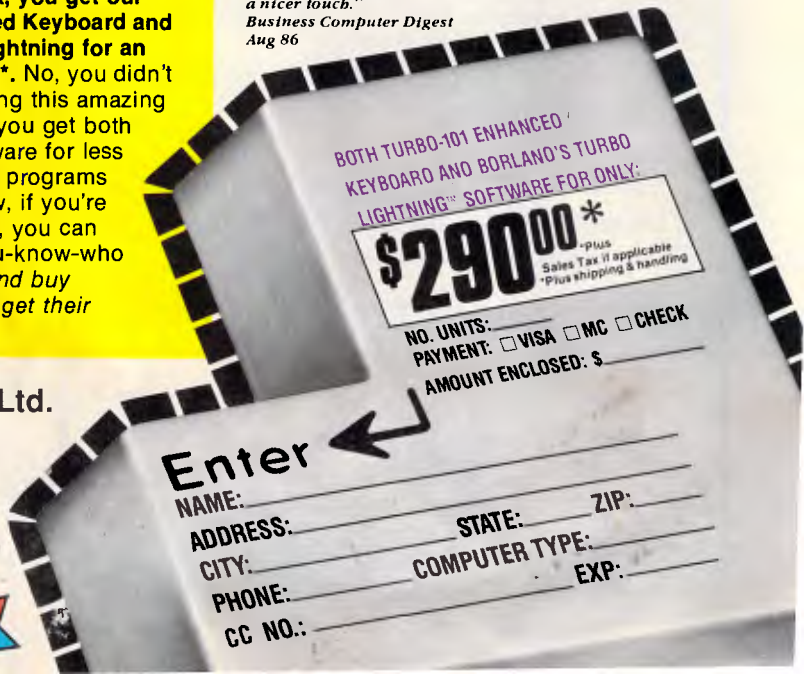
***"It solves all of the problems exhibited by their regular PC/XT keyboard...it's a great bargain!"***
***PC Productivity Digest May 86***

***"DataDesk Intl. has designed a sturdy and handsome keyboard that has tactile response...is the hardware bargain of the year"*** **says** ***Charles Humble, Oregonian Jan 86***

***"The best part of the keyboard is the way it feels. It's ideal! And fast. I've never worked on a keyboard with a nicer touch."***
***Business Computer Digest Aug 86***

***"It's a good keyboard. Good feel: the keys have tactile feedback. No mush at all. This is about as good a keyboard deal as you're likely to find...I have absolutely no hesitation in recommending the Model PC8700."***
***Jerry Pournelle, Byte Magazine Sept. 86***

***"This keyboard is neat to type on and feels solid. It has tactile feedback keys...I can type much faster on it."***
***Test Drive Scorecard: DataDesk-10 Key Tronics-9 Teleconnect Magazine May 86***

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**For just $15 -** you can test drive Lottocheck on your computer (minimum system: 256K RAM, 1 360K floppy drive), with the Demo disk and instructions.You get full program but for limited data update ability and uses a 50 draw sample dataset, and you get a file containing **ALL past draws** in text (ascii) format. On payment of the balance ($80) you get: full program, handbook and fully loaded database.

**Comments from purchasers of Lottocheck:**

*'I think you have an excellent program in Lottocheck.'* J. Remess, Sandy Bay, TAS.
*'It is very encouraging to see an Australian company taking such pride in their product.'* Peter Nicholas Pharmacy, Hermit Park, QLD.
*'The manual is excellent.'* C. McCarty, Braddon, ACT.

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Fullscreen, multi-windows (colour) with easy Lotus-like menus system: Do you have **trouble finding** your data/letters/programs etc, because you can't **remember** the filename or on which hard disk directory or floppy disk you put it? Yes! Then you **badly need** *The CAT*. Lets face it, its hard being descriptive with only 8 character filenames. With *The CAT*:
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# NEWSPRINT

ti currently manufactures its own XT and AT compatibles in the UK, and has provided PCs in Australia for third parties such as Starcard and Dick Smith Electronics in the past.

Under the terms of its agreement with IBM, Ferranti will sell IBM's PS/2 computers directly into vertical markets such as the airline industry, factories, and electric utilities. Additionally, Ferranti has agreed not to sell the machines through any of the normal retail channels.

Ferranti will re-label the PS/2 models as IS2000 series computers, and sell them throughout Europe. According to Effie Manolis, the marketing manager from Ferranti Computer Systems Australia, the IS2000 series will not be available in Australia in the foreseeable future.

## *Atari enters Unix market*

At a computer show held in Hanover (West Germany) recently, Atari demonstrated prototypes of its Unix workstation. The machine, which has yet to be given a name, is based on the Motorola 68030 chip and the VME bus architecture. Peripheral devices may be connected to the new Atari machine by way of its two serial ports, a SCSI (Small Computer Systems Interface) port, or a 1Mbps network port which accepts a twisted-pair cable.

Atari's first entry into the Unix workstation market should be on sale by July, and will come standard with 4Mbytes of RAM, and a 60Mbyte internal hard disk. Multiple Atari ST computers can reportedly be connected to the new workstation to create a multi-user environment.

Hardware options include a 44Mbyte removable cartridge system (similar to the Bernoulli Box), and a graphics board that supports graphics resolutions equivalent to the PC's CGA, EGA, and VGA standards.

Since Atari's operating system for the new machine will conform to the well-respected Motorola Binary Compatibility standard, software for the workstation should be available when the computer goes on sale sometime later this year.

END

***'We're hoping to get some more computers so we can teach them longer words'***

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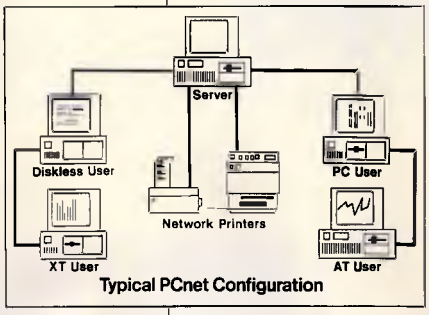

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☐ ***NetBIOS.*** Runs a wealth of programs for the IBM PC Network. It expands the base of software available for PCnet.

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# An octet of ATs

***Following on from last October's review of seven El-Cheapo PC/XT class machines, Ian Davies now takes a look at eight AT-compatible systems.***

The industry is full of PC, XT and AT compatible systems, as well as pundits who wander blithely about, bandying the terms around as if they were some sort of definition handed down from the mountain on high.

In reality, there is no fixed and universally accepted definition of what constitutes any one of these classes. The 'definitions' arose because IBM happened to release machines with those letters emblazoned on their front panels. And the industry followed suit, and the waters became muddied. Even IBM released an 80286-based machine with an XT expansion bus.

For the purposes of this review, we will define an AT-class machine as one which uses an 80286 processor and features IBM AT-compatible 16-bit expansion slots. Further, since AT machines are generally purchased for high-performance applications, we will consider a hard disk as standard equipment. All of the machines we examine are clearly members of the AT clan. But beware: things are not always so clear cut.

## *Why an AT ?*

Without doubt, some of the best value-for-money purchases available today are in the humble 8088 PC/XT arena, where a good machine with a hard disk is readily available for under $2000. The machines we examine in the AT realm are priced from $3000 to $10000, which is quite a significant increment in anyone's terms.

In the past, the higher cost of an AT paid for one thing — performance.

Now the outlook has changed, and the additional cost of an 80286 processor is also a down-payment on the future — maybe.

Performance is a touchy area, as those with a Lotus 1-2-3 spreadsheet which scrolls off the screen often think they need a more chunky machine. Generally this is not the case. The vast majority of the ten million PCs out there are used for mundane tasks which an 8088 can perform with one I/O port tied behind its back. Word processing, simple spreadsheeting and small database applications simply do not require a fast processor and a speedy hard disk.

The true benchmark as to whether you really need a faster machine is to analyse the amount of time you spend waiting for the computer to respond. Try to estimate what fraction of each minute is spent waiting, and extrapolate that over three years. Then assign an arbitrary cost to your time, for example, $50 per hour, and simply compare the cost of your time with the expense of a new machine.

From the above method, virtually any

*For maximum expandability, the Sotec Turbo offers six device bays*

*Where desk space is at a premium, the IPX offers the smallest case*

secretary can prove she should really be typing on a Cray X-MP. So a few words of moderation are in order.

For starters, do not include the time you spend waiting for something to print, as a faster machine will be of no assistance unless your application fails to drive the printer at its maximum throughput. Additionally, consider whether your time could be usefully re-deployed if the system responded more quickly. You may discover that the aggravating delays are in fact useful periods in which to plan your next course of action based on the results you are about to see. If this is the case, then delays due to the system will simply be converted into user think-time, or even worse, the user will thrash about without adequately maintaining a coherent 'game plan'. A study performed many years ago found that some users are actually off-put by an extremely fast system.

Moreover, it is always possible that you are simply not getting the best out of your computer, and maybe it is time to 'work smarter'. Print spoolers, RAM disks and caches can all be used to good effect. When dealing with novice users, always be on the lookout for oversights you wouldn't dare mention to seasoned professionals. Among the funny-if-it-weren't-so-serious situations I have seen are: one user complaining about dBASE response times but not using an index; and another user about to rush out and buy a bigger machine for her Lotus spreadsheet who had never heard of /Recalc Manual. In each case, the machine bottleneck was totally removed and the delays moved back to where they should be — with the user.

But don't be fooled into thinking that only novice users make this sort of mistake. Many professionals are also guilty of not making the most of their resources.

Often inappropriate tools are used for a job, mainly because programmers tend to stick to the languages they know best. For example, do not, under any circumstances, use dBASE for anything other than a traditional put-it-in-print-it-out-later database application. A small program with a run time of 24 hours in dBASE may finish in 5 minutes when converted to interpretive Basic, and in a matter of seconds when written in Turbo Pascal. Of course, rewrites are rarely attractive things, but the rewrite inevitably takes only one tenth of the time estimated by the person who has to do it.

Similarly, often there are better ways of doing things. The old adage "the best sort is no sort at all" still holds true today. Rather than sort the database on a regular basis, incrementally maintain an index. The total amount of work performed may actually exceed that done for the sort, but the work is distributed throughout the normal functioning of the system and is generally not noticed.

Despite all the above, applications which require fast machines do in fact exist. Often they are not the applications which novice users expect them to be, as neophytes tend to think in terms of what is difficult for people, rather than what is challenging for a machine. For example, calculating a complex insurance premium is a push-over in silicon, but determining two similar names to be the same is not. For every example one can think of which does not require high performance, the same example can be used in counterpoint. Many database systems, almost any desktop publishing application, CAD or other graphics, software development, pattern matching and yes, even spreadsheets, all can require extended horsepower.

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ter approach is available, often the economics will rule it out of the question. A two month rewrite will never be more cost effective than a $4000 hardware upgrade if the application is to run on a single machine, but the reverse will be true if the software is to be distributed to a hundred branch offices.

Often the final consideration is personal. A $2000 computer which nobody will use for whatever reasons — real or perceived — is *never* better than a $4000 system which may technically be an overkill.

## An eye to the future

These days an AT-class machine offers more than simple performance. It also offers (note: "offers," not promises) a highway into the brave new world of IBM's OS/2 operating system.

Many industry pundits (the Microlytic WordFinder offers 'highbrow egghead' as an alternative here, but we won't be swayed) claim that OS/2 will never displace MS-DOS, but this is hard to accept. The history of computing is riddled with myopia, dating back to the IBM president who estimated the total expected world-wide sales of computers to be . . . six. Users always demand bigger and better programs, and the constrained 8088 architecture will soon outlive its usefulness, regardless of its momentary remission by virtue of the LIM/EMS expanded memory scheme.

OS/2 was designed for the 80286 architecture, and can address up to 16Mbytes of RAM while managing multiple tasks running concurrently. The forthcoming Presentation Manager (Apple lawyers permitting) is simply too good to ignore, and will raise IBM compatibles up to the user friendliness of the Macintosh.

Of course, the 80286 is not the last word in microprocessors. It too has its constraints, among them being 64k segment limits. The 80386 goes a long way towards addressing these shortcomings, but is currently unsupported by a 'major league' operating system (if you discount Windows/386, VM/386 and Unix). The harsh reality is that the processor for today is the 80286.

OS/2 appears to be bonded to the PS/2 series of hardware, but this is not necessarily the case. Certainly OS/2 requires an 80286 CPU, but there is nothing in OS/2 which renders it dependent on the Micro Channel bus architecture; at least, nothing in the generic version. However, IBM appears to have taken steps to ensure that its version of OS/2 will cause all sorts of problems on compatible systems. (Not so Compaq and others; see 'OS/2 up and running' box.)

One common problem being reported (even by Intel, the guys who made the chip), is the method used by the IBM version of OS/2 to switch from protected mode back to real mode. The IBM method relies upon special hardware on the motherboard which detects a halted CPU and toggles the RESET line. The base Microsoft version of OS/2 generates a reset through the keyboard controller. Similarly, IBM decided to omit support for the 8250 communications chip, since all of its OS/2 capable machines utilise the newer 16450 chip.

It sounds messy, and indeed it is. In the past, users simply relied upon the 'generic' Microsoft version of MS-DOS and many vendors sensibly opted to supply the generic version with their hardware rather than OEM their own. It seems the same option will not be available with OS/2. Every vendor will be obliged to license and adapt their own OS/2 implementation from Microsoft, and the result will be mass confusion. Even Intel has had to OEM its own version for the InBoard/386 CPU expansion board.

The bottom line is twofold.

Firstly, will you want to run OS/2? The answer is maybe. It depends upon where the industry goes, and that is 80 per cent up to IBM and 20 per cent up to the corporate users. No one can give you a definite answer without the aid of a crystal ball. Sure, MS-DOS will continue to exist, just as CP/M exists today. But will it be *mainstream*? Will it be *the place to be*?

Secondly, does an 80286 processor mean that OS/2 can be run? The answer is . . . maybe. You almost certainly won't be able to run IBM's OS/2, as it seems so set to diverge. You will probably be able to run *somebody's* implementation of OS/2, but IBM's OS/2 may have diverged so much (unlike MS-DOS today) that the OEM implementations won't be worth the diskettes they're written on.

## Judging by the cover

The computers we examined encompass quite a mixed bag. They are the Epson PC AX2, the IPX Slimline 286 from Ipex Computers, the Skai 286 from Porchester, the Kaypro 286 from Intel-

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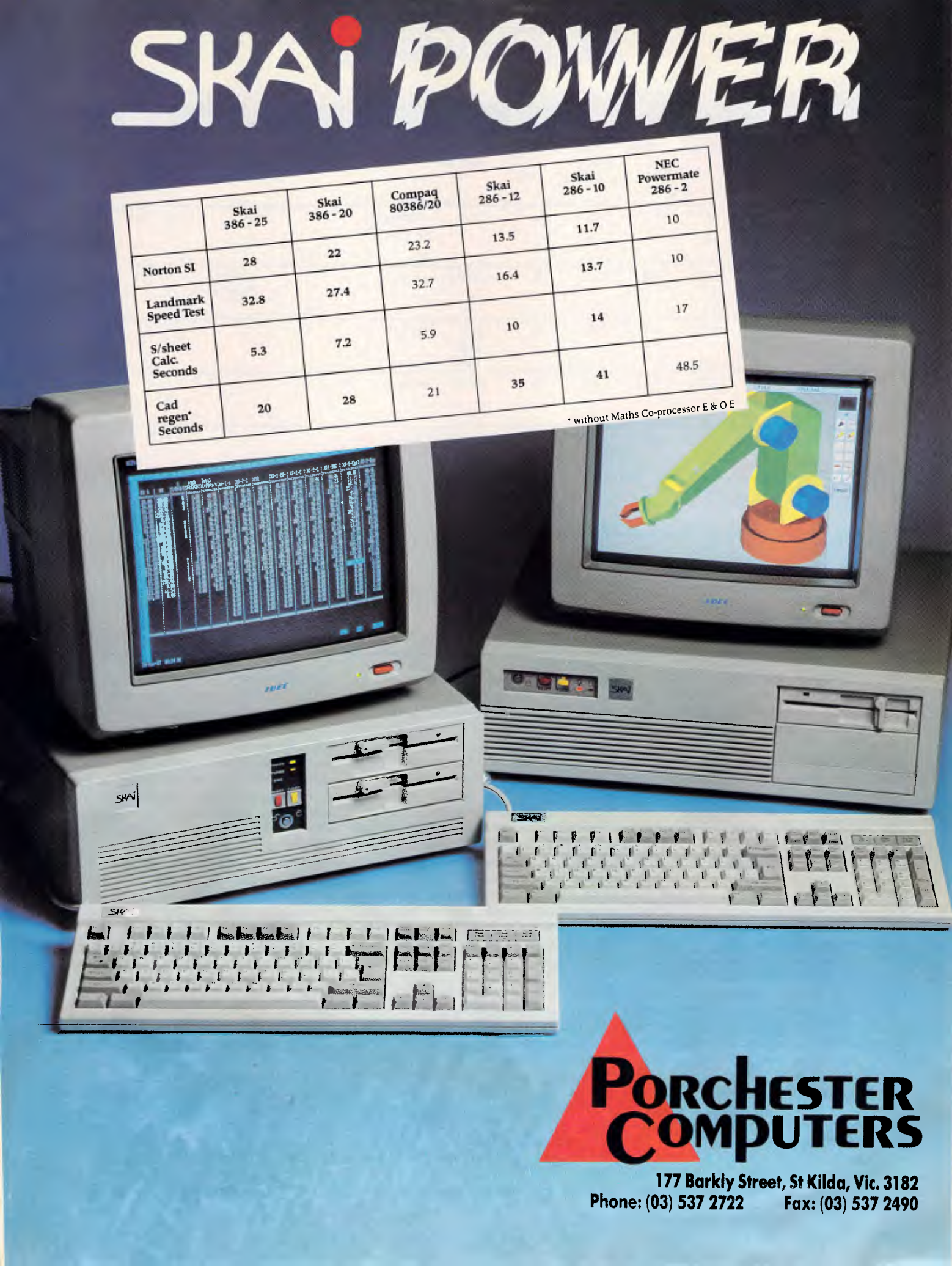
| | Skai 386 - 25 | Skai 386 - 20 | Compaq 80386/20 | Skai 286 - 12 | Skai 286 - 10 | NEC Powermate 286 - 2 |
|---|---|---|---|---|---|---|
| Norton SI | 28 | 22 | 23.2 | 13.5 | 11.7 | 10 |
| Landmark Speed Test | 32.8 | 27.4 | 32.7 | 16.4 | 13.7 | 10 |
| S/sheet Calc. Seconds | 5.3 | 7.2 | 5.9 | 10 | 14 | 17 |
| Cad regen* Seconds | 20 | 28 | 21 | 35 | 41 | 48.5 |

* without Maths Co-processor E & O E



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## At a glance

| Machine | Speed | RAM | Floppy | Hard Disk (Mbyte) | Disk Speed (ms) | Display Adaptor | Monitor | Comms Ports | Printer Ports | Half Height Devices | Dimens. | Price |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **HP Vectra ES/12** | 12 | 640 | 1.2 | 40 | 36 | EGA | Enhanced Colour | 1 | 1 | 3 | 42.5 x 39 x 16.5 | $10,453 |
| **Cleveland 286** | 6/10 | 1024 | 1.2 | 20 | 85 | HMDA | Mono | 1 | 2 | 2 (plus hard disk) | 40 x 35.5 x 16 | $4053 |
| **IPX** | 6/10/ 12.5 | 1024 | 1.44 | 32 | 46 | EGA, CGA, HMDA | Colour | 1 | 1 | 2 | 39 x 42 x 9.1 | POA |
| **Kaypro 286i** | 8 | 1024 | 1.2 | 20 | 84 | HMDA | Mono | 1 | 1 | 5 | 42 x 54 x 16.5 | $5040 |
| **Blue Chip** | 10 | 1024 | 1.2 | 20 | 104 | HMDA | Mono | 1 | 2 | 4 | 43 x 53 x 16.5 | $2995 |
| **Skai** | 10 | 640 | 1.2 | 20 | 56 | HMDA | Mono | 2 | 1 | 3 | 43 x 42 x 16 | $2895 |
| **Epson PC AX2** | 8/10 | 640 | 1.2 | 20 | 86 | HMDA | Mono | 1 | 2 | 3 | 40 x 41 x 15.5 | $4800 |
| **Sotec Turbo AT Tower** | 15 | 1024 | 1.2 | 32 | 54 | HMDA | Mono | 2 | 1 | 6 | 64 x 42.5 x 18.5 | $5165 |

ligent Terminals, the Vectra ES/12 from Hewlett-Packard, the Cleveland 286 from Computer Corporation of Australia, the Sotec AT Turbo Tower, and the Blue Chip 286.

Unlike the PC compatibles examined last year, these machines revealed a wide diversity of price, performance, configuration, design approach, and physical construction. In short, a reviewer's dream.

All of the machines are similar upon casual inspection, except the Sotec which is a floor mounted tower, and the IPX which is flattened down like a Model 30. These 'radicals' embrace two diametrically opposed design principles. The IPX assumes that desk space is the most valuable real estate in the world, and is not to be squandered at the expense of mere technology, albeit with some sacrifices in expandability, as the machine only leaves two expansion slots free. The Sotec works on the rationale that computers need expansion capability, and that most will end up on the floor anyway. The Sotec could conceivably be placed on a desk top, but would be larger than the original IBM AT. It comes with an integral floor stand, space for no less than six half-height devices, and five spare expansion slots. Removing the case provides easy access to almost any component, and the general aura of the machine is that of a work horse, ready to accept any peripheral and an almost perfect physical arrangement for a file server.

All of the other machines are quite unremarkable in their physical presence, and are vaguely similar to the original AT.

The Blue Chip is AT-sized and features a key lock mechanism, reset and turbo buttons, as well as LED indicators for power, turbo mode and hard disk access. Unusually, the internal speaker is mounted downwards over the hard disk, and space for four internal half height devices is provided. Additional cut-outs on the back panel allow for the installation of three 25-pin D-type connectors and two 9-pin connectors without loosing valuable expansion slots.

As a bonus to anyone who can't leave a poor, long-suffering machine in peace for more than five minutes, the case is a flip-top arrangement, catering for instant access to the internals. It is the only machine of the eight which uses a flip-top case.

The Hewlett-Packard Vectra is typical of HP gear — stylish, well thought out with original innovations, and very expensive. The Vectra is more the size of an Olivetti M24, being smaller than a standard PC but a little higher. It features accommodation for three half height devices, and a sparse front panel sporting only a centrally positioned power switch. The power switch feels a little strange when you switch it; this is because it is actually just the end of a long plastic rod which wends its way back into the sealed power unit. Not a bad idea, in reality, as it means that there is no potentially lethal 240 volt wires running inside the machine, just a harmless plastic poker. No reset button or turbo mode switch exists.

The Skai is also smaller than a normal AT, but with a more conventional front panel, featuring a key lock, reset switch and turbo button. Three LED indicators reflect power, turbo and disk access. It provides accommodation for three half height devices, and features a screw-down case which is virtually impossible to remove. Many Taiwanese machines have low physical tolerances, and the Skai was the worst of all the machines. Expansion boards do not fit smoothly and screw holes do not align properly with the case. It's always possible that the review machine simply came from a bad batch, so don't be put off too much.

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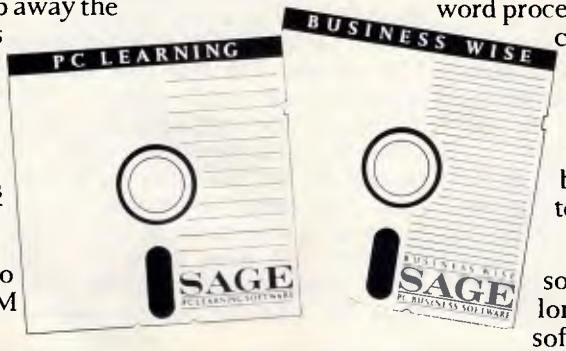


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ard IBM AT, both in its physical dimensions and front panel features. A key lock is provided, but no turbo mode switch. Space for five half height devices is provided.

The Epson PC AX2 joins Hewlett-Packard at the top of the range for innovative design. It is also packaged in a small but high case, secured by no fewer than nine screws. The front panel features only a power indicator, disk LED and power button, using the 'poker' approach also seen in the Vectra. A discrete flap on the front panel leads to more exciting territory, revealing a turbo switch, reset button and colour/monochrome primary display adaptor selector. The power indicator changes colour depending on the processor speed selected. Space for three half height devices is provided. The overall effect is very good, providing easy access to commonly required controls, but placing them out of the way. Another small flap is provided for the keyboard connector, which plugs into the front of the unit like all good keyboards should. Like the Vectra, the AX2 reeks of quality. All the boards fit correctly, and no amount of effort seems to have been spared. For example, unplugging the keyboard is a little awkward due to the low profile right angle DIN connector employed, so a tiny flip back handle has been mounted on the rear of the DIN plug to make the removal foolproof.

The Cleveland 286 is touted as an Australian-made machine, and even features an 'Advance Australia' sticker on the back panel. It is housed in an M24-style case and provides accommodation for only two half height devices. Things are not as bad as they sound, however, as the internal hard disk does not occupy one of the device bays, and is instead mounted beneath the power supply. This seems to be a very strange place for an electromagnetically sensitive gadget like a hard disk, but one must assume that any stray EMF leaking from the sealed power supply does not cause too many problems. Two additional 25-pin cut-outs are provided on the rear of the unit, and the front panel is featureless except for the badges which include a lovely blue Southern Cross logo.

The Sotec, as already mentioned, is in a floor mounted configuration with a small vertically-oriented panel half way down the front. The panel includes a rocker-type power switch, turbo and reset buttons and indicators for power, disk access and turbo mode. Six half height devices can be accommodated without any effort, and the rear features three spare 25-pin cut-outs and two 9-pin cut-outs. A plastic 'modesty cover' on the rear hides most of the unseemly metal work, just as on the original IBM AT. Physically, the machine is about the same size as a small MicroVAX.

At the other end of the scale, the IPX is about the size of a PS/2 Model 30, and is fully configured with two half height 3.5in devices. This may offer better integration with your fleet of PS/2 machines (if you have one), as 3.5in diskettes are definitely the way to go. Two cut-outs on the rear allow for an additional 9-pin and 25-pin socket — a feature of great importance on this machine with only two spare expansion slots, where spare mounting brackets cannot really be used for holding additional serial and parallel ports. The keyboard, display and external floppy interfaces are positioned on the side of the unit, with all other plugs and sockets conventionally at the rear.

The most unusual aspect of the IPX, however, is its front panel. The power and reset buttons are positioned centrally, along with indicators for power, disk access, keyboard, display, printer and communications port one and two I/O. As you type on the keyboard, the keyboard I/O indicator light flashes on and off. Similarly, as data is displayed on the screen, the screen light flashes on and off. One really has to question the value of some of these indicators. The communications lights are fair enough, but most users don't have to be told that they're typing on the keyboard. Moreover, the display indicator only operates with screen I/O which uses the standard BIOS routines. If you write directly to screen memory, as most software does, the light will remain off.

## *Inside*

All of these machines run 80286 microprocessors from Intel, and all feature a number of IBM AT-compatible expansion ports.

The Blue Chip is claimed to run the processor at 10MHz with no wait states, but it looked like it was actually running a little faster than that. Internal expansion comes in the form of six 16-bit AT style slots and two 8-bit PC style slots, three of which are already occupied. One slot holds the Taiwanese Protech Hercules-compatible HMDA display adaptor and printer port. This is a very small board

*The Cleveland 286, built in Australia, with the sticker on the back to prove it*

*Only one machine is designed with a flip-top lid for easy access: the Blue Chip 286*

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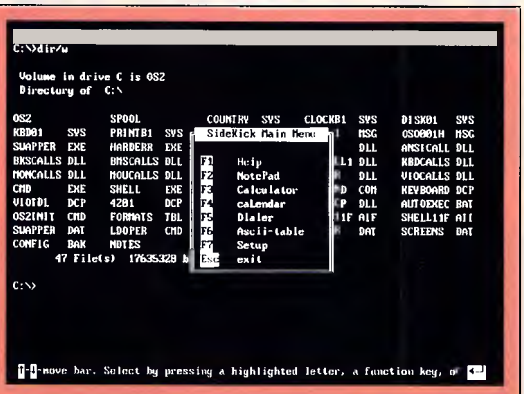
## OS/2 up and running




Although running an 80286 processor is not an absolute guarantee of being able to run OS/2, *APC* has been able to show that at least one of the machines reviewed here is OS/2 compatible.

Using a 2Mbyte Hypertec HypeRAM AT extended memory card, along with the Compaq version of OS/2 Standard Edition 1.0, the Epson PC AX2 happily ran the new operating system with no apparent problems.

All it involved was configuring the memory board as 'expanded' conventional memory above the one megabyte limit, booting the OS/2 disk and performing an install onto the hard disk. After the install, OS/2 could boot directly from the hard disk and could run multiple concurrent OS/2 sessions along with the single MS-DOS 'compatibility box' session. OS/2 had no problems loading the communications device drivers.

A word of warning. This does not mean that all the machines reviewed here will run OS/2, or that the Epson will run any other implementation of OS/2, or indeed any future version of the Compaq OS/2. All it means is that the combination of hardware and software we tried did work. If OS/2 features heavily in your plans, we would suggest you test out the intended components before you buy.

The accompanying screen dump shows the MS-DOS compatibility box of OS/2 with a directory listing of the hard disk and SideKick popped over the top. We had to show you the DOS compatibility box because our little doohickey which pumps screen images into the publishing system has not yet been ported to OS/2.

featuring only two VLSI chips and six MSI chips. Control of the storage devices is achieved using a Western Digital combined hard disk and floppy disk controller based on, understandably, the Western Digital controller chip. These two boards will become a recurrent theme among the machines. The third board provides additional I/O capability, featuring a 9-pin serial port, second printer port and games interface. A 9-pin to 25-pin adaptor cable was included with the review machine, but this appears not to be standard equipment. A three inch power cord was also supplied, presumably of some use in driving monitors. A full megabyte of RAM is provided on the system board, and the BIOS is copyright of Blue Chip.

The Cleveland PC also contains one megabyte of RAM using 256kbit chips, and drives the CPU at either 6 or 10MHz. The BIOS is copyright of Computer Corporation of Australia. Five AT style expansion slots and two PC slots are provided, three of which are initially occupied. The display adaptor is HMDA compatible and provides a printer port; the controller card is the same Western Digital product found in the Blue Chip. The third board is a combined parallel/serial card manufactured by CCA. The motherboard utilises the Chips & Technologies AT chip set — another recurring theme.

The Sotec sports the fastest processor of the bunch, running at 15MHz with one wait state. It also uses the CHIPS chip set, and comes standard with one megabyte on the motherboard. Five AT slots and two PC slots are provided, one of which is occupied by the Western Digital card and another by an HMDA compatible display board. Two serial ports are implemented on the motherboard, and a printer port shares the display card. The Award BIOS version 3.01 is used.

The IPX, always the odd man out, runs the 80286 at either 6, 10 or 12.5MHz. The machine doesn't really have a motherboard in the conventional sense. Rather, a back plane provides four AT-style expansion slots and normal motherboard functions are distributed between two cards which plug into the slots. The larger of the two boards is at the bottom and provides I/O, controller and EGA functionality. A normal-sized board plugs in above it and holds the CPU and CHIPS chip set. This leaves only two expansion ports free for the future. While it's true that most machines never fill all their slots, two is probably insufficient. For example, add a network adaptor, LIM/EMS board, and you're full. No room for that internal modem or mouse adaptor. The boards mount horizontally, so you may have problems with three quarter length boards which are not long enough to reach the far mounting bracket, but are long enough to droop. The machine comes with 640k of RAM as standard, along with a 9-pin serial port and printer port. The IPX really crosses standards here, as 3.5in disks are now 'in' thanks to the PS/2, but 9-pin serial ports are now 'out'.

Up at the top end of the market, the HP Vectra runs at 12MHz with a proprietary HP BIOS. Five AT and three PC expansion slots are provided. One port is occupied by a Hewlett-Packard EGA compatible display adaptor, and another by a combined floppy and hard disk controller, serial and printer port card, using the Western Digital controller chip. Again, we see the attention to detail only found on top-class machines. The parallel printer port, which many users tend to plug modems into, has a small plastic flap over it emblazoned with those immortal words 'printer port'. Inside the Vectra, surface-mount is the name of the game. The motherboard, EGA card and I/O card are almost exclusively surface mounted, except for chips which really need to be socketed, such as BIOS ROMs. This results in incredibly clean, neat and aesthetically pleasing boards, all of which will mean *absolutely nothing* to the guy at the end of the keyboard. The use of SMT may go part way to explaining the high cost of the Vectra — something which relevant to the user.

The Kaypro 286i runs its CPU at 8MHz, although a switchable 6/12MHz version will be available soon. The CHIPS chip set is not used, but a number of devices from AMD are. This results in a slightly more cluttered motherboard than the other machines. The Phoenix BIOS 3.07 is used. Six AT and two PC expansion slots are provided, initially occupied by an HMDA card based on Texas Instruments' chips made in Hong Kong and a combined floppy and hard disk controller using SMT technology from National Computer in Japan. The display card features a 132-character mode, but you'll need special drivers to make most applications take advantage of it. A full megabyte of RAM is installed.

Having said all of the above, the Skai machine is really just a series of subsets. The processor runs at 8 or 10MHz and is complemented by one megabyte of RAM. Six AT and two PC slots are provided, and an HMDA display adaptor and disk controller based on the Western Digital chip are installed. The motherboard uses the CHIPS chip set and the Award BIOS. The BIOS is extremely verbose, displaying two thirds of a screen of checkout information during the POST, which promptly disappears off

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the screen. An I/O card provides two 25-pin serial ports, printer port and games adaptor. Two of the spare back plane mounting brackets are used to accommodate the extra port connectors.

Finally, the other top-end machine, the Epson PC AX2, diverges yet again. Almost all of its components are by Seiko Epson, including the motherboard chip set. The processor runs at either 8 or 10MHz and is accompanied by 640k of RAM which is mounted, not on the motherboard, but on a vertical memory board with a piggy-back extension. The BIOS is by Epson. The hard disk controller board is also manufactured by Epson, but based on the Western Digital chip. A separate board controls the floppies and provides a 9-pin serial port and parallel printer interface. The display adaptor is the same Protech found in the Blue Chip. The display was of dismal quality, with pieces missing from each character and virtually unreadable. However, it is safe to assume that this was caused by a fault in the evaluation unit, and would not occur on production units. Certainly the other machines which used the Protech card did not have the same problem. Expansion is provided through three AT and three PC slots, three of which are initially occupied.

*The Skai 286 from Porchester was delivered with dual floppies*

*The Kaypro 286i utilises a BIOS from Phoenix*

## Peripherals

All of the machines came supplied with at least one hard disk, one floppy and a monitor of some sort.

The Cleveland 286 was supplied with a 1.2Mbyte Chinon floppy disk and 20Mbyte miniature Miniscribe disk with a tardy 85 millisecond average access speed.

The monitor supplied was a monochrome device from Hyundai in Korea, and featured one of those great piggy-back power leads that lets you plug the screen into the system unit so you only have to worry about turning one unit on and off. The only problem is that the system unit doesn't have a power outlet for the monitor, so you can't power it up. A minor oversight.

The IPX machine provides a 1.44Mbyte 3.5in floppy disk and 32Mbyte Miniscribe voice coil hard disk with an average access time of 46 milliseconds. The review machine was supplied with an ECM-5400 colour monitor.

The Blue Chip also sported a 1.2Mbyte floppy and 20Mbyte Miniscribe hard disk using a stepper motor, and quite slow with an access time of over 100 milliseconds.


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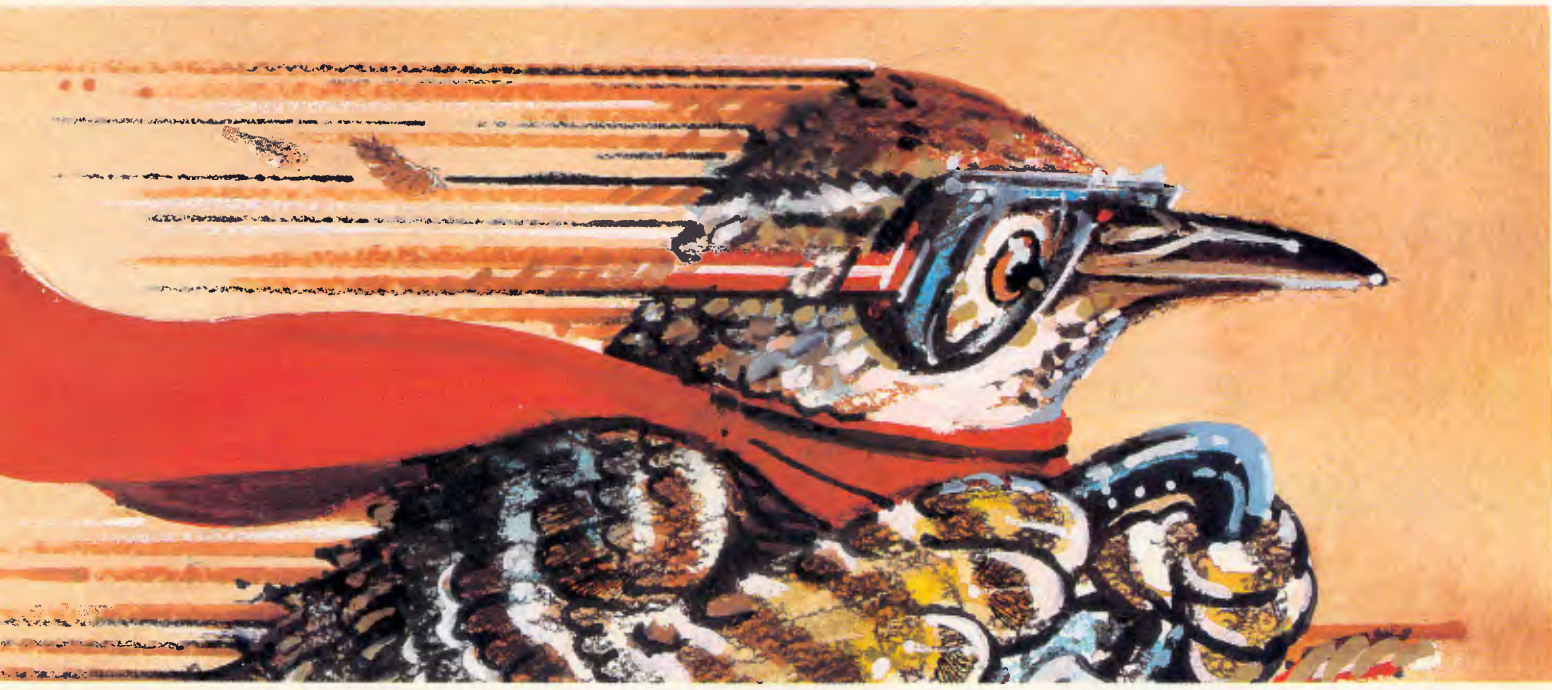

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## Benchmarks

| Machine | Int Math | Real Math | TriLog | Text Scrn | Graf Scrn | Store | Instr-uction Mix | x Stand-ard PC |
|---|---|---|---|---|---|---|---|---|
| **Vectra** | 0.7 | 7.6 | 10.6 | 20.2 | 2.4 | 11.3 | 6.04 | 7.3 |
| **Cleveland** | 0.9 | 8.8 | 12.4 | 15.2 | | 9.8 | 7.14 | 6.2 |
| **Kaypro** | 0.8 | 8.9 | 12.5 | 9.2 | | 11.9 | 7.14 | 6.2 |
| **Blue Chip** | 0.7 | 7.1 | 9.7 | 12.1 | | 11.0 | 5.60 | 8.1 |
| **Skai** | 0.6 | 7.0 | 9.8 | 6.9 | | 11.7 | 5.61 | 8.1 |
| **Epson** | 0.6 | 8.8 | 12.4 | 12.1 | | 11.6 | 7.14 | 6.2 |

The highest hard disk capacity is provided by the Vectra, boasting a 40Mbyte disk with a Hewlett-Packard logo on it, although I suspect it to actually be a Seagate. The disk is a voice coil, with the very respectable access time of 25 milliseconds. A 1.2Mbyte Matsushita floppy is also provided. The monitor provided for review was the chunky HP35743B enhanced colour display, a terrific display, as it should be for $1687.

Kaypro opted for a 20Mbyte stepper motor Seagate in its machine, accompanied by a 1.2Mbyte floppy disk. It seems the 286i is usually shipped with a 40Mbyte voice coil disk, so make sure which one you're getting before you sign the cheque. The monitor was a Kaypro monochrome device from Korea.

The Sotec machine was supplied with a 1.2Mbyte YE-Data floppy disk and 32Mbyte full height Rodime hard disk with an average access time measured at 53 milliseconds. The monitor was an ADC white monochrome screen with a tilt and swivel base.

Only one machine was supplied with dual floppies, and that was the Skai, which came with dual Matsushita 1.2Mbyte drives. Normally the machine is supplied with a single NEC floppy.A 20Mbyte Fuji voice coil hard disk is also included, and the monitor was an amber monochrome screen from Royal Information Electronics in Taiwan.

The Epson machine was also supplied with a 1.2Mbyte floppy from NEC and a 20Mbyte hard disk driven by a stepper motor. The monitor was a Samsung monochrome with a tilt and swivel base.

All of the machines have embraced the new IBM-standard keyboard layout with the twelve function keys running across the top. All, that is, except the Cleveland, which uses a standard AT layout. The other main exception was the Blue Chip, as EME neglected to provide a keyboard for it, although keyboards do normally come as standard.

The keyboards vary in quality and tactile feedback. The IPX keyboard has a good, soft feel to it. The HP Vectra has a typical Hewlett-Packard fast, 'squishy' keyboard, one that I could certainly learn to like. The keys are beveled, which makes mistakes over in the crowded numeric pad less likely. The HP keyboard appears more complicated than it actually is, due to the use of 'blanks' between the editing keys where other manufacturers just run the keyboard housing around the cursor diamond. The Sotec keyboard, on the other hand, goes for more positive tactile feedback.

## Extras

The bundled software and documentation supplied with each machine varies greatly. Roughly in order of volume, they are as follows.

The Kaypro 286i heads the list, coming with a 286i users guide, MS-DOS 3.2 manual, the SpeedStor hard disk management utilities and documentation, GW-Basic manual, two empty binders for putting it all in, and a copy of 'Profiles', the magazine for Kaypro computer users.

Epson comes next, featuring MS-DOS and GW-Basic, complete with good manuals, and a set-up document. The Epson documentation is of good quality and highly readable.

The Skai machine, from Porchester, is supplied with MS-DOS, GW-Basic, a guide to operation for the hardware, and the MS-DOS programmers reference manual. These are all the standard Microsoft works, and hence of good quality.

The Hewlett-Packard Vectra is supplied with a set-up manual and a communications program which provides HP, VT52 and VT100 terminal emulation. The program is fairly good for a freebee, but the Vectra does not come with MS-DOS or GW-Basic as standard. MS-DOS costs an extra $159.

Taking the other approach, the Cleveland comes with MS-DOS and GW-Basic, but no guide to operations for the hardware. The Sotec had MS-DOS 3.21 loaded on the hard disk, but was not supplied with any documentation worth speaking of. The IPX and Blue Chip were much the same.

While documentation is of paramount importance to a user, potential buyers should not necessarily be put off simply because the supplier does not share a similar view. Often, documentation is available and the local importers just don't think its important enough to send out.

Alternatively, it may be available at additional cost. Just make sure you get some before the cheque goes into the till.

## Conclusion

Despite the fun and games surrounding the PS/2 and its clones, the age of the AT is not yet past.

Decisions remain difficult, and as always, a final choice depends on what your intended use of the machine. For that reason, it is awkward to nominate a 'best' machine, so we'll start with a series of 'bests'.

If you want a big name machine which reeks of quality, then the choice comes down to the HP and the Epson. The Vectra essentially prices itself out of the market, so the Epson PC AX2 wins.

If, on the other hand, you're after a machine with the smallest possible physical dimensions (for whatever reason) and very little expansion capability, then the IPX is the one for you.

At the other end, for top notch performance with maximum possible expandability in a floor mounted configuration, the Sotec is the natural choice.

Alternatively, for an Australian-made machine, the Cleveland 286 is an option.

But perhaps the best overall is the Epson PC AX2. In many ways, it reminds me of my beloved Olivetti M24. Good performance and high quality from a reputable manufacturer at a reasonable price.

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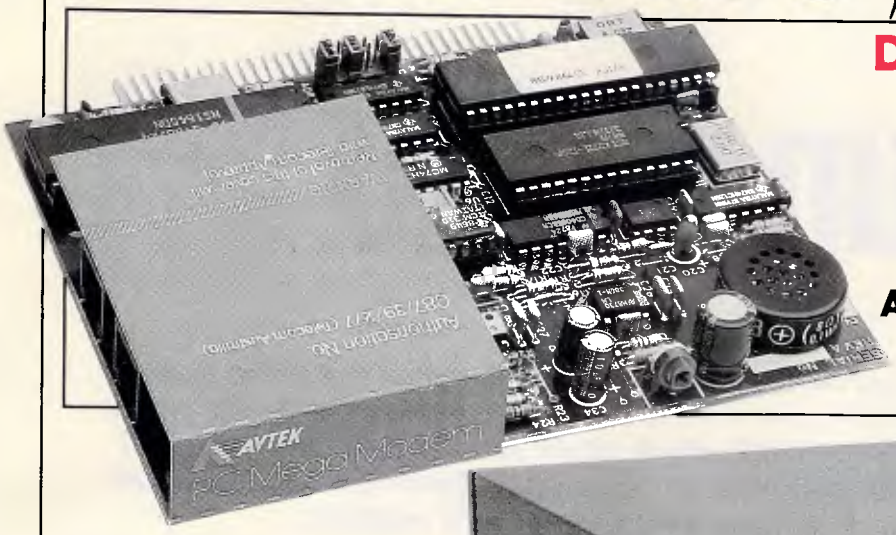


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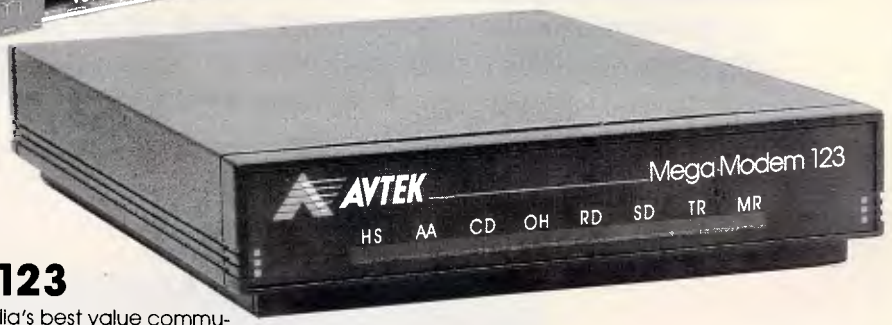


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# Sun 4/110

*The march of technology has narrowed the gap between the micro and the minicomputer, and with the Sun 4/110, Sun has pioneered the development of a micro-architecture machine which offers substantially more than PC performance. Peter Jackson gives an overall assessment, while individual facets are scrutinised by a team of APC regulars.*

Historically speaking, increasing processor power and bigger mass storage capacities have been used to support larger numbers of users but with roughly the same computer power per user. And then came the workstation, to prove Henry Ford's dictum that history is bunk.

The thinking behind the development of workstations was that users in particular sectors needed the processing power of minicomputers and mainframes, but also needed to put that power in the hands of individuals rather than reserving it for large groups of casual users.

But those power-hungry users in the fields of CAD and artificial intelligence could not afford a minicomputer each, so the workstation originators — young companies like Sun Microsystems and Apollo — adapted microcomputer hardware into mainframe-style architectures, using every possible design trick to wring the last milliMIPS out of relatively cheap processor and RAM technology.

Then they gave users a machine each, and put big and fast hard disks on a network for shared access and a lower overall system cost.

But now the workstation makers are starting to feel the squeeze. Microcomputers like the Compaq DeskPro 386/20 and the Macintosh II either have or promise near-workstation performance at much cheaper prices, and there are limits to the performance enhancements that the workstation makers can include to keep ahead, given the declining number of customers who would need that performance and the prices that would have to be charged for it.

Hence, finally, the Sun 4/110. What Sun has done is to cut down its top-end Sun 4 workstation, taking out some of the architectural speed enhancements and reducing the disk access speed to simplify the system and make it cheaper to build, while maintaining a performance premium over the high-end PC competition. In a very real sense the Sun 4/110 is a personal computer as we all understand it, using techniques and components that are becoming familiar in today's high-speed 80386 and 68020 machines but keeping the distinctive workstation features that have made Sun so popular.

Sun obviously thinks that this is the future of personal computing, and the way the 4/110 is put together may well give us some hints about the direction that future will take.

## Hardware

Externally, the most obvious feature of any Sun system is the big bit-mapped monitor that gives CAD users the scale and resolution they need. And that is even more so for the 4/110. The electronics of the system are contained in a slim system unit, about the same size as an IBM AT case but a third the height, while the disk and tape backup units are built into an external case that Sun accurately describes as a 'shoebox'.

In a normal configuration the whole system fits easily on a desk-top, with the big 19in monitor on top of the system unit and the disk shoebox either on the desk or under it.

The system unit is actually a three-slot card cage, and is common to all low-end Sun systems. The slots meet the VME bus standard, a 32-bit design much used in high-speed systems based on the Motorola 68000 family of processors; and, in Sun 3 workstations, all three slots are filled with processor, video, and memory boards. In the Sun 4/110, however, greater integration of electronic hardware on a single board means that only one slot of the three is officially occupied. But, in practice, two slots are used since the video circuitry is built on to a daughterboard that actually obscures the centre slot.

Indeed, the entire Sun 4/110 system can be removed from the system unit simply by pulling out the main board/daughterboard combination.

The main board itself is deceptively simple. The most obvious feature is the enormous amount of RAM on the board, made up of the now-usual single-in-line memory modules (SIMMs). There are 32 SIMM slots, and the default configuration is to have

## Sun 4/110 Mass Storage

Perhaps the most notable feature of the mass storage fitted to the Sun 4/110 workstation is its sheer orthodoxy. To be sure, the Winchester disk drives are bigger and faster than any offered before, but Winchesters they remain, and that fact in itself speaks volumes. For the 4/110, Sun has just introduced a 327Mbyte SCSI drive with an 18ms seek time and 1.2Mbytes per second transfer rate.

The SCSI bus allows overlapping access to several drives, which means that to the user they appear to be accessed simultaneously. To give you a handle on this level of performance, it's 15 times the capacity and 5 times the speed of the hard drive on the PC that I'm writing this on. What this means is that improvements in Winchester drive performance are broadly keeping up with increases in processor speed.

Machines like the Sun 4/110 point to the future requirements for personal computer mass storage. Ever greater bit-mapped screen resolution means huge volumes of data have to be manipulated; a 256 colour screen image at 1024 x 1024 pixel resolution fills 8Mbytes of store. It's not enough for mass storage just to keep up in capacity; it needs to get proportionally faster too to keep response times within the acceptable range. It seems likely that the tried-and-tested magnetic disk will still be the best bet for some time to come.

Vertical recording, a new technique in which the oxide grains are orientated perpendicular to the disk surface for closer spacing, promises to raise capacities by an order of magnitude, and 3.5in floppies holding 10Mbytes have been seen working in several Japanese laboratories.

Many times over the past decade we have been treated to prophesies of new mass storage technologies that were going to overthrow the rule of the magnetic disk drive. First, there was the non-volatile magnetic bubble memory. That proved too slow and too costly to fabricate and bubble memory is now almost unheard of outside exotic industrial environments.

More recently the betting has been on some form of optical disk storage. It is quite clear that laser-driven optical media can provide very much larger capacities than magnetic media; drives holding more than a gigabyte are already in production. Optical disks have two problems, though. First, no one can currently make a commercial optical disk that is erasable; the WORM (Write Once — Read Many Times) drives you can buy now are useful only for archival storage as they can never be re-used. Various Japanese and US manufacturers are close to launching erasable optical media, as they have been for the past five years.

Second, optical media are still an order of magnitude slower than the best Winchester disks. It seems likely that the optical disk will find its niche as long-term archival store, and for CD-ROM style reference works.

Another mass storage technology which looks likely to advance is plain old RAM. As RAM gets cheaper and computers with multi-megabyte memory become commonplace, it makes more and more sense to cache whole tracks of data for speed; for example, a 4Mbyte Mac II can use up to 1Mbyte of memory as a disk cache. Portable computers like the Tandy 100 show that non-volatile RAM or EPROM is a perfectly good mass storage medium for lower-volume applications, and Anamartic's wafer-scale 'disk' memories could add a new dimension to non-volatile memory. The mass storage system of the future might well be a 4Gbyte erasable optical disk cached into 100Mbytes of wafer RAM, cached into 1Mbyte of fast static RAM.

**Dick Pountain**

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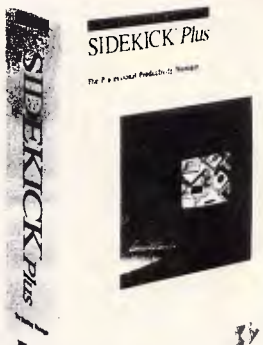


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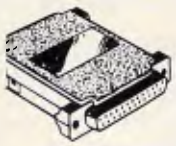

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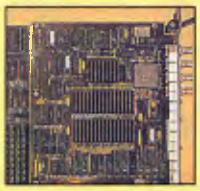
## Sun 4/110 Connectivity



Connectivity is a very important issue for computing in the future. As computers permeate the business environment it becomes more and more necessary for them to work well together. Even with the IBM standard in the PC market, networking can be a nightmare, particularly when connecting different types of computer. In addition, applications are ever hungry for more power and memory. Increased connectivity and communications can deliver this power to the desktop. Sun is basing its strategy on the need for the desktop computer to be a graphically powerful workstation which effectively presents powerful applications and large amounts of information.

Sun has a very comprehensive networking system and overall strategy to back it up. The company refers to this as its Open Network Computing (ONC) Environment. Physically, Sun workstations are connected to other machines (Suns, Sun Servers, VAXs, and so on) by Ethernet for local access, or via numerous other connections using standard communications protocols like X.25 and SNA to a wide range of other computers.

All of this interconnection is treated by ONC as if it were local, so Sun's networking strategy could be described as local area networking on a grand scale.

The network architecture Sun uses is based on Ethernet for physical and data connections; the Internetwork Protocol (IP) at the network level; Transmission Control Protocol (TCP) at the transport (or long-distance inter-network connection); and User Datagram Protocol (UDP) at the same level for controlling the interchange of data formats. All these protocols are used to ensure that the two connected systems understand what and why they are communicating, and also that they transmit the data itself correctly.

The exchange of information over the network is controlled by SunLink which is the family of data communication products provided as part of OSN. The other parts of OSN are the Open Network Computing (ONC) environment which allows different networks to connect together; the Network extensible Window System (NeWS), merged with the X-Window System so that windows will operate across the network; and the Catalyst third-party family of communications products (rivals to the Sun part of OSN).

SunLink is used to allow as many as possible of the rival and competing communications standards — such as X.25, the Manufacturing Automation Protocol (MAP), Technical and Office Protocol (TOP), IBM's SNA and BSC protocols and DECnet — to talk to each other. You could regard SunLink as a translator between all these different competing protocols. This strategy is an interesting one. Instead of creating yet another 'standard' in the area, Sun has chosen to connect all the other standards together like a web. The advantage is obvious; they work with everything else. The disadvantage is that they have to keep adding new sections to deal with new 'standards' as they come along.

Another way Sun has chosen to increase the number of systems it can communicate with is via its Network File System. A significant product for the PC market is the company's PC-NFS, a Network File System for IBM PCs and compatibles. This allows PCs to access files on Sun workstations, share printers, act as a terminal on a Sun network, access other systems via Sun gateways and even distribute applications over a Sun network.

ONC is transparent to the hardware using it because it uses standard Unix system administration procedures which have been modified for use across a network. Besides these, Sun has developed applications for use with networks. These are mostly used to display information on network performance and to test connections between specific nodes on the network. All these tools are used to keep the network operating at full speed and full efficiency. Much of ONC is in the public domain so that as many manufacturers as possible support it.

Connectivity on Sun systems does not extend beyond networks. At present they have made no provision for very closely-coupled information exchange — such as sharing instructions between processors. Sun could introduce this in the future, but to do so would require a new bus control/link chip designed for parallel or inter-processor communication. Instead, Sun has concentrated on making as wide a range of services and systems available to, and on, ONC as possible.

ONC may be a long way ahead of simple local area networks, but it can still be considered only as a form of data sharing. The only way that the processing of a difficult task can be shared is by running independent processes on different systems and transferring data between them. This allows heavy number-crunching processes to be passed off to a processor like a Cray and graphics manipulations on the resultant data to be done by the Sun itself.

This leaves us with two views of the future of computer connectivity for the moment. According to Sun, the future user will be confronted by a desktop workstation of great power (at least we'd consider it great power at the moment). This workstation will be either standalone or part of a local area network.

The machine or network will in turn be connected via a server to a much larger and more distributed network. Through this the user will have access to a large number and variety of systems, from little PCs right up to huge supercomputers. This distributed network will operate transparently. The user can say 'send a piece of mail to Sonya in California' and it will, or he/she can instruct the workstation to farm off a real-time neural network simulation to a new Japanese neural computer.

This contrasts sharply with the distributed processing point of view which is a lot less well defined. This again sees a workstation on the user's desk but this time the workstation is acting as a front end to a node of a giant distributed computer. If this node can handle the users' commands, it will. If it needs to send messages, they are 'broadcast' across the computer and performed by any free node they encounter. Results are transmitted back in a similar manner.

The latter vision is more unlikely to ever be completed but is potentially more powerful. The former will soon arrive and is almost certain to succeed. It is interesting to note how much both visions rely on fast and accurate communications.

**Owen Linderholm**

them all filled with SIMMs each holding 256k of parity-checked RAM, for a RAM capacity of 8Mbytes. Sun is cagey about further expansion, but it does not take a genius to work out that using 1Mbit chips rather than 256k chips would take the RAM capacity up to 32Mbytes on the main board.

This amount of RAM may seem excessive to those crammed beneath the 640k limit of MS-DOS on a PC, but large RAM capacities are crucial in the type of jobs that workstations do, and will become increasingly important in the personal computer market too. When large amounts of data are being handled, and complex graphical images are being displayed and manipulated on a big screen, the easiest way to get high perceived speed is to use a lot of fast RAM and keep as much data stored there as possible.

Naturally, the 4/110 RAM is 32 bits wide, and it also uses static column access techniques to cut down memory wait states. This technique, which first came to mass-market attention in the Compaq DeskPro 386, uses the fact that whenever a memory cell in a RAM chip is specified by its row and column addresses, the contents of the entire column are read into a column buffer in the chip.

So, if a system monitors RAM accesses and finds out that successive accesses are in the same column of the chip, then only the new row address needs to be sent. To put it another way, accessing successive memory locations in a single page of RAM takes half the time in a static column RAM architecture than it would in a conventional architecture.

Of course, this does not work for every RAM access. In most applications data is stored well away from

program code, meaning that static column access gives no benefits whenever that data is required. However, using this technique means that slower RAM chips can be used with a processor of a given speed without loosing throughput and, indeed, the 4/110's RAM chips are not particularly quick 120ns parts. Static column RAM will increasingly be used in personal computers, as will the more complex interleaved memory architecture now appearing on some 20MHz 80386 machines. Here, memory accesses are made alternately to two separate banks of RAM, with the second bank available for access while the first 'recovers' from its own last access.

Whatever the technique used, the speed of the CPU/memory architecture is crucial to getting top performance out of a high-speed processor. And tricks such as these will be increasingly used in the future.

As it turns out, the 4/110's central processor does not place any major speed demands on the RAM chips; it runs at a respectable but not blazing 14.28MHz, slower than the 16.67MHz 68020 in the Macintosh II, for example. But this central processor is the SF9010IU Integer Unit — the SPARC chip — which is a Sun-designed and Fujitsu-built RISC processor implemented as a gate array. The SPARC's RISC-derived advantages are described elsewhere, but it can deliver a claimed 7 VAX MIPS while the 80386 at a faster 16MHz can deliver only 3 to 4 MIPS under optimum conditions.

In the high-end Sun 4 system, the integer-only SPARC chip is linked with a sibling floating-point controller gate array and the Weitek 1164 and 1165 floating-point coprocessor chips for faster mathematical calculation. On the 4/110 these chips are optional, although the sockets are on the board and fitting them would take just seconds.

Again, this coprocessor configuration is filtering through into the power PC market. The Compaq DeskPro 386/20 has a socket for a Microway Weitek coprocessor board built around the 1164 and 1165 and collectively called the Weitek 1167 accelerator. The Portable 386 has a similar socket that cannot be used only because the Microway board is physically too big to fit in the case.

The Weitek processors outperform by large margins the 80387 and 68881 maths coprocessors for the 80386 and 68020, and users are becoming more conscious of the real benefits that can be gained by using maths chips in number-intensive applications such as CAD. Weitek must be rubbing its hands at the suddenly-increasing market for its products.

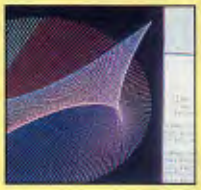
The other major features of the 4/110 board, apart from the boot EPROMs and real-time clock, are a SCSI controller that hooks up to the mass storage shoebox, an Ethernet interface, and two

The use of a SCSI controller may mislead some observers into thinking that the disk drives on the 4/110 are slow, but that is not the case. The SCSI port on the main board is simply used as a bus, and the disk and tape drive controllers sit on this bus and use their own communications standards to the drive hardware. The hard disk is a 327Mbyte drive with an ESDI controller, giving an average access time of 18ms and a data transfer rate of 1.2Mbytes per second into the SCSI port; while the tape controller uses the QIC-36 standard to handle a 60Mbyte streaming tape cartridge.

The Ethernet controller drives two back-panel ports; one thin Ethernet for cheaper cabling systems and one full Ethernet for co-axial cabling. And of the other two expansion buses, the first is simply the VME bus connection to the system unit, while the second, called the P4 bus, is the fast 32-bit connection to the video daughterboard.

There is a choice of video boards, both giving the normal Sun screen resolution of 1152 x 900 resolution either in standard monochrome format or with 256 grey scales. This board comes with 256k of video RAM, and drives the screen at a fast 66Hz non-interlaced refresh rate. There is a choice of 16in or 19in RGB colour monitors to go with the colour video board, which can display 256 colours simultaneously — eight bits per pixel — from a palette of more than 16 million, again at the standard Sun resolution, and can also limit itself to one bit per pixel to give faster monochrome operation.

## Sun 4/110 Image Processing



The Sun Microsystems machines are setting a standard in the field of workstations and, as the technology becomes cheaper, this will have significant implications for the PC market in general. The most striking feature of any of Sun Microsystems' range of workstations, compared with any similar machines, is the dominant 19in screen needed to display the two million pixels it uses. The general concepts of the WIMP user interface and object-orientated programming need a screen with the appropriate resolution, simply to make the user environment practical. Sun has led the field in providing the user with an appropriate screen for the WIMP operating environment and for the standard workstation applications of computer-aided engineering design (CAED), artificial intelligence (AI), fluid dynamics and molecular modelling. To provide this detailed screen resolution, Sun has developed some revolutionary ideas in both display software and hardware.

The original concept behind the Sun workstation was to use a main processor with a range of support processors, including a video coprocessor. Due to chip design and production difficulties, a software solution had been implemented and put into production before a hardware solution could be finalised.

It was later proven that, for monochrome machines, a hardware raster operations chip provided no significant increase in performance. When the colour machines were launched, the monochrome raster operations chip was extended and was extensively used to provide the support required for the complex raster operations needed in a typical windowing environment. This chip, alongside the proprietary memory management unit (MMU), provides the backbone to powerful screen graphics.

The MMU provides the mapping for up to 256Mbytes of memory and supports virtual memory access, allowing programs requiring vast amounts of memory to run in a limited amount of RAM. It also supports Direct Virtual Memory Access (DVMA) which allows the graphics coprocessor also to use the MMU chip and virtual memory access. This specialist interfacing of the SPARC chips allows for greater speed of operation and safer software control because all the complex transfer functions are achieved in hardware.

The raster operations chip, or 'blitter' chip, enables memory-to-frame-buffer, frame-buffer-to-memory or frame-buffer-to-frame-buffer data transfer to take place. During the transfer process, this chip can perform various logical operations at bit level and allows windows to be moved around the screen with little main processor intervention. In a typical windowing environment like GEM or Microsoft Windows, the processor would be relieved of what at present is a time-consuming duty. This provides a simple method for implementing processes like mouse manipulation, where a series of AND and OR functions are used to prevent data loss during mouse control.

The current Sun 4 series of workstations provides a 19in monitor with a screen resolution of 1600 x 1280 pixels. This generates a video bandwidth of 200MHz, where the video bandwidth is the product of the pixel count, the number of colours or grey levels and the video refresh rate. As the screen resolution increases, so obviously either the video band-

*Continued on page 39*

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width must increase or the refresh rate slow down to allow the extra data to be displayed. Unfortunately, at present, 200MHz is close to the current maximum possible on a desktop-sized and priced monitor.

The screen has a very stable, non-flickering display due to the screen refresh being non-interlaced and operating at a frequency of 66Hz. For the colour screen, the pixel resolution has been reduced to enable 256 colours to be displayed at the same time. The 256 colours can be chosen from the 16.7 million possible colour combinations provided by Sun's own look-up table (LUT).

For those who find that the standard configuration described above is not sufficient, Sun has developed two even more specialised video coprocessors, the GP Plus and the GP2. The GP Plus is aimed specifically at 2-D wire-frame applications such as computer-aided design. It provides a typical drawing performance of 65,000 2-D vectors per second. For those requiring 3-D vectorisation, the GP2 will provide more than 150,000 3-D vectors per second or 20,000 shaded polygons per second. Both these chips provide the power needed for such applications, but they are both very expensive and organise the machine into a very specialist, small area of powerful performance.

A specialist real-time application currently requiring very expensive equipment is the enhancement and reconstruction of satellite-transmitted television pictures. This is apparently only because of a fiftieth of a second delay that is added to enable the picture to be enhanced. As the blitter and SPARC technology improves, these enhancers will inevitably start appearing in televisions and videos, and will provide the facilities for the real-time image improvement necessary to remove transmission noise from the video signal. With the video system Sun provides, its workstation is becoming an important platform in the research and development of such technology.

Sun has also pioneered what is now being referred to as 'Display PostScript' Sun's Network/extensible Window System (NeWS) is the only production version of 'Display PostScript' available at present and allows for true WYSIWYG, especially as the screen resolution of the Sun monochrome monitor provides a display of approximately 115 dots per inch.

NeWS is different from Adobe's announced version of Display PostScripts because it is both a read and write language. It allows the user both to view a PostScript image description, and also to alter and rewrite it back as a PostScript file. NeWS is also a PostScript interpreter, so application developers can add new features and functions dynamically to the NeWS system itself. But its biggest advantage is the fact that it is completely device, media and resolution independent, and any NeWS application will run on any NeWS-supporting machine without modification.

In the future, the devolution of processing power will be more clearly defined, with video coprocessors or 'blitters' taking on more responsibility for the video interface. This will free the main processor from the usual time-consuming memory transfer operations and will provide more raw processing power for the useful operating code.

Ten years ago, when the research team at Xerox's Palo Alto Research Centre was developing the WIMP interface, the machine they used cost more than $150,000. Implementing their research fully in a production machine has taken 10 years of technological advance and innovation, and only now are such systems becoming a marketable reality.

**Andy Redfern**

Unlike larger Sun systems, there is no graphics accelerator hardware on these boards. The speed of the displays comes from the performance of the 32-bit P4 bus and the high overall processor throughput, and this should give encouragement to those PC graphics board makers toying with the idea of building 32-bit Micro Channel boards using graphics coprocessors like the TMS34010 and Intel 82786. We are already beginning to see 16-bit VGA-compatible boards from companies like Paradise Systems, giving display performance superior to that of conventional 8-bit VGA and EGA boards, and 32-bit boards are only a matter of time.

It is obvious that Sun has stripped some features from the main board to cut the price of the system and get everything on a single board. There is no dedicated cache RAM, for instance, though Sun called the static RAM architecture 'cache without the cost', and the monochrome graphics hardware normally included on Sun processor boards is missing. The processor board can only act as a VME master rather than a master or slave, so the implementation is really only a subset of standard VME.

The SCSI hardware on the board is new, but is a downgrading from Sun's normal ESMD controller which transfers data at 2.4Mbytes per second and comes on a separate VME board in larger systems.

In fact, there is nothing on the board that has not already been included on existing high-end PC and Macintosh systems, apart from the fast RISC processor made possible by the fact that Sun does not have to be MS-DOS or Macintosh Toolbox compatible.

It is interesting to see the personal computer manufacturers adopting as many of Sun's workstation techniques as they can afford to build in, and equally interesting to watch Sun giving way a little on performance and moving back


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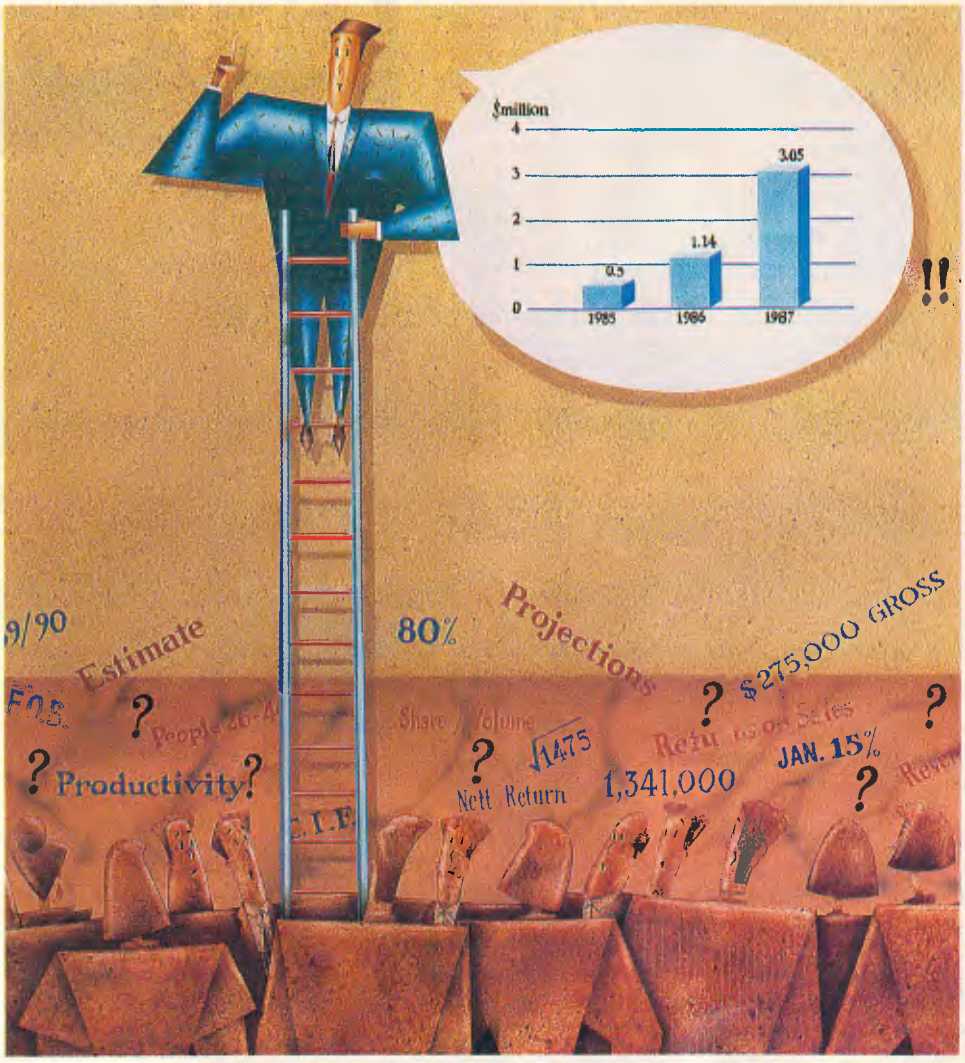


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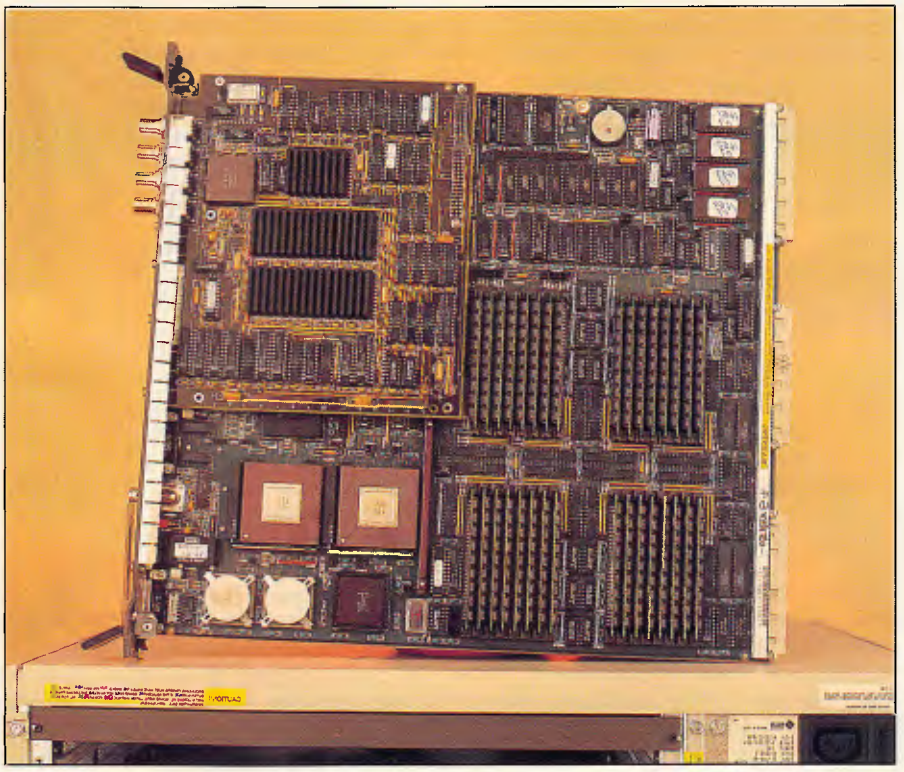
## System software

All workstations use Unix, and the 4/110 is no exception. Sun's SunOS is what the company calls 'Converged Unix', and is built up from AT&T Unix System V with the Berkeley 4.2BSD extensions to facilitate network connectivity and software development. On top of that — literally — Sun offers three windowing front-ends, SunView, X-Windows and NeWS, which are fully discussed in an accompanying box.

Hard-core Unix users with their own software using their own user interfaces will find no surprises here, and will be able to run their packages using all the familiar Unix commands and file structures after recompilation.

Programs can be recompiled using the 'cc' command in normal Unix style, and Sun also offers 680x0-to-SPARC and SPARC-to-680x0 cross-compilers. Apart from the inevitable C, compilers are on offer for VMS Fortran, Pascal, Sun Common Lisp, and Modula-2.

As usual, it is striking to find that raw Unix is not as unfriendly as it is made out to be for those familiar with MS-DOS versions 2.0 and above. The hierarchical directory structure in MS-DOS, for example, and the way it is controlled with MD, CD, and RD, was taken directly from Microsoft's Xenix implementation of Unix. The only difference is that ordinary forward slashes are used to separate directory path names in Unix, and backslashes in MS-DOS.



*The main board of the 4/110 slides out on rails from the casing. The SPARC chipset is on the lower right. The chips with large heatsinks are the Weitek coprocessor chips, and a frame-buffer daughterboard is at the top right*

In normal use the 4/110 user is shielded from Unix by SunView and the SunTools system command options, but it is nice to know that there is a fully-compatible underlying structure.

The SunLink connectivity options can link to IBM, DEC and other systems using SNA 3270, BSC 3270, X.25, BSC RJE, LU6.2, Channel Adaptor, OSI, DNI,

## Sun 4/110 SPARC Processor

The Sun 4 series workstations are all powered by a new proprietary 32-bit processor called the SPARC (Scalable Processor ARChitecture). SPARC is a Reduced Instruction Set Computer, or RISC, of formidable processing power. Sun claims that SPARC can perform seven times as many integer operations per second as a VAX 11/780 minicomputer, and five times as many floating operations when its floating point coprocessor is used (in acronymic jargon, that's 7 VAX MIPS and 1.1 Linpack MFLOPS).

The acceptance of the RISC design philosophy for high-performance computing applications has been one of the more remarkable stories of the past decade. Three years ago there were no commercially available RISC chips, and the idea was considered to be somewhat academic and highly controversial.

Now it is hard to imagine any new processor design that does not at least pay lip-service to RISC principles. As well as Sun's SPARC, we have seen IBM's RT processor, the Acorn ARM which powers the Archimedes, Hewlett-Packard's Precision Architecture, the MIPS processor, and more. Though not a 'pure' RISC design, the Inmos Transputer has been influenced by a similar philosophy, while Motorola's new 78000 family will be true RISCs. Only Intel seems still committed to the rococo style of processor design.

A Reduced Instruction Set Computer is one which employs very few fast primitive instructions rather than many complex powerful ones. In the early days of the microprocessor, the architecture was decided mainly by what the silicon technology could handle, and what would fit was what you got. Then, as new generations of processors emerged, the tendency was to incorporate all the instructions of the previous generation (for software compatibility) and then add some new ones. These new instructions were often more powerful or high-level to make life easier for Assembler programmers, and would do quite complicated things to data in main memory, like block-moving bytes or searching for a particular byte value.

Consider the Intel 8080 chip used in the very first personal computers, which had about 80 basic instructions: it was displaced by the upwardly compatible Zilog Z80 which has 256 instructions. Efficient memory usage was another design goal. A complex block-move instruction might occupy only a couple of program bytes, while it replaces a loop that takes dozens of bytes.

The first RISC design was the 801 minicomputer developed by IBM research labs in 1975. The researchers noticed that most computers, regardless of their instruction sets, spend most of their time executing a handful of relatively simple instructions. Thus, if these were made very efficient, overall throughput would increase. The 801 was never marketed but the work lives on in the current PC/RT. Then, in 1980, student projects at Berkeley and Stanford universities produced RISC microprocessor designs with startling performance. The second Berkeley chip (RISC II) with an 8MHz clock ran integer C programs faster than a 12MHz 68000. From 1983 onwards Sun Microsystems sponsored the Berkeley group under Dr

*Continued next page*

and TE100 standards; while the Open System Network environment combines Sun's NFS network system, Yellow Pages, REX Remote Execution, Sun-Link, X-Windows and NeWS.

## *In use*

Setting up the 4/110 for single-user operation is as simple as setting up a PC. The thick RGB cable, with separate RGB and Sync BNC connectors, hooks the monitor to the system unit while a simple SCSI cable connects the system unit to a storage shoebox. The shoebox is powered from the system unit, while the monitor requires a separate power cable of its own.

The keyboard, with a three-button Mouse Systems optical mouse coming out of the back of it, goes into its own socket. Then, turning on the power boots the system, either over Ethernet or from the local shoebox, depending on the configuration, and produces a big, blank, white screen with — on the review system — a 'camelot#' prompt. Quite why 'camelot' was used is a mystery. After the usual Unix login procedure, raw Unix is ready and waiting for use.

Typing 'suntools' starts the SunView user interface, which for most users will be all they see.

The black-on-white monochrome display of the 19in RGB monitor is impressive, with none of the graininess that often goes with displaying monochrome graphics on colour PC screens. In pure text mode outside SunView the display actually looks sluggish in putting text up on the screen, since each character of the default system font is drawn pixel by pixel and there are a lot of pixels involved. But SunView itself snaps windows open and resizes and moves them with a certain amount of vim, at around the speed of a Macintosh SE and slower than a Macintosh II. That difference is understandable, since SunView sits on top of the operating system, like Microsoft Windows, rather than acting as a fundamental part of the system software.

The startup options that can be used with SunView allow the user to choose which Tool programs should be loaded as defaults, set the foreground and background colours using any of the 16 million-plus available colours, and select a custom desktop pattern rather than the normal 50 per cent grey tone. These are the kinds of options that are available from the Control Panel in Macintosh systems, and allow users to customise their desktop machines as they wish.

Other features of SunView are also now appearing in the personal computer market. SunView can run using several monitors at once, giving a much larger effective desktop, just as the Macintosh II can — but not quite as effectively, since windows cannot extend across screen boundaries and items cannot be dragged from one screen to another. However, one thing SunView *can* do that the Macintosh can't is divide a single screen into separate monochrome and colour regions, each capable of being used independently.

Another interesting feature is that colour windows can be overlaid on the monochrome desktop, using the full 256 colours available for simultaneous display. But if one colour window uses 256 colours, and then a second colour window is opened, the colours will be 'false' in the second window, like an astronomical photograph or some flashy video effect. However, moving the mouse pointer into the new window corrects its colour display, sending the original window into false colour mode. This is a visually disturbing but neat solution to the limited choice of simultaneous colours available for display.

The real power of the 4/110 is not really apparent when a single task is being run under SunView, since it does appear slower than a Macintosh II, for example. But, when several processor-intensive tasks are loaded and run in different onscreen windows, it is easy to see what the system can do. With several copies of a single graphics image redrawing continuously in the windows, it was still possible to bang away on the keyboard, putting text into an editor window, with hardly any visible slowdown. If OS/2 can deliver this level of multi-tasking performance, it will be surprising.

The Sun keyboard is odd, with a total of 34 function keys arranged at the left end, right end, and across the top. The top row of function keys is squashed right down on top of the numeric row, making for typing errors, and the positioning of keys like Del, backspace, and backslash is unhappy and unfamiliar. Four of the right-hand function keys can operate as a cursor control diamond, but there is no separate cursor

David Patterson and SPARC is directly descended from the RISC II chip.

The RISC philosophy involves several trade-offs. RISC programs must use more of the simpler instructions, and the instructions themselves tend to be bigger since they contain a lot of the control information that would be stored in microcode ROM in a conventional, processor.

SPARC architecture is typical of modern RISC thinking. It has only 50 integer instructions, most of which execute in a single clock cycle and work on data held in registers. It employs 32-bit data paths throughout and a high degree of pipelining (overlapping execution of successive instructions). Branches and jumps are delayed until after the next instruction has executed to avoid pipeline breaks.

SPARC has its Floating Point Unit on a separate chip in the current implementation, but in future versions all may be put on to one chip. The CPU extracts all floating point instructions from its instruction stream and puts them into a queue for processing by the FPU, which runs fully concurrently. It's possible to add extra FPUs in a pipeline to increase floating point performance.

SPARC is a 'load/store' architecture which means that load and store instructions are the only ones which may access external memory, all arithmetic and logical instructions being confined to the contents of registers.

The current SPARC chip has 120 registers organised into 'windows' of 24 registers each (future chips may have even more windows). These windows are addressed as if they were arranged in a circle and only one window is active at any given time. Each window consists of three kinds of register: eight IN registers, eight LOCAL registers and eight OUT registers. Successive windows overlap so that the OUT registers of window 1 are the same physical locations as the IN registers of window 2, and so on. So, values can be 'passed' from window 1 to window 2 by simply switching windows, with no actual movement of data. These register windows correspond to the parameters used in procedure calls in high-level languages like Pascal and C, and so procedure call and return becomes very efficient.

The significance of the 'Scalable' in 'Scalable Processor ARChitecture' is that the simplicity and low device count of RISC designs means that they can be reduced in size without a major redesign and the possible introduction of more bugs, which is not typically true of complex designs like the 80386.

Sun hopes that its new architecture can be given a long life (and so become an industry standard) by implementing it in new high-speed technologies, such as gallium arsenide, as they become commercially viable.

Sun quotes the following performance figures for different manufacturing techniques. Fujitsu, using 1.5 micron silicon, achieves 7-10 VAX MIPS. These are the chips in the 4/110. Cypress Semiconductor, using custom CMOS technology, can extract 20 MIPS; and Bipolar, using its own ECL integrated technology, can expect 40 MIPS.

In addition, Sun jokingly refers to the 'SPARCinTOSH' and 'SPARCinCRAY' to emphasise that, by changing the levels of implementation and integration of its architecture, it can beat the price/performance of machines at both ends of the computing scale.

**Dick Pountain**

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# Sun 4/110 Operating System

The choice of Unix as the operating system for workstations has some good technological reasons behind it as well as marketing reasons. First, it is a portable operating system that can be ported to any processor that the workstation manufacturer happens to use — from the 68020 to the SPARC in Sun's case, or to the Xerox-designed Mesa in its 6085 workstation, say — without affecting applications software compatibility. Second, Unix is well-suited to the 32-bit 68020 architecture used in the majority of workstation designs. The 680x0 family uses a linear memory-addressing architecture, regarding memory as a single enormous lump of storage, rather than the segmented memory-addressing scheme of the Intel 80x86 family. This in turn means that a multi-tasking operating system like Unix does not need to keep track of multiple memory segments when manipulating concurrent 'processes'. And third, the lack of memory management functions in the 680x0 chips means that the operating system needs to control the context-switching between multi-tasking processes — and Unix does that handily.

Of course, the marketing considerations helped too. Unix is particularly strong in the engineering and academic markets, usually on DEC hardware, and the workstation makers had a good story to tell if they could offer Unix compatibility on a single-user machine at sub-DEC prices. Even now, the main markets for workstations are engineering CAD and academic artificial intelligence research.

The version of Unix used on the Sun 4/110 is a 'Converged Unix' called SunOS, which is actually the Berkeley 4.2BSD version with enhancements from 4.3BSD and the addition of AT&T System V compatibility in the kernel, libraries and utilities. In most cases the 4.2BSD and System V functions can be combined, but when incompatibilities do arise, Sun provides separate System V functions in separate libraries so that programs can be written compatible with Berkeley System V, or use functions from both to work with the converged Unix. Now though, Sun and AT&T have jointly announced a new Unix version, a unification of SunOS and System V, that will include an Application Binary Interface (ABI) to hook Unix applications into the operating system. This should work in the same way as the Application Program Interfaces (APIs) for network operating systems like Novell's NetWare, which allow developers to write software adhering to the interface and leave the operating system to handle the low-level technicalities of particular hardware configurations.

Perhaps the ABI will help to standardise the confusing world of workstation Unix implementation. So far, the differences between the different flavours of Unix led the workstation originators to adapt, modify and merge the flavours to produce their own proprietary operating systems. SunOS is one example; a more extreme one is Apollo's Aegis. However, there now seem to be moves towards standardisation based around AT&T's Unix System V 3.2, with Apollo announcing that its new operating system will merge Aegis, 4.3BSD, and the new System V so that software written for any or all of these flavours will run simultaneously on the same workstation.

There is no doubt that the next generation of personal computer hardware will need a flexible and portable 32-bit multi-tasking operating system that can handle the wide variety of processors, system architectures, and input and output devices that will be used. And Unix proponents will say that that is exactly what Unix is. But, for Unix to succeed in the mass market, it needs to provide assurances that every Unix application will run on every Unix system, and also needs a simpler command-line interface and a standardised graphics-based front-end to let users handle a Unix system without ever seeing Unix unless they want to.

The application compatibility seems to be coming, thanks to the improved communication between AT&T and other Unix suppliers about standards, and the promise of unified versions such as Posix. But the chances of altering the command-line interface are slim, given the strength of the Unix hackers' devotion to 'grep', 'ls', and the rest of the cryptic Unix command lexicon, so the graphical user interface is the most important need at present.

Fortunately, there are signs that Unix-based windowing systems are also heading towards standardisation. The Sun 4/110 comes with three such systems: Sun's own SunView, MIT's X-Windows, and NeWS, an implementation of Adobe's Display PostScript design. And Sun is planning a merged system combining NeWS and X-Windows for launch later this year.

The advantage of NeWS and X-Windows is that they are standards available to all. Display PostScript, which makes graphics output independent of the hardware used to display it, is being offered around the computing business and has already been signed up by Steve Jobs' NeXT workstation company as well as by DEC. And X-Windows, originally developed at MIT as part of its Project Athena plan to network various bit-mapped workstations, is now in revision 11 and is available from just about every workstation manufacturer.

All three windowing systems on the Sun range are so-called 'client/server' types rather than kernel-based systems like Apple's Macintosh Toolbox. The window manager software runs as just another Unix process, and other running processes send requests to the window manager server to get access to the display and input devices to the hardware. This method is ideal for network use, where programs running on a remote machine can get access to the window manager running on another. As far as the user is concerned, the program is running in a window on the local screen, even though it may physically be running on a machine a continent away. Doing it this way means that a user can distribute processing tasks to the network machines that best run them, for example, with Sun 4/110 systems, mathematics-intensive applications would be best run on a machine with the Weitek coprocessor set installed. With a client/server window manager, only one machine in a network would need to have this set for all other users to be able to run those applications on it, and display the results on their own screens.

But whatever the networking standard employed, the user interface on Sun systems resembles the original Xerox PARC windowing techniques more closely than the Macintosh and Microsoft Windows do. Some of the features are the same, notably the use of overlapping windows that can be moved and resized at will, and the use of a 'desktop metaphor' with icons representing applications and files. But some are very different.

Taking the standard SunView environment as an example, the most obvious difference is the way menus are implemented. Instead of having a menu bar at the top of the screen or in every onscreen window with pull-down menus attached, SunView implements the original Xerox scheme of pop-up menus at the mouse pointer position. Pressing the right-most of the three mouse buttons pops up a menu dependent on that mouse position: if the pointer is in a window, the menu refers to the applications running in that window, while on the desktop it refers to the system-level tools.

Another feature is what Sun calls 'walking menus', where small arrows next to a menu item indicate that sub-menus exist, and selecting an arrowed item pops the sub-menu up to the right of its parent.

Interestingly, Apple has implemented this walking menu scheme in its latest Macintosh system software versions, and there are even public-domain software packages that implement mouse-position pop-up menus on the machine. However, with MultiFinder, it looks as though Apple will not implement this officially.

Other SunView features are more familiar. For example, clicking and holding down the left mouse button while pointing at a window's title bar allows that window to be dragged to a new position; and, as with the Macintosh, the re-positioned window remains empty while the system figures out what information needs to be rewritten to the new position. But closing a window, resizing it or zooming it to full-screen size must be done by popping up a control menu associated with the title bar and choosing the appropriate command from it; there are no close, zoom, or resizing icons attached to windows. Starting an application from the desktop is done either by typing a command into the command-line interface in a Unix shell window, or by specifying the applications to load automatically at start-up time. If an application is loaded it can be reduced to an icon on the desktop, and re-opened into a window by a single click of the left mouse button.

In general, the SunView system is simple to learn and use, although the use of a three-button mouse is sometimes confusing to

*Continued on page 47*

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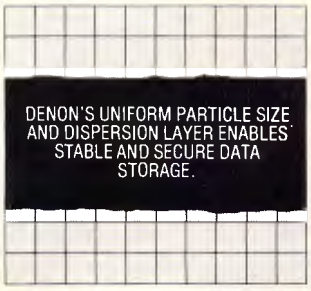

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those used to the single-button control provided by the Macintosh and now by Microsoft Windows. But there are things that Sun could learn from the personal computer windowing implementations, notably simple cut-and-paste of text and graphics between windows, a non-menu-based window size control, and the ability to activate a window simply by clicking on it rather than by selecting an implicit 'Un-hide Window' command from a menu.

And again, the windowing system looks slow compared with the personal computer competition, particularly when it comes to updating resized or repositioned windows. However, SunView scores heavily over the competition when it comes to configurability, as anything in the user interface can be changed at will.

What the personal computer business has to learn from windowing environments like SunView is the method of windowing applications running over a network with interprocess communications between windows, and the superior configuration options provided as standard. There is no doubt that client/server windowing systems running on top of a networked multi-tasking operating system that may or may not be Unix, are on the way in the personal computer market.

**Peter Jackson**

pad and no numeric pad either. But in use there was little problem, since the mouse control is extensive and the Mouse Systems mouse is accurate and light to the touch.

Indeed, the whole machine feels powerful and can be used without worrying about memory or storage limits. The benefits of big RAM capabilities and big hard disks, combined with a lot of processor power, become obvious in true multi-tasking environments.

## Conclusion

If you take all the architectural innovations of recent high-power PCs, it soon becomes clear that Sun has been using them and improving on them throughout its history. With the 4/110, however, it has come closer to producing a machine that shows a direct lineage from the personal computer and closes the price gulf between PCs and workstations. Some of its electronic features are already in use in PCs, and others, like enormous RAM capacities and extra-high-resolution mixed colour and monochrome bit-mapped displays, soon will be.

This type of machine is the future of personal computing — and the future is closer than you might think.

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# Canon BJ-130

***Following hot on the heels of Hewlett-Packard's announcement of its Deskjet bubble jet printer, is the BJ-130 from Canon. Expected to be available next month, it offers in excess of 300 dots-per-inch for less than $2000. This new technology is set to compete heavily with laser printers, as Simon Jones explains.***

The Canon BJ-130 Bubble Jet Printer is a remarkable machine giving laser printer quality for the price of a good 24-pin dot matrix. The basic technology is not new. Printers that fire jets of ink onto the paper have been around for a few years, but this is the first one to give such high-quality output.

In this review, however, as well as considering the quality, I was looking for ease of use, useful features, speed, and how easy the printer is to set up, all from

the point of view of a person who uses a PC for business. To carry out the review I used an IBM PC compatible running WordPerfect 4.2.

To show how good the image from a BJ-130 is, compare it with an ordinary impact dot matrix printer. On a 9-pin printer the pins are arranged in one column of nine. A 24-pin printer has two columns of 12 pins each in the same space, which gives a much better quality output. The BJ-130 has one column of 48 nozzles giving print of such high quality that it is almost indistinguishable from that of a daisywheel printer. The highest graphics resolution obtainable on the BJ-130 is an impressive 360 dots per inch: most laser printers under $10,000 can manage only 300 dpi.

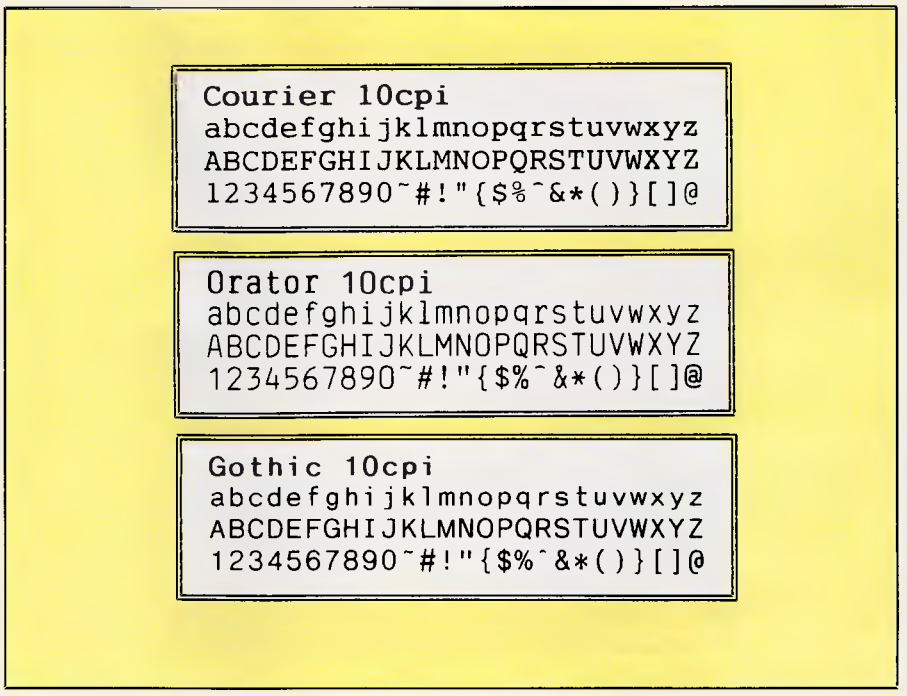
Most ink-jet printers use piezoelectric crystals to squirt the ink onto the paper. These crystals expand and contract when an electric current is applied to them, and this movement is used to squeeze ink onto the paper. Unfortunately, the crystals have to be a reasonable size in order to do their job. This limits the size of the print head and the packing density of the print nozzles.

However, a happy accident in Canon's Japanese laboratory in 1979 showed a way to create a print head with no moving parts.

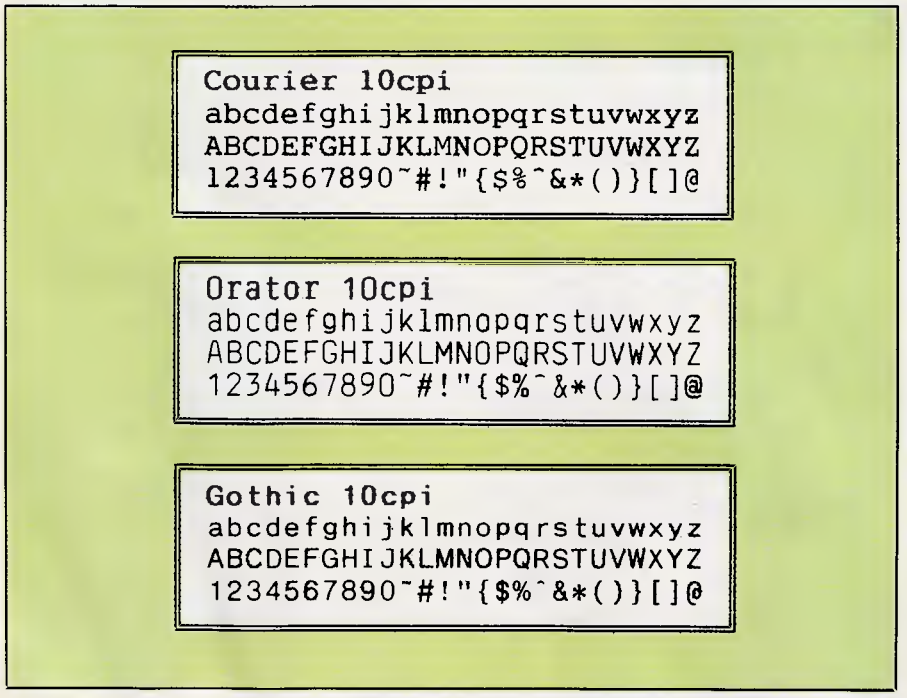
The BJ-130 is called a bubble jet printer because bubbles of ink vapour are used to force liquid ink out of the print head. Each of the 48 nozzles has a heating element built into the nozzle wall. When the element is turned on, the ink touching it boils momentarily, making bubbles. These bubbles force a drop of ink to be fired out of the open end of the nozzle. The heating element is then turned off and the surrounding ink cools the vapour in the bubble, making it collapse, drawing fresh ink into the nozzle. As the print head moves across the paper, the heating elements are fired in sequence to form the letters or graphics required.

The bubble jet print head is cheap and simple to make as it has no moving parts. This also means that it can be smaller, giving more closely-packed nozzles and better print quality. One of its biggest advantages is that it is very quiet. The only noise it makes is the movement of the paper and the print head.

There is one distinct disadvantage, though: you cannot produce carbon copies. If you need two or three copies of a document, you must either print it once and photocopy it or print it two or three times. Luckily, the BJ-130 is quite quick. Canon quotes 110 cps in High Quality (HQ) mode and 220 cps in High Speed (HS) mode.



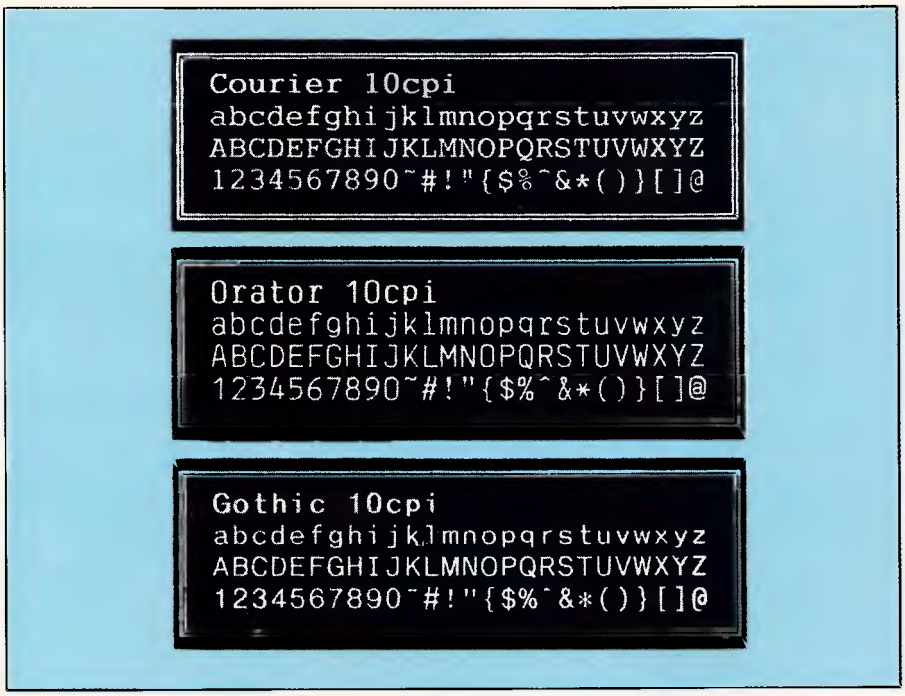

*Courier is the resident font on the BJ-130; while Orator and Gothic will be available as plug-in cartridges. Canon also plans to make a number of extra fonts available in the near future*



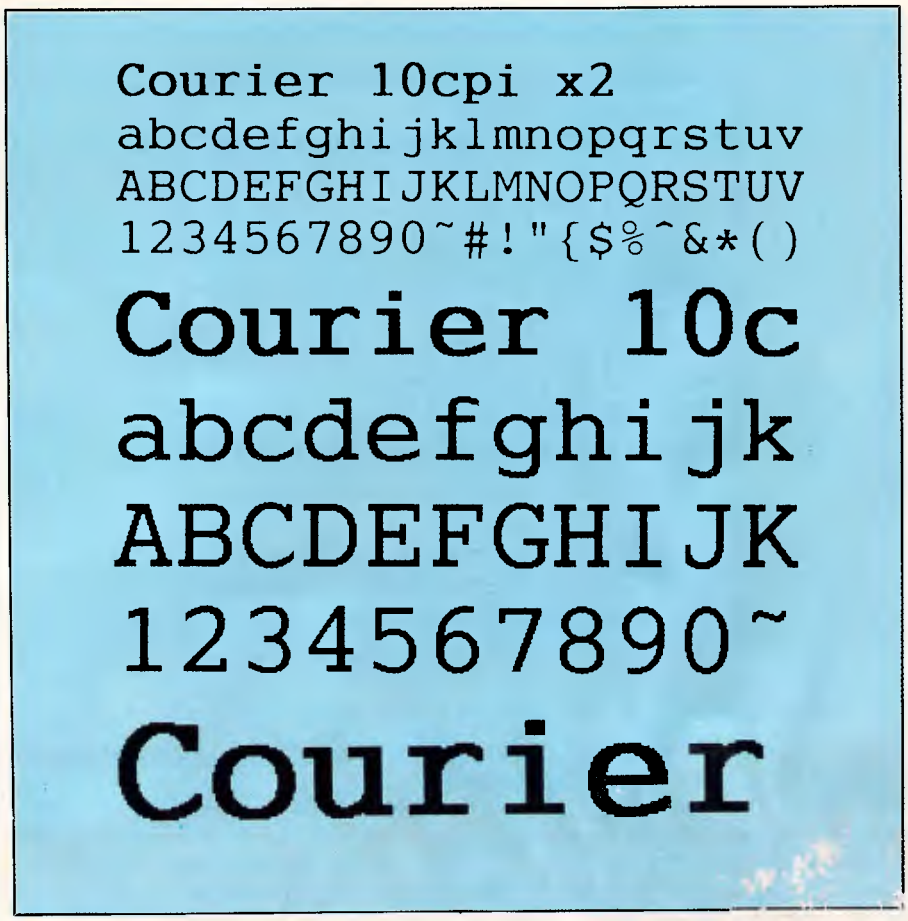

*An escape code enables the BJ-130 to print different shades of gray tint behind text, potentially very useful for desktop publishing*

The BJ-130 is a wide-carriage printer taking paper up to 16 inches wide. It comes with a cut-sheet feeder as standard; tractor feed is an optional extra.

Having a wide carriage means that this printer can take A4 paper both lengthways and sideways. The sheet-feed hopper can take about 100 sheets of 80 grams per square inch (gsm) paper. Ordinary photocopying paper works fine. The manual recommends using plain bond paper of between 52




*Unfortunately, bubble jet technology is no better at printing solid black than most dot matrix printers, suffering the same characteristic 'streaky' gray lines*




*Using the expand button or escape codes it is possible to increase the size of type by two, four or six times. However, no attempt is made to smooth curves*

and 81 gsm, which may lead you to think that using thicker paper or paper with a fancy surface may cause problems. In fact, I had no trouble at all using 100 gsm laid paper. (Laid paper has a rough surface and is often used for letterhead notepaper for business.)

One font, Courier, is supplied as standard and there are two slots for optional font cartridges under a flap on the front. I was supplied with three font cartridges to try: Orator, Gothic and Gothic Outline. Although there are only two slots, you can have three extra fonts in the machine at once. There is a simple way to copy one font cartridge into the printer's RAM and then replace that cartridge with another one, thus giving you four different fonts to work with. The printer's RAM is volatile, however, and will lose its contents when the printer is switched off.

All fonts can be printed at 10, 12 and 17 cpi and can be proportionally spaced. You cannot use the term NLQ (Near Letter Quality) to describe the output of this printer because even when it prints at its fastest speed, it produces perfectly-formed letters. The only difference between HQ and HS modes is that the print is darker in HQ mode. There is no special draft-quality font. The high speed option merely prints characters as an 18x48 matrix rather than the high-quality 36x48 matrix. This is done by moving the print head twice as fast across the paper and printing only every other column of dots. Both fonts and pitches (character counts) can be selected from the control panel, as can other features.

The control panel consists of seven 'buttons' and 14 LED indicators (the buttons are really just coloured areas on the smooth plastic surface). The switch mechanisms are underneath and give a little click when you press the buttons. One of the buttons is marked SHIFT and this changes the function of the other buttons. Thus the MODE button, which switches between HS and HQ modes, becomes, when the SHIFT button is on, the FONT button and chooses between the built-in font, the two font cartridge slots and the font RAM.

The REVERSE button makes the printer print white letters on a black background, and the SHADING button gives a pale gray wash under the letters. Both these facilities can, however, leave plain white spaces between the lines of print. This can be cured by printing at eight lines per inch rather than the more usual six, by enclosing the print in box characters.

The EXPAND button allows you to expand the print to two, four or six times

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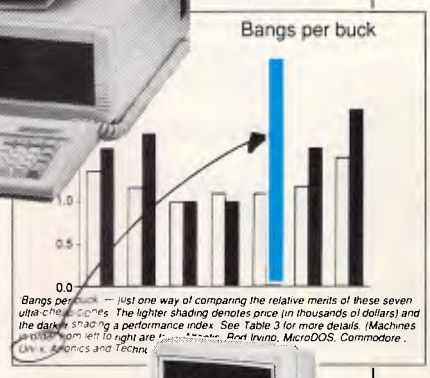


*Bangs per buck — just one way of comparing the relative merits of these seven ultra-cheap clones. The lighter shading denotes price (in thousands of dollars) and the darker shading a performance index. See Table 3 for more details. (Machines [illegible] from left to right are [illegible], Bod Irvino,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

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***Processor.***

[illegible] NEC. The Uni-x contains a NEC V20, manufactured by Sony.

[illegible] Thus a V20 running at 4.77MHz will outrun an 8088 running at the same clock speed. [illegible] machines examined provided a standard PC clock rate of 4.77MHz as a minimum, although the Uni-x delivered higher than standard performance even on this clock rate by virtue of the V20. The Atlantis and [illegible] machines [illegible]

***Performance.***

[illegible] The Uni-x is fastest overall, providing a 50 per cent boost over the Technology Interface due to the V20.

***Display.***

[illegible] and the Uni-x is delivered with a nice INTRA tilt/swivel amber screen. The [illegible]

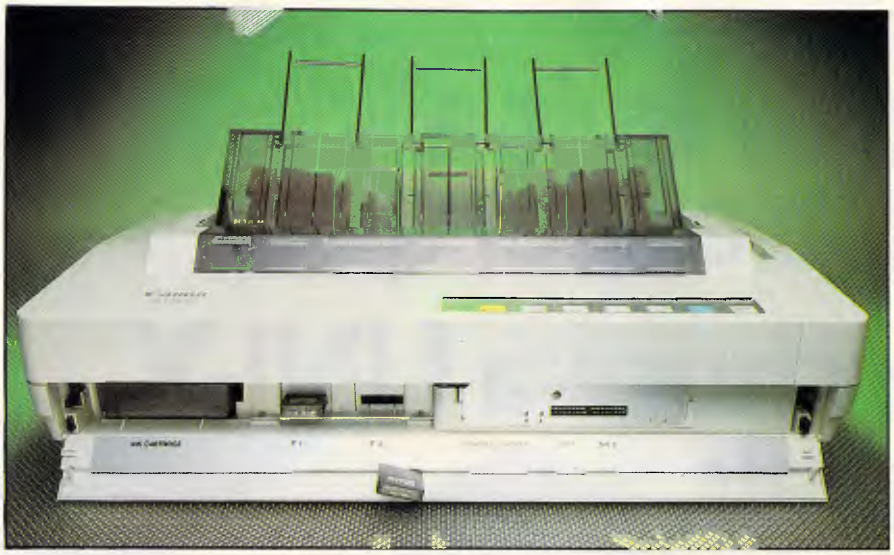
***Cost Effectiveness.***

[illegible] As you migh expect, the do-it-yourself Uni-x comes up trumps with its low cost and relatively high performance. [illegible]

***Specifics.***

[illegible] The Uni-x features a delightfully small motherboard. It has employed a VLSI component to replace the Intel 8253 timer, 8255 PPI, 8237 OMA controller and several other components. This reduced the component count and a simplified motherboard serves to reduce costs.

. . . see for yourself in the full Report in the October '87 issue, or ring us for a copy.



*Most routine operations such as changing ink cartridges, setting the DIP switches and installing new fonts can be accessed via a fold-down panel*

its original size, horizontally and vertically (that is, four, 16 or 36 times the area). The characters are still made from a 36x48 matrix so expanding them to more than twice their size does tend to show jagged edges. However, that apart, it is still a useful facility for producing signs and large labels quickly and cheaply.

There is a button marked CLEANING which will remove paper particles and dust which may have accumulated on the print head. You need to use this feature only if the printout has missing dots or the printer hasn't been used for some time.

There are LED indicators for most things on the control panel, including INK. One ink cartridge should last for about one million characters of HQ print — approximately 800 pages. Once the INK indicator lights up, you can only print about 10 lines more before you have to change the cartridge. Changing the cartridge is a very simple job, much easier than changing a ribbon on a daisywheel or dot matrix printer. But, clearly, it always pays to have a space cartridge handy. Cannon has no pricing details as this issue went to press, but our estimate is that they will sell for around $30.

Setting up the printer is quite simple. You clip one plastic panel into place to form a paper rest for the sheet feeder, two metal guides clip onto the front for some unknown, possibly decorative, purpose, and that's it. Loading paper is simply a matter of putting some in the sheetfeed hopper. The ink cartridge and font cartridges slide easily into place and the parallel interface cable plugs in the back.

Unfortunately, Canon could not supply me with the DIP switch setting information. There are two banks of 10 DIP switches under the front flap, which control the default settings for MODE and FONT, paper length, and so on. This vital information will be contained in the manual when the printer becomes available.

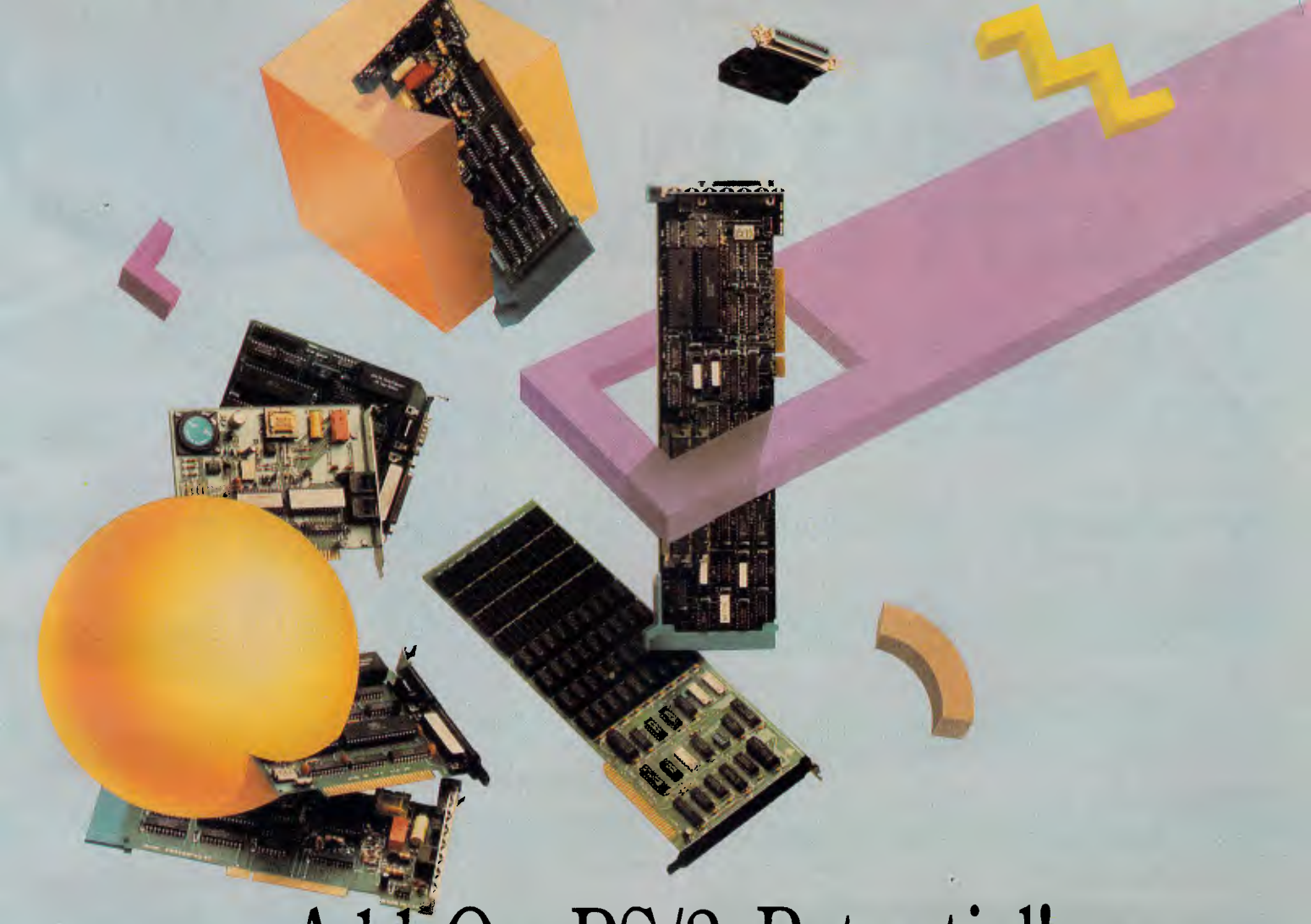
Many word-processing packages now have drivers for 24-pin printers and, as this printer emulates a 24-pin printer, you should be able to get it to work with your WP package without too much difficulty. I use WordPerfect for all my word processing, and it incorporates a utility which allows you to create your own printer driver routines as well as modify existing printer drivers.

To use the PRINTER utility you must have full details of the control codes the printer responds to. As the manuals for the BJ-130 were not ready when I was testing the printer, I could not construct a full printer driver for it.

It did respond to the driver routine for the IBM Quietwriter but, as the Quietwriter has only one font, I was

## Technical specifications

| | |
|---|---|
| **Price** | N/A (but expected to be under $2000) |
| **Dimensions** | |
| Height | 122 mm |
| Width | 610 mm |
| Depth | 347 mm |
| Weight | 11 kg |
| **Paper** | |
| Minimum Width | 4 inches |
| Maximum Width | 16 inches |
| Maximum Thickness | 1 sheet (<=0.2 mm) |
| **Maximum Line Length** | 272 chars at 20 cpi |
| **Ink Cartridge** | |
| Life | 1 Million HQ chars |
| Cost | N/A (but expected to be approximately $30) |
| **Number of Fonts** | |
| Standard | 1 |
| Optional Extras | 4 |
| Cost | N/A |
| **Quoted Speeds** | |
| High Speed 10 cpi | 220 cps |
| High Quality 10 cpi | 110 cps |
| **Input Buffer** | 32k |
| **Sheet Feeder** | Standard |
| **Serial Interface** | Optional (#50) |
| **Tractor Feed** | Optional (#40) |



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### PS/2 Product Selection Chart

| PRODUCT | FEATURES | PS/2 MODEL | | | | |
|---|---|---|---|---|---|---|
| | | 25 | 30 | 50 | 60 | 80 |
| Memory | EMS Memory | ■ | ■ | | | |
| I/O | Parallel and Two Serial Ports | ■ | ■ | | | |
| I/O (Game) | Game, Parallel and Serial Ports | ■ | ■ | | | |
| Multifunction | Extended Memory, Simulated EMS Memory, Parallel and Serial Ports | | | ■ | ■ | |
| Modems | Internal (1200/2400 baud) | ■ | ■ | ■ | ■ | ■ |
| | External (1200/2400 baud) | ■ | ■ | ■ | ■ | ■ |
| Connectivity | Format Converter | ■ | ■ | ■ | ■ | ■ |
| | ZuckerLINK | ■ | ■ | ■ | ■ | ■ |
| Electronic Imaging | 320 × 240 Resolution | | | ■ | ■ | ■ |
| | 640 × 480 Resolution | — | | ■ | ■ | ■ |

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restricted in the number of facilities I could use. Canon says that the BJ-130 will emulate an IBM Proprinter and an NEC Pinwriter if you set the DIP switches correctly.

The Canon BJ-130 is completely silent when idle, and is so quiet in use that when I first used it I thought there was something wrong with it. Canon quotes the noise level as being under 48dBa, roughly half as loud as a conventional dot matrix printer. There is a quiet whine as the print head moves across the paper and small clunks as the paper moves through the printer. When you first turn the printer on, when software sends it a reset code, or, about 20 seconds after it has finished printing, the printer makes a strange whirring noise. This is the sound of the print head being capped or uncapped. The print head must be kept capped when it's not in use.

The print head lives, when it's not printing, hidden away at the lefthand side of the printer and, unlike impact dot matrix printers, there is no flap or cover giving easy access to it. This is not, however, a problem as there is no ribbon to change.

## Documentation

The lack of a finished manual caused some problems when I was trying to write the review, but, from what I did see of it, it is fairly well-written with clear explanations and diagrams. It comes in two parts. The first part is a *User Guide* which contains details of setting up and operation, including how to load the paper and change the ink. The second part is the *Programmer's Guide* which lists all the control codes, and is vital to those who need to write their own printer driver routines. The *Programmer's Guide* wasn't available at the time of writing, but if it's as clear as the *User Guide*, it should be OK.

## Conclusion

All in all I was impressed with the Canon BJ-130. It is a nice machine to work with and blissfully quiet — and should be available next month.

If you can forgive the lack of carbon copies, it is a good machine for those who want high-quality printing at a reasonable price. It is certainly cheaper than a laser printer, faster than a daisy-wheel and quieter than a dot matrix. I'd buy one.

END

*Canon is on (03) 200 6 30.*


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| In Modem 1234 | $860 |
| In Modem 1200 | $510 |
| In Modem 2400 | $730 |
| Automodem 12/12 | $545 |
| Automodem 123 | $695 |
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| Miniscribe 20MB with cont | $660 |
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| Teac 1.2MB drive | $249 |
| 3.5 inch internal drive | $249 |
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|---|---|
| Tiko EGA with EGA Card | $999 |
| Tatung EGA with EGA Card | $999 |
| ADI PX22 EGA with card | $999 |
| ADI 12" Mono | $188 |
| ADI 14" Mono | $239 |
| Tatung 12" dualscan mono | $189 |
| Tatung 14" dualscan mono | $249 |
| Nec Multisync I | $999 |

## PRINTERS

| | |
|---|---|
| Star NX-1000 | call |
| Star NL-10 | call |
| Star NL-15 | call |
| Star NX-15 | call |
| Star NB 2410 | call |
| Star NB 2415 | call |
| Fujitsu DX2400 | $950 |
| Fujitsu DX2300 | $740 |
| Fujitsu DL3400 | $1290 |
| Fujitsu DL2400 | $1440 |
| Fujitsu DL2600 | $1950 |
| Olympia NP30 | $460 |
| Citoh A10-30 Daisywheel | $370 |
| Comx PL-80 plotter | $450 |
| Citoh Color thermal printer | $300 |

## PERIPHERALS

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| Ega card | $299 |
| Colour graphic card | $105 |
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| Microsoft mouse comp | $120 |
| IBM compatible joystick | $49 |
| Printer card | $40 |
| Serial card for XT | $51 |

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# Microsoft C

***Low-priced, turbo-charged rivals gave Microsoft good reason to update its C compiler. Adam Denning looks at Version 5 and its companion, Quick C.***

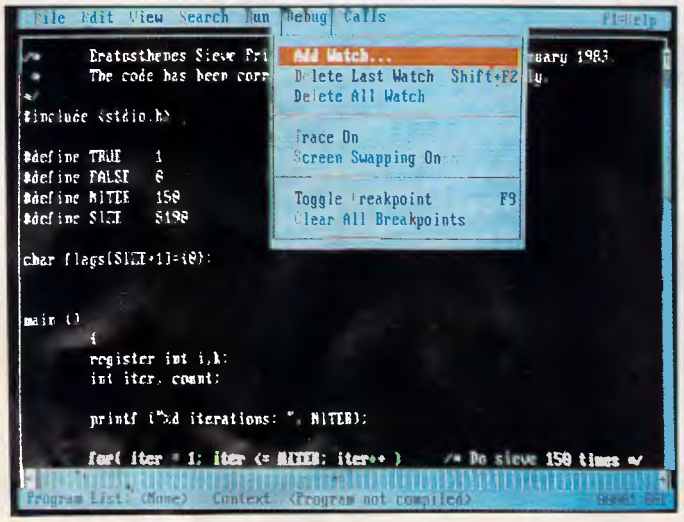
If you develop software for the IBM PC, AT and/or PS/2 families and their clones, the chances are you'll program some of your applications in C. More and more software houses are starting to use C for all development. This has meant a flood of compilers, third-party libraries and general add-on goodies for the professional C programmer, with a bewildering array of choices across a vast range of prices.

The 'which to use?' question has been examined in almost every technical computer publication in the world, but the answer is always out of date in a couple of months. One of the reasons for this is that just when we all think the market is stabilising, one or two companies release revolutionary products which stun the programming world into overnight changes of loyalty.

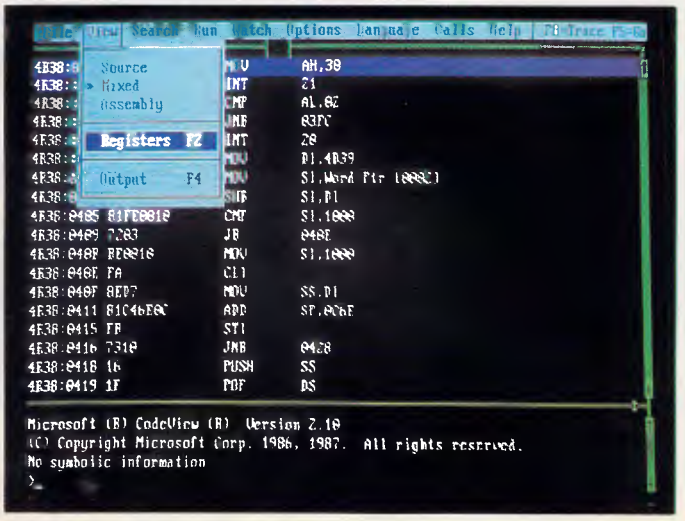
The initial launch of Microsoft C (version 3.00) was one such event. Then Microsoft itself was hit by Borland's Turbo C which, with Borland's advertising skills behind it, quickly became popular. It offers an integrated environment for editing, compiling, linking and debugging programs, as well as providing an extensive library of standard DOS and PC-specific functions. Turbo C is also, of course, very cheap.

Immediately before this, Microsoft launched version 4.00 of its compiler, which offered (basically) greater optimisation and the truly revolutionary (which is, after all, an over-used word!) CodeView debugger. CodeView makes the C programmer's life much easier than it ever was before. Not just symbolic debugging, but source-level debugging with full expression evaluation, variable alteration, windowing and watch/tracepoints. A joy to use.

Then a company called Zorland




*The Microsoft Quick C integrated environment offers an excellent prototyping tool before committing a program to the full-blown C compiler. Quick C can compile either directly into memory or to an object file*




*CodeView, the run-time debugger supplied with Microsoft C, can be used with later versions of Microsoft Basic, Pascal and Assembler. CodeView output can be viewed on a second screen while watching your program output on the main screen*

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| Multimate Adv II | $649 |
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| Epson EX1000 | $1060 |
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| Epson SQ2500 | $1995 |
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# INTEL

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INTEL 8087-2 RRP. $540
CLEARANCE PRICE $330 TAX INC.

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## Archive

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## Everex

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launched its own C compiler, at the low price of $99. Not surprisingly, it captured a lot of the amateur market as well as a fair chunk of the professional market. When Zorland released Version 2.00 of this system, sales rocketed because the price didn't go up but the speed and functionality did — a lot.

Microsoft, due to the sheer professionalism of its version 4.00 compiler, has never lost out, but it knows when it has to do something. So it came up with Microsoft C Version 5.00 and Quick C.

The easiest way to describe the new compiler is to say that everything Version 4.00 has, Version 5.00 has even better. Better manuals, better libraries, better code — even better CodeView. Quick C, which is available as a product in its own right for about $154, is shipped with C Version 5.00 so that program proto-typing is rather quicker than before. Let's take a closer look at what you get for your money.

## *In use*

Microsoft C Version 5.00 is supplied as nine 360k disks, three ring-bound manuals, a perfect-bound Quick C manual, an 80-odd page reference 'card' and two keyboard templates for CodeViews. For those owning previous versions, all this costs a mere $175 while Microsoft continues its friendly upgrade policy. People who don't have the Microsoft C compiler will have to pay $881.

The compiler is put on your hard disk by running the supplied SETUP program. This moves the executable and include files to specified or defaulted directories and then proceeds to build the libraries. You can choose which memory models you want installed when you run SETUP and at the same time you can decide whether you want to use the Emulator maths library, the 8087 maths library or the 'alternate' maths library. If you're like me, you'll want all memory models and all maths options — SETUP does this in one fell swoop and took about half an hour on my ageing 4.77MHz machine.

This building of libraries is a new step — previous versions of the compiler didn't do it. The libraries are built using the library manager, LIB (a new version of which is supplied with the compiler), to merge the standard library for a given memory model with all the option libraries chosen by the user. This means that each library ends up being huge (around 250k on average), but it does mean that linking is rather faster.

No serious compiler user is without a hard disk, but just in case you don't have one, it is just possible to use Microsoft C with two floppies.

The executable programs supplied with Microsoft C include new versions of LIB and LINK, the linker. LIB seems to have undergone no functional changes since the version supplied with C Version 4.00, but there are quite a few alterations to LINK, one of which is the provision for Quick libraries. These will be discussed when we look closer at Quick C.

Other executables are the compiler itself, supplied as a number of separate parts, the compiler program, CL, the Quick C package (QC is the compiler and QCL is the command-line driver), the CodeView debugger, CV, and a variety of utility programs such as MAKE, EXEMOD and EXEPACK.

None of the major programs is exactly small, but this is unlikely to cause concern, considering the performance of the software. Quick C, for example, is some 325k but its usefulness soon makes you forget this.

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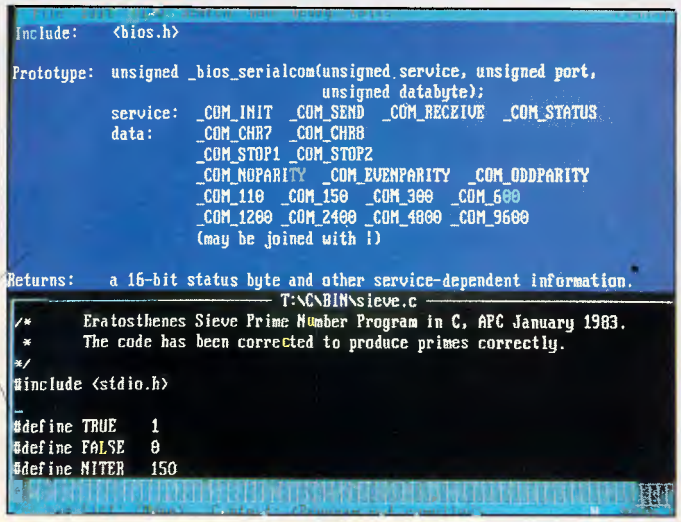
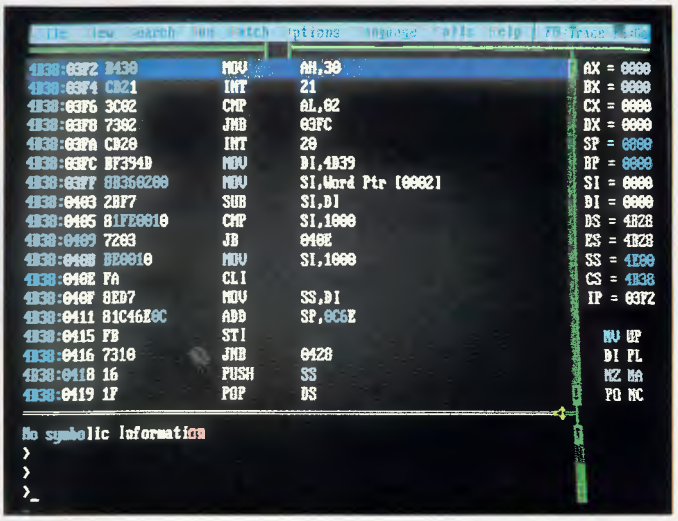



*The onscreen help available within Quick C goes beyond that needed to use the program, and explains such things as BIOS calls, library functions, memory models and even C language syntax*




*A multitude of windows can be displayed while using CodeView, including source code, assembly code, command-line processor dialogue, register status, and 'watch windows' showing the current status of specified variables or expressions*

modern dialect of the C language, that defined in the draft Ansi standard. This allows for enumerated types, const and volatile modifiers and functions which return structures. There's more to Ansi than this, of course, and the whole package reflects Microsoft's determination to be one of the front-line compiler vendors. Ansi-compatibility is everywhere.

One of the most useful features of an Ansi compiler such as Microsoft C is the introduction of the function prototype. A function prototype is a declaration of a function before its use (or definition). It includes the type of the function itself as well as the number and type of each of its arguments. For example, the Kernighan & Ritchie declaration of the standard function 'malloc' might be

```
char *malloc ( );
```

which tells us (or the compiler) very little except that malloc is a function which returns a pointer to a character. The Ansi-standard definition

```
void *malloc ( unsigned int );
```

tells us a bit more. It says that malloc is a function which returns a pointer to any type (which was true even in Kernighan and Ritchie's days — it's just that they had no way of specifying that) and that it takes one parameter — an unsigned integer. These 'prototypes' allow the compiler to perform argument type-checking, ensuring that we have passed to a given function the correct number of arguments and that each is of the correct (or convertible) type.

Of course, one of the most powerful features of C is that it allows functions to have varying numbers of parameters, and it also allows the programmer to take a number of liberties with types. Hence, if a function's usage goes against its prototype, the compiler generates only a warning, not an error. A special form of the prototype exists for functions which take varying numbers of parameters:

```
int fprintf ( FILE *, char *, . . . );
```

This prototype declares fprintf as a function returning an integer which takes at least two parameters, the first of which is a pointer to type FILE and the second of which is a character pointer. Other arguments, if present, are of unspecified types and therefore are not checked during compilation.

Microsoft C does in fact provide a number of warning levels, which allow the programmer to determine just how many warning messages will actually be shown. Error messages will always be generated, of course, but warnings can be all but switched off. Alternatively, and most usefully, the highest warning level can be used. This makes the compiler perform a number of 'lint-like' checks, including warnings about data conversions, dodgy constructs and unused variables. It is definitely recommended (by me) that the highest warning level is used at all times.

The compiler is invoked with the CL command, which can compile and link at the same time. Versions 3.00 and 4.00 of the compiler also had a driver program called MSC, which had a slightly more friendly front end. With the addition of Quick C, Microsoft has obviously decided that this is no longer required as it is not included with Version 5.00.

CL can cope with C source files, object files and library files. It can compile a number of files at a time, optionally linking them all into an executable program at the end, or it can stop after compilation so that the object files may be added to libraries. CL takes a vast number of options, some of which go to the linker and some of which are used by the individual passes of the compiler. These compiler options fall into a number of classes, some of which are examined below.

## Memory models

Options introduced with the characters -A select the memory model the compiler will use during the compilation. Memory models determine the maximum size of the code and data within programs: they are a consequence of the segmented architecture that Intel uses on the 8086 family of microprocessors. Items within a segment may be accessed with 16-bit pointers (often called near pointers): this feature produces faster and smaller code than using 32-bit (far) pointers, which is necessary if an item lies outside the current segment. A segment may be no larger than 64k, though.

To achieve the best compromise between program speed/size and accessible data, most compiler vendors support a number of memory models in which 16-bit pointers or 32-bit pointers may be chosen for code and data items, in any combination. Code items are functions; a near pointer to a function is just its offset within the code segment; a far pointer is the function's segment address as well as its offset. Data items are variables used by a program, including arrays and structures. Near pointers

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to data reference the data using just an offset, while far pointers use both the segment address and the offset.

The situation in which code and data pointers are 16-bit is called the small model, and by its nature it limits programs to a maximum 64k of code and a maximum 64k of data. This is often sufficient — luckily, because small model programs are smaller and faster than other models. The compact model uses near (16-bit) code pointers and far (32-bit) data pointers, allowing up to 64k of code and any amount of data (subject to physical memory constraints, of course). The medium model uses far code but near data, allowing as much code as you need but only 64k of data. The large model uses far pointers for both code and data, allowing unlimited code and unlimited data. As you would surmise, the largest model produces the slowest and largest code of each of these memory models.

Microsoft C also supports another memory model, called the huge model. Huge-model programs use far pointers for both code and data items, just like large-model programs, but allow individual data items to be any size. Large-model data items cannot exceed 64k each, although there can be any number of them. This is because each data item is assumed to lie wholly within a given segment, allowing pointer arithmetic to be performed only on the offset portion of a far pointer, which is naturally faster and smaller. Huge-model data items are not assumed to lie wholly within one segment, which means that pointer arithmetic is performed using both the segment and offset portions of a pointer. This gives maximum flexibility but less efficient code. The programmer has to choose which model to use for a given application.

Microsoft C makes the programmer's life considerably easier in this respect, by allowing a much larger range of memory models than the five described above. 'Custom' memory models may be specified to the compiler, allowing such things as small code with huge data. Note that code is accessed only with near or far pointers, never with huge pointers. This is because a function is assumed to lie wholly within a segment (if it didn't, it would be over 64k long!).

Furthermore, the language supported by Microsoft C provides the extra keywords 'near', 'far' and 'huge'. These keywords may be applied to data, functions and pointers to modify just that item. This is extremely powerful if you consider the situation in which you have a fairly small program which needs to manipulate a 100k array. It seems that you would need to use the huge-model process for this, but in fact you can declare the array as huge and compile the program with the small-model process. This means that everything except accesses to that array uses near pointers, resulting in the most compact and fastest program possible.

And there's more: those models with far/huge data pointers allocate initialised global and static data to the 'default data segment' if possible, allowing access to those items by near pointer. So-called compiler pragmas tell the compiler to make other assumptions. For example:

#pragma same_seg ( myvar1, myvar2 )

tells the compiler that the external variables myvar1 and myvar2 are in the same segment, which allows the compiler to generate more efficient code by using near pointers if possible when accessing these items.

## Optimisation

Microsoft calls this version of the compiler the 'optimising compiler', and optimising is certainly something it seems to do rather well. Optimisation involves looking again at code produced by naive translation to see if it can be made faster and/or smaller. Most programmers (or rather, most customers of programmers!) are more impressed by speed than by code size.

Microsoft C performs some quite remarkable optimisations. Take the first five Benchmark results, for example (see following page). They were unmeasurable because the compiler had optimised away the loops in them completely. It had worked out that they were doing nothing useful, so it removed all the code. You need to watch this, of course, if you're foolish enough to write simple time-delay loops in software.

One of the most spectacular optimisations Microsoft C can perform is that it can convert certain function calls into in-line assembler instead. Take the 'strcpy' function, for example, which is used heavily by most programs. Each time this function is called, both its parameters must be pushed on to the stack and the call must be made. Then on return, the stack pointer needs to be adjusted to remove the previously-pushed parameters. It is far more time-efficient to encode a strcpy call as the requisite 'rep movsb' and supporting instructions. Microsoft C can do this for quite a number of functions, making 'calls' to them considerably faster.

The compiler can generate code using special 80186 and 80286 instructions if required, making programs run faster on machines based on these processors.

To enhance program speed further, the special keywords 'pascal', 'fortran' and 'cdecl' are supported. Pascal and fortran are synonyms and, when applied to functions, cause those functions to use the Pascal/Fortran calling conventions. Cdecl is used to revert to the standard C calling conventions in a module being compiled, so that all its function calls are interpreted as being of type pascal. Pascal's calling convention is faster and smaller than C's, but is less flexible.

The -Ox option to CL tells the compiler to perform maximum optimisation, while -Od disables optimisations altogether. The latter is useful during debugging, as optimised code can be a lot harder to follow than non-optimised code. Various stages of optimisation between these two extremes are available through a mixture of command-line parameters to CL and the use of '#pragmas' in the source code.

## Compiler performance

All these optimisation strategies obviously take time to execute. The table of compile-and-link times compares the times taken by all variants of the Microsoft C compiler to compile a typical program. XPAGE is about 700 lines long and uses every C construct, particularly loops. It includes about another 800 lines of include files, so the figures represent the time taken to compile about 1500 lines of text. From these figures, we can see that CL with no optimisation (cl -Od . . .) is about 1.5 times faster than compilation with full optimisation (cl -Ox . . .) once the link time is subtracted from the total time. The variants of Quick C are of course even faster — they are examined later on.

If you think these times are depressingly slow, remember that they were performed on the slowest machine possible. An 8MHz PC/AT compiles this program in considerably less than a minute.

The fastest version of XPAGE produced by this process was then run on simple data. As the Benchmark results show, the output from Microsoft C Version 5.00 is considerably faster than the output from Borland Turbo C Version 1.00.

## CodeView

The CodeView debugger has been much discussed because it so improved programming in C on the PC. CodeView offers source-level debugging with breakpoints, watchpoints and tracepoints, online help, complete variable and expression control, assembly-lan-

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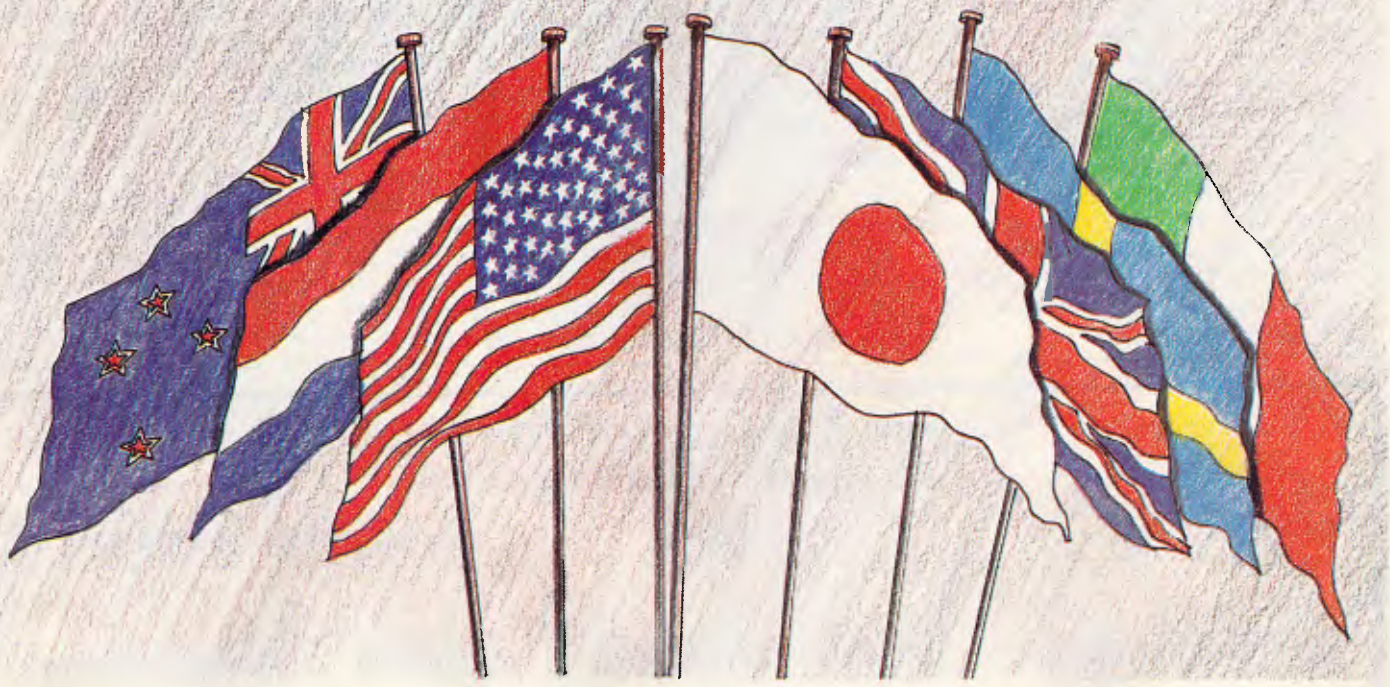

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guage symbolic debugging and much more. This version is better than earlier versions in that it can handle much larger programs (and overlaid programs, too) and in that it is multi-language. This means that this version of CodeView may be used to debug programs written in assembler, Fortran and QuickBASIC (Version 4.00) as well as in C.

The program detects which language is in use, if possible, and selects the appropriate expression evaluator. If you decide that you would like to change this during debugging, you can select a different expression evaluator on the fly.

## Quick C

Quick C is one of the major reasons for upgrading your C compiler. Everyone knows just how tedious it is going through the seemingly endless edit-compile-link-debug cycle and, although CodeView makes the latter part of this cycle considerably less painful, it is very hard to be patient while your program compiles just this once more. By using Quick C, you get an integrated environment in the true sense of the word. It comprises a full-screen editor, a compiler and a debugger.

You may say that this is no more than Turbo C — well, there is a difference. In fact, there are several differences. First of all, programs can be compiled in memory — that is, the resulting executable program is left in memory rather than having to be written to disk before it can be run. This makes compilation faster. Also, the link stage (for single-module programs, anyway) is not required with Quick C during development because linkage is performed at compile-time to memory-resident library routines.

### Benchmarks

| | |
|---|---|
| **Intmath** | 0.0067 |
| **Realmath** | 0.0067 |
| **Triglog** | 0.0067 |
| **TextScrn** | 31.28 |
| **GrafScrn** | 10.24 |
| **Store (h/d)** | 3.68 |
| **Store (f/d)** | 10.24 |

These benchmarks were run on a 4.77MHz IBM PC clone with a 20Mbyte hard disk and an EGA screen.

The programmer may enhance the standard libraries by loading his/her quick libraries with Quick C. A quick library is a special-format object file which contains library functions in a format usable by both Quick C and QuickBASIC (Version 4.00) in-memory programs.

Another, major, difference between Quick C and Turbo C is the debugger. Although the integrated debugger within Quick C is not as powerful as CodeView, it does offer single-stepping of source statements, variable interrogation, watchpoints and breakpoints. Development of a program is therefore straightforward and fast. The one edge which Basic had over C — that its development cycle is that much faster because interpreters are available — is no longer valid.

Newcomers to C particularly will benefit from Quick C (in fact, they'd be better off buying Quick C alone first of all, and then moving up to the full system when they are proficient in that), because it offers superlative online help facilities. Suppose, for example, you want to know the syntax of the C switch


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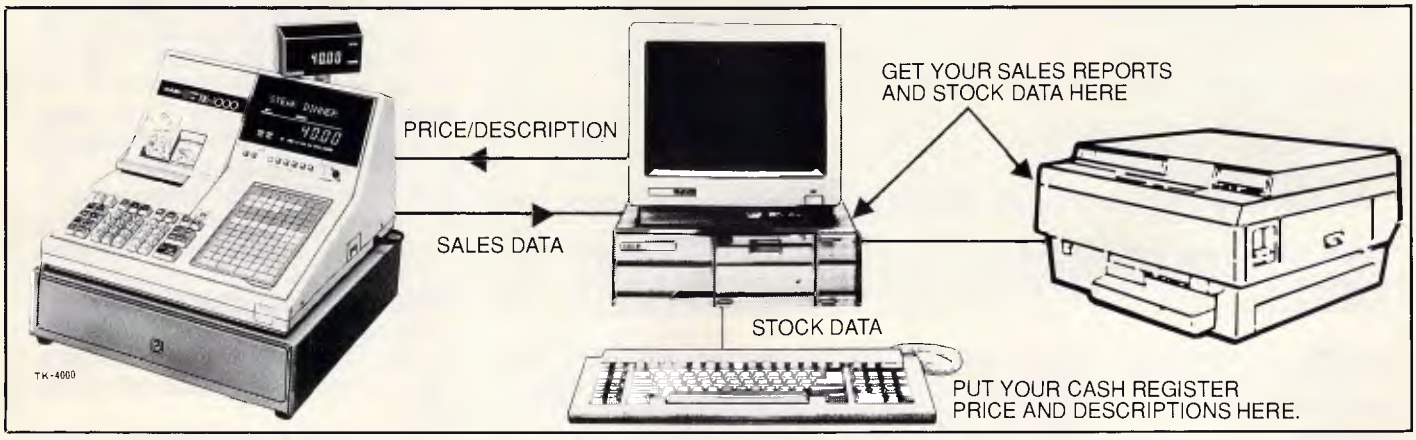


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## Compile-and-link times for a typical source file

**Microsoft C**

| | |
|---|---|
| cl -Ox -W3 -F 2000 xpage.c -link sadams/noe | 181.7 |
| cl -Od -W3 -F 2000 xpage.c -link sadams/noe | 132.2 |
| qc1 -Ox -W3 -F 2000 xpage.c -link sadams/noe | 100.0 |
| qc1 -Od -W3 -F 2000 xpage.c -link sadams/noe | 66.0 |

These times incorporate a link time of approximately 20.8 seconds.

| | |
|---|---|
| Quick C in-memory compilation with optimisation | 58.0 |
| Quick C in-memory compilation with no optimisation | 34.0 |

Size and execution speed of fastest XPAGE.EXE: 15701 bytes, 148 seconds.

**Turbo C V1.00**

| | |
|---|---|
| tcc -Z -G -O -k -w xpage.c | 43.33 |
| tcc -k -w xpage.c | 42.90 |

Size and execution speed of fastest XPAGE.EXE: 14032 bytes, 202 seconds.

Note: All compilations were performed on a 4.77MHz 8088-based IBM PC clone running IBM PC-DOS 3.30. An 8087 was used in tests 7, 8 and 15 (see text).

statement. You can find out in two ways — either press F1 and select the relevant topic, or place the cursor anywhere in the word 'switch' inside your program and press SHIFT-F1. Either way, the requisite help message pops up. Library functions also can be used in this way, so if you're unsure of quite how 'printf' works, or you've temporarily forgotten just how to use 'fread', you can press SHIFT-F1 once you've typed the function name and the program will tell you how to use it. I must confess that I find this feature rather more useful than having to go back to the runtime library reference manual.

Quick C can also be used as a command-line-driven compiler in the same way as the full compiler, using the compiler-driven program QCL. It takes the same command-line options as CL and can compile and link at the same time. It can produce code in all memory models except huge, and although its optimisations are not as powerful as those provided with the full compiler, it produces perfectly respectable code in about half the time it takes CL. Because it can produce CodeView-compatible debugging information, it can be used to prototype programs in circumstances where the Quick C environment is not suitable.

## The libraries

The libraries supplied with Microsoft C cater for just about all requirements. A major advance over the libraries in Version 4.00 is the inclusion of specialist PC-specific graphics and BIOS functions, as well as slightly more general-purpose low-level DOS functions. The graphics functions provide support for line-drawing, cursor positioning, ellipse and arc drawing and flood-filling. Also provided are routines to perform BIOS-level text output and manipulation. The graphics library is a great bonus for those who want to achieve the sort of graphics that are so easy in languages like QuickBASIC.

The BIOS-level routines provide functions to talk to the comms ports (setting up the baud rates, parity and so forth, as well as sending and receiving characters), talking to the parallel port, reading and writing absolute disk sectors and so forth. The DOS-level functions perform such things as ambiguous filename searches, low-level file-handling and memory allocation and setting the default drive.

Apart from all this, of course, there is the large Unix/Ansi library, with all the usual functions for string-handling, memory allocation, file-handling and so on. A large set of standard header files complements the library and makes it easy to use. Various Microsoft additions to the standard functions are also provided to stop you re-inventing the wheel.

## Bugs

Two bugs have come to light since I started using the compiler in earnest. The first concerns the runtime library; specifically, the 'halloc' function. This is very similar to malloc, which allocates heap memory and returns to the program a pointer to the allocated chunk.

Halloc is the Microsoft-special version. It is used to allocate 'huge' chunks of memory (that is to say, typically over 64k) and the documentation states that arrays allocated with halloc must, if over 128k, have elements which are powers of two in size. This is fair enough and quite understandable. It's also the way the earlier version of halloc works — the one provided with Version 4.00. A program I have which uses an array of between 64k and 128k works perfectly with Version 4.00 but refuses to work with Version 5.00. Investigation showed that it was halloc which was failing. After examining the disassembled version of halloc, it became clear that it was failing because the memory I was allocating was not in power-of-two-sized chunks. It seems that the new version of halloc requires elements of arrays to be powers of two in size if the array is greater than 64k, not the 128k limit of earlier versions. The documentation does not reflect this.

The other bug is less frustrating. Using the Quick C compiler to prototype rapidly a program I was developing, I got the message:

```
qcbug.c (146) : fatal error C1001:
Internal Compiler Error (compiler
file 'gencode.c', line 390) Contact
     Microsoft Technical Support
```

This message was caused by a very dubious line of code that I used because I wanted to test something quickly. The line involved was an IF statement which called the 'mkdir' function up to 17 times and, if one of the calls failed, the IF-controlled statement was executed. Each mkdir call was separated by a logical-OR operator, !!, so the expression was quite complex. The full compiler (CL) handled this expression with absolutely no problems, but obviously Quick C wasn't prepared for Denning code!

Neither bug is serious in that once they are known about, they are easily avoided, and they're the sort of thing you expect to find in any new product. Nevertheless, it's worth making public very quickly all known bugs, so that other programmers can avoid having to find them all by themselves. Microsoft has been advised of the bugs and no doubt will change something.

## Documentation

The documentation supplied with the package is of the highest quality. It is, unequivocally, the best I have seen for a compiler system. Apart from the 400-page

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## SCREENTEST

*Quick C Manual,* there are three main manuals. The first is a *User's Guide* and this describes, in careful, readable detail, how to use the compiler and its subsidiary programs, and what each of the options does. An adjunct to this manual is the *Microsoft Mixed-Language Programming Guide,* which is supplied with Microsoft's macro assembler, C, Fortran, Pascal and QuickBASIC (Version 4.00) packages. It describes how to call modules written in any of these languages from any of the others.

The second manual contains the *Language Reference* manual and the *CodeView* and *Utilities* manuals. *Language Reference* details precisely the dialect of C accepted by the compiler and is, therefore, much more useful to the modern-day programmer than the C reference manual at the back of Kernighan & Ritchie. The third is the *Runtime Library Reference* manual which describes each function in the libraries provided with the system, with examples for each. Microsoft seems to have found the one true documentation style.

### *Conclusion*

Microsoft C Version 5.00 is undoubtedly excellent. It is probably the most professional C compiler system available for MS-DOS systems, and its combination of superlative documentation, excellent performance, fast, convenient prototyping in Quick C, and the productivity-enhancing debugging powers of CodeView make this compiler system just about the only real choice for a company developing software in C for PCs and PS/2s.

There is nothing this compiler lacks, except perhaps a multi-file lint facility. The programmer who needs to write code for ROM-based systems is also catered for now, so you no longer have to buy something like Aztec C for ROMming.

If you're not a professional programmer, though, you may wonder whether the price difference between this system and Turbo C is worth it. If that's what you're thinking, buy Quick C first. If you like what you see and have the money to spare, the odds are you'll find yourself justifying the purchase of the full system before long. It really is that good!

It remains to be seen just how good the new release of Turbo C, Version 1.5, is; but, knowing Borland, it will probably get Microsoft wondering about Version 6.00 — or at least Version 2.00 of Quick C. It is unlikely to be good enough, though, to turn the professional programmer away from Microsoft's truly professional C compiler system.

END

# Byline

***Ashton-Tate seems to have missed when it tried to board the DTP bandwagon. A hurriedly-prepared product, alarmingly simple in design and seriously lacking in sophistication, does not make for good presentation. Graham Jones despairs.***

Massive growth in desktop publishing has seen a large number of newcomers to the software scene in the past couple of years. For the most part, top software houses have remained remarkably silent about desktop publishing, reflecting sadly, perhaps, that they did not discover the market themselves. However, there have been rumours in the computer trade press that some of the big firms were developing desktop publishing packages. One of these rumours has at last come to fruition with the launch of Ashton-Tate's desktop publishing product Byline.

Byline is branded by Ashton-Tate as 'PC desktop publishing for PC users'. The promotional blurb that accompanied the review copy makes it clear that this is a product which does not need a mouse, or an operating environment such as Microsoft Windows. Implicit in Ashton-Tate's promotion is the idea that real PC users don't need a WIMP environment.

While it is undoubtedly true that the vast majority of PC users do not use mice, and run software happily under MS-DOS without Windows or GEM, it is skating on thin ice to imply that desktop publishing can be done without such enhancements. And, as you will see, the Byline product proves this to be the case.

## What, no WIMP?

Desktop publishing is a graphic activity. Page layout requires a combination of artistic skill and typographical precision, and the WIMP environment provides publishers with both of these. Running a program under MS-DOS must surely limit the creative process either of picking items up and shoving them around the page until it looks right, or of managing your publication through a series of windows. In the US, Ashton-Tate has already been heavily criticised for its anti-WIMP attitude, with one commentator pointing out, quite rightly, that dBASE Mac utilises the environment admirably.

So why has Ashton-Tate opted for a non-WIMP desktop publishing program? Probably it is due to the simple fact that most PC users do not use this form of operating environment, but may well wish to gain the benefits of desktop publishing. But can Byline deliver the goods?

*'...it is skating on thin ice to imply that desktop publishing can be done without such enhancements.'*

The answer to that question depends very much on the sort of publishing you want to do. If you are a publishing professional, you can safely ignore Byline. You would too easily become frustrated with its cumbersome way of design and its overall slowness. However, if you are in business and want a program to produce professional documentation, you could consider Byline.

The reason professional publishers will not like Byline is the fact that it does not allow you to design pages following traditional principles, unlike PageMaker, Ventura or XPress. With these packages you can, using the WIMP environment, place items on a page 'freehand' and then deal with the precision layout once the page looks right.

## In use

Byline does not allow you to place items on a page freehand. Instead you must manipulate them either with the cursor arrow keys, or by typing in the precise positioning of the item into a dialogue box.

Byline comes on five standard floppy disks (the 3.5in format is expected to be produced in the near future). One of the floppy disks contains a number of clip art items, another has the tutorial publications upon it, so the actual program itself only takes up three disks. To load Byline you need an IBM PC or 100 per cent compatible with at least 384k of RAM. You will need a display adaptor providing at least CGA standard, and you will also require MS-DOS 2.0 or higher.

Byline is best used with a hard disk since more than 100 files are used and these take up about 1Mbyte. If you use a floppy system, you will be involved in a great deal of time-consuming disk swapping.

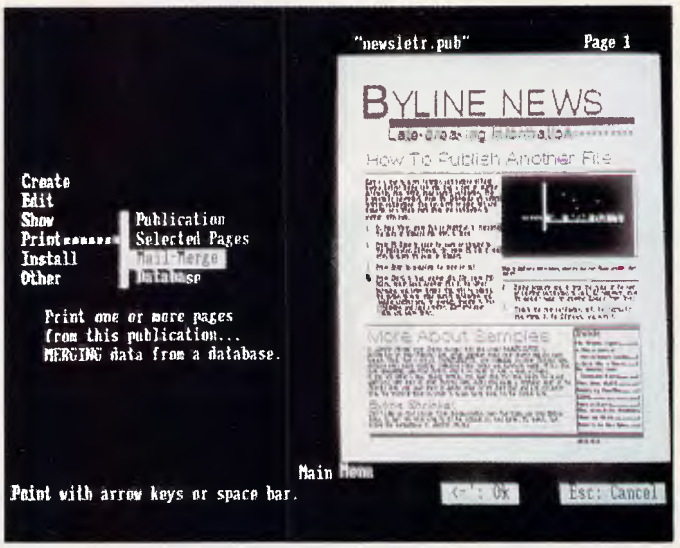
Once you have Byline up and running, you are presented with a split screen. On one side is the 'spec sheet' and on the other is a representation of the whole page. The blurb with Byline suggests that it is WYSIWYG. It is not. Byline produces a *representation* of what will be printed and not the sort of

WYSIWYG you get on something like a Macintosh.

However, for many office publishing purposes true WYSIWYG may not be necessary, so the limitation of Byline might not be important. Professional publishers, however, would find it a distraction.

The spec sheet is the area in which you type information relating to the items you position on the page. Before you enter any material you must position a box to receive it. Boxes will either take 'text' or 'photos'. Quite why the word 'photo' has been chosen by Ashton-Tate is a mystery. Professional publishers do not refer to graphic items as photos, and the bit-mapped graphic supplied as examples by Ashton-Tate could hardly be described as such.

However, when you decide what type of item box you require, Byline automatically places a two-inch square box at the top left of the page. If you want it somewhere else, you can move it using the arrow keys, and you can resize it using a combination of tabs and arrows. Alternatively, you can type the position and size of the box directly into the spec sheet. Every single item on the page has its own spec sheet, which is automatically generated by the program when you add an item to a page. Each page also has its own spec sheet. In this way, you can build up your own style sheets and supply them whenever necessary.




*Byline includes a unique dBASE merge facility that enables users to import dBASE III Plus databases into pre-styled formats for mail-merge letters, database-driven directories, invoices and other similar reports*

Whichever way you position boxes in Byline, it is cumbersome. Using the arrow keys is slow. Even with the added enhancement of using Shift-Arrow which speeds up the movement 10 times; it is slower than using a mouse to lift it and move it. If you decide to describe the size and position of the box on the page accurately, you will need to have designed your page on paper first to a reasonable degree of accuracy, which destroys much of the point of buying a DTP package in the first place!

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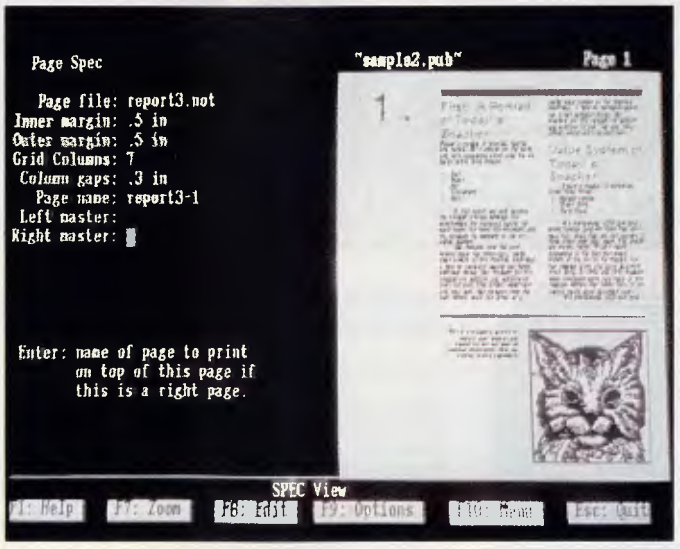
'element' boxes, as Byline refers to them, in inches, centimetres, picas and points. The default setting according to the manual is inches. The version of Byline used for this review had a default of millimetres, and the manual does not reveal how to change this default to the more professional system of picas and points.

Once your boxes are in place you can begin to import material into them. Byline accepts a wide range of word processor and graphics formats, as well as ASCII files. However, there is one glaring error in that it cannot import directly from Microsoft Word, which is one of the most popular word processors.

## Style matters

When material is imported, it will take on the styles incorporated into the spec sheet for the box in question. Each text box, for example, can have three levels of heading as well as the body text described in the spec sheet. However, Byline comes with only five typefaces — Courier, Times, Bookman, dBASE Elite, and Swiss — so if you are looking at serious publishing you will need to buy additional typefaces. Indeed, in terms of professional publishing only Bookman and Times actually rate at all, so Byline is seriously limited in typographical choice.




*Byline contains 23 sample templates that enable fast and easy construction of reports requiring a standardised format, such as memos, agendas and other business communication applications. This allows a new user to produce documents quickly and with little effort or knowledge of the system*

The text box spec sheet also allows you to choose the method of justification, and the amount of leading (spacing between lines of text). However, you can adjust the leading only within single-point increments (a point is 1/72nd of an inch). For good typographical results this is not good enough, and a much finer degree of control is required.

The spec sheet also allows you to decide how many columns there should be, whether or not there should be rules between columns and how thick these should be, and also the size of any borders. The gutter between the columns (called the 'column gap' by Byline


# uage and compiles it fast

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despite the fact that no professional publisher ever refers to the gutter as this) is not controllable by the user. This is present in the spec sheet for the page and means that all gutters on a given page must be the same. This is typographically incorrect, especially in newsletters and magazines, and is a serious flaw in Byline.

Spec sheets for the photo boxes allow you to define the size of the box, any cropping of the graphics contained within them, and the size of any borders or boxes required around the material.

## Making up is hard to do

When your material has been loaded into the relevant boxes, and the spec sheets have been tidied up to produce the effect you want, you can move material around the page to get the best look. With a WIMP environment this is easy. You just use the mouse to point to the item you want to move and literally move it. With Byline, shifting items around the page is awkward and slow. You have to use either the arrow keys, or alter the spec sheets. It means that you must have a very precise design in advance if you are to use Byline with any kind of speed.

This reveals that Byline is not really a sophisticated desktop publishing program at all. It is a fairly basic page make-up application that combines text files with graphics files. But you can do that quite easily with Microsoft Word, for example. Sophisticated desktop publishing programs, in the true sense, allow you to do much more than just mixing text and graphics. They allow you to emulate the traditional publishing process, merely providing a tool by which publications are produced. Byline does not emulate traditional publishing, but takes a completely different approach to document design. Sophisticated desktop publishing programs also allow you to manufacture your own simple graphics, and even new word processors such as FullWrite Professional give you a complete drawing package as a menu-selection.

Byline professes a simple graphics capability, but this is limited to rules and boxes. Byline does not, for example, produce tints, nor does it support white text reversed out of a black background — both commonly used in publishing.

However, Byline does have a reasonably good text editor. This is a fairly fast but basic word processor which allows you to write your text directly into the publication instead of importing it from a word processor file. The advantage of using the Byline text processor is the fact that you do not have to quit the application to write articles for your publication. In addition, Byline saves all your text files in an ASCII format so that they can easily be exported back to your main word-processor application if required.

The text editor in Byline can use either half of the screen, replacing the spec sheet, or the whole screen. It has all the usual basic word processing facilities such as cut and paste, which are accessed through function keys, as well as type styling and formatting. The text processor also includes search and replace facilities, but does not have a spelling checker. Once you save your text, it automatically appears in its box on the mini page representation. However, Byline cannot let you write unless you give it a filename first. You need to remember the names of your text files before you start writing so that you do not double up. If you do type in the name of an existing text file, Byline will load this into memory. The result would be a waste of your time while you closed this file and renamed a fresh one.

*'This looks like a product rushed out to claim some part of the desktop publishing market.'*

When you are happy with your text and graphics, you can enhance the pages if you wish to. Byline allows you to produce both left and right-hand master pages, and you can generate automatic headers, as well as automatic page numbering. You can also experiment with various 'looks' by adjusting the number of columns in each text box, the justification of text, the size of headlines and so on. Byline supports all fonts from eight point to 144 point.

## In print

Printing the output of Byline should be easy for most PC users. The program supports a wide range of printers including PostScript compatibles such as the Apple LaserWriter, as well as other laser printers like the popular Hewlett-Packard LaserJet series. Byline also supports 9 and 24-pin dot matrix printers including those from Epson, IBM and [illegible]ata. If the printer you are using does [illegible]ave the typeface specified in [illegible]la spec sheet, Byline autom[illegible] stitutes one which is availab[illegible] chosen printer. (When you install Byline, you have to specify which printer you will be using so that the correct driver can be loaded.)

To enhance your printing Byline also allows you to kern characters. Kerning is the typographical process whereby letters are moved closer together to improve their appearance on the page. Kerning in Byline is automatic, although you can alter the degree of kerning by changing the kerning tables using the text editor. Kerning tables are descriptions of the space taken up by particular pairs of characters. For example, an A and a V need to be moved closer together, so a kerning table may describe this pair of characters as taking up only 75 per cent of the actual space required for them. This moves them closer together. For the same letters in some other typefaces 75 per cent may be too close and you would need to alter the kerning table to say, 85 per cent. This is time-consuming, however, and much more cumbersome than the simple keyboard manual kerning supported by the likes of PageMaker. But it is a mystery why Byline allows for the typographical precision of kerning at all, while removing the more important control over gutters and having so few typefaces. In addition, you can select type sizes only in single point increments, which is not accurate enough for many publishing activities. Another typographical problem with Byline is the fact that you cannot change the method of justification or of letter spacing to improve the look of text, as you can with PageMaker or XPress.

Of interest to many PC users, however, will be Byline's ability to import directly from Lotus 1-2-3 and Symphony. This means that Byline could be very useful in the publication of management information and in spreadsheet publishing. In addition, Byline has the unique capability of using dBASE III files in mail-merge letters, directories, and so on. Because of this fact, Byline could become very useful in basic directory and database publishing.

It is hard, however, to believe that Byline will become anything more than a useful tool for a minority of individuals. It does not offer the degree of sophistication provided by other PC desktop publishing packages. Byline also falls down in terms of typographical control: someone who wants to produce top-class material will not get the level of precision required from Byline. Byline also lacks sufficient [illegible]blish[illegible]efaces. Businesses which [illegible]e smart documentation

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## SCREENTEST

may find a home for Byline, but they too will become frustrated, as I did, with the cumbersome way of doing things and the appalling lack of speed.

The whole problem revolves around the entire concept of Byline. It has been designed with the WIMP environment an absent, seemingly unwanted, item. It is this factor alone which dramatically reduces the capabilities of the package. The product has been designed to use the capabilities of the basic IBM PC or clone, without any enhancements — save that of improved screen handling, The IBM PC was never designed with the graphic work of publishing in mind. To produce a program like Byline to take advantage of the lack of features of the PC is a retrograde step.

Byline is not, like DTP packages which use the WIMP environment, intuitive. It does take time to learn. However, it is very difficult to use comfortably. While the idea of a spec sheet for every item is useful, though not new since Ventura uses style sheets (much more effectively), their constant overbearing presence on the screen tends to take your mind off the real work in hand — designing a page. Also, the slowness of the program, due to its awkward way of working, is frustrating and not conducive to effective publishing.

### Documentation

Like many computer manuals, the one included with Byline is incomplete. It has a poor index, for example, so finding the answers to your inevitable questions at the beginning is not easy.

### Conclusion

Byline is a simple page make-up application which may benefit those who want to produce fairly basic page layouts as might be required in the production of business documentation; it is not a good tool for the production of newsletters or magazines. If your needs are simple and you do not want the level of sophistication offered by the larger, more expensive packages like PageMaker, then it's worth a look.

However, the lack of typographical choice and precision found in Byline is a serious problem, and one which should be considered carefully. This looks like a product rushed out to claim some part of the desktop publishing market. From a company with the reputation of Ashton-Tate, this is something of a surprise.

*Byline retails for $595.*

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# Talking pictures

***In the final part of our Teach Yourself Smalltalk series, Carl Phillips looks at the language's interactive programming environment, and presents a picture of how it looks on the screen.***

One of the distinguishing characteristics of Smalltalk systems is their support for interactive bit-mapped graphics. The ability to create, manipulate, and display high-quality graphical images is a fundamental part of the system. The interactive Smalltalk programming environment and Smalltalk applications programs rely heavily on the graphics classes.

Since this series has referred to 'Smalltalk — the language' and not 'Smalltalk — the interactive programming environment' I haven't said much about what Smalltalk looks like on the screen. However, to appreciate the graphics classes built into Smalltalk, it is useful to see what a Smalltalk screen looks like. Shown later in this article is a typical view: in this case, Digitalk's Smalltalk/V at work.

As on the Apple Macintosh, work is performed in overlapping windows which are manipulated using the mouse. These windows are further sub-divided into different areas called 'panes'. Entering, editing, and compiling Smalltalk code is done in specialised multi-paned windows called 'browsers'. Applications that run within the Smalltalk environment usually provide their own specialised windows or browsers which reflect their use. For example, one simple application that comes with Smalltalk systems is the 'Form Editor' (a 'Form' is the Smalltalk name for a bitmap). This displays a window which lets the user create and edit bitmaps in a similar way to MacPaint on the Mac.

Xerox Smalltalk was the *first* bit-mapped windowing system — the Apple Macintosh, Microsoft Windows and GEM subsequently borrowed these ideas. Dan Ingalls, one of the original Xerox researchers who created Smalltalk-80, is credited with inventing the — now famous — 'bit block transfer' or 'BitBLT' graphics operation (bit block transfer was the name of an instruction on one of the Xerox research computers). BitBLT is a single underlying graphics primitive which can support all screen operations on a bit-mapped screen. It became famous as the operation at the heart of the windowing systems provided by the Apple Macintosh ROM toolkit, Microsoft Windows and GEM. Some modern personal computers such as the Commodore Amiga have a hardware BitBlt where the operation uses custom hardware to speed things up.

Of the three Smalltalk dialects discussed so far, Xerox Smalltalk-80 and Digitalk's Smalltalk/V both support a rich set of graphics functions. Little Smalltalk currently only provides a simple 'turtle graphics' library which reflects its origins on Unix systems. Little Smalltalk can have windows and BitBLT-style opera-

tions added if the underlying operating system or hardware supports it.

## *BitBLT*

BitBLT operations appear directly in Smalltalk as a named class 'BitBlt'. An object of class BitBlt represents a movement of bits from one place to another, possibly with a transformation taking place during the movement, and with a number of parameters (such as clipRect, which limits the rectangle of bits affected in the destination).

BitBlt is an interesting example of how objects can represent what is normally thought of as a pure procedure. It is possible to create a BitBlt object as usual by sending the class BitBlt a message requesting a new instance of a BitBlt object. The object returned can then be sent various messages that set the parameters for the BitBLT operation.

The message 'copyBits' sent to a BitBLT

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object will actually perform the fundamental operation associated with BitBlts — moving bytes from place to place with certain transformations (governed by the parameters) taking place during the transfer. The benefits of representing BitBLTs as objects rather than, say, having a 'BitBLT' message to a bitmap object include simplicity and flexibility. After having performed one 'copyBits' operation, it is easy to change one or two parameters and send 'copyBits' again to the same BitBLT object, leaving the rest of the parameters the same. Common screen update tasks and animation are performed efficiently in this way.

## Forms and pens

As well as BitBlt, Smalltalk has several other classes associated with graphics. Objects of class 'Form' are bitmapped images consisting of an array of words that hold the raw bitmap data plus the height and width of the bitmap image. Form objects can provide the source and destination objects for BitBlt transfers.

The display screen is usually a Form object in Smalltalk as a Form (or an object of class DisplayScreen which is a specialised subclass of Form). Note that the graphics operations can use any form for the destination — there is no need for all graphics to appear on the screen.

Class Pen gives Smalltalk the 'turtle graphics' facilities made famous in the programming language Logo. 'Pens' are a subclass of BitBlt that have some additional state and methods, and take the form of a brush or a nib, as well as a position, direction and state (whether the pen is up or down). Pens respond to messages sending their colour, their position, direction, and state.

Class CharacterScanner is a subclass of Class BitBlt that allows the easy manipulation and display of characters onscreen. Objects that are instances of class CharacterScanner are BitBlt, such as 'procedural' objects that will convert strings of ASCII characters to a bitmap source image which can then be transferred to the screen. Among other things CharacterScanners have a font object associated with them that governs the appearance of each displayed character. CharacterScanners respond to the message 'display:at:' to actually display a string as the message 'copyBits' is used with BitBlts.

These graphic objects are created and manipulated using simple Smalltalk statements, just like any other kind of Smalltalk object.

For example, the ST/V statements:

```
| aForm |
aForm := Form fromUser.
aForm displayAT: 34@20
```

will ask the user to appoint a rectangular area of the screen using the mouse, copy that area to aForm, and then redisplay the saved form at a particular location — the point object 34@20.

The message 'fromUser' is a class message — sent to the class Form and not to an instance of Form. The method that implements the 'fromUser' message will use a BitBLT operation to transfer the bitmap the user designates from the screen to a newly created form and return that form object. This form is assigned to the temporary variable aForm which is sent the message 'displayAT:' with a single argument — the point object 34@20. The method in Class Form that implements the response of form objects to the 'displayAt:' message will create and execute a new BitBlt object that copies the source form (in this case aForm) to the destination form — in this case the display screen — at the point 34@20.

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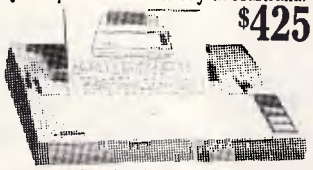

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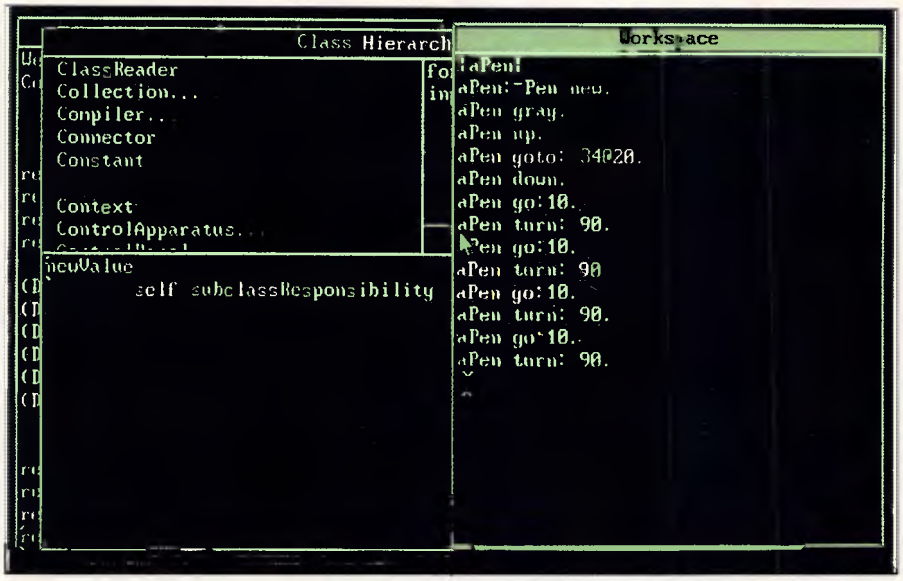


*A typical Digitalk Smalltalk/V screen showing turtle graphics commands being entered directly into the workspace window*

by making use of the classes supplied with Smalltalk, very high-level graphics operations can be performed in just a few statements. Graphics operations with Pen objects are easy too:

```
| aPen |
aPen := Pen new.
aPen grey.
aPen goto: 34@20.
aPen down.
aPen go: 10.
aPen turn: 90.
aPen go: 10.
aPen turn: 90.
aPen go: 10.
aPen turn: 90.
aPen go: 10.
```

will draw a grey rectangle on the screen beginning at point 34@20. These statements create a new instance of class Pen, send a message to aPen setting its colour to grey, send a message setting its position to the object 34@20, send a message setting its state to down, and then a series of messages commanding it to move about the screen drawing the rectangle.

These graphic classes provide the underlying basis for the Smalltalk user interface. Coupled with the Smalltalk user interface classes they provide the elements for building serious applications programs.

## Interface classes

Software systems, such as the Apple Macintosh toolbox, Microsoft Windows, or GEM, provide a library of routines that can be called from an application program to provide a graphical interface. In Smalltalk, the standard user interface is provided in a set of classes. There is no distinction between an application program, operating system, or window manager in Smalltalk; they all live and cooperate in the single integrated Smalltalk environment, so the user interface classes that you use in building Smalltalk applications programs also support the browsers and windows that are used to implement Smalltalk.

By re-using these standard classes built into Smalltalk in the creation of an application program you can save yourself a lot of work. There are many predefined building block user interface classes that support the facilities built into Smalltalk. By directly creating and using instances of these classes or by subclassing to change their behaviour as required, you build on what has been done before rather than reinvent the wheel. Since representing everything as an object is a powerful abstraction you can re-use both high and low-level objects in your work. If, for example, part of your application needs to create and edit bitmap images, you can just re-use the classes that make up the Form Editor directly.

This is in sharp contrast to the window manager systems on the Macintosh or Microsoft Windows. While these provide low-level building blocks of varying degrees of utility, there is no easy way to re-use higher level abstractions.

## Model-View-Controller

Xerox Smalltalk-80 uses a system called 'Model-View-Controller' (usually abbreviated to MVC) to provide a high-quality user interface. Digitalk's Smalltalk-V has a roughly parallel but simpler set of classes and uses different terminology — application-pane-dispatcher rather than model-view-controller. This explanation will use the Smalltalk terminology but the fundamental ideas remain the same. One problem with Model-View-Controller is that up until recently it had not been very well documented anywhere. Xerox and Addison-Wesley have published a series of three books about Smalltalk-80 but the fourth book about using Model-View-Controller was announced but never materialised. This means that

*The Class Hierarchy Browser gives access to an important feature of Smalltalk: the ability to manipulate and create your own classes*

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**Video input signal:** Composite/TTL Switchable
**Polarity:** Negative/Positive
**Level:** 0·5 - 2·0Vp-p/4·0 + 1·5Vp-p
**Impedance:** 75ohm, more than 6·8K ohm
**Scanning frequency:**
**Horizontal:** 15.75 KHz + −0·1%/18·432KHz + −0·1%
**Vertical:** 47-63Hz
**Video bandwidth:** 20MHz
**Active display area:**
Composite: 206(H) x 160(V)mm.
TTL: 216(H) x 160(V)mm
**Display character:**
80 characters x 25 rows.
**Input terminal:** Phono Pin Jack, 9 pin D-Sub Connector.
**Controls:**
**Outside:** Power Switch, Contrast, Brightness, Signal Select, V-Hold, V-Size.
**Inside:** H-Width, H/V linearity, Focus, H/V-Shift.
**Power supply:** 110/120V 60Hz, 220/240V 50Hz
**Dimensions:**
308(W) x 297(H) x 307(L)mm
**Weight:** 7·3 Kg
**Shipping weight:** 8·3 Kg

| Cat.No. | Description | Price |
|---|---|---|
| X14509 | (GREEN) | $179 |

## 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**
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## 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 comas standard with female connector
- Bale locks are standard

**2 WAY** (X19130) ..... only $59
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## VERBATIM HARD DISK CARD

Available 20 or 30 M/Byte! IBM* compatible, plugs straight in to your computers bus connectors!

X20020 ..... **$955**
X20030 ..... **$1,095**

## THOMSON EGA MONITOR

Top quality high resolution EGA monitors with a space-age design.

**SPECIFICATIONS:**
**CRT:** 14 inch (360mm) diagonal, 90 degree deflection.
**Display Size:** 245(H) x 180(V)mm
**Phosphor:** P22, non glare, tinted screen.
**Dot Pitch:** 0.31mm
**Video Bandwidth:** 18 MHz
**Resolution:** 15·75KHz - 640 x 200 21·85KHz 640 x 350
**Input Signals:**
1. RGBI - positive, H(+), V(+)
2. RrGgBbI - positive, H(+), V(−)
**Input Impedance:** TTL Level (330 ohms)
**Dual Scanning Frequency:**
Horizontal: 15·75 KHz or 21·85 KHz + −10Hz
Vertical: 50 - 60 Hz
**Connector:** 9 pin, D-type
**Size:** 312(H) x 363(L) x 380(W)mm
**Weight:** 10·8 Kg (Net)
X14525 ..... **$895**

## 5¼" FLOPPY DISK DRIVE EXTENSION CABLE

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

P19045 ..... **$99.95**

## 3½" FLOPPY DISK DRIVE EXTENSION CABLE

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

P19046 ..... **$99.95**

## 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**

## JOYSTICK FOR IBM

Features Selectable "Spring centering" or "free floating". Electrical trim adjustments on both axis. 360 degree cursor control

Cat. C14205 ..... $39.95

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**EP R340002 Cartridge:**
For Canon and HP Laserjet.
**EP-S R640002 Cartridge:**
For Canon and HP Series 2 Laserjets.

..... **each $210**

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## 3½" EXTERNAL DRIVE

- 720K formatted capacity.
- 37 way D type connector fits directly onto drive controller card.
- Compatible with IBM* PC/XT
- Requires DOS 3·2 or greater.
- Size: 266(D) x 104(W) x 75(H)mm

..... **only $395**

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- Copy area 9½" x 11"
- Sliding line guide
- Flat metal base

C21060 ..... $39.95

## CENTRONICS GENDER CHANGERS

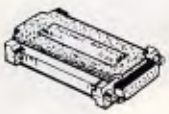
- Female to Female.
- Saves modifying or replacing non-mating Centronics cables.
- All 36 pins wired straight through.

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
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## RS232 WIRING ADAPTOR BOX

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- 2 mini jumpers
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- Male to female connections
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T.D. Transmit Data
D.S.R. Data Set Ready
R.D. Receive Data
C.D. Carrier Detect
R.T.S. Request to Send
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C.T.S. Clear to Send

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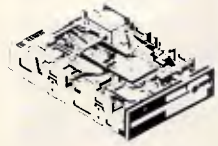
## SAMSUNG 12" FLAT SCREEN COMPOSITE MONITOR ONLY $149

**FEATURES....**
- Flat, high contrast, non-glare screen
- High resolution, 80 or 40 character display
- Tilt/swivel base
- Compatible with Apple* and IBM* colour composite signal

**SPECIFICATIONS....**
**Picture tube:** 12" diagonal and 90° deflection
**Phosphor:** Available in Green or Amber
**Video input signal:** Composite Signal
**Polarity:** Negative Sync
**Level:** 0·5-2·0Vp-p
**Impedance:** 75ohm
**Scanning frequency:**
**Horizontal:** 15.734 KHz + -0·1%
**Vertical:** 50-60Hz
**Video bandwidth:** 20MHz
**Active display area:**
216(H) x 160(V)mm.
**Dispiay character:**
80 character x 24 rows.
**Input terminal:** RCA Phono Jack.
**Controls:**
**Outside:** Power Switch, Contrast, Brightness, H-Shift, V-Size.
**Inside:** H-Width, H/V hold, H/V linearity, Focus.
**Power supply:** 110/120V 60Hz, 220/240V 50Hz
**Dimensions:**
310(W) x 307(H) x 300(L)mm
**Weight:** 8·1 Kg
**Shipping weight:** 9·6 Kg

Cat.No. Description Price
X14510 GREEN **only $149**
X14512 AMBER **only $149**



## NEC DISK DRIVES

### 3½" DISK DRIVE
- 1 M/Byte unformatted, (640K formatted),
- Double sided, double density,
- Access Time 3m/sec

Cat. ..... **$255**

### 5¼" SLIMLINE
- Switchable 1.6 M/Byte to 1 M/Byte unformatted
  1.2 M/Byte to 720K formatted
- Double sided, double density,
- AT compatible

Cat. C11906 ..... **$269**

### 8" SLIMLINE
- Double sided, double density,
- 1.6 M/Byte unformatted.

Cat. C11908 ..... **$785**

## CANON A-50 PRINTER
- Serial Impact Dot Matrix
- 180 C.P.S
- Near Letter Quality Mode
- 1.4K Buffer

Cat. C20045 ..... **$595**

## SAMSUNG 12" 20MHz COMPOSITE MONITOR ONLY $129

**FEATURES....**
- High contrast, non-glare screen
- High resolution, 80 or 40 character display

**SPECIFICATIONS....**
**Picture tube:** 12" diagonal and 90° deflection
**Phosphor:** Available in Green (P39) or Amber
**Video input signal:** Composite Signal
**Polarity:** Negative Sync.
**Level:** 0·5V-2·0Vp-p
**Scanning frequency:**
**Horizontal:** 15.734 KHz + -0·1%.
**Vertical:** 60Hz
**Video bandwidth:** 20MHz
**Active display area:**
216(H) x 160(V)mm.
**Display character:**
80 characters x 25 rows.
**Input terminal:** RCA Phono Jack
**Controls:**
**Outside:** Power Switch, Contrast, Brightness, H-Shift, V-Size.
**Inside:** H-Width, H/V hold, H/V linearity, Focus.
**Power supply:** 110/120V 60Hz, 220/240V 50Hz
**Dimensions:**
308(W) x 307(H) x 297(L)mm
**Weight:** 7·3 Kg
**Shipping weight:** 8·3 Kg

Cat.No. Description Price
X14514 (GREEN) **$129**
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Seagate drive, IBM* compatible. 12 month warranty.
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**$27** **$26** **$24**

(ALL PRICES PER 10 DISKS. TAX EXEMPT PRICES LESS $2)

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| 5¼" 1S/2D | $12.95 | $11.95 |
| 5¼" 2S/2D | $13.95 | $12.95 |

(SEND $2 FOR SAMPLE DISK!)

## 5¼" DISK STORAGE (DD50-L)

Efficient and practical. Protect your disks from being damaged or lost!
**Features...**
- 50 x 5¼" disk capacity
- Smoked plastic hinged lid
- Lockable (2 keys supplied)
- Contemporary Design

Cat. C16025 ..... **only $14.95**

## JUMBO 5¼" DISK STORAGE (DD120-L)

If you have lots of disks, you'll appreciate the extra capacity of this disk storage unit when it comes to locating a particular disk.
**Features...**
- 120 x 5¼" disk capacity
- Smoked plastic hinged lid
- Lockable (2 keys supplied)
- High impact plastic base

C16028 ..... **only $22.95**

## 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**

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***All prices 10 disk boxes!***

| Description | 1-9 boxes | 10+ boxes |
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| 3½" 1S/2D | $44.95 | $42.95 |
| 3½" 2S/2D | $46.95 | $43.95 |
| 5¼" 1S/2D | $22.00 | $21.00 |
| 5¼" 2S/2D | $26.00 | $24.00 |
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It only takes a minute amount of dust, dirt or magnetic oxide particles on your drive heads to cause problems: errors, downtime or an expensive service call. Regular use of a head cleaner will keep your drive free of trouble causing dirt and help keep your system up and running. These disk cleaners are simple to use, and include cleaning solution and instructions.

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|---|---|---|
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| C12555 | 5¼" | $6.95 |

## 5¼" DISK STORAGE (DD100-L)

Efficient and practical. Protect your disks from being damaged or lost!
**Features...**
- 100 x 5¼" disk capacity
- Smoked plastic hinged lid
- Lockable (2 keys supplied)
- High impact ABS plastic base.
- Contemporary design

C16020 **only $17.95**

## 3½" DISK STORAGE (DD80-L)
- Holds up to 80 x 3½" diskettes.
- Smoked plastic hinged lid
- Lockable (2 keys supplied)
- High impact plastic base
- Contemporary design

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## Smalltalk is cheap

*APC* has negotiated a special deal with Software Express which will enable our readers to follow the 'Teach Yourself Smalltalk' series at a reasonable cost.

For owners of an IBM compatible, an Acorn Archimedes or an Atari ST, Little Smalltalk is available for $15 for the disk and minimal documentation. All versions of Little Smalltalk will be supplied with the original C source code and example programs.

Smalltalk/V, the highly recommended graphical Smalltalk programming environment for IBM compatibles with at least 512k of RAM and two floppy disk drives, is available for $165 including full documentation. A free copy of Little Smalltalk will also be supplied with Smalltalk/V.

All prices include tax and postage & packing. Cheques should be made payable to 'Software Express', 48 A'Beckett Street, Melbourne Vic 3000.

MVC has acquired an unjustified reputation for being difficult to use and understand.

Many people who supply Smalltalk systems publish applications notes or papers that describe how to use Model-View-Controller, but it still remains a stumbling block for novice Smalltalk programmers. Source code for the MVC classes is provided with Smalltalk and using the browser to look at the Model-View-Controller class source code and see how the existing Smalltalk tools make use of them is a good way to learn about the MVC classes.

Model-View-Controller divides an application up into three elements: the 'Model', the 'View' and the 'Controller'. For most applications only the model will require extensive programming. The View and Controller elements are created by re-using classes from the View or Controller class hierarchy.

The 'Model' is the object that represents the application being displayed or viewed. Any Smalltalk object can act as the model — until recently there was no class Model defined in Xerox Smalltalk — which was the source of some confusion. All the objects care about is that the object being used as the model can understand the messages that they send to it and that the results are intelligible to them. The messages that provide these links between Models, Views and Controllers and the message protocol that is assumed are implemented in Class Object — so all objects understand them.

A 'View' provides a visual picture or view of some part of the model. There can be multiple views of the same object or different parts of the object. At the top of the class hierarchy for Smalltalk view objects is the Class View. Other views are subclasses of View that get more and more specialised but perform more useful functions for the user. Some examples are BinaryChoiceView which displays a view giving a choice between two different options, FormView which provides a view onto a form object, and TextView which provides a view of formatted text. (Smalltalk/V uses slightly different names for some of these classes.)

A 'Controller' handles the interaction between the application and the user — the interface with the keyboard, mouse or other peripheral devices. As with Views, Smalltalk provides a set of different Controller classes which can be re-used in an application. At the top of the hierarchy is class Controller which implements the messages all controllers have to understand. Other controllers include: BinaryChoiceControllers, which let a user choose between two different options; MouseMenuController, which handles the interaction with a pop-up menu controlled by a mouse; ParagraphEditor, which is a controller that allows the input of formatted text; and ListController, which lets the user choose between items displayed on the screen.

*'The ability to create, manipulate and display high-quality graphical images is a fundamental part of the (Smalltalk system).'*

Class StandardSystemController is the standard controller for a Smalltalk window. It handles all the interactions that allow a window to be displayed, moved, have its size altered, and so on.

The objects that represent the model, one or more views, and one or more controllers are linked together through a dependency chain. This is a mechanism by which Smalltalk objects can communicate changes in their internal state to other interested objects. Whenever the state of an object changes, it can send itself a 'self changed' or similar message. The implementation of this message sends further messages to the objects that are dependent on that object. This is a powerful but simple mechanism. There are a number of messages provided in class Object that enhance the basic dependency mechanism by allowing an object to broadcast messages to all interested objects at once or to alter the update mechanism to improve efficiency.

For example, suppose we have an object that stores a number, and a simple object that provides a view onto that number. Whenever the value of the number changes, the view object will get a message saying its model has changed its value. The View object can then ask the model object its new value and display the result on the screen. If a user points at the view on the screen and changes the number, the controller object can be used to notify the view and model to accept a new input value.

## The constraint system browser

By putting the simple network constraint system described last month ('Class system', *APC*, March) together with the Smalltalk graphics and user interface classes, it is possible to create an interactive application program — the constraint browser. This will allow the graphical display and input of constraint networks created using last month's programs.

To do this we can make use of a number of the standard building block classes from the View and Controller class hierarchies. An instance of Class Network would represent the model. A custom subclass of one of the view classes will provide a view onto the displayed network and a controller subclass will let the user point at the displayed network and make changes. Such applications can be built incrementally: having created the constraint Network classes and tested them using Smalltalk applications, we can now reuse them in an interactive application.

END

## Homework

- Investigate the Smalltalk graphics classes.
- Can you use Class Pen and Class Rectangle to create a class of Rectangle that knows how to display itself onscreen?
- How about using BitBlt instead of Class Pen to do the same job?

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**NEW**

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**NEW**

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**UnDELETE:** Restores erased or deleted files. UnDelete will show a list of all deleted files in the File Allocation Table and allow you to choose the one you wish to undelete. Recovers easily, quickly and safely.

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**RESTORE BOOT SECTOR:** The Boot sector contains a program that loads DOS when the computer is turned on. It also has information pertaining to the format of the disk or partition. RESTORE BOOT will copy, from a picture taken by MACE, a new boot sector to an unbootable drive.

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**SQZD:** Optimizes directory paths. SQZD removes deleted entries from all directories and closes up the spaces.

**VCACHE:** Hard disk accelerator increases speed of cartridge and fixed disk operations using memory caching to eliminate repetitive disk access. Allocate up to 8MB of extended or expanded memory, or 512K of standard memory for caching disk data. Automatic and transparent after installation.

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# Better bit-mapped lines

***Jerry Van Aken and Carrell Killebrew show how Bresenham's Line Algorithm provides a quick way to approximate lines on a bit-mapped display***

Drawing a line is a fundamental operation in a computer graphics system, but representing a line on a bit-mapped display is not as simple as it seems. The problem is that computers cannot represent a straight line exactly. Since few pixels are likely to lie exactly on the line, a line algorithm must choose a connected set of pixels that follows the path of the line as closely as possible.

Early computer graphics systems used a digital differential analyser (DDA) algorithm to choose the pixels for drawing a line. DDA line generation suffers because the algorithm uses floating-point arithmetic, which is slow in a typical computer system. A line algorithm using simple integer arithmetic would be much faster.

In 1965, Jack Bresenham of IBM published a fast line-drawing algorithm that uses only integer addition and subtraction. This article derives Bresenham's Line Algorithm from basic principles and provides source program listings in Pascal. The easiest way to get these listings is by downloading them from Microtex (see page *6663#). Alternatively, they may be obtained by sending an IBM PC-formatted 5.25in disk to 'Bit-mapped lines', c/- *APC,* 124 Castlereagh Street, Sydney 2000.

## Drawing a line faster

Fig 1 illustrates the basic principle of Bresenham's algorithm. A line segment extends from the origin to a point *(a,b)*, and the equation that must be satisfied by all points on this line is

$$f(x,y) = b \times x - a \times y = 0$$

Points that do not satisfy this equation lie to one side or the other of the line. As Bresenham's algorithm tracks the line from beginning to end, it measures the value of $f(x,y)$ at regular intervals in order to choose pixels along the way to represent the line. At a point $(x,y)$ located below the line, $f(x,y)$ is positive (ie, $b \times x - a \times y > 0$). Above the line, $f(x,y)$ is negative. By monitoring the sign of the function at or near the current pixel, the algorithm can tell whether it is moving too far above or below the line, and make a course correction when choosing the next pixel. This is a powerful technique that has been extended to computer drawing of more complex curves such as circles, ellipses, and other conic sections.

Fig 2 is a line drawn by the algorithm. The line segment starts at (0,0) ends at

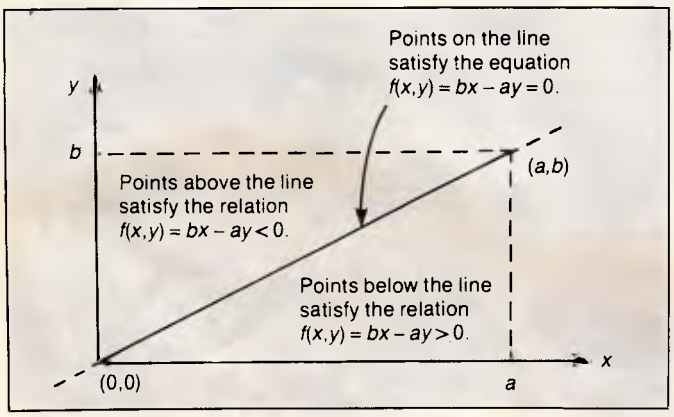


*Fig 1 Basic principles of the algorithm*

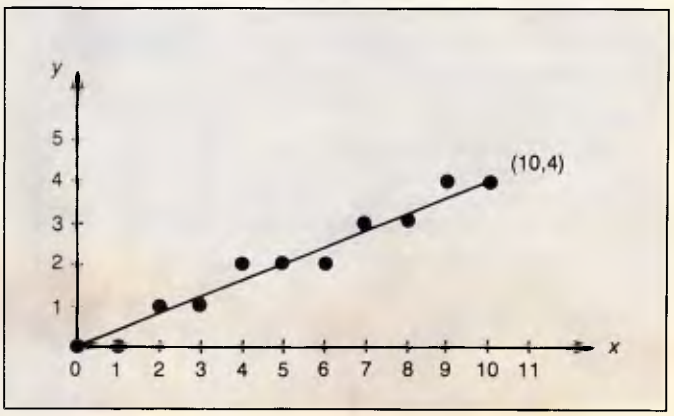


*Fig 2 Pixel approximations of line from origin to (10,4)*

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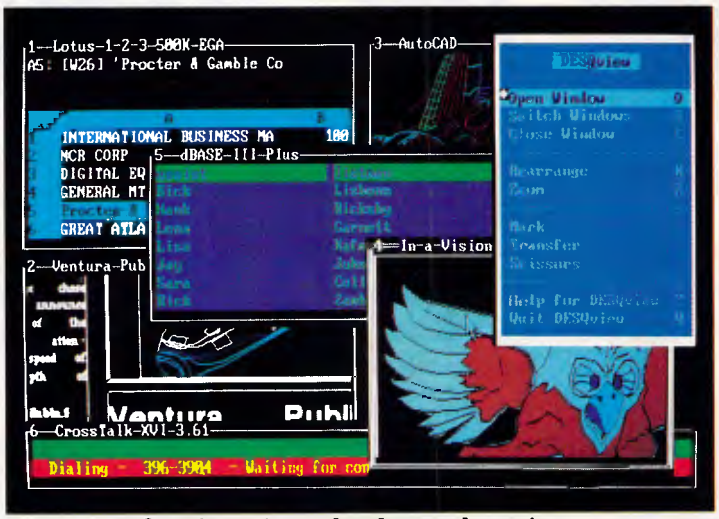


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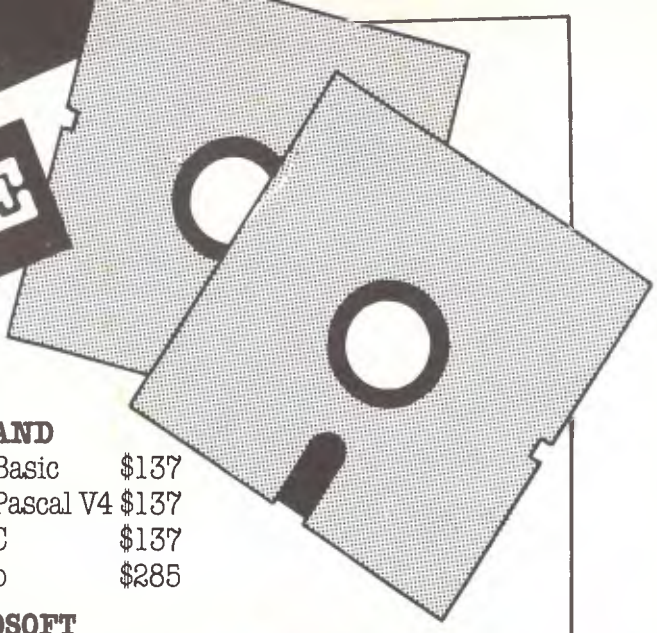

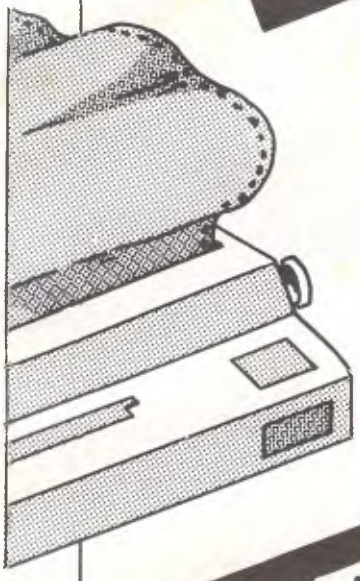

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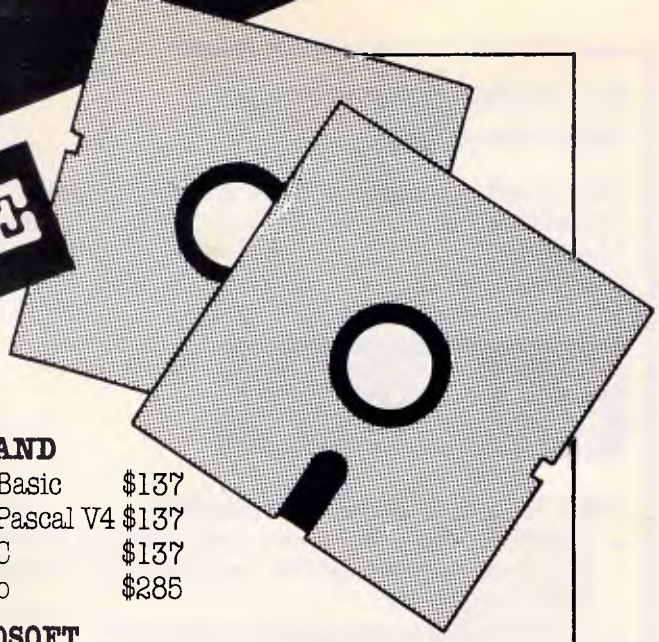

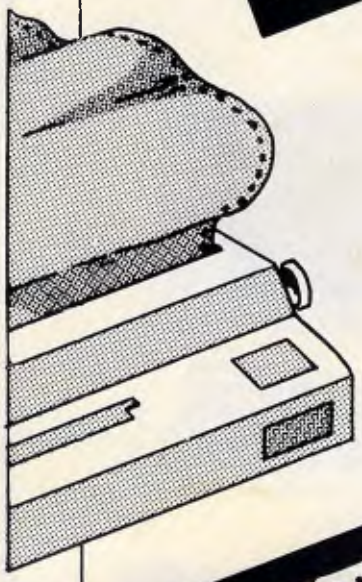

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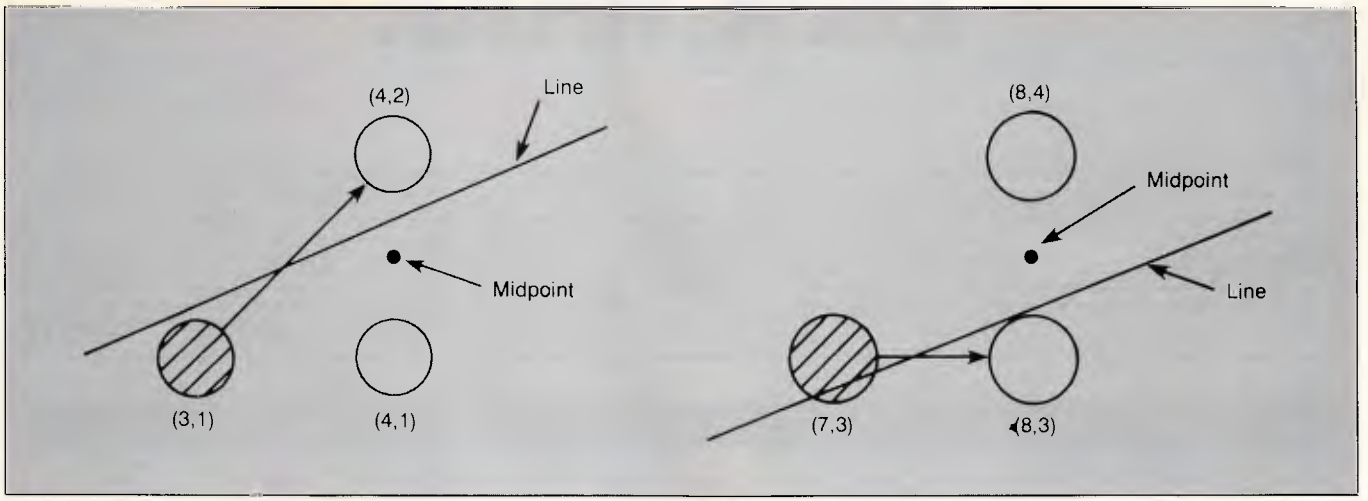


*Fig 3 Examples of the decision process*

(10,4), and is defined by the equation.

$f(x,y) = 4 \times x - 10 \times y = 0$

The algorithm selects the pixels in Fig 2 that lie as close as possible to the actual line. As the line is drawn from left to right, each new pixel is selected to be either the pixel directly to the right of the previous pixel (a horizontal move), or the pixel above and to the right of the previous pixel (a diagonal move).

The algorithm chooses between these two pixels by determining which is closer to the actual line. It does so by checking whether the point exactly halfway between the two pixels lies above or below the line. If the line passes below the midpoint, it chooses the lower pixel; otherwise, it chooses the upper pixel.

Fig 3a shows where the algorithm chooses the upper pixel. It illustrates the decision process performed by Bresenham's algorithm in selecting the pixel at (4,2) in Fig 2. The pixel at (3,1) is already turned on, having been selected in the previous step. The problem now is to choose between the pixels at (4,1) and (4,2). To make this decision, the algorithm evaluates the function $f(x,y) = 4 \times x - 10 \times y$ at a point lying at (4,1.5), halfway between the two pixels under consideration. At the mid-point, the function evaluates to $4 \times 4 - 10 \times 1.5 = 1$. Since this is a positive value, the midpoint must lie below the line. The pixel at (4,2) therefore lies closer to the line, and is selected.

Fig 3b is an example where the algorithm selects the lower of the two pixels it considered. This figure illustrates the selection of the pixel at (8,3) in Fig 2. The algorithm chooses the pixel at (8,3) over the one at (8,4) by observing that the function $f(x,y)$ evaluated at the midpoint (8,3.5) is $4 \times 8 - 10 \times 3.5 = -3$. The negative value indicates that the midpoint is located above the line. The pixel at (8,3) therefore is closer to the line than the one at (8,4) and is selected.

## The basic algorithm

Listing 1 is a rudimentary form of the algorithm capable of drawing the line shown in Fig 2. It takes as its input arguments the endpoint coordinates *a* and *b*. For the sake of simplicity, assume that the starting point is always (0,0) and that the endpoint coordinates *(a,b)* satisfy the relation $0 \le b \le a$, where *a* and *b* are integers. (In other words, point *(a,b)* lies in the first octant of Cartesian coordinate space). The algorithm is easily extended to overcome these restrictions, as we will show later.

```
procedure draw_line (a, b: integer);
                    { a is the endpoint x
                              coordinate. }
                    { b is the  endpoint y
                              coordinate.}

var x,              { current x coordinate }
    y,              { current y coordinate }
    d,              { decision variable    }
    i:              { loop index           }
       integer;

begin { draw_line }
    x := 0;         { line starts at (0,0) }
    y := 0;
    for i := 0 to a do  { Draw the a+1 pixels
                          in the line. }
      begin
    draw_pixel(x,y);
    d :=  b * (x + x + 2) { Evaluate line
                           formula at
                           midpoint. }
          - a * (y + y + 1);
    if d < 0 then         { Is midpoint  above
                                the line? }
       x := x + 1;        { Yes, step
                            horizontally. }
    else
      begin             { Midpoint is below the
                                    line, }
       x := x + 1;      { so step diagonally. }
       y := y + 1
      end { else }
     end { for }
end; { draw_line }
```

*Listing 1: A line algorithm restricted to the first octant*

A drawback to this form of the algorithm is that each iteration of the inner loop requires two multiplications, which are more time-consuming than simple operations such as addition. A later version of the algorithm will replace the multiplications with simpler operations in order to speed up line drawing. The line drawn by the algorithm in listing 1 is described by the equation $f(x,y) = b \times x - a \times y = 0$. At the start of iteration 'i' of the 'for' loop, a single pixel is drawn at the current location $(x[i],y[i])$ by the function 'draw_pixel'. As illustrated in the examples of Fig 2, the two candidate pixels for the next point to be drawn are located at $(x[i] + 1,y[i])$ and $(x[i] + 1,y[i] + 1)$, and the midpoint of these two pixels is at $(x[i] + 1,y[i] + 1/2)$. The algorithm chooses between the two candidate pixels based on the sign of *f()* evaluated at the midpoint, which is $b \times (x[i] + 1) - a \times (y[i] + 1/2)$. The algorithm in listing 1, in fact, assigns twice this value to variable *d*, called the decision variable:

$d[i] = 2 \times f(x[i] + 1,y[i] + 1/2)$
$= b \times (2 \times x[i] + 2) - a \times (2 \times y[i] + 1).$

Multiplying *f()* by 2 ensures that *d* is an integer for all values of *a*; the factor of 2 has no other effect, since the sign of *d* will always be the same as that of *f()* evaluated at the midpoint.

## Speeding up the algorithm

You can make the algorithm in listing 1 faster by reducing the calculations required to evaluate *d* during each iteration of the loop. In general, *d* increases by 2

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```
procedure draw_line (a, b: integer);
{ a is the endpoint x coordinate. }
{ b is the endpoint y coordinate. }
var x,          { current x coordinate }
    y,          { current y coordinate }
    d,          { decision variable    }
    diag_inc,               { d's increment
              for diagonal steps }
    nondiag_inc:            { d's incr. for
               non-diagonal steps )
       integer;
begin { draw_line }
    x := 0;         y :=0; { start at (0,0) }
    d := b + b - a; { initial value for d }
    nondiag_inc := b + b;
      { Evaluate the d increment values.  }
    diag_inc := b + b - a - a;
    for i := 0 to a do            { Draw the
                  a+1 pixels in the line. }
      begin
  draw_pixel(x,y);
  if d < 0 then          { Is midpoint
                    above the line? }
    begin       { Yes, step horizontally. }
      x := x + 1;
      d := d + nondiag_inc   { Update the
                         decision variable.  }
    end { if-then }
  else
    begin  { Midpoint is below the line,  }
      x := x + 1;   { so step diagonally.   }
      y := y + 1;
      d := d + diag_inc      { Update the
                       decision variable.  }
    end { else }
      end { for }
end; { draw_line }
```

*Listing 2: A faster line algorithm, but still restricted to the first octant*

```
procedure draw_line (xstart, ystart, xend,
                                yend: integer);

var x, y,       {current x and y coordinates}
  d,          {decision variable}
  a, b,       {line displacements in x and y}
  dx_diag,    {diagonal x step for next pixel}
  dy_diag,    {diagonal y step for next pixel}
  dx_nondiag, {nondiagonal x step for next
                                pixel}
  dy_nondiag, {nondiagonal y step for next
                                pixel}
  diag_inc,   {d's incr. for diagonal steps}
  nondiag_inc, {d's incr. for nondiagonal
                                steps}
  swap:       {temporary variable for swaps}
    integer;

begin{draw_line}
  x := xstart;      {line starting point}
  y := ystart;
{Determine drawing direction and step to the
                                next pixel.}
  a := xend - xstart;   {Calculate difference
                                in x}
  b := yend - ystart;   {Calculate difference
                                in y}
{Determine whether ending point lies to right
 or left of start point.}
  if a < 0 then      {Drawing towards smaller
                                x-values?}
   begin         {Yes, because a is negative.}
  a := -a;       {Make a positive    }
  dx_diag := -1 {and set x-movement
                                accordingly.}
   end
  else       {Draw is towards larger x-
                                values.}
  dx_diag := 1; {Set x-movement towards
                                larger x.}
{Determine whether ending point lies above or
 below starting point.}
  if b < 0 then {Drawing towards smaller y-
                                values?}
   begin       {Yes, because b is negative.}
  b := -b;      {Make b positive and}
  dy_diag := -1      {set y-movement
                                accordingly.}
   end
  else       {Draw is towards larger y-
                                values.}
  dy_diag := 1;      {Set y-movement towards
                                larger y.}
{Identify octant containing ending point. }
  if a < b then      {Is y-diff. larger than
                                x-diff.?}
   begin       {Yes, so swap a and b    }
  swap := a;
  a := b;
  b := swap;
  dx_nondiag := 0;   {Since y difference is
                                larger, x}
  dy_nondiag :=dy_diag  {doesn't change on
                                nondiagonal}
   end{if-then}      {steps, but y changes
                                every step.}
  else       {When x-diff. is larger than  }
   begin       {y-diff., x changes every
                                step,}
  dx_nondiag := dx_diag;    {and y changes
                                only on the}
  dy_nondiag := 0     {diagonal steps.}
   end{else}
  d := b + b - a;    {Initial value for d is
                                2*b-a.}
  nondiag_inc := b + b;    {Set initial d
                               increment values}

  diag_inc := b + b - a - a;
  for i := 0 to a do  {Draw the a+1 pixels.}
   begin
  draw_pixel(x,y);
  if d < 0 then      {Is midpoint above the
                                line?}
   begin      {Yes, step nondiagonally.}
    x := x + dx_nondiag;
    y := y + dy_nondiag;
    d := d + nondiag_inc  {Update the
                 decision variable.}
   end{if-then}
  else       {Midpoint is below the line,}
   begin      {so step diagonally.}
    x := x + dx_diag;
    y := y + dy_diag;
    d := d + diag_inc    {Update the decision
                                variable.}
   end{else}
   end{for}
end;{draw_line}
```

*Listing 3: Final form of Bresenham's Li[illegible]rithm*

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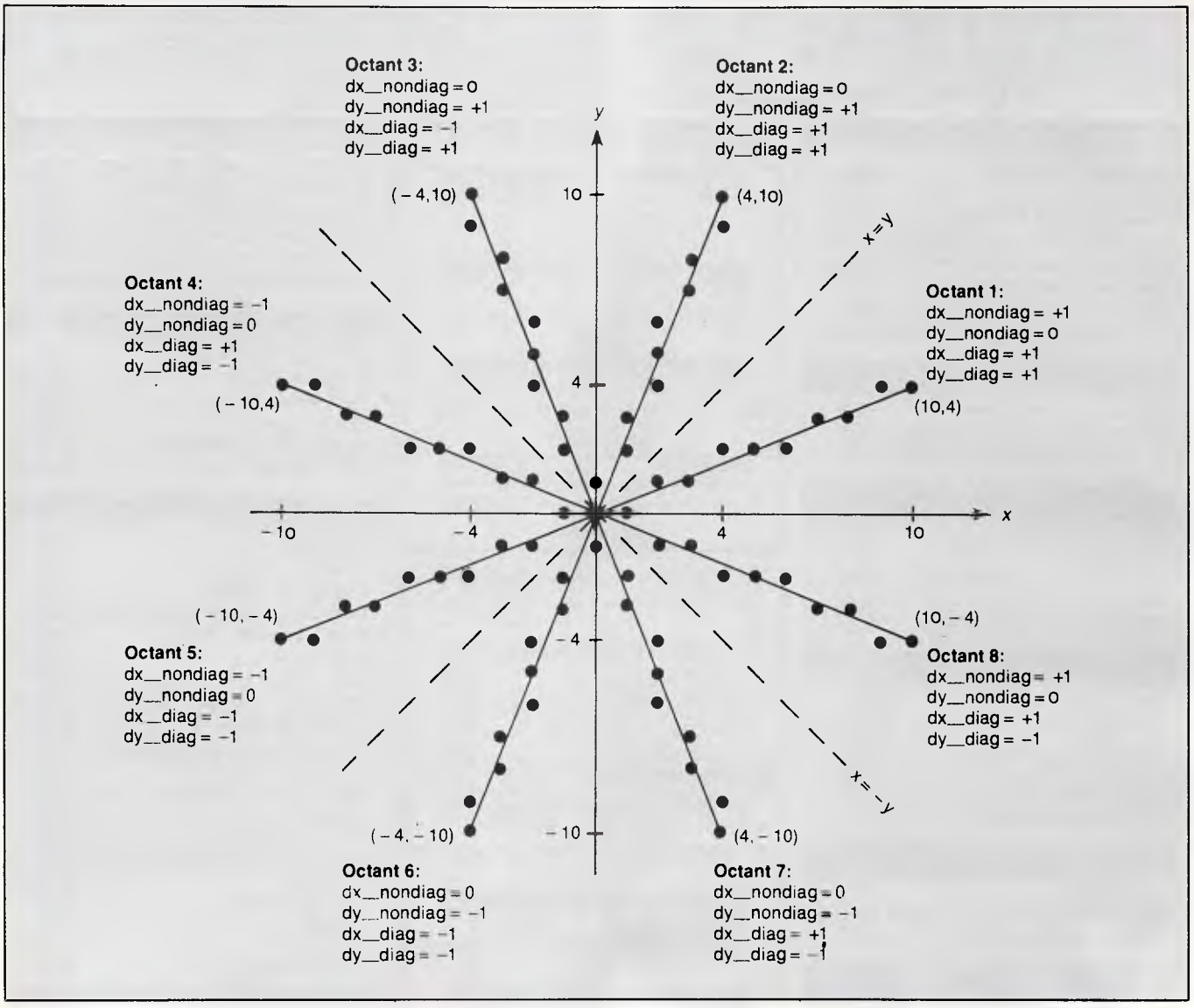


*Fig 4 Eight-way symmetry used for the general algorithm*

x *b* — 2 x *a* for a diagonal step, and 2 x *b* for a horizontal step. A little algebra shows that this is always true. In stepping diagonally from a point

(*x*[*i*],*y*[*i*])

to

(*x*[*i*] + 1,*y*[*i*] + 1),

the value of *d* changes from

*d*[*i*] = 2 x *b* x *x*[*i*] + 2 x *b* — 2 x *a* x *y*[i] — *a*

to

*d*[*i* +1] = 2 x *b* x *x*[*i*] + 4 x *b* — 2 x *a* x *y*[*i*] — 3 x *a*

(a change of 2 x *b* — 2 x *a*). When a horizontal step is taken from a point

(*x*[*i*],*y*[*i*])

to

(*x*[*i*] + 1,*y*[*i*]),

the value of *d* changes from

*d*[*i*] = 2 x *b* x *x*[*i*] + 2 x *b* — 2 x *y*[*i*] — *a*

to

*d*[*i* +1] = 2 x *b* x *x*[*i*] + 4 x *b* — 2 x *a* x *y*[*i*] — *a*

(a change of 2 x *b*). By calculating these two values prior to entering the drawing loop, you can improve line-drawing performance. This way, you reduce updating *d* during each iteration to simply incrementing *d* by the appropriate loop constant.

Listing 2 is an improved version of the algorithm in listing 1. It eliminates the two multiplies per loop, and updates decision variable *d* incrementally. It calculates the initial value of *d* in terms of the initial values of *x* and *y* as follows:

*d*[0] = *b* x (2 x *x*[0] + 2) — *a* x (2 x *y*[0] + 1) = 2 x *b* — *a*

where *x*[0] = *y*[0] = 0. *Two new variables, 'nondiag_inc' (which equals 2* x *b*) and 'diag_inc' (which equals 2 x *b* — 2 x *a*) are created to increment *d* during each iteration.

## *A fast unrestricted algorithm*

The algorithm in listing 2 is still subject to

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the restrictions that the starting point must lie at (0,0) (the origin), and the endpoint coordinates must satisfy $0 \leq b \leq a$ (which restricts the ending point to the first octant of Cartesian coordinate space). In listing 3, both restrictions have been removed by using symmetry and translation. This is the final form of Bresenham's algorithm.

Fig 4 illustrates how you can use symmetry to draw lines in any of the eight octants. Although each of the eight lines is in a different octant, the lines all have the same shape because they follow identical sequences of diagonal and non-diagonal steps in moving from the starting point to the ending point. The symmetry of the eight lines in Fig 4 results from the fact that the algorithm uses the same values of *a* and *b* (for this example, $a = 10$, $b = 4$) for each of the lines. The only difference between drawing in one octant and another is the direction of diagonal and non-diagonal steps. The algorithm in listing 3 tests the endpoints to determine in which octant the line lies. After the target octant is determined, the *x* and *y* increments for diagonal and non-diagonal steps are adjusted to draw the line in the proper direction.

In listing 3, non-diagonal steps cause *x* and *y* to increment by 'dx_nondiag' and 'dy_nondiag'. Fig 4 shows the values of these increments in each of the eight octants.

The final step in achieving the general form of the algorithm in listing 3 is to allow the line to begin at points other than the origin. Whereas variables *a* and *b* represented the co-ordinates of the endpoint in listings 1 and 2, in listing 3 they represent the distances in *x* and *y* from the starting point to the ending point; *a* is set to the larger of these distances, and *b* to the smaller.

Described in geometric terms, when the algorithm initially assigns values to parameters *a* and *b*, it effectively translates the starting point of the line to the origin.

At this point in the algorithm, the ending point of the translated line is at (*a*,*b*), and variables *a* and *b* contain information regarding both the shape of the line and the octant of the translated ending point. In the three subsequent tests of the values of *a* and *b* (Is $a < 0$? Is $b < 0$? Is $a < b$?) the octant information is stripped away from *a* and *b*, leaving only the shape information. Meanwhile, all information regarding the octant of the ending point is transferred to the *x* and *y* increments 'dx_diag', 'dy_diag', 'dx_nondiag' and 'dy_nondiag'. All this takes place prior to entering the 'for' loop in listing 3.

## *Practical implementations*

In a real graphics system, you should encode the algorithm in listing 3 in assembly language to make it run as fast as possible. For instance, a typical CAD diagram might contain hundreds of lines, and the user waits while the computer draws the diagram on the screen. The programmer should put the most effort into speeding up the 'for' loop, since this is executed once for each pixel drawn, and one line may contain hundreds of pixels.

By comparison, the code that precedes the 'for' loop executes only once per line. The call to the 'draw_pixel' procedure should be replaced by in-line code for the 'draw_pixel' operation in order to remove the subroutine call overhead from the inner loop.

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# Programming with Intuition

***Popular though the Amiga may be, its programming resources and the potential for its window operating system, Intuition, remain virtually untapped or buried in its voluminous manuals. Mark Burgess develops some basic ideas in C, the machine's native language.***

Very little has been written about programming the Amiga and its window operating system, Intuition: and virtually nothing has been written about them from the point of view of C, despite the fact that C remains the native language of the Amiga, with most of its large and difficult manuals being addressed to C programmers and authors to embrace C as the natural language for the machine.

Whatever the reason, Intuition remains the most powerful windowing environment available for a micro and C remains the ideal language for it.

## Overview

A glance through the four hefty Amiga programmers' manuals (which can be obtained at vast expense from Addison Wesley) is possibly the most depressing start to Amiga programming that a novice can make.

These manuals, some of which resemble a thick mail order catalogue, require a high degree of technical knowledge and each one is intimately cross-referenced to each of the others, so a serious programmer must have them all. Despite this, in many cases it should be possible to get away with the Intuition manual alone, with the help of a little foreknowledge.

Intuition is the name given to the highest level of the Amiga's windowing systems. It controls windows, graphics, mouse operations and all of the menu functions. In this respect, it is like GEM or Macintosh windows. In essence, what you normally see on an Amiga screen is what Intuition does. But, Intuition is different from other windowing systems in one crucially important way: Amiga windows multi-task.

What is so special about that? In fact, quite a lot. Think of a situation in which there are two (or more) programs running together, simultaneously, on the screen. Suddenly, both programs stop and wait for input from the user. The user starts to type something on the keyboard and ... wait! Which program receives the input? How does the user direct input to the right program?

The answer is that Intuition keeps only one window 'active' at any time: all other windows are 'ghosted' or are kept in a state of isolation from the outside world. The user can make any window the currently active window by clicking the mouse anywhere inside it. Since this is so fundamental to the operation of the Amiga, even when there are no WIMP-based programs running, it is almost impossible to get rid of the mouse pointer from an Amiga screen — it is an integral part of the computer's operation.

The upshot of all this is that the window/mouse manager, Intuition, has to be able to communicate, in private, with every program, individually, in the society of programs which is running on the machine. It does this by means of 'messages'.

## Messages & events

A message is a bundle of information which Intuition creates for a program each time something happens with the mouse, the keyboard, or the input generally. It is created in the form of a 'structure' in C, called:

```
struct IntuiMessage
```

As the user does more mouse clicking and keyboard tapping, these software messages queue up in the machine, separately for each program, and wait to

### Glossary for non-C programmers

**Pointer:** A pointer is a variable which stores the location of a variable in memory.
**Structure:** Called 'records' in many other languages, structures are 'packages' which can hold several variables of different types. Different types of structure have different names — for example, NewWindow, Border. Different kinds of structure hold different names — for example, NewWindow, Border. Different kinds of structure hold different configurations of variables. The variables inside a structure are called its 'members'.

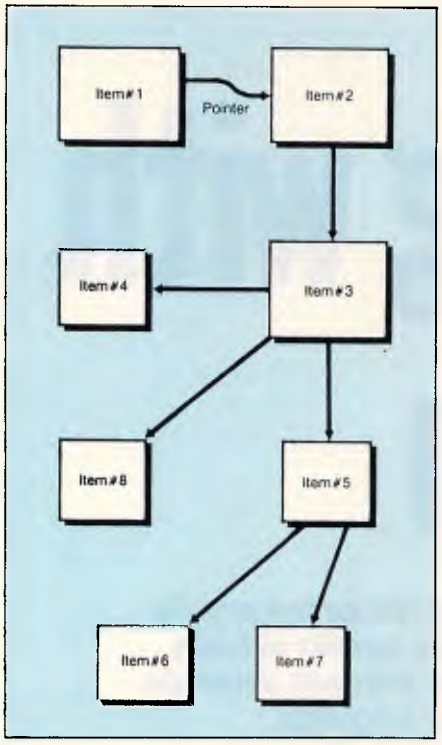


*Fig 1 A linked list is a versatile way of making a list. The items are 'structures' and arrows are pointer to other structures. The possibilities are unlimited*

be read. On an ordinary single-processor machine, a program learns about mouse clicking and keyboard tapping from 'events' or software interrupts. Messages are the Amiga's answer to events which are private for each multi-tasking program, executing concurrently on the machine. Each message contains a bundle of information, identifying itself to a program.

Intuition messages come in a variety of different 'classes' which have names, defined as macros in the C header files:

types.h

and

intuition.h

Each class of message is about a different kind of input event. A program learns about the class of message by interrogating the 'information bundle' and deciding what the message is about. A rogram is then expected to 'reply' to a message in order to eliminate it from the queue. All of this can be done very simply with a 'message monitor' which reads messages one after the other and acts upon them. The whole process is reduced to a relatively simple loop.

Intuition does most of the work for a programmer who wants to write WIMP (window, icon, mouse and pull-down menus) based programs. It issues messages to programs about what happens in the application's window. A programmer has only to design the imagery on the screen and Intuition handles the rest.

## Bits & pieces

One of the things which makes Amiga programming difficult is that Intuition is surrounded by a plethora of fantastic jargon. Everything on the Amiga seems to have a special name which adds to the 'Amiga myth' but often loses the adventurer. Once the jargon has been mastered, though, it all adds to the illusion that you are really programming something new and unique; and whatever vows you make never to talk Amiga-speak, they'll soon be broken. Computers are like that.

The basic objects on the screen are:

- WORKBENCH This is the 'desktop' environment which boots up on starting the Amiga. This desktop multi-tasks, so it is always active and in control. Workbench is also the name of a 'screen' which the the backdrop for all windows.
- WINDOW A window is a rectangular box which is a kind of portal for programs to the outside world. Amiga windows are usually independent (connected to different programs).
- ICON This is a picture with a name which the user clicks in order to run a program.
- MENU A pull-down menu.
- GADGET Gadgets come in several different types. They are things which the user activates with the mouse, such as switches, toggles and sliders — in other words, easy ways of playing with the program.
- GADGET SELECT BOX The area on the screen in which the user has to move the mouse pointer in order to use a gadget.
- STRING GADGET A gadget which takes a string from the user.
- BOOLEAN GADGET This is a push-button-type gadget which the user 'presses' once. For example, press a button to quit the program.
- BORDER A series of graphic lines connected together to make up some kind of image on the screen. A border does not have to be the border of anything, but that is how the name started. Borders are coordinate-drawn relative to a local origin — a gadget box for example.

## Setting up an application

A program can make use of the above-mentioned input utilities in a simple way, Intuition, as a device, is set up for C programmers and it uses C's structures for all the basic WIMP objects in a program. The simples way to understand the Intuition approach is to look at a simple example program. (The rest of this article centres around the Intuition features which are relevant to the example program listed at the end of this article.

Consider an applications program which prints address labels like the one sketched out below:

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The idea is to create a program which is run by clicking an icon on the Amiga Workbench: a window props up in the middle of the screen, the user types out a couple of labels and then quits; the window closes and that's that. What does the program need? Obviously, it needs to have a window to communicate with the user. It requires some way of editing (typing lines of text). And finally, it needs to have some kind of switch which prints out the label, and another to quit the program.

The Intuition philosophy is to make all of this information about screen objects into a list. The list is linked up in some way and handed lock, stock and barrel to Intuition, which then does all the draw-

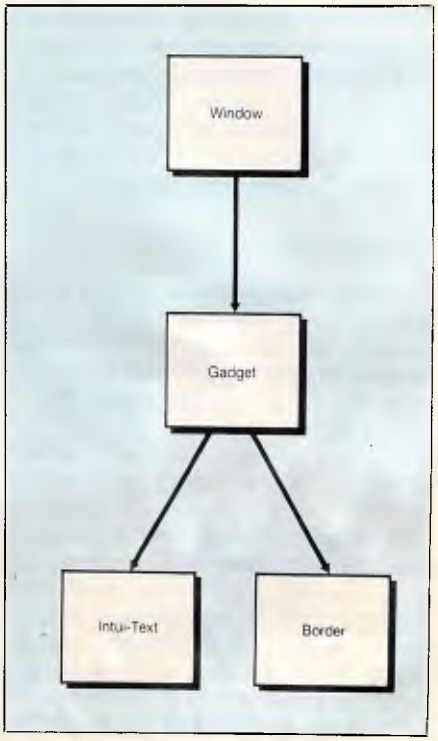


*Fig 2 A hierarchy of data is reflected by the structure of a multiply-linked list*

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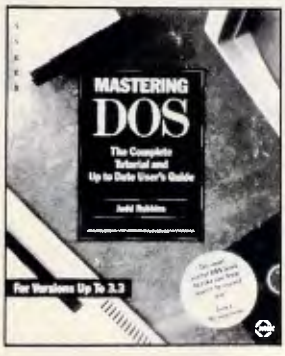


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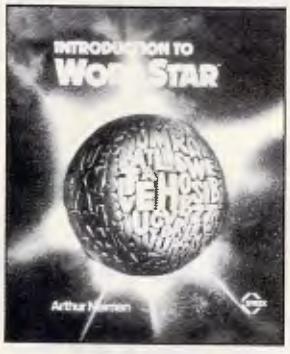


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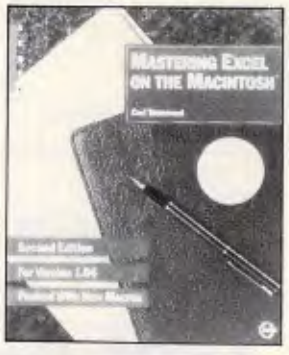


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ing and sets up the necessary management for the mouse and gadgets. The lists are special lists, called 'linked lists', made up of C structures and connected with pointers. They are a very basic data structure for Intuition, almost as fundamental as a 'stack' is to a program. These lists are used because they are so versatile; they can be added to and bits can be removed from them, and moving through them is fast and efficient.

Complex Intuition programs generate long lists, but the programs to handle them are simple. As long as program logic and Intuition 'fiddling' are kept separate, Amiga programs, written in C, remain simple — all the real work is handed over to Intuition.

## Structures & linked lists

A linked list is a list of structures, not necessarily all of the same type, which are joined together with pointers (see Fig 1). Here is a selection of the different kinds of structure in the example program:

struct NewWindow
struct Window
struct RastPort
struct Gadget
struct Border
struct IntuiText
struct IntuiMessage

All of these are 'variable types', rather than variables themselves. In fact, to be precise, they are 'aggregate' types: that is, types which are constructed of clusters of several primitive variable types. Each one of these structures is like a different-shaped brick in a building kit. Each structure contains pointers which can join it onto another kind of structure, but not just any kind: the 'bricks' have to match at the seams to create a valid structure. For example, a program might need to use a mouse gadget to quit the program. The gadget has to go into a certain window, so the gadget structure connects to the window

```
struct Gadget

  {
  struct Gadget   *NextGadget;                    /* 1 */
  SHORT LeftEdge, TopEdge, Width, Height;
  USHORT Flags;
  USHORT Activation;
  APTR GadgetRender;                              /* 2 */
  APTR SelectRender;                              /* 3 */
  struct IntuiText *GadgetText;
  LONG MutualExclude;
  APTR SpecialInfo;                               /* 4 */
  USHORT GadgetID;
  APTR UserData;                                  /* 5 */
  };
```

*Blueprint of a 'gadget' structure*


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structure. The gadget must contain some text to say 'Quit!' and should have a box drawn around it so that the user knows where to point the mouse. So a text structure and a graphics (border) structure is connected to the gadget structure (see Fig 2).

Alternatively, think of a program which simply wants to draw a gadget surrounded by a lot of lines. Again, things would start with a window structure. The gadget structure would be connected to the window structure, the border structure would connect to the gadget structure, another border structure would be connected to the border structure, another border structure to the border structure ... This might sound complicated, but it isn't really difficult: it's just long-winded. Programmers have to realise, though, that data is data and there are no two ways around it: that data must be entered into a program somehow. A linked list is as good a way as any and better than most.

## Pointers

A pointer is a variable which contains the address of another variable in memory. In a linked list there must be space, therefore, in the structures, for the Amiga display objects to contain the addresses of adjoining members of the list. For example, the box on the previous page shows the blueprint of a 'gadget' structure.

There are five pointer members in this structure, and all except the one labelled (5) make a connection to another structure type. In order to connect two structures together, the programmer has simply to store the address of the next structure variable in the member of the gadget structure. For example, to include the text for a gadget, the programmer would write:

```
/* Declarations */

struct Gadget my_gadget;

struct IntuiText my_text;

/* some code which initialises the
   members of these */

my_gadget.GadgetText =
  &(my_text);
```

The ampersand (&) symbol means 'find the address of' or 'find a pointer to'. Thus, the gadget structure variable 'my_gadget' is joined, by a pointer, to an Intuition text structure called 'my_text'. When Intuition comes to 'render' or draw these graphics objects, it will know how to find the text for the gadget.

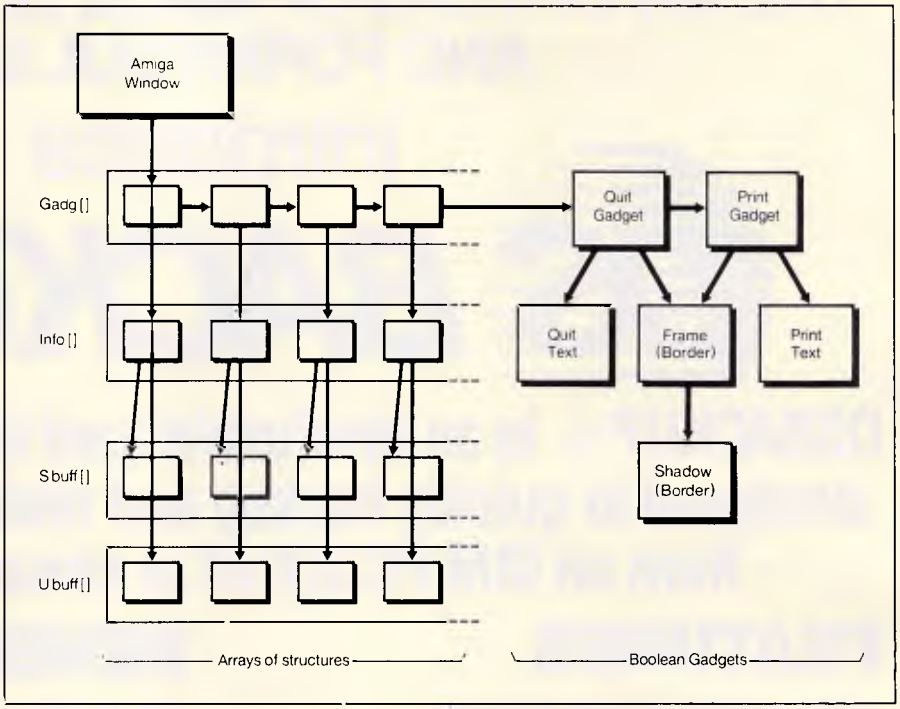


*Fig 3 In an Intuition program, all the complexity is in the data structure*

Alert readers will notice that there are several different and unusual data types in the 'gadget' structure. To begin with there are several kinds of structure, then there are things like APTR which are in upper case. All of these are defined specifically by Intuition — they are not a predefined part of C. The types are declared automatically when programs include the library files:

```
types.h

intuition.h
```

from the header file library in the compiler.

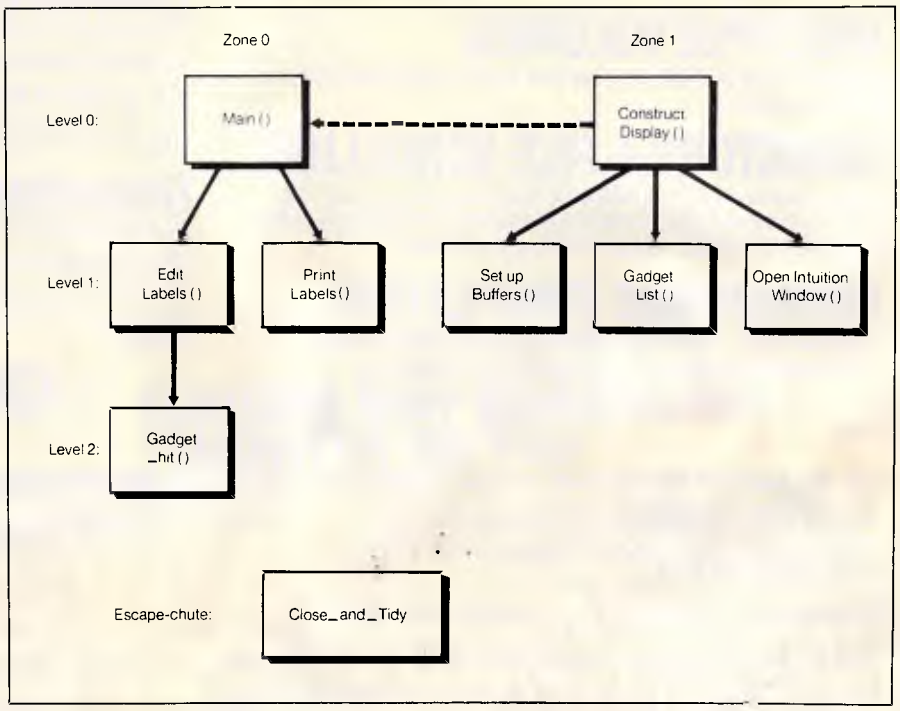


*Fig 4 Program structure diagram*

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```
int IntuitionBase = NULL;
int GfxBase = NULL;
struct Window *window;

if ((GfxBase = OpenLibrary ("graphics.library",0)) == NULL)
   {
   Close_and_Tidy (0);
   }

if ((IntuitionBase=OpenLibrary("intuition.library",0))==NULL)
   {
   Close_and_Tidy (1);
   }

if ((window = OpenWindow(&definewindow)) == NULL)
   {
   Close_and_Tidy (2);
   }
```

*A typical library/window opening session*

Readers who have seen, or have access to, the Amiga manuals will have noticed that the pointer types do not always match in these definitions. For example, in the Gadget-Render field of the structure (which should contain a pointer to information about graphics for the gadget), the type is asserted to be APTR. What it actually connects to is one of two structure types called:

```
struct Image *
```

or

```
struct Border *
```

The Gadget structure therefore defines this member to be a generic pointer (APTR == 'a pointer'). However, formally, this is still a type mismatch and a C compiler will spot it. The cure is to use the cast operator to mould the pointer into shape:

```
my_gadget.GadgetRender = (APTR)
  &(my_border_structure):
```

## Static or dynamic structures?

One of C's real lifesavers is the ability to initialise arrays and structures which are declared 'static'. This often eliminates the need for longwinded assignments such as:

```
my_text.FrontPen = BLACK;
my_text.BackPen = WHITE;
my_text.DrawMode = JAM1;
  ... and so on.
```

If the structures are built into a program for good, they can usefully be declared static and then initialised:

```
static struct IntuiText my_text =
  {
  BLACK,WHITE,
  JAM1,
  20,10,
  NULL,
  'MY TEXT ...',
  NULL
  }:
```

The curly brackets define a list of items which are to be assigned to successive items in the structure 'my_text'. This saves a lot of typing and program assignment time since the initialised structures are stored ready for use in a program file. (Not that it would take the Amiga more than a blink of an eye to assign everything anyway)!

Sometimes it is advantageous to use 'auto' (non-static) structure variables. This can be useful in cases where lots of similar gadgets have to be positioned in a regular way; programs can then make use of recursion to simplify the process.

Above all, programming the Amiga under Intuition means thinking in pictures. Programmers must learn to think in a new way — in terms of data structure diagrams rather than in terms of program structure diagrams (see Fig 3). Programs are built up from elaborate data structures of gadgets and menus, and so on.

Moreover, programmers have to think recursively with the lists of gadgets because the graphics origins are local: border structures connected inside a gadget use the top left-hand corner of the gadget select box for their (0,0) co-ordinate.

Border structures inside border structures use the last border origin ... and so on. Intuition calculates all the offsets.

## Window structure

The size and shape of a window and the things which go into it are defined by a 'NewWindow' structure. This is just a bundle of information which is passed to the Intuition function 'OpenWindow()', and it is most easily defined as a static structure. Below is such a structure written in terms of pseudo constants:

```
struct NewWindow definewindow =

  {
  top,left,                  /* constants */
  window_width,window_height,
  text_colour,outline_colour,
  events_to_be_monitored,
  gadgets_in_window_itself,
  refresh_behaviour,
  list_of_user_gadgets,
  menu_tick_image,
  window_title,
  custom_screen,
  custom_bit_map,
  minimum_width,
  minimum_height,
  screen_type
  }:
```

The NewWindow structure defines the links reaching out of a window structure: that is, it connects to the gadgets and graphics structures directly. It also defines the initial position on the screen and the size limits for windows which have a resizing gadget built in. The *Intuition Reference Manual* contains full details of this structure.

In order to use any of the special input devices, a program must have a window to work from. A window is opened by a call to the Intuition function 'OpenWindow()'. This function is not normally available from C, but can be found in a special disk library called 'intuition.library' which can be made available to a program by 'opening' it before a program commences. Libraries are opened with calls to 'OpenLibrary()', which causes the code for the intuition functions to be loaded into memory. The programmer must also make sure to include the library files:

```
types.h
intuition.h
```

which contain the necessary macros and type definitions for using the library. In addition to the basic intuition functions, a program which uses graphics functions such as area files or line/point drawing must open the graphics library. Intuition opens the graphics header files as standard, but some programs might need to include 'gfxmacros.h'. This

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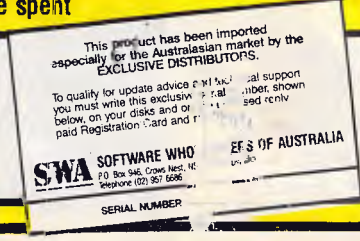


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## Notes on the example program

The example listing is the address label editor described in this article. It has been written as two text files, so that the actual doing part of the program is kept separate from the setting-up part. The active part of the program, is labelled ZONE 0 and the passive (setting-up) part is called ZONE 1. ZONE 1 contains all the design work. It works like this:

- The Zone starts with 'ConstructDisplay()'. Because the list of structure definitions is implicitly static, it is ready-built by the C compiler in a program file, with all the links made. However, none of the objects in the list has been drawn yet.
- An array of gadget structures is defined as 'gadg()'. This will be used to make the string gadgets.
- An array of Info structures is also defined. This is for special information about the Intuition string gadgets, positions, and so on.
- 'GadgetList()', is then called, which assigns the whole array of string gadgets recursively (see Fig 3) and tags on two Boolean gadgets for 'print labels' and 'quit'.
- 'ConstructDisplay()' then calls 'OpenIntuitionWindow()', which opens all the libraries, and the NewWindow which is defined at the start of ZONE 1. When the Intuition function OpenWindow() is called , all the imagery is drawn in one go.
- Finally, the background is coloured white by plotting a filled rectangle over the whole window. Unfortunately, this is plotted over beautifully-drawn gadgets, sc a call to the intuition function RefreshGadgets() sets things right again.

That is the imagery complete. The only other function in this zone is the clear-up function 'Close_and_Tidy()' which shuts down everything that the zone has done.

ZONE 0 contains the actual logical details of the program. It works in the following way:

- Calls ZONE 1 to build the display.
- Enters a loop which waits for intuition messages.
- Checks every 'GADGETUP' message (which means that a Boolean gadget has been hit).
- Finds out the identity of the gadget which produced the message by comparing the pointer in the message to the pointer of the two gadgets.
- Finally, either quits or prints the labels once.

It is worth noting that the string gadgets work quite independently of the program. All the programmer has to do is provide a buffer for the string to be contained in, and the characters will be delivered to their buffers by the operating system.

should be checked in the *ROM Kernel Manual*.

A typical library/window opening session might look like that shown in the box on the previous page. The return values of OpenLibrary() and OpenWindow() should be checked for errors, such as 'there was insufficient memory to open a window'.

At the end of this sequence, a program should have a window. It is important to close all libraries and windows that are used in a program after they are finished with, as this relinquishes the memory taken up by them for other programs. The simplest way to close down a program is to call a function like this:

```
Close_and_Tidy (level)

int level:

{
switch (level)
        {
        default :
        case 2 : CloseWindow (window):
        case 1 : if (IntuitionBase !=NULL)
                {
                CloseLibrary
                        (IntuitionBase):
                }
        case 0 : if (GfxBase !=NULL)
                {
                CloseLibrary (GfxBase):
                }
        }

exit (0):
}
```

This closes down the application and exits in one go. (Please do not use the 'GOTO' method expounded in the Amiga manuals. It really does make an unnecessary mess).

## Raster ports

Programmers who take a pride in their work will doubtless want to make decorative displays for their Intuition programs. Again, Intuition governs the way in which this is done. Each window in a program has its own allocation of screen memory. This is necessary because windows can overlap and move around: it is not enough to allocate simply one lot of memory for the whole screen. Any graphics-drawing operations must, therefore, know which screen memory they are to write into. The Amiga uses the term 'raster port', or just RastPort, for this.

The information about a raster port is held in a structure:

```
struct RastPort
```

which is assigned from a subsection of a Window structure:

```
struct Rastport *ptr_to_screen_memory;

struct Window *window;

window = OpenWindow (&(new
  _window_struct);

ptr_to_screen_memory = window
  →RPort;
```

The pointer 'ptr_to_screen_memory' is needed for graphics operations like rectangle filling.

The command

```
RectFill (ptr_to_screen_memory,x,
  y,width,height);
```

is a typical graphics operation.

The full set of graphics primitives can be found in *The ROM Kernel Manual: Libraries and Devices.*

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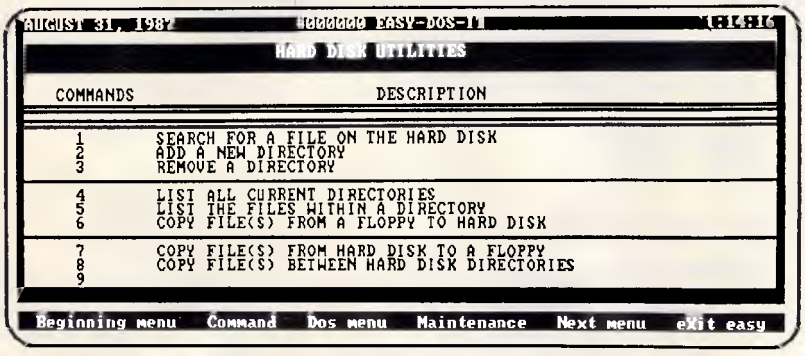


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```
/*************************************************************/
/*                                                           */
/*  LABEL PRINTING UTILITY : Mark Burgess 1987 : ZONE Ø      */
/*                                                           */
/*  For the Commodore Amiga ONLY                             */
/*                                                           */
/*************************************************************/

   #include <stdio.h>
   #include <util1.c>

   #define  editing       true
   #define  intui_message (1<<window->UserPort->mp_SigBit)

   enum GadgetSignals

      {
      PRINT,
      QUIT
      };

/*************************************************************/
/* LEVEL Ø : main program                                    */
/*************************************************************/

   main ()

   { enum GadgetSignals response;
     enum GadgetSignals EditLabels();


   ConstructDisplay ();                          /* Zone 1 */

   while (true)
      {
      switch (response = EditLabels())
         {
         case PRINT : print_labels();
                      break;
         case QUIT  : Close_and_Tidy (4);
         }
      }
   }

/*************************************************************/
/* LEVEL 1                                                   */
/*************************************************************/

   enum GadgetSignals EditLabels ()          /* Event monitor */

   { enum GadgetSignals gadget_hit();
     struct IntuiMessage *mess;
     int    wakeup;
     USHORT class;
     APTR   Identity;


   while (editing)
      {
      wakeup = Wait (intui_message);

      if (wakeup & intui_message)
         {
         while (mess=(struct IntuiMessage *)
                                   GetMsg(window->UserPort))
            {
            class = mess->Class;
            Identity = mess->IAddress;
            ReplyMsg (mess);

            switch (class)
               {
               case GADGETUP : return (gadget_hit(Identity));
               }
            }
         }
      }
   }

/*************************************************************/

   print_labels ()              /* Print two labels to printer */

   { int i,j;
     FILE *printer;
```

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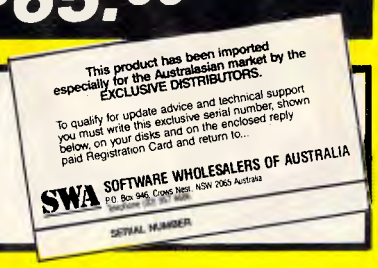


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```
    if ((printer = fopen ("PRT:","w")) == NULL)
       {
       fprintf (stderr,"Printer Device unavailable\n");
       }

    for (i = 0; i < numofgadg; i++)
       {
       fprintf (printer,"      ");
       for (j = 0; j < buffsize; j++)
          {
          fprintf (printer,"%c",strbuffer[i][j]);
          }
       fprintf (printer,"          ");
       for (j = 0; j < buffsize; j++)
          {
          fprintf (printer,"%c",strbuffer[i][j]);
          }
       fprintf (printer,"\n");
       }

    fprintf (printer,"\n\n");
    fclose (printer);
    }

/*****************************************************************/
/** LEVEL 2                                                     **/
/*****************************************************************/

    enum GadgetSignals gadget hit (ID)      /* Identify gadget */

    APTR ID;

    {
    if (ID == (APTR)(&PrintGadg))
       {
       return (PRINT);
       }

    if (ID == (APTR)(&QuitGadg))
       {
       return (QUIT);
       }
    }

/*****************************************************************/
/*                                                               */
/*  Zone 1 : INTUITION                                           */
/*                                                               */
/*  Labeller I/O structure                                       */
/*                                                               */
/*****************************************************************/

  /* Define window type and display graphics in this file */
  /* In other words, everything to do with the display    */

   #include <types.h>
   #include <intuition.h>

   extern struct Window *OpenWindow(); /*

/*****************************************************************/
/* Manifest constants / macros / static variables                */
/*****************************************************************/

   #define true          1
   #define false         0
   #define buffsize      32
   #define WinWidth      400
   #define WinHeight     150
   #define numofgadg     6
   #define GboxWidth     120
   #define GboxHeight    25
   #define Woffset       10
   #define Hoffset       2
   #define FrameWidth    (GboxWidth   Woffset)
   #define FrameHeight   (GboxHeight   Hoffset)

   enum colours
      {
      GREY,
      WHITE,
      BLACK,
      ORANGE
      };
```

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**MS1236 VERSATILE PRINTER SETUP:** Great generic printer setup utility that can be used for almost any printer to easily configure it the way you want. Can be used as memory resident utility. Includes setup for IBM, Epson, Gemini, NEC and HP Laserjet.

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```
    int     IntuitionBase = NULL;
    int     GfxBase = NULL;

    char    strbuffer[numofgadg][buffsize];
    char    undobuffer[numofgadg][buffsize];

    struct Gadget      gadg[numofgadg];
    struct StringInfo info[numofgadg];

/*************************************************************/
/* WINDOW                                                    */
/*************************************************************/

  struct NewWindow definewindow =

      {                                 /* UTILITY'S OWN WINDOW */
      150, 50,                          /* top left x,y */
      WinWidth, WinHeight,              /* width,height */
      2, 3,                             /* detail/block colours */

       GADGETDOWN                       /* Events to be monitered */
     | GADGETUP,

     (                                  /* Gadgets to be rendered */
       WINDOWDEPTH
     | WINDOWDRAG
     | GIMMEZEROZERO
     | ACTIVATE
     | SMART_REFRESH                    /* Window refresh behaviour */
     | NOCAREREFRESH
     ),

     (struct Gadget *) gadg,            /* Pointer to first gadget */

      NULL,                             /*            N/A          */
      "Labeller",                       /* Window Title Message    */
      NULL,                             /*            N/A          */
      NULL,                             /*            N/A          */
      50,40,480,0,                      /* Min,Max : width height  */
      WBENCHSCREEN                      /* Background Screen Type  */
      };


/*************************************************************/

   struct Window *window;               /* Global Window pointer */
   struct RastPort *rast;               /* Screen memory pointer */

/*************************************************************/
/* GADGETS AND GADGET GRAPHICS                               */
/*************************************************************/

   SHORT FrameArray[] =          /* Coord array for line graphics */

      {
      0,0,
      FrameWidth,0,
      FrameWidth,FrameHeight,
      0, FrameHeight,
      0,0
      };

/*************************************************************/

   SHORT ShadowArray[] =

      {
      Woffset,GboxHeight,
      FrameWidth,GboxHeight,
      FrameWidth,Hoffset
      };
/*************************************************************/

   struct Border shadow =

      {
      Woffset,Hoffset/2,
      ORANGE,WHITE,
      JAM1,
      3,
      ShadowArray,
      NULL
      };

/*************************************************************/
```


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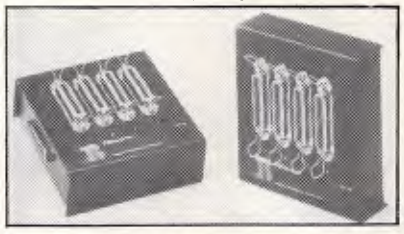

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```
struct Border frame =

    {
    Woffset/2,Hoffset/2,        /* origin x,y rel to gadg */
    BLACK,WHITE,                /* Front pen / back pen */
    JAM1,                       /* draw mode */
    5,                          /* no. of coord pairs */
    FrameArray,                 /* coord array pointer */
    &shadow                     /* ptr to another struct */
    };

/*****************************************************************/

struct IntuiText SGtext =

    {
    GREY,WHITE,                  /* Front colour, Bback col */
    JAM1,                        /* Draw mode               */
    300,0,                       /* Left edge, Top Edge     */
    NULL,                        /* custom font pointer     */
    "<<<<",                      /* Actual text!            */
    NULL                         /* Ptr to next text struct */
    };
/*****************************************************************
/

struct IntuiText PrintGadgText =

    {
    BLACK,WHITE,     /* front pen / back pen colour */
    JAM1,            /* draw mode */
    20,10,           /* left edge / top edge */
    NULL,            /* disk font ? */
    "* Print *",     /* text ! */
    NULL             /* next text struct */
    };


/*****************************************************************/
struct IntuiText QuitGadgText =

    {
    BLACK,WHITE,
    JAM1,
    20,10,
    NULL,
    "* Quit *",
    NULL
    };


/*****************************************************************/

struct Gadget PrintGadg =

    {
    NULL,                           /* ptr to next gadget */
    60,100,                         /* left/top of select box*/
    GboxWidth,GboxHeight,           /* width/height of select box */
    GADGHCOMP,                      /* flags */
    GADGIMMEDIATE | RELVERIFY,      /* activation flags */
    BOOLGADGET,                     /* gadget type */
    (APTR) &(frame),                /* gadget render (border) */
    NULL,                           /* select render */
    &(PrintGadgText),               /* gadget text structure */
    NULL,                           /* mutual exclude   N/A */
    NULL,                           /* special info */
    NULL,                           /* user space */
    NULL                            /* user space */
    };

/*****************************************************************/

struct Gadget QuitGadg =

    {
    &(PrintGadg),
    200,100,
    GboxWidth,GboxHeight,
    GADGHCOMP,
    GADGIMMEDIATE | RELVERIFY,
    BOOLGADGET,
    (APTR) &(frame),
    NULL,
    &(QuitGadgText),
    NULL,
```

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```
    NULL,
    NULL,
    NULL
    };
/*****************************************************************/
/* ZONE 1 : LEVEL Ø                                              */
/*****************************************************************/

    ConstructDisplay ()

    { struct Gadget *GadgetList ();
      struct Gadget *setup;

    SetUpBuffers ();
    setup = GadgetList (Ø);
    OpenIntuitionWindow ();
    rast = window->RPort;
    SetAPen (rast,WHITE);
    RectFill (rast,Ø,Ø,WinWidth,WinHeight);
    RefreshGadgets((struct Gadget *)gadg,window,NULL);
    }

/*****************************************************************/
/* ZONE 1 : LEVEL 1                                              */
/*****************************************************************/

    OpenIntuitionWindow ()

    {
    if ((GfxBase = OpenLibrary ("graphics.library",Ø)) == NULL)
       {
       Close_and_Tidy (Ø);
       }

    if ((IntuitionBase = OpenLibrary("intuition.library",Ø)) ==
NULL)
       {
       Close_and_Tidy (1);
       }

    if ((window = OpenWindow(&definewindow)) == NULL)
       {
       Close_and_Tidy (2);
       }

    }

/*****************************************************************/
    SetUpBuffers ()
    { int i;
      char *sbuff,*ubuff;

    for (i=Ø; i < numofgadg; i++)

       {
       sbuff = &(strbuffer[i][Ø]);
       ubuff = &(undobuffer[i][Ø]);

       info[i].Buffer = sbuff;
       info[i].UndoBuffer = ubuff;
       info[i].BufferPos = Ø;
       info[i].MaxChars = 32;
       info[i].DispPos = Ø;
       info[i].UndoPos = Ø;
       info[i].NumChars = Ø;
       info[i].DispCount = 2Ø;
       info[i].CLeft = 2Ø;
       info[i].CTop = 15*i;
       }

    }

/*****************************************************************/
    struct Gadget *GadgetList (i)                 /* Recursive! */

    int i;

    {
    if (i < numofgadg)

       {
       gadg[i].NextGadget = GadgetList (i+1);
       gadg[i].LeftEdge = 2Ø;
       gadg[i].TopEdge = 15*i;
       gadg[i].Width = 3ØØ;
```

```
        gadg[i].Height = 14;
        gadg[i].Flags = SELECTED;
        gadg[i].Activation = NULL;
        gadg[i].GadgetType = STRGADGET;
        gadg[i].GadgetRender = NULL;
        gadg[i].SelectRender = NULL;
        gadg[i].GadgetText = &SGtext;
        gadg[i].MutualExclude = NULL;
        gadg[i].SpecialInfo = (APTR) &(info[i]);

        return ((struct Gadget *) &(gadg[i]));
        }

    else

        {
        return ((struct Gadget *) &(QuitGadg));
        }
    }
/*************************************************************/
/* ZONE 1 : SNAKES & LADDERS                                 */
/*************************************************************/
      Close_and_Tidy (level)

      int level;

      {
      switch (level)
        {
         default :
         case 2  : CloseWindow (window);
         case 1  : if (IntuitionBase != NULL)
                     {
                     CloseLibrary (IntuitionBase);
                     }
         case 0  : if (GfxBase != NULL)
                     {
                     CloseLibrary (GfxBase);
                     }
        }

      exit (1);
      }
```

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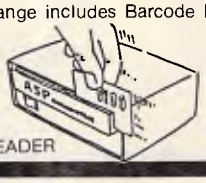

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# Faster than fast Fourier

***The fast Hartley transform is twice as fast as the fast Fourier and uses only half the computer resources. Mark O'Neill explains.***

Joseph Fourier left to mathematics a rich legacy: the transform that bears his name processes many of today's audio and electromagnetic signals. Image processing and digital filtering of signals use the Fourier transform or its faster descendant.

However, the fast Fourier transform (FFT) requires a large amount of computer resources. The fast Hartley transform (FHT) can accomplish the same results faster, using fewer resources. First described by Ronald Bracewell (see reference 1), the FHT handles many of the jobs now done by the Fourier transform.

Both the FHT and the FFT let you map a continuous signal over time onto a frequency function. The Fourier transform maps a real function of time $X(t)$ to a complex function of frequency, $F(f)$.

The Hartley transform maps a real function of time $X(t)$ onto a real function of frequency $H(f)$. Since the Hartley frequency function is real, you need only single arithmetic operations to compute it.

Compare this to the many arithmetic operations required of the complex Fourier frequency function (four operations for a complex multiply or divide, and two for complex addition or subtraction).

Furthermore, real data arrays require only half the memory storage of complex data arrays. This means that the Hartley transform will require considerably less memory for a given data set than the Fourier transform. Therefore, the Hartley transform will be distinctly faster and use less memory than the conventional Fourier transform in digital filtering and image enhancement applications where you have to process large amounts of data.

## A definition of the Hartley transform

Equation (1) shows the analytical form of the Hartley transform, and (2) shows its inverse transform, used to map the frequency function back into the time domain:

$$H(f) = \frac{1}{2\pi} \int_{-\infty}^{\infty} x(t)\,\mathrm{cas}(2\pi ft)\,dt, \qquad (1)$$

$$X(t) = \int_{-\infty}^{\infty} H(f)\,\mathrm{cas}(2\pi ft)\,df, \qquad (2)$$

where $\mathrm{cas}(2\pi ft) = \cos(2\pi ft) + \sin(2\pi ft)$.

The function $\mathrm{cas}(2\pi ft)$ was introduced by R Hartley (see reference 2), who first proposed the Hartley transform in 1942.

You can see that these equations are very similar to those of the Fourier transform and its inverse:

$$F(f) = \frac{1}{2\pi} \int_{-\infty}^{\infty} X(t)\,e^{-j2\pi ft}\,dt, \qquad (3)$$

$$X(t) = \int_{-\infty}^{\infty} F(f)\,e^{j2\pi ft}\,df, \qquad (4)$$

where $e^{j2\pi ft} = \cos(2\pi ft) + j\sin(2\pi ft)$, and $e^{-j2\pi ft} = \cos(2\pi ft) - j\sin(2\pi ft)$. (These are known as Euler's formulae.)

Note that I'm using the electrical engineering convention of labelling the imaginary unit $i$ and $j$. The principal difference between the two functions is that the real function $\mathrm{cas}(2\pi ft)$ in the Hartley transform replaces the complex exponential term $e^{\pm j2\pi ft}$ in the Fourier transform pair.

The Hartley and Fourier transform functions in (1) through (4) deal only with continuous variables. As is often the case with computer data in the real world, signals are sampled at discrete intervals of time or for a specific interval. Fortunately, you can define a discrete transform that can represent a quantised continuous signal, or a signal of limited duration. The discrete forms of the Hartley transform pairs are

$$H(f) = \frac{1}{N} \sum_{t=0}^{N-1} F(t)\,\mathrm{cas}(2\pi ft/N) \qquad (5)$$

and

$$X(t) = \sum_{f=0}^{N-1} H(f)\,\mathrm{cas}(2\pi ft/N). \qquad (6)$$

Again, note the similarities to the Fourier transform pairs:

$$F(f) = \frac{1}{N} \sum_{t=0}^{N-1} X(t)\,e^{(-j2\pi ft/N)}, \qquad (7)$$

$$X(t) = \sum_{f=0}^{N-1} F(f)\,e^{(j2\pi ft/N)}. \qquad (8)$$

## The fast algorithm

As it stands in (5) and (6), computation of the discrete Hartley transform presents an analogous problem to the

computation of the discrete Fourier transform. That is, you have to perform $N^2$ arithmetic operations to compute the discrete Hartley transform on an $N$-element data set.

A classic paper by Cooley and Tukey (see reference 3) in 1965 led to the development of a fast algorithm for the machine computation of a complex Fourier series.

Essentially, the FFT uses a permutation process to bisect the data until data pairs are reached. Calculating the Fourier transform of such data pairs is trivial (ie, rapid).

The idea behind the permutation process is that it's faster to split the data into pairs, compute the transform of the pairs, and recombine these to make the entire transform rather than to compute the transform for the complete data set.

Permutation is particularly fast when the amount of data is large. If you superimpose all such two-element pairs using a process sometimes referred to as the 'butterfly' (due to the appearance of the diagram of the data flow; see Fig 1), you can compute the Fourier transform of the input data set. It takes approximately $N$ log ($N$) seconds to compute the transform of an $N$-point data set.

Bracewell (see reference 4) has shown that you can employ a similar methodology in the case of the Hartley transform. Again, you use the permutation process to bisect the data until you get data pairs.

The Hartley transform of a data pair $(a,b)$ is $1/2(a + b, a - b)$, and the computation of such pairs is trivial. You can also superimpose these two-element sequences to calculate the Hartley transform of the input data set. However, to do so requires a formula that expresses a complete discrete Hartley transform (DHT) in terms of its half-length subsequences.

Bracewell has shown by application of the Shift and the Similarity theorems that (9) expresses the general decomposition formula for the DHT. This general decomposition formula generates the desired DHT by bisecting the data.

Put another way, it's the rule used to generate the elements to be used in the butterfly computation of the transform. You can apply similar methodology to the Fourier transform to yield the decomposition formula given in (10):

$$H(f) = H_1(f) + H_2(f)\cos(2\pi f/N_s) + H_2(N_s - f)\sin(2\pi f/N_s), \quad (9)$$

$$F(f) = F_1(f) + F_2(f)e^{j2\pi f/N_s}, \quad (10)$$

where $N_s$ is the number of elements in the half-length sequence, and thus $N_s = N/2$ for a data set of $N$ elements. Fig 1 shows a complete butterfly diagram for computing the FHT for an eight-element data set.

The decomposition formula for the FHT differs from the FFT in one important respect: the elements multiplied by the trigonometric terms are not symmetric. In the FFT decomposition formula of (10), terms multiplied by the trigonometric coefficients involve terms only in $F(f)$. In the FHT decomposition formula of (9), both $H(f)$ and $H(N_s - f)$ have sine coefficients. This asymmetry becomes apparent when you express the discrete transforms as matrix operations: FFT matrix terms are symmetric about the matrices' leading diagonal, while corresponding terms for the FHT are asymmetric.

This introduces some computation problems, because asymmetric matrix processing is difficult to implement. You can deal with this asymmetry by using an independent variable as an index for the elements multiplied by the sine coefficients. This index decreases while the other indices increase; this behaviour is called retrograde indexing. Bracewell gives descriptions of the FHT and FFT algorithms using matrix formalism (see reference 5).

You can obtain the inverse Hartley

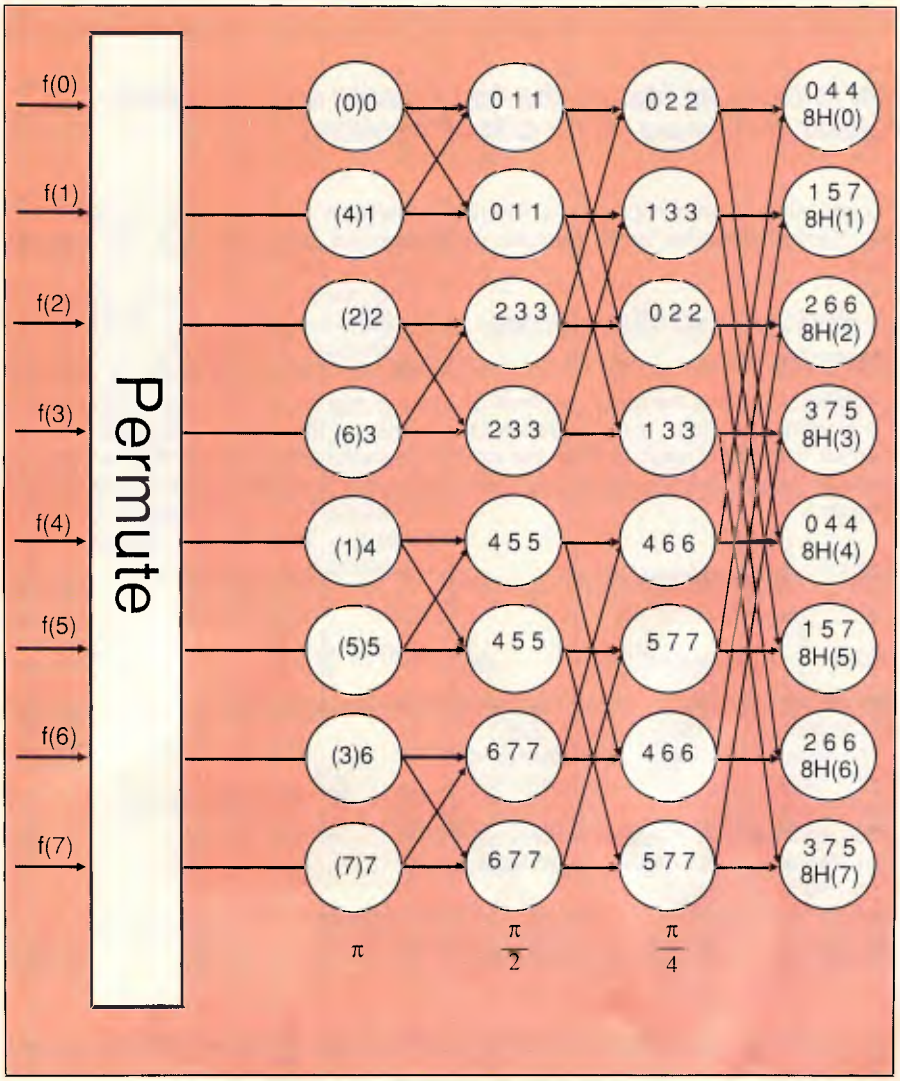


*Fig 1 The butterfly diagram for the fast Hartley transform for an eight-element data set. In the first column of cells, the indices show the effects of permutation on the data elements. The next three columns represent the data elements as superimposed by the decomposition formula for the butterfly computation. These cells show the three indices of the elements. You can see the effects of retrograde indexing for an eight-element data set in indices for the third and fourth iteration of the butterfly. Radians at the bottom of the diagram give the angular spacing between trigonometric coefficients*

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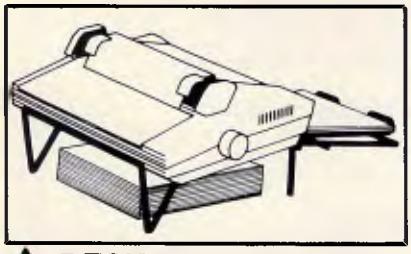

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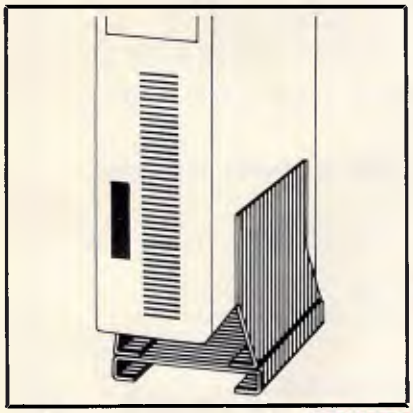

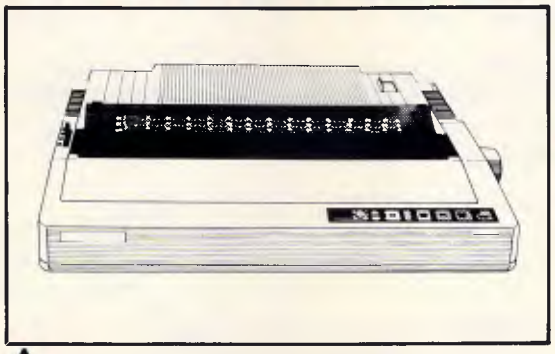

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APC 261

```
{-------------------------------------
   Fast Hartley transform routine ...
   version 1.00, Dated 22nd November 1986,

transform:= forward; Forward transform from
time frequency domain. transform := reverse;
Reverse transform from frequency to time
domain.

power_index: Index to which 2 must be raised
to generate a transform containing 'syze'
elements:
      if syze = 8  then power_index = 3;
      if syze = 16 then power_index = 4; etc
...

syze:  Number of element in the input data
array.
-------------------------------------}

const
   datasize = 512;
type
   direction_type = (forward,reverse);
   data_array_type = array[1..datasize] of
real;
var
   dir, test_option: char;
   i,j,syze,iter,demo: integer;
   data_array: data_array_type;
   transform_direction: direction_type;

procedure fht(var data_array: data_array_type;
                     power_index,
                     syze: integer;
                     transform:direction_type);

var
   i,
   j,
   k,
   trg_ind,
   trg_inc,
   power,
   t_a,
   f_a,
   i_temp,
   section,
   s_start,
   s_end: integer;
   sne,csn: array[1..datasize] of real;
   accu: array[1..2,1..datasize] of real;

{-------------------------------------
Permutation routine. This routine
reorders the data before the butterly
transform routine is called ...
-------------------------------------}

function permute(index: integer): integer;
var
  i,j,s: integer;
begin
   j := 0;
   index := index - 1;
   for i := 1 to power_index do
   begin
      s := index div 2;
      j := j + j + index - s - s;
      index := s;
   end;
   permute := j + 1;
end;

{-------------------------------------
Calculate the trigonometric functions
required by the FHT and store values.
For a N point transform, the trigno-
metric functions will be calculated
at intervals of Nths of a turn ...
-------------------------------------}

procedure trig_table(npts: integer);
const
   pi = 3.14159265;
var
   i: integer;
   angle,omega: real;
begin
   angle := 0;
   omega := 2 * pi / npts;
   for i := 1 to npts do
   begin
      sne[i] := sin(angle);
      csn[i] := cos(angle);
      angle := angle + omega;
   end;
end;

{-------------------------------------
Calculate the address of the retrograde
index for the sine term for the dual
place algorithm, if it is required ...
-------------------------------------}

function modify(power,s_start,s_end,index:
integer): integer;
begin
   if (s_start = index) or (power < 3) then
      modify := index
   else
      modify := s_start + s_end - index + 1;
end;
{-------------------------------------
   Butterfly transform an index pair ...
-------------------------------------}

procedure butterfly(trig_ind,i_1,i_2,i_3:
integer);
begin
   accu[t_a,i_1] := accu[f_a,i_1] +
         accu[f_a,i_2] * csn[trig_ind] +
         accu[f_a,i_3] * sne[trig_ind];
   trig_ind := trig_ind + syze div 2;
   accu[t_a,i_2] := accu[f_a,i_1] +
         accu[f_a,i_2] * csn[trig_ind] +
         accu[f_a,i_3] * sne[trig_ind];
end;

{-------------------------------------
   Main program for the fast Hartley
   transform.
-------------------------------------}

begin

   power := 1;
   f_a := 1;
   t_a := 2;
   trig_table(syze);
   for i := 1 to syze do accu[f_a,permute(i)]
:=
         data_array[i];
```

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```
{-------------------------------------
   Start of the Hartley butterfly
   transform ...
-------------------------------------}

   for i := 1 to power_index do
   begin
      j := 1;
      section := 1;
      trg_inc := syze div (power + power);
      repeat
         trg_ind := 1;
         s_start := section * power + 1;
         s_end   := (section + 1) * power;
         for k := 1 to power do
         begin
            butterfly(trg_ind,j,j + power,
                 modify(power,s_start,s_end,j
                                + power));
            trg_ind := trg_ind + trg_inc;
            j := j + 1;
         end;
         j := j + power;
         section := section + 2;
      until j > syze;
      power := power + power;
      i_temp := t_a;
      t_a    := f_a;
      f_a    := i_temp;
end;

{-------------------------------------
End of Hartley butterfly. The results are
scaled if necessary, and then placed in
back into the array data ...
-------------------------------------}

   case transform_direction of
            forward: for i := 1 to syze do
                                data_array[i] :=
accu[f_a,i] / syze;
          reverse: for i := 1 to syze do
                                data_array[i] :=
accu[f_a,i];
   end;
end;
```

*Listing 1 The code fragment from 'hartley.pas' that shows the complete Hartley transform as implemented in TML Pascal*

transform by applying the FHT algorithm again to its own output, thus regenerating the input data. This means that you can use the same program code to compute the transform and its inverse. However, there is a slight asymmetry between the FHT and its inverse. In the case of the time-to-frequency transform, you need to scale the result of the butterfly computation. That is, for an input data set of $N$ elements, you must divide the output of the butterfly by $N$ to obtain the discrete Hartley transform.

You don't need to do this for frequency-to-time transform; consequently, the butterfly computation itself constitutes the inverse transform. It is not difficult to add a small amount of code to control whether scaling should be applied during a conversion.

## Comparing the FFT and FHT algorithms

You can use the FHT algorithm for many of the applications for which you would now use the FFT algorithm. These include convolution and deconvolution (used to remove artifacts introduced into data by imperfections in the sensors), and the generation of power spectra for filtering. You can also obtain the Fourier transform itself from the Hartley transform. In fact, it is often faster to generate the Fourier transform and power spectrum with the FHT than with the FFT, because computing the butterfly using real rather than complex quantities requires fewer floating-point operations. You assemble the real and imaginary parts of the FFT at the end of the calculation using the equations

$$F_r = H(f) + H(N-f)$$

and

$$F_{im} = H(f) - H(N-f),$$

where $F_r$ is the real portion of the complex Fourier transform, $F_{im}$ is the imaginary portion, and $N$ is the number of elements in the data set.

You can calculate the power spectrum directly from the Hartley transform using the equation

$$P_s(f) = [H(f)^2 + H(N-f)^2]/2,$$

where $P_s$ is the power spectrum.

The theorem for convolving a pair of functions is almost identical, whether you are considering the Hartley transform or the Fourier transform. Again, the FHT should prove superior to the FFT in terms of speed for any given implementation. Equation (11) summarises the theorem for the convolution for the Hartley transform, (12) for the Fourier transforms.

$$f_1(t) \oplus f_2(t) = H_1(f)H_{2e}(f) + H_1(-f)H_{2o}(f) \quad (11)$$

and

$$f_1(t) \oplus f_2(t) = F_1(f)F_2(f). \quad (12)$$

The $\oplus$ symbol denotes the convolution operation.

The subscripts $e$ and $o$ in (11) denote the even and odd parts of the Hartley transform. Note that if one of the functions being convoluted is either even *or* odd, then the form of the convolution theorem for the Hartley transform reduces to the particularly simple form indicated in (13):

$$f_1(t) \oplus f_2(t) = H_1(f)H_2(f). \quad (13)$$

In practical applications, many of the convolution functions are even. For example, the Gaussian function, used in image-enhancement work, is an even function. We can take advantage of the nature of these functions to use the computational shortcut provided by (13).

## Spectral leakage

As with the FFT algorithm, the FHT algorithm will produce an erroneous frequency function if the data set to be transformed does not smoothly approach 0 at both ends of its range. Such spectral leakage is undesirable in many cases. You can reduce it by multiplying the data set to be transformed by a suitable window function before computing the transform.

All these window functions cause the data to smoothly approach 0 at the limits of its range. Stigall, Ziemer, and Hudec have reviewed the effects of these window functions on the power spectrum (see reference 6).

If you're interested in some experimentation, I've provided a number of the window functions below. The triangular window is a low-quality window func-

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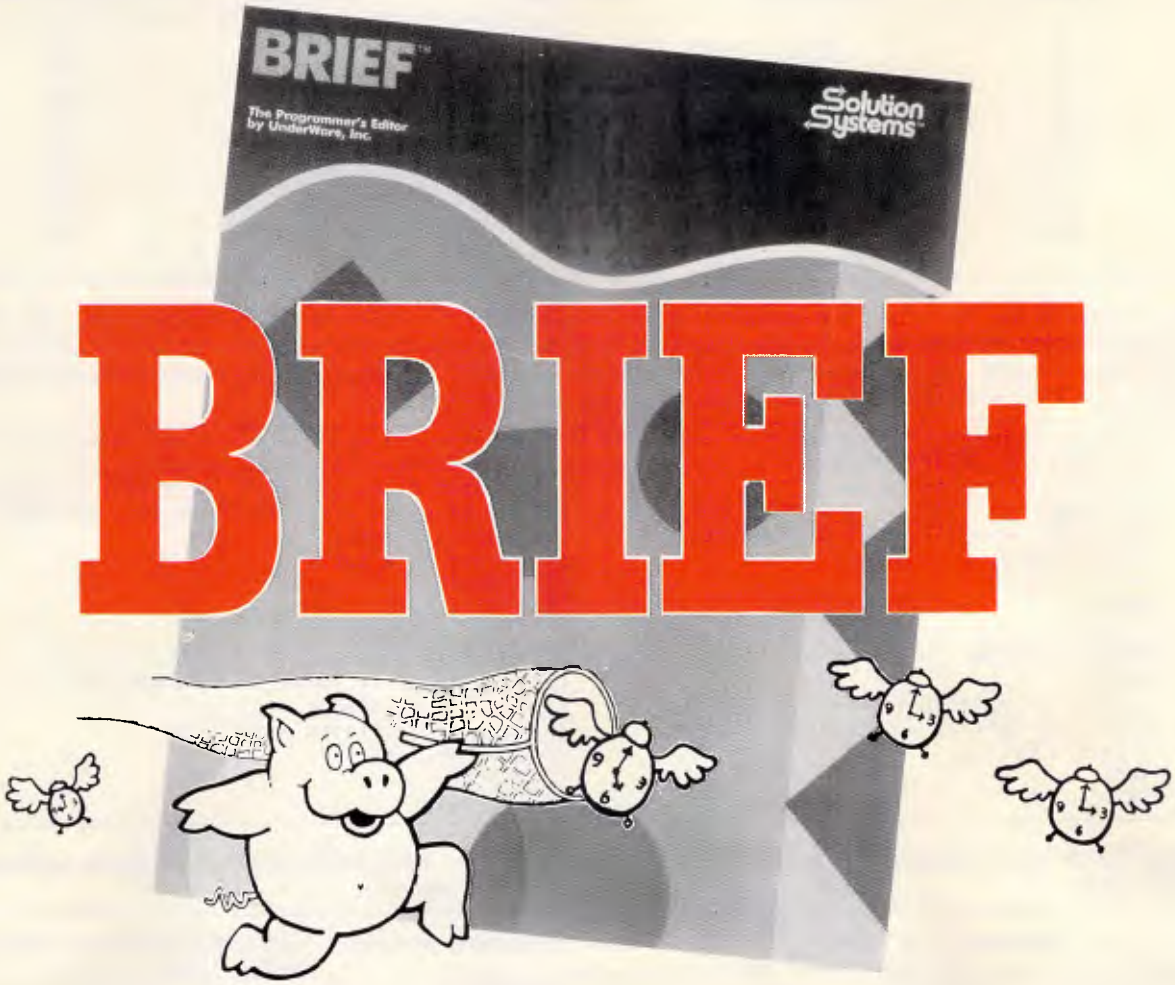


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*Table 1 Timings for the 'hartley.pas' demonstrator program on several machines. For the Macintosh computers, TML Pascal version 2.50 was used, and times are to the nearest second. No 68881 coprocessor code was generated for the test, so the Mac II's 68881 was not used. You can expect better times if you use the 68881. For comparison, the results of the same code compiled on a Sun-3/160 workstation using ISO Pascal are shown. Times are in seconds*

```
Procedure get_FFT(var data:
array[l0..h0:s_int] of real;
 var r_pt: array[l1..h1:s_int] of real;
 var i_pt: array[l2..h2:s_int] of real;
 size: s_int);
 var i: s_int;
 begin
 i := 1;
while i<size do
 begin
 r_pt[i] := data[i] + data[size - i + 1];
i_pt[i] := data[i] - data[size - i + 1];
 i := i + 2;
 end;
end;
```

*Listing 2: Pascal code to compute the Fourier transform from the FHT algorithm*

```
 procedure get_power_spectrum
 (var data: array[l0..h0:s_int] of real;
 var p_sp: array[l1..h1:s_int] of real;
size: s_int);
 var i: s_int;
begin
 i := 1;
while i<size do
 begin
 p_sp[i] := (data[i] * data[i] +
      data[size - i + 1] *
      data[size - i]) / 2;
 i := i + 1;
 end;
 end;
```

*Listing 3: Pascal code to compute the power spectrum from the FHT algorithm*

whose primary advantage is its speed. An example of its use is to filter noise from telemetry signals in real time.

Triangular window:
$W(n) = 2(n+0.5)/n$,
$W(N - n - 1) = W(n)$,

where $n = 0,1, \ldots i, \ldots, N/2$.

The Hanning and Hamming windows feature better reduction in spectral leakage, but at the expense of speed. I've used these window functions to preprocess satellite image data before using the Hartley transform to correct the images for defects in the camera optics.

Hanning window: $W(n)=0.5(1-\cos(2\pi(n+0.5)/N))$,

where $n = 0,1, \ldots i, \ldots, N-1$.

Hamming window: $W(n)=0.54-0.46(\cos(2\pi(n+0.5)/N))$,

where $n = 0,1, \ldots i, \ldots, N-1$.

The Blackman window is for data sets where the Hamming/Hanning windows would not be suitable.
Blackman window: $W(n)=0.42-0.5\cos(2\pi(n+0.5)/(N-1))+0.08\cos(4\pi(n+0.5)/(N-1))$,

where $n = 0,1, \ldots i, \ldots, N-1$.

You can find additional information about spectral window functions in the papers by Harris (see reference 7) and Nutall (see reference 8).

## The FHT program

The demonstrator program 'hartley.pas' described below computes the Hartley transform and inverse Hartley transform of an $N$-element data set. The program was originally written in Acornsoft ISO Pascal for the BBC Microcomputer, but few machine-dependent Pascal extensions are used.

The routine has also been successfully ported to a Prime 9975 minicomputer, running Sheffield Pascal, and a Sun-3/160 workstation running International Standard Organisation level 0 Pascal.

As an example of just how easy it is to port the fast Hartley routine to other machines, I have included the code for 'hartley.pas' as written in TML Pascal for the Macintosh.

The 'hartley.pas' program simply generates a suitable function to be transformed and then calls the 'fht' procedure twice. Thus, the program calculates both the Hartley transform and its inverse transform. The procedure 'fht' is the major routine in the program. Listing 1 is a code fragment of 'hartley.pas' that contains the 'fht' procedure.

The code within procedure 'fht' complies with the ISO level 1 standard for Pascal, except that the program uses the underscore character in variable names. Consequently, you can lift the procedure from the demonstration program and use it freely in your own applications. However, a brief description of 'fht' and its embedded subprocedures may be useful if you'd like to experiment with the program.

The procedure 'trig_table' precalculates the trigonometric functions required by 'fht'. For an input data set containing $N$ elements, adjacent entries in this table are $2\pi/N$ radians apart. This precalculation of the trigonometric terms avoids redundant computations of these values if they are needed frequently during

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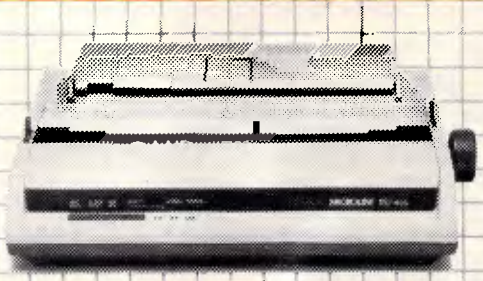

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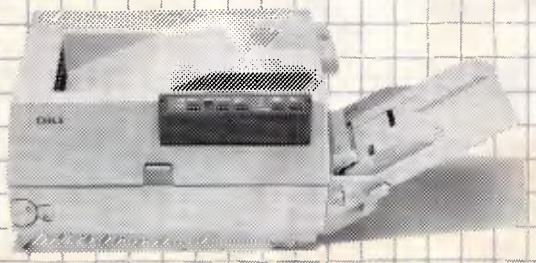

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processing. The procedure 'permute' bisects the input data set progressively until data pairs are reached. The algorithm given is adapted from one described by Bracewell, who has also described faster permutation routines (see reference 5) that you can substitute if you want.

The procedure 'butterfly' calculates the butterfly of a single index pair. This procedure requires three indices to use as entry parameters. This takes into account the possibility of retrograde indexing for the data element multiplied by the sine factor. Where retrograde indexing is necessary, the procedure 'modify' calculates the retrograde indices used by the procedure 'butterfly'.

The main program of the 'fht' procedure first precalculates the trigonometric function tables and permutes the input data.

The program then enters an iterative loop that computes the butterfly for the whole of the *N*-element input data set. You then scale the resulting output by a factor of *N* if you are computing the time-to-frequency transform.

When you have to deal with the complex form of the frequency transform, you can obtain Fourier transform from the FHT algorithm by operating on the output data of the procedure 'fht' using the Pascal procedure 'get_FFT.pas', shown in listing 2. By the time you exit from this procedure, the real and imaginary parts of the Fourier transform will be in the arrays. They are passed via the dummy conformant array variables 'r_pt' and 'i_pt', respectively.

A similar procedure in 'get_pwr.pas' called 'get_power_spectrum' (shown in listing 3) allows you to obtain the power spectrum from the Hartley transform. At exit from this procedure, the power spectrum will be in the array passed to the procedure via the dummy conformant array variable 'p_sp. You can use both of the above procedures in applications programs without any modification. These procedures conform to the ISO level 1 standard of the Pascal language, and should be usable directly on any computer that supports an ISO level 1 Pascal compiler.

The modifications required to compile these procedures with an ISO level 0 compiler are trivial. Basically, it is just a case of replacing all the conformant array parameters' procedure headers of 'get_fft' and 'get_power_spectrum', with array parameters of fixed size.

## Performance

The BBC Microcomputer implementation of the FHT program has proved to be fast and is currently running on a 6502A-based BBC Microcomputer with a second add-on 3MHz 6502 processor, which executes the program. This hardware can compute a 356-point transform in about 32 seconds. This compares favourably with the two minutes it took Bracewell's original implementation of the FHT algorithm to accomplish a 256-point transform on an HP-85 system. You can expect even better performance from 16-bit microcomputers.

Table 1 shows the timings for running the FHT program on the Macintosh Plus and Mac II using TML Pascal and the Sun-3/160 workstation using ISO Pascal.

Note that you can attain very high speeds with the Sun workstation, with its combination of a 20-MHz 68020 processor, 68881 floating-point coprocessor, and optimising Pascal compiler.

## New limits to explore

I hope this article has given you enough information to seriously consider using the Hartley transform for your signal processing needs. Since the transform uses only real functions, you don't need computationally expensive complex maths to digitally filter or enhance a signal.

The elimination of complex numbers also reduces the amount of memory required to process a signal. Finally, since the Hartley transform uses fewer operations to process a signal, you will have fewer roundoff errors.

The FFT made a lot of what we call image processing possible by manipulating large amounts of data in a reasonable amount of time. The FHT offers better performance using less computational resources. With the same code you use to compute the transform, you can compute its inverse when necessary. It will be interesting to see what new uses will result from the expanded limits of processing that the Hartley transform provides.

END

*Source code listings which accompany this article are available on Microtex 666, page *6663#, on Telecom's Viatel.*


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# When facts get fuzzy

***Bradley Richards explains how to add fuzzy logic to your Turbo Prolog programs so they'll be able to cope with the uncertainties of real-world situations.***

Most of us like to reason in absolutes. For example, we might say, "If the sky is blue, then it isn't raining." This simple approach works well for reasoning in artificial domains such as formula-proving. But as soon as the meteorologist says, "partly cloudy," we are thrown back into the real world, where facts are often ambiguous. If artificial intelligence (AI) is to succeed at modelling human reasoning, it must be able to deal with information that might be uncertain, or even inaccurate.

Fuzzy logic lets us do just that. Programs using fuzzy logic are a series of fuzzy-logic statements, just as ordinary Prolog programs are a series of predicate (ie, two-valued) logic statements.

## Reasoning with uncertainty

In traditional set theory, an element either belongs to a set or it doesn't. Elements in a fuzzy set may belong only partially to the set. The classic example is the set of 'young' people. At what age is someone no longer young? There is no established dividing line, so a fuzzy-set definition might show a person 20 years old as '90 per cent young', while someone 60 years old would be only '30 per cent young'. The degree of membership in a fuzzy set ranges from 0 to 1.

This ability to deal with a continuous range of values, rather than just true and false, is exactly what we need to reason in the real world. However, applications that try to model human reasoning also need additional operations derived from probability theory, since we often think in terms of probabilities. To date, the sets of operations that different applications use to deal with uncertainty have had little in common.

Fuzzy logic defines the minimum set of operations needed by most applications that deal with uncertainty, and is therefore a good candidate to use as a standard. Applications with unusual requirements can define further fuzzy-logic operations by building on this basic set. Fuzzy logic is a superset of predicate logic, which means that non-fuzzy information is handled normally, using the same operators that you would use to handle fuzzy information.

Fuzzy-logic operators are defined on fuzzy truth values, which range from 0 (false) to 1 (true). There are four binary operations: fuzzy AND, fuzzy OR, probability AND, and probability OR (which are written as f-AND, f-OR, p-AND, and p-OR). One unary operation is defined: NOT. We can describe these operations by ordinary arithmetic functions:

```
a f-AND b     = min(a,b)
a f-OR b      = max(a,b)
a p-AND b     = axb
a p-OR b      = a+b - (axb)
NOT a         = 1 - a
```

The three operations f-AND, f-OR, and NOT correspond directly to the predicate-logic operations AND, OR, and NOT. They produce the same results on non-fuzzy values (ie, 0 and 1), and they obey the same mathematical properties.

## Operations from fuzzy-set theory

Fuzzy-set theory, like ordinary set theory, has the three basic set operations: *intersection, union,* and *complement.* From these operations we can derive the f-AND, f-OR, and NOT operations, as I'll explain.

- *Fuzzy intersection.* If an element has differing degrees of membership in two fuzzy sets, the lesser degree dictates its degree of membership in an intersection of the two sets. For example, if a man is 80 per cent young and 40 per cent good-looking, he is only 40 per cent young *and* good-looking. With the non-fuzzy values 0 and 1, this operation produces the same results as an AND in predicate logic. From this operation we derive the f-AND.
- *Fuzzy union.* Conversely, if an element has differing degrees of membership in two fuzzy sets, the greater of the two indicates its degree of membership in a union of two fuzzy sets. Using the previous example, our subject would then be 80 per cent young *or* good-looking.

With non-fuzzy values, this operation is equivalent to the predicate logic OR. This becomes the f-OR operation. It is the only significant incompatibility between Prolog and Fuzzy Prolog; the Prolog OR operator is a decision point rather than a true predicate logic OR.

- *Fuzzy complement.* An element's degree of membership in the complement of a fuzzy set is 1 minus its degree of membership in the set itself. Someone who is 80 per cent young is, therefore, only 20 per cent old. With non-fuzzy values, this operation is equivalent to the NOT in predicate logic and is the basis for the NOT in fuzzy logic. It is not called the f-NOT, since there is no difference between the complement operation we derive from fuzzy-set theory and the one we will derive from probability theory.

Fuzzy-set operations are important,

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since they essentially extend predicate logic into the realm of fuzzy information without altering the way we think about logic. Past enhancements to Lisp and Prolog that added fuzzy reasoning abilities have used some or all of these fuzzy-set operations. Unfortunately, fuzzy-set operators are not, by themselves, sufficient to model human reasoning. Most applications require additional operations derived from probability theory.

## Operations from probability theory

The need for reasoning in probabilities comes up in everyday experience. When you make a decision based on uncertain information, you intuitively weight the data according to importance and certainty. You then select the source of action which, based on all the evidence, seems most likely to yield a desired result.

Consider, for example, the process of diagnosing a disease. Several symptoms may be characteristic of the disease, and the more symptoms we observe, the more certain we are that the disease is present. Symptoms may not have equal importance — a headache could indicate any number of ailments, but blurred vision is more specific and more indicative of a particular disease.

Fuzzy-set operators provide no good means of combining weightings of symptoms. The best we can do is use the f-OR. If symptom A indicates a 70 per cent chance of the disease and symptom B indicates a 40 per cent chance, the likelihood of the disease would be calculated as

```
0.4 f-OR 0.7 = max(0.4,
      0.7) = 0.7
```

This totally disregards the accumulation of evidence; it only considers the single most significant symptom.

Now, let's consider a probability function. Given two independent events A and B, the probability of either occurring is

```
p(A or B) = p(A) + p(B) -
          (p(A) x p(B)).
```

If we apply this function to the diagnosis above, we find that the likelihood of the disease is

```
0.4 p-OR 0.7 = 0.4 + 0.7 -
          (0.4 x 0.7) = 0.82,
```

which does show an accumulation of evidence. This is the *probability-OR* (p-OR) in fuzzy logic.

Up to this point, we've assumed that symptoms are either present or absent. This two-valued logic is exactly what fuzzy logic is supposed to avoid. Suppose, for example, that one of the symptoms is an elevated white-blood-cell count. There is no specific value above which the cell count suddenly becomes 'elevated'. The cell count covers a continuous range; higher counts yield more certainty that something is wrong. So, the proper way to handle this is to map the range of cell counts onto the range of fuzzy values and include this certainty factor in the calculations.

The way to include the certainty factor is to use another probability function. Given two independent events, A and B, the probability of both occurring is

```
p(A and B) = p(A) x p(B).
```

In the example above, the probabilities are: the chance that a symptom is present (the certainty factor) and the relative importance of that symptom to the diagnosis (the weighting factor). This


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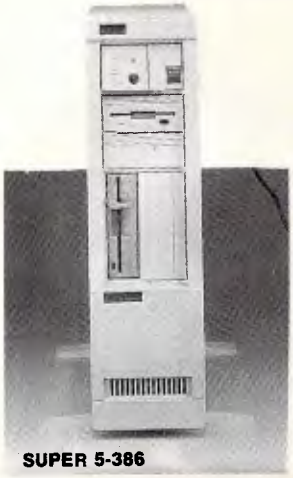

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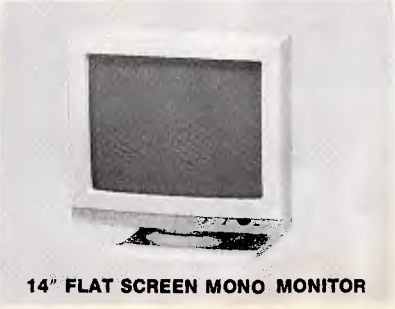

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```
database
  truth(real)
  thresh(real)

predicates
  init_fuzzy  fuzzy(real)  threshold(real)
  f_OR  f_AND  p_OR  p_AND  f_NOT

  fuzzy_max(real, real, real)
  fuzzy_min(real, real, real)

clauses

  /* Init_fuzzy must be called before any
     fuzzy  operators or predicates are used.
     It sets the initial search threshold to
     which fuzzy truth values are compared.*/

  init_fuzzy :- asserta(thresh(0.01)).


  /* Fuzzy is used to specify a particular
     fuzzy truth value, or to retrieve the
     current truth value.                */

  fuzzy(Truth) :- bound(Truth),
                  asserta(truth(Truth)),
                  retract(thresh(Thresh)),
                  asserta(thresh(Thresh)), !,
                  Truth >= Thresh.

  fuzzy(Truth) :- retract(truth(Truth)),
                  asserta(truth(Truth)), !.

/* Threshold sets or retrieves the search
   threshold used by the Fuzzy Logic
   operations. If a call to FUZZY or the
   result of a Fuzzy Logic operator results
   in a truth value less than the threshold,
   the predicate or operator will fail.   */

threshold(Truth) :- bound(Truth),
                    retract(thresh(_)),
                    asserta(thresh(Truth)),
                    retract(truth(Current)),
                    asserta(truth(Current)),
                    !,Current >= Truth.

threshold(Truth) :- retract(thresh(Truth)),
                    asserta(thresh(Truth)),
                    !.


/* Fuzzy logic contains five basic
   operators: fuzzy-AND, fuzzy-OR,
   probability-AND, probability-OR, and
   NOT. In this Turbo Prolog implementation,
   these are represented by f-AND, f-OR,
   p-AND, p-OR, and f-NOT respectively.
   "f-NOT" is used  to avoid conflicting
   with the Turbo Prolog predicate "NOT."


Since Turbo Prolog does not support
true  operator definition, the Fuzzy
Logic operators are used syntactically
```


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is the *probability-AND* (p-AND) function in fuzzy logic.

Finally, we can derive a complement operation from probability theory. If we know the probability of event A, then the probability that the event will not occur is

`p(not A) = 1 - p(A)`.

Since this is identical to the complement function derived from fuzzy-set theory, no distinction need be drawn between the two.

```
as predicates, in the order specified
by Reverse Polish Notation (RPN). For
example, the clause

  woof :- fuzzy(0.6), fuzzy(0.7),
          p-AND, fuzzy(0.4), p-OR.


represents the Fuzzy Logic expression

  (0.6 p-AND 0.7) p-OR 0.4

Note that only predicates which use
Fuzzy Logic will generate fuzzy truth
value  operands. Other predicates,
including those built in to Turbo
Prolog, do not generate fuzzy truth
values. Hence, the clause

  woof(X, Y) :- fuzzy(0.6), X > Y,
                f-AND.

is incorrect since f-AND requires two
operands, but only one (from the FUZZY
predicate) has been generated.      */
```

```
f_OR :- retract(truth(X)),
        retract(truth(Y)),!,
        fuzzy_max(X, Y, Z), fuzzy(Z), !.
f_AND :- retract(truth(X)),
         retract(truth(Y)),!,
         fuzzy_min(X, Y, Z), fuzzy(Z), !.
p_OR :- retract(truth(X)),
        retract(truth(Y)),!,
        Z = X + Y - (X * Y), fuzzy(Z), !.
p_AND :- retract(truth(X)),
         retract(truth(Y)),!,
         Z = X * Y, fuzzy(Z), !.
f_NOT :- retract(truth(X)), !,
         Z = 1 - X, fuzzy(Z), !.


     /*  Local predicates used by the
         fuzzy operators          */

fuzzy_max(X, Y, Z) :- X >= Y, !, Z = X.
fuzzy_max(_, Y, Z) :- Z = Y.

fuzzy_min(X, Y, Z) :- X <= Y, !, Z = X.
fuzzy_min(_, Y, Z) :- Z = Y.
```

*Listing 1 This file, FUZZY.PRO, adds fuzzy-logic to Turbo Prolog when referenced as an include file in Turbo Prolog programs*


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```
/*
   City -- This is a simple program which
   uses fuzzy logic to determine how "nice"
   various cities are.                    */


include "fuzzy.pro"    /* Include the fuzzy
                          logic module    */


predicates
  nice_city(symbol)   location(symbol)
  city(symbol)        climate(symbol)
  warm(symbol)        dry(symbol)
  characteristics(symbol)
  population(symbol, integer)
  expensive(symbol)


clauses

  nice_city(X) :- init_fuzzy, location(X),
                  fuzzy(0.5), p_AND,
                  characteristics(X),
                  fuzzy(0.9), p_AND, p_OR,
                  fuzzy(Rating),
                  write(X,
                        " has a rating of ",
                        Rating),
                  nl.

  location(X) :- city(X), climate(X), f_AND.

climate(X) :- warm(X), dry(X), f_AND.

characteristics(X) :- population(X,Pop),
                      Val = Pop/2500.0,
                      fuzzy(Val),
                      fuzzy(0.9), p_AND,
                      expensive(X), f_NOT,
                      fuzzy(0.5), p_AND,
                      p_OR, f_AND.


/*  Data on various cities  */

city(albuquerque) :- fuzzy(1.0).
city(boston) :- fuzzy(1.0).
city(ft_worth) :- fuzzy(1.0).

warm(albuquerque) :- fuzzy(0.9).
warm(boston) :- fuzzy(0.5).
warm(ft_worth) :- fuzzy(0.9).

dry(albuquerque) :- fuzzy(0.9).
dry(boston) :- fuzzy(0.6).
dry(ft_worth) :- fuzzy(0.7).

population(albuquerque, 500) :- fuzzy(1.0).
population(boston, 2000) :- fuzzy(1.0).
population(ft_worth, 1500) :- fuzzy(1.0).

expensive(albuquerque) :- fuzzy(0.6).
expensive(boston) :- fuzzy(0.9).
expensive(ft_worth) :- fuzzy(0.8).
```

*Listing 2 The program CITY.PRO uses the fuzzy-logic operations in listing 1 to evaluate the quality of life in different cities*

## Using fuzzy logic

The most common method of adding fuzzy-logic capabilities to existing AI languages is to write a shell that runs on top of the existing language. For example, we can add fuzzy-logic operations to Turbo Prolog with the file FUZZY.PRO (see listing 1). This file is referenced as an include file by Turbo Prolog programs in which you wish to use fuzzy logic.

Since Turbo Prolog does not allow the definition of new operators, the fuzzy-logic operators are used as predicates, and fuzzy-logic statements are expressed in Reverse Polish Notation. We use the symbols below to represent the five operators in fuzzy logic.

| | |
|---|---|
| **NOT** | f_NOT |
| **p-AND** | p_AND |
| **p-OR** | p_OR |
| **f-AND** | f_AND |
| **f-OR** | f_OR |

In addition, we define and use the two predicates 'fuzzy' and 'threshold'. Listing 1, FUZZY.PRO, uses 'fuzzy' to set and retrieve fuzzy-truth values, and it uses 'threshold' to tell the program the lowest acceptable truth value, below which Prolog should backtrack and search for another solution. In Prolog, the statement (or *rule*)

```
grandparent(X, Z) :-parent
        (X, Y), parent(Y, Z).
```

means 'X is the grandparent of Z if X is the parent of Y and Y is the parent of Z'. Similarly, simple facts are represented as

```
parent(betty, tammy).
parent(anna, betty).
```

Given these two facts, and the rule above, if you ask

```
grandparent(anna, tammy).
```

Prolog will respond

```
True.
```

With fuzzy logic, Prolog will also accept facts like

```
scary(king_kong) :-fuzzy(0.5).
funny(king_kong) :-fuzzy(0.5).
```

and rules like

```
good_movie(X) :-scary(X),
funny(X), p_OR,
threshold(0.6).
```

The values in the facts are fuzzy-truth values. *King Kong* is moderately scary, but not particularly funny.

*An American Werewolf in London* is both moderately scary and moderately funny.

The rule says, in effect, that a move is good if it is sufficiently scary or sufficiently funny; the threshold of 'good' is defined as any truth value 0.6 or higher. You use the p-OR operator in cases like this where evidence is to be accumulated. *American Werewolf* wouldn't be 'good' based on either factor alone, but the p-OR will calculate the combined value

```
0.5 p-OR 0.5 = 0.5 + 0.5 -
        (0.5 x 0.5) = 0.75,
```

which is high enough to pass the threshold test and to be accepted. For *King Kong*, on the other hand, the value calculated would be

```
0.5 p-OR 0.1 = 0.5 + 0.1 -
       (0.5 x 0.1) = 0.55,
```

which would not pass the test. So, if we asked

```
good_movie(X).
```

the program would respond with

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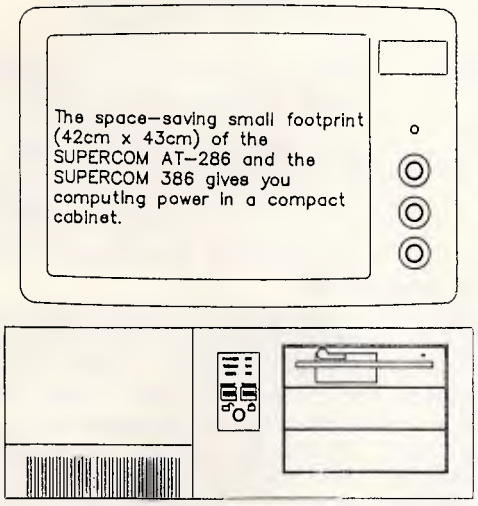


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```
X=american_werewolf
1 Solution
```

indicating that *American Werewolf* is the only good move it knows of, based on the program's criteria.

As another example of how you can use fuzzy logic, look at listing 2, CITY.PRO. This program evaluates the quality of life in different cities, based on a few factors that reflect one view of what is important. It uses a database of facts that describe the characteristics of various cities: how warm and dry the climate is, the approximate population, and the relative cost of living. All values but the population are rated on a scale from 0 to 1.

The program breaks these criteria into two categories, 'location' and 'characteristics', and it treats these categories as evidence to be accumulated using the probability operators. It assigns a weight, or importance, of 0.5 to 'location' using the p-AND operator, and similarly assigns a weight of 0.9 to 'characteristics'. The main rule reads

```
nice_city(X) :-
    init_fuzzy, location(X),
      fuzzy(0.5), p_AND,
    characteristics(X),
      fuzzy(0.9), p_AND, p_OR,
    fuzzy(Rating),
    write(X, "has a rating
      of," Rating), nl.
```

The first predicate, 'init_fuzzy', initialises the fuzzy-logic operations. 'Location' generates the fuzzy-truth value of 0.5, which is then combined with the value from 'location' using the p_AND operator. This sequence is repeated with 'characteristics', and then the weighted results of 'location' and 'characteristics' are combined with the p_OR. Finally, the program calls 'fuzzy' with the variable Rating (which has no value yet) to retrieve the current fuzzy-truth value, and prints this as the rating of the city.

Not all predicates generate fuzzy-truth values — only user-defined ones that themselves use fuzzy logic, and the predicate 'fuzzy' called with an instantiated value, generate fuzzy-truth values, which can be combined using the fuzzy operators.

In 'nice_city', the first predicate resolved is 'location', which contains two predicates and a fuzzy-logic operator

```
location(X) :-city(X),
climate(X), f_AND.
```

These provide the name of the city and an evaluation of 'climate'. So long as the database contains a city that hasn't been looked at, predicate 'city' will set X to a city name and return a fuzzy-truth value of 1. This value is combined with the results of 'climate' by an f_AND (which selects the lowest value); hence; 'location' will return the truth value from 'climate'.

'Climate' evaluates the two climatic factors by using the f-AND

```
climate(X) :-warm(X), dry(X),
f_AND.
```

Since the f-AND selects the lower of the two values, this reflects the idea that a climate is only as nice as its worst factor; in order to be pleasant, a city must be both warm and dry.

The 'characteristics' rule evaluates the population and cost of living:

```
characteristics(X) :-
    population(X,Pop), Val =
      Pop/2500.0,
    fuzzy(Val), fuzzy(0.9),
      p_AND,
    expensive(X), f_NOT,
      fuzzy(0.5), p_AND,
    p_OR, f_AND.
```

The first task of this rule is to map population (given in thousands) onto the range 0 to 1. In this case, the population is simply divided by 2500 and the answer stored in 'Val'. The fuzzy predicate turns this into a fuzzy-truth value.

The factor for cost of living is higher for cities where the cost of living is higher. To determine the desirability of a city, the program uses f-NOT to invert the truth value of the expensive predicate so that less expensive cities receive higher ratings. The population and expense factors are combined using the same method of accumulating evidence discussed above. The final f-AND considers this value and the truth (1.0) returned by population and chooses the lesser of the two, and so does not change the calculated value. The f-AND is required, however, to remove the population truth value from the evaluation stack.

To see how all this works, let's trace the execution of the program. If you ask

```
nice_city(Where),
```

the program will enter the 'nice_city' rule and begin by evaluating 'location', which, in turn, first evaluates 'city'. The 'city' predicate searches the database and returns with X set to 'albuquerque', the first city appearing in the database; its truth value is 1.0.

Location continues by evaluating 'climate'. The 'climate' predicate gets the values for 'warm(albuquerque)' and 'dry (albuquerque)', which are both 0.9, combines them with the f-AND operator, and returns the result of 0.9. 'Location' takes this value, f-ANDs it with the truth value returned by 'city'(1.0, since it found a city), and hence returns with its own truth value set to 0.9. Predicate 'nice_city' weights this with the value 0.5, resulting in an intermediate value of 0.45.

The program must then resolve 'characteristics'. In 'characteristics', the program retrieves the population of 'albuquerque', divides it by 2500, and stores the result of 0.2 in 'Val'. The evidence accumulation

```
fuzzy(Val), fuzzy(0.9), p_AND,
expensive(X), f_NOT,
    fuzzy(0.5), p_AND,
p_OR
```

takes the value of 'Val', 0.2, and p-ANDs it with the weighting 0.9, resulting in a value of 0.18. The second half of the expression retrieves the 'expensive' value of 0.6, uses f-NOT to invert it to 0.4, and weights it with the value 0.5 for a result of 0.2. The two halves are combined with the p-OR, which yields a value of 0.344.

This value is f-ANDed with the truth value 1.0 returned when the population was retrieved. This results in no change, so the program returns value 0.344 as the truth value of 'characteristics'.

Finally, the program can evaluate the 'nice_city' clause. The value from 'characteristics' is p-ANDed with 0.9, producing a value of 0.3096, and this is p-ORed with the truth value from the first half, which was 0.45. This yields a final rating for Albuquerque of 0.62028. Based on this, the program will respond to our query about where nice cities are located with

```
albuquerque has a rating of
   0.62028
Where=albuquerque
```

The program also provides the answers:

```
boston has a rating of 0.74545
Where=boston

ft_worth has a rating of
    0.69281
Where=ft_worth

3Solutions
```

From this, we can see that the program continued searching the database for more cities. It evaluated the cities in the order it found them, and printed out the results for each nice city it found.

## Creating Fuzzy Prolog from the ground up

While you can add fuzzy logic to an existing dialect of Prolog, applications pay a significant penalty in efficiency, since the shell adds another layer of software between the application and the machine. Also, the result is often awkward to use. This is true of my Turbo Prolog implementation in two regards: using Reverse Polish Notation for fuzzy-logic operators, and remembering which predicates produce fuzzy-truth values can be confusing. In addition, backtracking will not properly undo the results of fuzzy operations, since they are not an implicit part of the language.

The best solution to these difficulties is to build fuzzy logic into a dialect of Prolog from the ground up. I have written a dialect of Prolog called Fuzzy Prolog, which implements fuzzy logic.

Since fuzzy-logic operations are an implicit part of the language, the difficulties mentioned above do not exist. Also, since fuzzy logic is a superset of predicate logic, Fuzzy Prolog remains compatible with Prolog and will run all ordinary Prolog programs.

## A fuzzy standard

Problems are rarely black and white, and answers almost never true or false. Current applications that try to simulate human reasoning must deal with uncertainty before they can begin to address their real objectives.

To date, however, the different approaches that have been developed for dealing with uncertainty have shown little consistency with one another. Fuzzy logic provides a common core of operations and, thereby, a basis for standardisation. Making fuzzy logic an implicit feature of a language such as Fuzzy Prolog relieves applications of much of the burden of dealing with uncertainty. Consequently, software development will take less time, and the resulting software will be less complex. Of that, we can be fairly certain

END

*(The Turbo Prolog programs FUZZY.PRO and CITY.PRO and the source code for the Fuzzy Prolog interpreter are available on Microtex, page *6663#. They may also be obtained by sending stamped, self-addressed package containing a blank, IBM PC formatted 5.25in floppy disk to FUZZY.PRO, c/- APC, 124 Castlereagh Street, Sydney 2000. The Fuzzy Prolog interpreter is written in Ada, and the source code is public domain.)*

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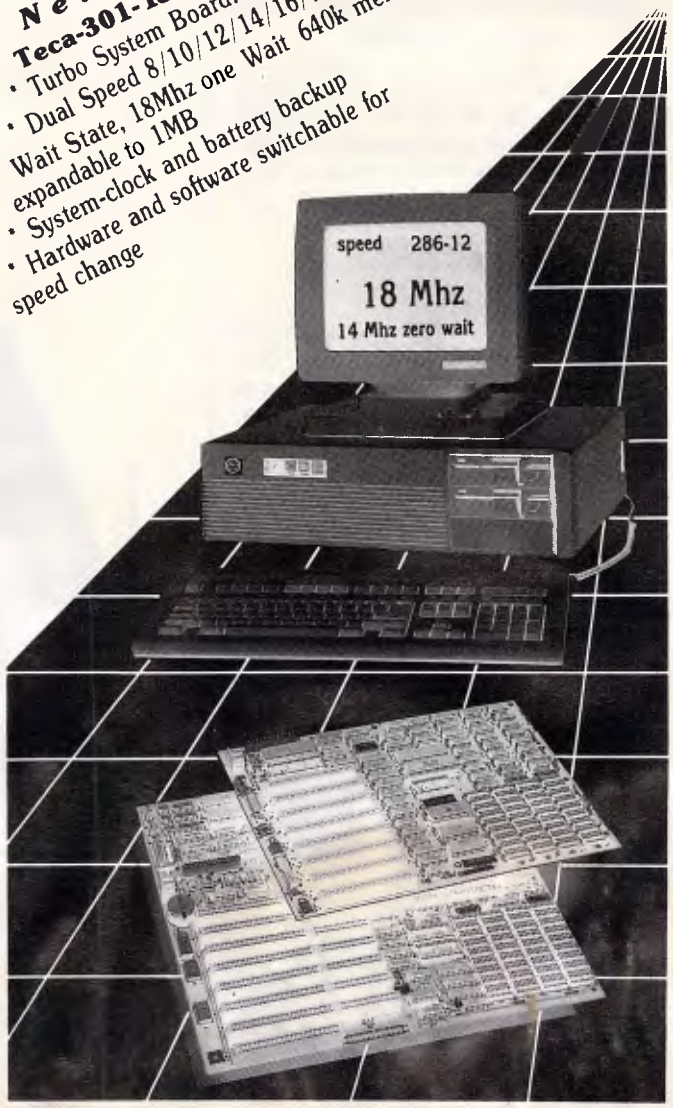


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# Making the most of Ventura Publisher

***The popular DTP software package, Ventura Publisher, boasts ease of use and powerful facilities, yet you may need a little help to get the most from your system. Edward Brown documents some of the package's salient features and outlines some useful and effective methods of presenting your text.***

It is hard to believe that Xerox Ventura Publisher Version 1.0 was first launched into the IBM PC world only one year ago. With its launch, the second generation of desktop publishing software was made available on an IBM PC/XT providing facilities which were previously considered possible only on an Apple Macintosh. Since then Ventura Publisher has been further refined and improved and Version 1.1 has been released in several languages throughout the world.

Ventura Publisher provides a quick and easy method of producing documents ranging from one page to several hundred pages in length. To do this it utilises the concept of 'stylesheets' which store the details of the document layout, making it easy to experiment with different layouts for the same piece of text. The ease of use yet powerful facilities of Ventura Publisher are what makes it the most popular desktop publishing package for businesses today, but some people may still not be using Ventura Publisher to its full potential.

The purpose of this article is to show you some ways of making better use of Ventura Publisher. I shall do this by overviewing the configuration of the system followed by a brief look at the menus. Then I'll be looking at ways of using the menus to create a variety of effects.

## Configuring the system

Ventura should be configured to gain the maximum from the system. The normal configuration for a system with Ventura Publisher is to place the BUFFERS=15 and FILES=15 statements in the CONFIG.SYS file. At the same time as doing this, check to see that there is no memory resident software loaded by the CONFIG.SYS file. For some mice it may be necessary to load a memory-resident program via the CONFIG.SYS FILE. Next check the AUTOEXEC.BAT file and remove any programs that would become memory-resident.

Typically, these are programs such as SideKick or Superkey which are initiated from the keyboard by a special key sequence. Ventura Publisher will run on a 512k system, although when using Version 1.1 it is better to have a 640k system. Both memory and time can be saved by using the US hyphenation algorithm in place of the UK hyphenation algorithm. The fast US algorithm is not as accurate as the UK algorithm but the advantage is that it occupies only one third of the memory.

To install this algorithm, first rename the UKENGLSH.HY1 algorithm in the VENTURA sub-directory to UKENGLSH.OLD. Following this, copy the USENGLSH.HY2 algorithm off disk 1 onto the VENTURA sub-directory using the command:

```
COPY A:USENGLSH.HY2
  C:\VENTURA\USENGLSH.HY1.
```

Ventura Publisher will now use the faster US hyphenation algorithm to hyphenate the text. Although there is an increase in speed, this is only noticeable when the text is first loaded and hyphenated — as such the benefit of this change is limited. The prime advantage is for those with 512k systems who would benefit from the additional free memory. *Do remember* that if you have used this technique and then return to the other algorithm that the text file you are working on may no longer fit in memory; this may require it to be spooled out to disk which will greatly slow down performance.

If you have more memory available to you than the basic 640k, then a number of techniques can be employed to enhance the performance of Ventura Publisher. You can create a RAM disk and use this as the spool area if the limit of 640k is exceeded. To do this you must alter the VP.BAT file by adding/O=M: to the line beginning DRVRMRGR where M: is the RAM disk you have created. When doing this, it is also necessary to ensure that the SET LASTDRIVE= statement is used in the AUTOEXEC.BAT file to ensure that the M: drive can be accessed and to set up the RAM disk prior to use.

A better way of utilising the additional RAM is to install a disk caching program,

## Sub headline

This sub headline was created by first selecting the paragraph and creating a new tag called 'sub head'. Next the tag was set to 18 point Times Roman bold using the font entry of the paragraph menu. The 'Ruling Line Below' option was selected from the paragraph menu and custom width was selected from the top line of options. The custom indent on the right-hand side of the dialogue box was set at two and a half inches with the custom width set to one inch. Finally, the space above rule one was set to 0.04 inches and the height of rule one was set to 0.02 inches. Although the ruling line below can be placed anywhere across the page, it is best placed centrally under the text. To calculate the custom indent value, subtract the width of the frame, take this value and halve it to give the custom indent value. If the custom width is to be the same as the text, it is better to use the option of setting the width to text wide. This avoids unnecessary manual work when the text changes.

**sub headline**

## Drop capitals

Drop capitals, or big first characters as they are known in Ventura Publisher, are most often used to introduce the first paragraph of a chapter or article. They can be used to great artistic effect and it is for this reason that they were used so frequently in illustrated manuscripts. Typically the character is in a large font which is different to the main body text, and the characters within the body of the text flow round the letter in some way. The example here was created by typing the paragraph and then selecting the 'Special Effects' option from the paragraph menu. Within the special effects dialogue box, the 'Big First Characters' option was selected, the set font option was then selected and the size of the character was set to 38 points so that it lined up with the bottom of the second line. By experimenting with the size and font of the character, together with the space allowed for the big first character, many different effects can be achieved and it is worth spending a little time examining the combinations. One application which I have recently seen employed is a special symbol font to introduce individual paragraphs.

Other effects can be obtained by combining the big first character with the 'Reversed Effect' illustrated later in the article. The effect of a white character on a black background can be created by utilising a custom ruling line to highlight the individual character or by using the technique already described and creating the first character as a separate paragraph. If a custom ruling line is used, be aware that every time you alter the first character you will have to modify the ruling line setting. Creating the effect with two separate paragraphs requires a little more practice but is more flexible in the long run.

Example of big first character showing how the characters on following lines flow round the character which is dropped into the next

## Tables

Although tables can be created very easily using Ventura Publisher's built-in graphics, this can be time-consuming and inconvenient when the information is coming from a different package. Another way of creating tables is to use the paragraph and ruling box around features of Ventura. This method was used to produce the table shown here. First of all the text was typed in ensuring that there was a paragraph end after each entry so that column one, column two and column three are separate paragraphs. Once the paragraphs ahd been entered, three tags called col1, col2 and col3 were created. The font for each of these tags was set to 12 point Times Roman and the ruling line around option was set with the height of rule 1 being 0.01 inches and the width being frame wide. Each tag was set to an indent of 0.08ins using the Alignment option. As the basic attributes of each tag are the same, you may find it easier to set up one tag and then use the Create New Tag box in the side bar to create the other two from the original. Once the basic configuration was set up, each tag in turn was assigned to a paragraph. The paragraph containing the text 'column one' was selected and the tag col1 was assigned to it. The spacing option from the paragraph menu was used to set the in from left space to 0 and the in from right space to be 0. Following this, the paragraph containing the text 'column two' was tagged with the col2 tag and the spacing option was used to set the in from left space to 1.5in and the in from right space to be 0. The paragraph containing the text 'column three' was tagged col3 and the spacing option used to set the in from left space to 3.0in and the in from right spacing to 0. The various columns were aligned in the shape of steps with each item of text on a separate line. All that remains is to get the three columns on the same line. This was done by selecting column three and using the spacing option of the paragraph menu to set the above space to 0, the below space to 0.19ins and the interline spacing to 0. Then the Breaks option was used to set the Paragraphs break to none, column breaks to none and the line breaks to after. Next both col1 and col2 were set so that the above, below and interline spacing was 0 and the paragraph break, column break and line breaks were set to none. Once this was done, all the columns were now on the same line in the form of a table. The rest of the table items were tagged, making sure to tag the right-most ones first as this makes the whole exercise a lot easier. Doing this, it is best to tag the right-most table paragraphs first as this makes it easier to tag the other paragraphs.

| Column one | Column two | Column three |
|---|---|---|
| Item one | Item two | Item three |

such as FLASH, which will utilise the RAM provided by buffering the files as they are used. This cuts down on the number of disk reads which are required and speeds up the whole process. By using FLASH the disk is rarely accessed when changing between modes, and this greatly increases the overall performance of Ventura Publisher.

## *A la carte menus*

Let's look first of all at ways of using Ventura Publisher's menus.

**Desk menu** At first glance the Desk menu appears to have nothing of interest to the user and this is how it is *intended* to look. However, if you move the mouse to the word Ventura located in the top of the bottom left-hand box and click on the mouse, another dialogue box will appear. This dialogue box gives useful information about the current state of Ventura. The most important value to look at is the 'amount' swapped out. If this value is not zero, it means that Ventura Publisher has started to utilise the disk for swapping data and the speed will be affected.

**Files menu** When dealing with files within Ventura, it must be remembered that several different files are used for each chapter. As a rule of thumb, if you are creating a one-chapter publication, then store all the files in one sub-directory; if you are creating a multi-chapter publication, store your files in several sub-directories under one main directory. The breakdown of the sub-directories should be based on those which Ventura uses for making a Multi-Chapter Copy All.

When starting a chapter, first load the

## *Reversed headline*

The reversed headline shown here was created by first selecting the paragraph and then creating a new tag using the 'Create New Tag' button in the side bar. This new tag was called 'Reverse Head'. Next, the font was set to 24 point Times Roman bold and the colour was set to white using the font entry of the paragraph menu. The ruling line above entry of the paragraph menu was used to create a ruling line which was text wide with a rule one height of 30 points. The space below rule three was set to 30 points minus. The minus is selected by using the two boxes to the right of the space below rule 3 setting. The selection of a negative value causes the ruling line to drop down over the text providing the reversed headline. Now, wherever you want a reversed headline, you can tag the paragraph with the newly created reverse head tag. Other effects can be created in a similar way by using different colours of text and background, and it is worth spending some time experimenting with different combinations of shading to see what effects you can produce on your printer.

**REVERSED HEADLINE**

## *Change bars*

When text is updated it is often desirable to place a change bar in the margin so that other readers can see which paragraph has changed. This can be achieved using the ruling box around effect of Ventura Publisher. First a new tag called 'Change Bar' was created by selecting the paragraph followed by 'Create New Tag'. This provided a tag with the same attributes as the base tag. Next, the ruling box around option was selected from the paragraph menu and the custom width was selected from the first line of the dialogue box. The height of rule one was set to 0.003ins, the custom indent was set to 3 points, the indent set to minus, and the custom width set to 0. This Change Bar can now be used, whenever required, by assigning it to one of the function keys by using the CTRL K shortcut; it can also be used when entering text within Ventura, thus providing a useful way of feeding back to the authors any changes that were made in the text.

> The ruling box around feature can be used to provide a change tag facility.

## *Bullets*

Bullets are used to introduce a list of items such as:

- Agenda items
- Action items
- Contents
- Enclosures

where each item is preceded by a distinguishing character. In the example here, the bullet used has been a dot placed in front of the text in a central position followed by an indent. Using Ventura Publisher it is easy to produce this type of bullet, by first selecting paragraph mode and creating a new tag called 'Bullet'. Then the 'Special Effects' option of the paragraph menu was selected, followed by the bullet box on the top right. The bullet options then became highlighted, the round bullet was selected and the ASCII code for this was displayed in the dialogue box as 195. Next, the set font attribute box was selected and the font was set to 12 point. The values were then accepted and the bullet was added to the font of the text. Great flexibility in bullet styles can be achieved by selecting the box which says 'Other' and selecting a different font such as the symbol font or a dingbats font (the latter font is only available if you have a postscript printer).

### Example of a bullet list

- Type text
- select paragraph
- select 'create new tag'
- call it bullet
- select special effects
- ✍ select bullet
- ✍ select dot
- ✍ select set font
- ✍ set to 12 point Times Roman Normal
- ✍ select OK
- select OK

## Call outs

Often in magazines a call out such as the one shown here is used to draw attention to a particular passage in the main text. This effect is a variation on the sub headline method of creating a tag. The call out was created by first selecting the paragraph and creating a new tag called 'Call Out'. Next the tag was set to 18 point Times Roman bold by using the font entry of the paragraph menu. The ruling line below option was selected and the frame wide option selected from the top line. The space above rule one was set to 0.04 inches and the height of rule one was set to 0.04 inches. Having completed the settings for the ruling line below, the ruling line above option was selected and the ruling line was again set to frame wide. This time the space above rule one was set to zero, the height of rule one was set to 0.20 inches and the space below rule one was set to 0.08 inches. Now the Call Out tag can be used wherever required.

**Call out as in magazines**

stylesheet required and, before making any changes, use the 'Save As New Style' option to save it to the required sub-directory. Next use the 'Save As' option to save the chapter in the required sub-directory. By doing this, the danger of overwriting a stylesheet is greatly reduced and the chapter can be saved at regular intervals using the controls (^S) command sequence.

For several of the graphics options, when a file is loaded it is converted into a GEM format. By using these GEM files in place of the original files, the amount of disk space required can be reduced. To do this the original files need to be loaded into the chapter which will cause them to be converted. Next, load the GEM files created and replace the originals in the chapter. Now remove the originals from the file list by using the 'Remove Text/File' option in the edit menu and save the chapter. You can now exit Ventura and copy the original files onto a floppy for archive purposes and delete them from the hard disk.

**Edit menu** The 'File Type/Rename' option can be used to change the form of a text file so that it can be used by another word processor. This is achieved by selecting the option and then specifying the new format of the file. The next time the chapter is saved, the text file will be saved in the new format.

**Page menu** The 'Go to Page' option can be used to move to any page in the document rapidly. Use the keyboard shortcut ctrl-G (^G) to achieve this as it is more convenient. When selecting page numbering and chapter numbering, it is worth noting that the text options (for example, ONE, TWO, THREE) are not available in language versions apart form English and American English. When working on a chapter, remember to perform a renumber chapter at regular intervals to maintain the numbering in your chapters.

**Frame menu** A number of useful effects can be created with the ruling lines options from the frame and paragraph menus, and these are discussed below. The Anchors and Captions option is used in conjunction with the edit and page menus to tie graphics to a particular piece of text. In this way, text can refer to diagrams in a manner such as 'see diagram below', and the diagram can be maintained by anchoring it to the text and using the Frame re-anchor option in the pages menu.

**Paragraph menu** The Paragraph menu is used for creating a number of effects to enhance the appearance of your output. The most obvious of these is the special effect option which provides the facility to produce bullets and large first letters together with full positioning and size control. When used in moderation these can be quite dramatic. By using the Assign Function Keys, paragraph tag values can be assigned to the function keys and used during the paragraph tagging or text editing phase of document preparation.

**Graphics menu** When using the graphics menu use the 'Save To' and 'Load From' options for saving and restoring line and fill attributes.

**Options menu** Use the Options menu to set up the various facilities Ventura Publisher offers. For most uses turn on the rulers as they are useful for positioning columns and frames. Graphics should be turned off except when it is essential to see the graphics. This will considerably increase the speed at which the screen is redrawn. Use the Add/Remove Fonts option to reduce the fonts loaded to those which you are going to use.

Good design means that you should only be using two or three typefaces in

## Small Caps

As shown in the example here, small caps are of an equivalent size to the lower-case letters of the font used and are used for such things as product names. The small caps in the example were created by selecting text mode and then positioning the text cursor at the beginning of Lotus 1-2-3. Next, the shift key was pressed and the cross bar cursor moved to the end of Lotus 1-2-3. The mouse button was depressed, which resulted in the text being highlighted. It is also possible to drag the cursor across the text in order to highlight it if this is preferable. With the phrase 'Lotus 1-2-3' highlighted, the option 'Upper Case' was selected from the side bar window followed by the option 'Small'; this resulted in the text being changed to small capitals. The same was then done for the other product names in the example. It is worth noting that the dBase example had to take into account the fact that dBase starts with a lower-case letter and that this also needs to be in the small mode to match up with the rest of the name.

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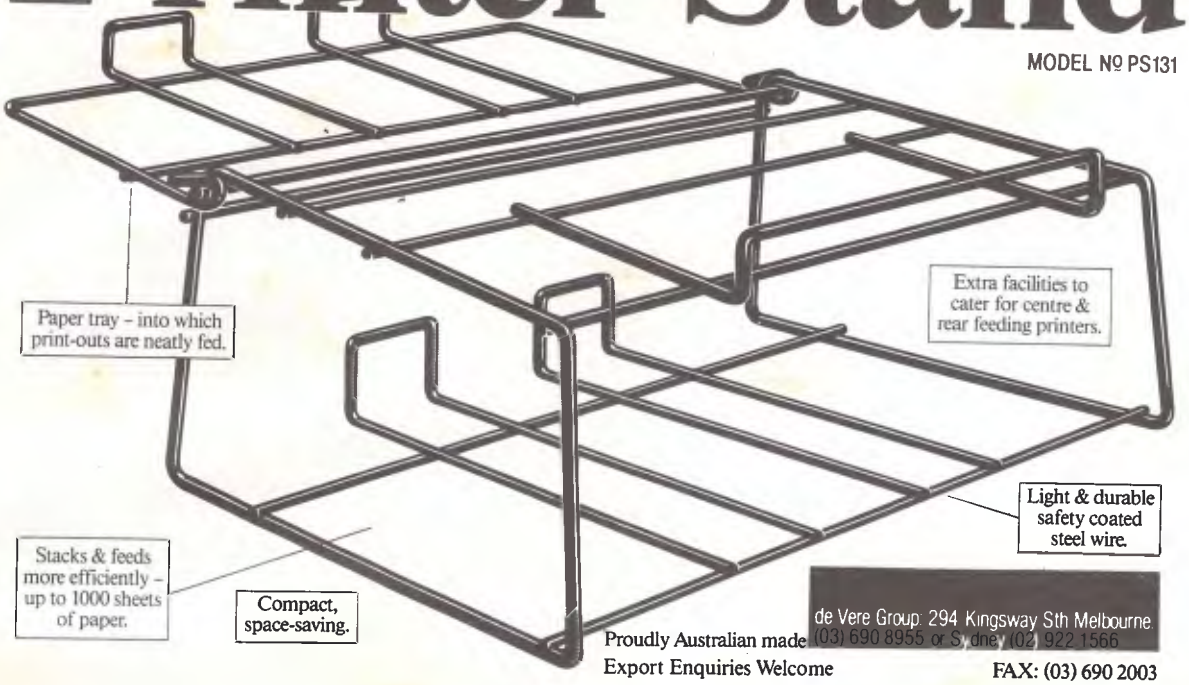


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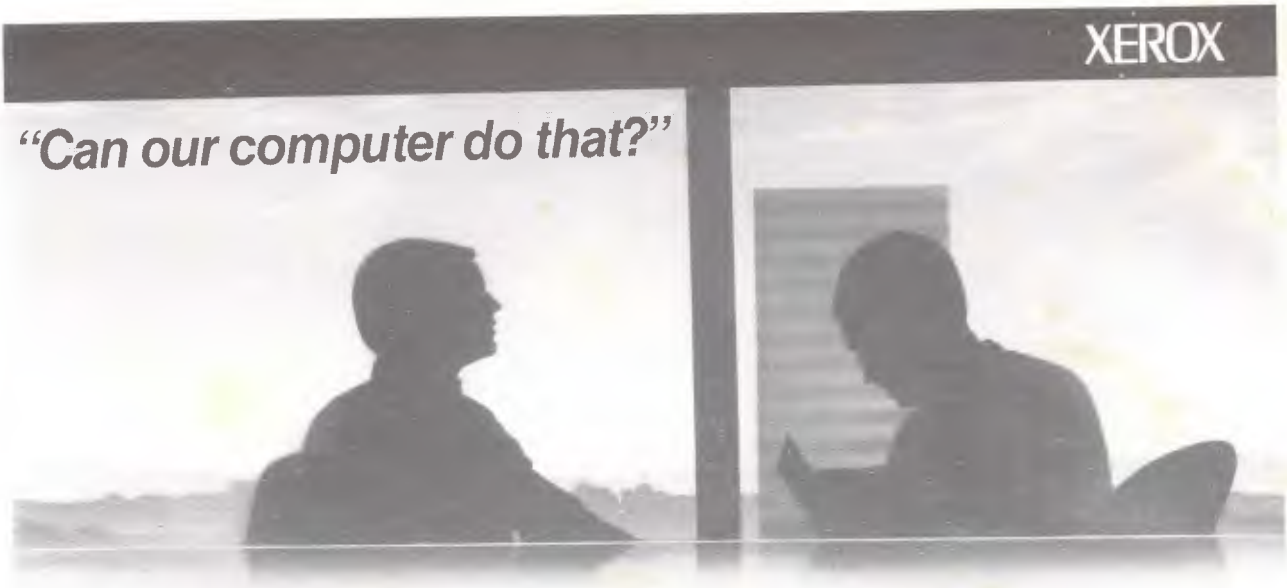


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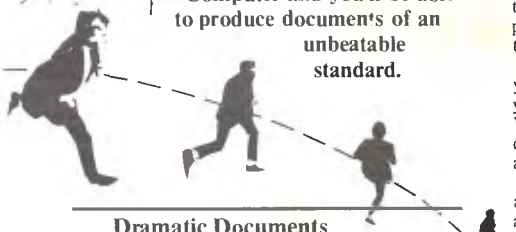

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## Additional information

The use of different fonts for several of the examples here shows what can be achieved with a little thought as to how to present information. The restriction on fonts is now changing, and there are a number of products available which enable the user to select the fonts he or she requires.

One of the most recent and interesting products on the market is the Fontware Package for Ventura Publisher which is available from Bitstream. This allows the user to select the fonts he requires for his printer, together with matching screen fonts for the screen he selects. Other products in this line which I have recently seen are available from Softcraft Inc, Weaver Graphics, The Laser Edge, and Graphic Displays.

Including graphics in your presentation is another way of drawing attention to your document and two useful things are screen images and clip art. Screen images are straightforward captures of what is on the screen and clip art is a collection of images from other sources. With regard to screen capture the most useful package I have so far come across is Hotshot from Symsoft, which allows the capture of both graphics and text screens. These can then be converted to PCX format or EPSF format, both of which can be loaded into Ventura Publisher. Other screen capture programs are available within many graphics programs and probably one of the most useful with Ventura Publisher is that supplied with Halo DPE from Media Cybernetics. With regard to clip art, the only examples I have seen are from PC-Quick Art Inc which keeps an extensive library.

Two further programs which have been specially designed to work with Ventura Publisher are worthy of mention . VP/Tabs and VP/Saddle are both written by the Laser Edge and are designed to enhance the use of Ventura Publisher. VP/Tabs is used as a pre-processor for Lotus spreadsheets so that they can be loaded into Ventura Publisher and processed correctly. This is done by replacing the spaces inserted by Lotus with tabs which can then be set up in Ventura Publisher.

VP/Saddle is used to post process a PostScript file to produce pages in various formats which are suitable for the production of books and booklets.

two or three sizes for your document. This will reduce the size of the width table and increase the memory available for Ventura to perform other tasks.

### Conclusion

Many useful and effective methods of presenting text can be developed using the facilities provided by Ventura Publisher. These effects only need to be created once and can then be used over and over again in your documents simply by tagging the text with the required tag. Some of these effects are illustrated in the boxes which accompany this article.

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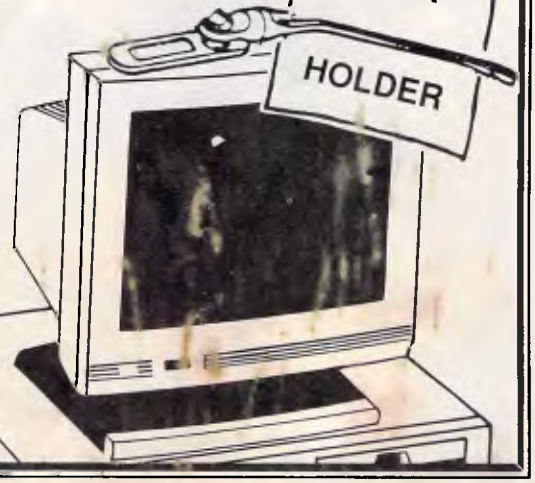

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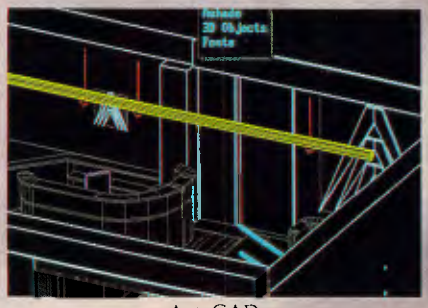

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# From chaos to beauty

***From the depths of scientific mystery and a basic knowledge of mathematics, weird and wonderful designs can be produced, from a computer with graphical output. Barry Martin and Mike Mudge present a kaleidoscope of patterns and figures.***

'Chaos' is a respectable scientific discipline emerging in many areas, ranging from turbulent flow through population dynamics, heart cell dynamics and neurological patterns to the study of lasers. Any readers interested in the underlying theory can refer to the publication, *The Universality of Chaos,* a collection of papers edited by Predrag Cvitanovic and published by Adam Hilger (1984). However, with no knowledge of the theory and only a minimal knowledge of basic mathematics, patterns and designs of breathtaking beauty and intricacy can be produced — all that is required is a microcomputer with graphical output. Colour graphics, although not essential, can be used to produce subtle effects and attractive designs.

The procedure is based on iterations of ordinary real numbers. A starting point $(x_0,y_0)$ is chosen and then successive points $(x_1,y_1)$, $(x_2,y_2)$, and so on, are generated using some mathematical function. A digital computer plots the points so quickly that it appears as if electronic raindrops are falling onto the graphics screen. Eventually, after a thousand or so points have been plotted, a pattern begins to emerge. Patterns can be varied by changing the starting point or by changing numerical parameters in the mathematical function, thus giving infinite variety from any one point generator.

Do not, however, get the impression that the formulae have to be complicated in order to produce exotic patterns. Very simple formulae using, for example,

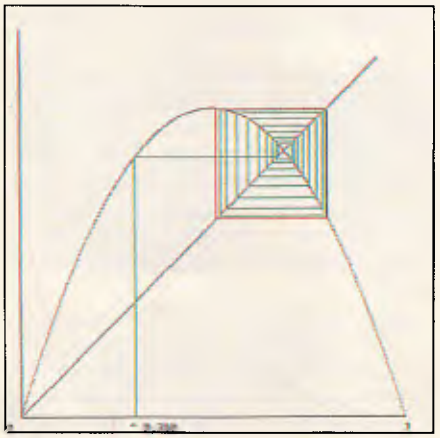

*Fig 1*

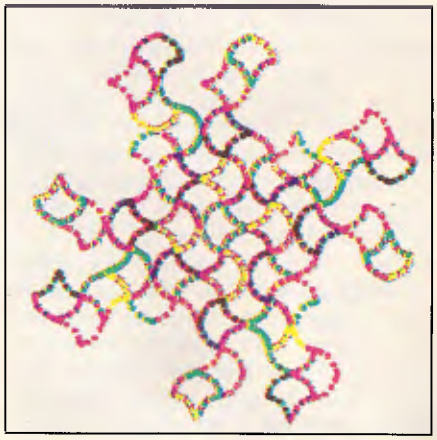

*Fig 2*

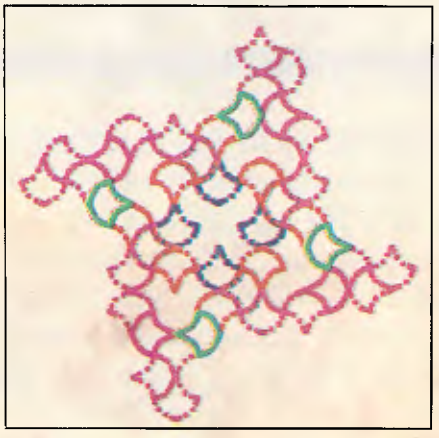

*Fig 3*

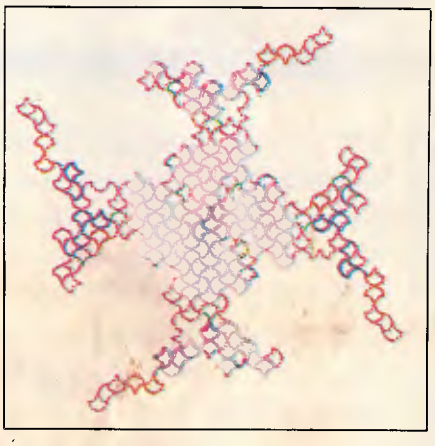

*Fig 4*

functions such as SGN(x) and SQR(ABS)x)), which are available on all micros, can yield exquisite designs as can be seen from the detailed examples which appear in this article.

Some patterns seem to build up in one area of the screen for thousands of iterations and then, suddenly, the whole process jumps to another region and a further segment of the pattern develops. Obviously, some experimentation with scaling is usually necessary to reveal the full content of a given point generator. Increasing the magnification of an area surrounding a particular point of a pattern will reveal more of the microstructure of the pattern and will probably produce a thing of beauty in itself.

Colours may be used to enhance the artistic appeal of the patterns, for example, by assigning colour according to how far the point being plotted is from the origin of co-ordinates. Alternatively, you can change colour according to the number of iterations required to compute the position of the point — for example, vary the colour every 100 iterations.

The techniques for developing the patterns described in this article were inspired by the Mandelbrot sets presented by Dr M Novak and Jack Weber in the article 'Fractal Sets', *APC*, January 1987. Mandelbrot's patterns emerge from complex numbers (not easy things for many people to manipulate on their computers) and the seeds for the iterative process are the points, infinite in number, found in a region of the plane. For every point on the screen a complicated calculation needs to be done many times over, and the computer generation of a complete pattern may take hours or even days, although Weber does describe ways to reduce this computation time.

Furthermore, to obtain detailed resolution of the final picture, high-powered graphics facilities are required. The process described here, on the other hand, uses only real numbers and the pattern grows from only a single seed, the starting point ($x_0$,$y_0$). The pattern begins to appear after a minute or so of computation, and exciting pictures can be produced using nothing more elaborate than the screen of portable TV set.

Using such pattern-generating techniques, it is possible to design your own personalised wallpaper or textiles so that no-one else in the world would be likely to have the same pattern. Imagine going into a shop, keying a couple of your own secret numbers into a computer terminal, and a computer-based automatic 'pattern designer' then produces rolls of unique personalised wallpaper or even a unique dress fabric.

However, to return to the 'chaos' of reality upon which all of this is based, before you all branch out into computerised wallpaper design, we will look at a one-dimensional case (no pretty pictures) which will illustrate how chaotic phenomena rise from an ordered situation.

```
 10  REM PROGRAM "HOPALONG".
 20  REM THIS GENERATES PATTERNS BY ITERATION FROM "HOPALONG".
 40
 50 MODE1
 60  REM READ IN DATA: CONSTANTS P,Q,R, INITIAL POINT, CENTRE POSITION,
 70  REM SCALE AND NUMBER OF ITERATIONS.
 80 INPUT "CONSTANT P ",P
 90 INPUT "CONSTANT Q ",Q
100 INPUT "CONSTANT R ",R
110 INPUT "X COORDINATE OF STARTING POINT ",X
120 INPUT "Y COORDINATE OF STARTING POINT ",Y
130 INPUT "X COORDINATES OF CENTRE POINT ",XC
140 INPUT "Y COORDINATES OF CENTRE POINT ",YC
150 INPUT "HORIZONTAL SCALE ",XS
160 INPUT "VERTICAL SCALE ",YS
170 INPUT "NUMBER OF ITERATIONS REQUIRED ",N
180 CLS
190 ICOUNT=0
200 T=1/SQR(2)
210
220  REM START ITERATION.
230 FOR I=1 TO N
240 X1=Y-SGN(X)*SQR(ABS(Q*X-R))
250 Y=P-X
260 X=X1
270 ICOUNT=ICOUNT+1
280 PRINT TAB(0,0);ICOUNT
290  REM ROTATE PLOT THROUGH -45 DEGREES.
300 U=T*X+T*Y
310 V=-T*X+T*Y
320 PLOT 69,XC+XS*U,YC+YS*V
330 NEXT I
340 STOP
```

## *One-dimensional chaos*

As an example we will look at the equation (known to mathematicians as the logistic equation) **(1) . . .$x_r$+ 1= 4C$x_r$ (1-$x_r$)**, where r = 0,1,2 . . . successively. We take a starting value $x_0$ anywhere be-

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tween 0 and 1 and then compute $x_1$, $x_2$, $x_3$ . . .

using equation (1).

A procedure such as this is called an 'iterative scheme' and the computation of each successive x — value is called an iteration. Before starting, however, we must decide on a value for the constant C, as the behaviour of the iterative scheme is dependent on the constant we choose. Firstly, C must lie between 0 and 1; this keeps the successive iterates within the range zero to one. If C is less than 0.25, the values of $x_r$ as r becomes large, approach zero. If C lies between 0.25 and 0.75, the values of $x_r$ approach $1-1/4C$.

For C between 0.75 and 0.9, more interesting features begin to emerge. For example, where C = 0.76, $x_r$ alternately approaches the two values of 0.589356083 . . . and 0.730591286 . . . and, as larger values of C less than 0.9 (or, more accurately, 0.8925 . . .) are chosen, $x_r$ simultaneously approaches an increasing number of these 'limit' values, as shown in the box below.

| C | Number of 'limit' values |
|---|---|
| 0.2 | 1 |
| 0.24 | 1 |
| 0.76 | 2 |
| 0.87 | 4 |
| 0.89 | 8 |
| 0.892 | 16 |

*Limit values*

The algebraic significance of this phenomenon is well understood by the mathematical pundits and is, indeed quite predictable and orderly. However, as C gets closer to the special value 0.8925 . . ., order ceases and chaos takes over. The values of $x_r$ become distributed between 0 and 1 in a thoroughly haphazard way, but order can return as C is further increased towards unity. For example, if you try $x_0$ = 0.96, you should find that just three points are visited.

All the various features described above can be displayed using the program 'CHAOSMW'. This first draws the parabola having equation **(2) y= 4Cx(1-x),** together with the straight line having equation **(3) y = x.** It then carries out the iterative process which is illustrated in Fig 1 where, in this case, C = 0.8 and $x_0$ = 0.3.

To help you centre and scale the plots on your own monitor, it will be useful to know that on a screen of 1280 × 1024 pixels, xo = 200, yo = 100, xs = 900 and ys = 900 gives a good picture.

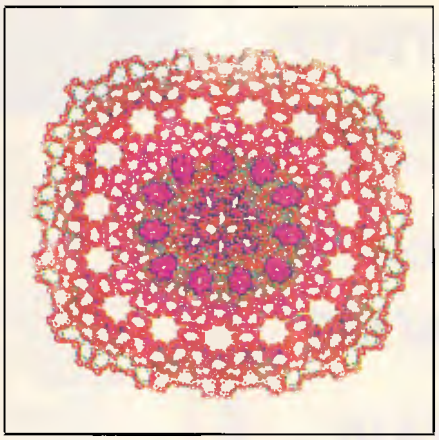


*Fig 5*

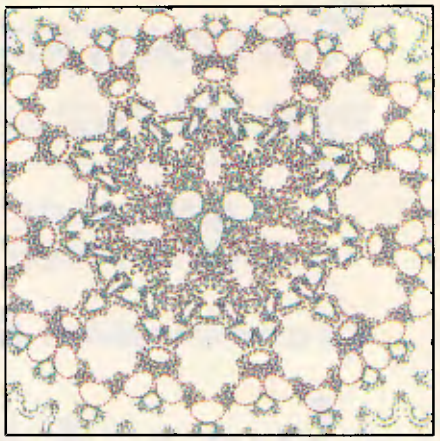


*Fig 6*

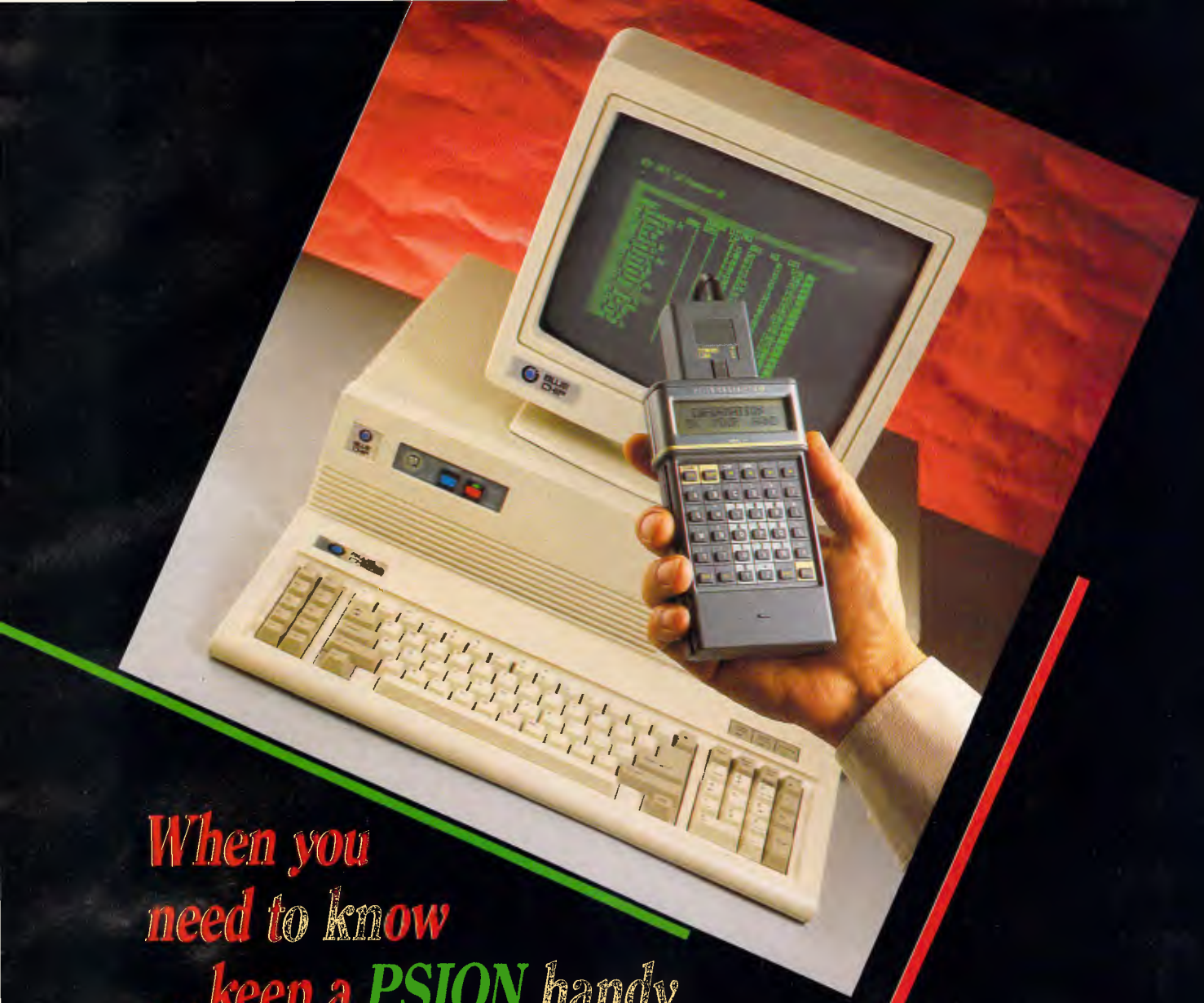
## Two-dimensional chaos

The two-dimensional mappings which we will consider are of the form **(4) $x_r$ + 1= f($x_r$ + $y_r$), $y_r$ +1= A - $x_r$,** where A is a numerical constant, r = 0,1,2 . . . successively and starting values ($x_0$, $y_0$) are to be specified, and f(X,Y) is a non-linear function of the ordered pair (x,y). Readers have the opportunity to investigate the consequences of replacing $y_r$ +1= A - $x_r$ by $y_r$ +1+ g($x_r$ + $y_r$), a second non-linear function. Brief experimentation within this area, however, suggests that the resulting patterns may be overelaborate with a consequent loss of aesthetic appeal.

The first family of mappings to be considered is **(5) $x_r$ +1 = $y_r$ - sin($x_r$), $y_r$ + 1= A - $x_r$,** where r = 0,1,2 . . . successively with starting values of (0,0). The necessary program 'AXHEADS', is listed elsewhere in this article.

It seems that if A = π = 3.1415026 . . ., this program displays a repetition of the four points (0,0), (0,π), (π,π) and (π,0). This phenomenon is somewhat analogous to the predictable and orderly behaviour previously described for the one-dimensional mapping equation (1) when the constant C is less than 0.87 . . . We are not, therefore, surprised by the approximation to fourfold symmetry that results from choos-

```
 10  REM PROGRAM  "AXHEADS".
 20  REM THIS  GENERATES ITERATES  WHICH "TILE" THE PLANE
 30  REM WITH AXEHEAD LIKE FORMS.
 50
 60 MODE1
 70  REM READ IN DATA: CONSTANT A, INITIAL POINT, 'CENTRE' POSITION,
 80  REM SCALE AND NUMBER OF ITERATIONS.
 90 INPUT "CONSTANT A ",A
100 INPUT "X COORDINATE OF STARTING POINT ",X
110 INPUT "Y COORDINATE OF STARTING POINT ",Y
120 INPUT "X COORDINATES OF CENTRE POINT ",XC
130 INPUT "Y COORDINATES OF CENTRE POINT ",YC
140 INPUT "HORIZONTAL SCALE ",XS
150 INPUT "VERTICAL SCALE ",YS
160 INPUT "NUMBER OF ITERATIONS REQUIRED ",N
170 CLS
180 ICOUNT=0
190 T=1/SQR(2)
200
210  REM START ITERATION.
220 FOR I=1 TO N
230 X1=Y-SIN(X)
240 Y=A-X
250 X=X1
260 ICOUNT=ICOUNT+1
270 PRINT TAB(0,0);ICOUNT
280  REM ROTATE PLOT THROUGH -45 DEGREES.
290 U=T*X+T*Y
300 V=-T*X+T*Y
310 PLOT 69,XC+XS*U,YC+YS*V
320 NEXT I
330 STOP
```



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```
 10  REM  PROGRAM   "CHAOSMW".
 20  REM THIS PROGRAM DISPLAYS SUCCESIVE ITERATES OF THE LOGISTIC EQUATION
 30  REM X(N+1)=4*C*X(N)*(1-X(N)).
 40  REM TO START IT ASKS FOR A VALUE OF C BETWEEN 0 AND 1
 50  REM AND FOR AN INITIAL VALUE OF X BETWEEN 0 AND 1.
 60  REM THIS PROGRAM WAS WRITTEN BY MATTHEW WELLS. 1986.
 70 MODE1
 80
 90 INPUT "CONSTANT 0<C<1 ",C
100 INPUT "STARTING VALUE 0<STARTX<1 ",STARTX
110 INPUT "MAXIMUM NUMBER OF ITERATIONS ",MAXIT
120 INPUT "X COORDINATE OF ORIGIN ",XO
130 INPUT "Y COORDINATE OF ORIGIN ",YO
140 INPUT "LENGTH IN PIXELS OF X-AXIS ",XS
150 INPUT "LENGTH IN PIXELS OF Y-AXIS ",YS
160
170  REM DRAW AXES AND THE PARABOLA 4*C*X*(1-X).
180 CLS
190 PRINT TAB(0,0)
200 PRINT TAB(4,31) "0"
210 PRINT TAB(0,0)
220 PRINT TAB(34,31) "1"
230 PRINT TAB(0,0)
240 PRINT "C=";C
250 PRINT "X(0)=";STARTX
260 PLOT 4,XO,YO
270 PLOT 5,XO+XS,YO
280 PLOT 4,XO,YO
290 PLOT 5,XO,YS
300 PLOT 4,XO,YO
310 PLOT 5,XO+XS,YO+YS
320 X=0.0
330 SCALE=1/YS
340 FOR I=1 TO YS
350 X=I*SCALE
360 PLOT 69,XO+X*XS,YO+YS*4*X*C*(1-X)
370 NEXT I
380
390 M=0
400 X=STARTX
410 PLOT 4,XO+STARTX*XS,YO
420 GCOL 0,1
430  REM START ITERATION.
440 Y=4*X*C*(1-X)
450
460  REM PAUSE TO SEE DEVELOPMENT OF PLOT.
470 FOR N=0 TO 400
480 NEXT
490 PLOT 5,XO+X*XS,YO+YS*Y
500 PLOT 5,XO+Y*XS,YO+Y*YS
510 X=Y
520 M=M+1
530  REM INTRODUCE COLOUR CHANGE AFTER 50 ITERATIONS.
540 IF M<50 THEN GOTO 560
550 GCOL 0,2
560 IF M=MAXIT THEN STOP
570 GOTO 440
```

ing a value for A which is sufficiently close to $\pi$ (see Fig 2 referring to A = 3.1421).

20,000+ points have been plotted and the colour changed every 50 iterations. However, the results associated with the value A = 3.15 and using different numbers of iterations are displayed in Figs 3 and 4. These pictures display some of the infinite variety associated with the point-generator equation (5), as discussed in the introduction.

Scaling with A = 3.12, and initial point (0,0) on the screen mentioned above, is reasonable with xc = 600, yc = 550, xs = 10 and ys = 10.

A second family of mappings to be considered is **(6)** $x_r + 1 = y_r - \text{sign}(x_r) \times |Qx_r - R|, y_r + 1 = P - x_r$, where P, Q and R are numerical constants, r = 0,1,2 . . . successively and starting values $(x_0,y_0)$ are to be specified.

The case when $x_0 = 0$, $y_0 = 0$, R = 0 and Q = 1 has been discussed by Martin, *The Mathematical Gazette,* volume 70, number 452, June 1986, pages 140-142, for a range of values of P.

The general investigation of the point generator, equation (6) , may be carried out using the program 'HOPALONG' (the name was coined by AK Dewdney who writes on Computer Recreations in *Scientific American* magazine) for which specimen output is provided in the form of Figs 5 and 6.

## History

This approach to pattern generation has been inspired by the analysis of the so-called Hénon Attractor defined by **(7)** $x_r + 1 = 1 + y_r - ax^2r, y_r + 1 = bx_r$, where a and b are numerical constants, r = 0,1,2 . . . successively and starting values $(x_0,y_0)$ are to be specified (see, for example, M Hénon, *Communications in Mathematical Physics,* volume 50, pages 69-77, 1976). The chaotic situation resulting when a = 1.4 and b = 0.3 is displayed through four stages of magnification using up to 5 x$10^6$ points with starting values (0,0). The black-on-white pictures presented have no artistic merit, but did prompt considerable mathematical investigations resulting in part from their apparent 'ultimate' simplicity.

Such advantages seem unlikely in relation to the point generators (5) and (6) featured here, although some mathematicians are optimistic. Readers are encouraged to experiment with alternative forms of (4) — that is, to develop new designs rather than to seek underlying advances in the rather difficult mathematical theory.

END

*Refer to the program listing 'Fast Basic Chaos' in the Programming Supplement accompanying this issue of APC for another example of this type.*

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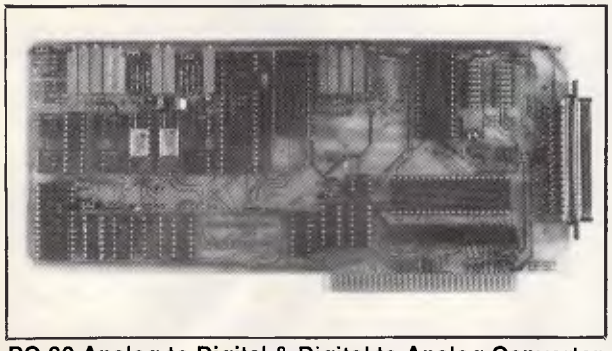

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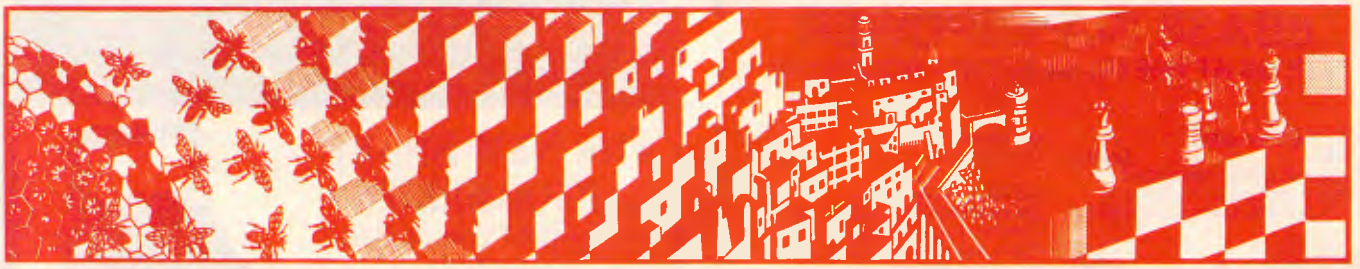


***How low can you go? If hanging around seedy clubs is your thing, Activision has the game for you. It's almost as much fun — and a lot safer. Steven Applebaum looks at the best of this month's games.***

## The butt of the joke

**Title: Leisure Suit Larry in The Land of the Lounge Lizards**
**Computer: Atari ST; IBM PC; Amiga**
**Supplier: Ozisoft**
**Format: Disk**
**Price $59.95**

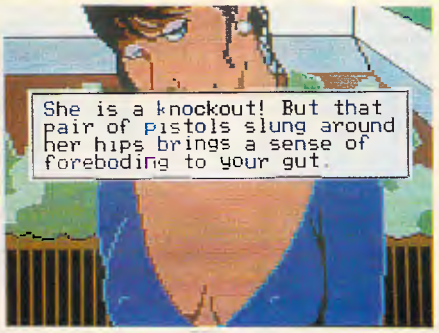
Leisure Suit Larry in the Land of the Lounge Lizards is a picaresque tale about a rather seedy chap who scours the less glamorous clubs and bars of Lost Wages for a girl who will submit to his, er . . . charm. Larry has just turned 40 and has never been 'kissed', for want of a better word. Tonight could be the night, however, when his dreams finally come true. Then again, tonight could also be the night when he gets knocked down by a speeding car, or mugged and beaten up by an irate taxi driver, or urinated on by an errant hound or even crippled with some unspeakable disease.

Before anyone starts ranting about the corruption of the country's youth, it should be noted that Leisure Suit Larry is aimed specifically at adults. A printed warning, albeit one of almost microscopic proportions, on the outer packaging informs people that the game contains 'adult subject matter' and that 'parental guidance is suggested'.

After this first rather weak line of defence comes a series of 'adult'-oriented questions which must be answered before the computer will load the game proper. If you do not answer the requisite number of questions correctly, the program crashes and you have to re-boot the disk.

Larry Laffer is the hero of this rather wild 3-D animated adventure from the creators of the King's Quest series, and also the character you play. Despite his pretensions to being cool and irresistible to the opposite sex, Larry is actually a bit of a bozo.

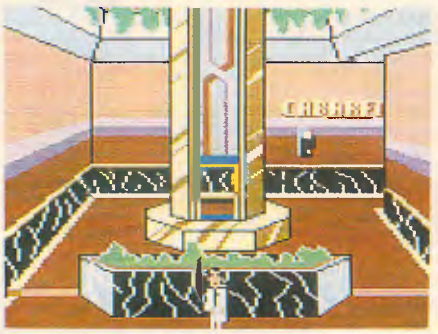
He is the kind of character who goes to discos alone, dresses in a




white suit like that worn by John Travolta in *Saturday Night Fever*, and reeks of after-shave. Apart from hovering round the edge of the dance floor leering at the ladies, he can usually be found carelessly leaning against the bar, sipping a 'Long-Slow Screw Against The Wall' cocktail or a Malibu and pineapple. Larry is the kind of guy, in other words, that female contestants on *Blind Date* have nightmares about choosing, or, equally bad, being chosen by. But whatever one may think of Larry, he is unfortunately the hero of the game, so I suppose we must sympathise with his plight.

The game opens with Larry standing outside the door of what the proprietors laughingly call a hotel, but is really a brothel. Inside, Larry can buy a drink at the bar, talk to a drunk, and do what you would normally expect to do at such a place. Getting into the hotel is easy, but unless Larry has a 'mate' with him, he will not survive long after his little rendezvous with the lady of the house. Those who go in, rarely come out.

The escapades of our would-be Don Juan are shown in colourful, fully-animated graphics, similar in style to those in Sierra's other 3-D adventures. Before you get too worried, though (or over-excited, depending on your temperament), the graphics, on the whole, are simple and lack detail. Larry, like the hero in King's Quest III, can be made to walk around the screen using the numeric



keypad. (If anyone is wondering, actions of a lubricious nature are controlled by the computer.)

Although Larry can get to most locations on foot, there are times when he has to take a taxi. This, as far as I am concerned, makes for one of the game's most inventive screens. Once Larry has climbed into the rear seat of a cab, the display changes to a view from behind the vehicle. Looking through the rear window, you can see the back of Larry's head, the driver, and the oncoming buildings as they rush by on either side.

If Larry happens to be carrying a bottle of liquor in his pocket, the driver snatches it from him and knocks its contents back in a single blast. Consequently, he swerves the car from side to side and eventually crashes it. The effect is amusing and a little hair-raising.

A feature that Leisure Suit Larry has which other games of its genre do not are facial close-ups. When Larry meets a girl, typing 'Look At. . .' reveals a close-up of her face, complete with batting eyelashes and pouting lips. Depending on the chat-up line you use, she either smiles or frowns.

Taxi rides, drinks, discos, girls, all require money; and, in a town called Lost Wages, nothing comes cheap. When your finances begin to dry up, the only way to replenish them is to go to the town's casino and play blackjack or the slots (fruit machines). These, too, are shown in

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.28mm dot pitch

**Resolution**
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Vertical: 600 lines

**Display colors**
Infinite color palette in analog mode: 8, 16 or 64 colors in TTL mode

**Characters**
2000 Characters
(80 characters x 25 lines)

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The first IBM-compatible multisynchronous RGB color monitor to support the Enhanced Graphics Adaptor standard. Automatically switched between EGA and CGA modes. The HX-12E builds on the award winning features of the HX-12. Features a .28mm dot pitch for sharp, crisp text and graphics.

**CRT**
12" Diagonal, 90 Degree,
In-Line Gun,
.28mm Dot Pitch Black Matrix Tube,
Tinted Non-Glare Etched Screen

**Resolution**
640 pixels x 350 lines at 21.8 KHz (Non-interlaced)
640 pixels x 200 lines at 15.7 KHz (Non-interlaced)
(770 x 350 max in 215mm x 160mm area at 21.8 KHz)

**Display Colors**
64 colors at 21.8 KHz
16 colors at 15.7 KHz

**Characters**
2000 Characters
(80 Characters by 25 Rows)

### MAX-12

The first high resolution multisynchronous amber monochrome monitor that allows you to display 15 shades of amber when used with most color cards. Features dynamic focusing circuitry for sharp, clear text and graphics. Can also be used with most monochrome cards.

**CRT**
12" Diagonal, 90 Degree,
Non-Glare Screen

**Resolution**

| Mode 1 | Mode 2 |
|---|---|
| (H) 720 pixels | 640 pixels |
| (V) 350 lines | 240 lines |
| (900 x 350 max in 210mm x 158mm area at 18.4 KHz) | |

**Display Colors**
15 Shades of Amber

**Characters**
2000 Characters
(80 Characters by 25 Rows)

### LM-300

The first true "What You See is What You Get" (WYSIWYG) monitor for your IBM XT/AT or compatible - features a portrait mounted 15" screen to display full pages. Super high resolution of 1200 x 1664. Four levels of gray are teamed with 150 dpi performance for halftone duplicaion and 300 dpi emulation. The LM-300 together with the Laserpage display adaptor offers compatibility with Aldus PageMaker, Ventura Publisher, Lotus 1,2,3 (graphics) and most popular desktop publishing software.

**CRT**
15" Degree Portrait Mounted

**Resolution**
1200 (H) x 1664 (V)

**Display Colors**
4 Shades of Gray

**Characters**
N/A

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close-up. The blackjack sequence looks and plays as good as any card program on the market. The animated fruit machine is also excellent, though you should avoid it unless you can afford to lose the odd dollar.

Leisure Suit Larry in the Land of the Lounge Lizards is a great fun game. That said, however, its treatment of women is rather dubious — for the most part they are portrayed as sex objects and nothing else. One comment I find particularly distasteful is one made by a character who, giving Larry a knife, tells him he might need it because there 'are some kinky girls in this town'.

In the game's defence, it is the women who are the real heroes, not Larry. Although seemingly the victims, they outwit him every time.

## *Killing time*

**Title: Trust & Betrayal: The Legacy of Siboot**
**Computer: Macintosh**
**Supplier: ISD**
**Format: Disk**
**Price: Not fixed at press time**

Chris Crawford's work is nothing if not original. His previous venture, the controversial Balance of Power, was an intelligent and thought-provoking blend of politics and military strategy based on contemporary world fear of nuclear war. Trust & Betrayal is far removed from that concept, but it is equally controversial since it portrays, as a virtue, man's ability to betray his 'friends'.

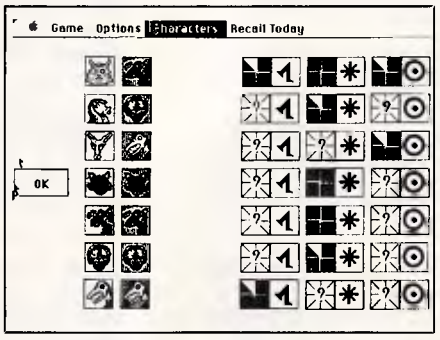
However, to make the whole thing more palatable, Crawford has dissociated the game's action from our everyday experience by locating it in an alien environment, inhabited by grotesque creatures which look like exiles from *Alice in Wonderland*.

The scene, then, is Kira, a moon of the planet Lamina. Kira is a spiritual centre, inhabited by creatures who communicate telepathically. The moon's spiritual leader, known as the Shepard, has died, and a new leader must be appointed before Kiran society falls into chaos.

Seven acolytes, of which you play one, are in line for the Shepardship. To be admitted to the office, an acolyte must have mastered to perfection the art of telepathy. But, as usual, there is a catch: there are three forms of telepathy, each of which is made up of eight 'auras'. Perfection is achieved only when all eight auras of each category of telepathy have been collected.

In play, Trust & Betrayal is unique. Like most Macintosh games it uses icons, but in a way that has, as far as I know, never been tried before. When play begins, the screen is divided into five sections comprising four rectangular windows, and a vertical strip which runs down the full length of the left-hand side of the screen. A menu bar, more of which later, is situated above the main playing area.

The above-mentioned strip is a menu which constantly changes to indicate, by way of small icons, the




actions that are available at any given moment. Initially, there are just two icons in the menu. One shows a walking figure, and the other the rather incongruous symbol of a gun pointing at a watch: the former means 'go to' and the latter 'kill time', or wait.

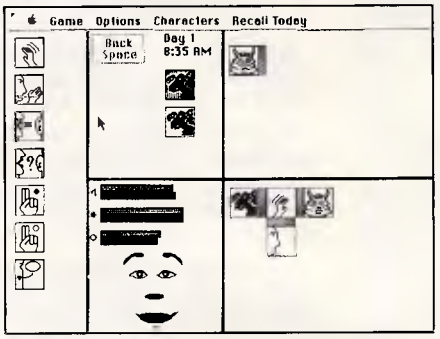
Although there are a great many such icons in the game, several of which are very similar, you don't have to refer constantly to the manual to find out what each one does.

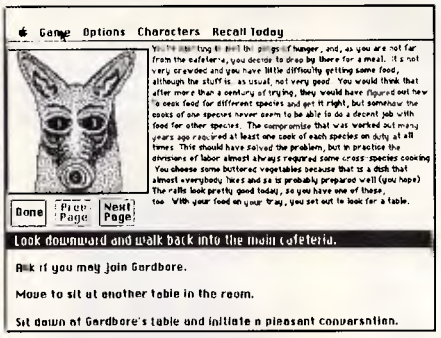
The 'go to' icon enables you to walk to your own house or that of any one of the other six acolytes. If you reach a house which is occupied, you may ask to be let in. Once inside, you can strike up a conversation with the creature whose house it is.

Dialogue with other characters is important, as it is the means by which you discover the telepathy levels of other acolytes. To be successful you must be diplomatic, or you will find characters reluctant to pass on information.

Communication with your fellow acolytes is simple, as, like everything else in the game, it is enabled through icons. The way you express yourself is extremely important. Some people like to be spoken to nicely, while others will yield information only after being threatened. It is important that you weigh up the character you wish to talk to and modify your speech accordingly.

The way you greet someone is crucial, as first impressions can have a profound effect on the way a character responds to your request for information. Trust & Betrayal contains seven icons simply for modifying a greeting. With these, you can greet a



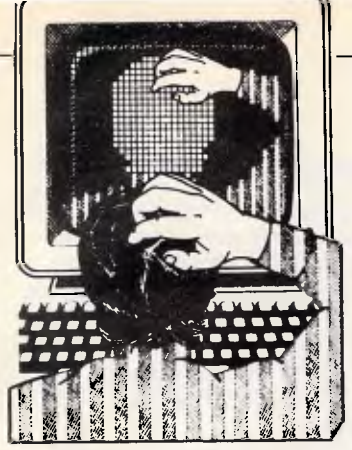

character warmly, nicely, sincerely, coolly, threateningly, haughtily or formally.

It is usually possible to see how well you are doing by the expression on a face that appears near the bottom of the screen. Clicking on the face gives a short, detailed description of the character's feelings towards you; whether it is suspicious, flattered or angry.

When night comes, you must select a character to fight for a prize of aura units. Clicking on the 'Characters' option in the menu bar along the top of the display gives a full run-down of the acolytes' individual aura counts. This gives you a chance to select the character who has the units you need.

To fight, you click on an adversary and then on the type of aura you intend to use as your 'weapon'. Which one you choose depends on the type of aura you want from the acolyte. Each aura has a different strength ratio and it is important that you choose the right one, as a defeat means losing whatever aura unit it was that you chose to fight with.

Trust & Betrayal is wonderfully whimsical. It is one of those games that is very simple to play but so strategically complex that it is infuriatingly difficult to win.



# 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.***

*Due to space restrictions in this issue, TJ's is shorter than normal and is an 'all IBM' edition.*

*The response to this column has been overwhelming since its re-introduction last year. To clear the back log of dozens of excellent tips for a huge variety of machines, the May edition of APC will feature a double-sized TJ's Workshop. In the meantime, keep tipping!*

## Audible virtual RAMdisk

Just as physical disk drives give audible and visual indicators when in use, the following patch to the DOS 3.x VDISK.SYS will turn on the PC's internal speaker at each read/write of any RAMdisk created by the DOS VDISK.SYS utility.

Type in the VDISK.SCR script file in Fig 1 using a pure-ASCII word processor or EDLIN or the DOS COPY CON command. Omit the semicolons and the comments after them! Be sure to hit the Enter key after each line, especially the last one with the Q. Then make sure VDISK.SYS is in the current directory or a directory in your path, and type

```
DEBUG < VDISK.SCR
```

*Note:* The duration of the PC's equivalent of Concert A depends on the length of time between a call to turn on the speaker and a call to turn off the speaker. Short data transfers will make a click on the speaker and long transfers will make a beep because the sound is on longer. The two calls are useful for debugging: placed around suspect code, they will tell whether the code is working or looping.

***B Chuong***

*The boops and beeps this makes also tell you when DOS is sniffing through your RAMdisk. It's often very helpful to know when DOS is loading something from your RAMdisk rather than your physical disks — and it can save you lots of anguish if DOS writes to a virtual disk when you think it's making a permanent copy — PS.*

## One-key ScrollLock

Having to use two keys, Ctrl and NumLock (or Ctrl and S), to pause scrolling screen output, and then a third key to resume scrolling, is awkward. Using the MORE filter, when applicable, is not much better.

The resident NOSCROLL.COM program, created by assembling the NOSCROLL.ASM listing in Fig 2 or running the NOSCROLL.BAS program in Fig 3, will alternately pause and restart scrolling when the ScrollLock key is pressed.

NOSCROLL works by servicing keyboard interrupt 9. When it sees that ScrollLock has been pressed, it sets a flag, enables interrupts, then waits until the flag is cleared after another press of the ScrollLock key. Since the routine waits with interrupts enabled, all hardware interrupts will continue to be serviced, including the keyboard interrupt. Normal keystrokes will continue to be placed in the keystroke buffer; however, they will not be echoed until screen output is resumed.

***W Hood***

*One-handed operation is indeed far better, but as with other programs like these that fool with INT 9, don't use it when SideKick is installed — PS.*

```
N VDISK.SYS
L
E 223 E8 08 02       ;CALL 042E          Turn on speaker at entry of I/O INOUT
E 226 90             ;NOP                and make sure that I/O is within the
E 227 90             ;NOP                the VDISK sector boundaries
E 23B E9 0B 02       ;JMP     0449       Turn off if I/O not in sector boundrs
E 2C9 E9 83 01       ;JMP     044F       Turn off speaker if all sectors xfrd
E 371 E9 E0 00       ;JMP     0454       Turn off speaker at exit from INOUT
E 42E 50             ;PUSH AX            TURN ON SPEAKER -- Save AX
E 42F B0 B6          ;MOV     AL,B6      Timer chip control word
E 431 E6 43          ;OUT     43,AL      Send to timer
E 433 B8 98 0A       ;MOV     AX,0A98    Frequency 2712 (440 Hz) Concert A
E 436 E6 42          ;OUT     42,AL      Output least significant byte lsb
E 438 8A C4          ;MOV     AL,AH
E 43A E6 42          ;OUT     42,AL      Output most  significant byte msb
E 43C E4 61          ;IN      AL,61      Get speaker/timer value
E 43E 0C 03          ;OR      AL,03      Turn on timer & speaker
E 440 E6 61          ;OUT     61,AL      Set timer chip
E 442 58             ;POP     AX         Restore AX
E 443 2E             ;CS:
E 444 8B 0E 53 00    ;MOV     CX,[0053] Get total sector count
E 448 C3             ;RET
E 449 B8 08 80       ;MOV     AX,8008    Indicate "Sector not found" error.
E 44C EB 09          ;JMP     0457
E 44E 90             ;NOP
E 44F 74 06          ;JZ      0457
E 451 E9 3A FE       ;JMP     028E       Go back to transfer some sectors
E 454 8B E7          ;MOV     SP,DI      Restore old SP
E 456 FB             ;STI
E 457 E4 61          ;IN      AL,61      TURN OFF SPEAKER -- Get timer value
E 459 24 FC          ;AND     AL,FC      Turn off apeaker & timer
E 45B E6 61          ;OUT     61,AL      Set timer chip
E 45D C3             ;RET
W
Q
```

*Fig 1 DEBUG VDISK.SCR to modify DOS 3.x VDISK.SYS so that it makes sounds when DOS writes to or reads from it. Type in the script using a pure-ASCII word processor or EDLIN or the DOS COPY CON command. Omit the semicolons and the comments after them! Be sure to hit the Enter key after each line, especially the last one with the Q. Then make sure VDISK.SYS is handy and type DEBUG < VDISK.SCR*

```
;Program sets up a resident keyboard interrupt routine. If ScrollLock
;is pressed the routine will go into a wait loop until the key is
;pressed again. Use EXE2BIN to convert from EXE to COM format.
code_seg    segment
            assume  cs code_seg, ds:nothing
            org 100h
start:      jmp     setup

old_vector  dd      ?               ;where old interrupt vector is saved.
noscroll    db      0               ;noscroll flag
message     db 'NOSCROLL installed, by William G. Hood - (C) 1987 PC Magazine',13,10,'$

key_int:    push    ax              ;start of keyboard interrupt routine.
            push    ds
                                    ;read key's scan code from port A
            in      al,60h          ;of 8255 peripheral interface chip.
            cmp     al,46h          ;if key is not "Scroll Lock"
            jne     normalkey       ;then let BIOS process it,
                                    ;else if key is "Scroll Lock" then...
            mov     ax,0
            mov     ds,ax                   ;check keyboard status byte at 417h.
            test  byte ptr ds:[417h],4  ;if Ctrl key is depressed
            jnz     breakkey                ;then let BIOS handle Ctrl-Break,
                                            ;else...
            xor     cs:noscroll,1   ;toggle noscroll flag.

            in      al,61h          ;read port B of 8255 peripheral interface.
            mov     ah,al
            or      al,80h          ;turn on bit 7 of port B
            out     61h,al          ;to send acknowledge to keyboard.
            mov     al,ah           ;restore old port B value.
            out     61h,al
            mov     al,20h          ;signal end of interrupt to
            out     20h,al          ;8259 hardware interrupt controller.
            sti                     ;enable interrupts.

wait:       test    cs:noscroll,1   ;if noscroll flag is set then
            jnz     wait            ;wait until another interrupt clears flag.

            pop     ds
            pop     ax
            iret                    ;return from interrupt.

breakkey:   mov     cs:noscroll,0   ;clear noscroll flag if Ctrl-Break.
normalkey:  pop     ds              ;if key is to be processed by BIOS
            pop     ax              ;then
            jmp     cs:old_vector   ;jmp indirect to where old vector points.

;The following code sets up the TSR interrupt routine.
setup:      mov     ax,3509h        ;use DOS int to get old int #9 vector.
            int     21h
            mov     word ptr old_vector,bx ;save old vector returned in es:bx
            mov     word ptr old_vector+2,es
            mov     dx, offset key_int     ;put new vector in ds:dx
            mov     ax,2509h           ;use DOS int to set new int #9 vector.
            int     21h
            mov     dx, offset message ;use DOS int to print message.
            mov     ah,9
            int     21h
            mov     dx, offset setup+1 ;point to end of interrupt routine
            int     27h                ;terminate, leave int routine resident

code_seg    ends
            end     start
```

*Fig 2 NOSCROLL.ASM listing to create NOSCROLL.COM*

## Avoiding printer errors

A frequent source of irritation is to begin printing a report or document, only to discover that the printer is not ready. One solution is to test the printer before attempting to send anything to it. This can easily be accomplished by using the QuickBASIC INT86 routine to access the BIOS service that reports the printer status.

Interrupt &H17 can be called specifying which printer to test, and the status will then be returned as a bit-coded integer word. Only three of the bits are important, and they can be extracted with AND and XOR, as shown in the example program (Fig 4).

Interrupt &H17 uses the number 2 in the AH register to indicate the printer test service, and a number between 0 and 2 in DX tells which print (1-3) is to be tested. The printer status is then returned in AX and will tell if the printer is turned off, not selected, or out of paper.

***L McIntyre***

*This will tell if the printer is available only at the time when it is called; it does not prevent errors that occur during printing. Nonetheless, it catches most obvious errors and could always be called immediately before printing each line. Of course, On Error will also prevent printer errors from causing a program to crash, but many people don't like to use On Error because it makes a program larger and slower — EW.*

## Bringing ANSI to Turbo Pascal

*You can't normally issue command strings to ANSI.SYS from Turbo Pascal. That's because Turbo has its own output routines that don't go through DOS Standard Output (StdOut). You can use*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*the P and G compiler directives (eg, {$P512,$G512}) to force your program's output to use StdOut, but you give up a lot. You lose Window, GotoXY, WhereX, WhereY, ClrEOL, and almost all the screen-oriented commands.*

*The program in Fig 5 demonstrates a compromise. If you assign a text file variable to the CON device, it's hooked to StdOut. Anything you write to that 'file' will get to ANSI.SYS. The output will not recognise Turbo's windows or colours, but you can get around that by setting the colours using ANSI and by placing the cursor before each Write statement — NR.*

## An editing macro

The macro shown in Fig 6 adds three editing features not normally available in 1-2-3. First, it can delete the characters to the right of the point you specify within an entry. Second, it can delete the characters to the left of that point. Finally, it can remove the characters between any two points you specify.

Before invoking the macro, you should position the cell pointer on the cell that contains the label you want to edit. The first statement in the macro brings that label to the Edit line and pauses for you to insert the appropriate block marker symbols. To delete characters from a certain point to the beginning or end of the label, you should insert an * (asterisk) marker at that point. To remove a block of text from the middle of the label, insert an * at the beginning of the block and a + (plus) at the end.

When you have inserted the appropriate marker(s) and pressed Enter, you're prompted for the number that corresponds to the type of edit you want to perform. Entering 1 will delete all the characters to the right of the * marker; 2 knocks out the characters to the left of the cursor; and 3 chops out the portion of the label between the * and + markers. Just press Enter after typing the appropriate value.

The fourth statement in the macro moves the cell pointer one cell to the left. This cell should be blank. The next statement places the label form of the formula corresponding to your choice of editing type from the three-cell range named INDEX (in this case, cells B12..B14) into the cell named HERE (the next cell of the macro). When 1-2-3 executes the cell named HERE, it enters the label form of the formula in that cell into the cell where the pointer is positioned. (This will be the cell to the left of the one you are editing.) The formula returns the desired substring and the macro continues by copying that over the original label. The final statement in the macro erases the formula.

***R Ruiz***

*Mr Ruiz's macro demonstrates a clever use of 1-2-3's string functions and its @INDEX function. In most cases, however, it would be easier to use the Backspace and Del keys to edit labels — DC.*

```
100 ' NOSCROLL.BAS program to create NOSCROLL.COM
110 E=14:CLS:PRINT "Checking DATA; please wait..."
120 FOR B=1 TO 11: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 "NOSCROLL.COM" AS #1 LEN=1
150 FIELD #1,1 AS D$:FOR B=1 TO 11:FOR C=1 TO 16:READ A$
160 LSET D$=CHR$(VAL("&H"+A$)):PUT #1:IF B=11 AND C=E THEN 180
170 NEXT:READ F$:NEXT
180 CLOSE:PRINT "NOSCROLL.COM CREATED"
190 DATA E9,88,00,00,00,00,00,00,4E,4F,53,43,52,4F,4C,4C,989
200 DATA 20,69,6E,73,74,61,6C,6C,65,64,2C,20,62,79,20,57,1406
210 DATA 69,6C,6C,69,61,6D,20,47,2E,20,48,6F,6F,64,20,2D,1284
220 DATA 20,28,43,29,20,31,39,38,37,20,50,43,20,4D,61,67,917
230 DATA 61,7A,69,6E,65,0D,0A,24,50,1E,E4,60,3C,46,75,34,1327
240 DATA B8,00,00,8E,D8,F6,06,17,04,04,75,22,2E,80,36,07,1211
250 DATA 01,01,E4,61,8A,E0,0C,80,E6,61,8A,C4,E6,61,B0,20,2025
260 DATA E6,20,FB,2E,F6,06,07,01,01,75,F8,1F,58,CF,2E,C6,1755
270 DATA 06,07,01,00,1F,58,2E,FF,2E,03,01,B8,09,35,CD,21,968
280 DATA 2E,89,1E,03,01,2E,8C,06,05,01,BA,48,01,B8,09,25,904
290 DATA CD,21,BA,08,01,B4,09,CD,21,BA,8C,01,CD,27,00,00,1431
```

*Fig 3 NOSCROLL.BAS program to create NOSCROLL.COM*

```
Input "Printer Number: ", X%
Call Printer.Check(X%)

Select Case X%
Case 0
     Print "Printer is ready"
Case Else
     Print "Printer is not ready"
End Select


Sub Printer.Check(Num%) Static

    If Num% < 1 Or Num% > 3 Then        'invalid printer
       Num% = 1
       Exit Sub
    End If

    Redim InArray%(7), OutArray%(7)     'used by INT86
    InArray%(0) = &H200
    InArray%(3) = Num% - 1              'adjust 1-3 to 0-2

    Call Int86(&H17, Varptr(InArray%(0)), VarPtr(OutArray%(0)))
    Num% = (OutArray%(0) And &H3800) XOr &H1000

End Sub
```

*Fig 4 A QuickBASIC program that reports if the printer is ready*

## Creating small files

Did you ever want to send just a few control characters to your printer? Or create a small file to use as input to another program? And did you ever want to do these things from within a batch file, without operator intervention? Most text editors won't handle control characters. Some can be coaxed into running themselves (through the use of macros), but using them to create a file a few bytes long is like using a pile driver to pound in a carpet tack — effective, but excessively time-consuming when setup time is considered. Using

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```
PROGRAM Ansi_demo;
VAR
  Ansi : text;
BEGIN
  ClrScr;
  Assign(Ansi,'CON');
ReWrite(Ansi);
Window(10,5,70,20);
TextColor(black);
TextBackground(white);
ClrScr;
Write('THIS text is going to the normal TURBO console');
Write(' output.  If a line hits the end of the current ');
WriteLn('window, it will wrap around automatically.');
WriteLn;
Write(Ansi,'BUT this text is going to the CON device via ');
Write(Ansi,'a file called "Ansi", and it has no respect ');
Write(Ansi,'at all for TURBO''s windows.');
WriteLn;  WriteLn;
Write(Ansi,#27,'[0;47;34;1mAn ANSI command string ');
Write(Ansi,'caused this color change');
WriteLn; WriteLn;
Write(Ansi,'Solution: When writing to the CON device');
WriteLn;
Write(Ansi,'    1) do not EVER overrun the window size.');
WriteLn;
Write(Ansi,'    2) always place the cursor before writing');
WriteLn(Ansi,#27,'[0;40;37m');
END.
```

*Fig 5 Use ANSI codes without losing Turbo screen commands*

```
        A       B       C
1       \a      {Edit}{?}~
2       LOOP    {GetNumber "Enter edit type (1-3): ",TYPE}
3               {If TYPE<1#OR#TYPE>3}{Beep}{Branch LOOP}
4               {Left}
5               {Let HERE,@INDEX(TABLE,0,TYPE)}
6       HERE
7               /rv~{Right}~
8               /re~
9
10      TYPE
11
12      TABLE   '@LEFT({Right},@FIND("*",{Right},0))~
13                      '@RIGHT({Right},@LENGTH({Right})-@FIND("*",{Right},0)-1)~
14                      '@LEFT({Right},@FIND("*",{Right},0))
                        &@RIGHT({Right},@LENGTH({Right})-@FIND("*",{Right},0)-1)~
```

*Fig 6 This macro adds block-editing features. Cell B14 is shown broken into two lines*

```
; Output numbers from command line
; by Philip J. Erdelsky

CODE            SEGMENT
                ASSUME  CS:CODE

                ORG     100H

MAIN            PROC    NEAR
                MOV     SI,81H          ; pointer to command line
MAIN_LOOP:      CLD                     ; clear direction flag
                LODSB                   ; get next character
                CMP     AL,13           ; carriage ret ends command line
                JZ      MAIN_EXIT
                CALL    IS_DIGIT        ; is the character a digit?
                JC      MAIN_LOOP       ; if not, keep scanning
                MOV     DL,AL           ; if so, DL = numeric value
```

*continued. . .*

*Fig 7 ONCL.ASM source code. Assemble, Link, then EXE2BIN it to produce ONCL.COM*

Basic or DEBUG is not much better.

The small ONCL.COM program created by the ONCL.ASM listing in Fig 7 or the ONCL.BAS program in Fig 8 does all these things very well. Just type ONCL followed by the decimal values for the desired characters. The utility sends the characters to the standard output, from which they can be redirected to a file, an output device, or another program.

For example, to configure my printer to its elite pitch, I can type

```
ONCL  27  77  27  126  1  >PRN
```

Then to get it back to its default configuration, I can type

```
ONCL  27  126  0  27  80  >PRN
```

The utility can also be used to make small files containing control characters. If the characters won't fit on the command line, the utility can be called repeatedly, using the double bracket to append the output to the previous results. For example, Fig 9 shows the utility making a copy of itself. If you don't redirect the output, it will go to the screen. For example, the command line

```
ONCL  7
```

will make the console beep. You might want to put this at the end of a long batch file so the computer will call you when it's done.

Some readers may wonder why I used DOS function 40 to output a single byte, when it would have been much simpler to do it with DOS function 02 (which sends the contents of DL to standard output). The reason is that DOS function 02 does some meddlesome things like expanding tabs.

***P Erdelsky***

*This is also useful for generating ANSI Escape sequences. If you have ANSI loaded (with a DEVICE=ANSI.SYS line in your CONFIG.SYS file), you can run commands like*

```
ONCL  27  91  51  55  59  52
52  109
```

*to set the colours to blue text on a white background, or*

```
ONCL  27  91  51  52  59  52
55  109
```

*to set them to white text on a blue background, or*

```
ONCL  27  91  74
```

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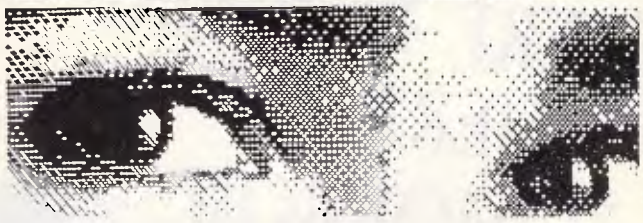

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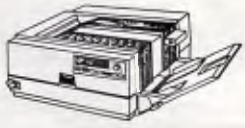

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```
NUMBER_LOOP:        LODSB                       ; get next character
                    CALL    IS_DIGIT            ; is the character a digit?
                    JC      OUTPUT              ; if not, go output byte in DL
                    ADD     DL,DL               ; otherwise DL = 10 * DL + AL
                    ADD     AL,DL
                    ADD     DL,DL
                    ADD     DL,DL
                    ADD     DL,AL
                    JMP     NUMBER_LOOP         ; continue scanning number
OUTPUT:             PUSH    DX                  ; push byte to stack
                    MOV     BX,1                ; standard output handle
                    MOV     DX,SP               ; one-byte buffer is on stack
                    MOV     CX,1                ; character count is one
                    MOV     AH,40H              ; DOS file output
                    INT     21H
                    POP     DX                  ; restore stack
                    DEC     SI                  ; decrement pointer
                    JMP     MAIN_LOOP           ; keep going

MAIN_EXIT:          RET

MAIN                ENDP

; Convert an ASCII digit (48-57) into the corresponding numeric value
; (0-9), and return with the carry flag set if the ASCII character is
; not a digit

IS_DIGIT            PROC    NEAR
                    SUB     AL,'0'              ; convert to numeric value
                    JC      IS_DIGIT_EXIT       ; carry set if char < '0'
                    MOV     AH,9
                    CMP     AH,AL               ; carry set if number > 9
IS_DIGIT_EXIT:      RET
IS_DIGIT ENDP

CODE                ENDS
                    END     MAIN
```

*to clear the screen to those colours. This works because*

```
ONCL  27  91  51  55  59  52  52  109
        |   |   |   |   |   |   |   |
      ESC   [   3   7   ;   4   4   m
     char-
     acter
```

and the command to set colours to white on blue is ESC (the ASCII 27 Escape character) plus [37;44m.

*This can also come in handy when you're trying to create a .COM file and all you have is a list of DATA statements in a Basic program. If the list is made up of hex numbers, you can use the DEBUG E command to enter them directly. But if the numbers in the DATA statements are decimal, try adapting the technique Mr Erdelsky used to create the ONCL.COM program itself — PS.*

## Find it with XREF

XREF.BAT is a useful cross-reference utility for groups of dBASE programs or any other files written in ASCII format. It finds variables, reserved verbs, or constants, and you can direct its output to screen, printer, or a disk file.

The syntax requires three parameters: (1) the filename(s) to be searched (DOS wildcards are OK); (2) the string you are searching for; and (3) the output device (you type con for console or prn for printer, or specify a filename). For example:

```
xref db*.prg varblname con
```

XREF.BAT is so short you can create it right from the keyboard:

```
COPY CON: XREF.BAT
ECHO OFF
FOR %%A IN (%1) DO FIND/N "%2" %%A >>%3
^Z <Enter>
```

*(The ^Z can be created either by hitting F6 or by typing Ctrl-Z — Ed.)* One of the nice features of this command is that it displays the line number where the target string is found, so you know where it is if you must change it. Note that the DOS program, FIND.EXE, must be in the same directory or have a pathing pointing to it.

***D Martin and R Trussel***

*Don't you just love a great one-liner? Unlike Norton's TextSearch, XREF is case sensitive, which is sometimes an advantage (sometimes a pain). The big limitation of XREF is that the search string must be one word long — BS.*

## Seeing footnotes

Writing and editing documents that contain footnotes or endnotes (such as articles for legal periodicals) is difficult using WordPerfect. While Version 4.2's preview function lets you see the text of your notes as they will appear after printing, you can't edit on the preview screen. In addition, preview has trouble with large documents on a dual-floppy system. *(WordPerfect creates the preview in a disk file, so you need available disk space when you preview a document — NR.)* The note edit screen displays only one note at a time.

My solution is a macro set that displays all notes at once in Doc 2. After I retrieve the document as Doc 1, I in-


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```
100 ' ONCL.BAS program to create ONCL.COM -- Philip J. Erdelsky
110 E=13:CLS:PRINT "Checking DATA; please wait..."
120 FOR B=1 TO 4: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 "ONCL.COM" AS #1 LEN=1
150 FIELD #1,1 AS D$:FOR B=1 TO 4:FOR C=1 TO 16:READ A$
160 LSET D$=CHR$(VAL("&H"+A$)):PUT #1:IF B=4 AND C=E THEN 180
170 NEXT:READ F$:NEXT
180 CLOSE:PRINT "ONCL.COM CREATED"
190 DATA BE,81,00,FC,AC,3C,0D,74,2A,E8,28,00,72,F5,8A,D0,1951
200 DATA AC,E8,20,00,72,0C,02,D2,02,C2,02,D2,02,D2,02,D0,1604
210 DATA EB,EE,52,BB,01,00,8B,D4,B9,01,00,B4,40,CD,21,5A,1852
220 DATA 4E,EB,D0,C3,2C,30,72,04,B4,09,3A,E0,C3,00,00,00,1592
```

*Fig 8 Basic ONCL.BAS program to create ONCL.COM*

```
ONCL  190 129 0 252 172 60 13 116 42  >ONCL2.COM
ONCL  232 40 0 114 245 138 208 172  >>ONCL2.COM
ONCL  232 32 0 114 12 2 210 2 194 2  >>ONCL2.COM
ONCL  210 2 210 2 208 235 238 82 187  >>ONCL2.COM
ONCL  1 0 139 212 185 1 0 180 64 205  >>ONCL2.COM
ONCL  33 90 78 235 208 195 44 48 114  >>ONCL2.COM
ONCL  4 180 9 58 224 195  >>ONCL2.COM
```

*Fig 9 ONCL.COM can make a copy of itself using these lines of code*


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voke the macro SEENOTES. SEENOTES sets up Doc 2 and chains to the macro FNEXEC, which is itself a repeating chain. When the macro finishes, simply switch to Doc 2 to view all of your notes. You can now edit a note in its proper context, cutting and pasting to Doc 1's note edit screen to register changes. The two macros you need are shown in Fig 10.

***J Divack***

*This macro system creates a second document for you consisting of your endnotes alone, in order and numbered. You can print this document, save it, edit it, whatever you please. Do realise, however, that the changes you make do not affect the original document unless you cut them from Doc 2 and paste them back in. The main benefit you get is the ability to swap quickly between the document containing all your notes and the context of the original document — NR.*

## Scrolling messages

Much of the time spent in a Basic program involves getting a single key response from the operator in answer to a prompt. But while INPUT is a simple solution, there are much better techniques available.

I have written a subroutine (Fig 11) that will display a message on line 25 of the video display, centred, and will rotate the message in 'billboard' fashion. The routine also accepts an attribute byte, so different messages can be displayed in different colours. The message will rotate until a key is typed. This key is then returned to the calling program. The demonstration portion of the listing (lines 10 to 270) shows how to use the routine to display a prompt for changing the screen colours. A slight delay (DLY%) is provided in the program at line 40111 and may be adjusted to suit.

***H Borrmann***

*This is strictly for use with the Basic interpreter, though it could be modified to work with QuickBASIC and Turbo Basic by changing the DATA statements comprised by the assembly language code. Note that the assembler routine is really only printing the characters, and the string is being rotated in Basic. Thus, the program fragment in Fig 12 duplicates Mr Borrmann's routine and will work with any of the newer Basic compilers — EW.*

## Counting bytes with pipes

*Mr Ramesh Santhanam submitted a*

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```
SEENOTES.MAC
<Ctrl-F10>                  Begin macro definition
SEENOTES<CR>                Call it SEENOTES
<Home><Home><Up>            Go to top of document
<Shift-F3>                  Switch to other document
<Alt-F5>6131<CR>            Set paragraph numbers to legal style
<Alt-F5>1                   Turn outline mode on
<Shift-F3>                  Back to starting document
<Alt-F10>FNEXEC<CR>         Invoke macro FNEXEC
<Ctrl-F10>                  End macro definition

FNEXEC.MAC
<Ctrl-F10>                  Begin macro definition
<Ctrl-F7>2<CR>              Edit next footnote
<Alt-F4>                    Block On
<Home><Home><Down>          To bottom of note
<ctrl-F4>2                  Copy block
<F7>                        Exit from footnote
<Shift-F3>                  Switch documents
<CR><CR><Space>             Separate this entry from last
<Ctrl-F4>5                  Retrieve text
<Home><Home><Down>          Go to bottom
<Shift-F3>                  switch documents
<Alt-F10>FNEXEC<CR>         Re-invoke FNEXEC
<Ctrl-F10>                  End macro definition
```

*Fig 10 Two macros that allow you to write and edit footnotes in WordPerfect*

```
10 '-------------------------------------------------------------
20 'L i n e  -  i n  -  M o t i o n                    HCB 8/87
30 'Demonstration of the subroutine  "MOTION.SUB"
40 '-------------------------------------------------------------
50 SCREEN 0 : KEY OFF : COLOR 7,0 : CLS : FCOL% = 14 : BCOL% = 0
60 ON KEY(1) GOSUB 220 : ON KEY(2) GOSUB 240 : KEY(1) ON : KEY(2) ON
70 ON KEY(3) GOSUB 260 : KEY(3) ON
75 QU$=" L i n e  -  i n  -  M o t i o n "
80 LOCATE 4,12 : PRINT " <F1> changes the foreground color  = ";
90 LOCATE 6,12 : PRINT " <F2> changes the background color  = ";
100 LOCATE 8,12 : PRINT " <F3> to quit this demonstration.";
110 LOCATE 14,12 : PRINT " Type any key : ";
120 COLOR 14,0 : LOCATE 1,1
125 PRINT CHR$(201); STRING$(78,205); CHR$(187);
130 FOR X = 2 TO 23
135     LOCATE X,1 : PRINT CHR$(186); : LOCATE X,80 : PRINT CHR$(186);
136 NEXT
140 LOCATE 24,1 : PRINT CHR$(200); STRING$(78,205); CHR$(188);
150 LOCATE 1,24 : COLOR 3 : PRINT QU$; : COLOR 7,0
160 TEXT$ = STRING$(20,"-") + QU$
170 'TEXT$ = STRING$(20,196) + "M A K E    M Y    D A Y"
180 GOSUB 40000 : LOCATE 14,28 : PRINT "<"; : COLOR 10
190 PRINT RTR$;
191 COLOR 7,0 : PRINT ">"; : COLOR 7,0 : PRINT" was typed    ";
195 SOUND 700,1
200 GOTO 180
210 '
220 FCOL% = FCOL% + 1 : IF FCOL% > 15 THEN FCOL% = 0
230 COLOR FCOL%,0 : LOCATE 4,50 : PRINT FCOL%; : COLOR 7,0 : RETURN
240 BCOL% = BCOL% + 1 : IF BCOL% > 15 THEN BCOL% = 0
250 COLOR BCOL%,0 : LOCATE 6,50 : PRINT BCOL%; : COLOR 7,0 : RETURN
260 RETURN 270
270 COLOR 7,0 : LOCATE 8,2 : SOUND 400,1 : END
280 '
290 '
40000 GOTO 40060
40001 '=========================================================
40005 'Call this subroutine in interpreted BASIC with GOSUB 40000
40010 '     Requires :  Text to be displayed on line 25 in TEXT$
```

*continued . . .*

*Fig 11 A Basic and assembler routine to provide a scrolling prompt message*

*program, BYTES, that used pipes to make a DOS DIR command more useful. Mr Santhanam wrote that he often faces the problem of having to manually add up the total disk space used by the files in an individual directory. The DOS DIR command displays file sizes and remaining disk space, but not the total accumulated disk space used by all of the files in a directory listing.*

*His original program presented a complex solution to the problem, which I have simplified here. BYTES, shown in Fig 13, is a filter written in C that reads a directory listing piped to it and prints the accumulated byte count of the files listed.*

*You can use BYTES by typing*

```
DIR | BYTES
```

*at the DOS prompt or in a batch file. An example of the output of BYTES is shown in Fig 14.*

*The directory listing produced by BYTES is slightly modified to place the total byte count directly under the byte count for each file. The free space is placed on the next line to keep the display compact.*

*BYTES uses a DOS 'pipe' to get its input. As DOS sends the output of the DIR command to BYTES, the program reads each line, looking for directory entries. By checking the character in column 35 (CHECKCOL in the listing; offset from column 0, in C fashion) for a colon, the time-stamp part of a directory listing can be located. When a directory entry is found, the file size in column 12 (START-Size) is saved and summed. Then the line is printed just like any normal DIR listing.*

*If the line does not contain a directory entry. BYTES looks for the 'File' phrase in column 10 (FILE_COL), an indication that the listing is ending. The number of files and disk free-space numbers are read from the line and printed in the two-line format shown in Fig 14.*

*BYTES uses the printf(), formatted-print function with the '% 9ld' format string. This forces a total of nine character positions to be used and filled with spaces, ensuring that the columns are lined up.*

*Note that BYTES expects a DIR command without the /W parameter, which will not provide the file sizes — RS.*

## Order for calculations

Even though the two expressions in Fig 15 are functionally equivalent, Turbo Pascal will execute the second much faster than the first for a number of reasons.

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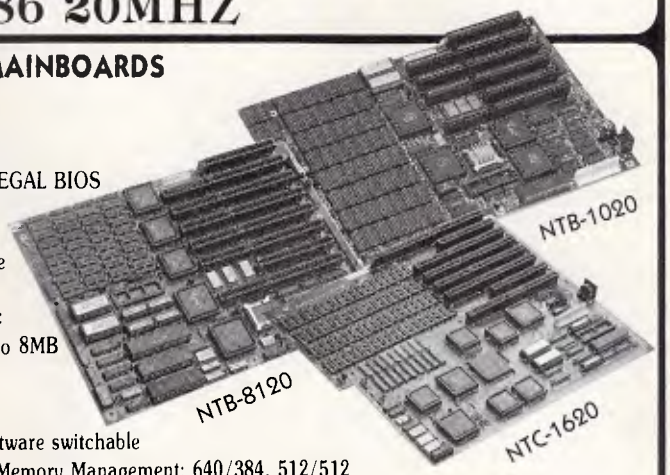


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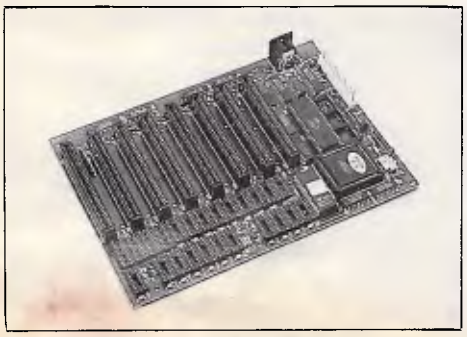

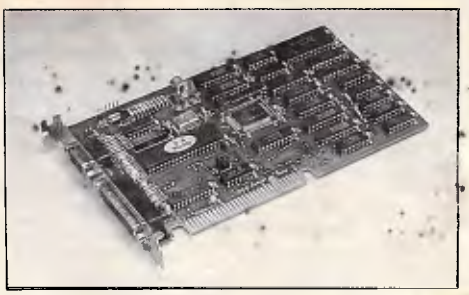

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```
40015 '                 The foreground color in FCOL%.
40020 '                 The background color in BCOL%.
40025 '      Furnishes : The key pressed in RTR$
40030 '             by: Hubert C. Borrmann. (written in August 1987)
40035 '.....................................................................
40040 ' The following variables are also used in this subroutine:
40045 ' FLAG   TEXT   TEXT%   X%  Y%  ATTR%   DLY%
40050 ' Calls the machine language routine : CALL TEXT (ATTR%,TEXT$)
40055 ' ===================================================================
40060 WHILE FLAG = 0 : FLAG = 1 : DIM TEXT%(30) : RESTORE 40070
40065 FOR X% = 0 TO 55
40066    READ Y% : POKE (VARPTR(TEXT%(0)) + X%), Y%
40067 NEXT X%
40070 DATA &H55, &H8B, &HEC, &H8B, &H7E, &H08, &H8A
40071 DATA &H1D, &H8B, &H7E, &H06, &HB0, &H50, &H2A
40075 DATA &H05, &HD0, &HE8, &H8A, &HD0, &H8A, &H0D
40076 DATA &H32, &HED, &H8B, &H7D, &H01, &HB6, &H18
40080 DATA &H51, &HB7, &H00, &HB4, &H02, &HCD, &H10
40081 DATA &H8A, &H05, &HB9, &H01, &H00, &HB4, &H09
40085 DATA &HB7, &H00, &HCD, &H10, &HFE, &HC2, &H47
40086 DATA &H59, &HE2, &HE8, &H5D, &HCA, &H04, &H00
40090 WEND
40095 IF TEXT$ = "" THEN TEXT$ = ".?.?.?.?.?.?.?.?.?.?"
40100 TEXT$ = RIGHT$(TEXT$,LEN(TEXT$)-1) + LEFT$(TEXT$,1)
40101 ATTR% = BCOL% * 16 + FCOL%
40105 DEF SEG : TEXT = VARPTR(TEXT%(0)) : CALL TEXT(ATTR%,TEXT$)
40110 RTR$ = INKEY$
40111 IF RTR$ = "" THEN FOR DLY% = 1 TO 40 : NEXT DLY% : GOTO 40100
40115 RETURN
```

First, integer arithmetic executes faster than floating-point arithmetic. In the first expression the floating-point maths comes first, which forces Turbo to do all of the calculations as floating point. By moving the integer arithmetic to the beginning, Turbo can execute part of the calculation in integer arithmetic before switching to floating point.

Second, floating-point multiplication executes much faster than floating-point division. Therefore, instead of dividing by 100 we multiply by 0.01.

Third, the order in which variables and constants are specified makes a difference in speed. Just as it is easier for you to multiply 1,234,567 by 89 than to multiply 89 by 1,234,567, it is easier for Turbo to evaluate 3600.0*CH than the reverse.

***M Babigian***

*Putting your calculations in optimal order can certainly speed them up, as shown here. However, the most significant optimisation you can perform on a Turbo Pascal 3.0 program is to convert it to Version 4.0. I was amazed at the speed improvement in both of the example expressions. A quick speed check showed TP4 three to six times faster. The optimally ordered expression*


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```
Show$ = "This is a scrolling message . . . "
Print "Press a key when you feel like it"
GetKey:
    X$ = Inkey$
    Call Motion(Show$)
    If X$ = "" Goto GetKey
    Print "You pressed " Chr$(34) X$ Chr$(34)

Sub Motion(X$) Static
    Static P              'remembers the position between calls
    H = Pos(0)            'save the current cursor position
    V = CsrLin
    L = Len(X$)
    P = P + 1
    If P > L Then P = 1
    Locate 25, 40 - L \ 2
    Print Right$(X$, L - P + 1) Left$(X$, P - 1);
    X! = Timer                        'delay so the scroll isn't too fast
    While X! + .1 > Timer : Wend      'change .1 for different scroll speeds
    Locate V, H                       'restore the cursor position
End Sub
```

*Fig 12 A purely Basic approach to scrolling messages on the screen*

*is still faster than the other, but by a smaller margin. And in TP4, it appears that the order of the operands makes no difference — NR.*

## For loop warning

Forcing an exit from a FOR loop by assigning the control variable a value greater than the test condition is a bad programming practice. Under Turbo Pascal 4.0, its effects are worse than ever. The code in Fig 16 *seems* to work under Turbo Pascal 3.0, but what actually happens is that the loop will repeat ten times no matter what. The assignment is ignored. In 4.0, your program will never get out of the loop. It's setting count to 11, making it 12, then back to 11, endlessly. You can see this effect by putting a 'WriteLn(count)' statement inside the loop.

Better programming would use While or Repeat loops. For speed, use 'Inc (count)' under 4.0 instead of 'count := count + 1' in such loops. If you really must force a FOR loop exit under 4.0, set the control variable exactly equal to the test condition, not beyond.

Note that LongInt variables *can* control a FOR loop in Turbo Pascal 4.0. This is a terrific feature! If you use loops like this:

```
x := 0.0;
WHILE x < 1000000.0 do
  BEGIN
    some_task;
    x := x + 1.0
  END;
```

```
 Volume in drive C has no label
 Directory of  C:\WORD\LANGS\WRK\BYTES

.              <DIR>       9-24-87   8:22p
..             <DIR>       9-24-87   8:22p
BYTES    OBJ      1110     9-23-87  11:21p
BYTES    EXE      8015     9-23-87  11:22p
BYTES    C        1026     9-23-87  11:21p
             10151 bytes used in 5 File(s)
             27703296 bytes free
```

*Fig 14 An example of the output produced by BYTES.EXE*

```
VAR
  CH, CL, DH, DL  : byte;
  time_in_seconds : real;

  (*This way is slower:*)
  time_in_seconds := (CH*3600.0)+(CL*60)+DH+(DL/100);
  (*This way is faster:*)
  time_in_seconds := (CL*60)+DH+(3600.0*CH)+(0.01*DL);
```

*Fig 15 Putting terms in optimal order can speed evaluation of expressions*

```
FOR count := 1 TO 10 DO
  BEGIN
    IF short_circuit_condition_exists THEN
      count := 11; {<== WRONG!}
    do_something_important
  END;
```

*Fig 16 A bad programming practice that's even worse in Turbo Pascal 4.0*

```
/* bytes.c
 *
 *   To compile with Microsoft C 4.0/5.0
 *         cl bytes.c
 *   To compile with Microsoft QuickC:
 *         cl /qc bytes.c
 */

#include<stdio.h>
#include<stdlib.h>
#include<ctype.h>

#define FILE_COL     10
#define STARTSIZE    12
#define ENDSIZE      21
#define FREESPACE    19
#define ENDFREE      27

{
     if(buffer[CHECKCOL] == '<')    /* if check col has "<"  */
     {                              /* we found an entry     */
          strncpy(sizestr,&buffer[STARTSIZE],sizeof(sizestr)-1);
          sizestr[sizeof(sizestr)-1] = NULL;
          if(l = atol(sizestr))     /* get size              */
               accum += l;          /* accumulate it         */
     }
     else                           /* not a directory entry */
     {
                                    /* if "File" found       */
          if(!strncmp(&buffer[FILE_COL],"File",4) && accum)
          {
               strncpy(sizestr,buffer,sizeof(sizestr)-1);
               sizestr[sizeof(sizestr)-1] = NULL;
                                    /* get number of files   */
               numfiles = atoi(sizestr);
```

```
#define CHECKCOL     35
#define DIRWIDTH     50
char buffer[DIRWIDTH];

main()
{
     FILE *fp;
     long l,accum = 0L,freespace = 0L;
     int       numfiles = 0;
     char sizestr[10];

     if(!(fp = stdin))                  /* point to standard in  */
          exit(1);

                                        /* get each line         */
     while( fgets(buffer,sizeof(buffer)-1,fp))

                                        /* get free space number */
               buffer[ENDFREE] = N LL;
               freespace = atol(&buffer[FREESPACE]);
                                        /* print results         */
               printf("          %9ld bytes used in %d File(s)",
                    accum,numfiles);
               printf("\n           %8ld bytes free",freespace);
               break;                   /* break out of loop     */
          }
     }
     printf("%s",buffer);
}
     exit(0);
}
```

*Fig 13 The listing for BYTES.C that determines space used by all the files in a subdirectory*

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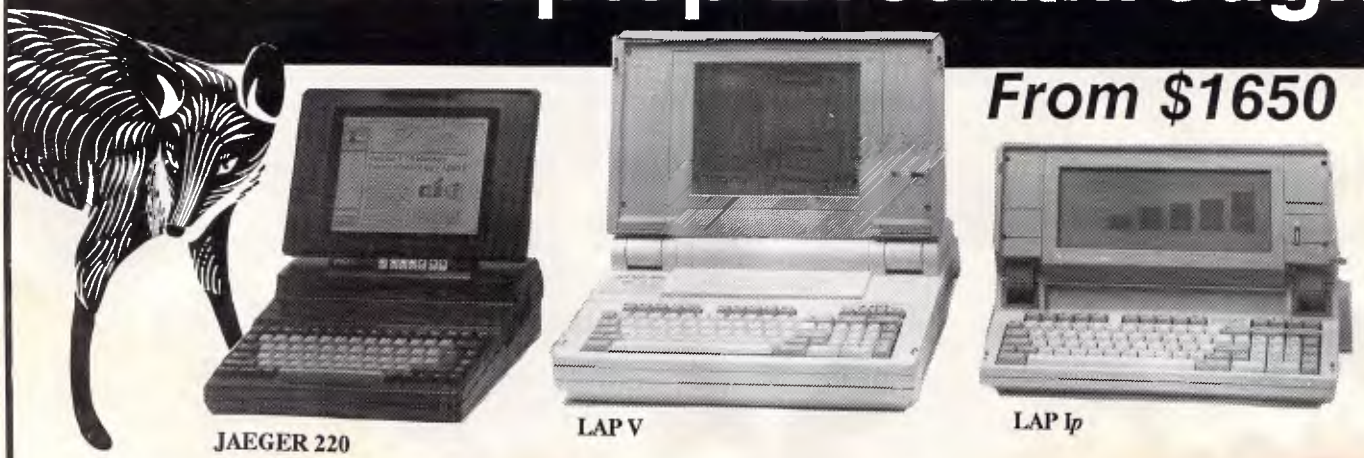


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## TJ'S WORKSHOP

rewrite them like this:

```
FOR x := 1 TO 1000000 DO
  BEGIN
     some_task;
  END;
```

I've found that using LongInt variables is much faster than using any type of real variable.

***M Caro***

*The Jensen and Wirth Pascal User Manual says, "The control variable . . . must not be altered by the FOR statement." That's clear enough — if you need a loop that you can break out of, use a REPEAT or WHILE — NR.*

END


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# Hypercard's hyperactivity

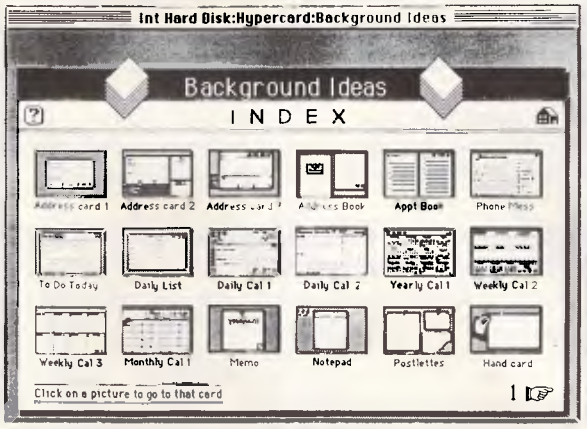
*John Donaldson fills in the background to HyperCard, a program development package with the common touch. One of its features is the variety of demo applications which can be customised and fitted together to suit the user.*

HyperCard must have been one of the most hyped programs of 1987. If you believed the publicity, when this program is coupled with a Macintosh computer, there is nothing you won't be able to do.

While the truth is somewhat different from the hyperbole, HyperCard is still extremely impressive, offering both ease of use and power at the same time. In this article, I hope to guide you through the basics of creating HyperCard systems and then go on to explore its programming system in more detail.

## Your first HyperCard stack

The basic idea behind HyperCard is to allow people who don't know much about programming to create quickly and easily, applications that work well and look good. It achieves this well and is very easy to use. Because HyperCard isn't like any other programming system, it is quite possible to create a simple application without typing a single command let alone getting involved with a programming language. For the first-time user, one of the great things about HyperCard is that, in addition to HyperCard itself, the distribution disks also contain a vast range of demonstration HyperCard applications. These include a useful diary system and a large amount of pre-drawn artwork and ideas that could be expanded. These applications are provided not only as demonstrations, but also as a basis for users to create their own programs.




*The Background Ideas stack contains a wide range of pre-drawn artwork*

Much of the power of HyperCard for users in the early stages lies in the fact that they can create their own applications by cutting and pasting pieces from the demo applications into their own files. This Lego-like approach means that they don't have to understand how something works before they can use it: they simply cut it out and paste it down.

Before we get into creating a simple application, I must explain the basic structures and technical terms used when describing the different parts of HyperCard.

In many ways, it is structured like a traditional flat-file database. The main areas where programs and data are stored are called 'stacks'. There can be as many stacks as you like in the system. Each stack must have a unique name and is stored as a file on disk.

The system comes complete with a special stack called 'Home' and this must be present on disk at all times. Although it is possible to work on only one stack at a time, it is easy to switch between stacks almost instantaneously.

Each stack contains two types of object: cards and backgrounds. A card is like a record within a database with a different card for each different set of information. A stack can contain as many cards as you like. The main function of a background is to hold items which will be common to a group of cards. So if you want a number of cards to look the same and contain the

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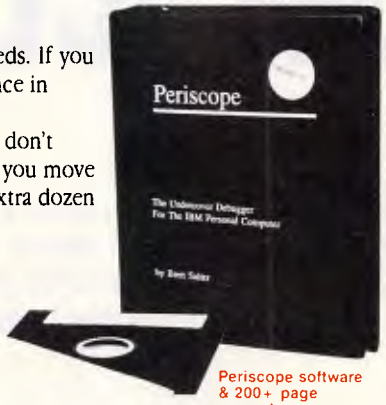


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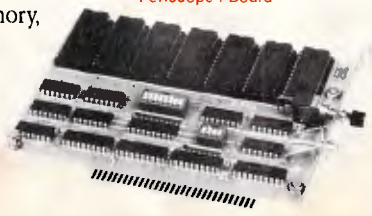
Periscope I Board



Periscope III has a board with 64K of write-protected RAM, which performs the same function as the Periscope I protected memory. AND...

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Periscope III Board

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"I am very impressed with Periscope II-X ...it has become my 'heavy duty' debugger of choice, especially if I need to work on a memory resident utility or a device driver."
**Periscope II-X user**

"... Periscope III is the perfect answer to the debugging needs of anyone involved in real-time programming for the PC ... The real time trace feature has saved me many hours of heartache already."
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**REQUIREMENTS:** IBM PC, XT, AT, or close compatible (Periscope III requires hardware as well as software compatibility); DOS 2.0 or later; 64K available memory; one disk drive; an 80-column monitor.

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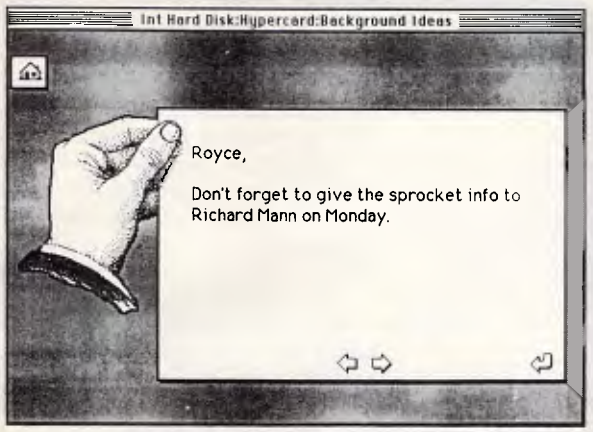



*The Hand background forms the basis of our demonstration stack*

same artwork and objects, you give them the same background.

On the next level down are fields and buttons. Both cards and backgrounds can contain fields and buttons. Each field holds data in much the same way as a field in the database. A button is a means of running a small program. When you select a button onscreen with the mouse, the program within that button is run.

To create a new application, the first thing to do is to create a new stack. This is done from the File menu. When you create a new stack, you are given the option of creating a new background or copying over the background from the stack you are looking at. One of the functions of a background is to hold the artwork which governs how each card within your new stack will look. If, like me, you have the artistic abilities of a deranged iguana, the best idea is to copy a background from the pre-drawn examples supplied by Apple.

One of Apple's demonstration stacks is called 'Background Ideas'. This contains 75 different professionally designed backgrounds for you to choose from. All are visually impressive and there is almost certainly one which would be right for your application. It doesn't matter if the background doesn't quite match your needs: later I'll look at how to add features and change the look of a background. The screentest shows the background I have chosen for demonstration purposes. It is called 'Hand Card' and is the 18th card in the Background Ideas Stack.

To create your own stack using the Hand background, simply go to the 18th card in the demo stack and select 'New' from the 'File' pulldown menu. This brings up the standard Apple file dialogue box which asks for the filename of the new stack. Simply type a new filename, select 'Copy Current Background' and click the 'New' button. HyperCard creates the new stack and then takes you into the new file.

As well as containing good-looking artwork, the demo backgrounds also come complete with all the necessary fields and buttons to allow you to start entering data straight away. In the case of the Hand background, these include a large field in the centre of the screen into which you can type notes and buttons in the shape of arrows which allow you to move to the previous or next card, a picture of a house which takes you to the 'Home' stack and an angled arrow which takes you back one step.

*'Much of the power of HyperCard for users in the early stages lies in the fact that they can create their own applications by cutting and pasting pieces from the demo applications into their own files.'*

## Modifying a stack

Most of the tools provided by HyperCard are dedicated to modifying and generally mucking about with stacks. Using the HyperCard tools you can add and delete fields and buttons as well as play endlessly with the artwork in stacks and backgrounds.

The first thing to remember when you are modifying a stack is whether you are working on a card or on a background. If you are working in the background, however, the changes you make will be reflected in all the cards that use the current background.

The only way you can tell the difference is that when you select Background from the Edit menu, the menu bar is displayed with stripes along the edges. On many occasions I thought I was changing the background, only to discover that I was in the wrong mode.

Another point to watch out for with HyperCard is that it automatically saves its data to disk. For this reason there is no Save command in the File menu. Although automatically saving data to disk avoids problems if something goes wrong, it can also cause some troubles. When you are creating artwork or developing applications, for example, any mistakes you make are automatically incorporated into the stack and saved to disk. Often there is no easy way to get back and rectify the mistake. For this reason, a 'Save a Copy' command is provided with HyperCard so that you can save old versions of your work as you go along. Now if you make a mistake, you can simply revert to an older version.

Most of the stack editing features of HyperCard are in the Tools pulldown menu. This menu is unusual because it can be 'torn' off from the menu bar and displayed in its own little window anywhere on the screen. Each tool is represented by an icon, with the top row of three icons representing the browser and button and field editing, and the rest of the icons relating to artwork editing tools.

## Editing artwork

The art editing tools will be familiar to anyone who has used MacPaint or a similar package. The tools include a box and lasso for selecting parts of a drawing, a pencil and paintbrush for drawing lines, an eraser for rubbing things out, and an aerosol can and a tin of paint for shading and filling an area with a specific pattern. The toolbox also contains icons which allow you to draw straight lines, boxes, ellipses and polygons as well as a tool which allows you to enter text in any of the Mac's fonts and type styles.

As soon as any of the painting tools ar selected from the toolbox, HyperCard adds three extra pulldown menus to the menu bar. These are 'Paint', 'Options' and 'Patterns'.

Paint contains commands which allow you to play around with the way the image looks. Some of the commands are more powerful than those provided

in MacPaint, and include commands to rotate and invert images as well as commands to fill, pick up, darken and lighten images

The Options menu allows you to select Fat Bits for close detail work as well as commands to allow you to change the line size or brush shape and to edit patterns. The Patterns menu can be torn off the menu bar in the same way as the toolbox can. This contains the standard Mac fill patterns that can be used when creating artwork.

When used with some artistic flair, these tools allow impressive images to be created within HyperCard; but then, you would expect this from the man who wrote MacPaint.

## Editing buttons and fields

Adding new fields or buttons to a HyperCard application is simply a question of selecting New Field or New Button from the Objects menu. This displays the new button or field onscreen and you can then drag it around with the mouse until it is in the right position.

To edit a field or button, simply select the appropriate icon from the Tools menu. If you select the button editor, all the current buttons will be highlighted onscreen. Similarly, selecting the field editor will highlight all the current fields.

Double-clicking a field or button will bring up a dialogue box which allows you to set various parameters about the object. For example, if you select the field editor tool in our example stack, the field which contains the text notes will be displayed in the middle of the screen. Double-clicking the field allows you to reset the way in which the field is displayed.

Just as an example, one of the options inside the dialogue box is called 'Scrolling'. If you select this and click OK, the field will now be displayed with a scroll bar down its right side. This allows you to enter as much text as you like into a card and then scroll the field to display the section of text you want to edit.

To continue our Hand example, suppose we want to include a new button which allows us to search for a particular word across all the cards in the stack. Later on I'll look at programming buttons, but for now we'll content ourselves with the fact that another of Apple's demo stacks is called 'Button Ideas'.

As you would expect, this contains a large selection of buttons which do different things. One of these is called 'Find' and allows you to find a specified word. Copying the button to our demonstration Hand Stack is easy: simply highlight the Find button in the Button Ideas Stack and then select Copy Button from the Edit menu. On returning to our demo Hand Stack, select Background from the Edit menu and then select 'Paste Button' again from the Edit menu. Drag the button to where you want on the screen and return to Browse mode.

Now, when you click your new Find button, HyperCard will prompt you for the word you want to find and then go off to look for it. To give the Find button even more polish, you could assign an icon to the button to replace its rather mundane, standard style. This can be done by selecting the 'Icon' option from the buttons dialogue box, which allows you to choose from a list of standard icons included in the system. Simply choose an icon from the list and the button will be displayed with that icon.

*'Usually, HyperTalk commands are passed through the system until they reach HyperCard which knows what to do with them.'*

## Simple HyperTalk

Until now we have concentrated on cannibalising the demonstration files provided by Apple. There is no doubt that this can be an extremely quick and effective way of creating stacks within HyperCard. indeed, it is likely that many users will be content with this and won't go any further. This would be a shame, however, because the full power of HyperCard can be unlocked only by using its built-in programming language - HyperTalk. On one level this is an extremely simple language that can be used by almost anyone. But it also proves to be a very powerful system giving almost total control over the way the Macintosh works.

At its simplest level, small HyperTalk programs can be incorporated into buttons so that each time the button is selected with the mouse, the HyperTalk program is run.

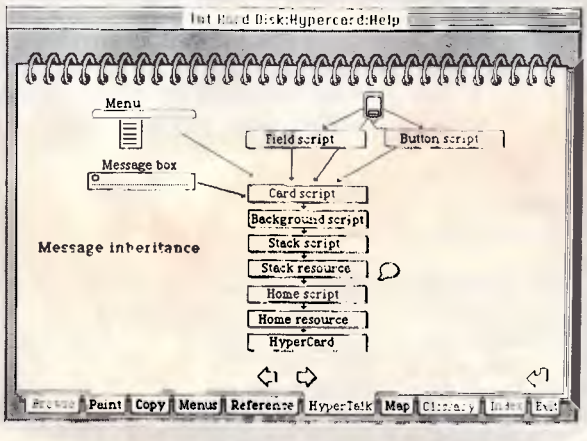
Each button has an associated 'Script' which is where the HyperTalk program resides. To look at the script, simply select the Script option from the dialogue box with a text display area and a scroll bar which allows you to scroll through a long HyperTalk program.

For a new button, HyperCard automatically enters two HyperTalk commands. These are ON MOUSEUP and END MOUSEUP. Any HyperTalk commands which you enter between the ON MOUSEUP command and the END MOUSEUP command are automatically carried out every time the mouse button is released inside the new button.

This article is not intended to explain the individual commands in HyperTalk, and users should consult either the programming manual or the online help system for details of all the commands. However, two important points are that HyperTalk supports both the IF...THEN...ELSE and the REPEAT...END...REPEAT command constructs. Both of these allow you to create sophisticated HyperTalk programs.

As an example, let's look again at our Hand example stack. Suppose we want to create a button which will automatically create some empty cards that can be filled in at a later date. The program to do this would be as follows:

```
on mouseUp
  answer "How many cards shall I
    make?" with "10" or "20"
  put it into count
```




*The HyperTalk command inheritance structure including external resources*

```
  repeat for count
    doMenu "New Card"
  end repeat
end mouseUp
```

This program is run every time the mouse button is released inside the button. The first line displays a dialogue box asking the user to select 10 or 20 cards by clicking with the mouse. The next line takes the result which has been placed in a special system variable called 'it' and places it in a user-defined variable called 'count'.

The next three lines are a loop which repeat either 10 or 20 times according to the user's choice. The 'doMenu' command allows HyperTalk to execute any command found in a pulldown menu from within HyperTalk. In this case, the command is 'New Card' which, as its name suggests, creates a new card.

## Advanced HyperTalk

In order to get the most out of HyperTalk, it is necessary to understand how it works.

As well as being able to incorporate HyperTalk Scripts into buttons, you can also embed scripts into other parts of the HyperCard stack. Scripts can be embedded within fields, buttons, cards, backgrounds, the current stack and the home stack. As we will see later, the exact place you choose to put your code can affect the workings of the overall system.

One of the main concepts used by HyperTalk is the idea of the 'message'. Every time something happens with HyperCard, a message is generated saying what has happened. The internal architecture of HyperCard can act as a highway allowing messages to pass freely. Each message passes through the system until it encounters an object which knows what to do with it. An object which knows what to do with a particular event is known as a message handler.

HyperCard has a very tightly defined hierarchy which governs the way messages are sent through the system. Messages start off either in a field or button script; from a command typed in the message box; or as a menu item selected from one of the pulldown menus. From here they are sent to the script of the current card and then to the current background script. Next up the chain of commands is the stack script followed by the home script and, finally, HyperCard itself.

As an example, let's suppose someone typed 'Find Fred' in the message box. This would first be passed to the card script which would be asked "what does 'Find Fred' mean?." The card wouldn't have the faintest idea, and would say 'I don't know, try asking the background'. The background wouldn't know either, and the process would continue all the way up the tree until the message reached HyperCard itself where an object would understand what 'Find Fred' meant and would handle the event.

Messages are not restricted to the internals of HyperCard. Whenever something interesting happens in the world outside the Macintosh, HyperCard generates a message saying what has happened. This is known as an event. It could be that someone had pressed a key on the keyboard or clicked the button on a mouse. Once the event message has been generated, it is treated just like any other message and passed up the tree in search of an object which knows what to do with it.

The ideas of objects, messages and events are central to unlocking the power of HyperTalk. It is important to remember that almost everything that happens inside HyperCard generates a message. Once you understand this, a number of interesting points follow.

The first is that it is possible to generate and handle your own messages. For example, if you typed the word 'Eric' into the message box or incorporated it into a Script, the message would be passed up through the system looking for an object that knew what to do with 'Eric'. Because 'Eric' isn't a standard HyperTalk command, you would get an error message from HyperCard saying 'I don't know what to do with Eric'.

It is possible, however, to write your own message handler.

```
on Eric
  put "Hello Word" into card field 1
end Eric
```

If you put this routine into the scrip of the current card, the background or the stack, then next time you typed 'Eric' it would go to your routine and be handled as usual.

Defining you own messages allows you to create effects which are akin to subroutines in traditional programming languages. You could incorporate the following structure in a button script, for example:

```
on mouseUp
  Initialise
  DoIt
  CleanUp
end mouseUp
on Initialise
  ...
end Initialise
on DoIt
  ...
end DoIt
on CleanUp
  ...
end Cleanup
```

The HyperTalk programming manual encourages this kind of top-down style, but there are a couple of problems. The first is that because variables are usually local to a message handler rather than to a script, any variables you want to set up in the initialise routine must be declared as global so that they can be carried back to the main loop. This often negates any advantage in using a separate Initialise routine.

Secondly, although it is possible to pass parameters to a message handler, it is not possible to pass them back to the calling routine. This means that results have to be sent back in the form of global variables. This can be dangerous, because there is no guarantee that a different stack is not using the same global variable name. If this happens, you could run into trouble as soon as the competing stack is opened.

## Handling events

Every time something happens in the outside world, HyperCard generates an event which is sent through the system as a message in the normal way. This means that you can trap events and write a handler to do what you want with them. The most common event is 'MouseUp', which forms the basis of all button routines. The HyperCard generates a great many event messages and there isn't room to go into them all here. However, my favourite is that when a button or field is about to be deleted, HyperCard warns it of its impending doom and asks it if it would like to do anything about it!

## Hijacking HyperTalk

One very useful point to remember is that even HyperTalk commands themselves are messages. Usually, HyperTalk commands are passed through the system until they reach HyperCard which knows what to do with them. But, there is nothing to stop you from writing a message handler for a particular command and hijacking it before it gets to HyperCard.

This facility can be extremely useful if the handler is put in the right place in the message hierarchy. When this is done well you can set the system so that, in general, a message is passed to HyperCard; but in certain special cases it is handled by your own routine. Consider

the following example:

```
on openStack
  hide menubar
  hide message box
end openStack

on doMenu string
  if string = "Message" then exit
    doMenu
  pass doMenu
end doMenu
```

When placed in the script of a stack, these two routines can stop users altering an applications stack. The first routine simply hides the menu bar and message box so that users don't have addresses to HyperTalk commands. However, a determined user could get the message box back simply by typing 'Command-M' on the keyboard.

The second routine stops this from happening by intercepting the DoMenu command and examining it to see if the parameter is the 'Message' command which is invoked by pressing Command-M. If this is the case, the message is intercepted. If not, the message is passed on to HyperCard for processing as normal.

It is extremely important to use the 'Pass' command when hijacking HyperTalk messages because sometimes, if a message doesn't reach HyperCard, the system can behave rather strangely.

## Expanding HyperCard

If HyperCard doesn't have a command you want, you can write an external message handler in Pascal or C and include it as a resource in the stack. Many of the specialised Macintosh bulletin boards already have example external functions which can be downloaded, so it should not be too hard for users to expand their systems.

In order to use external resources, you must have a resource editor program such as ResEdit. Using this you can cut and paste external resources between stacks at will. While you are at it, you can also add extra button icons and cursor types by copying them from applications or from other stacks and pasting them into your own stacks. The best place to put external resources is the Home stack. This makes them available to all the other stacks.

## Conclusion

At the moment HyperCard is only at the beginning of its useful life. Once users and programmers get used to its ways, there could be no end to the software available.

# NUMBERS

***Mike Mudge returns to the popular topic of prime numbers including reference to recently published results.***

| | |
|---|---|
| 9 | $= 3^2$ |
| 94249 | $= 307^2$ |
| 942060249 | $= 30693^2$ |
| 9420645460249 | $= 3069307^2$ |
| 94206450305460249 | $= 306930693^2$ |
| 942064503484305460249 | $= 30693069307^2$ |
| 9420645034800084305460249 | $= 3069306930693^2$ |

*Fig 1*

**Definition** Denote by p(n) the number of prime numbers not exceeding n. Thus p(1) = 0, ( ); p(10) = 4, (2,3,5,7); p(100) = 25, (2,3,5,7, . . . 79,83,89,97).

## The state of the art

EDF Meissel (*Math Ann* 1870, vol 2, pp636-642; 1871 vol 3, p525; 1885, vol 25, pp251-257) calculated and published $p(10) = 664579$, $p(10^8) = 5761455$ and $p(10^9)$ . . . which remained the largest published result until 1959. In that year DH Lehmer (*Illinois Journal of Math* vol 3, pp381-388) corrected $p(10^9)$ (the value calculated — by hand — by Meissel being too small by 56) and published $p(10^{10})$ (in fact, too large by 1).

In 1986 P Shiu (*Math Comp* vol 47, pp351-360) published $p(10^{11})$ and $p(10^{12})$ while JC Lagarias, VS Miller and AM Odlyzko (*Math Comp* vol 44, pp537-560) calculated $p(4x10^{16})$ using approximately 30 hours processing time on an IBM 3081 Model K.

It is clear, therefore, that *APC* readers should not feel encouraged to extend the range of values of p(n) beyond $4x10^{16}$.

**Problem**

The computing problem associated with p(n) which follows is formulated in such a way that it tests the skill and ingenuity of the programmer rather than the speed and word length of the computer, the efficiency of the compiler or the choice of language.

How many basic operations do *you* need to compute p(n) for a given n? In particular, for n = 10, 100, 1000, 10,000. *Note* It is recommended that an algorithm is detailed, coded and checked, then an operation count carried out. If possible, the fundamental operations of arithmetic should be separated into + - * & / and, in turn, separated from logical operations. It is thought inadvisable to attempt this count from the algorithm at its pencil and paper stage. Readers may feel differently! If such a count seems too laborious, an alternative measure of efficiency may be supplied in the form of ratios of times taken to evaluate $p(10^n)$:times taken to evaluate $p(10^{n-1})$ as a function of n.

As and when multi-precision arithmetic becomes essential, many readers will feel that they are excluded from entry. . . but rest assured an efficient algorithm developed within the normal arithmetic precision of the computer is likely to remain efficient when combined with suitable arithmetic multi-precision routines which may not be immediately available.

Changing the subject:

**A Nearly Pattern involving Palindromic Squares**

In February 1985 a study of palindromic numbers (reading the same way backwards and forwards) produced the record ever response to a 'Numbers' article. Thus it seemed appropriate to quote the result (see Fig 1) of JKR Barnett (*Bulletin IMA*, vol 23, Nos 6/7, June/July 1987 pp100-101).

Now construct the eighth member of the sequence of squares appearing on the right-hand side. It is nearly, but not quite, palindromic! Why?

Readers are invited to send their attempts at either, or both, of the above problems to Mike Mudge, c/- *APC*, 124 Castlereagh Street, Sydney 2000 to arrive by 16 May 1988.

It would be appreciated if such submissions contained a brief summary of results obtained, 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 only be returned if a stamped addressed envelope is provided.

**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.

END

# USER GROUPS

***Below is a list of updates and additions to the full User Group listing which is available to readers on request. Please send a SSA envelope to 'User Groups', APC, 124 Castlereagh Street, Sydney 2000.***

## NSW

The dBase user Group catering for Database Applications meets on the third Tuesday of each month at Bird, Cameron, 15th Floor, 4 Bligh Street. City, at 6pm.

For more details contact Catherine Rosenbrauer, Microcomp, 33 Pitt Street, Sydney, (02) 27 8273

## VIC

A group of software professionals in Melbourne has formed the RBase Users Group of Melbourne.

The group plans to act as a forum for discussion and sharing of ideas and methods for the highly acclaimed Microsoft/Microrim RBase Relational Database System for PCs, ATs and PC Networks.

The Group meets on the evening of the first Monday of each month at the offices of Communicat, 502 Spencer Street, Melbourne.

For further information contact Malcolm White on (03) 329 0766

ACS Special Interest Group — Expert Systems — meets on the third Monday of each month at 5.45pm-7.30pm using the premises of Data General Australia, 100 Dorcas Street, South Melbourne.

For further information contact Tony Davidzik on (03) 873 1664 day or night.

END

# DIARY DATA

## Exhibitions

### April

**12-15** Computer '88 Products exhibited will include mainframes, minis and micros as well as software packages, CAD/CAM systems and data communications systems. To be held at the Hong Kong Exhibition Centre, Wanchai. *Enquiries, tel: (062) 917 707*

**19-21** **Atug '88** Organised by Riddell Exhibition Promotions. The 5th telecommunications exhibition being held at the Royal Exhibition Buildings in Melbourne. *Enquiries, tel: (03) 429 6088*

**21-23** **Nopex '88 Exhibition** For buyers of office products, furniture, office machines and computers. Organised by the National Office Products Association and held at the Royal Exhibition Buildings in Melbourne. *Enquiries, tel: (03) 699 2077*

### May

**5-7** **Computer '88** More than 50 companies from all over Australia will participate in W.A.'s only computer exhibition. Your chance to view the latest technology. Organised by Swan Exhibitions. *Enquiries, Heather Wheeler, tel: (09) 443 3400*

**31-0** **Comsoft** This exhibition/seminar to be held at the Adelaide Hilton Hotel from May 31-June 2 will have demonstrations and explanations of software, software and more software! *Enquiries, Ray Goldie, tel: (08) 363 1757*

### June

**7-10** **2nd Australian Internat. Tech. Exhibition** This exhibition attracts widespread interest in generating business opportunities for 114 participating companies. To be held at Darling Harbour. *Enquiries, tel: (02) 436 3266*

## Conferences

### April

**11-13** **SNA Explained** A three-day seminar for anyone concerned with data communications networks. To be held in Sydney, Melbourne and Canberra. *Enquiries, MTE, tel: (02) 261 5555*

**13** **Bendigo Regional SIG Meeting** The next meeting will be held at 7.30pm at the Bendigo College of TAFE. *Enquiries, Frank Bourke, tel: (054) 434 866*

**13** **Structural Engineering Interest Group Meeting** To be held at Ceanet, 56 Berry St. North Sydney between 9.00-10.30am.

**14** **CAD Management Group Meeting** To be held at Norman, Disney and Young, Level 5, 1 Chandos St, St Leonards between 4.00-6.00pm. *Enquiries, ACADS, tel: (02) 929 8097*

**15-14** **Advanced SNA** A two-day seminar for anyone concerned with data communications networks. To be held in Sydney, Melbourne and Canberra. *Enquiries, MTE, tel: (02) 261 5555*

**16-21** **Atug '88** Telecommunications - convergence, liberalisation and competition and the quest for the Australian solution. To be held at the Royal Exhibition Buildings, Melbourne. *Enquiries, tel: (008) 22 6281*

**18-20** **4GL Symposium** To be held at the Hyatt Kingsgate Hotel in Sydney. *Enquiries, tel: (02) 922 3285*

**18** **Turbo Pascal SIG Meeting** The next meeting will be held at 7.30pm at St Mark's Anglican Church, Cnr Canterbury and Burke Rds, Camberwell. *Enquiries, Ron Savage, tel: (03) 699 3566*

**18-20** **International Database Symposium** The International Database and 4th/5th Generation Language Symposium will be held in Sydney and will also go to Wellington and Singapore during April. *Enquiries, tel: (02) 922 5532*

**19** **Post Script Group Meeting** The next meeting will be held at 6.30pm, at Peat, Marwick and Mitchell, 18th floor, 500 Bourke St, Melbourne.

**20** **Tech SIG Meeting** The next one will be held at 7.30pm at the Physics Department, Melbourne University. *Enquiries, Patrick Kearney. tel: (03) 344 5465*

**21** **Austrade Seminar** This half-day seminar will discuss software exporting, international law, taxation policies, copyright matters and much more. To be held at Austrade, 181 Castlereagh St, Sydney. *Enquiries, tel: (02) 265 3520*

**26** **Public Domain SIG Meeting** The next meeting will be held at 7.30pm at St Mark's Anglican Church, Cnr Canterbury and Burke Rds, Camberwell. *Enquiries, Leon Cohen, tel: (03) 520 6414*

**27-29** **EDP Auditors Association Conference '88** Major topics of this conference include data and physical security, communications, personal computers, networks and system development. *Enquiries, tel: (02) 250 050*

**27** **Low Cost CAD Shoot-Out** This seminar will provide a basis for comparison of various CAD systems on compatibles and workstations. To be held at the Building Centre, 165 Lambton Rd, Broadmeadow between 1.30-6.00pm. *Enquiries, ACADS, tel: (02) 929 8097*

**27** **Geelong Regional SIG Meeting** The next meeting will be held at 7.30pm at the Geelong Amateur Radio Club room. *Enquiries, Ron Vahland, tel: (052) 75 6813*

# LAZING AROUND

***Brainteasers courtesy of J J Clessa.***

## *Prize puzzle*

My wife returned from an antique shop yesterday with three items – a statue, a lamp and a painting. The statue cost less than the lamp which in turn cost less than the painting.

If I tell you that the total of the prices was 3150 (thank heavens it wasn't the sum!) you won't be able to tell me the cost of the statue.

Even if I told you how much she'd spent altogether, you still wouldn't be able to tell me the cost of the statue.

But if I then told you that the painting cost more than the statue and the lamp put together, you would.

How much did she spend on the statue?

Answers on postcards, or backs of envelopes only, to arrive not later than 29 April, 1988.

Send your entries to:
Lazing Around April, 124 Castlereagh Street, Sydney 2000.

## *Prize puzzle*

January's puzzle wasn't too difficult. Perhaps we should have asked for more than one solution.

Anyway, the winning entry came from Glen Barnett of Ryde.

Well done, Glen, your prize is on its way.

The correct solution was:
Jane = 4
Mary = 1
Sally = 5

To all the also rans — keep trying, you could be next.

END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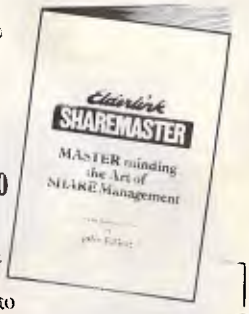


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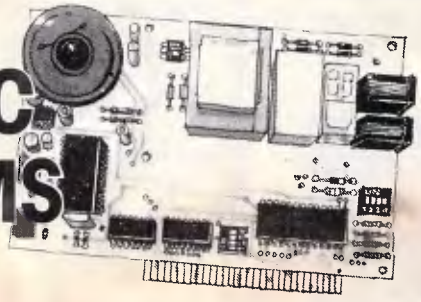

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