December 1996

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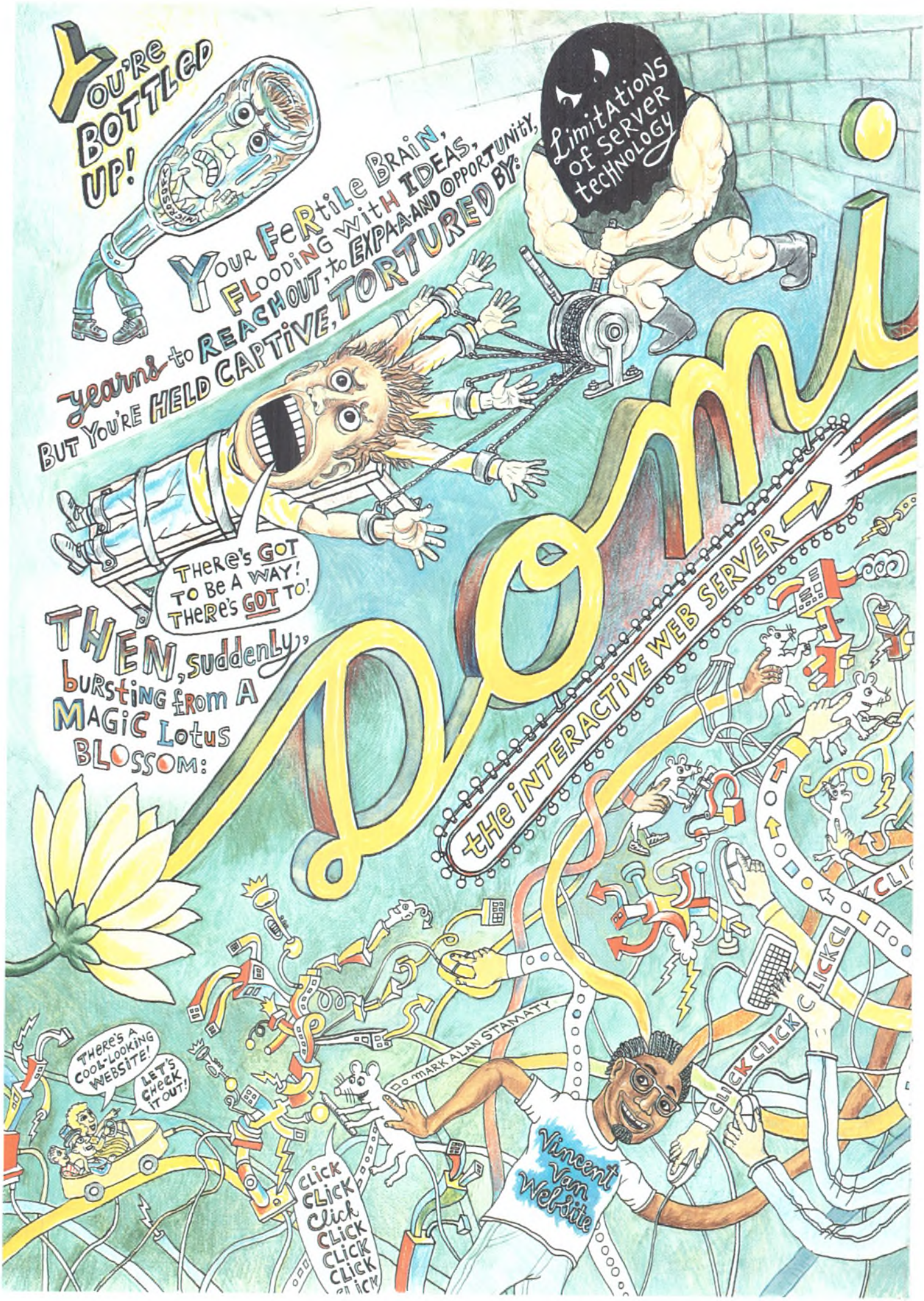
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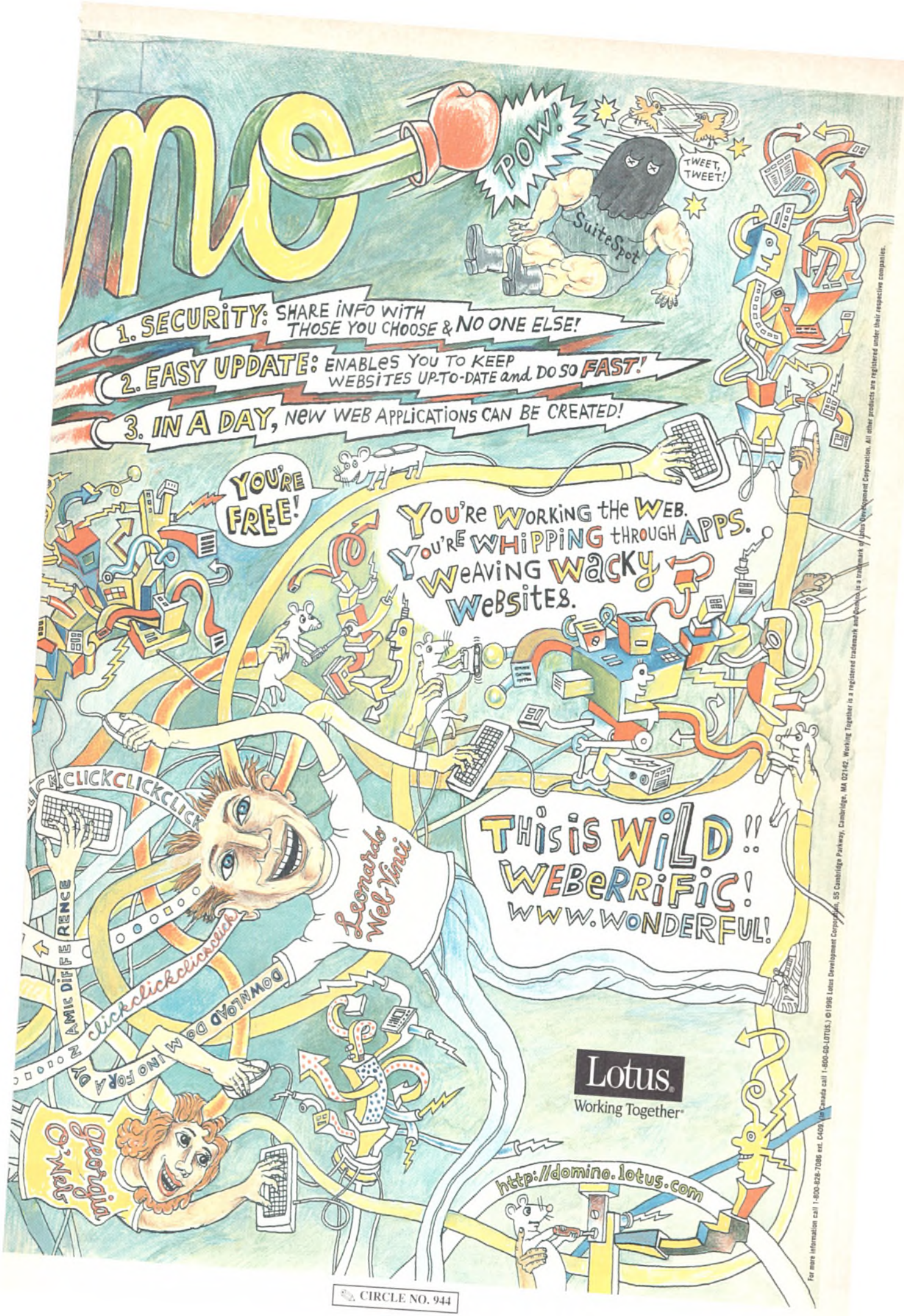

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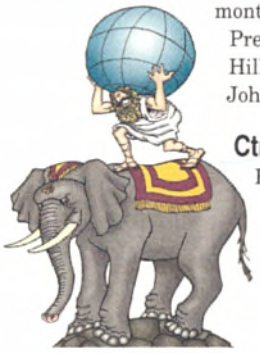

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SoapFlakes

Software amateuring

Software development is frequently touted as Software *Engineering*, as part of the grand field of Computer *Science*. If you ask me, this is quite pompous! On hearing this you would expect all systems to be flawless state-of-the-art software. Why is this clearly not the case? Why is there such a gap between the theory and current practice? Let's take as an example the realm of operating systems.

During her speech at Apple Expo, Ellen Hancock explained – in a very open and frank manner – the current situation regarding Mac OS: 'the two highest-demand features [are] pre-emptive multitasking and memory protection. And we can't build those into System 7. Those we will be building into Mac OS 8. And we'll be delivering them at the API level'. The fact that Hancock has been Chief Technology Officer at Apple for only four months and the references to the version numbers of the OS give away the date of this speech: only last month.

From that quote, someone not knowledgeable in OS theory would imagine that both pre-emptive multitasking and memory protection are among the latest cutting-edge features to be found only in Apple's research labs. Not quite. Not only have these two topics been covered at great length in many books for at least fifteen years, but any Computer Science student specialising in operating systems will have written either a task manager or a memory manager (or both) as a three month project. The usual assignment consists, for a task manager, of a full-featured multi-threading, multitasking kernel with at least one CPU allocation strategy if not several. As for the other, it would be the implementation of a complete segmented and paged memory manager. And of course in these three months a group of two or three students would have written full documentation for the project explaining the rationale of the different strategies chosen.

If Apple was used as an example it is not the only culprit: just look at Windows 3.1 and 95 for probably the most widespread use of antiquated technology. Where are all the Computer Science students going? Do they prefer to stay in the research labs? And who are all the developers employed by these large companies? Shouldn't they know better?

These days all operating systems should have a decent multi-threaded kernel and virtual memory with pagination. The war between OSs should happen at another level and by that I don't mean which one crashes fewer times per day. In the words of Free Software Fondation's Richard Stallman, whose own Hurd kernel recently came online, 'By definition, a properly functioning kernel doesn't allow user programs to make it crash unless they say 'please'.

David Mery

By any other name?

When the technology historians of a future decade look back upon the last twelve months in software development, I wonder what they will call 1996. 'The year of Java'? Doubtful. 'The year of the Intranet'? Probably not. My money is on 'the year of renamed technologies'. In what other year have so many products and technologies turned another face, Janus-like, to the industry, and tried to pass themselves off as something new? Certain companies are more guilty than others in this plot to peddle mutton dressed as lamb, or in some cases simply newer, more appealing mutton. To an extent, however, most of the big names in our industry have played the renaming game this year.

1996 kicked off with a new name for OLE. Henceforth OLE (which had already gone through a period of being misnamed COM by some confused members of the public) would be known as ActiveX. OLE Controls were now Active Controls. Or ActiveX Controls. (To this day, no-one is 100% sure which is right). I for one was bemused by this turn of events, as I had previously believed ActiveX to be the group name for a series of technologies such as ActiveMovie, rather like DirectX, which was – and, subject to plausible denial by Microsoft HQ in Redmond, still is – the blanket banner for a series of hardware interfacing technologies like DirectDraw and Direct3D. Microsoft was not satisfied with such a small change, to be sure. Jakarta became Visual J++, and Network OLE became DCOM when by rights it should have become Network Active(X) Distributed... something.

Those of us who follow beta programmes and vapourware religiously have known for some time about Borland's forthcoming Java tool, Latté. But the company which was cool enough to leave Delphi with its original codename has declared that from now on Latté will rejoice in the name of Open JBuilder. IBM decided that DAX was a silly name for its joint OS/2 and Win32 API and renamed it Open32, while failing against much expectation to rename version 4 of OS/2 'Merlin'. Netscape obtained a license from Sun to dub its LiveScript browser language JavaScript. Even Apple has got in on the act of late, and OpenDoc has recently become LiveObjects.

While some name changes in the software industry are no doubt brought on by the embarrassing naffness of the first choice (after all, who wouldn't feel silly getting excited about a cross-platform C++-like language called Oak?), I suspect that most are conceived by marketing executives and image consultants who believe that a new, catchy title for an established or retro-fitted product will make it seem exciting and generate renewed interest – and therefore revenue. And as I sit here and look back on 1996, this 'year of renamed technologies', and survey the state of the software market, I am increasingly worried that they may be right.

Neil Hewitt

Mayhem!

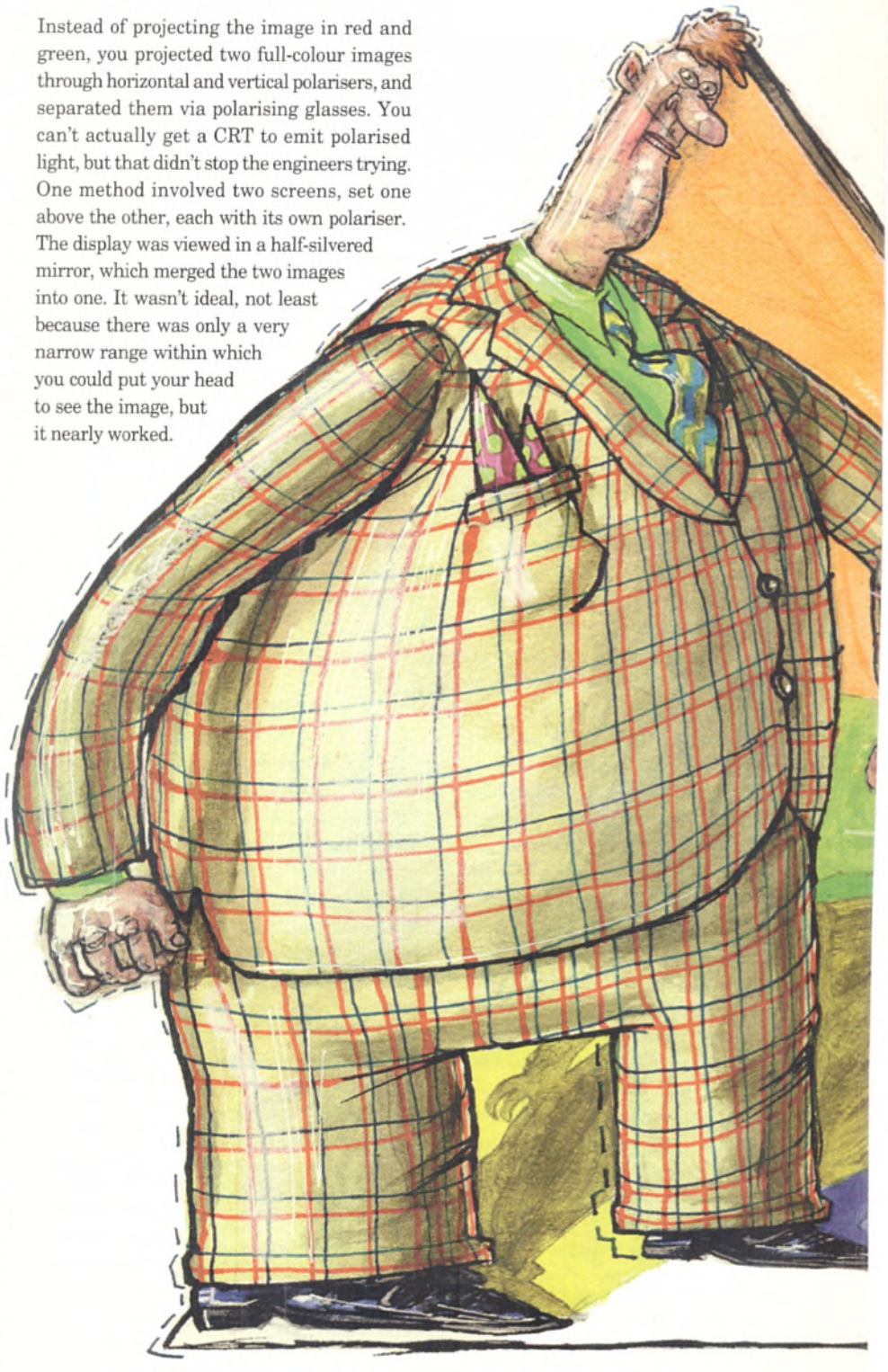
Jules has been looking into computer displays, and he's starting to experience phosphor burn.

I guess it didn't take long; virtual reality has virtually died off. It was always expensive, it was always difficult, and it was always a solution in search of a problem. It may be that the thing which really nailed the coffin closed was the horde of companies jumping onto the bandwagon created by the name, and trying to sell basic, old-tech fly-by animation systems as full-fledged VR, when in reality they were nothing of the kind.

But the real reason why virtual reality systems never stood a chance was the core technology. How are you supposed to present a user with full 3D information? Believe it or not, engineers have been struggling with this problem for almost as long as programmers have been struggling with computers. Many ingenious and esoteric devices have been produced, but so far they have all had one thing in common: none of them worked properly.

The Victorians knew that if you viewed two pictures taken at slightly different angles, one to each eye, you'd see a single 3D image. They made stereoscopes into which you could put cards or transparencies, but it was pretty obvious that only one person at a time could peer into the gadget. Then they discovered that you could print the two pictures on the same piece of board, one in red and the other in green, and view the 3D image by wearing red and green filters over your eyes like spectacles. This technique has been used in 3D movies since the 30s, is occasionally seen in 3D comic books, and has been used in at least one computer game. Trouble is, the 3D glasses are fiddly, easy to lose, and make normal scenes look quite horrible.

In the 50s and 60s, they discovered that you could do the same thing in full colour. Instead of projecting the image in red and green, you projected two full-colour images through horizontal and vertical polarisers, and separated them via polarising glasses. You can't actually get a CRT to emit polarised light, but that didn't stop the engineers trying. One method involved two screens, set one above the other, each with its own polariser. The display was viewed in a half-silvered mirror, which merged the two images into one. It wasn't ideal, not least because there was only a very narrow range within which you could put your head to see the image, but it nearly worked.



A better approach to the same problem was to use alternating shutters over the user's eyes. The screen displayed one image while one shutter was open, then the other while the second shutter was open. You got full colour, and it had just as wide a range as the red and green filters. There were technical problems to do with the persistence of the phosphor in the screen and the time it took to switch the liquid crystal shutters, but at least it showed the principle could work.

The main problem with two-channel stereoscopy, though, is that there's a lot of redundant information. Because the eyes of the British Standard human being are at nearly the same height, the scenes seen by our two eyes are differentiated only in horizontal position. If the scenes presented by a stereoscopic display are differentiated vertically as well, the 3D illusion breaks up almost immediately. That vertical differentiation can be produced by the viewer tilting his head, or looking at the picture from the side. Most users find that being required to hold their head in a vertical position all the time is tiring, and such systems are no good for long-term use. To address this problem, a number of systems were tried which create a genuine image floating in space.

Lenticular screens seem promising. They were used in the 70s to make decimal converters, and they're appearing again as 'virtual video' toys. They work by composing a single image from many strips, where each strip is itself made of several substrips, one for each image. When you place cylindrical lenses over the image, the lenses focus on a single substrip at a time. If the lenses are arranged vertically, they show a different image to each eye, but since the strips and lenses are so small, you can move your head a little without affecting the image. The problem is that the resolution is very limited.

Here's a good one: build a screen, and draw an image on it with a laser. Naturally, because of the persistence of human vision, the image will appear to be stable. Now, take this whole assembly and spin it around at high speed. You can place a dot anywhere in space by waiting until the screen turns so that it intersects the dot that you want, and then pointing the laser at the appropriate point. Sure, there are problems, but with clever programming and sufficiently enormous motors and bearings, this can be made to work.

It's actually easier to do the same thing with mirrors. Instead of trying to throw laser light around, you use a normal monitor screen. You spin a plane mirror around, and as the mirror moves, the reflection of the screen appears to move. It's lighter, sure, but it's still noisy and unreliable.

Rather more elegant was a system based on a mirror which didn't move, but changed shape instead. Imagine you're looking at a screen in a mirror. If you bend the mirror so that it's concave, the image will appear to get smaller and further away. If you bend it the other way, the image gets larger and closer. The idea was to make a mirror out of a piece of mylar film (the stuff they make survival blankets out of), and then stretch it across a loudspeaker. As the loudspeaker cone moves, the air pressure behind the film will cause it to bend. Unfortunately, loudspeakers have been designed to be good at making lots of noise, and sure enough, this one did. Not only that, the film resonated, producing ugly distortions.

At MIT they explored a totally different principle, more akin to holograms. They modelled an object set between two parallel screens. For every light ray from every point on the model, they found the point at which the ray crossed the two screens. Then, they set up a contraption comprising a TV monitor and a liquid crystal screen, each set where the screens in the model were. As the dot on the monitor moved, they opened and closed the liquid crystal pixels corresponding to the paths of light they'd computed. The results were encouraging: you could see the model suspended in space, and you could move around it to look at it from different sides. True 3D, with only one drawback: it took several weeks to compute the data for a single model. Oh well.

There has actually been far more success making 3D printers than 3D displays. Techniques exist to generate holograms from computer models, and many of them are used routinely today. Even more striking is a technique called stereolithography, wherein lasers paint a shape in a bath of goo, and the goo goes solid. When the process is finished, you can lift a complete solid model out of the bath. In addition, robots which can cut a shape out of a solid block of material are now almost par for the course.

The fact is, if you want to see something in 3D it's probably easier to make it. ■

After adding another dimension to computer screens, Jules is now working on time travel . He can be contacted on 01707 662698, or on cix as Jules@cix.compulink.co.uk

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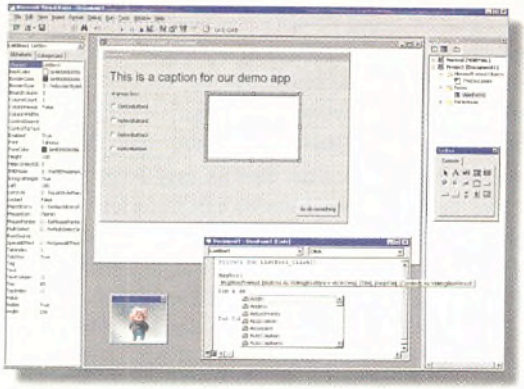


Microsoft recently announced Office 97 Developer Edition, a full-fledged development kit for the forthcoming Office release. The Developer Edition brings together material which was previously only available in separate products, including the full Professional edition of Office 97 itself and the latest Office Resource Kit, plus complete paper documentation on all the Office OLE interfaces and APIs. This is unusual for Microsoft, whose development tool documentation is usually only provided on CD-ROM.

Office 97 will ship with Visual Basic for Applications (VBA) 5.0, preceding the release of the full Visual Basic 5.0 product later in the year. VBA 5.0 includes a host of novel features. The editor can automatically prompt you with the methods of any object you invoke, and can remind you of a function's parameters with a bubble help popup. The standard tool palette supports the addition of new resource types (which can include any standard ActiveX or OLE control) on its 'custom' page. VBA 5.0's online help is integrated with the new Office 97 'Assistant' scheme – assistants are animated characters which can answer questions expressed in reasonably plain language. The system works on the basis of context and so will offer only VBA-related help when the user is building macros and forms.

Unlike previous versions of VBA, Microsoft will be licensing 5.0 to other companies: one early adopter is Visio. The packaging of VBA into a licensable technology brings it closer in concept to VB Script, but whereas VB Script has limited functionality – it only supports the variant data type and can interact with the user only via HTML forms and message boxes, and has only a subset of the full VB feature set – VBA supports the full range of data types and functions of traditional VB, and has all the OLE and ActiveX integration features, but can run only in the context of another application.

Microsoft has committed itself to making all its applications expose COM interfaces, so VB developers will have access to more off-the-shelf functionality in the near future. No pricing or availability information for Office 97 Developer Edition is currently available.

◗ *Microsoft: 01734 27000* ◗ *URL: http://www.microsoft.com*

Apple Expo draws record crowds

Bigger than last year's affair, the show took over the entire main hall at Olympia as well as the upstairs balcony area. The hall was dominated by Apple's huge stand, where the company was showing the latest in its PowerMac, Server, and Newton product lines. The E-mate 300, a new sub-notebook based on Newton technology, drew big crowds, as did the MessagePad 2000. Power Computing showed its expanded range of Macintosh clones, including an off-the-peg system running Jean-Louis Gassée's BeOS. Adobe and Macromedia were showing new versions of their flagship products, while Microsoft was previewing Internet Explorer 3.0 for the Mac.

Mac developers were catered for by the Development Pavilion, a collection of small stands from many specialist tools developers and vendors. Long-time Mac stalwart Metrowerks was showing several new versions of its CodeWarrior and ObjectPascal packages, including CodeWarrior Gold 10 for Macintosh, CodeWarrior for Windows, and products targeting Java, and BeOS. The company has moved further into the console and palmtop markets with the release of CodeWarrior for Pilot, a development system for the US Robotics PalmPilot PDA, and CodeWarrior for Playstation, the first graphical development system for Sony's increasingly popular games machine. Both these packages, together with CodeWarrior for Java, can be hosted on either PowerMac or Windows platforms, while the company was keen to stress that at £285, its cross-platform Windows-hosted Windows/Mac development system is considerably cheaper than rival systems. Most of the Metrowerks products mentioned should be available as you read this.

◗ *Contact UK distributors Full Moon Software on 0168 666084*

◗ *URL: http://www.metrowerks.com*

Enhancing the client

Going against the current trend of adding graphical middleware, Pericom Software has just finished TeemCreator, a GUI front-end development tool for Unix and legacy hosts running on both Windows and X11/Motif. It supports terminal emulation for virtually all terminal protocols and integrates a specialised compiled language for handling character screens. A complete runtime with all the terminal and network protocols is about 1.5 MB.

◗ *Pericom Software is on 01908 265533* ◗ *The SDK starts at £6,000*

NEWS

◗ **MKS Source Integrity** 7.2, recently released on Windows and Unix platforms, has now been ported to OS/2. The product is now available on virtually every PC platform including 10 varieties of Unix. Price £375. Tel: 0171 624 0100

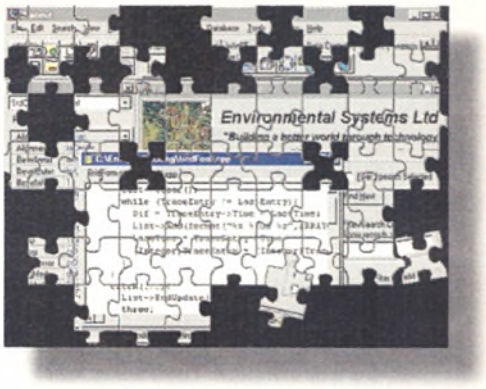
◗ The **Java Developers Academy** scheduled for the end of the last month has been **postponed** due to unforeseen difficulties. The event should now take place in May or June 1997. For an update, call **Interactive Exhibitions** on 0181 541 5040

◗ **Sun** has announced a suite of development and deployment technologies for TMN networks, including an enhanced version if its **CMIP** environment for **TMN** agent development, and the **Solstice TMNscript** language. TMNscript provides a Java binding for creating management applets. Pricing from $1995 (CMIP runtime) to $14,995 (TMNscript toolkit). URL: http://www.sun.com

◗ **Oracle**'s visual Basic tool **Power Objects 2.0** includes technology licensed from Intersolv and Crystal Reports 5.0. Pricing is at £250 per seat for the Developer edition, and £1250 per seat for the client/server edition. http://www.oracle.com/products/tools/power_objects/

◗ The beta of **Internet Explorer 3.0** for **Mac** is available for free download from http://www.microsoft.com/ie. Requiring only 4 MB of memory to run, it includes full support for the HTML 3.2 standard, style sheets and Java applets.

Borland's future...?



Messages about Anders Hejlsberg's move from Borland to Microsoft have been flying around the Net all this month. He was one of Borland's original employees and the chief architect of both Turbo Pascal and Delphi. Describing the move, he said: 'This has not been an easy decision to make, but I have now been with Borland for 13 years, and I feel that it is time for me to try some new challenges.' This comes after the departure of Paul Gross, VP of R&D, earlier this year.

But that's not the limit of the bad news for Borland. Its financial results haven't been that good, Netscape recently abandoned bundling its just-in-time Java compiler in favour of the rival product from Symantec, and of course it is still searching for a permanent replacement for ex-CEO Gary Wetzel, who left in July.

In the middle of this, Borland is trying to reassure developers and analysts alike, showing off work done on some of the products which should appear around the beginning of next year. Hejlsberg comments: 'Delphi was built by a team, and I have full confidence in the team's ability to develop and deliver new versions of Delphi. In fact, the Delphi team at this point is almost twice the size it was when we shipped 1.0 in early '95. Zack Urlocker adds: 'the architectural work that Anders covers is complete for Delphi 97 and we're in beta. Anders' departure won't affect the ship date or features going forward. Chuck Jazdzewski [...] will be [...] taking over the full architectural duties.'

Ebony and Ivory

On Borland's product strategy Urlocker says 'Delphi fits into a whole family of interoperable development tools that includes client/server and Internet development'.

The other family member hinted at is Ebony (previously known as Pronto), a Delphi 2.01-based 32-bit C++ environment which supports VCLs. In fact, the integration is so close that Ebony can compile Delphi code in addition to C++, through the included DCC32 command line compiler. When a Pascal unit is included in a project, a corresponding .hpp header file is automatically created. Ebony can import OCXs, but cannot be used to create them.

Other features include an incremental linker and cached compilation, so unmodified components can be pulled from the cache to speed up overall build time. The environment will feature the same APIs as Delphi. It is not yet known if it will bundle MFC. David Intersimone sums it up as such: 'Ebony is Delphi 2.0 for C++'. Borland C++ will still be sold and updated for hard-core C++ development.

Delphi 97, codenamed Ivory, will add support for the Enterprise Component Foundry (VCLs in DLLs) and multiple interfaces, plus COM and distributed application support. There will be a new project option in the form of packages which will allow you to specify which classes are required or contained.

A pre-release of Open JBuilder, formerly known as Latté, will be available by the end of the month (check out Borland's Web site). The product will not only generate Java bytecode but also native code for Intel PCs, with in-built optimisation across method boundaries. It will sport Java Beans wrappers for Microsoft's ActiveX and Netscape's IFC. For more low-level developers, the TASM assembler is still present. A new version supporting Intel's MMX extensions should be out soon.

No firm release date has been given but expect Ebony to ship around February, Ivory in the February/March time-frame and Open JBuilder sometimes in the first quarter of 1997.

Borland is on 01734 320022 *http://www.borland.com*

IIOP everywhere with Visigenic

CORBA Object Request Broker (ORB) vendor Visigenic has announced a range of new products aimed at connecting object models across networks. The company, founded and headed by Informix president Roger Sippl, is introducing new versions of its VisiChannel and VisiBroker packages which provide interoperability between JDBC and ODBC, COM and CORBA, and IIOP on Sun's JavaStation.

The feat of connecting the previously incompatible Microsoft COM standard with CORBA has been achieved through the OMG's ActiveX Bridge technology which can disguise CORBA objects accessed across networks through IIOP as COM objects on the local system. A developer takes an existing CORBA object's Interface Definition Language files and through the VisiBroker for ActiveX 'Wizard' generates placeholder COM objects which handle communication to and from the remote CORBA objects.

JDBC/ODBC integration comes with the VisiChannel for JDBC product. The client software is written entirely in Java and conforms to the JDBC 1.0 standard, while supporting IIOP interfaces. VisiBroker for Java, Visigenic's Java-based ORB, is to be bundled with the forthcoming Netscape Navigator 4.0.

Visigenic is on 00 1 415 286 1900 *Fax: 00 1 415 28*

- The latest product in **IBM**'s **VisualAge** line has arrived in the shape of **VisualAge for Basic**, which can build client applications on OS/2, Windows 95 and NT, and server applications NT, OS/2 and AIX. Support for both OLE 2.0 and SOM is included. URL: http://www.software.ibm.com/ad/vabasic

- The latest **Unix** versions of **Pure Atria**'s **Purify** and **PureCoverage** error detection and code coverage products offer improved static checking facilities and just-in-time debugging for integration with third-party debuggers. Available for SunOS, Solaris, HP-UX and Irix. URL: http://www.pureatria.com

- Version 5.0 of the **Visual FoxPro** DBMS supports interoperability with ActiveX components, improved performance, and an enhanced development environment with source code control. Pricing is approximately $499 for new users and $249 for upgrades. http://www.microsoft.com/vfoxpro/

- **Philips Semiconductors** has shipped a development environment for its **Trimedia** media processor. The environment includes VUW compilers and tools for C/C++ development, a software simulator, and a set of libraries supporting MPEG-1 and 2, modem functionality and audio synthesis. Prices start at $15,000. URL: http://www.semiconductors.philips.com

Microsoft Visual J++ compiles JAVA code at over 10,000 lines a second.

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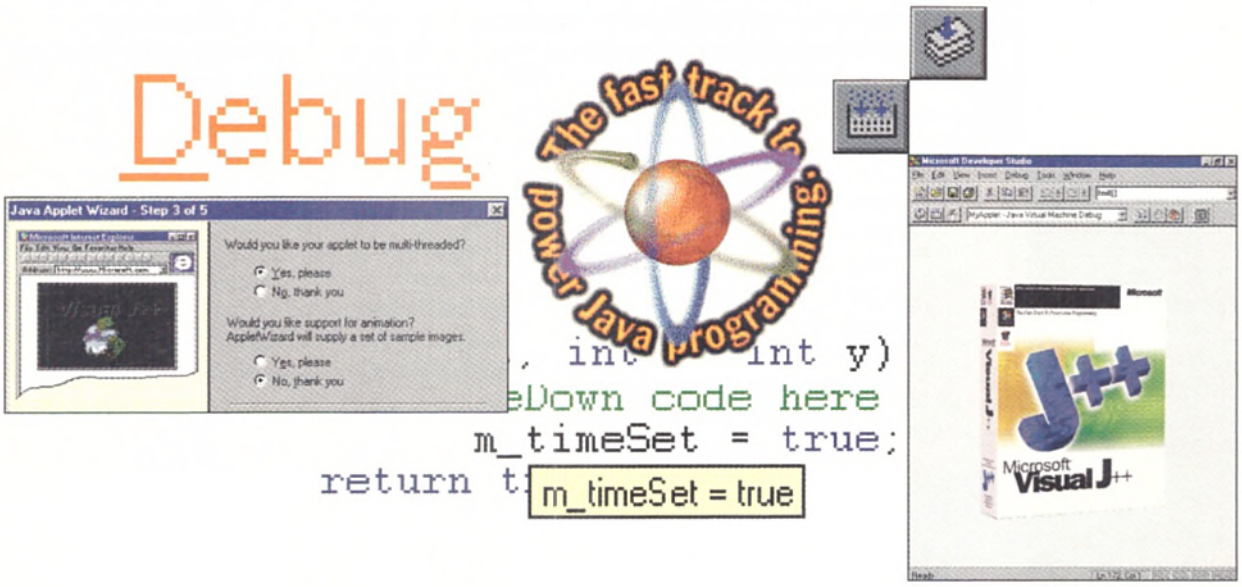

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CIRCLE NO. 948

Microsoft pushes the 'Active platform' to the web

At last month's Site Builder conference in San Jose, Microsoft revealed its strategy for 'putting the browser at the centre of the system', integrating HTML with scripting, ActiveX components and operating system services. The opening keynote by vice-president Paul Maritz outlined new technology for both clients and servers, demonstrating the desktop-integrated Internet Explorer 4.0 and an early version of the Trident dynamic HTML technology replacement for MSHTML.DLL.

Much was made of the componentised architecture of IE4, which will enable upcoming programs share common HTML display behaviour.

Continuing its push to see NT as the standard server operating system, the company announced major extensions to the BackOffice product family, along with the in-beta Active Server and in-alpha Internet Studio technologies for tying them together. The principal medium of integration is the language-independent Active Scripting environment for automating ActiveX controls. VB Script-powered demonstrations were given of the upcoming Internet Agent technology (animated helpers similar to the Assistants of Office 97), complete with very wobbly speech recognition ('it's the background noise', a voice repeats...). It has been left to third parties to implement support for languages other than VB Script and JScript.

The future of workstation management was previewed in the shape of the Zero Administration Initiative for automating system updates and application installation. This is particularly important for Microsoft if it is to see its Intel collaboration super-NC NetPC low cost workstation initiative succeed. The functionality will trickle in to the next versions of Windows over the next couple of years. Automatic component updates and installation-without-reboot are due in the next Windows 9x 'Memphis' release, and NT 5 is due to see server-maintained state information with automatic upgrading of application and system software.

- *http://www.microsoft.com/sitebuilder*
- *Microsoft: 01734 270001*

Internet Studio to produce Web applications

Microsoft is targeting internet developers with its Internet Studio RAD environment for Web development. The IDE is based on the latest generation of the Developer Studio environment, with Explorer-style site navigation and site management tools integrated with FrontPage 97.

The tool includes support for creating Active Server Pages (ASPs), as seen on the MSN Web pages. ASPs are a new feature of Internet Information Server (IIS) version 3, which enable authors to embed server-side scripts in HTML source documents, which are processed by the server to generating HTML.

The environment provides visual tools for producing server-side scripting, as well as a 2.5D HTML layout editor that enables you to lay out interactive Web pages like Visual Basic forms. Database connectivity through ODBC is supported by a set of Database Wizards, and visual query and database design tools.

A new type of ActiveX controls is introduced in Internet Studio. Design-time controls differ from normal ActiveX controls in that they do not interact directly with the client machine, but instead generate HTML and textual content. A number of design-time controls are bundled, including a data range control and a data command control for interacting with databases. Integrated source management for team products is provided with the integration of Visual Source Safe.

A public beta version of the environment will be available for download from Microsoft's Web site later this year, and the shipping version is expected next year.

- *http://www.microsoft.com/istudio*
- *http://www.microsoft.com/vbasic*

Transactions in the BackOffice

The BackOffice range of server products has received a boost with the conference launch of the 'Normandy' technologies, including the Merchant Server Internet commerce package. BackOffice now includes Proxy Server, the Personalisation System for IIS and the Conference Server, complementing NetMeeting to support shared whiteboard, chat and IP phone applications.

Microsoft has also brought transaction processing to NT in the shape of Viper. The technology, which aims to marry transaction processing (TP) with component development to bring transaction capability to the whole system. Viper draws on 30 years of TP experience from other companies, gained, according to developer relations evangelist Ben Willett, by '[driving] over there with the dumptruck full of money'. The current version is aimed at applications on the scale of 100-200 users, with additional multiplexing 'of everything' improving scalability in the Viper 97 'enterprise' release due next year. Message queuing functionality will be added in the shape of Falcon, currently in beta.

- *http://www.microsoft.com/merchant/*

- **Novell** has expanded its **DeveloperNet** program with a free electronic service and additions to its base and advanced subscription options, including multimedia self-study courses and the Novell Research Anthology CD. URL: http://www.developer.novell.com

- **ICL** and partners are developing a proposal for **CORBA** support in the **Eiffel** language for submission to the OMG. The company is incorporating Eiffel support into its Dais ORB, expected next year. URL: http://www.icl.com/dais

- Drag-and-drop creation of Java-based client/server code for **Informix** databases is provided by the **Informix JWorks** tool, expected early next year. The environment includes pre-built Java components supporting both SQL3 and Informix's **DataBlade** technology. URL: http://www.informix.com

- **Unisys** and **Rational** have announced plans to integrate **Rational Rose** with the **Unisys Universal Repository** for distributed object and client/server application development. A free repository evaluation kit is available on the Web at http://www.unisys.com/Products/urep

- Version 3.0 of **Microsoft**'s **ODBC SDK** offers better error diagnostics, more flexible ways to bind multiple data sets and support for bulk operations. It will be distributed to Developer Network subscribers later this year, and is available for download at http://www.microsoft.com/odbc

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CIRCLE NO. 949

Letters

We welcome short letters on any subject relevant to software development. Please write to: The Editor, *EXE Magazine*, St. Giles House, 50 Poland St, London W1V 4AX, or email **editorial@dotexe.demon.co.uk**. Your letter will be considered for inclusion unless it is marked 'not for publication'. Letters may be edited.

Crossing the 't's

Dear Sir,

David Mery listed five possible causes for the typesetter's glitch which led to October's *EXE* being printed with all extended characters replaced by a space: a virus, a hardware problem, human error, sabotage, and an elusive bug. A sixth possibility is a soft error inside some computer system somewhere along the typesetting pipeline. On the whole, memory and disks are much more reliable than they used to be, but it is still possible for a bit in a memory chip to be reset by a random event such as an alpha particle. It is not obvious how a bit error could have led to the actual error, but consider code such as

```
if (it's an extended character) {
  if (the current character set has
      extended characters) {
    process extended character
  } else {
    print a space
  }
}
```

If a bit error corrupted the machine code corresponding to the second test, the result could well have been lots of spaces.

A long time ago I used to work at IBM's Hursley Laboratory. One morning, one of the mainframes crashed – actually quite a rare event. The machine was rebooted and it crashed again. A colleague was testing a floating point algorithm and both crashes occurred just as he started up his program. (Remember that this is a secure multi-user machine, no way any user-level software should be able to crash the whole machine). The second time he got suspicious and dialled the operators. After much persuasion, and tedious single stepping through machine code instructions, they discovered that the crash happened when a particular floating point instruction was executed. It turned out that this instruction was supported in loadable microcode which, for some reason, had been corrupted. The normal means of restarting the mainframe (a warm restart) bypassed the microcode load. The problem was 'solved' by a cold restart which forced a new copy of the microcode to be loaded off disk.

So, I reckon you should blame your printing glitch on a cosmic ray, and hope the sunspots are pointing a different way in future.

Andy Gravell
A.M.Gravell@ecs.soton.ac.uk

I ruled out the 'soft error' deeming that the 'hardware problem' and the 'elusive bug' were covering this type of situation. After loads of tests, Intel considered cosmic rays not to be a problem. Alpha particles do impact chips, but since it is impossible to eliminate radioactive emisions, modern chips are built to be alpha proof, as explained in the Jargon file v4.0.0 'Cosmic Rays' entry.

David Mery

Year 2000

Dear Sir,

Surely David Hughes (Letters, November '96) has the wrong image of the year 2000 problem. He suggests that it can be attacked by changing language and compiler standards for storing dates.

The main reason for the problem is the lack of standards for storing dates. Arguably, if the major computer manufacturers had chosen to provide support for a 'date' data type in the machines and languages of the 1960s and 1970s there would be no significant problem. It arises precisely because programmers had to (and still have to) force dates into unsuitable data types.

David also misses an important portability point in his solution. The ASCII code for ':' may be one greater than the ASCII code for '9'. In EBCDIC it is not even close, and there are probably more lines of mainframe code than lines of PC code. Sadly there really is no alternative to inspecting the logic.

Richard Howells
100121.77@CompuServe.COM

Yearlight saving time

Dear Sir,

I have been reading with interest all the concern regarding the Year 2000 Problem. I believe I have found the solution to everyone's problem, it is so simple that I am surprised no one else has suggested it – on the stroke of midnight at some pre-assigned date, we turn the calendars back 20 years! This is simply an extension of the current idea of 'daylight saving time'. Of course, it would have to apply worldwide on the same night and it would have to be done every 20 years.

Using this method means that we never have to worry about running out of space in the date field come the year 9999 or any other time in the future. Also, we avoid the numerous bugs caused by hasty patches applied to fix the date problem.

I have of course patented the idea and will be charging governments a small fee to use it, but this will still be far cheaper than the alternatives.

Satpal Sandhu
Berkshire

Handwritten *EXE*

Dear Sir,

I demand that the entire magazine is now handwritten (having voted against Francis Glassborow's code I now see the error of my ways). Let the printers try and drop extended characters from that.

John Cooper
john@jpsc.co.uk

Revenge of the dot

Dear Sir,

The reason for your problems is very simple – it is the Revenge of the Punctuation following your removal of the prefixing period to the magazine name. Restore the name to *.EXE* and you will never be affected again!

Furthermore, if you have been using apostrophes inappropriately, the Association for the Abolition of Aberrant Apostrophes may also have been involved (see Keith Whiteouse, President of that association, in the Daily Mail).

Alan G. Lloyd
Farnborough, Hants

TIARA

Dear Sir,

Chris Smithies offered TIARA as the ultimate recursive acronym in the last issue – I'm afraid that it is a real acronym in use in the US (and not a recursive one). It stands for Tactical Intelligence And Related Activities.

Anon.

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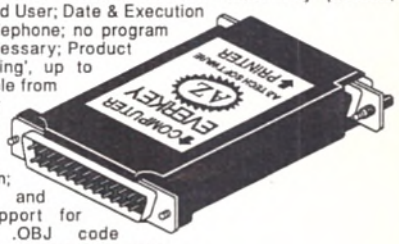

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THE ELEC

Even as machines beget ever more powerful machines, the exponential expansion in software size and complexity continues to overtake and swamp them. **Peter Cochrane** foresees a more natural situation...

The remarkable advances in computer hardware speed and storage density sustained by a doubling of capabilities every 18 months since 1960 (as predicted by Gordon Moore) have been no match for the software explosion. Word processing and other applications that required 0.5 MB of RAM 10 years ago are now demanding well over 5 MB, and there are many more of them. So today's Power PCs seem to run slower than the lowly 386s of a few years ago. In industry the disease seems even worse with control systems totalling millions of lines of code. What is happening? Has the software industry lost control? Will it continue to just consume all future hardware gains, ignore optimisation, and provide ever more complex and unwanted facilities embedded in more and more lines of over-complicated code?

At the present rate of software bloat we will need a supercomputer to write an office memo by the year 2010. And this phenomenon is almost universally true of all commercial, defence and engineering systems – software just keeps expanding. It is as if we have learned nothing from our decades of working with hardware where we delight in doing more with less. Superficially, the engineering differences between hardware and software now seem minimal, and in fact software is often the more expensive to produce. So why do we not optimise and worry about software cost and efficiency? Why do we seem to be doing less with more? Are we really trying to build the world's heaviest aeroplane, or is there more to all this?

It could be that software is something so new and so complex that it will defy all human effort at analysis and formalisation. Never before have we had to construct systems or tackle problems involving hundreds and thousands of loops and I/O functions. This being the case, we could simply be in a

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realm of the unknowable. Much of our software seems beyond our established mathematical models and techniques – and defies our limited human mental capacity to understand. So what are we to do? Of course we can continue on our present course and suffer a continuing, and probably terminal, slowdown. Or we could pin our hopes on new programming languages that are tighter, lighter, smarter and better organised. Perhaps these will see us take the vital step to producing software building blocks that can be glued together, Lego-like, in an understandable and efficient manner. But then, perhaps not: software history does not bode well in this direction.

From particles to materials

In the physical world, we built bridges of wood, stone and steel, worked at investigating their material properties, and later discovered molecules and atoms. In the software world we seem to have started with the electrons and have yet to discover molecules, let alone physical materials. We currently lack any suitable abstractions to form a systematic view, and we know little or nothing of the general properties. Software modules – discrete building blocks – might be the conceptual fix we need. Progress in this direction has been very slow, but there may be an alternative that would fit our needs, arising from network, system and information bases.

Developments in artificial life systems now see genetic mutation and exchange creating a different richness of solutions. Software that writes itself in a similar manner to the evolutionary process of life is now a crude reality. Control systems consisting of millions of lines of code have been replaced by dramatically smaller evolved solutions, and purists now worry about having to trust systems without being able to understand anything about how they work. But the truth is we are not all that clever about understanding how we work either – the complexity of artificial systems is generally well beyond the capacity of a single human mind.

Here is a new world where machines teach themselves about the problems and tasks at hand, and generate solutions automatically, while we unknowingly use the tools they hand us. Most impressively, the computers may soon monitor us, learning from our habits as they change and making continual modifications to their behaviour to closer meet our requirements.

Self organisation and chaos are vital ingredients for all carbon based life. Every living thing exists on the edge of a strange attractor, just a hairs breadth from death, in a risky, fit for purpose, non-linear world of weak hierarchies. In the natural world, complex behaviour is predicated by simple rules, and uncertainty, competition, mutation and reproduction are key to survival and progress. Unless life lives on the edge, it does not live at all. So far, these principles have not been applied to engineered systems which are largely linear, strongly hierarchical and non-competitive, and which attempt to minimise risk through large safety margins and free energy.

It is curious that we are moving in a direction of creating ever more complex software to perform what are essentially simple tasks. In contrast, nature does the converse, generating unbelievably complex behaviour from incredibly simple programming. Of course, nature has had millions of years to get it right, while we face much shorter time scales. All the same, simple life systems, such as worms, ants and bees have been simulated on modest computers, realising the complex interactions within nests and communities. Some of this work has spawned practical applications in the form of network control software and information agents. It also shows much promise as a way of engineering complex systems.

Emergent behaviour

While the underlying software for each entity may be only a few hundred lines of easily understood code, the emergent behaviour of a society of such entities is another matter. This generally defies prediction and is full of surprises. It looks as though systems of this type cannot be engineered from the traditional standpoint of our established methods and principles. We may have to let go of our long held desire to define and constrain all outcomes by rigorously specifying, designing and testing systems. We may just have to stand back and watch the behaviour emerge and develop.

Exponentially growing communication, mobility and information working is creating an increasingly chaotic (in the mathematical sense) world. The notion that

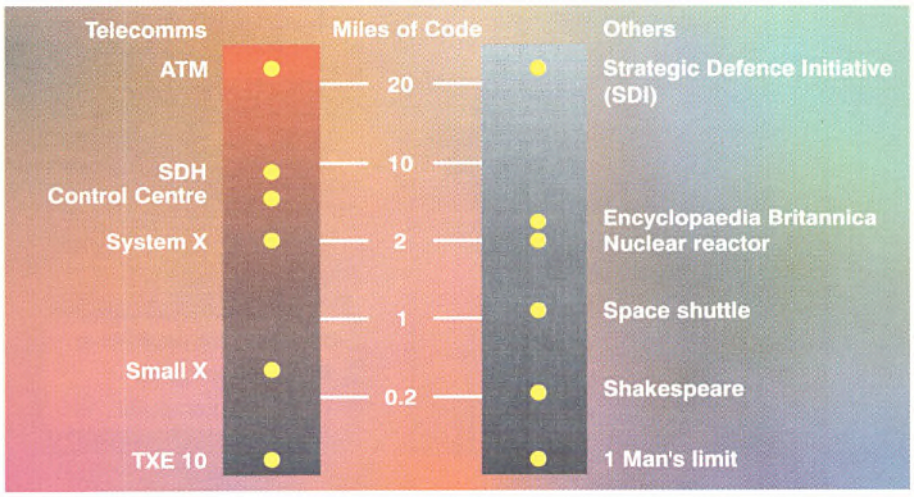


Figure 1 - Examples of Foster's metric. It is a measure of software size: length of a program when printed on standard line printer pages (400 000 lines of code is equivalent to one mile of continuous paper).

everything can be controlled, ordered and specified in a manner reminiscent of the early days of the telephone network is a grave error. No matter how many people are employed writing software, there will never be enough. Systems will not be able to keep up with developments in applications, peripheral devices and new modes of human and machine interaction.

Just 20 years ago, all telephones were static devices sitting on the end of a wire, with users making an average of two or three telephone calls per day at unrelated time. There were busy hours, and meal-times and tea breaks would see a distinct lack of activity, but by and large calls were governed by random events. This all changed with the arrival of the TV phone-in programme: someone from Liverpool singing a song on TV could result in half a million people telephoning London to cast votes for their local hero in the space of 15 minutes. A new world of network chaos was born. With the explosion in mobile telephone usage, a new phase erupted: traffic jams, flight cancellations and the like all trigger correlated activity – within a few minutes, everyone calls their home or office. Naturally, cellular systems are overloaded by these surges of thousands of people demanding to be connected at the same time. A transition has occurred from a random world of reasonably distributed events to a highly localised and closely correlated world of activity triggered by anything that causes individuals to act in unison.

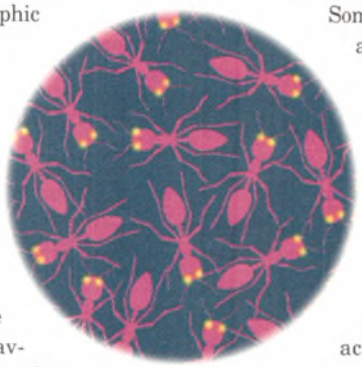
For the near future, consider the prospect of network computers. When several of us are in a meeting together, our low cost NCs will all be plugged into the same line, network or server. At critical times during the discussion, we may all simultaneously attempt to access some information or communicate with distant colleagues. This is correlated activity with a vengeance, and on a large scale is difficult to deal with.

Probably the most famous example of problems with correlated activity between machines was the computerisation of the London Stock Market and the Big Bang. Machines were programmed with similar 'buy' and 'sell' routines with no concept of delays built in. Shortly after taking over from human operators, the machines sent the market into a synchrony of buy, sell, buy, sell. This is an existence theorem for uncontrolled and catastrophic chaos – it *is* possible.

Chaotic systems

Many people equate chaos with randomness, but they are very different. Random systems are totally unpredictable. Chaotic systems exhibit patterns that can be used to predict their behaviour, although in a near cyclic manner they are often difficult for us to perceive. Curiously, without computers we would know little or nothing about the workings of chaotic systems, and yet they may turn out to be the source of network chaos on a scale we might not be able to match.

The dominant language on planet earth today has a binary base. There are now far more conversations between machines every working day than humans, and their high bit rates mean there is more information transferred between machines in a 24-hour period than between the whole of the human race throughout its history. Very soon, there will be more machines telecommunicating than people, and we have no idea of the behavioural patterns that will emerge. I would bet on chaos, with low average traffic and massive, closely correlated, peaks.



Information waves

Anyone who drives on motorways will have experienced traffic waves created by unseen events ahead. Probably the best place to experience this phenomena in the UK is on the M25 where, for no apparent reason, the average speed of traffic can oscillate between 10 and 70 mph for long periods. Sometimes the traffic comes to a complete halt and then lurches forward to 40 mph and back down to 0. This is the classic behaviour of a system of independent entities in a serial queue with a delay between observation and action. In this case the observation might be an accident, a breakdown, or someone driving foolishly. The delay is between our eye, brain and foot. We see something happening, and reach for the brake pedal. As does everyone else, starting the wave.

There is no doubt that rubber-necking while driving a car is very dangerous, but people do it. An accident or incident occurs and people slow down to take a look, then speed up again on the far side. Strangely when the incident has been cleared away the wave that has been set in motion may last the rest of the day. While traffic is dense, the wave's oscillation persists long after the event has subsided. The system has an unseen memory: us. Only when the traffic density thins out does this memory fade away. Might we expect similar phenomena to occur in electronic systems?

Packet switching and transmission systems are an ideal medium for the creation of information waves. To date these have largely gone unnoticed because terminal equipments order packets to construct a complete message, file or picture and end users see nothing of the chaotic action of the network itself. But information packets jostle for position, and queue for transmission slots in a similar manner to cars on a busy road network. Only when we try to use such networks for real time communication do we experience more overt arrival uncertainties: delays and distortions in speech and moving pictures are difficult to miss.

Packet systems are fundamentally unsuited to real-time communication between people and machines. So why use

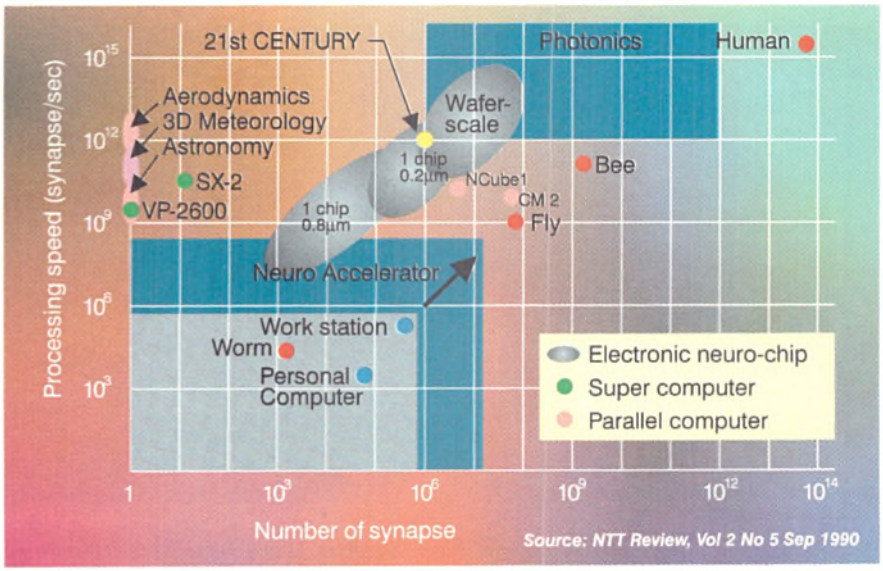


Figure 2 - Processing power evolution

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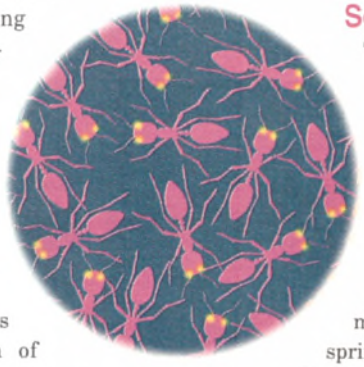
them? Well, for data communication when arrival time is not an issue, they make highly efficient use of the available bandwidth. These systems were born in an era when bandwidth was very expensive, and represent an entirely different paradigm for switching and transmission. However, the champions of 'packet everything' always like to tell you that it is the true way for information to be communicated. Curiously, they often do this by sending you a single line email message with a 35 line header.

Fit for purpose

Telecommunications, networking, and almost all resource allocation in computing will increasingly be about having all the desired capability in the wrong place at critical times. Finding information, people, packet and bit routings, or free CPU power represent an increasingly large class of problems looking for a solution. It could be that just throwing cheap bandwidth at the problem and exploiting the vast capacity of optical fibre networks might offset the need for large and complex software systems. Mother nature often adopts this tactic by selecting a 'fit for purpose' rather than optimal solution. However, while near-zero cost bandwidth is certainly feasible, it is not certain to solve all our problems, and in any case we do not have the economic mechanisms we would need to realise it anyway.

A new line of thinking began with a study of ants. Some of these creatures have only 200 neurons, with only a tiny amount of programming defining the majority of their individual behaviour. But their social behaviour, involving the interaction of thousands, is phenomenally complex, adaptive and resilient. Emulating them proved relatively simple and rewarding, with ant-like simulations of only 400 lines of code able to seek out and retrieve information across networks. The addition of memory cells and collaborative communication – to compare missions, sites visited and information won – has turned these programs into an extremely versatile and efficient breed of information agents.



An extension of these concepts has resulted in new network restoration algorithms for counteracting the effects of underground cable damage and network equipment failures. The new software totals less than 1 K of code, constructed and tested in a matter of weeks, which replaced 1.6 M lines of structured code which had gone through years of development. However, the code was still dead, wholly deterministic, with fixed functionality that did not learn or mutate. In the strict sense, it could never learn or evolve.

Software sex

Taking a leaf out of nature's book, it is clear that we will increasingly need evolutionary solutions to meet the growing chaotic demands on our systems and deal with operational changes. The concepts of genetics, sex, mutation and procreation spring to mind, but we cannot afford to wait for millions of years of chance mutations.

In carbon-based systems, the world is dominated by one and two-sex species, with two sexes seeming more adaptable, complex and intelligent. So, we might suppose that the combination of software sex and the speed of machines might suffice, but should we place constraints on the mechanism and nature of procreation involved in order to reflect natural systems? Probably not. In software, no con-

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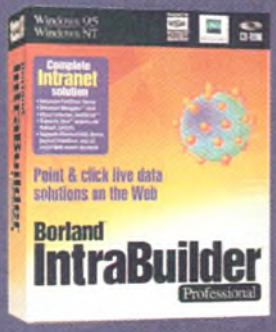

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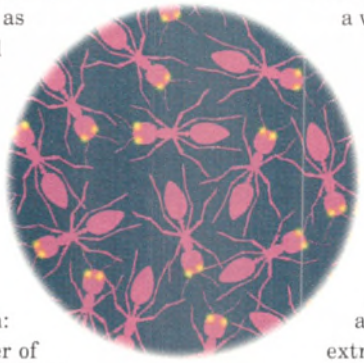
straints are necessary – no concepts of morality or society exist to reduce the richness of behaviour.

It turns out that in a stable environment, or within a fixed and bounded problem class, two or three-sex systems seem to dominate as the most adaptable and efficient way to generate solutions. However, as the problem space grows beyond the mutation and evolution abilities of two-sex systems, failure to find a solution increasingly becomes a problem. An easy solution: simply increase the number of sexes to fill the problem space. In nature, single sex systems dominate in flora and fauna, and two-sex systems are the smartest. But fungi have 10,000 sexes, and some insect species 7 or 17. In the event of some future cataclysm, guess who dies and who survives!



We might envisage a silicon world where positive behaviour is passed on from generation to generation with a degree of freedom unavailable to carbon-based entities: progeny by instalments. This might be a means of avoiding the evolutionary cul-de-sacs that so evidently hamper natural entities. Progeny by piece parts, creating software entities from many offspring glued together to make the whole may offer a further degree of freedom, and enable us to solve a wider class of problems.

Silicon life

To date it has been demonstrated that such a natural engineering approach can produce viable solutions to the travelling salesman problem that are very low cost but extremely efficient in terms of code and time to converge. It has also been used to produce programs that sort and prioritise information stacks, and model the behaviour of markets and companies. Evolutionary systems increasingly exhibit remarkable degrees of intelligence, for example in the search behaviour of screen-based robots. While we are unlikely to see machines writing their own word processors, these systems are an insignificant burden for humans compared to the system and network problems we have yet to face.

When all of this comes together with noisy decision making, a subtle blending of random uncertainty and chaos (instead of the full determinism of nailed down logic), we may have the right conditions for silicon life. The technology will no longer require our hand to steer it to find solutions. We will then have to be content to be the spectators of the evolution, and try to understand and decode the outcomes of this new engineering method.

For the most part people do not understand people, and people do not understand machines. The big question is, will machines understand machines and people? And will we be smart enough to spot artificial life when it spontaneously erupts? ■

Peter Cochrane is the head of research at BT Laboratories, managing 660 staff focused on the future of advanced media, computing, communications and networks. He is also a visiting Professor, a consultant to numerous international organisations, a Fellow of the IEE, IEEE and the Royal Academy of Engineering, and a member of the New York Academy of Sciences. His home page is at http://www.labs.bt.com/people/cochrap/

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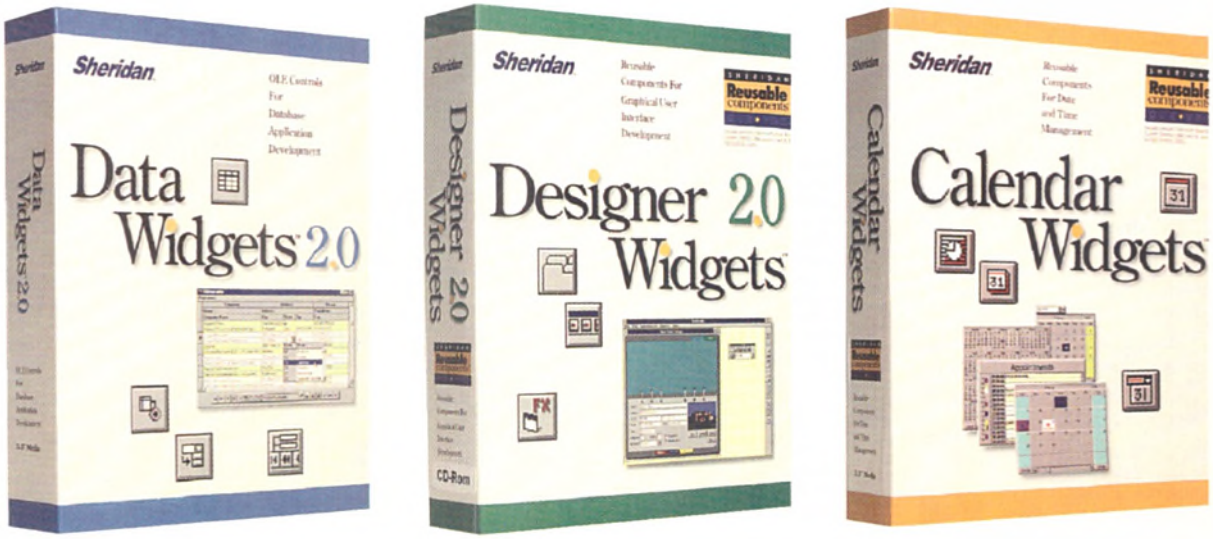

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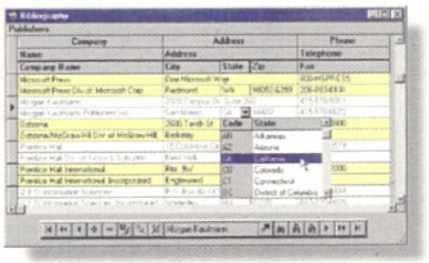

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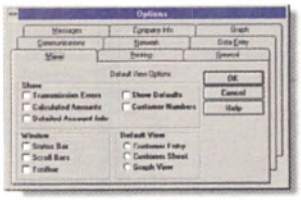

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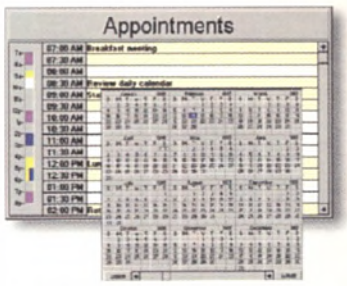

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Not just another line drawing algorithm

In recent years, huge increases in processing power have made near real-time 3D graphics on cheap desktop computers a reality. **John Mears** explores one of the techniques used for these sophisticated computations: the midpoint algorithm, which has applications from texture mapping to polynomial rendering.

One of the most common tasks in graphics applications is drawing straight lines on the screen. Generally, a line can be defined by its gradient m and point of intercept with the y-axis c, with the equation $y = mx + c$. For lines at angles between 0 and 45 degrees (with a gradient between 0 and 1), we can work out which pixels to plot by stepping along each x value in turn, and using this equation to work out the corresponding y value. (When the line is more vertical, we switch the process around and step along the y values, since the normal approach would result in gaps in the line caused by missing pixels).

A rendering routine based on this naive approach is shown in Listing 1. For simplicity we assume that the line's gradient is between 0 and 1, and that the whole of video memory is addressed linearly in a single segment (as in mode 0x13).

Of course, performing a floating point multiplication and rounding for every single pixel is horribly inefficient (as you can see from the timings in Table 1). An easy improvement is to replace the multiplication with a simple increment, since each y value can be calculated from the previous one. Surprisingly, this actually makes little difference to the speed of the routine. This is partly because the FPU does not perform addition very much faster than multiplication. Additionally, it is the delay incurred when transferring data to and from the FPU that dominates the timings observed.

Clearly, to get better performance we have to avoid floating point data: integer arithmetic will be much more efficient, particularly for the addition and subtraction operations. But how can we do this? We cannot just replace `float` with `int` in our code sample, since this would result in the gradient being truncated, forcing all lines to be at 0, 45 or 90 degrees. What we need is an integer method which won't lose the precision, perhaps one that stores the fractional parts as remainders that are accumulated instead of being discarded.

This is exactly what Bresenham's classic line drawing algorithm does. He developed algorithms for both line and circle rendering by gradually optimising naive solutions – as we started to do above – until he reached the optimum speed. We will take a slightly different route which results in the same algorithm, by applying the midpoint technique, developed by Pitteway and published in 1967. This technique turns out to be far more general in its application, as the two sidebars explain.

Listing 2 shows a C implementation of the midpoint algorithm for straight line drawing. This executes many times faster than the floating point version (see Table 1). There are a couple of points worth noting about this approach: it calculates screen addresses incrementally, and although integer arithmetic is used, there is no loss of precision. Additionally, the coordinates of the ends of the line need not be integers. This may seem strange, but imagine a near-horizontal line rendered on the screen as a number of stepped horizontal line segments. If you raise the left end of the line by a fractional amount, the positions of the steps will move to the right, creating the illusion of a higher screen resolution than is actually the case.

The midpoint algorithm translates easily to assembler, as shown in Listing 3. The assembler code loads the C variables into registers for fast access: the data segment register **ds** is set to the display RAM segment, with **si** holding the offset. Since the video memory can be accessed linearly, this offset is $(y * 320) + x$.

The assembler version is considerably faster. The time taken to draw a line pixel is now divided into three roughly equal parts: the time to write to the display memory, the time to decide where to draw the next pixel, and the loop overhead.

The Pentium's superscalar architecture means that the time taken to execute a program is less than the sum of its parts, so to increase the speed of drawing still further it is not sufficient to reduce just one of the three factors. For this reason it is hard to optimise this code further, for example by unwrapping the loop.

The midpoint line algorithm is also useful for linear scaling, for example to map a bitmap into a given area on the screen.

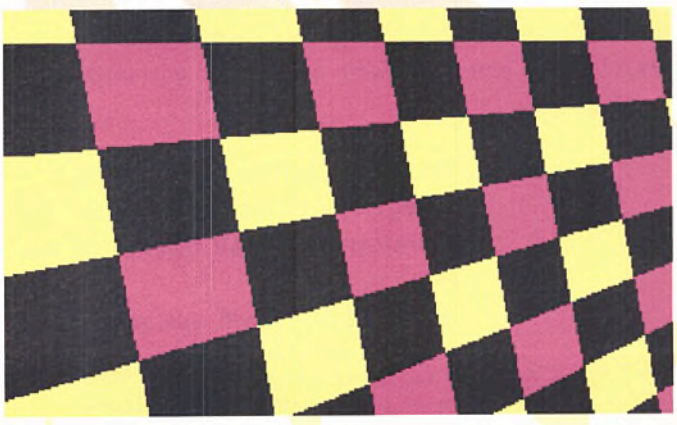

Figure 1 – Bitmap rotated and tilted by Listing 6.

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The midpoint algorithm

Lines

The midpoint algorithm is both elegant and easy to understand. Suppose we are rendering a line on the screen, as shown in Figure 2. For simplicity's sake the line's gradient is between 0 and 1 and we are drawing from left to right. The *n*th pixel has just been plotted and we need to decide which pixel to plot next. Since we are drawing from left to right it must be in column *n+1*. We know the inclination of the line is in the range 0° to 45° so the next pixel to plot must be either P or Q. How do we decide which?

The theoretical line has equation

$y=mx+c$ (1)

We can rewrite this (for reasons we will shortly see) as:

$f(x,y):ax+by+c=0$ (2)

where a, b and c are related to m and c in equation 1. The function $f(x,y)$ is zero at any point on the line, positive at any point below the line and negative at any point above it, corresponding to the green and blue regions of the graph above. Thus, one way to decide which pixel to plot, P or Q, is to evaluate f at a point midway between P and Q, labelled m in Figure 2. If the result is positive, the next pixel to plot is Q, otherwise it is P. We know the co-ordinates (x_n,y_n) of the pixel we have just plotted, so we just need to test the sign of $f(x_n+1, y_n+fi)$. For convenience, we define

$g(x,y)=f(x+1,y+fi)$ (3)

In this context, g is known as the *decision variable*. After drawing a pixel at (x,y), we evaluate $g(x,y)$ and test the sign of the result to decide which of two pixels to plot next.

How does this help to draw a line quickly? The trick is to calculate the decision variable g incrementally from its previous value. As each pixel is plotted, a simple increment (Δg) is applied to the value of the decision variable. Because there is a choice of two pixels to plot at any stage, there is also a choice of two increments to apply. These can be precalculated by subtracting consecutive values of g. Using equations 2 and 3,

$\Delta g=a(x_{n+1}-x_n)+b(y_{n+1}-y_n)$

So when we step one pixel to the right, $\Delta g=a$, and when we step one pixel to the right and one pixel up $\Delta g=a+b$. Thus, the value of the decision variable can be calculated from its previous value by simply adding either a or $a+b$. The resulting program to draw a straight line from (x1, y1) to (x2, y2) takes the following form:

1. Draw the first pixel. Calculate the initial value of the decision variable using equation 3.
2. Test the sign of the decision variable. If it is positive, increment x and y and add a+b to the decision variable. Otherwise, increment x and add a to decision variable.
3. Plot the pixel at (x, y).
4. Repeat from step 2 until the line is complete.

Notice that integer arithmetic will suffice for steps 2 to 4 provided a, b and c are chosen to be integers. There is still a problem in step 1 however: the initial value of the decision variable from equation 3 contains fi. The solution is easy – since only the sign of the decision variable is important, all quantities can be multiplied by 2, eliminating the awkward fraction.

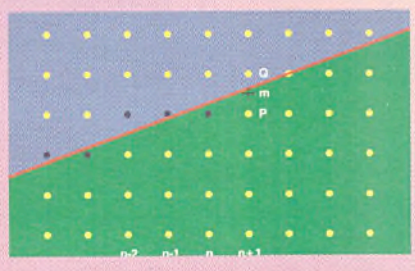

Figure 2 – Drawing a line on the screen. The yellow dots are pixel positions, and the blue dots are those pixels which have been plotted so far.

Of course I cheated by assuming the line increases from left to right and has a gradient in the range 0 to 1. However, it is simple to derive similar procedures for the other cases, and add some code to choose the appropriate one and deal with the special cases of horizontal, vertical and 45° lines.

This algorithm is sometimes referred to as a *digital differential analyser* (DDA) algorithm. A DDA is a 'mechanical' device for calculating successive (x,y) values by adding increments to x and y proportional to their rates of change.

Other curves

Although I have taken a straight line as an example, the same technique can be used to design a fast algorithm for generating points on any curve which has an equation in the form $f(x,y,)=0$ where $f(x,y)$ is a polynomial. This family includes circles, ellipses, parabolas, hyperbolas and many less common curves.

In general, the design steps are as follows:

1. Identify sections of the curve which can be drawn choosing from only two pixels at each stage. For the straight line this was easy and could be determined for the line as a whole by examining its gradient. In general this can be more complicated, but there is often a common-sense short cut.
2. Work out an expression for the decision variable, similar to equation 3 above.
3. Calculate the increments to apply to the decision variable in moving from one pixel to the next.

Circles

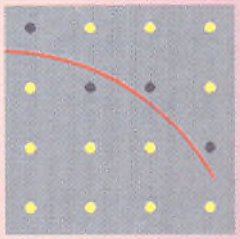

Figure 3 – A single 45° circle octant.

Another common application of the technique is circle rendering. In reality you often want to draw ellipses to compensate for screen aspect ratios, but the calculations for circles and ellipses are very similar, and I will only consider circles here for simplicity.

The first step is to identify which parts of the circle can be drawn with the same algorithm. This is fairly easy for a circle: just divide it into 45° octants. Within each octant the inclination of a line from the centre to any point on the circumference does not go outside a 45° range. Let's consider the octant drawn from 90° to 45°. As you can see from Figure 3, at each stage we have the choice of drawing the pixels at $(x+1,y)$ or $(x+1,y-1)$.

We need to derive an expression for the decision variable from the circle's equation. For a circle centred at the origin, this is $f(x,y)=x^2+y^2-r^2=0$, where r is the radius of the circle. $f(x,y)$is positive outside the circle and negative inside it. A small amount of algebra yields the following expressions for the decision variable and increments:

$g(x,y)=(x+1)^2+(y-fi)^2-r^2$

$\Delta g_1=2x+3$

$\Delta g_2=2x-2y+5$

Notice that the increments are not constant as they were in the case of straight lines. It would seem a multiplication is required, but this is easily eliminated by calculating the increment itself incrementally, resulting in two increments to perform per pixel step. In general, an nth order polynomial curve requires n levels of increment.

Unfortunately, the initial calculation of the decision variable (step 1 above) involves a fraction so it appears that integer arithmetic cannot be used. In practice a trick to solve this problem is simply to add/to the decision variable. This will not affect the sign test because we are using integer arithmetic. The result is a very fast method for drawing circle octants.

Other shapes

The midpoint algorithm for circle drawing (discussed in the box) is shown in Listing 4. It is identical in form to the straight line version, the main change being in the calculation of the differences – there are three increments inside the loop where there was one before. This is simply because circles are described by higher order functions than lines. Another difference is that this algorithm calculates the y coordinate explicitly as it progresses so that it can test for the end of the octant being drawn, adding another increment. The efficiency of execution consequently suffers slightly, but the algorithm is still capable of impressive speed as shown in Table 2.

A real-life routine for rendering circular arcs would contain a number of sections for drawing each individual octant of the arc, each very similar to Listing 4. Of course, if an entire circle is being drawn, symmetry can be used to reduce the total calculation required.

The circle drawing algorithm translates easily to assembler as shown in Listing 5. As before, most variables are loaded into CPU registers for efficiency, but unfortunately there aren't quite enough available to hold all of the calculations. As the order of the curve drawn increases, this will become more of a problem. However, RAM caching is very effective at speeding up access to non-CPU data. Again, the routine is significantly faster than the C version, as shown in Table 2.

Texture mapping

What has all this got to do with the real-time 3D graphics seen in games like Doom, Descent and Quake? These games continually change the player's 3D view of the environment as they move. To provide reasonably smooth screen updates, many frames per second must be calculated and drawn. For example, if 20 frames per second are calculated in a graphics resolution of 320 x 200 pixels, about 1 µs is available per pixel. This doesn't sound like much, and it isn't: in this time the program has to perform all its 3D, perspective, lighting, texture mapping, and hidden surface calculations, as well as dealing with game logic. The most significant part of the program's time is spent repeating the optimised inner loop which draws surface textures on the screen.

For each pixel on the screen, the game has to choose which part of a texture (ie which texture pixel or *texel*) to draw. The surface being drawn may be at any distance or orientation relative to the player, so this calculation is not trivial. There is a major difference here between the way that Doom and Descent work: Doom only permits rotation of the player about a vertical axis – they cannot look up or down, or roll from side to side. This makes the texture mapping calculations much easier, since all the textures can be drawn with a technique similar to linear scaling, using the midpoint algorithm described above.

Texture mapping in Descent is more interesting, since the player has total freedom of movement: full rotation and perspective calculations are required for each screen pixel. The equations which control this and a midpoint algorithm to calculate texel co-ordinates are discussed in the sidebar, and the algorithm is implemented in Listing 6. The viewer is looking along the z-axis at a chessboard bitmap which is projected onto an imaginary viewing screen between the viewer and the bitmap.

Note that the program avoids the need for floating point arithmetic by scaling the vector components up by a factor of 16 and storing them as integers. The programs starts by defining the position and orientation of the bitmap relative to the viewer.

```
void Line(int x1, int y1, int x2, int y2, byte Colour)
// Draw a line from (x1, y1) to (x2, y2).
// Assumes that x1<x2 and the gradient is less than 1.
{

  float m = ((float) (y2 - y1)) / ((float) (x2 - x1));
  float c = y1 - m * x1;
  for (int x = x1; x <= x2; x++) {
    float fy = m * x + c;
    int y = fy + 0.5;
    ScreenBase[x + y * SizeX] = Colour;
  }
}
```

Listing 1 – Naive line drawing solution using floating point.

```
void Line(int x1, int y1, int x2,
  int y2, byte Colour)
// Draw a line from (x1, y1) to (x2, y2).
// Assumes x1<x2 and the gradient is less than 1.
{
register int x, G, DeltaG1, DeltaG2;
  int a = y2 - y1;
  int b = x2 - x1;
  G = 2 * a - b;
  DeltaG1 = 2 * (a - b);
  DeltaG2 = 2 * a;
  byte far *Screen = ScreenBase + x1 + y1 * SizeX;
  *Screen = Colour;
  for (x = x1; x <= x2; x++) {
    if (G > 0) {
      G += DeltaG1;
      Screen += SizeX + 1; // Next column and row.
    } else {
      G += DeltaG2;
      Screen += 1;         // Next column.
    }
    *Screen = Colour;
  }
}
```

Listing 2 – The midpoint algorithm in C.

```
void Line(int x1, int y1, int x2, int y2, byte Colour)
// Draw a line from (x1, y1) to (x2, y2).
// Assumes x1<x2 and the gradient is less than 1.
{
int G, DeltaG1, DeltaG2;

  int a = y2 - y1;
  int b = x2 - x1;
  G = 2 * a - b;
  DeltaG1 = 2 * (a - b);
  DeltaG2 = 2 * a;
  int ScreenOffset = x1 + y1 * SizeX;
  asm {
  // Move C variables into CPU registers:
    mov si, ScreenOffset// Offset into screen segment
    mov di, x2
    sub di, x1          // Number of columns to plot.
    mov ax, DeltaG1     // Increment to apply to cx.
    mov bx, DeltaG2     // Increment to apply to cx.
    mov cx, G           // The decision variable.
    mov dl, Colour      // Colour to plot the line in.
    push ds
    push 0xA000         // The screen memory segment.
    pop ds
  // Draw the line:
    mov [si], dl        // Plot the first point.
plot1: or cx, cx        // Test the sign of the decision variable,
    jle plot2           // and choose which way to step.
    add cx, ax          // Step to the next row and column.
    add si, SizeX + 1
    jmp plot3
plot2: add cx, bx       // Step to the next column.
    inc si
plot3: mov [si], dl     // Plot the point.
    dec di
    jg plot1
    pop ds              // Restore original data segment.
  }
}
```

Listing 3 – The midpoint algorithm in assembler.

Texture maps

Texture mapping is the process of projecting a position on one plane onto another plane. One plane corresponds to a position in a bitmap containing an image drawn on that surface; the other is the viewing surface or computer screen. The planes may be at any position and orientation relative to each other in three dimensions, so the projection calculations must incorporate offset, rotation and perspective transformations. The equations which relate screen pixel co-ordinates *(x, y)* to bitmap texel co-ordinates *(u, v)* are as follows:

$$u = \frac{Ax+B}{Cx+D} \qquad v = \frac{Ex+F}{Gx+H}$$

The values A through H are constants for a given surface being projected onto a particular row of pixels on the screen. They are related to the position and orientation of the viewer and the surface, and are calculated by straightforward geometry. Since they do not need to be calculated for every screen pixel, this operation does not have a major impact on drawing speed. Where speed is critical, however, is in the calculation of *(u,v)* from a particular *(x,y)* pair.

Consider the first equation, which relates u and x. Although we do not want to draw the curve *u vs x* on the display, the midpoint algorithm can still be used. Or rather two sets of algorithms: one set relating u to x and the other v to x.

The first step in deriving a midpoint algorithm for this calculation is to identify segments in the graph of *u vs x* which can be drawn with the same algorithm. This is not so simple as for the straight line or circle, and is discussed in the main text. For the moment, consider the segment where the gradient of u vs x is between 0 and 1, as we did for the straight line. This means that each time x is incremented, u either does not change or increments just by 1, and we can use a decision variable to work out which.

The next step is to write down expressions for the decision variable and its increments. As for the circle these are derived in a very few lines of algebra, resulting in the following:

$f(x,u)=Cxu+Du-Ax-B$

$g(x,u)=2f(x+1,u+fi)$

$\Delta g_1=C(2u+1)-2A$

$\Delta g_2=C(2u+2x+5)-2A+2D$

We use the same trick as we used for the straight line: the decision variable includes a factor 2 to eliminate awkward fractions. In common with the circle drawing algorithm, $g(x,u)$ is a second order equation, so the increments turn out to be in two levels.

Algorithms for other inclinations of the u vs x curve can be derived very similar to the above. In addition, the relations for v to x must also be derived.

```
typedef int int16;
typedef long int32;
struct TVector { int16 x, y, z; };

#define MIDPOINT

void TexMap()
{
int32 v, u;     // Bitmap texel coordinates.
int32 x, y;     // Screen pixel coordinates.
TVector O;      // Position of polygon origin in 3D.
TVector i, j;   // Projections of the polygon's axes onto x,y,z.
TVector k;      // Normal to the polygon, not unit vector.

// Distance of viewer from projection screen:
const int16 d = 130;
// Define the bitmap's orientation and position:
  i.x = 16; i.y = 3; i.z = 5;
  j.x = -3; j.y = 16; j.z = 0;
  k.x = -5; k.y = 0; k.z = 16;
  O.x = 0; O.y = 0; O.z = 100;

  byte far *Screen = ScreenBase;
  for (int row = 0; row < SizeY; row++) {
    y = MidY - row;  // Offset to screen centre:
    x = -MidX;
// For the first pixel in each row, calculate the
// texel coordinates by brute force:
    int32 A = y * O.z - d * O.y;
    int32 D = d * j.y - y * j.z;
    int32 E = d * i.y - y * i.z;
    int32 H = d * j.y - y * j.z;
    int32 Au = -j.z * A - O.z * D;
    int32 Bu = d * j.x * A + d * O.x * D;
    int32 Cu = - E * j.z + i.z * H;
    int32 Du = d * j.x * E - d * i.x * H;
    int32 Av = -i.z * A - O.z * E;
    int32 Bv = A * d * i.x + d * O.x * E;
    int32 Cv = -Cu;
    int32 Dv = -Du;
// Scale up coefficients to match the scale of the bitmap axes:
    Au *= 16;  Bu *= 16;
    Av *= 16;  Bv *= 16;
// Calculate the initial texel coordinates:
    u = (Au * x + Bu) / (Cu * x + Du);
    v = (Av * x + Bv) / (Cv * x + Dv);
// Calculate decision variable and incr. for the bitmap's i axis:
    int32 Gu = 2 * Cu * x * u + x * (Cu - 2 * Au)
      + 2 * u * (Cu + Du) + Cu + Du - 2 * (Au + Bu);
    int32 ku1 = 2 * Cu * u + Cu - 2 * Au;
    int32 ku2 = 2 * Cu * u + 2 * Cu * x + 5 * Cu - 2 * Au + 2 * Du;
    int32 ku3 = 2 * Cu;
    int32 ku4 = 4 * Cu;
// Calculate decision variable and incr. for the bitmap's j axis:
    int32 Gv = 2 * Cv * x * v + x * (-Cv - 2 * Av)
      + 2 * v * (Cv + Dv) - Cv - Dv - 2 * (Av + Bv);
    int32 kv1 = 2 * Cv * v - Cv - 2 * Av;
    int32 kv2 = 2 * Cv * v - 2 * Cv * x - 5 * Cv - 2 * Av - 2 * Dv;
    int32 kv3 = 2 * Cv;
    int32 kv4 = 4 * Cv;

    while (x < MidX) {
      x++;
#ifdef MIDPOINT
      if (Gu < 0) {
        Gu += ku1;
        ku2 += ku3;
      } else {
        u++;
        Gu += ku2;
        ku1 += ku3;
        ku2 += ku4;
      }
      if (Gv < 0) {
        Gv += kv1;
        kv2 -= kv3;
      } else {
        v--;
        Gv += kv2;
        kv1 -= kv3;
        kv2 -= kv4;
      }
#else
      u = (Au * x + Bu) / (Cu * x + Du);
      v = (Av * x + Bv) / (Cv * x + Dv);
#endif
      // Make a coloured chess board:
      int Invert = u & 32;
      int OddBlock = v & 32;
      int Colour = OddBlock ^ Invert ? (u & 32 ? 14 : 13) : 0;
      *Screen = Colour;
      Screen++;
    }
  }
}
```

Listing 6 – Fast texture mapping in C.

```
void Circle(int Radius, byte Colour)
// Draw the first octant of a circle centred on the top
// left corner of the screen. This algorithm will only draw
// an arc whose inclination is between 0 and 45 degrees.
{
register int x, y, G, DeltaG1, DeltaG2;
  x = 0;
  y = Radius;
  G = 1 - Radius;
  DeltaG1 = 3;
  DeltaG2 = -2 * Radius + 5;
  byte far *Screen = ScreenBase + x + y * SizeX;
  *Screen = Colour;
  while (x < y)
  { if (G < 0)
    { G += DeltaG1;
      DeltaG1 += 2;
      DeltaG2 += 2;
      Screen += 1;
    } else {
      G += DeltaG2;
      DeltaG1 += 2;
      DeltaG2 += 4;
      Screen += 1 - SizeX;
      y--;
    }
    x++;
    *Screen = Colour;
  }
}
```

Listing 4 – Fast circle drawing in C.

```
void Circle(int Radius, byte Colour)
// Draw the second octant of a circle centred on the top
// left corner of the screen. This routine will only draw
// an arc whose inclination is between 0 and 45 degrees.
{
int x, y, G, DeltaG1, DeltaG2;

  x = 0;
  y = Radius;
  G = 1 - Radius;
  DeltaG1 = 3;
  DeltaG2 = -2 * Radius + 5;
  int ScreenOffset = x + y * SizeX;
  asm {
    mov si, ScreenOffset
    mov di, x
    mov ax, DeltaG1
    mov bx, DeltaG2
    mov cx, G
    mov dl, Colour
    push ds          // point the data segment to
    push 0xA000      // the display.
    pop ds
    mov [si], dl     // Plot the first point.
plot1: or cx, cx     // Test the sign of the decision variable,
    jle plot2        // and choose which way to step.
    add cx, bx       // Step to the next row and column.
    add ax, 2
    add bx, 4
    sub y, 1         // Decrement y.
    add si, 1 - SizeX
    jmp plot3
plot2: add cx, ax    // Step to the next column.
    add ax, 2
    add bx, 2
    inc si
plot3: mov [si], dl // Plot the point.
    inc di           // Increment x.
    cmp di, y        // Test for the end of the arc.
    jle plot1
    pop ds           // Restore the original data segment.
  }
}
```

Listing 5 – Fast circle drawing in assembler.

The starting texel co-ordinates are calculated for the left end of each row of pixels to be drawn. This is a brute force projection operation following directly from the basic geometry. The midpoint algorithm is used in the inner loop which draws individual rows on the screen. As for circles, two levels of increment are required, but here there are two separate midpoint calculations for two independent parameters,

	Time to draw a line pixel
Naive floating point method (Listing 1)	10.3 µs
Midpoint algorithm in C (Listing 2)	0.18 µs
Midpoint algorithm in assembler (Listing 3)	0.12 µs

Table 1 – Line drawing speed for various algorithms. The speed was measured using a 100 MHz Pentium PC.

	Time to draw a circle pixel
Midpoint algorithm in C	0.21 µs
Midpoint algorithm in assembler	0.14 µs

Table 2 – Circle drawing speed for various algorithms. The speed was measured using a 100 MHz Pentium PC.

	Time to draw a texture pixel
16-bit midpoint algorithm in C (Listing 6 with MIDPOINT defined)	1.05 µs
Brute force algorithm in C (Listing 6 with MIDPOINT not defined)	2.05 µs
Midpoint algorithm in assembler using 32-bit registers	0.52 µs

Table 3 – Texture mapping speed. The speed was measured using a 100 MHz Pentium PC.

namely u and v. These values could be used to index into a bitmap, but here they are used as parameters in a function which defines a chessboard texture. The result is illustrated in Figure 1.

For comparison, the non-midpoint calculations are included in Listing 6: remove the definition of `MIDPOINT` to confirm that the results are exactly the same. Table 3 shows the speed of both methods. The midpoint algorithm is a great improvement over the brute force approach, and it can be improved still further. An obvious optimisation is to compile the example for 32-bit arithmetic using the full extended register set of the 80386 and up. The next step is to translate the code into assembler as we did for the line and circle routines above.

Listing 6 has some limitations introduced for simplicity. Firstly, not all cases of the midpoint algorithm are implemented – only the case in which u increases and v decreases as x increases. It is a fairly simple matter to derive the other cases and test before drawing each line to see which algorithm to use. Secondly, the algorithm only works for the case when no more than one texel increment is required per screen pixel increment. The solution here is to store versions of the bitmap at various resolutions and choose the one whose resolution is closest to the plotting resolution required. There is no space here to print the completed texture mapping program but you can find it on *EXE*'s web site. The routine's timings are shown in Table 3. It is fast enough for 30 full screen updates per second, enough for realistic animation.

The actual algorithms used by modern 3D games will of course differ – this approach still requires a large amount of processing power and many game players do not have fast enough computers. While I do not have any inside information, I suspect many of today's games use tricks such as linear interpolation, sacrificing exactness for speed. Nevertheless, we have seen that the midpoint algorithm can be used for feasible high speed true texture mapping.

■

John Mears is C++ programmer who has spent 8 years specialising in real-time control of instrumentation. His coordination is so poor that he watches other people playing Descent, and spends all his time wondering how it works. He can be contacted at john.mears@oxinst.co.uk.

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hide & seek

Before the GUI age, people hunted their files through command lines, barking terse instructions amid crackling line noise. Don't look back in anger, says **Peter Collinson**...

When people ask me what I do, I normally say 'Oh, I'm a computing person'. It's a defence mechanism born from the blank looks that I used to get when I said 'Internet' or 'Unix'. Nowadays I mention these only if I'm pressed. The 'Internet' word can provoke conversations about subjects ranging all the way from pornography to hackers, and saying 'Unix' usually elicits the old business of 'Unix is hard to use' or 'Unix is so unfriendly' or something else along these lines. I've become too aged to leap into a religious defence of the system, and usually just smile when I have this repeated to me. 'You may think this, I state. I couldn't possibly comment'.

Unix came into prominence at a time when people talked to computers using a command line interface, passing characters back and forth along slow terminal lines to get their work done. There's a big usability problem with command lines. To execute a command, you have to know its name, ie what to type into the computer to get it to perform the task that you have in mind, so there's instantly a learning curve involved with using the system.

Unix has always been uncompromisingly uncooperative in assisting trainee users along this learning curve because the system was designed for efficient use by experienced users. There's a strong assumption that you know what you are doing and, incidentally, what the system is doing.

I guess that the sparseness of response in Unix is one of the reasons people accuse it of unfriendly behaviour. However, if you are using the system on a terminal line using a mechanical teletype at 110 baud, then it's by no means unfriendly to suppress unnecessary output that gets in the way of the next command that you want to type.

Problems with the interface also arise from the commands themselves. Unix command names are typically terse, and most can't be easily deduced from the operation that the command performs. In addition, they tend to give you very little help about the parameters that they expect. Other systems do better. For example, if you wanted to copy a file on VMS, and just typed the command name, then the system would prompt you for the name of the source file and the name of the destination file. If you supply no arguments to the Unix `cp` command, however, you will get some error message like:

```
$ cp
cp: Insufficient arguments (0)
Usage: cp [-f] [-i] [-p] f1 f2
    cp [-f] [-i] [-p] f1 ... fn d1
    cp -r|R [-f] [-i] [-p] d1 ... dn-1 dn
```

If you are a Unix person, then you are probably thinking: 'Sure, what's he bleating about?' Well, this error message means a lot to you. You understand that the square brackets denote optional parameters and that the vertical bar in the fourth line means that there's a mandatory `-r` or `-R` argument. Learners have rarely had this syntax explained to them, and actually it's frequently undocumented.

Beginners also have to fight to understand the system's documentary manual pages. Again, the original manual set was

Illustration: Frazer Hudson @ Monster

intentionally terse and used a 'well known' syntax to describe how commands are controlled. However, novices don't often pick up on this typography at first glance, and will miss, for example, the nuances of the characters in the **NAME** section of the pages. On the plus side, though, it's often forgotten that Unix was probably the first system to supply its documentation online, something which nowadays we have come to expect.

The WIMP interface

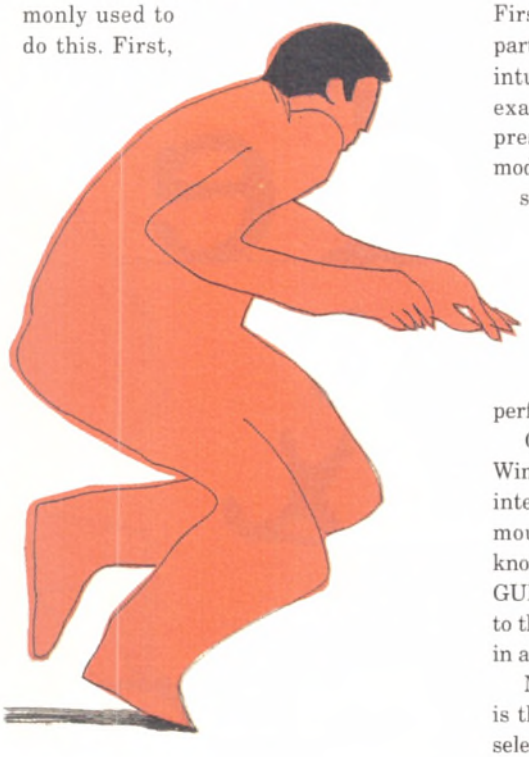
As time has gone on, we've replaced command lines by point and click graphical user interfaces. It's true to say that GUIs have taken some considerable time to become useful on Unix systems: many X Window users still live in a world of text and see the windowing system purely as an improved way to flexibly deal with that text, using the mouse only for selection and copying, and to change the focus. To be sure, this is changing: the Common Desktop Environment will provide for a consistent set of clickable icons and drag-and-drop interfaces.

The GUI that has swept the world is, of course, from Microsoft. Perhaps it's successful for marketing rather than technical reasons, but it has made universal point-and-click a reality. On my NT machine, I find I don't need the keyboard at all for many jobs. As a result, it tends to live on top of the monitor, and I am prepared to reach it to type the odd word here and there.

GUIs have swept away the need to learn command names because they display the total set of commands on the screen as icons or lists of files. You can see the icon representing the command, read the (hopefully) useful text tag that sits beneath it, and start the command running with a click.

This obviously makes it easy to see all the commands available, but it's only really helpful when all the possible commands that you can use are mapped onto the screen. On Windows, you can easily lose commands or fail to discover their existence if they don't appear on the desktop. The help files are generally attached to the commands themselves so it's possible for commands to lurk undetected, making it difficult to expand your knowledge to encompass the complete ability of your system. It's made more inconvenient by the fact that all Windows flavours seem to hide commands in odd places on the file system. What you can't see, you cannot get.

Unlike command line programs, GUI commands tend not to have parameters, although they can launch a dialogue box asking you for any arguments or keep constant arguments as part of their initial environment. Of course, we can implicitly provide file arguments using the paradigm of bringing the data to the command. There are two methods commonly used to do this. First, the system can attach commands to certain file types, so a click on the file opens the relevant program. Second, it could use a drag-and-drop approach, enabling the user to pick an object up from the screen and drop it onto a relevant command icon.



On my NT machine, I find I don't need the keyboard at all for many jobs.

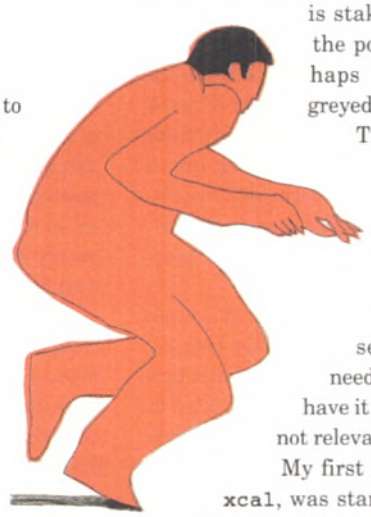
GUI commands are themselves graphically oriented, displaying their features in menus and toolbar buttons and inviting the user to make choices. If you like, they advertise their services, making them very approachable for beginners.

In my opinion, current GUI interfaces (both Windows and X) have two main flaws. First, many applications have concealed parts of the human interface that are non-intuitive and are often unexplained. For example, some programs combine key presses with mouse clicks to change the mode of the action being taken: you click to select a file; hold down shift and click to select a range of files; hold down the control key and click to add to a selection; and so on. Hiding parts of the interface in this way is a bad thing because there is no indication to the user that they can perform these operations.

One of the really good things about the Win32 GUI in Windows 95 and NT 4 is the intelligent use of the right button on the mouse to provide a coherent and 'well known' path into mode setting parts of the GUI. This adds a tangible and visible asset to the whole interface, it cleaned things up in a significant and coherent way.

My second problem with the extant GUIs is that they are not dynamic enough. If I select some action that requires additional input or further selections, then I want to see those options only after I make the original click with the mouse, not hanging around cluttering up the screen whether I need them or not. I'd like to change the appearance of the user's screen in a very dynamic way presenting only the options that are relevant at that moment.

I am grasping at something that I find hard to pin down exactly. Maybe an illustration of what I consider to be a bodge will help. There are several aspects of current GUIs that are actually convenient work-arounds. For example, it's expensive to rearrange all the little boxes on the screen that make up the GUI, so the screen real-estate is staked out showing all the possible options, perhaps with some parts greyed out as unselectable. The display of unselectable parts of the screen is a work-around. What I want to happen is for that option to be presented when it's needed or actionable, and have it not be seen when it's not relevant.



My first large X application, `xcal`, was started with the intention of implementing a very dynamic

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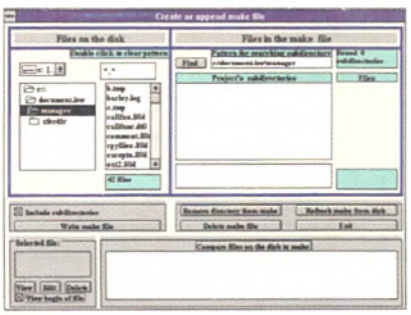

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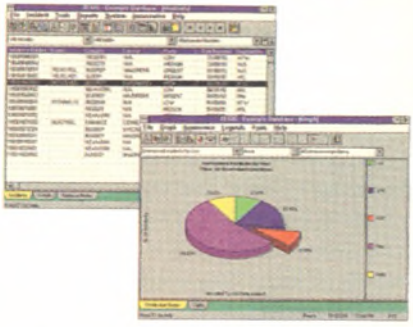

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Canterbury Tour

My Canterbury Tour is available on *http://www.hillside.co.uk/tour*. You can still get `xcal` from *ftp.hillside.co.uk* in the *pub/xcal* directory. Some years ago, I wrote a piece that was intended to make people smile while explaining the terseness of Unix. The article is called *On the design of the Unix operating system* and you can find it on my web server at *http://www.hillside.co.uk/articles/typing.html*.

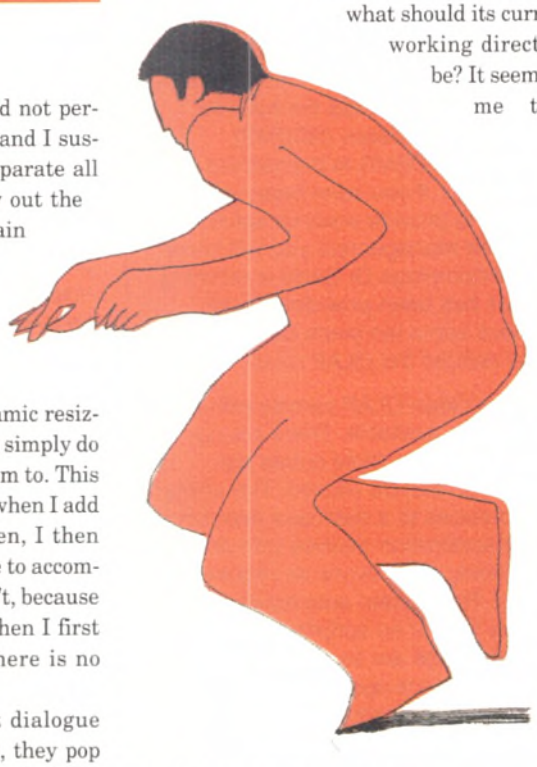
interface, but I found that I could not persuade X to do what I wanted. X (and I suspect Windows) expects you to separate all your code into the parts that lay out the screen and the parts that maintain the image based on the state of the program. The understanding that 'this is the way that people write GUI programs' is embedded deep in the structure of the system. Features like dynamic resizing or adding extra screen objects simply do not work the way I would like them to. This is clearly demonstrated in `xcal`: when I add a text line to a box on the screen, I then would like that box to change size to accommodate the extra text line. It won't, because the screen area is set in stone when I first create the screen object and there is no clean way to make it expand.

Well, you are saying, aren't dialogue boxes dynamic enough? After all, they pop up dynamically and are intended for dynamic responses. Well, they do this to a certain extent, but I find that there are several problems with Windows dialogue boxes. First, they're often modal and refuse to go away for a short time while I use another application to find the data I need. Second, they often don't accept pasted entries – indeed, the whole area of application support for cutting and pasting is a mess. Third, you cannot change the size of dialogue boxes, and this is often a pain. These days many of them contain interior windows to display the file system or files within it. You cannot change the size of this window: all you can do is scroll it. This can make navigating a large or complex file system a trying business.

Directorial control

The biggest problem with GUI based interfaces is how they deal with context of the files on which applications operate. Since files are stored in directory trees, the user has to have some way of dealing with the geography of their system. With a command line interface, the notion of the current working directory provides a consistent method of allowing the user to select the primary location for running commands. All commands are executed in the context of a single directory and every command that is started from the command line will inherit knowledge of that directory, generating and accessing files relative to it.

GUIs, on the other hand, have great problems with file context. When a command is launched from the desktop, what should its current working directory be? It seems to me that this problem has never been tackled too well by any of the click and launch interfaces that I have used, the result being that users spend a high proportion of their time in those fixed size file selector dialogue boxes trying to get to the correct place in the file system.



There are several aspects of current GUIs That are actually convenient work-arounds

In general, if you click on a command icon, then the command will start in its own default home directory. It's usually possible to set which directory, either globally for that particular command, or these days, for each shortcut icon that exists on the desktop. Some applications will pick up the last directory that the user touched with the program. Finally, there's often a default setting, which is the directory where the system found the binary for the program, and this results in lots of unwanted litter in the system directories. Of course, you can click on a file to launch an application, or drag a file onto an application icon. It seems then that Windows hands the problem of file context to the application. It's up to the programmer to decide whether the NEW, OPEN or SAVE AS menu options should use the directory of the source file, the default directory, or the last place that the user touched. Every application deals with this problem using its own rules, disregarding any thought as to interface consistency.

Most applications are set up to work well when you open a file in one directory, work on it and save it again. Complications start to multiply when you are moving files from one directory to another providing some processing with the package but preserving the original file. If you are processing many files, then you will spend a considerable part of your life entering clicks into the file selection dialogue box to choose either the source or destination directory. This becomes tedious and is prone to error.

What's needed is a recognition that file context is a problem, rather than just forcing people to waste their time doing it by hand. I can see various solutions: perhaps each file selection box should have the ability to select from a known history of file contexts; or maybe each application should have the notion of a source and destination file context that can be set for each file that is processed. There needs to be a system-wide decision about this problem so that the solution is mandatory and applied consistently everywhere.

Scaling problems

The biggest fault of GUI systems is that they don't scale: GUI applications are great at doing something to one dataset stored in one file, but hopeless at applying changes to many files.

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but if you want to have a great number of documents with a consistent style, then you have to spend some time getting to grips with the style management tools, and religiously apply the correct style to every appropriate part of every document. There's a chance that you can make changes to the house document style by loading new style settings into Word and applying them to all the documents that you already have. However, this job has to be done manually by a human operator. Ideally, I'd like to automate the necessary edits.

Contrast this to the way that I went about creating the 300 or so pages that comprise my Canterbury Tour that is sitting on the Web waiting for you to visit. Each HTML file contains much the same layout information but different data. At the outset, I created two or three pages using an HTML editor before realising that this was not the way to go. Now, a page in the Canterbury Tour starts life as a description file much like:

```
TITLE: The End of Stour Street
COPYRIGHT: August 1996
LANDSCAPE: d232.jpg
DIRECTION: South-West
NEXT: d234.html
LEFT: d239.html
RIGHT: d238.html
BACK: d233.html
TEXT:
<p> With the St. Mildred's Tannery on
the right,
etc
```

This file is passed into a shell script that turns the keyword lines into a set of M4 macro definitions that are in turn applied to a template file to generate the HTML. The point is that I can change the page style and standard content very simply by editing the template file and automatically regenerating all the HTML files.

It didn't take a lot of time to put the whole system together. The tools I use to create these 300-odd pages are those used in my everyday-life as a Unix user. The program is a 41 line shell script, and is mostly input to the `sed` command that converts the description file to the M4 source file. The point is that the Unix learning curve that I started to climb up some twenty years ago gave me access not only to a set of tools but also to a methodology that can be used to put these tools together to perform new tasks. And, of course, they can be applied to a thousand files as easily as to one.

The biggest fault of GUI systems is that they don't scale.

I don't see this combinatorial paradigm in any of the GUI based tools: the creator of each application has to attempt to foresee all the ways that their program might be used. This is hard. The different people who wrote `sed` and `m4` in the early 80's were writing general purpose tools and didn't need to foresee that I would be using them to generate HTML in the late 90's. There is also a need for proper automation in performing consistent actions to a set of files: this is simply lacking on most GUIs, being replaced by tedious human activity.

Paradise lost

In moving towards GUI based systems, we have certainly made computers more accessible to a wider base of users, but we have also lost sight of several positive features. In fact, we've lost many of the features that made Unix popular in the first place. People don't seem to complain about this, perhaps because their expectations of what the system should do is limited by the 'style of use' pushed hard by current system vendors. It's often said that Unix killed operating system research, a statement that I think is only partially true. What happened was that Unix proved flexible enough for operating system research to move onto it. It's possibly the case that Windows has killed GUI research with an inflexible *fait accompli*. As I said before: what you can't see, you cannot get. ■

Peter Collinson is a freelance consultant specialising in Unix. He can be reached electronically as pc@hillside.co.uk, *by phone on 01227 761824 or on the Web at* http://www.hillside.co.uk.

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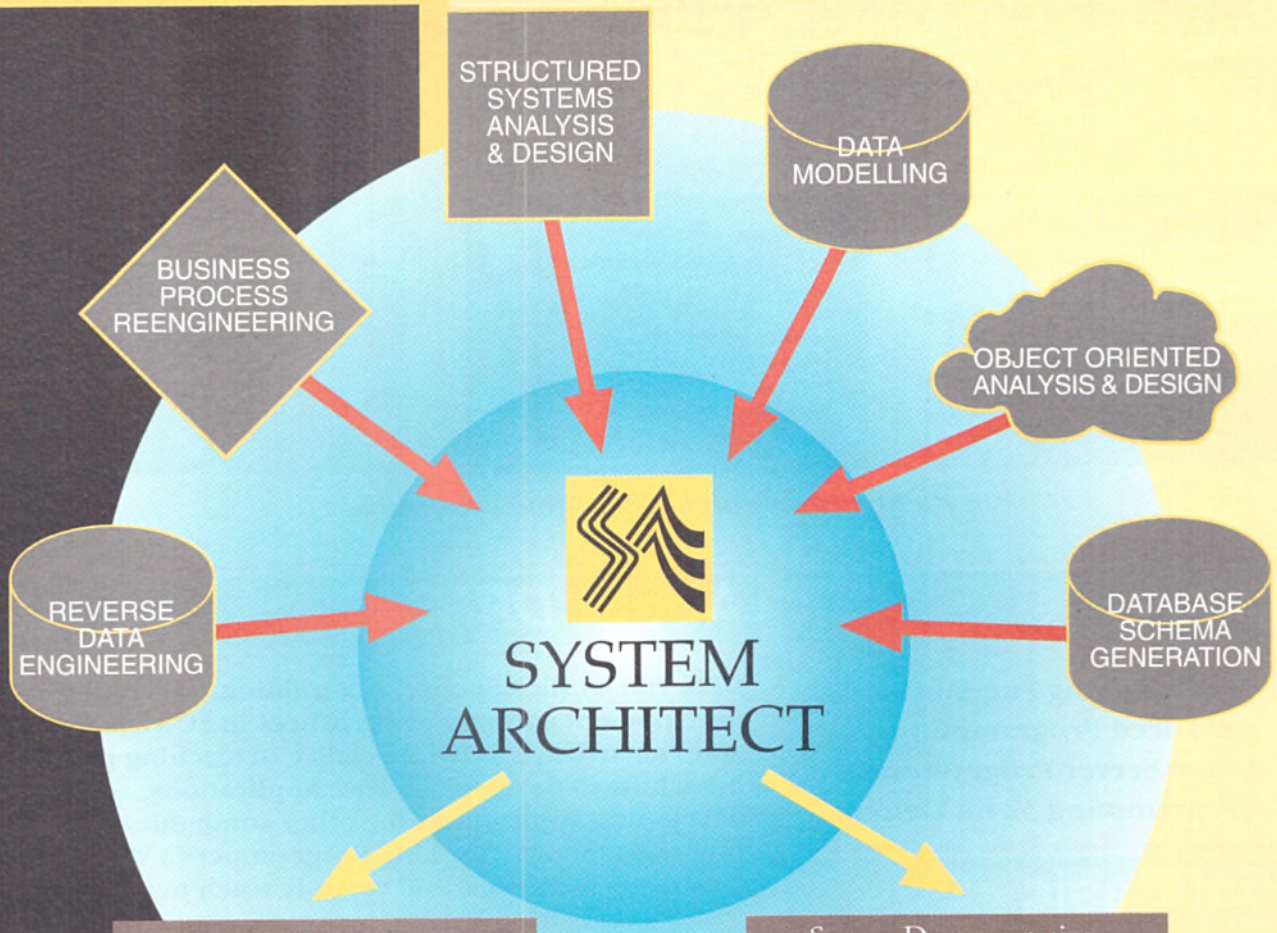

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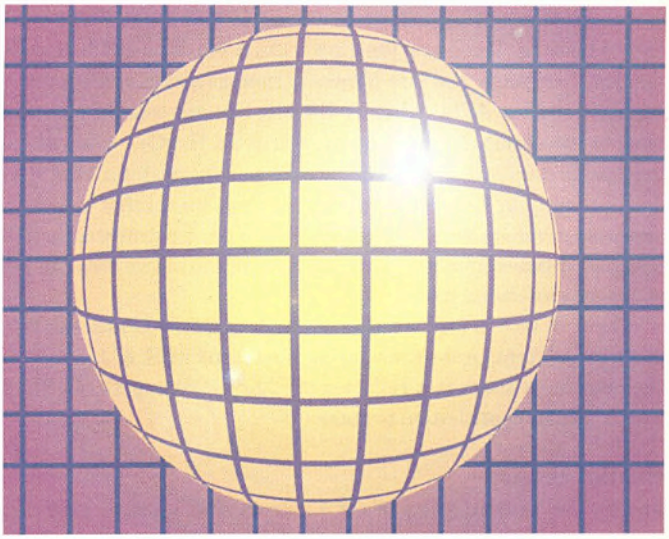

A standard inlining facility for C may seem simple to define, but there are some subtle issues involved, as **Francis Glassborow** explains...

Over the last few weeks there has been an increasing amount of discussion among those involved in developing the next C standard about providing an `inline` facility in C.

The first bone of contention is whether this should involve introducing a new keyword. Despite the opinions of the old school on new keywords, it would seem to make sense for the next version of C to reserve all the C++ keywords. While I recognise that ISO C and ISO C++ are separate languages (though derived from a common ancestor), this is not to say that I am against making it easier to move code between them.

If we do elect to reserve the `inline` keyword in C, we might as well use it. The question is: should C just adopt the C++ convention with all the consequential problems of writing a 'one definition rule', or can it do better without introducing forward compatibility problems?

There are basically two different situations we must consider: file scope function definitions (with internal linkage) and global ones (external linkage).

The first question to ask is whether we need a version of `inline` for file-scope purposes. A compiler can always inline a `static` function since it already has all the information it needs. Any quality compiler (are there any?) should inline functions like:

```
static fn(int i) {return i++;}
```

because it is clearly advantageous both for size and speed reasons. For larger functions, the decision is more complicated, but compilers can still make sensible choices. The fact that most do not treat `static` qualification of a function as a hint to consider inlining is irrelevant: they should.

As no one is suggesting that `inline` should force inlining in all cases, introducing inline qualification for static functions gains nothing. Some argue that it would encourage programmers to use such declarations instead of manually inlining code with preprocessor macros, but this does not stand up to examination. The preprocessor is the only option (apart from writing the code in yourself) if you want code to be inlined in both C and C++. Certainly we should discourage the use of preprocessor macros – they are a source of almost as many problems as leaving out prototypes – but this is really a matter of quality training coupled with quality compilers.

I have no problem with making file-scope `inline` a hint to the compiler to optimise the use of the definition for speed by actually inlining or partially inlining the code. I just do not think that it buys us as much as some experts think.

The issue of global inlining is both more complicated and more worthwhile. As we develop more sophisticated compilers we can anticipate that they will be able to inline functions that reside outside the current file. In such circumstances a prototype such as:

```
extern inline void fn(void);
```

might be made to mean: 'Go and look for the definition of `fn()` and if you find it consider using that definition in its own context to generate inline code for the places it is used'. If the compiler cannot find the definition it will simply ignore the `inline` qualification. This certainly seems to make sense as `inline` becomes a hint to the compiler both to look for the definition and to consider its use if and when it finds it.

As we are still some way from having such compilation tools readily available, we might consider giving meaning to the following:

```
extern inline void fn(void) {
  puts("This is an example");
  return;
}
```

so that the compiler treats this as a prototype for `fn()` with a local copy of the definition code provided for convenience in inlining.

Now what should we do with code such as:

```
static int counter = 0;
static inline int local (){
  return counter++;
}
extern inline int global (){
  return counter++;
}
```

There is no problem with `local()` as there is no reason why it should not bind `counter` to the file-scope `counter` that has been provided. The question is what we should do about `global()`. I think we have two alternatives. The first (which I prefer) is to specify that identifiers used in such cases shall not bind to file-scope identifiers. The other option is to specifically require a diagnostic because such a binding will breach the 'one definition' rule. Even today, any halfway reasonable C++ compiler should issue a diagnostic for such implicit breaches of ODR.

What I hope that no one will find acceptable is adding another instance of undefined behaviour. C should be seeking to reduce undefined behaviour not the opposite.

Java standardisation

The recent London meeting of ISO's SC22 set up a study group to consider standardising Java. There are several issues to consider, the

first being what actually needs standardising. The current consensus is that there are at least three and possibly four areas where work should be done. These are: the Java Virtual Machine and byte code, the Java language, the core libraries (such as string and exception support) and the APIs. Whether the last two are separate items is open to discussion. I hope that we will avoid the C++ route of one monolithic standard. There is much to be said for getting a JVM standard out early so that those that want to implement other languages and tools to run on the JVM or who want to provide translation tools and just-in-time compilers to convert byte code to native code can rely on a single universal model.

The first face to face meeting of the Java Study Group will take place in California some time during the second week of January. In the meantime there is a reflector (SC22JSG@dkuug.dk) for those with a serious contribution to make.

Books & CDs

Among the vast quantity of C/C++ dross that clutters bookshop shelves you will sometimes find a book that is informative. Unfortunately, most experts write in a style that makes reading hard work. This makes the rare exception something worth shouting about. *Ruminations on C++* (0-201-42339-1, £21-95) by Andrew Koenig and Barbara Moo is one such book. Andrew's earlier book, *C Traps and Pitfalls,* is still one of those books that are well worth reading but over the years he and his co-author have honed their writing skills while contributing articles to *JOOP* and *C++ Report*. This book is the result, and while the contents have all been published elsewhere as articles they have undergone substantial revision. The technical content has been updated where relevant, but more to the point the writing has benefited from that extra look. This is definitely one of those books that every C++ programmer should read.

In a more specialist vein, those interested in parallel programming will find the collection of papers in *Parallel Programming Using C++* (edited by Gregory Wilson and Paul Lu, 0-262-73118-5, £34-95) worth reading. It is a broad survey of the current work using libraries and augmented C++ compilers to support the various models of parallel processing. The editors have done a good job of getting the large number of contributors to write intelligibly.

Two more CDs arrived on my desk this month. This time they come from Miller Freeman who acquired RD Publications last year and thereby became the publishers of *C/C++ Users Journal* and *Windows Developers Journal*. CUJ started out as the newsletter of the C Users Group (a US based group) and then grew into a commercial publication. Its contributors are expert C/C++ practitioners. If you do not already know about it the CD with six year's issues (January 1990 - December 1995) will make an excellent introduction.

WDJ targets Windows developers across the whole range of languages and tools that are appropriate. The CD covers all issues from the first (December 1991) up to December 1995.

Both these CDs are excellent value at £39-95. They can be obtained in Europe from Parkway Gordon (01491 875386 or email: parkway@rmplc.co.uk).

Last month's problem

The problem was to find all of the errors in the following code, assuming that all necessary headers have been included.

The first, and very serious error, is that the type of `buffer` is different in each file. In `file1.c` its type is array of `SIZE chars`. In `file2.c` it is pointer to `char`. Because of the way so many books present the use of arrays, some programmers believe that the type in `file1.c` is pointer to `char`. While it is true that for most uses it decays to such a type, that is not its underlying type.

```
File1.c:
char buffer[size]; //SIZE provided in an includer header file
/* other C code */
File2.c:
extern char * buffer;
void capitals(){
   int i;
   for(i=0; i<SIZE; i++)
     if(buffer[i]>='a' & buffer[i]<='z')
          buffer[i] -= 32;
   return;
}
```

Consider how your compiler will generate code for `buffer[0]` in each file. In `file1.c` it simply uses the address provided by the linker/loader as the address of a `char`. In file2.c, the code will attempt to use another level of indirection, and use the address provided by the linker/loader as the source of a pointer to `char`. Unless we have assigned new values to the elements of the array this address will consist of the zero bit patterns in sufficient successive (probably two or four) elements of the array. This zero bit pattern may or may not correspond to the null pointer – there is no requirement I am aware of that this should be the case. This leads to a whole nest of arcane speculations that are of no practical value to the working programmer.

Though it has not been stated, there is a clear implication that the function `capitals` defined in `file2.c` is intended to convert the string in `buffer` to upper-case. Some programmers are so conditioned by having English as their mother tongue that they completely forget that even when using extended ASCII the conversion by subtracting 32 from the value for a lower-case letter does not work for any language using accented letters. The function should read:

```
void capitals(){
   int i;
   for(i=0; i<SIZE; i++)
          buffer[i] = toupper(buffer[i]);
   return;
}
```

Now our code is independent of the character coding and *locale* may look after some of the other problems. Unfortunately even in English we use accented letters where we are using foreign words so the function may still fail to do all that might have been intended. In the real world case conversions are considerably more complicated than many realise.

This month's problem

We all, I hope, know that there is a difference between `char` and `signed char`. However, what is the difference between `int` and `signed int`? Just about every C programmer thinks they are the same but there is one place where they are not. Do you know what it is?

ACCU Conference 1997

The Friday (July 18th) is beginning to look interesting with seminars from such experts as Neil Martin on software quality assurance, Richard Jones on garbage collection, one of Rational Rose's formidable team on UML. That is just a few of the top class line-up of seminars to complement the main speakers on the Saturday (Bjarne Stroustrup, Tom Plum, Dan Saks, P J Plauger and probably Andrew Koenig). I hope you have the dates in your diary. ■

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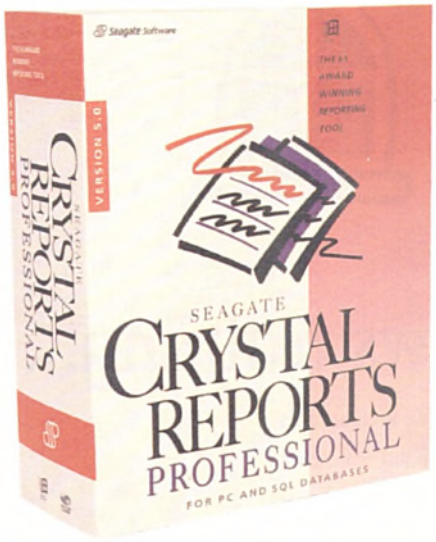

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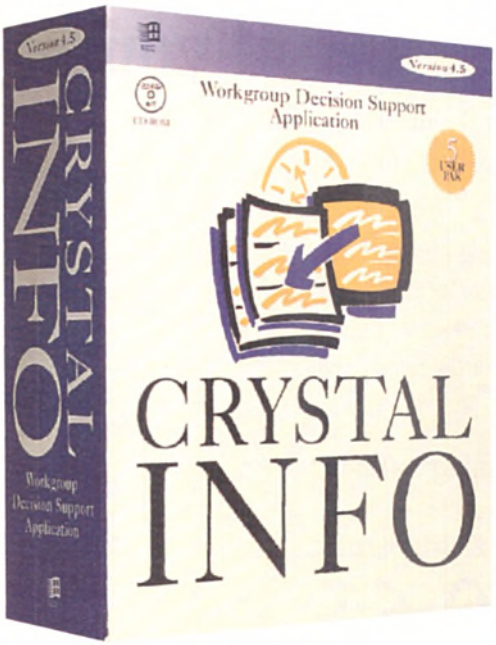

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CIRCLE NO. 969

Christmas Quiz

It has been a long tradition at *EXE* – ie since last year – to run a Christmas quiz. Here's the 1996 edition...

Questions

A This year's events

A1 What is the name of the father of Turbo Pascal who left Borland for Microsoft after 13 years? (Brownie points if you get the spelling correct).

A2 Microsoft rationalised its software tools range recently. Which product did it sell to which company (pun intended)?

A3 Which J used to be an Indonesian city?

A4 Which J had too much milk in it?

A5 What fate has befallen the inventor of Tetris?

B 1996 Birthdays

B1 Which storage peripheral celebrated its 40th birthday this year?

B2 Which major feature of Algol was invented 35 years ago?

B3 Which electronic design celebrated its 25th birthday?

B4 Which microcomputer company celebrated its 20th birthday?

B5 Which PC operating system celebrated its 15th birthday?

B6 Which world class programming journal celebrated its 10th birthday? (Clue: not Dr Dobbs).

C Languages

C1 What is the origin of LISP's `car` and `cdr` instructions?

C2 How can you exchange two variables in LISP without using a third one?

C3 How can you exchange two variables in C without using a third one?

C4 How can you exchange two variables in Forth without using a third one?

C5 What does the following program do:

```
char*f="char*f=%c%s%c;main()
{printf(f,34,f,34,10);}%c";
main(){printf(f,34,f,34,10);}?
```

D Internet and Web

D1 What is the maximum size of the data area of a legal ICMP ECHO Ping request (according to RFC-792)? Why is this significant?

D2 Which RFC states that 'Users, service providers, and hardware and software vendors are responsible for co-operating to provide security'?

D3 List five trusted TCP ports.

D4 What is the HTML tag used to force a remote server to push a page on a client?

D5 Name five HTML tags which are singletons, ie have no paired end tag.

E Acronyms and codenames

E1 What does Java stands for?

E2 What does GIGO stands for?

E3 What was the original name for C++?

E4 What was the original codename for Java?

E5 Why was the work on Apple's OS contributed to Taligent called Pink?

E Acronyms and codenames

E1 Nothing according to Sun. Some say it's Just Another Vague Acronym.

E2 Garbage In, Garbage Out.

E3 Bjarne Stroustrup initially called C++, 'C with Classes'.

E4 Oak because it was initially intended for (TV) set-top boxes.

E5 At the end of the 1980s, when Apple asked its programmers which features should be added, the ones that could be added to MacOS were written on blue strips of paper and new features were written on pink ones. (see Guardian online at Apple Expo 31/10/1996).

E6 Microsoft (Tripoli, Denali, Daytona, Nashville, Cairo…)

E7 IBM (Borg, Klingon, Warp, Eagle, Merlin…)

F Famous quotes

F1 Bill Gates at Comdex.

F2 Bjarne Stroustrup in The Design and Evolution of C++.

F3 Dennis Ritchie in his interview published in EXE in February 1991.

F4 Anders Hejlsberg in his interview published in EXE in June 1995.

F5 Richard Stallman in his interview published in EXE in October 1996.

F6 Bjarne Stroustrup in his interview published in EXE in March 1992.

G Books

G1 A book on the Model View Controller paradigm.

G2 Sorting and Searching (The Art of Computer Programming volume 3).

E6 Which company uses city names as codenames for its products?

E7 Which company changed its inspiration from Star Trek to birds for codenames?

F Famous quotes

F1 Who said 'We believe OS/2 is the platform for the 90s'?

F2 Who said 'Within C++, there is a much smaller and cleaner language struggling to get out'?

F3 Who said 'He decided we couldn't have a serious system without FORTRAN, so he sat down to write a FORTRAN compiler using TMG'?

F4 Who said 'I sometimes hear frustrated users comment: "The programmers that wrote this %&##$ thing should be forced to use it themselves!". Well we did, and we're proud of the result'?

F5 Who said 'I would either write free software or do no software at all'?

F6 Who said 'I also hope that journalists won't declare C++ dead because people will – as they should – write better C in the beginning'?

G Books

G1 Which forthcoming book by Adele Goldberg was announced several years ago and still has not been published?

G2 What is next in the following sequence: Compilers, The Theory of Languages, Syntactical Algorithms, Combinatorial Algorithms…

Answers

A This year's events

A1 Anders Hejlsberg. He was also the chief architect of Delphi.

A2 Microsoft sold Visual Test to Rational Software.

A3 Microsoft Visual J++ was codenamed Jakarta.

A4 Borland's Open JBuilder was codenamed Latté.

A5 Alexei Pajitnov, its inventor, joined Microsoft.

B Birthdays

B1 The hard disk. IBM introduced the first computer disk storage system: the 305 RAMAC (Random Access Method of Accounting and Control). It had a whopping 5 MB on 50 disks of 24 inches!

B2 Thunks were invented in 1961 by P. Z. Ingerman.

B3 Microprocessors (Intel's 4004 dates back from 1971). 1971 also saw the second Forth programmer, Elizabeth Rather, joining its inventor Charles H Moore. And, in November the trademe 'Microsoft' was registered.

B4 Apple Computer was founded after first showing the Apple I at the Homebrew Computer Club. The same year, Bob Metcalfe invented Ethernet at Xerox PARC to be featured a few years later in the Alto which came completed with a Smalltalk system and a mouse.

B5 In April 1981, Seattle Computer Products released 86-DOS version 1.00 (later to be bought by Microsoft and renamed MS-DOS).

B6 *EXE*.

C Languages

C1 It comes from the IBM 7004 instruction used to implement the list operations, `car` meant 'Content of Address part of Register' and `cdr` meant 'Content of Decrement part of Register'. By the way, the LISP language was created in 1958 by Jim McCarthy.

C2 `(SETQ X (PROG2 0 Y (SETQ Y X)))`.

C3 `X ^= Y; Y ^= X; X ^= Y;`.

C4 You might consider using the `swap` operation.

C5 It outputs a copy of its own text! This program comes from the 'quine' entry in the Jargon file version 4.0.0, 24 Jul '96.

D Internet and Web

D1 The maximum allowable size of the data area is 65535 - 20 - 8 = 65507 bytes (max packet length - header - ICMP information). Its significance is that sending a larger packet (easy from Windows 95 or NT) will just break many OSs!

D2 RFC 1281: Guidelines for the Secure Operation of the Internet.

D3 SYSTAT (11), NETSTAT (15), CHARGEN (19), FTP data (20), FTP control (21), TELNET (23), SMTP (25) and FINGER (79).

D4 It's a meta tag: `<META HTTP-EQUIV=REFRESH CONTENT=2;URL=http://page.html>`

D5 `<FRAME...>, <HR>, <BR>, <META...>, <ISINDEX>, <BASE...>`...

E Acronyms and codenames

E1 Nothing according to Sun. Some say it's Just Another Vague Acronym.

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E6 Microsoft (Tripoli, Denali, Daytona, Nashville, Cairo…)

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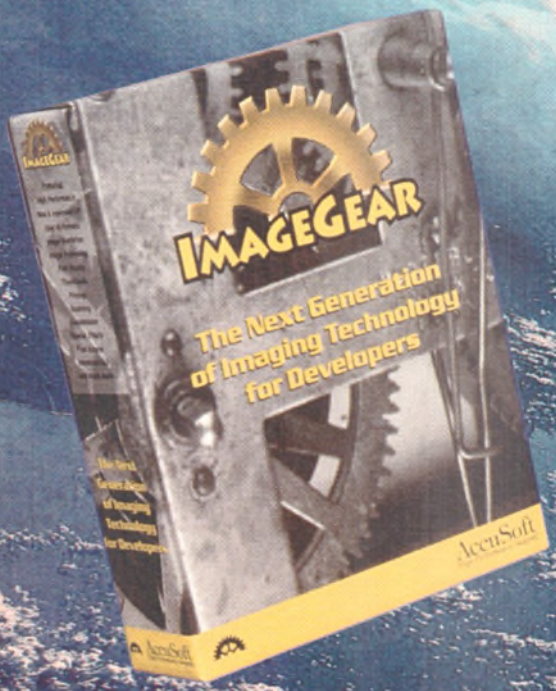

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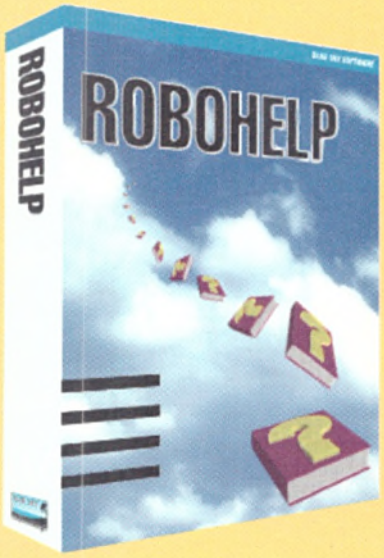

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Client/server development is one of those things that seems easy to pin down, but amidst the mass of terminology, true enlightenment can be difficult to attain. **Jon Perkins** explains the Visual Basic way...

Three-tier architecture

Traditional client/server development is a two-tiered affair: client applications directly interact with data sources and make all the decisions about how the data should be manipulated. This approach has several drawbacks, the most significant being that an entire data set often needs to be pulled across the network to the client machine (which in many cases will be low spec), only to be discarded once a result has been derived. Under these circumstances, result sets can get paged out to disk, making the application's performance suffer. Another unfortunate by-product of this architecture is that all the application code is very specific to the task for which it was written. If a similar application is required, the same logic must be recreated, either from scratch or by copying code from previous applications and editing it as appropriate. Worse still, any general changes which need to be made to the code (eg to reflect a change in the database structure) now need to be made (and tested) twice.

The three-tier model

In Visual Basic 4, Microsoft introduced its first implementation of a *three-tier* architectural model, in which the client/server system is broken down into three separate components, specifically *data services*, *business services*, and *user services*. Although in reality the implementation of a three-tier system can vary architecturally, the tiers split functions as follows:

The *data services* component is the actual source of the data, and may include such low-level items as stored procedures (typically the means for manipulating data at the 'physical' level) and triggers (used to ensure the referential integrity of the database is preserved). In short, this tier is solely concerned with the mechanics of data access.

Business services is a layer that acts as a wrapper for the physical database. It is the component which actually orders data manipulation and processing, validating its actions against business rules. For example, in a stock control system we might want a user to be prevented from reordering a specific item until a certain minimum stock level is reached. We could achieve this by calling a 'reorder' method as normal, but making it return an error instead of initiating the action.

The *user services* layer is typically the program run by the end user. This layer is also known as the 'presentation layer' (because that's all it should do). This component interfaces only to the business services layer and all of its requests for data are satisfied from that level. The user services component never communicates directly with the data services component.

This approach to client/server design is known as *services model*. The philosophy behind it is that the implementation of each layer is independent from the other two layers as long as the interfaces that exist are clearly and rigidly defined up front. In VB4 terminology, such a definition is known as a *contract*.

Visual Basic implements the three-tier architecture by way of its automation facilities (previously called OLE Automation) which enable separate object components,

Figure 1 – Generic object hierarchy.

known as *automation objects* to communicate with each other, independent of whether they exist on the same machine or not.

Crafting the server

With the above definition of a three-tier model, the term 'server' can be a little ambiguous. To clarify this point, here I am referring to the business services component.

To design a server component for VB, it is necessary to map the requirements of the application to a set of abstract business objects, which can then be mapped to software objects, and a logical hierarchy built for their access. Figure 1 shows an example of the current best practice design for such a hierarchy. It contains a top-level interface object called `Application`, which encapsulates the entire object set of the server application. In this case the single object `Customers`, which is itself a collection of individual `Customer` objects.

One of the design goals for a business services component should be reuse. Therefore when grouping together areas of functionality, you have to decide whether some areas are so dissimilar from each other as to warrant placing them within separate server applications. Identifying granularity of this kind is good practice because it lends itself towards greater reuse within the organisation as a whole. The Component Manager application within the VB4 Enterprise can assist in this process, and tools such as the BackOffice Systems Management Server (or SMS) can ensure that reused objects are kept up to date throughout the whole enterprise.

The object model that we're putting together for our server consists of three classes. The first is the server `Application` object mentioned above. It is the only object that can be accessed directly from client applications – all other objects must be accessed via its methods. It is thus the only object that we allow external programs to create instances of, by setting its Instancing property (in the properties dialog for the class module) to either `Creatable SingleUse` or `Creatable MultiUse` (see sidebar).

To expose our other business objects (`Customers` and `Customer`) to client programs, we must declare them as Public, but set their instancing properties to `Not Creatable`. Thus, our `Application` class can expose an instance of the `Customers` class in the declarations section as follows (note that I have deliberately avoided adopting any naming conventions for readability):

```
Public Customers As New Customers
```

Strictly speaking, no more code is required for the `Application` class. However, you may like to make available other methods or properties such as the version number of the server. It's also worth mentioning that the use of the name `Application` for the top-level class might not always be suitable (depending on the scope of the server).

In our example, the `Customers` class is designed to mimic (where appropriate) the behaviour of VB's predefined `Collection` class, which stores other objects and provides certain methods and properties for accessing them. Simplified code for the `Customers` class is shown in Listing 1.

The `Customer` class is little more than a data container which either receives or returns data by using the new VB `Let/Get` property statements. The code for this class is shown in Listing 2. Note that the actual data members are declared as `Private`. This is where the strength of the class model can be found: modifications to the data can be validated and refined, or rejected if necessary, before they are applied. It is simple to use these features to implement business-oriented validation checks, since the 'real' data is hidden.

Running the server

Having gone this far in a real project, we need to make a few changes in order to get it to run as a server. When a new VB project is created, a blank `Form1` is always created with it. This can probably be deleted, since the server is unlikely to need to interact with a local user. For OLE servers, it is more usual to set the application start point as `Sub Main`, rather than having a startup form. In our example, no actual initialisation code is required (although `Sub Main` still has to exist), but in real life this is the natural place for code that does things like loading registry entries (for example, to determine the location of the central error repository).

The application start point is set in the Project page of the Tools Options dialog. This dialog also contains a few other settings of note:

Project Name: This string is used to identify (within the registry) the classes defined as `Public`. It is used as the Type Library name, and is the string associated with the globally unique id (GUID).

Application Description: This is the text that will be displayed in the Tools References dialog to identify the server.

Start Mode: The normal behaviour for an OLE server is to terminate itself if there are no references to it. Setting the start mode to OLE Server overrides this and keeps the server open. This is necessary because the entries in the registry for applications that are running from the development environment only exist while the server is actually in run mode. If the server were to start up and then immediately close down again because there were no references to it then the client application would not find the server's entries in the registry and thus would not be able to connect to it.

Once these are set, it is just a matter of selecting the Run command and, correct syntax permitting, the server should be running.

SingleUse vs. MultiUse

If a server is declared as `Creatable MultiUse` then only one instance of it is ever created on the host machine, with the result that each client process will access the same instance of the server. Each client will get a fresh instance of the classes contained within the server, but any globally defined variables within the server will be shared. Since Visual Basic does not yet support the development of multi-threaded components, calls from different clients will be serialised, significantly affecting performance.

On the other hand, the `Creatable SingleUse` option will create a fresh process for each client process connecting to the `Application` interface. This overcomes the serialisation issue, but does of course mean that there will be a significantly greater use of system resources.

Communication between layers

Any software component built by Visual Basic which uses automation will automati-

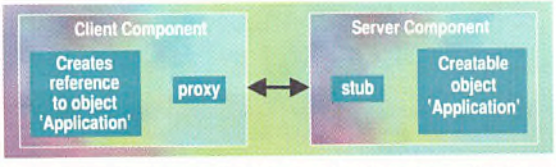

Figure 2 – Proxy/stub communication on a single machine.

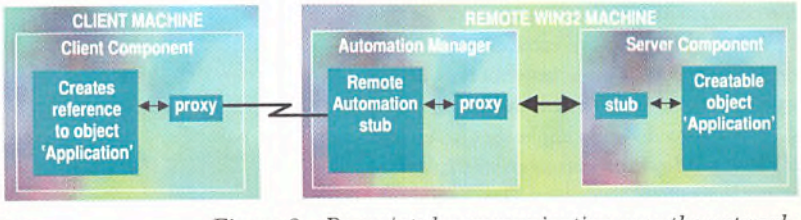

Figure 3 – Proxy/stub communication over the network.

```
'custmers.cls
Option Explicit
Private coll_Customers As New Collection

Public Sub Add(str_FirstName As String, str_Surname As String, _
str_Address1 As String, str_Address2 As String, str_PostCode As String)
  ' Create a new Customer object
  Dim obj_New As New Customer
  ' Populate the new object with data
  With obj_New
    .FirstName = str_FirstName
    .Surname = str_Surname
    .Address1 = str_Address1
    .Address2 = str_Address2
    .Postcode = str_PostCode
    ' Now add this object to the coll_Customers collection
    coll_Customers.Add Item:=obj_New, Key:=str_Surname
  End With
End Sub

Public Property Get Item(var_Key As Variant) As Customer
  'Returns a specific Customer object
  Set Item = coll_Customers.Item(var_Key)
End Property

Public Sub Remove(var_Key As Variant) ' Remove object from the collection
  coll_Customers.Remove var_Key
End Sub

Public Property Get Count() As Integer 'Return the Count property
  Count = coll_Customers.Count
End Property
```

Listing 1 – Simple Customers code listing.

cally include an additional software component, either a *proxy* or a *stub* (although it could conceivably contain both). Proxies are associated with clients, and stubs with servers (see Figure 2). These agents take care of marshalling parameter data to and from the process address spaces, and co-ordinate communications between the automation objects via the remote procedure call service.

If the client and server processes reside on different machines then an additional program (the automation manager) needs to be running on the server's machine. It handles the additional processing necessary to ferry RPC calls across the network (see Figure 3).

Note: this VB-specific networked RPC mechanism may not be around forever: it would seem likely that version 5 will sport a DCOM-based implementation.

Error handling

Visual Basic, by nature, ideally needs an error handler to be installed in each `Sub` or `Function` that contains code. This may appear to increase the coding workload, but this process can be helped by using tools such as TMS's AutoCoder for generating configurable code templates with standard error handling for each `Sub`/`Function`.

For the server application it is unlikely that you would ever wish to report an error simply by popping up a message box – the fault might not be noticed until a user complains that the application is not responding. Therefore, the error handler should either deal with the error locally (if it can) or use the `Err.Raise` syntax to pass the error up to the next item in the call chain, which is probably the calling application. If it isn't, then each layer should fail gracefully and pass the error back up the chain until the top layer is reached.

It is not possible to predict every error that can occur, so allowance must be made for this by defining some sort of catch-all error code. Because a catch-all error trap can only return a general error value back to the calling procedure, it is a good idea to implement some form of server-side error manager which writes errors to a central repository. The client application can then report to the user that an unforeseen error occurred in the server and that the helpline should investigate it. This process can be of most use if you allow the client application to report a serial number which relates to the primary id of the error record. For database applications, it is better to implement this central repository as a separate database or even a flat file, since the error might have been a problem reported by the data services component (eg a communication link failure). In general error handling should never be reliant on other components.

The client application

The client application is the representation of the user services component – the presentation layer interacting with the business services component and displaying results to the end user for viewing or manipulation. To interact with the server, the client needs to obtain a reference to the `Application` class.

References can be obtained via the `Set...As New <class>` statement. Eg:

```
Dim myServer As CustomerServer.Application
Set myServer = New CustomerServer.Application
```

And then used like this:

```
Debug.Print "Connected to _
   CustomerServer.Application version " _
   & myServer.VersionNumber
```

After some usage, the reference is then deallocated:

```
Set myServer = Nothing
```

The client application needs to know where the `CustomerServer` object exists. To tell it, open the Tools References dialog and select the object entry which corresponds to the application description that you gave to the server. It can be worth using the priority button to raise your server's entry to near the top of the list. This will alter the order which VB uses for looking up server names – if there are any conflicts, the server which is highest in the list will get the connection.

The customer server illustrates some key points of client/server programming, but is limited by its lack of support for persistent data. It is possible to modify the existing `Customers` class without changing any of the interfaces, and replacement code for the relevant methods is shown in Listing 3. These listings are somewhat simplified and contain no error handling – the sample code on the *EXE OnLine* site (*ftp://ftp.exe.co.uk/pub/exestuff/vbcs*) is more comprehensive. Note that the code uses stored procedures on the database, I could have used pure RDO calls which would have made for easier coding. The reason I used this approach is to illustrate processing being performed at the data services layer.

Navigating the dots

While the remote automation architecture offers a tidy way to developing three-tier applications, performance can be a problem if there is repetitive accessing of interfaces (eg using the `Object.Property` syntax). If our example contained 50 records then it would be a reasonable assumption that to access all of them, the new `For...Each...Next` language construct would be the correct course of action. This could be coded as:

```
Dim myCust As Customer
For Each myCust in myCustomers _
  myListBox.AddItem myCust.FirstName _
  & " " & myCust.Surname
Next
```

```
' custmer.cls

Option Explicit
Private mlng_ID As Long
Private mstr_FirstName As String
Private mstr_Surname As String
Private mstr_Address1 As String
Private mstr_Address2 As String
Private mstr_Postcode As String

Public Property Get ID() As Long
  ID = mlng_ID
End Property

Public Property Let ID(lng_NewValue As Long)
  mlng_ID = lng_NewValue
End Property

Public Property Get Surname() As String
  Surname = mstr_Surname
End Property

Public Property Let Surname(str_NewValue As String)
  mstr_Surname = str_NewValue
End Property

' ... Get & Let for FirstName, Address1, Address2 and
'  Postcode are coded in a similar way as for Surname
```

Listing 2 – Simple Customer code listing.

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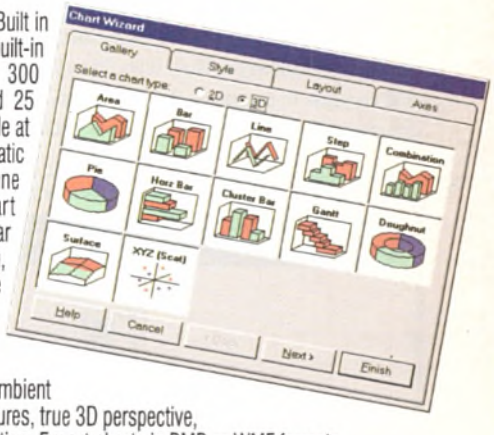

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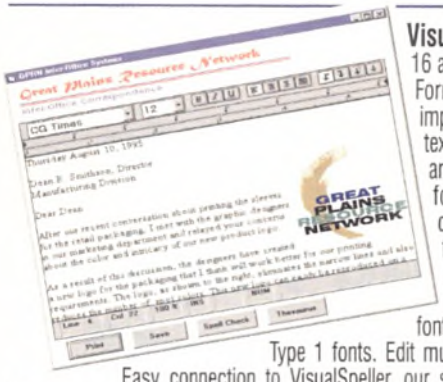

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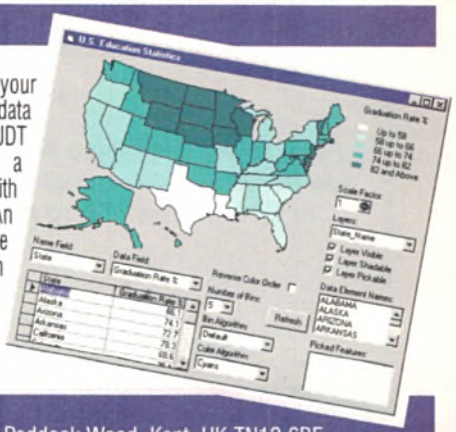

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CIRCLE NO. 975

```
' Custmers.cls
Public Sub Add(str_FirstName As String, str_Surname As String, _
str_Address1 As String, str_Address2 As String, str_PostCode As String)
  ' Adds a new record to the database
  Dim obj_New As New Customer  ' Create a new CCustomer object
  Dim str_sql As String
  ' Send the data down to SQL Server
  str_sql = "execute sp_InsCustomer '" & str_FirstName & "', '"
  str_sql = str_sql str_Surname & "', '" & str_Address1 & "', '"
  str_sql = str_sql & str_Address2"', '" & str_PostCode & "'"
  Dim rdo_ps As rdoPreparedStatement ' Prepare the SQL string
  Set rdo_ps = grdo_Conn.CreatePreparedStatement("", str_sql)
  rdo_ps.Execute    ' Run it
  Set rdo_ps = Nothing    ' Dereference object
  ' Rebuild the object hierarchy. Must be done as a fresh read because
  ' the new CustomerId value is allocated automatically by SQL Server
  SetupCollection
End Sub

Public Sub Remove(var_Key As Variant) ' Deletes a record
  Dim rdo_ps As rdoPreparedStatement
  Dim str_sql As String
  Set rdo_ps = grdo_Conn.CreatePreparedStatement("", _
    "execute sp_DelCustomer " & Trim(CStr(var_Key)))
  rdo_ps.Execute
  Set rdo_ps = Nothing
  ' If the error handler has not yet triggered then it is safe to go
  ' ahead and remove the record from the local collection object
  coll_Customers.Remove CStr(var_Key)
End Sub

Private Sub SetupCollection()
  ' Reads all records from the database, writes each record to a new
  ' Customer object and then adds this object to coll_Customers
  Dim lng_DelCount As Long
  Dim rdo_ps As rdoPreparedStatement
  Dim rdo_rs As rdoResultset
  For lng_DelCount = 1 To coll_Customers.Count  'Empty the collection
    coll_Customers.Remove 1
  Next lng_DelCount
  ' Execute the stored procedure which gets all of the customer records
  Set rdo_ps = grdo_Conn.CreatePreparedStatement("", _
    "{call sp_GetAllCustomers}")
  Set rdo_rs = rdo_ps.OpenResultset(rdOpenKeyset)  ' Open the record set
  While Not rdo_rs.EOF  ' For each record in the result set...
    Dim obj_Local As New Customer  ' Create a new Customer object
     With obj_Local ' Add each field of the current record to the new obj.
      .ID = CLng(rdo_rs(SQL_CUSTOMER_ID))
      .FirstName = rdo_rs(SQL_CUSTOMER_FIRSTNAME)
      .Surname = rdo_rs(SQL_CUSTOMER_SURNAME)
      .Address1 = rdo_rs(SQL_CUSTOMER_ADDRESS1)
      .Address2 = rdo_rs(SQL_CUSTOMER_ADDRESS2)
      .Postcode = rdo_rs(SQL_CUSTOMER_POSTCODE)
    End With
    coll_Customers.Add Item:=obj_Local,_  ' Add the new (populated) obj.
      Key:=CStr(rdo_rs(SQL_CUSTOMER_ID))  ' to the coll_Customers coll.
    Set obj_Local = Nothing  ' Release our reference to the local object
    rdo_rs.MoveNext          ' Move to the next record in the result set
  Wend  ' And loop around again...
  Set rdo_rs = Nothing  ' Dereference the connections
  Set rdo_ps = Nothing
End Sub

Public Sub Update()
  ' Updates the database with the modified values
  Dim rdo_ps As rdoPreparedStatement
  Dim str_sql As String
  ' Build up a SQL-style string using the sp_UpdCustomer stored procedure
  str_sql = "execute sp_UpdCustomer " & CStr(mlng_ID) & ", '"
  str_sql = str_sql & mstr_FirstName & "', '" & mstr_Surname & "', '"
  str_sql = str_sql & mstr_Address1 & "', '" & mstr_Address2 & "', '"
  str_sql = str_sql & mstr_Postcode & "'"
  ' Set up the SQL statement for processing via rdo
  Set rdo_ps = grdo_Conn.CreatePreparedStatement("", str_sql)
  rdo_ps.Execute  ' Run the SQL command
  Set rdo_ps = Nothing  ' Release the rdo interface
End Sub
```

Listing 3 – Replacement code to add database support.

In fact, if this code were run as a client talking to a remote server then it could take several seconds to complete the execution. Now imagine a form which had several such list boxes. The user would have time to go and get a coffee while it worked. Why is it so slow? The reason is the overhead for the preparation of every RPC transaction between the proxy and the stub. Single events go unnoticed but when this is magnified by a factor of 50 (in this case) then the effect becomes more pronounced. Rumours

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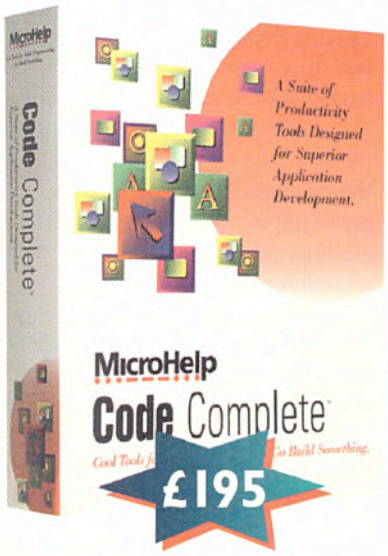

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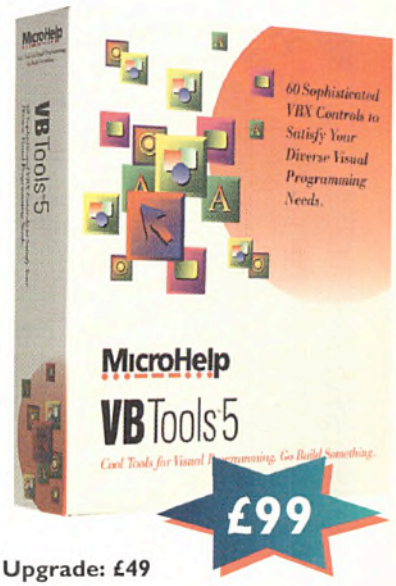

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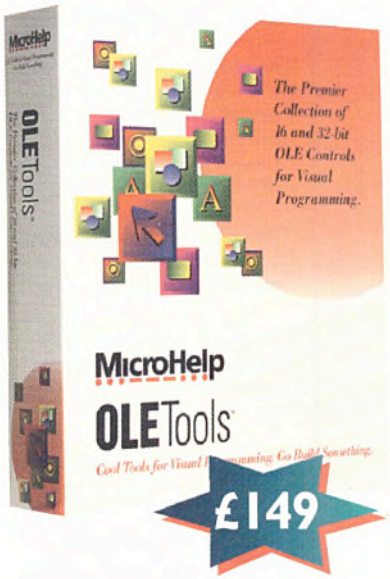

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suggest that Microsoft has reduced the overhead substantially.

One way to overcome this problem is to build generic array-passing mechanisms into the server. The client and server can then use a single RPC call to deal with many pieces of data at a time. A simple example of this array handling technique is shown in Listing 4. It could of course be extended to accept a variable number of parameters (using the `ParamArray` syntax) to define specific fields to return. It would also be possible to include range parameters to restrict the amount of data being sent back into manageable subsets.

Other performance issues

There is a certain amount of tuning which can be performed in order to optimise the three-tier configuration. The choice of data access model depends upon the scope of the system. If everything is intended to reside on a single machine and the database resides locally (eg an Access database), then DAO is the ideal choice. For server-based data services (eg SQL Server), RDO is the more obvious choice since it is designed to support the object model, although for the really brave the ODBC API is slightly faster and gives a greater degree of control over what you are doing. Beware, though: you can get into difficulty more easily (and more substantially). The other Microsoft data access mechanism, the VBSQL.OCX control, has apparently had its day and is no longer being developed.

The amount of processing required of the server component and the actual performance of the CPU should be weighed against the throughput capability of the network infrastructure. It may be beneficial to either have the business objects on an entirely separate machine from the database server, or to have them reside on the same machine. It may also be beneficial to use either `Creatable SingleUse` or `Creatable MultiUse`, as explained in the sidebar.

Finally, it is worth considering a pool manager application to reduce the object initialisation overhead. For example, if an object is declared as `Creatable SingleUse` and needs to initialise itself with data from the data services layer, then a new connection by a client could display a noticeable delay while the new object starts itself up. A pool manager is designed to maintain several extra running objects, and thereby overcome the delay. Visual Basic provides a sample pool manager as a springboard.

```
>>Client process (relevant lines):
  Dim myArray() As String    'Declare the array
  ReDim myArray(myCustomers.Count, 5)  'Size it
  myCustomers.ItemList myArray  '..and populate it

>>Server process:
Public Sub ItemList(ByRef arr_Data() As String)
  Dim int_CurrentRow As Integer
  Dim myCust As Customer
  int_CurrentRow = 0
'For each object add each field to the array
For Each myCust In coll_Customers
    arr_Data(int_CurrentRow, 0) = myCust.FirstName
    arr_Data(int_CurrentRow, 1) = myCust.Surname
    arr_Data(int_CurrentRow, 2) = myCust.Address1
    arr_Data(int_CurrentRow, 3) = myCust.Address2
    arr_Data(int_CurrentRow, 4) = myCust.Postcode
    int_CurrentRow = int_CurrentRow + 1
  Next myCust
End Sub
```

Listing 4 – Data array passing method.

Raw performance increases are likely to be one of the features of the forthcoming VB 5. The fact that VB has substantial competition in the form of Delphi should have given the folks from Redmond the motivation they needed to speed things up. I hope. ■

Jon Perkins is a Microsoft Certified Professional, and is an associate developer with The Mandelbrot Set (TMS), a Windows only software house offering consultancy, development and technical training. TMS can be contacted on 01451 861212 or by email at 100526.2624@compuserve.com

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CIRCLE NO. 980

RAD fan **Dave Jewell** has been looking for a C++ environment as convenient as Delphi. He checks out Powersoft's Optima++ version 1.5.

Photos: Franwyn Black

Dial O for Optima

Embarking on a project with one of the mainstream C++ development systems such as Visual C++ or Borland C++ is a bit like using one of those old role-playing 'Adventure' games. Near the beginning of the game, you meet a kindly Wizard, Expert, Sage or Warlock who offers to be your guide. He takes you by the hand and leads you assuredly through a dense, murky forest asking you questions about what sort of project you want to build. 'Will it be OLE enabled, will it have support for Print Preview, will it use MDI?', and so forth. Each time you reply, he confidently selects a different path from among the many branching, indistinct forest trails, all alike. You're glad you've got his help.

Then, all of a sudden, he stops asking questions and says, 'Well – here we are!' You look around and see nothing out of the ordinary, but your surroundings look hauntingly familiar. Suddenly, he gives you a vicious kick which sends you crashing through the undergrowth and down into a deep, dark pit. As you black out, you remember that no matter how you answer the questions, you always seem to end up in the same pit...

When you regain consciousness, you find yourself at the bottom of the pit, surrounded by thousands of lines of printout covered in indecipherable C++ source code. The walls of the pit are covered with slime and impossible to negotiate. In the darkness, you hear some wild, hungry beast inching towards you. You realise that the only way out is to understand the C++ code in front of you – but there's not much time and the boss (errr... I mean, the beast) is becoming violently impatient and near crazed with hunger. You cry out for help and hear the Wizard cackling insanely, high above you...

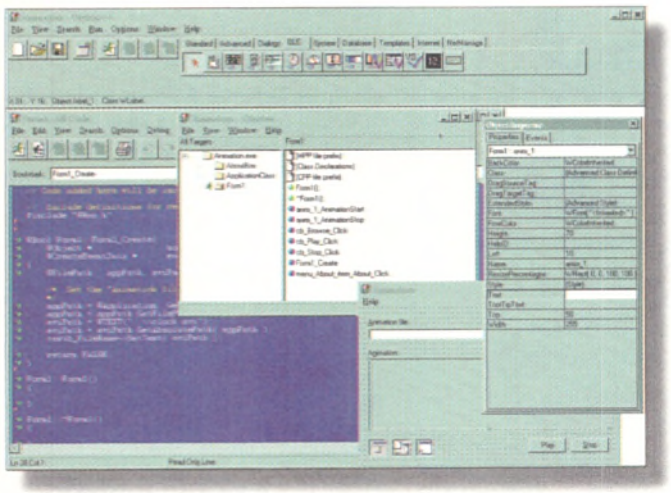

Figure 1 – The Optima++ IDE. Is this Delphi I see before me, or could it be Visual Basic? In fact, Optima++ borrows ideas heavily from both these tools, and why not? The IDE is capable of performing background compilation of your C++ source while working on a project, in order to minimise build time.

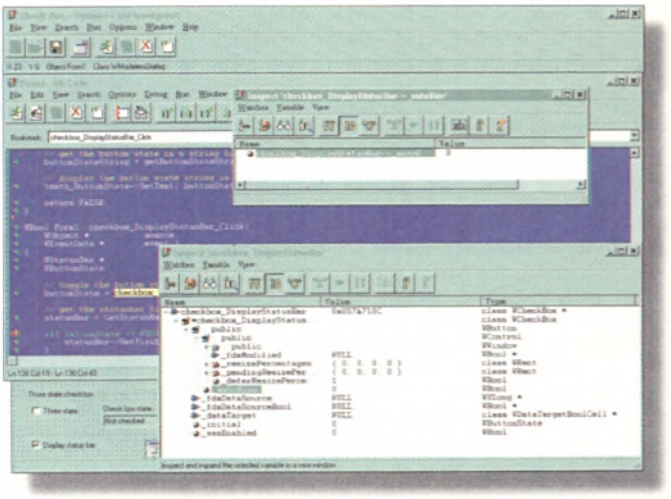

Figure 2 – The Optima++ debugger in action. You can display a hierarchical view of global and local procedures, set watch-points and conditional breakpoints. Support is also included for multi-threaded applications. A big improvement over previous Watcom debuggers.

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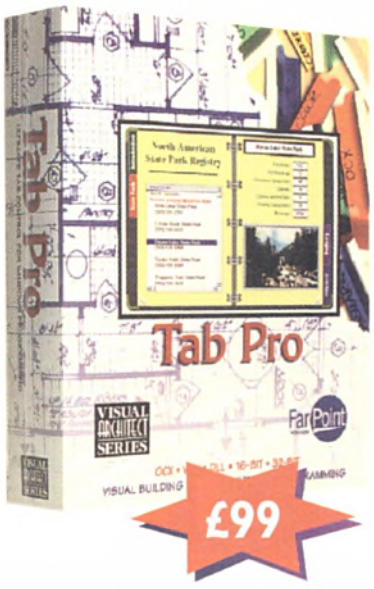

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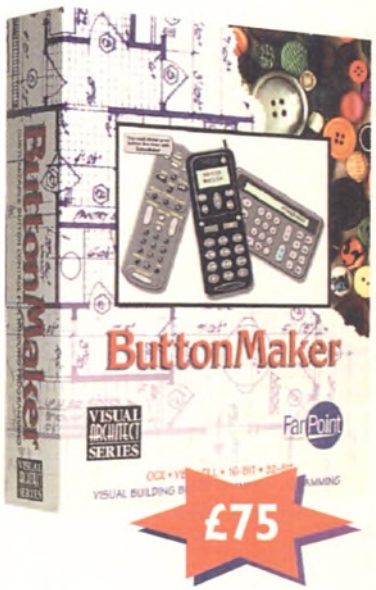

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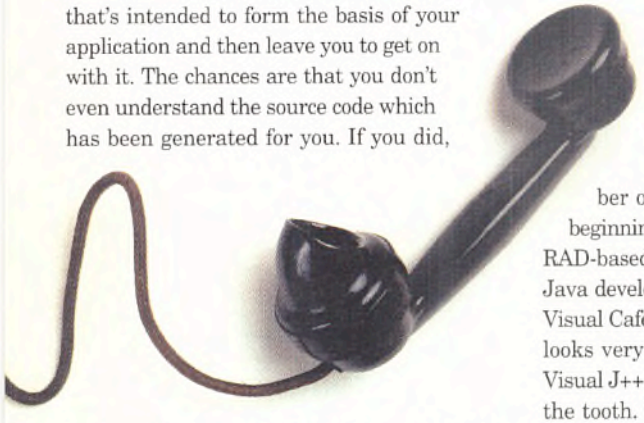
CIRCLE NO. 982

The real and the counterfeit

Maybe you've never played any of the old text-mode (non-Visual!) adventure games, but if you've had much exposure to Microsoft and Borland's current C++ offerings, then you may well have woken up screaming from an nightmare rather similar to the 'adventure' described above. The fact is that modern C++ development aids ask you a few questions, churn out a huge amount of C++ source code that's intended to form the basis of your application and then leave you to get on with it. The chances are that you don't even understand the source code which has been generated for you. If you did,



you wouldn't have bothered to use a Wizard/Expert in the first place – you'd just have cut and pasted relevant code from a previous project, giving you a lot more control over the end result.

Before you all start accusing me of being too controversial, and sticking pins in wax effigies of Dave Jewell, let me just gently point out that there are plenty of others who share my perceptions – quite a few of them within Microsoft. In the November 1996 issue of *Windows Tech Journal*, the editorial states that Microsoft, Borland and Powersoft all agreed that 'barefoot' C++ programming is rapidly becoming obsolete. The next generation of C++ tools will hide the underlying complexity of the class library and allow you to concentrate on the job in hand. Some people hold up their hands in horror at this so-called 'dumbing-down' of C++. However, it's a trend which I believe is very welcome and long overdue. Put bluntly, Visual C++ and Borland C++ are simply not visual programming tools and they just don't cut *la moutarde* when stacked up against tools like Delphi or Visual Basic.

Ah yes – Delphi. It was arguably Delphi that provoked this current revolution. For many years, Visual Basic programmers have been able to build attractive user interfaces in a fraction of the time taken by a C++ developer. However, those of us who program 'professionally' have always been able to look down our object-oriented noses at Basic programmers, pity their under-powered, interpreted applications and maybe go so far as to acknowledge that the RAD paradigm was useful for knocking up a quick, slow prototype of something that was eventually going to be coded in C++. But when Delphi arrived on the scene, the cold wind of change began to blow through the C++ community. C++ developers were confronted with a system that was not only demonstrably far more productive than a C++ development system but – ye gods! – it produced compiled code too.

The problem with Delphi, of course, is that it's based around a proprietary language, only available for one hardware platform and comes from a company that (in the last year or so) has had something of a question mark over it's long term future. Many C++ developers began saying that they would kill for a C++ version of Delphi...

More recently, an increasing number of other development systems are beginning to appear which all use the same RAD-based paradigm. There's SuperCede (a Java development system from Asymmetrix), Visual Café and others. Suddenly, Visual C++ looks very dated and even the young blood Visual J++ is looking more than a little long in the tooth. Clearly, Microsoft need to regain some lost ground. Is it just a coincidence that Anders Hejlsberg, chief architect of Turbo Pascal and Delphi, has just left Borland and joined Microsoft? Time will tell...

Introducing Optima++

With all the above in mind, it should come as no surprise to learn that Optima++ integrates its C++ compiler with a friendly, RAD-style front-end. The compiler in question is our old friend from Watcom. I was not particularly inspired by my earlier experiences with Watcom's Windows-hosted development system, but Optima++ is a completely different animal and is much more pleasant to work with. Unlike the earlier system, in which integration between the various components was extremely poor, Optima++ behaves and feels like a single, integrated IDE.

As with Delphi or VB, you can select pre-packaged modules from a component palette, drag them to a form and tweak them to your heart's content using pop-up property dialogs or an Object Inspector window. The 'standard' and 'advanced' pages of the palette contain the usual arsenal of Windows controls you'd expect to find, including the Windows 95 common controls. Optima++ includes some controls that are inexplicably missing in Delphi such as an animation control – great if you can find an .AVI file that it will accept. (The control is alarmingly picky).

A number of OLE controls are bundled with the package and you can add other registered controls to the OLE palette page in the usual way. I particularly liked the set of NetManage Internet components which comes with a good suite of pre-built sample applications. Within a minute or two of building the FTP client project, I was using it to download last-minute product enhancements from Powersoft's FTP site in the States. The other NetManage components include clients for HTML, HTTP, POP and SMTP.

Certain components can function as containers, (eg tabbed dialog controls and group boxes) allowing for easier placement of controls and user interface design. The usual options for aligning and sizing components are immediately available through pop-up menu selections. Again, as with Delphi, renaming a component will automatically modify references to that component, including renaming of any methods that already exist. You can add a new event handler by double-clicking on the

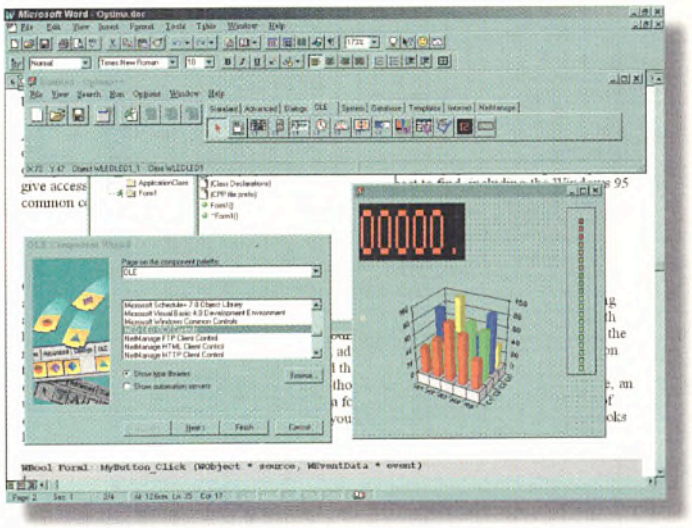


Figure 3 – Optima++ supports the importing of OLE controls into the development system and – unlike some other development systems – the imported controls do actually work! Here's the First Impression chart control in action (which comes with the product). I've also imported the NED LED OCX Controls (downloaded from the Web).

events page of the Object Inspector window and the handler is then added as a method of the current form's class. As a convention, the method name is made up of the component name, an underscore and the event type. Thus, if you've got a form called `Form1`, a button component (of class `WCommandButton`) called `MyButton`, then you might end up with a `Click` handler that looks like this:

```
WBool Form1::MyButton_Click
      (WObject * source, WEventData * event)
{
  WAppObject.Beep ();
  return FALSE;
}
```

In Delphi, if you inadvertently add a method that you don't want, the environment will automatically remove it the next time you build or save the project – it is able to look for empty event handlers and silently delete them. Optima++ doesn't do that – instead you must manually delete the method through the class-oriented view of your project in the Classes window. Mercifully, deleting a particular component will automatically discard all methods associated with that component.

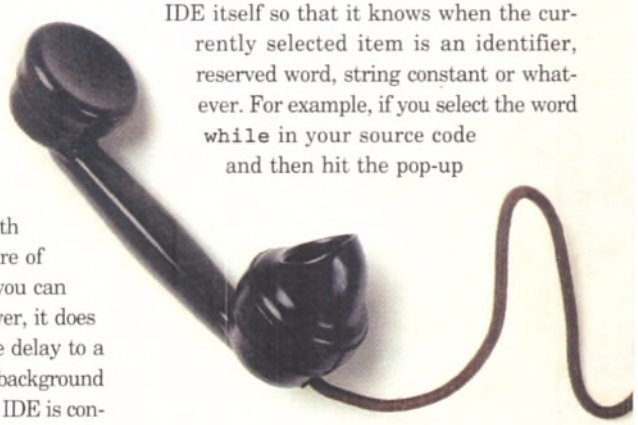
As you'll have gathered, Optima++ is based around an extensive class library which shields the programmer from the underlying API and chops up the complex business of Windows message processing into 'bite-sized' event handlers. The class library does well to present a relatively high-level view of the world but contains some surprising omissions such as the ability to throw exceptions when errors occur. No exceptions are thrown anywhere in the class library, which means that if you want to take advantage of exception handling within your own application, you'll need to perform data validation before dropping down into the library code. By default, the compiler option for supporting exceptions is disabled.

Another feature allows your applications to link statically to the class library, or dynamically to a DLL which contains all the library code. The latter option can reduce the size of executables significantly: a typical size would be around 50 KB. The DLL itself is around 1.44 MB. Interestingly, the next version of Delphi (3.0) will provide the same option.

Optima++ in use

Notwithstanding radical advances in computer science, C++ compilation will never be as fast as the frighteningly quick one pass compiler built into Delphi. With Optima++, you're very much aware of the compiler 'doing its bit' before you can start running the program. However, it does use some neat tricks to reduce the delay to a minimum. For one thing, there's a 'background build' option which means that the IDE is continually looking over your shoulder, so to speak, and rebuilding things behind the scenes as you change compiler options, introduce new header files, and so forth. The downside to this is that you lose some of the responsiveness in the IDE itself, but not to an unacceptable level. Using an external DLL for the class library also reduces link time considerably.

The text editor is a big improvement over that supplied with the earlier Watcom development systems. It features syntax highlighting, customisable colour schemes, drag and drop for moving text around (à la Word), and a convenient bookmark facility available from a combo box located above the text editing area. You can select an identifier in your source code and immediately pop up a 'reference card' of helpful information. Other pop-up menu selections allow you to instantly get a list of all occurrences of a particular identifier within your project, or open the source code relating to a designated item. Any IDE which incorporates syntax highlighting must, of necessity, perform a certain amount of pre-processing of the source code. This information really needs to be brought out and made available to the IDE itself so that it knows when the currently selected item is an identifier, reserved word, string constant or whatever. For example, if you select the word `while` in your source code and then hit the pop-up



menu, you get an item inviting you to open up the source code for `while`, or `if` or 3.1415926, or... ho hum...

Like any well-dressed IDE, Optima++ supports integrated debugging. You can toggle a breakpoint in true Delphi-style by clicking in the left-hand margin of a source code window, or else run to the current cursor location. As with VC++, Optima++ generates separate 'Release' and 'Debug' sub-directories of the main project directory, and you can easily flip from one state to the other, with different build options for each.

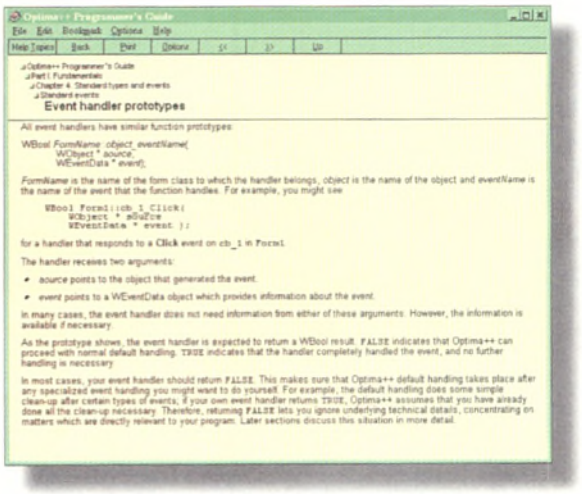


Figure 4 –Very comprehensive help is included in the product, and there are facilities for selecting an identifier in the editor, jumping straight to the online reference material for that item, or else scanning your project for other references to the same thing.

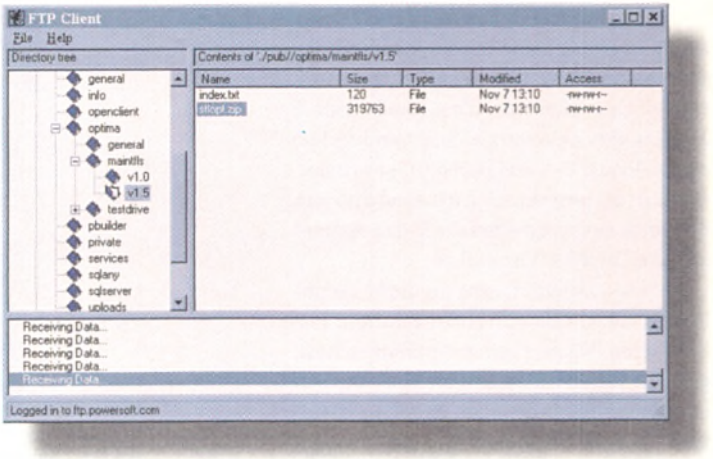


Figure 5 – And here's one I prepared earlier. Optima++ makes it very easy to create Internet-enabled utilities because of the NetManage components included in the package. Here's the freshly built FTP client, downloading the Standard Template Library (STL) headers from Powersoft's FTP site.

The debugger is rather nice. It gives you a hierarchical view of a C++ object, letting you 'drill down' (ugh – don't you just loathe these Americanisms?) to any structures or arrays contained within the object. You can set watches, conditional breakpoints and so forth and there's full support for debugging multi-threaded applications. On the negative side, the debugger can be a bit sluggish. If you hit a breakpoint, you often see something like a two-second pause (on a 200 MHz Pentium Pro!) from when the program stops running until the debugger window is displayed. However, this is a lot more acceptable than the constant text-mode/graphic-mode switching that used to be the case with Watcom's earlier text-mode debugger. There are plenty of niggles, but nothing too major. The user interface isn't as clean and intuitive as Delphi and you sometimes have to jump through hoops to perform a task which should be dead simple. For example, by default no pre-compiled header for WINDOWS.H is included into projects. Just a checkbox to click somewhere, you might think? Not at all. The manual details a baroque, tortuous, eight or nine step procedure which you need to follow in order to include WINDOWS.H, and thus be able to make direct Windows API calls from inside your project. Ok, the Optima++ class library provides much of the functionality you're likely to need, but there will certainly be times when you need to hit the API and there really should be an easier way of getting to it.

Another problem concerns the design of the class library itself. Although potentially very versatile, the emphasis on flexibility can sometimes mitigate against usability. For example, consider the case of the humble `Slider` control – a wrapper around the slider provided in Microsoft's Common Control DLL. With Delphi, there are exactly ten different events that you can hook into as a slider control receives the focus, loses the focus, responds to key presses, and so forth. If you wanted to make something happen each time the slider position is altered, you'd just add an event handler for the `OnChange` event – simple. But now look at the situation in Optima++: there are around eighty (yes, eighty!) different events exposed for the `Slider` control. If you wanted the equivalent to Delphi's `OnChange` event, you might well cast your eye over `SettingChange`, `UserChanged`, `PositionChanged` and `PositionChanging`. How do you figure out which of these is the one you want? Actually, none of them will do – the one you're after is called `Scroll`!

In practice, things aren't that desperate, provided you use the pop-up menus wherever possible. The Object Inspector presents a sort of 'global view' of the selected component but it's the pop-up menu that provides more pertinent information. Select a `Slider` control, right-click it and you'll see a menu with an Events sub-menu. Enter the sub-menu and you'll see that there's just one event – `Scroll` – defined.

Like Delphi, Optima++'s Object Inspector allows you to select a particular event and then click F1 to bring up context sensitive help. Just as importantly, you can browse through the large number of pre-built sample projects to see how a particular effect is achieved. But overall, I'd say that the learning curve with Optima++'s class library is steeper than that with Delphi.

Three flavours

As you might expect, Optima++ is a big product. It's recommended that you have at least 32 MB of RAM for development and, based on my experience, I'd say that you also need a pretty fast machine. Optima++ comes in three different flavours which broadly parallel the three different levels of Delphi which are available, these being Developer, Professional and Enterprise. The Professional level product builds on the base package by offering a multi-user SQL Anywhere server, check-in/check-out facilities for version control packages, the sophisticated Powersoft DataWindow control for displaying database data in a variety of ways, and the Internet controls mentioned earlier. The Enterprise level adds a query and reporting tool, the ObjectCycle version control system and native drivers for Sybase SQL Server, Microsoft SQL Server, Oracle, Informix, and others. I haven't said a great deal about database development in this review because my primary interest in Optima++ is as a general purpose programming tool, a role it fits very well.

So do I like it? Yes, very much. I have some reservations over the fact that source code for the class library isn't supplied, and that you can't use the class library with other C++ compilers. However, if you've been suffering from 'Delphi envy' for the last year or so, I reckon that Optima++ will go a long way towards curing you! It's a very productive way of building sophisticated applications, and the numerous working samples prove that the product really does deliver. I was also impressed with the quality of the online help which, in a system of this complexity, is very important. It comprises an electronic version of the 840-page Programmer's Guide, one of several manuals which make up the documentation set. ■

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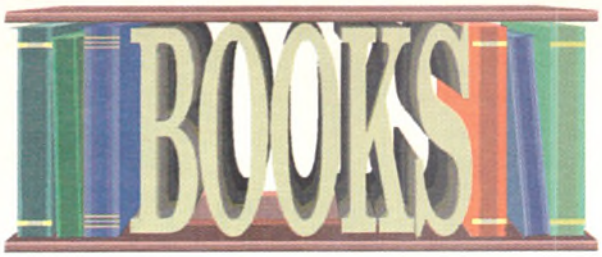
Optima++ is available from System Science (0171 833 1022) and QBS Software (0181 956 8000), or call Powersoft on 0800 444455. The Developer edition costs £139 until the end of December (£208 thereafter), the Professional one is at £349 until the end of December (£698 thereafter) and the Enterprise one is at £1350.



Readers who bought the Revolutionary Guide to Delphi 2 (reviewed in the October issue of EXE) might want to check out the errata for the book at http://members.aol.com/drbobnl/errata.htm (Thanks to Brian Long for sending us the URL).

Programmer's Bookshelf for Windows 95 reviewed by **Colin Smith**

Programmer's Bookshelf (PB) represents Microsoft Press' venture into CD-based book distribution. It uses the standardised InfoViewer interface as popularised by Books Online from VC++ and the Microsoft Developers Library.

PB comprises a hefty amount of material derived from several titles, namely: *Programming Windows 95* (Charles Petzold), *Advanced Windows* (Jeffrey Richter), *Developing International Software for Windows 95 and NT* (Nadine Kano), *OLE Controls Inside and Out* (Adam Denning), *Programming the Windows 95 Interface* (Nancy Winnick Cluts), and the first 5 chapters of *Programming Windows 95 with MFC* (Jeff Prosise).

PW95, reviewed in the October issue of *EXE*, is the updated version of the best-selling MS Press *Programming Windows* book, ideally suited for novice Windows programmers. *Advanced Windows* follows on with the new features of the Win32 API, including processes and threads, with practical examples in C.

DIS (written by a Microsoft insider) covers internationalisation techniques, introducing the localisation progress, how to design a global program, dealing with character sets and localisation conventions, and coding practices. The material is mostly presented as a general discussion, so there isn't much in the way of practical programming advice. Of most use is the valuable reference material (23 indices!) listing keyboard layouts, code pages, address formats, and so forth. What the book lacks is coverage of development tools for automating and managing the internationalisation and translation processes – many developers create their own system, but internationalisation tools do exist.

OCIO is a primer on OLE Control (aka ActiveX) development. The code examples are for C++/MFC only, and make use of the CDK (Control Developers Kit), so you will have to modify them slightly to compile in VC++4.0. Topics include property pages, converting VBXs to OCXs, 16-bit/32-bit and cross-platform issues, and official Microsoft guidelines.

PW95UI consists of three parts: part one introduces all the Windows 95 controls such as common dialogs, status bars, toolbars, etc. The second part introduces interface features such as long filenames, creation of shortcuts, access bars (and how to implement your own taskbar) and file viewers. Part three shows how to extend the UI with context menu handlers, icon handlers, property sheet handlers, and shell namespace extensions. The initial Windows 95 control code examples are presented in C and C++/MFC. However, C goes out the window as part two and three enter OLE territory, which experiments with the Shell OLE Interfaces.

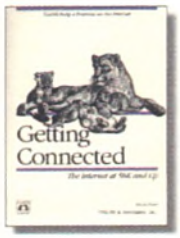
Together, OCIO and PW95UI provide a good incentive for learning OLE (you can't put off Inside OLE any longer), which is becoming more and more prevalent. AW and PW95 are useful if you are the sort of person that can't get by with the standard API documentation (errors and all).

Current subscribers to the Microsoft Developer Library will already have online versions of PW95UI and Advanced Windows NT (which is very similar to AW), so the value of this title is diminished a little. However, it is excellent value if you can stomach reading 'online' books, or don't mind a large printer consumables bill.

✔ **Verdict: recommended for intermediate Windows programmers**

Title:	*Programmer's Bookshelf for Windows 95*
Author:	*Petzold, Richter et al.*
Publisher:	*Microsoft Press*
ISBN:	*1-572-31311-0*
Price:	*£65.48 (inc. VAT)*
Pages:	*Thousands!*

Getting Connected: the Internet at 56K and up reviewed by **Paul Dunne**



'Getting Connected' is a guide for those who need an Internet setup more ambitious than a bog-standard dial-up account with the friendly local service provider. It delves into the murky waters of dedicated Internet connections.

The book begins with an examination of the various decisions which need to be made before any work starts on the link itself, with advice on calculating bandwidth requirements and figuring out overall costs.

There follows a particularly clear and helpful discussion of routers, containing practical examples dealing with access lists and filtering. This is noteworthy, as few publications deal with this important area in any detail, leaving implementers to the tender mercies of vendor-supplied manuals.

The mandatory explanation of networking layers follows in the shape of an overview of IP on an Ethernet LAN. The various types of physical connection, such as leased lines and ISDN, are examined, as are the data link protocols available, chapters being devoted to PPP and SLIP, Frame Relay, X.25, ATM, SMDS and HDLC. An 'IP on the desktop' section discusses the various TCP/IP connectivity options on the common desktop OSs.

There is a good introduction to DNS, which provides all the basic information necessary to set it up, both for simple hosts and firewalls (which are themselves covered in a practical chapter on security).

The chapter on 'Internet mail' covers sendmail, wisely focusing on the use of a Unix server as a plug-in unit, providing mail services to the rest of the LAN. The fearsome sendmail.cf configuration file is covered in sufficient detail to enable the attentive reader to make simple changes to his setup.

Overall, the book is very strong on real-world problems and solutions, and has particularly good coverage of DNS, firewalls and e-mail. A worthwhile purchase for anyone linking to the net: those with a dial-up line will find much relevant information here, and for those with a fixed link, it is invaluable.

✔ **Verdict: Recommended**

Title:	*Getting Connected: the Internet at 56K and up*
Author:	*Kevin Dowd*
Publisher:	*O'Reilly*
ISBN:	*1-56592-154-2*
Price:	*£22*
Pages:	*410*

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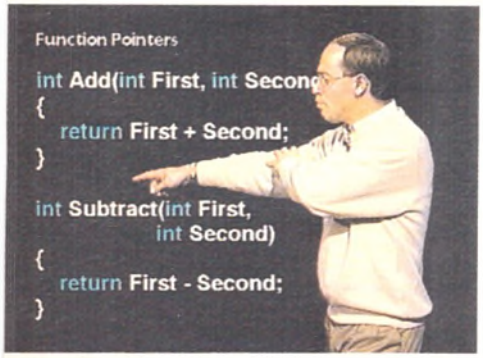

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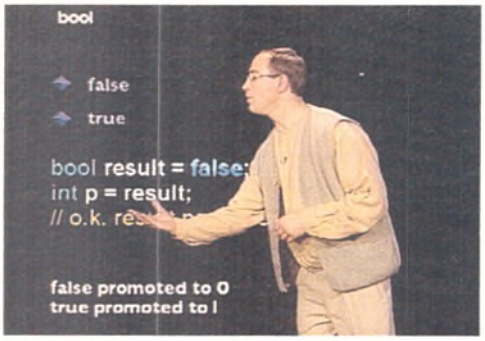

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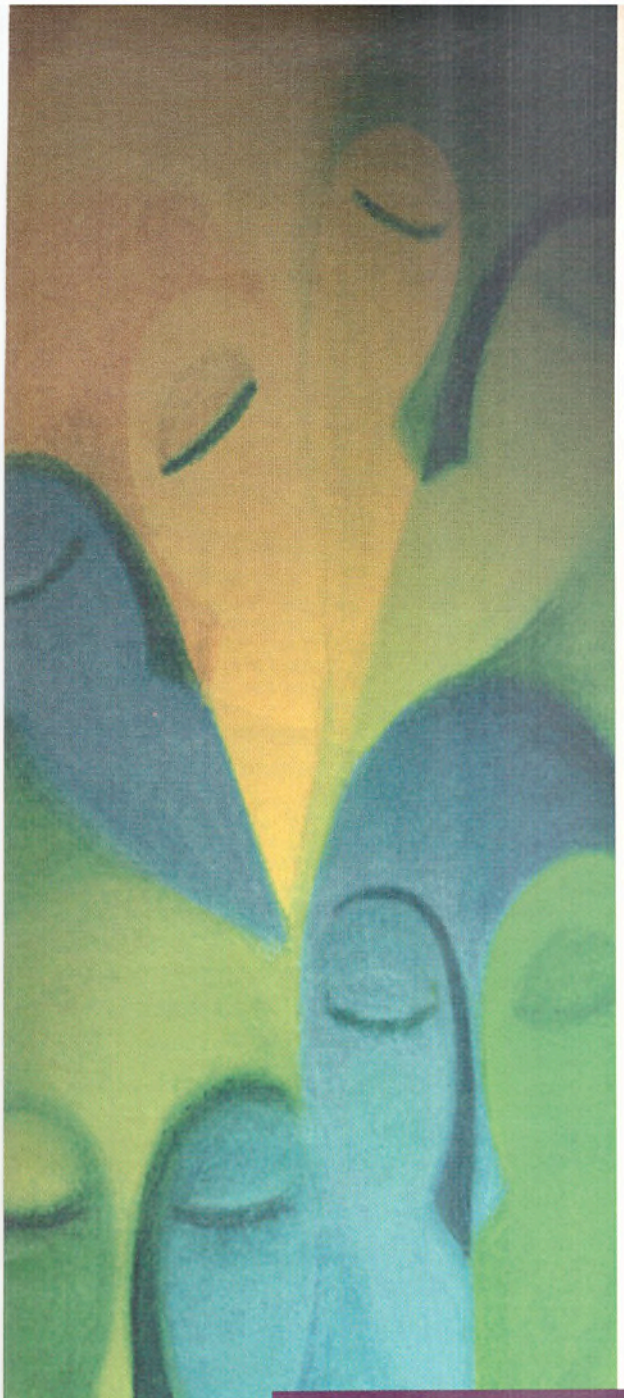

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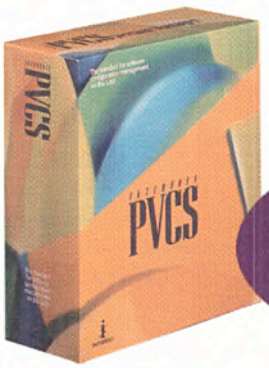

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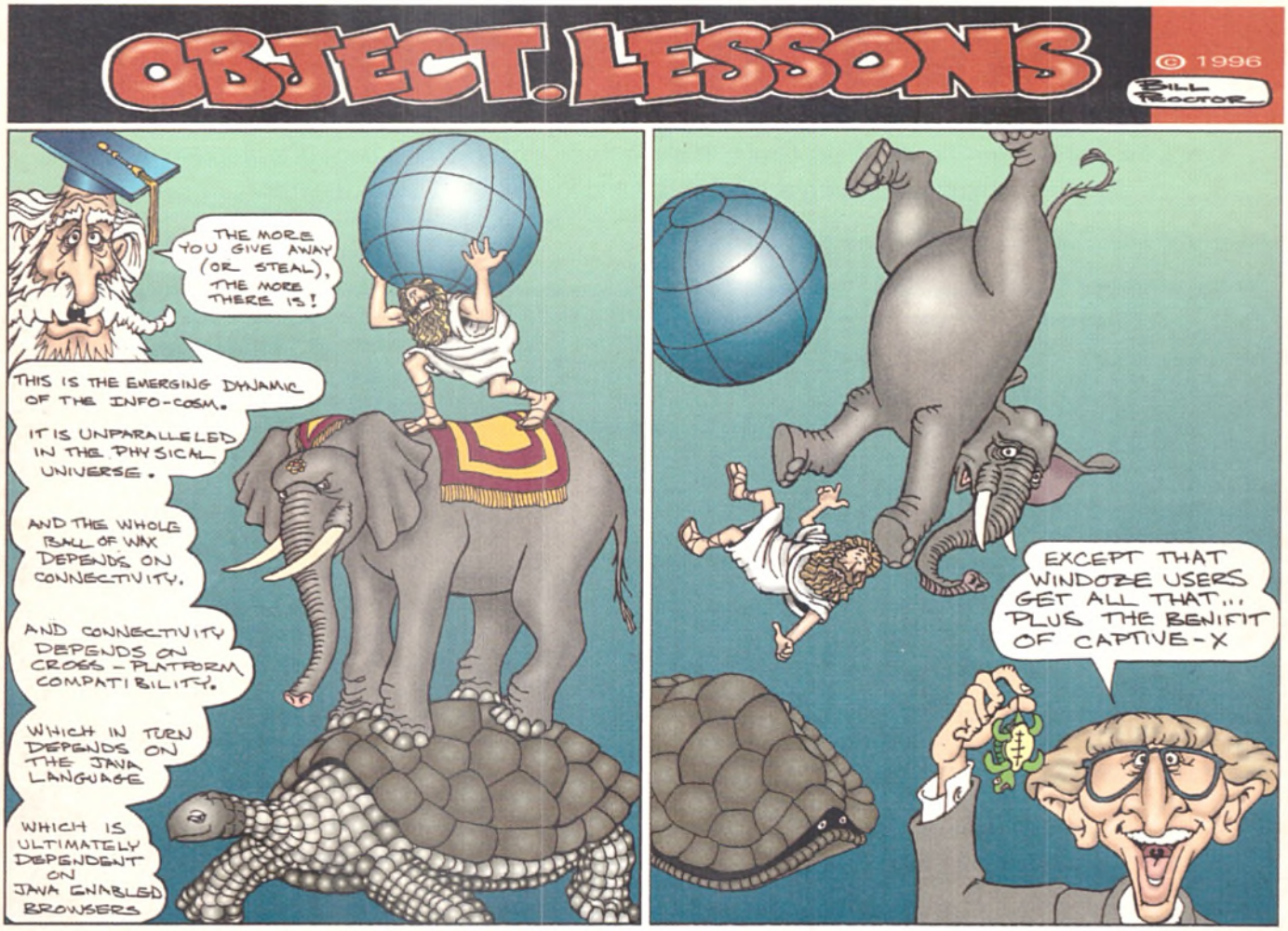
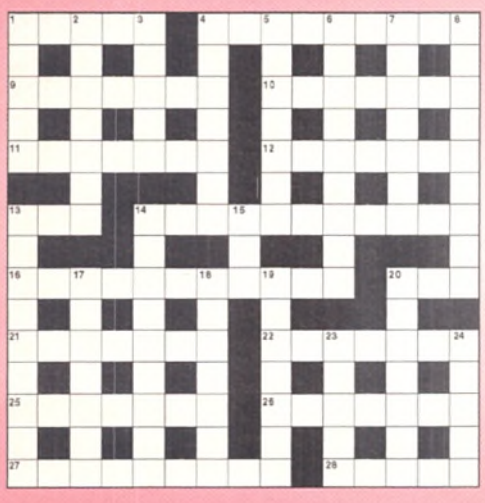


All hail the Master of IT

Ctrl-Brk is glad to hear that the Worshipful Company of Information Technologists has a new master, one Keith Arnold. Arnold, founder of the, erm, well-known Race Electronics, will head the, erm, well-known forum which, apparently, 'has become the very hub of the IT industry.' Arnold's reign began with an installation ceremony held at the summit of the BT tower here in downtown London. The installation was, we gather, trouble-free. Which is more than can be said for most products in the IT industry.

CROSSWORD



ACROSS

1. & 4 our message to you now (5,9)
4. See 1
9. The season provides much: what a waste (7)
10. The Southern one 16 in that of your own home (7)
11. Listen to the herald angels, Kenneth (7)
12. The start is all for mice in the rye maybe (7)
13. Seasonal colour is berry nice (3)
14. Party game winners get on top of intellects (11)
16. 15 does not, but other season's input does (11)
20. Home to wander round in slippers (3)
21. One who fantasises before 4? (7)
22. Like the Magi go north after next festival (7)
25. Feeble reasons for sex cues in the air (7)
26. Leave round second Christmas pudding (7)
27. Go through dance or program with timidity (4,5)
28. Monsters from the snow (5)

DOWN

1. Third 19 originally - how bitter! (5)
2. What to do to the lamp to get your wish (3,4)
3. One shout from the foxy master maybe ... (5)
4. ... who goes together with the hounds? (7)
5. About the bike, how to conserve year end 9 (7)
6. Soundly add and multiply on occasion (9)
7. Tie up chicken: just a little bird (7)
8. Took off serious things as one Diana rests a bit (9)
13. Official Santa's team (9)
14. Gets the most as gun is used two ways (9)
15. Ate round five o'clock (3)
17. Not very clear in the early stages of syrup (7)
18. Bob like a lady of manners in brief (7)
19. EVEn when Solomon Grundy was christened (7)
20. Give now! (7)
23. Perhaps babyish like dear sibling (5)
24. Sounds of carols - and the outcomes? (5)

SOLUTION TO NOVEMBER'S CROSSWORD

ACROSS: 1. READING 5. ENQUIRE 9. EON 10. BOOLEAN 11. COOLEST 12. TOTAL 13. REDUNDANT 14. CODASYL 16. READERS 19. TRANSIT 22. ALBUMEN 25. BOOTSTRAP 27. GERMS 28. LOOKUPS 29. NOISOME 30. TAD 31. RESIDES 32. STYLIST
DOWN: 1. ROBOTIC 2. ABORTED 3. IDEALISTS 4. GENERAL 5. ENCODER 6. QUORN 7. ITERATE 8. ESTATES 15. OAR 17. AMBIGUITY 18. RUE 19. TABULAR 20. AMOROUS 21. THRUSTS 22. APPENDS 23. MARCONI 24. NASCENT 26. SOUND

Book of An-ders

'[Look for the] Reader-friendly Waite Group 'Bible' format' – *blurb on the back of a programming book.*
'Anders Hejlsberg is leaving Borland for Microsoft' – *the Internet.*

An-ders' dream. Famine among the sons of Kahn. *AN-DERS 17-19*

1. And it came to pass *that* the sons of Kahn, who dwelt in the valley of Scotts, in the land of California, fell upon hard times. For they were hard plagued by the Mic-rosoftees who dwelt in the north, yet ruled all the lands around, and forced all to bow down and pay tribute before *their* god Vi Su-Albahsic. And there was much wailing and gnashing of teeth in the valley, *and* also much careful scholarship of the Situations Vacant columns.

2. And then An-ders, an elder in the tribe of the sons of Kahn, *dreamed* a dream. And he called together all the tribe and spake unto them saying: Brothers – last night I dreamed that everyone in the world paid tribute to the god Vi Su-Albahsic. And the Mic-rosoftees did come down *into* the valley of Scotts, and forced all men who dwelt there to worship Vi Su-Albahsic. And the sons of Kahn gave in and became programmers like Jerripur-Nel, the scribe of Bytemag, *who* toileth *still* upon Roberta's Basic Flash-Card Program; yea, yet he hath toiled upon it for seven and four-score years or more, as it seemeth to me.

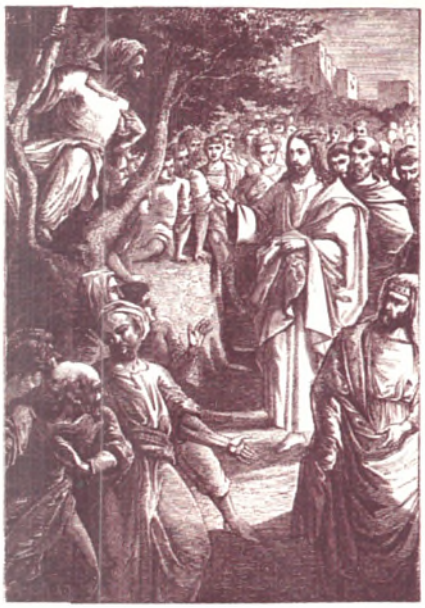
3. And An-ders spake, saying: Do you want *this* to happen?

4. And the sons of Kahn replied as one saying: Indeed, we sodding well do not.

5. And so it came to pass that the sons of Kahn looked once more upon Tur Bhopas-kal, and into the void *which* was called Owl. And they saw *that*, while calling it a void was a tad unfair, there was plenty of scope *for* improvement. And An-ders and Gar'ee and Zackur-Lockur and Giant I and many others girded up their loins, and toiled long and hard. And together they fashioned TObject.

6. And TObject conceived, and begat TPersistent. And TPersistent begat TComponent, and TComponent begat TControl, and TControl begat TWinControl, and TWinControl begat TCustomControl, and TCustomControl begat TCustomGrid, and TCustomGrid begat TDrawGrid, and TDrawGrid begat TStringGrid.

7. And TObject also begat Exception, and Exception begat EMathError, and EMathError *[that's enough begatting – Ed.]*



8. And so it came to pass *that* the fruit of TObject's loins were indeed fruitful, and the whole multiplied much. And the tribe of TObject's children was known as Veesee-ell. And Tur Bhopas-kal was henceforth named by the name of Delphi, by decree of the department of market, who had once spent a happy fortnight in Corfu, and was wise in the ways of the Greeks.

9. When the sons of Kahn looked upon Veesee-ell and Delphi, and they saw that Delphi micturateth upon the head of Vi Su-Albahsic, as though from the peak of mount Rockee.

18. 1. And the sons of Kahn were glad within their hearts, indeed they were well chuffed.

2. And there was much wining and celebration and slaughtering of fatted calves in the valley of Scotts, *with* plenty of alcohol-free and meat-free alternatives laid on for those who cannot partake *of* strong drink or murdered animals for reasons of medication or creed or obstinacy, or because *their* girlfriends won't let them. And by all a good time was had.

3. And it came to pass that two seasons came and went. And the first season was rich and fruitful for the sons of Kahn, and their bellies grew round and plump with milk and honey.

19. 1. But the second season was thin and lean, and was a time of famine. For verily the department *of* market *of* the sons *of* Kahn was not unpractised at snatching defeat, yea even from the very jaws of victory. And the sound of weeping and wailing was heard once more in the valley.

2. And one day An-ders journeyed *to* the wilderness, and wept and wailed and cried out unto the Lord, saying 'Shall I spend the rest of my days tinkering *with* a Pascal compiler I wrote 15 years ago? Couldn't I have a go at something else? Shall I never have stock options which consistently increase in value? Can I not be on the winning side *for* a change?'

3. And it so happened *that* nearby stood a scout for the tribe of the Mic-rosoftees, disguised as a juniper bush. And he heard An-ders cry out. And he came forward to An-ders, saying, 'Can I be of assistance?'

4. And one thing led *unto* another.

5. And when the sons of Kahn heard what had happened, they put *upon* the matter a brave face saying: An-ders hath worked *but* a little on recent releases, we will be on time with Delphi 3.0, we are sorry to see him go, of course, but it will come to pass that this will not impact any of our technology.

6. But friends of the sons of Kahn remembered the wisdom *of* M'andee-rice Davis. And *such* men were sore afraid *for* the sons of Kahn. ■

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