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Mayhem!

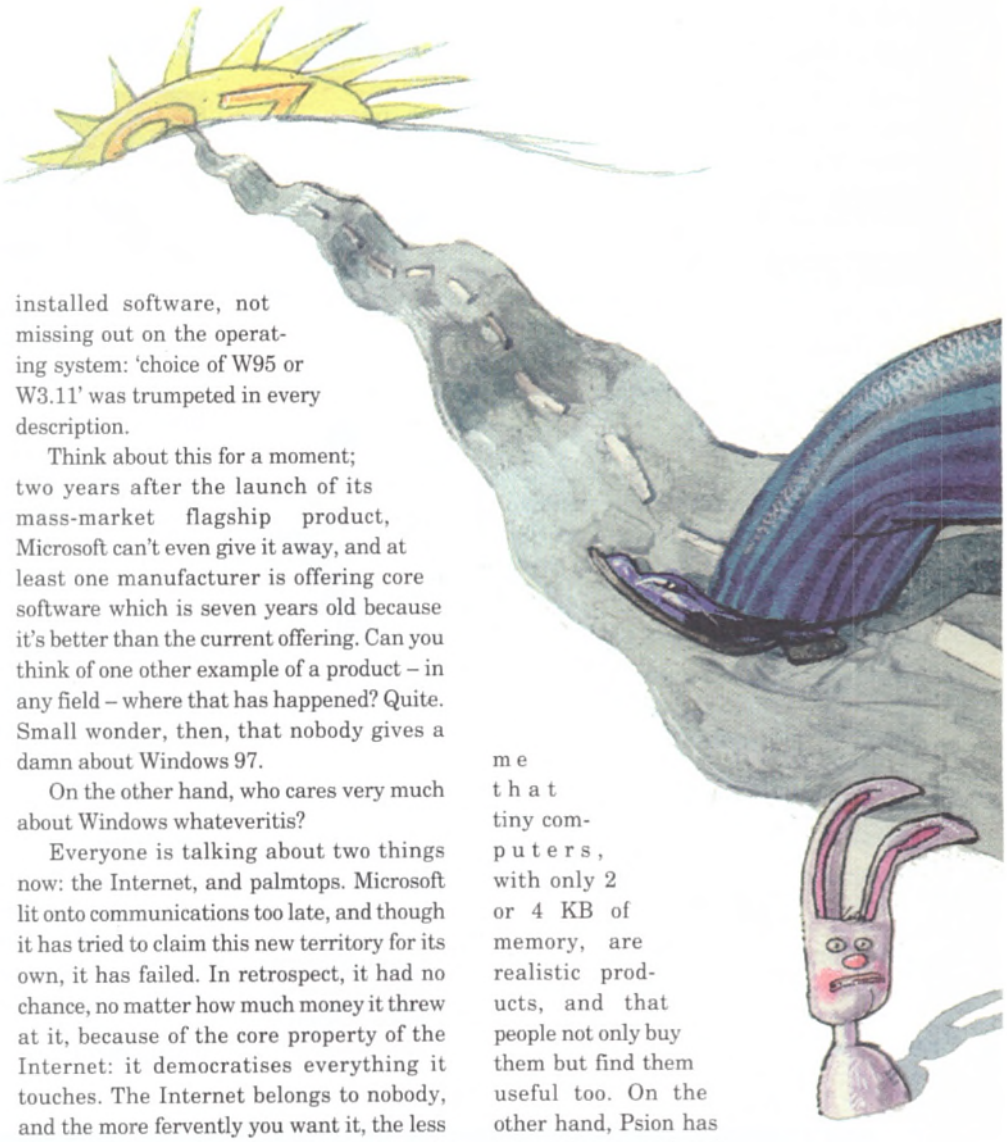
Jules thinks of 97 things he'd like to CE.

Windows 97 is just over the horizon. Well, that's what we've been told, but Windows 95 was so late, I guess most people have learned by now that Microsoft has enough difficulty getting its products launched in the correct decade, and nobody seems to be taking much notice. And, was W95 worth the wait? No. The hype surrounding the launch will be discussed for years to come, and won Microsoft an enormous takeup of its product. But it was so overdone that many users were thoroughly disappointed with W95 when they got it, and abandoned it in distressing numbers.

I guess the problem is that Microsoft has no more idea than anyone else about how to run a large software project. Plug and play involved more plugging and unplugging, and more playing about, than the old system (which everyone seems to have returned to). In trying so hard to hide the dirty bits of Windows under pretty interfaces and Wizards, Microsoft prevented users from understanding the barest essentials of what their computers were doing. I know a few people who are still using DOS because they don't know what their computer is doing when it runs Windows.

W95 made what problems there were far worse, because users had no idea how to uninstall programs they didn't want, and gadgets like fax modems needed so much setting up in so many different dialogs (all of which interacted in peculiar ways, and most of which tried to outguess users). My phone never stopped ringing with customers (and prospective customers) wanting help to make their computer behave like a normal computer should.

The last, richly deserved nail in the coffin of W95 came through my letterbox the other day. It was one of those catalogues which offer everything you need for your computer, from a single floppy disk to an entire computer complete with multi-media hardware-accelerated oil refinery. In the computers section, it listed the complement of pre-installed software, not missing out on the operating system: 'choice of W95 or W3.11' was trumpeted in every description.



Think about this for a moment; two years after the launch of its mass-market flagship product, Microsoft can't even give it away, and at least one manufacturer is offering core software which is seven years old because it's better than the current offering. Can you think of one other example of a product – in any field – where that has happened? Quite. Small wonder, then, that nobody gives a damn about Windows 97.

On the other hand, who cares very much about Windows whateveritis?

Everyone is talking about two things now: the Internet, and palmtops. Microsoft lit onto communications too late, and though it has tried to claim this new territory for its own, it has failed. In retrospect, it had no chance, no matter how much money it threw at it, because of the core property of the Internet: it democratises everything it touches. The Internet belongs to nobody, and the more fervently you want it, the less chance you have of getting it. I have a suspicion that Web browsers, Java-to-be interpreters, and massively distributed, mirrored filing systems are going to be designed into the deepest levels of the next generation of operating systems, and then the subsequent generation of silicon. Nintendo, of all people, has already started.

Palmtops are rather harder to predict. It has been a constant source of amazement to me that tiny computers, with only 2 or 4 KB of memory, are realistic products, and that people not only buy them but find them useful too. On the other hand, Psion has had rather more butch machines available for several years (I'd feel naked without mine), and the Japanese are starting to catch up. Microsoft, for all its peculiar myopia, has noticed at least this trend, and has decided it wants a piece of the action. Dismissing the suggestion that users want applications that work, it thinks that users would be much better off with the

same applications on their palmtops as they want on their desktops. No matter that mice don't work on palmtops; no matter that the keyboards are too fiddly to touch-type (and are unusable by anyone with long fingernails, such as women and guitarists); and no matter that 2 MB is an awful lot of memory to power from batteries (so applications like Word wouldn't even start up). Microsoft has decreed that what palmtops *really* need is a version of Windows, compatible with W95, W97 and everything else it can think of. CE it's called.

Actually, what palmtops really need is transparent communications with data on desktops, and thence with the Internet. They need to be able to store, arrange, and discard hundreds of linked but heterogeneous records. They need to be able to send faxes through cellular phone networks. Microsoft has rather missed the boat, because all these things are being done today, and Windows is no help to any of them.

But let's set these objections aside, and take a look at the requirements for CE. It's got to be small enough to fit into a palmtop's memory (because long-term storage is not much different from core memory on a palmtop), and allow other programs to run. It's got to handle a screen which could be any size, but is bound to be small (otherwise it will eat too much power), so it can't waste loads of pixels with decoration. It's got to be responsive (no Pentiums to blitz crappy task-switchers which would fossilise on a 386). It has to withstand power failures caused by flat batteries, so it can't have enormous configuration files spread all over the place. In short, it (and its applications) have to run on a decent desktop of ten years ago.

Now, if Microsoft could do this, it could (in theory) have done it with Windows 2. It should have done it with Windows 3. It should certainly have done it by W95. Between you and me, judging by past performance, I don't think it can do it at all. But what occurs to me is this: if, by some stretch of the imagination, it does pull this off, I'd quite like one running my desktop. Even if it makes a complete pig's ear of CE, relabelling it as W97 might be a pretty good move. ■

Jules likes to write programs, but spends most of his time getting computers to run. When he's sufficiently drunk, he calls himself a configuration consultant. If your computer is holding its breath until it turns blue, you can get help on 01707 662698, or at jules@cix.compulink.co.uk

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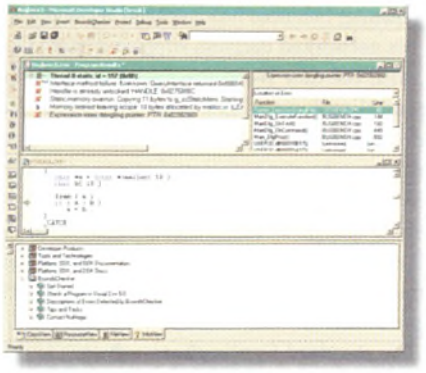


The latest version of NuMega's popular Bounds Checker error detection tool is claimed to be significantly faster than before, thanks to two new technological tricks which the company has named ActiveCheck and FinalCheck. Previous versions of BoundsChecker employed a re-compilation technique which inserted traps into an application's source code around memory accesses and API calls; this bloated code size and required a seprate re-compilation each time the application was to be checked for errors.

ActiveCheck takes a different approach by sitting in between the application and the system DLLs, intercepting calls, validating parameters, and identifying errors. As standard, ActiveCheck handles calls into all the Win32 system DLLs, ODBC 3.0, the Microsoft Internet APIs, as well as ActiveX and DirectX interfaces.

FinalCheck still relies on code instrumentation, but instead of directly patching code, it interfaces at the intermediate code level as a direct part of the compilation process, drastically reducing the time required to analyse the program. Because FinalCheck must be directly integrated with the compiler, it is currently only available for the forthcoming Visual C++ 5.0.

BoundsChecker 5.0 will be available in three versions: a standard edition, a Visual C++ 5.0 edition, and a Delphi 2.0 edition. Previous versions of the product had some degree of integration into Visual C++, but BoundsChecker 5.0 merges seamlessly into the menu and toolbar structure. The Delphi version promises a similar degree of shell integration.

No UK pricing was available at the time of writing, but all three versions are expected to be available for resellers including System Science and QBS by the time you read this.

◗ *NuMega 00 1 603 578 8400* ◗ *Fax 00 1 603 889 1135* ◗ *URL: http//www.numega.com*

Windows Show 97

This year's Windows Show at Olympia was noticeably smaller than last year's event, fitting for the first time into the main part of the Great Hall. Perhaps encouragingly for developers, though, the software development part of the exhibition has grown.

Several companies were noticeable by their absence: there were no stands from IBM, Lotus, Apple or Novell, and Netscape was limited to a handful of representatives guesting on the Symantec stand.

There were few new development products on show, although Microsoft was giving test-drives of its forthcoming Visual Studio package. InstallShield showed off Install From The Web, which – as the name implies – allows for software to be installed directly across an IP connection. Symantec was giving demos of Visual Café Pro, its client/server enabled version of Visual Café, and Borland was showing C++ Builder (reviewed in this month's issue) and previewing JBuilder, its long-awaited Java environment, which was formerly known as Latté. JBuilder is expected to ship shortly.

Of the non-development products at the show, probably of most interest was Microsoft's Windows CE, the palmtop Windows-like OS which will be available on handhelds in the UK from the summer. A developers toolkit for CE is already available from the Microsoft Web site.

Embed the Web with Spyglass

Most people probably remember Spyglass as the company which bought Mosaic, the 'original' graphical browser for the World Wide Web, from the NCSA where it was originally developed. A few releases of Spyglass Mosaic for various platforms then followed, but despite the early dominance of this browser the rival – and frankly better – alternatives from Netscape (based on Mosaic and written by most of the same programming team) and Microsoft quickly overtook it. (A few people might remember that Microsoft's Internet Explorer is actually based on licensed Mosaic technology as well.)

Rather than try to compete against the 'big two' in the browser wars, Spyglass has diversified into alternative Web technologies and it is in this spirit that it has released Device Mosaic, a mini-browser for embedded platforms. Available as a development kit for Solaris, Device Mosaic can be quickly ported to most embedded operating systems with standard tools. Developers choose the level of functionality to add to their build by adding in or removing modules – for instance scripting or Java support – as necessary to suit the target platform. The 'basic' Device Mosaic build which includes support for HTML 2.0, GIF and JPG images, cookies, and server push weighs in with a 890 KB binary and will run in as little as 1.7MB overall memory, making it suitable for embedded applications such as phones, in-car systems, consumer electronics and industrial equipment.

Device Mosaic development licenses are priced from $50,000 per seat with run-time licensing priced individually per customer. Development consultancy is also available.

◗ *Spyglass: 01753 705003* ◗ *URL: http://www.spyglass.com*

◗ Digital watermarking expert **Digimarc** has released a beta version of the **Digimarc Watermarking SDK**, a set of C++ class libraries for embedding, detecting and verifying watermarks in copyright images. www.digimarc.com

◗ **Visigenic** has extended its **VisiBroker** product range with naming and events services for Java and C++ which are compliant with the OMG's **CORBAservices** specification. Available on **NT** and **Solaris**, priced from $150 per runtime user. 00 1 415 286 1900

◗ **Charm Works** is a GUI toolkit for National Instrument's **LabVIEW** system for developing realtime process analysis applications graphically. The toolkit allows chemometrics to be integrated with realtime data acquisition and process control systems. 01252 373000

◗ **Intersolv** – of **PVCS** fame – has become the first company to ship ODBC 3.0-compliant drivers for Win32. Its **DataDirect** drivers support the full standard including Microsoft's **OLE DB** and **ADO**. 01727 812812

◗ From Data Junction comes **DJ:Engine**, a runtime version of the Data Junction data conversion engine for Windows NT and Unix platforms. Application development still takes place in the **Data Junction** environment but code is now portable between platforms. 0171 833 1022

- The winner of the Windows Show 97 prize draw was Mr D Patel, a technical support contractor from Rochester, who walks away with the **IconAuthor** package donated by **Aimtech**.

- The final version of the Java Development Kit (**JDK**) 1.1 is available for download at http://java.sun.com/products/jdk/1.1, including **Unicode 2.0** support and dramatic improvements to **AWT**.

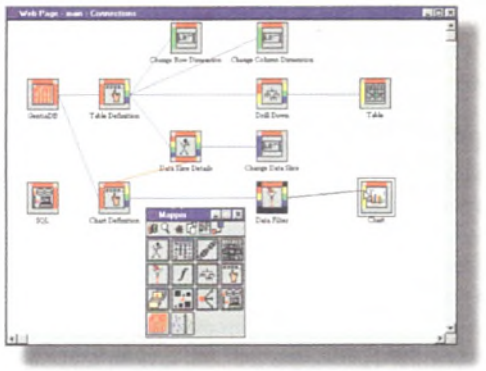
- **Rational** and **SQA** have jointly announced new releases of their visual modelling and testing tools, **Rational Rose 4.0** and **SQA Suite 6.0**. Both products now provide full support for **Visual Basic 5.0**. http://www.rational.com

- The oddly-named **BDK** (Beans Development Kit) for Sun's **Java Beans** component model is shipping, along with the Java Beans Bridge for **ActiveX.** It is available from Sun's web site, http://www.sun.com

- Also from Sun is the **JRE** (Java Runtime Environment) a set of updated Java classes that give any Java Virtual Machine an instant boost to JDK 1.1 functionality. JRE can be included royalty-free with Java applications.

- From MapInfo comes SpatialWare technology, for integrating spatial and geographical data into **Oracle** and soon **Informix** databases. The data is accessed with 20 spatial extensions to SQL, and a C API is available. http://www.spatialware.com

Gentia takes the initiative with MD-API



Planning Sciences has released version 3.1 of its networked decision support system Gentia, with the new WebSuite package for deploying applications which use standard Web browsers as clients. WebSuite uses the Gentia Web server to communicate between the standard Web server and a Gentia application server running alongside, receiving requests through a CGI stub (for efficiency reasons, we're told) and dynamically generating HTML pages for the user's browser.

The standard Gentia client software is used to generate page templates and link them to the underlying Gentia application, with a highly visual interface, including drag-and-drop editing of report filters. Custom Java applets can be stored natively within Gentia's Object Store, and WebSuite includes an applet which interprets and charts data on the client machine, avoiding the overhead of transmitting chart bitmaps over the network.

Gentia 3.1's GentiaDB API is the first multidimensional database API to support the OLAP Council's MD-API standard, with numerous extra features for programming Gentia's proprietary features. These include support for intelligent user agents and *text infobases*, plain text 'databases' with extremely powerful search capabilities.

Gentia 3.1 is available on all major platforms, including Windows, OS/2, and major Unix variants, with licensing terms based on the number of concurrent users.

◗ *URL: http://www.gentia.com* ◗ *Planning Sciences 0181 971 4000*

Versant speeds object communication

True high-performance distributed object computing comes a step nearer with release 5.0 of the Versant object database. The new version, aimed at very high end distributed applications such as large scale data, audio and video streaming, boasts improved language bindings and a two to three-fold boost in performance. The database's core client and server code has been revamped with native multi-threading, multi-session client capabilities, improved memory management and server SMP enhancements.

Versant has the potential to become a standard base for efficient distributed object computing, offering significantly more efficient support for fine-grained objects than technologies like CORBA. Currently, it supports C++ and Smalltalk as core development languages, with a Java Direct interface in beta. Code written in one language can access objects created with different languages as if they were native.

The C++ interface is fully compliant with the Object Database Management Group's (ODMG) specifications, and integrates with both the Standard Template Library and Rogue Wave's C++ tools. The Smalltalk interface (claimed by Versant to offer the highest performance object access in the industry) supports IBM VisualAge 3.0, ParcPlace Digitalk VisualWorks 2.5, and VisualWave. The ODMG has not yet defined standard interfaces for Smalltalk and Java, but work is in progress.

Access to the outside world is provided by third party CORBA integration tools from Iona (in the shape of Orbix+Versant) and Expersoft (which is integrating PowerBroker with Versant). On the Java front, Versant has announced an intention to work with SunSoft to integrate with the NEO environment.

Two new database access products are added to the family with this release: VersantWeb, for Internet access to Versant databases (complete with state and session management and load balancing across multiple servers), and the Versant SQL Suite, which uses automatic mapping and indexing to implement access from SQL, ODBC and JDBC.

Versant release 5.0 is due to be generally available from May, on Solaris, HP/UX and Windows NT. Pricing starts at £2200 for the Unix versions, and £1400 for Windows, with support for one of the three development interfaces. VersantWeb is scheduled for release this month, and the Java Direct interface sometime in the second quarter of the year.

◗ *URL: http://www.versant.com* ◗ *Versant Europe: 00 49 89 456 0350*

Linux, DOS... and DOS source code

Caldera will start shipping Open Linux Standard this month, to be followed in the Summer by the Deluxe edition. The standard version ($300) includes Netscape 3.01 Gold, FastTrack, OpenDOS, StarOffice, the Visix JVM and SNA, SDLC, HDLC and IPX routing. Deluxe (around $1000) adds NetWare file and print capabilities and SQL, along with GroupWise and NDS. OpenDOS, which is based on DR-DOS, is available for download with a light client (browser and email). It's free for academic use, and will cost from about $20 to less than $1 for high volumes. More significantly, the OpenDOS source code is due to be made available on Caldera's Web site.

◗ *URL: http://www.caldera.com* ◗ *Tel: 01264 333600*

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ACM97

The Association of Computing Machinery, as its name might suggest, is the oldest association for computer professionals, created back in 1947. To mark its 50th birthday, it organised a conference and an exhibition on what computing will be like in 50 years time! The exhibition was set up as an archaeological dig in 2047. See *http://ww.acm.org/acm97*.

Forecasting the future

The speakers covered both the technical side of the evolution of computing and its social impact. Quite a few talks focused on what will happen when the number of electrons at a transistor gate is reduced to just one – the demise of CMOS being predicted for around 2010. Joel Birnbaum, Carver Mead and Gordon Bell explored the possibilities of DNA-based, quantum, optical and analogue computing. Other events included Murray Gell-Mann discussing the importance of cross-fertilisation between fields (being a generalist as well as a specialist), and Elliot Soloway's argument that modern schools are still based on an industrial-age model and need to be radically overhauled. Bruce Sterling, speaking from experience of course, reminded everyone of the importance of leisure time. Most presentations were fascinating and provocative, and I strongly recommend that you check out the whole conference at *http://www.vxtreme.com*. We only have space for an excerpt of the talk by Maurice Wilkes, the English computer pioneer who invented labels, developed the first programming system based on subroutines along with David Wheeler and Stanley Gill, and co-authored the first book about programming. Here are his views on the past and future of programming:

'Programming languages took a wrong turn at the beginning, in the late 1950s and I'd like to see this put right. It was a very great pity that Fortran and Algol gave rise to two opposed camps when there should have been cross-fertilisation between them. There's much that those two groups could have done for each other and we would have had better languages much faster. What I particularly regret is that the people responsible for modern programming languages remained wedded to the Algol stack-oriented block structure. One of the reasons for the success of Fortran was that there was no block structure. Block structure makes it difficult to include machine-code subroutines in a program. It inhibits progress in separate compilation and in the reuse of subroutines, and it imposes an unsuitable hierarchical protection model.

I hope that we may look forward to a time now when properly handled objects will be the answer. Objects are much talked about [but] not always understood. We need an evangelist to stress the important thing about them: that they can stand alone, that they have a clearly defined interface to the outside world. Any routine can communicate with an object if it observes the correct protocol and objects can communicate with each other. They have no ordering, they have no taking order, they are all on a level. I think because of the coming of object systems we are seeing a renewed interest in the things I mentioned, particularly reuse of software. It always puzzled me that people are so fascinated by hierarchies. If you want to see what can be done with a flat non-hierarchical system then you only have to look at the Web.

We made a great deal of progress in software over the years [...] and we shall make a great deal more. I do have a despair of operating systems. They desperately need simplifying and streamlining. They allow you to do things in all sort of different ways, one of which would be enough. The designers seem to have no idea of balance between response time, which is all-important, and the service provided and so on. I do not myself confidently predict that OSs will be any better 50 years hence.'

Digging back to 1997

The exhibition was quite unusual on several fronts, displaying artefacts from current computer 'history', usually in an irreverent manner, like the Cray computer two-thirds exposed from the sand in the middle of the floor. Unusual too, is that the exhibition was free, not only to the visitors but also to the companies, research centres and universities exhibiting. The exhibition was paid by a few underwriters and the space was given on a merit basis.

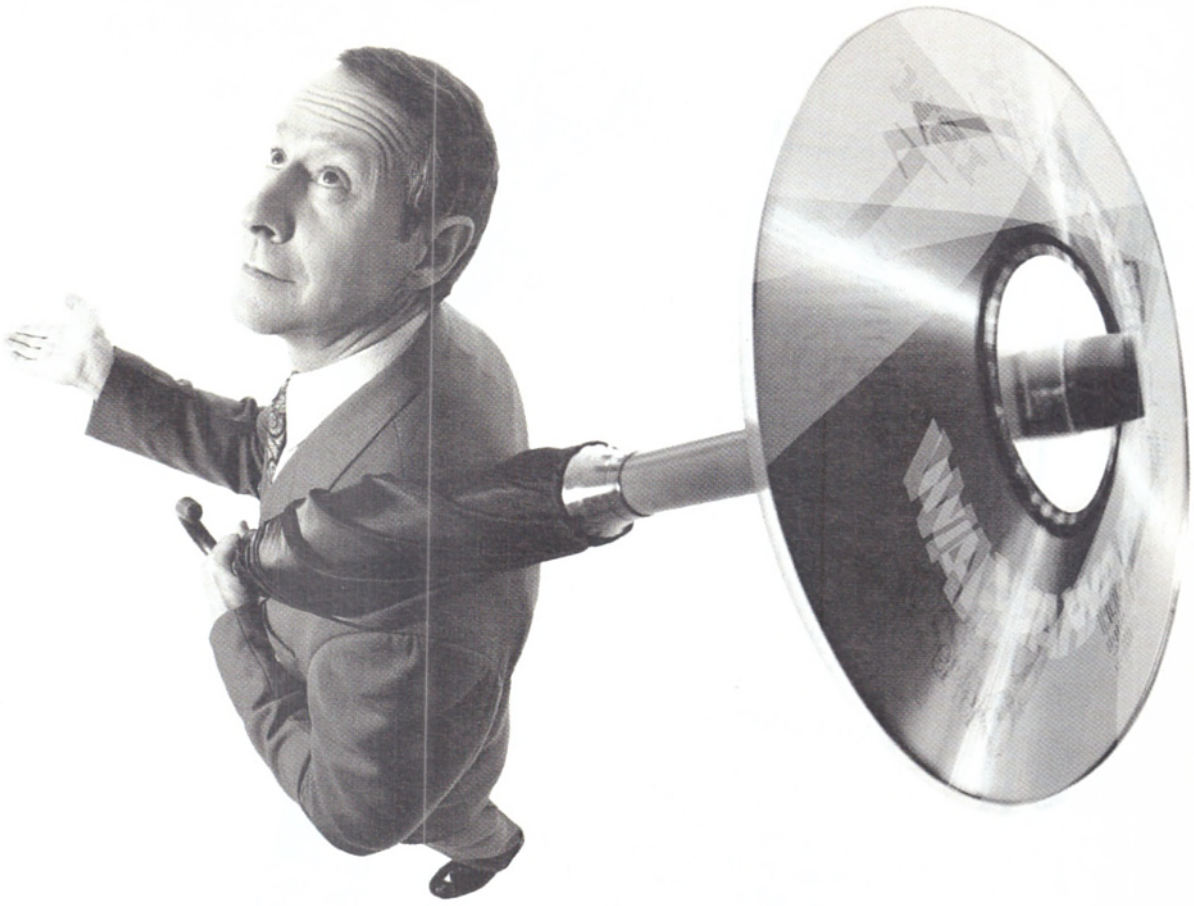
Virtual reality was heavily represented, with demonstrations like the East Carolina University School of Medicine's remote doctor consultation via telepresence, a virtual manipulation physics course where one could manipulate field forces in 3D (from the University of Houston and NASA), a virtual kabuki theatre where two actors where filmed acting body and face movements which were applied in real-time to a virtual actor (by ATR Media), and synthetic interviews (from Carnegie-Mellon University) which gave me the chance to have a conversation with Albert Einstein. I could ask any questions directly using a microphone and Einstein answered via a TV screen, with a delay of between 2 to 15 seconds depending on the length of the question (from 'are you still alive?', to a long question on difference between the different relativity theories). It works with a large database of text from speeches and documents produced during his life. Speaker-independent speech recognition analyses the questions and builds answers. It worked amazingly well.

Among the more conventional exhibits, Immersion showed its I-Force API for force-feedback on joysticks (*http://www.force-feedback.com*) and Lucent Technologies exhibited a code visualisation tool which displays code modules in boxes, with each line colour coded according to an attribute such as the age of the code (*http://www.bell-labs.com/project/visualinsights*). The San Diego Supercomputer Center had some limited information on its Distributed Object Computation Testbed: a meta-database to store terabytes of data-sets (*http://www.sdsc.edu/DOCT*).

Windows' future

Nathan Myhrvold, Microsoft's Chief Technology Officer, has already started to plan Windows 2047. He drew a comparative table with Windows 2.0 (see below). One thing missing from Myhrvold's public presentation was the future role of the developer. He later revealed this important part of Microsoft's plans to *EXE*: in Windows 2047, 'the developer is the parent'. The deeper implications of such a statement can be grasped from another highlight of his talk: 'I hope I am not talking about software. I hope I *am* software'. Myhrvold considers that today: 'you [can] fit on a floppy disk'. The human genome occupies about 1 GB, individual differences amount for about 25%, which after a loss-less compression of 2:1 amounts only to 1.2 MB. CQFD. On a similar not, the whole human population is worth less than 3.7 TB, after compressing all the family relatives it goes down to less than 1 TB, the size of big Web site.

Windows 2.0 (1987)	Windows 2047
Multi-tasking	Multiple personalities
Virtual memory	Virtual memory
Compatible with MS-DOS applications	Compatible with meat-based humans
Breaking the 640 KB barrier	Breaking the 640 PB (10^{15} bytes) barrier
GUI	U&I



"I started running OS/2 Warp Server on all my networks and guess what?

My rainy days are over."

Umbrella

It was time to consider consolidating his mixed environment network onto a single operating system, so Steve Conaway, Director of Computer Services at the Financial Times, decided to check out the new release of OS/2 Warp Server. In no time at all, Steve was waxing poetic over OS/2 Warp Server's ability to handle blockbuster-sized databases and make Internet and Intranet access a breeze. He was also impressed with all the advanced printing capabilities and management features that simplified the running of both his network and his life. From now on, Steve definitely regards his OS/2 Warp Server as his umbrella network operating system.

To find out what got Steve so excited, call 0800 96 90 45 for your free 60-day evaluation copy of Warp Server, or you can visit our web site at www.software.ibm.com/info/ws031.

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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.

Internationalisation tools

Dear Editor,
In the review of the *Programmer's Bookshelf for Windows 95* (*EXE* December '96), Colin Smith ends his comments on *Developing International Software for Windows 95* with the following observation: 'what the book lacks is coverage of development tools for automating and managing the internationalisation process – many developers create their own systems, but internationalisation tools do exist'.

While I have found quite a bit of advice on how to prepare the source code for internationalisation, I have not come across any of these internationalisation tools to manage (and especially automate) the internationalisation process itself.

At my place of work we are planning to translate our Windows software into a small number of European languages. I have made a modest start, but before we get any further I want to get as much information as possible in order to avoid getting into a maintenance nightmare.

We use Microsoft Visual C++ and MFC, and for the time being, everything will be for 16-bit only. To extract the strings from the RC files I have used the excellent RCMAN utility from the December 1994 issue of *EXE*, and modified it to handle slightly longer strings. In order to allow our translators to use their own favourite text editor I have also extended RCMAN with a new option that converts the octal literals that AppStudio produces for character codes greater than 128 back into ANSI characters.

For the very first translation this works well enough, but it is not very efficient when it comes to modifying each translation for new versions of the software. I would be extremely grateful if you could persuade Colin Smith to follow up his book review with a discussion of these internationalisation tools.

Maria Rutgers
bobs@cel.ltd.uk

There are two resource management tools that I know of, but I suspect there are some better systems out there: RLMAN (part of the RLTOOLS.EXE package) is an unsupported tool available on the Microsft Developer Network and Microsoft's ftp site. The other one is a Visual Basic program whose name escapes me. For a list of wordprocessors and tools for localisation, you might try http://www.tiziana.com/tools.html. As for doing an article, I'd have to research a bit deeper.

I also heard about a tool called ResourceShield (by the same people who did InstallShield) but no one could tell me where to buy it! [We weren't able to trace it either, and InstallShield don't sell a product of that name. Any information appreciated – Ed]

Colin Smith

Microsoft and Macintosh cross development

Dear Editor,
I wonder if you can help me? For some months now I have been trying to get a response from Microsoft about their attitude to repairing bugs in their Visual C++ cross development kit for the Macintosh.

In case you are not familiar with this, it is a product which allows you to take a Windows (or better still MFC-based) 32-bit application and build a version for the Macintosh. If you target PowerMac machines, and use MFC you have remarkably little to do to get a program working on the Mac. The product is an add-on to Visual C++ (and is quite expensive in the UK, I think it cost us £1000ish).

In the main, the product works very well, but it has flaws and limits to what it can do (as any reasonable person might expect). It also produces bugs in the compiled code that one cannot easily work around.

Some months ago I contacted the Microsoft Technical Support and reported a code generation bug. After denials that there was a bug, it became clear that they could not even try the code in the UK, so I sent them an annotated machine code listing, showing where it all went wrong. After much to-ing and fro-ing, I was informed that the bug was confirmed. I have searched the MS Web site and though there are bugs listed, compiler code generation problems such as those I suffer from are not. The great shame of this is that the product is potentially a great solution to the developer who needs to get an MFC application out on the Mac. It is spoilt by an unreliable compiler (I can provide evidence if required) and lack of any confirmation of future support.

I asked the reasonable question, 'When can I expect to hear about a fix, or a workaround'. I am still waiting for an answer. My suspicion is that MS produced this product a year or so back, but after one revision disbanded the team, so support rather dried up.

We managed to work around that particular bug. Today we have traced another elusive problem that also turns out to be a code generation bug. We have a product to get out, and a compiler we cannot rely on, but that we are locked into because of our reliance on MFC. I wonder if you could use whatever influence you have as an editor of a serious software developers' magazine to get Microsoft to answer these questions:

1. What is the status of the Visual C++ for Macintosh kit in terms of future development and support (ie will it stay marooned at version 4.0, or will it catch up with the Intel version)?

2. What are users who have bought their kit and are hit by bugs in the compiler expected to do about it?

Anonymous

We forwarded your questions to Microsoft's UK Product Manager for the Developer Division and after three weeks still haven't received replies to either of

them. He did, though, confirm that he will send us more information on the status of the Visual C++ for Macintosh product.

Ed.

Some more Meyer

Dear Editor,

I was leafing through my (.)*EXE* back issues recently when I came across the May 1992 issue containing an interview with Bertrand Meyer, designer of the Eiffel language. Previously, Object Oriented Programming had been merely a mysterious acronym to me, but reading this article was like a personal damascene conversion – Meyer put across the OOP philosophy so lucidly and (mostly) reasonably that one wondered how anyone could possibly want to program any other way.

Anyway, in view of the fact that (i) a new Object Oriented language (Java, what else?) seems to be starting to provide a serious challenge to the cuckoo in the nest that is C++ and (ii) a newly-released version of Visual Eiffel is available (check out *http://www.eiffel.com*), would not a 5th anniversary interview with the good Dr. Meyer seem a good candidate for a future issue of your esteemed organ?

Enjoy the magazine enormously – keep up the good work (but I can't help feeling that the dot added a certain *Je ne sais quoi...*)

Charles Liddell
cliddell@cix.co.uk

It's nice to see that Bertrand Meyer succeeded in passing his vision, even if he hasn't managed to convert the whole world to Eiffel. We're not planning another interview with him for the time being, though there are plans to interview other personalities not yet featured in the magazine.

Ed.

Green communication

Dear Editor,

In last month's issue, Jules May writes: 'No resources, renewable or otherwise, are expended on an electronic conversation. No pollution is created by downloading a page'. What about the resources ('renewable or otherwise') consumed and pollution created to allow us to converse electronically and download pages?

Gordon Smith
gs@gordys.demon.co.uk

It seems to me that a chip factory is far less polluting than a paper mill, that silicon for chips and glass fibre is more plentiful than wood, adhesive, and so on, and that the human involvement in a publication is far less than the human involvement in a conventional mailshot. The infrastructure for electronic communication exists, and though it will have to be expanded, the costs of expanding it (and running the expanded system) are relatively small.

Think of it this way; if I print my ad on a piece of paper, the paper will then be thrown away or go through a complex and expensive recycling process. On the other hand, I can change the colour of every pixel on my monitor with complete freedom. Surely, a CRT is the ultimate in recycling :-)

Jules May

Symantec C++ 7.5 delayed

Dear Editor,

In the February '97 issue of your magazine the article on page 46 talks of Symantec C++ 7.5 being available from Silicon River for £69. I checked their advert and indeed there it was. The advert clearly states that *'all these Symantec products are shipping and available from stock'*. I phoned an order through and was told that 'it was currently out of stock due to demand' but would be back in stock by the following week. Three and a half weeks later I phone up to find out where it is and am told that the product is not shipping until the 'end of February'. It may be wise to print something to this extent in a future issue or even check for yourselves with Silicon River to see which story is correct. As far as I can see their advert contains a blatant falsehood if the product is truly not shipping until the end of February.

Matt James
mcj@ckshq.com

Just to clarify, Visual Café Pro made it at the beginning of February. C++ 7.5 finally made it this month (March 6th) due to a last minute problem with the master that was issued early February but had to be re-worked which delayed shipment to this month. Apologies for any problems this may have caused but I'm sure the reader would prefer a fully working version and these things happen in the software industry :-(

In fact we also shipped the dbANYWHERE Server (with unlimited connections) in February and released patch updates to Visual Café and Visual Café Pro. A Preview of Café Mac 1.5 is up on the Web site right now – due for final release in a few days. A new version of C++ Mac is due to ship in the second quarter and all of our Java products (Café, Visual Café and Visual Café Pro) are being updated to be compatible with JDK 1.1 as soon as possible.

Paul White
Symantec, IPM Development Tools

Symantec is now giving us a confirmed availability date of March 7th. It earlier indicated that this would be ready for end of January (along with Visual Café Pro). Visual Café Pro made it but C++ did not.

We have had our orders for this product in since early January. I guess 'falsehood' is true if you want to be harsh about it, but 'blatant' is not, it's after all bad business for us to pay magazines to advertise products that we can't sell. We lose out on this too! Incidentally every other product on our ad (and it featured many) was available. At the time the copy was prepared we were told in good faith C++ 7.5 would be available with time to spare. We made the decision to put it in the ad. The product got delayed at the last minute. Hence in this one respect our ad was wrong. We are sorry that this upset your reader (and our potential customer).

As for the product 'being out of stock due to demand', I can't understand this as we have never had any stock. This must be some misunderstanding between the reader and our telesales.

Paul Leathers
Silicon River, Director

Internet taxation

Dear Editor,

Luckily for free speech it seems unlikely that a tax on the Internet will be possible (see Mayhem, *EXE* March '97). One of the main problems is defining what the Internet is and thus what would and would not be taxed. If I connect two of my machines together then surely that is not the Internet, but what if I am using TCP/IP? What if I connect more machines together? What about chips on the same computer? If a tax was placed on the Internet, the result would be that everyone would declare it was not the Internet and still carry on doing what they did before.

Robert Ennals
ennals@aol.com,
http://members.aol.com/ennals/

You're right, of course. There are innumerable reasons why a tax on the Internet can't be done. That doesn't stop the bureaucrats thinking about it, though, and it seems pretty strong evidence to me that they still simply don't understand it. I don't think it's really the tax itself which concerns me; it's more the motivation behind the suggestion.

Jules May

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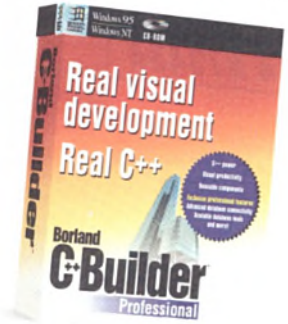

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CIRCLE NO. 160

The bear facts

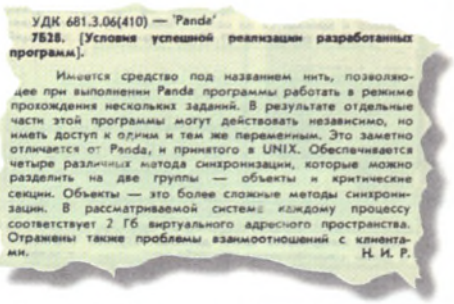
笑话 It's not just the British and Americans who can invent obscure programming languages. China got in on the act too – without anyone even knowing it. **Joe Kerr** looks at a language with a trick or two hidden up its sleeve.

There's probably a language for every day of the year. From the most well-known – Basic, C++, Lisp or Fortran – to more obscure ones like Occam, Python or Intercal. But not many developers have heard of Panda. A simple language with a mixture of C and Basic-like syntax developed at Beijing University during the 1970s, its main purpose was to allow scientific personnel spread around the world in Chinese embassies to covertly exchange software used, among other things, for surveillance and codebreaking applications. Encoded into apparently straightforward source code were in fact far more complex algorithms and data. The technique used to achieve this was steganography, the science of hiding secret messages in apparently innocuous data. Concealing textual data within other text is very difficult – usually in steganography, text is encoded into image files – but as Panda demonstrates, it can be done.

The precise algorithm behind Panda's astonishing steganographical capabilities is still a secret, but what is known is that the order and precedence of operators, and the physical layout of the code are major factors. According to a Chinese myth, there exists an ancient scroll depicting a Panda which supposedly had some wonderful secret hidden within, hence the name of the language.

It seems the language was used by a large number of people in the Chinese civil service. Most Panda developers were unaware of the language's hidden functions and used it to write ordinary programs. Only a select few diplomatic employees would have used the steganographic features. (As you can see from Listing 1, Panda code looks rather inoffensive).

Very little was known about Panda until – unfortunately for the Chinese – a KGB mole in Beijing University discovered a working copy of the prototype Panda compiler for Unix, a Panda Virtual Compiler for DOS, and a language specification. She passed these on to Moscow, thus rendering Panda of academic interest only. With the collapse of the Soviet Union, much of the Panda material became public and was posted late last year to the rus.comp.sys newsgroup by a Russian reporter, Eta Vsyashutka, who discovered Panda while rooting through declassified KGB archives relating to computer hacking and decided to bring it to global attention as a Cold War curiosity. Vsyashutka is an IT journalist for Sevodnyashiye Komputerniye Sistyemi (Computer Systems Today) in Moscow (see Figure 1 for an excerpt from Eta's original Panda article for that journal).



УДК 681.3.06(410) — 'Panda'

7528. [Условия успешной реализации разработанных программ].

Имеется средство под названием нить, позволяющее при выполнении Panda программы работать в режиме прохождения нескольких заданий. В результате отдельные части этой программы могут действовать независимо, но иметь доступ к одним и тем же переменным. Это заметно отличается от Panda, и принятого в UNIX. Обеспечивается четыре различных метода синхронизации, которые можно разделить на две группы — объекты и критические секции. Объекты — это более сложные методы синхронизации. В рассматриваемой системе каждому процессу соответствует 2 Гб виртуального адресного пространства. Отражены также проблемы взаимоотношений с клиентами.

Н. И. Р.

Figure 1 – Excerpt courtesy of Computer Systems Today.

Of course, the original compiler implementation and the specifications should have been destroyed after the prototype was made to work properly. Panda's influence has through obscure means gotten into any number of things, the most well-known being the recent spate of viruses which masquerade as ordinary Word or Excel macros. Although Panda is no longer in use, it offers a fascinating glimpse into the world of cloak-and-dagger software which is normally only the preserve of military programmers. ■

Joe Kerr studied Chinese at University, spent four months chasing pandas in Sechuan province, then became a cryptographic analyst for a Government agency. He welcomes any further opportunity to mix his two favourite subjects. Any Panda-related material or questions can be sent to him at: BM Panda, London WC1N 3XX.

```
~ Panda programs begin with a 'start' function.
fn start() <<
~ Panda uses the '<<' & '>>' symbols instead of braces which are- not common on Chinese-Roman
keyboards
          var integer a,f;
          print("Sample Panda program (C)1997 J.Kerr",$CR,$CR);

          ~ Note that print handles automatic type conversion

          for (f,10,0,-1) <<

          ~ 'for' takes four parameters - count variable (must be an int),
          ~ initial value, end value, step size - rather like Basic

                    print(f+" green bottles hanging on the wall, "+f+$CR);
                    print(f+" green bottles hanging on the wall, "+f+$CR);
                    print("And if one green bottle should accidentally fall,"+$CR);
                    print("There'll be "+(f-1)+" green bottles, hanging on the wall."+$CR+$CR);

                    set a @ getkey();

                    ~ Note that Panda function return values can be automatically
                    ~ cast to the correct type for the assignment.

          >>

          print("End of program."+$CR);

>>
```

Listing 1 – Some sample Panda code.

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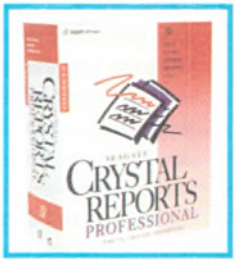

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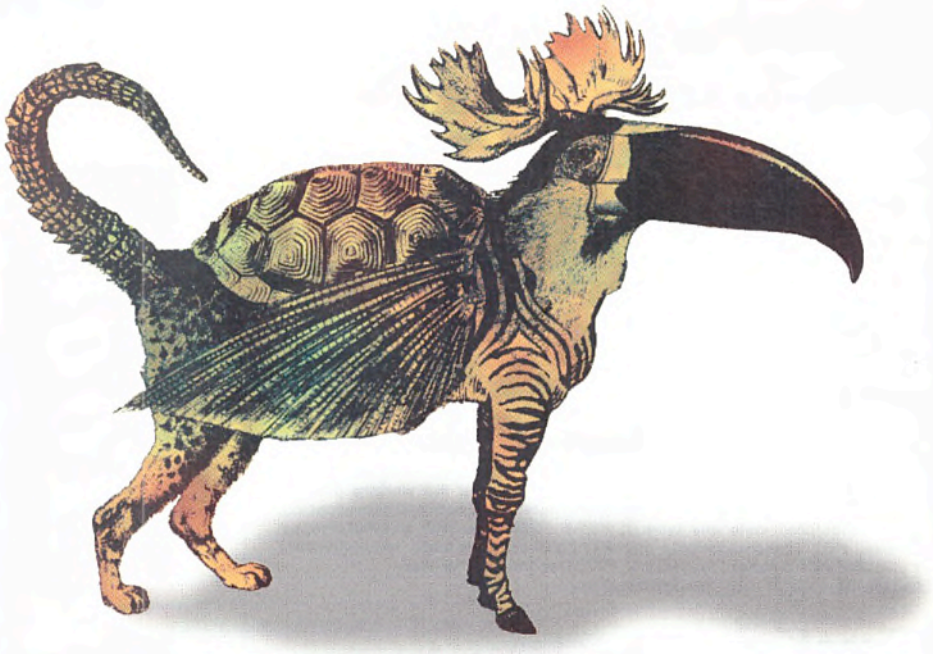
GENETIC ALGORITHMS

Many common problems have no easy algorithmic solution. **Mark Harman** and **Chris Kopec** explain how genetic algorithms can evolve solutions to these problems with Darwin's law of natural selection.



Growing your own code

Many engineers faced with difficult problems turn to nature for help. For example, Brunel's Thames tunnel was built by a machine inspired by the activities of the ship worm. Of course, this approach is not always so fruitful – early attempts at flight involving flapping wings proved to be a rather comical blind alley. With hindsight, we can see this as really just a case of taking the analogy too far: you can learn a lot about aerodynamics by studying a bird's wing, but birds do not constantly have to flap their wings to remain aloft.

We are accustomed to writing programs in a way which treats computers as humble and obedient servants of our every command, thinking that if God had meant computers to be innovative he would have given them brains. You might say that this is the rationale behind neural networks, which attempt to solve problems by mimicking (in a simple way) the workings of brains. But there are other leaves we could take out of nature's book: we could attempt to evolve solutions to problems in a similar way to how nature produced its flying machines – by natural selection.

So called *genetic algorithms* are generally applied to optimisation problems. For example, working out the best route on a transport network, the optimal configuration of chips on a motherboard, the ideal set of test data for maximum test coverage of a program. Even a simple problem like converting a number from denary representation into binary could be thought of as an optimisation problem: namely, finding the best binary number to represent the denary number.

For all these problems (except possibly the last one) we'd have to think hard to work out an algorithm for finding a solution. We have to do all the creative thinking so that the dumb machine can be programmed to calculate the best answer.

Genetic algorithms let the computer do some of the work in finding the best solution. The idea is that we do not tell the computer *how* to find the solution, we simply tell it *what* the solution is. Or more precisely, we tell the computer how to assess two possible solutions to see which is closer to the answer we want. In this way we move up a level from the problem. Instead of worrying about how to find the answer, we worry about how to ensure that we know *what* the answer is and what makes one answer *better* than another. We can use this as the basis of a system of natural selection, and combine it with nature's other 'engineering practices' – genetic mutation and sexual reproduction – to evolve answers to analytic problems like the ones we saw above. To keep things simple, we'll use one example from above (converting a denary number into binary), which could easily be solved without a genetic algorithm.

The genetic approach is completely unlike other approaches to programming. The system often comes up with answers that we couldn't possibly have expected and which can turn out to be better than we dared hope for. Of course, for the denary to binary conversion problem, we *shall* know the answer we want, but the interesting thing is that the computer produces the right answer without being told how to do so. There is no shifting or division in our conversion program. In their place you will find genes, gene-sequences, mating and mutation. Our solution is simply an individual in a population of possible solutions which are developed according to the law of natural selection: 'survival of the fittest', as Darwin's theory of evolution is often paraphrased.

Genetic algorithms are great fun because they take a lot of the drudgery out of programming. Tweaking the parameters of a genetic algorithm to see what effect it has upon the individuals you breed beats searching for bugs every time. Because we essentially *do not know* how the algorithm produces the answer we *can not* fix it, so

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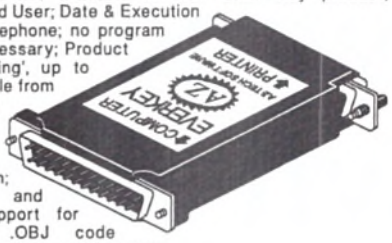

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there is no debugging in the conventional sense of the word. This is not to say we can not improve a genetic algorithm – we can, because we know the right answer when we see it. Sometimes there is no right answer, but in these cases there will be some limit above which we consider an answer to be 'satisfactory', and we will be able to see whether the algorithm is making progress towards that goal. We therefore replace the normal test-and-debug phase of the development life cycle with an experiment-and-adjust phase. We adjust the rate of mutation, and fiddle with the way in which mating takes place. Or perhaps we introduce a new gene, or remove an existing one. It's all a lot more exciting than tracing through the execution of a `while` loop.

Gene bit

The first step in designing a genetic algorithm is to work out how we are going to represent individuals in the *population*, which is our current set of possible solutions to the problem in hand. The natural choice to a programmer is to use a bit string – this is the most efficient representation in terms of storage space, and it will help us in performing some of the operations on individuals (such as mating and mutation) later on.

How does this relate to genetics? Well, as we know a living thing is largely defined by its DNA. All living things have a *DNA sequence* made up of their genes. A gene is simply a section of the DNA that manifests itself in some observable characteristic, for example eye-colour. The entire DNA sequence is made up of four elements, labelled C, G, A and T, named after the chemicals which make up each of them. This means that a gene is simply a sequence of these four elements (called bases). In our genetic algorithm we shall have two bases, not four, but the difference is largely a matter of taste – we could think of every two bits as a representation of a single base. Our definition of a gene will therefore simply be a sequence of bits.

So, what does a gene code mean in terms of our problem? Well, in the broadest sense, it represents a part of the overall solution. For example, if we are trying to find the optimal path through a set of cities (commonly known as the *travelling salesman problem*), then each gene could represent a city, with the position of genes in the sequence representing the order in which cities will be visited.

In our simple example, the solution we are trying to evolve is a binary number, so we will not have any problems with representation. Each gene is one bit long and effectively codes for nothing other than itself. For more complex problems, however, there is a lot of mileage to be gained from experimenting with different representations of an individual.

Measuring individuals

In order to measure how well a particular individual solves the problem (and whether or not they represent a satisfactory solution), we have to work out some value to represent its *fitness*, by applying a *fitness function*. This function is used to 'play God' with the individuals the algorithm is evolving, discarding some and allowing others to propagate by mating.

Often it's more convenient to measure an individual's unfitness rather than its fitness, because we then simply calculate how far away from the ideal solution the individual is. For example, in converting from denary to binary the unfitness is the absolute difference between the denary number and the individual which is trying to be its binary representation. If the unfitness is zero, we have the perfect (ie correct) binary representation of the denary number.

Measuring individuals in this way is rather like measuring programs using software metrics (see *EXE*, January 1997). All we need to do is to give a score to an individual that represents how good we think it is.

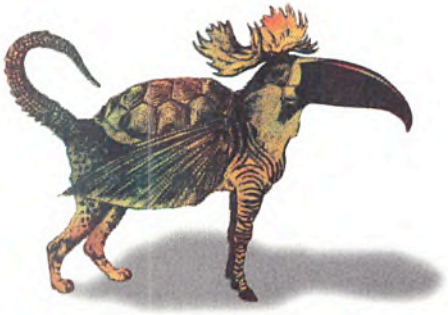
Wet computing?

The travelling salesman problem (TSP) involves visiting a set number of locations and returning to the starting point, while minimising the distance travelled. As the number of locations increases, the number of ways in which you could visit all the locations becomes extremely large: fifty locations can be toured in 1064 different ways. A supercomputer recently solved a TSP involving 3038 locations, and took one and a half years to do it!

Since they are so complex, TSPs have become benchmarks for testing the efficiency of algorithms. Researchers at British Telecom have built a genetic algorithm to solve TSPs, that amazingly can get within 4% of the best solution for the 3038-location problem in just 25 minutes on a standard workstation.

The idea of genetic computing has even been extended to the point where a computer based on DNA has been built, and applied to the travelling salesman problem (concerned with a journey between two cities). The experiment used 20 nucleotides to represent a city, amplifying the paths generated by each step with polymerase chain reaction or PCR (made famous in the recent OJ Simpson trial). The result was a gene print (those bar-code like transparencies used in many criminal trials) that could be interpreted as a particular path through the cities.

The 'DNA computer' is massively parallel, able to process trillions of potential solutions at the same time. At least 400 times faster than current super computers and using a tiny fraction of the energy, it also stores information one thousand billion times more densely than current technology.



It is the mating process that allows a genetic algorithm to 'home in' on good solutions.

```
void crossover () {
  int p2, /*second parent*/  i, /*bit counter*/ bit_cross, k;
  for (int j=0; j<24; j++) {    do {  p2=random(24);  } while (p2==j);
    for (i=0; i<31;) {
      bit_cross=random(31)+1; //max consecutive bits from each parent
      for (k=0; ((k<bit_cross)&&(i<31)); k++) {
        newind[i]=binaries[j][i++];
      }
      for (k=0; ((k<bit_cross)&&(i<31)); k++) {
        newind[i]=binaries[p2][i++];
      }
    }
    place_child(p2);
  }
}
```

Listing 1 – Function for mating.

Mutation and mating

We start off with a random population of individuals, none of which are likely to represent particularly good solutions to the problem in hand. For our algorithm to make some progress towards its goal, therefore, we must change the population in some way.

One way of achieving change is to mutate selected individuals. Mutation occurs in natural systems, and ensures that new approaches to the problem (be they good or bad) have some way of entering the population. In terms of bit strings, this simply means flipping one or more of the bits in some of the individuals in our population. For our example, we'll choose which bits to toggle at random, but this is only one of the many ways we could have defined mutation in our population.

We shall want to use our fitness measurement to decide which individuals survive and which die. This will ensure that the population as a whole gradually moves towards a solution to our problem as one generation replaces another. If the only mechanism for change we have is mutation, then our population will only be capable of finding the best solution that happens to be close to its initial state. In the long run, this nearest solution may not turn out to be the best one.

The secret of genetic algorithms lies in their approach to sex (see *EXE*, December 1996): that is, their ability to mate solutions. This process (as with its analogue in real life) creates a new individual which shares some of the characteristics of each of its parents. It is the mating process that allows a genetic algorithm to 'home in' on good solutions.

In its simplest form, called *cross-over*, mating takes two *parent* gene sequences and produces a new gene sequence containing parts of both the originals, called the *child*. We shall use our fitness function to select fit parents to mate with one another and apply the rule that we will only let the child survive if it is fitter than some individual already in the population.

Combining the two parents is simple: we copy a random number of bits from the first parent's sequence to the child's, then a random number from the second parent, and so on until the child's sequence is complete. The child is thus made up of concatenated subsequences from the parents.

```
void mutate (unsigned long int &unfit) {
  int r = random(40);
  if (r<1) { //shall we flip a row of the least significant bits?
    int q = random(31);
    for (int i=31; i>=q; --i) { flip_bit(i); }
  }
  if (r<2) { //shall we flip a few bits at random?
    int p = random(3) + 1;
    for (int i=0; i<p; i++) { flip_bit(-1); }
      unfit=unfitness(); // if mutation occurred assess unfitness
  }
}
```

Listing 3 – The mutation function.

The system often comes up with answers that we couldn't possibly have expected.

Selecting which individuals to mate and which to kill off, however, is more involved. You might think that we should simply mate the fittest possible parents and let their children kill off the least fit members of the population. The trouble with this approach is that the population may home in too quickly on a sub-optimal solution, and completely ignore better solutions that are simply harder to find. Unfit individuals that are making slower progress towards what is actually a better solution are killed off by the more immediately impressive individuals who are achieving early success with a poorer solution.

For our denary to binary conversion problem, we shall instead choose to mate every individual in the population once with another individual chosen at random from the rest of the population. In addition, we will use a 'parent only' replacement strategy, whereby a child replaces one of its parents if it is fitter than that parent. This ensures that members of the population which are killed off are replaced by similar individuals, which in turn helps to maintain the diversity of the population. As with naturally evolving systems, diversity is of critical importance if the best solution to the problem is to be found. The trick is to both encourage the population to evolve towards ever higher levels of fitness, while maintaining a high level of diversity. That way, when a sub-population reaches an evolutionary dead end, the rest of the population will eventually evolve beyond it and the dead-end population will gradually become extinct. In programming terms, we are carrying out a parallel search, with each sub-population representing the task of a single processor searching a sub-domain of the overall solution space. The more diverse the population, the greater the level of parallelism.

```
void place_child (int p2) {
  unsigned long int unfit = unfitness(); // calculates the child's unfitness
  if ((unfit<=binary_unfitness[p2])&&(binary_unfitness[p2]!=0)) {
    if (unfit!=0) { mutate(unfit);   }
    for (int i=0; i<31; i++) {
      binaries[p2][i]=newind[i];
    }
    binary_unfitness[p2]=unfit;
  }
}
```

Listing 2 – Deciding whether a child should replace one of its parents.

The genetic converter

Our genetic denary to binary converter translates a denary number into a 31-bit binary representation. It uses a population of 24 individuals, stored in the integer array `binaries`. While the algorithm is being evolved, the 'DNA' of the current generation of individuals is shown on the left of the screen, alongside their unfitness ratings. To the right there is a generation counter, a display of the denary value being converted, and the average unfitness of the population at the current time. When the run terminates, the program displays an approximate count of how many possible solutions were tried.

The `crossover` function (shown in Listing 1) goes through the individuals in the population, selecting at random a mate from the rest of the population. It then crosses over the two parents to form a new individual, by alternately copying a random-length bit string from each parent until the new 31-bit sequence is complete. Next, the function `place_child` (shown in Listing 2) is called to determine whether the child lives (and replaces one of its less fit parents) or dies, and whether it is mutated.

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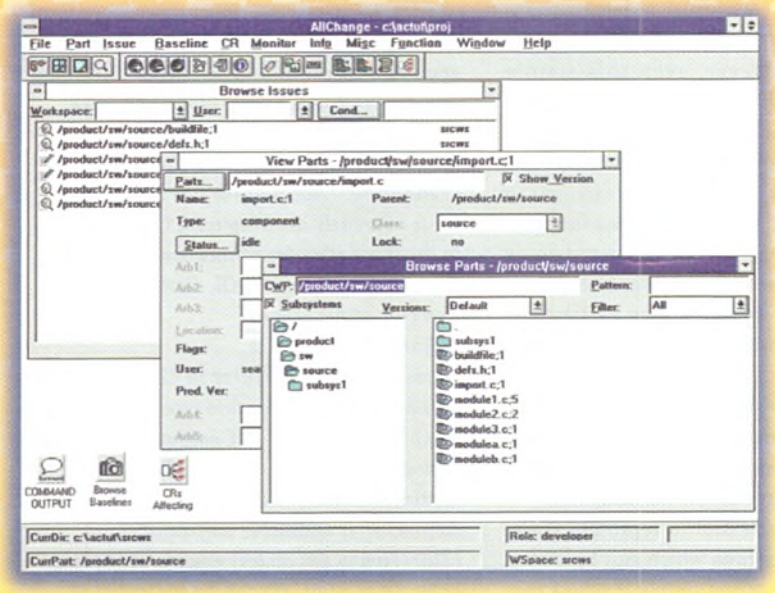

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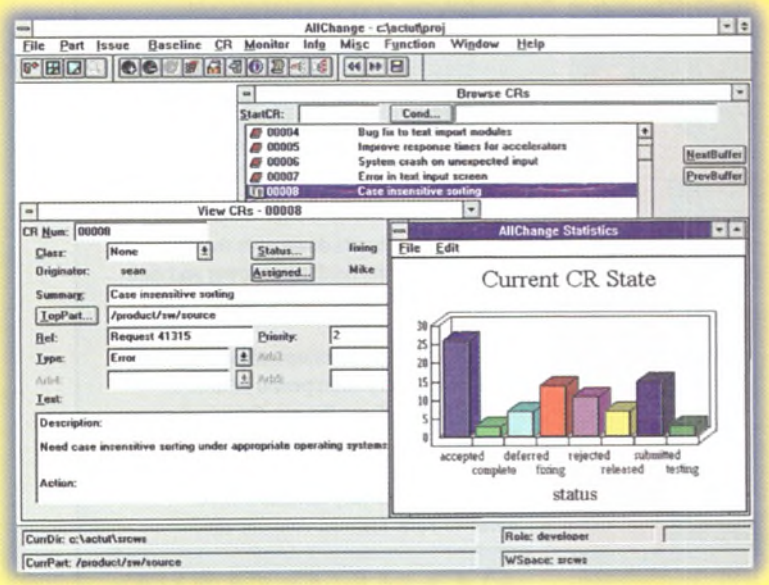

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Mutation is about maintaining genetic diversity and preventing our algorithm from getting stuck in a rut. Occasionally, you will see this happen when you try the program out. It happens because most of the population will reach an unfitness value from which it is unable to improve, until a mutation jolts it out of its complacency. The population may appear to jump from one sticking point to another as it hops between solutions.

We have set the mutation rate at 5% (see Listing 3: we mutate if the pseudorandom number `r` is less than 2). Individuals are mutated by flipping a random number (up to a maximum of three) of bits with the `flip_bit` routine. (Passing the dummy value `-1` to `flip_bit` specifies that the bit to be flipped should be chosen at random). We additionally mutate an entire sequence of the least significant bits in 2.5% of cases. The code picks a random point in the bit string and flips all of the bits from that point up to the end.

Watching the program run, you will notice (particularly for small numbers), that the algorithm optimises from the left, organising the most significant bits first. This is a natural consequence of the way in which we defined the fitness function – the difference between the denary equivalent of the binary number represented by an individual and the denary number we are searching for.

Mutations allow the algorithm to investigate genetic sequences that are variations on a 'model' fit individual. By introducing all such children into the population we ensure a steady supply of genetic variations based on the best models that are available (ie those that make up the current population). These variations provide the diversity that the crossover process needs to progress towards better solutions.

As we know, converting a denary number into binary is algorithmically easy. Genetically, however, even this simple example is searching in a space of over 2 billion possible solutions. Even so, it is unusual for the program to take more than 500 generations (or 12,000 bit strings) to find the correct binary representation – hugely efficient compared to a random or enumerative search which would on average take about 90,000 times as long, or about two months on a Pentium 166!

Massed ranks

Genetic algorithms can be applied in a huge variety of scenarios. All we need is the ability to rank candidate solutions according to some numeric scale and to represent these solutions as sequences which can be mated and mutated. Mutation simply involves 'corrupting' the data that represents a solution, and mating merging two solutions in some way. We'll look next month at how the effectiveness of a genetic algorithm can be changed by different ways of representing, measuring and mutating individuals.

With these basic ingredients we can simply leave our system to percolate solutions with the law of evolution until a good enough solution is found. Programming will never be the same again. ■

The source code for the converter is available online at http://www.unl.ac.uk/~mark/students/kopec/exearticle.html, and on EXE OnLine.Mark Harman is director of research at the School of Computing, University of North London. He is currently working with Chris Kopec to see if genetic algorithms can be applied to program slicing (EXE, October 1996). You can email him at m.harman@unl.ac.uk.
Chris Kopec is a Lecturer in Computing and Mathematics. He has recently completed an M.Sc. in Computing at the University of North London. His thesis, 'Optimisation: A Generic Genetic Approach' is available on-line at http://www.unl.ac.uk/~mark/students/kopec/msc.html. He can be contacted at 100556,2714@compuserve.com

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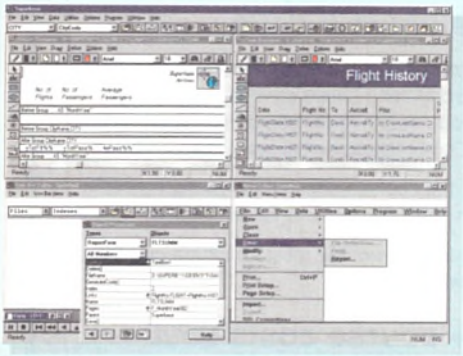

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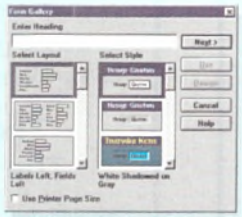

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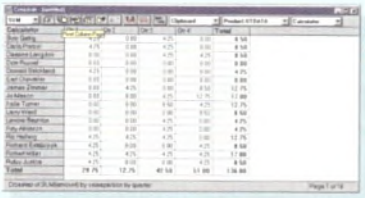

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Trad or RA

In the modern world of Visual-everything, traditional development methods are shunned by many as obsolete. But, do they still have a place? **John Watson** analyses the data.

To some IT people, traditional highly structured application development methodologies represent the only way to work. To many devotees of modern development styles, however, they are an irrelevant mystery. Analyst-programmers, technical managers, (and their employers) need to have an appreciation of the opposing viewpoints in order to assess when the old fashioned way of doing things is correct, and when the newer techniques should be applied. At the very least they should be able to say, after the event, why things went wrong.

The Boring Old Fogies

As an example of a structured method that fits into the traditional development life-cycle, let's examine SSADM, the Structured Systems Analysis and Design Method, developed with UK government sponsorship and now in its fourth major version. Similar techniques have been developed in other countries, and many large companies have produced their own variations. The details of these techniques vary, but the principles are the same. In particular, most stress that the user requirements and system design stages must be complete and fixed before a single line of code is written. The general steps are:

1 Terms of reference (scope the project).
2 Feasibility study (determine how and whether to proceed).
3 Detailed requirements analysis.
4 Detailed system design.
5 Implementation.
6 Review.

SSADM is concerned for the most part with the analysis and design stages, where the bulk of the work is done. The 'requirement' is assumed to consist of a synthesis of the current system (which may or may not exist), along with a list of perceived inadequacies. This information is gathered from the end-users, and used to generate the requirements and system design models. From then on, the involvement of the end-users is very limited.

So how are the models developed? SSADM and its cousins use three views of the system. A *data* oriented view describes what the information that will be processed is. A *process* oriented view describes what will be done to the data, and an *event* oriented view outlines when and why processes are applied to the data. These are all abstract models – they do not necessarily describe the physical structures that will end up being implemented.

Modelling

The data modelling process starts with a mess of data items derived from end-user interviews, which can be transformed through entity-relation diagramming into an ordered structure of tables linked by keys. The goal is for these tables to be in *third normal form*, or 3NF (sometimes called TNF). The first and second normal forms are subsets, or steps on the way to 3NF, which is the 'optimum' structure for a relational database.

The tables produced by the initial analysis generally contain repeating groups of information, such as multiple item description lines on an invoice. These are difficult to analyse for distinguishing records, and in any case processing a record that is effectively of variable length is not easy. First normal form requires placing these repeating groups in a separate table, with a unique field that can act as a *foreign key* (say an invoice number) indexed from the original table. Next, you remove any repeating fixed information (such as a customer's address, which will be in each occurrence of an invoice) to a separate table, with another foreign key. This is the second normal form – no data (except keys) is stored more than once.

Tables in 2NF can have many-to-many links: one product will be used by many customers, and customers may use many products). In 3NF, one removes (or 'resolves', to use the correct parlance) these relationships into another table – in this case, a customer/product table, linking particular customers to particular products. We now have a pretty much 'optimal' way of storing the data.

Process modelling is done with data flow diagrams (DFDs), with data flowing between external entities (people), processes (which represent the operations which can be performed), and data stores. The contents of the data stores and the items on the data flows correspond with the entities and attributes defined in the data analysis. The model uses a top-down approach, splitting processes into increasingly specific subprocesses, each with its own DFD, until a sufficiently low level is reached.

The event model ties everything together, and should validate the model's internal consistency. Each entity has events which will trigger the creation, modification, and deletion of an occurrence of the entity by a process.

In addition to these models, SSADM will document the data capture forms and methods, and produce a retrievals catalogue of outputs, and descriptions of all screen dialogues. Only when all this is done does work start on the system design, and it is at this point that one may compromise the model to take account of constraints on resources. When the system design is complete, one may finally begin coding.

The central idea of this technique is that the end result will satisfy the original requirement, or at least what was signed off as the original requirement. One thing it doesn't cover is the cost of producing the system – sup-

posedly the responsibility of the project managers. It can be criticised for its tendency to prolong the development process and deliver what everyone thought they wanted, not what was actually needed. Perhaps more importantly in a fast moving enterprise, what it delivers may be too late to be of much real benefit. So we come to the alternative: RAD.

The Bright Young Things

Rapid Application Development (RAD) techniques are an anathema to the traditional style of development, because the basic principle is to develop as you specify. For the simple example used above, a RAD developer could begin by designing a data entry screen (with one table behind it) that looks like the invoice form. The end-users look at it, try it out, and decide whether it is usable. The need for multiple tables and better structure will become apparent when they notice things like having to type in all the customer's details every time they issue a new invoice, and the prototype will be adjusted accordingly. Development is incremental, going through an iterative process of re-design and trial.

The fact that a crude synopsis of RAD development can be given in one paragraph rather than the many needed for traditional methods reflects the speed with which an application can be developed. The benefits are clear: rapid deployment, and a system that really should satisfy the business need. But there are problems with this approach. Early design decisions, based on incomplete understanding of the business problem, might cripple subsequent development, and refusing to nail down a fixed set of requirements tends to result in creeping functionality.

In order to bring proper quality to RAD and make it respectable, the Dynamic Systems Development Method (DSDM) was launched in 1995 by a consortium of end-users and developers. It uses a five stage system development life-cycle:

1 Feasibility study (determine whether DSDM is suitable).
2 Business study (scope the project).
3 Functional model iteration.
4 Design and build iteration.
5 Implementation.

The bulk of the work is in the two iterative stages. The functional stage uses prototypes to identify requirements, and the design stage ensures that the prototypes are sufficiently robust to be converted into a production system. Each stage will typically go through three iterations, with end-users closely involved at all times. An important point is that the stages can overlap: there is no reason why some components should not be completed while others are still being defined.

The emphasis throughout the iterations is on satisfying a minimum business need within a fixed time scale. Each iteration has four phases: define the functions and success criteria for the prototype; fix a time-scale for its development (the *timebox*); build it; and review the finished product against the objectives.

In the event all the functionality cannot be implemented (or new requirements come to light) within the timebox, the requirements are reviewed. During the build phase, mandatory objectives are dealt with first and non-mandatory ones completed only if time allows. Any particular module need only be completed to the level where work can proceed on the next module – it can be completed in a later iteration.

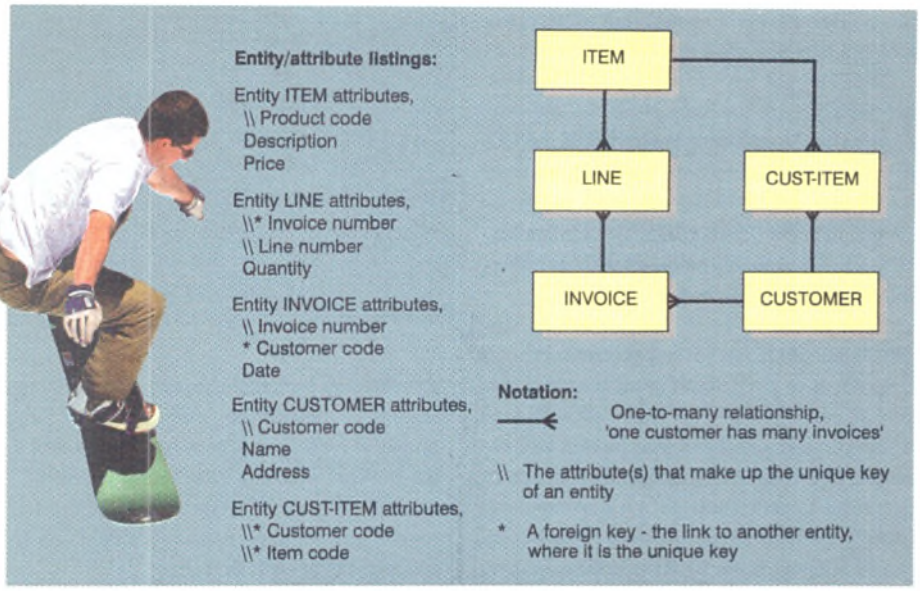

Figure 2 - Entity/relation diagram.

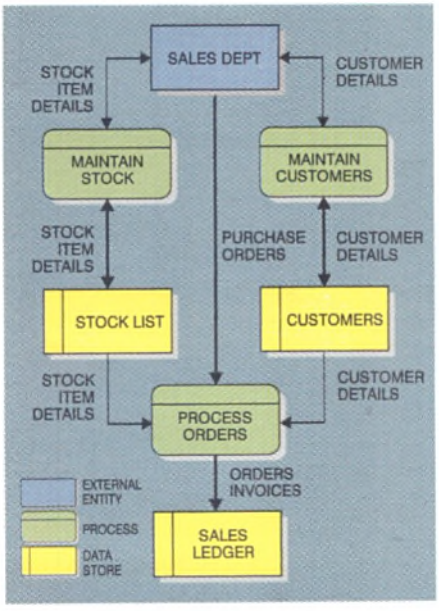

Figure 1 - Data flow diagram.

You can't have it both ways

A glib way to distinguish between traditional and RAD techniques would be to say that with the former, the functionality to be delivered is fixed (which is contractually nice), but the time and cost are not; and with the latter, the converse is true. It is, of course, not that simple. SSADM's separation of requirements from system design should make it possible to take a specification to several suppliers who might propose to implement it in different ways. With a RAD project, on the other hand, one must almost certainly choose one platform (and supplier) right at the start and stick with it.

Can the two approaches be combined? Not according to the books: the only point in SSADM where RAD might, possibly, fit is in what SSADM calls 'prototyping'. However, reading between the lines of the manuals one suspects that prototyping was only introduced as an afterthought, and it is made clear that any prototype should be completely separate from the actual implementation. Seen from the RAD point of view, SSADM's refusal to return to a previous phase or make concessions to unforeseen factors make it very hard to coexist with. While it is not impossible that some of the tools and techniques defined in SSADM and RAD may be used in either, the system development life-cycles are incompatible.

So which is better? RAD is certainly the easier target. 'Knock up something that seems to work, get it installed, and tidy it up later' (as an unknowledgeable sceptic could describe it) doesn't sound very professional. On the other hand, no one is likely to accept the time and cost overheads of SSADM for all projects. For any particular endeavour, how can one choose which approach to use? The feasibility stage of

the DSDM life-cycle should help determine this, but here are a few general pointers:

What do you have to work with? Consider the suitability of the tools available, and constraints on the operating environment. An OO development tool is best for RAD, so that developers and modules can work independently. Likewise, if your database is inflexible, then you are probably better off with an inflexible development method.

Can you involve the end-users in the development? If you cannot get commitment from them to participate in all stages of the project, then you will be better off with traditional methods. But if you have a technically literate end-user community which is prepared to contribute to the development (ideally with some as full time members of the development team), then RAD may give you a much more satisfied customer.

How complete does the product have to be? Will 80% of it do, for now at least? If time and resources are limited, but there is room for manoeuvre in the requirements, then RAD will be better. If it is a case of 'all or nothing' (as in safety-critical systems), however, stay traditional.

How fast-moving is the environment? Traditional methods will deliver a complete system, but it may be out of date by the time it is shipped, and it will be expensive to amend the specification part way through. A short timescale RAD methodology makes it easier for a project to react to requirements change, and if the product will only have a short shelf life, any failings may not matter. In a stable environment, though, perhaps one should aim to get everything right first time.

What about accountability? In a tightly structured quality controlled environment, RAD's lack of paperwork (at least, compared with the volumes produced by SSADM) can leave the developers exposed to criticism if it does prove necessary to limit the functions delivered. End-users must be aware that while the measure of quality for a traditional project is that it should meet its specifications as efficiently as possible, the measure of quality for a RAD project is that certain minimum requirements are fulfilled in a fixed time.

A note on terminology and notation

In common parlance, data is stored in 'files' containing 'records' which are made up of 'fields', and is tracked via 'indexes'. In order to prevent one from confusing the theoretical model used during the analysis stage with how an application will work in the real world, SSADM uses its own terminology. Models are composed of 'entities' and 'occurrences of an entity', with certain 'attributes' and a set of 'relationships'.

There are numerous variations on notation for the diagrammatic techniques and the terminology – they don't matter, so long as your readers know what you are using. Generally, it is best to include a glossary every time one produces a paper using structured methods.

Decision time...

Neither approach will be right for all applications in all circumstances. The development life-cycle methodology should be selected according to the nature of the project, and the onus should be on the development team to justify why it has decided on one technique rather than the other. But there is one rule even more important than this: *any* defined method is better than none. ■

John Watson is a computer services team leader at the Space Operations Centre of the European Space Agency. He was not responsible for the Ariane 5 rocket blowing up last year (though it did make good television). You can contact him at jwatson@bcs.org.uk

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CIRCLE NO. 173

Dressin

To look at most textbook introductions to splines, you might think an N-dimensional brain is required to understand them. **Jules May** proves otherwise.

Suppose you have a set of data which has been sampled at specific points. It could be the prices of a commodity, or the heights of a piece of landscape, or the positions of a sprite in a game. Your problem is to find a line which represents the data at points between the samples. Often, you'll want that interpolating line to be smooth. You want a spline.

Spline curves are very important in CAD, where surfaces are defined by sets of points, and in graphics where animation is defined by keyframes (moments at which position, rotation, or camera angles are known). But splines appear in other places as well; Truetype fonts are defined using splines, and in statistical analysis very noisy data can be filtered using other kinds of spline.

In this series of articles, I'm going to explain splines in detail. Unlike most texts, which are intensely mathematical, this is much more informal. A small amount of maths is inevitable, but if you don't like maths then don't be put off, because I'm taking an approach which keeps the maths simple. On the other hand, I've tried to avoid watering down the material to make it artificially simple, and if you need more than I've presented, you should be able to find your way around the more rigorous texts.

Preliminary ideas

There are, of course, infinitely many different curved lines which can be drawn, so we need some way of defining which one we want. The easiest approach to take is to use a *control polygon*. This is essentially a series of *control points*, usually shown joined by straight lines. The control polygon roughly approximates the shape we want, except that it is jagged. There are two approaches we can take to smoothing it: we can draw a smooth line through the control points, or we can file the corners off the polygon, resulting in a line which approaches the control points but doesn't pass through them. The first approach is called *interpolating*, and the second is called *approximating*. In general, you'll mostly want to interpolate, but we'll see occasions in later sections when approximation is better.

The control polygon is slightly more complex than a simple sequence of points. Imagine you are standing at one end of the control polygon, and start walking along it. After some time (assuming you're interpolating), you'll reach the first control point, and turn a corner. You keep moving in this way until you get to the end of the polygon. But, you might want to vary your speed: some sections you may decide to run along, and some to crawl along. If you run along a section, it will be harder for you to change direction (and you'll want to take the shortest path in any case), so the curve between this section and the next will be more straight than if you were walking slowly.

As you can see, the finished curve is controlled not just by *where* the control points are, but *when* they are as well. We will place the control points in time with the parameter t (although some books refer to it as u). The values of time for each point are called *knots*. Splines with equal knot spacing (where all the control points are spaced equally in time) are called *uniform* splines and they are a very useful subset. Their main advantage comes from the fact that a lot of the math (and the user interaction) becomes much simpler.

Figures 1 and 2 show examples of control polygons where each of the control points are two-dimensional. Control points can have any number of dimensions (when defining surfaces, for example, three are needed), but no matter how many they have we need to be able to talk meaningfully about the time parameter as well. To do this, we can use

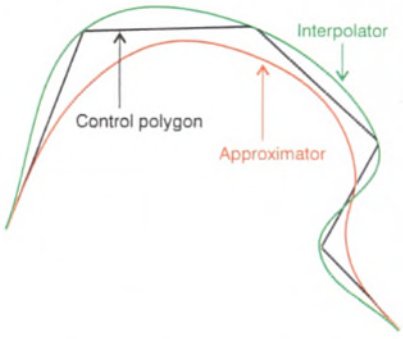

Figure 1 – Different kinds of spline.

g up for the curve ball

either of two types of diagram. Figure 3a shows the control polygon from Figure 2, with the addition of a time line. Each of the marks on the time line represents one of the control points, showing the sequence as well as the timing of the points. Notice that there's a comparatively long time between the two central control points, which is why Figure 2 says we're crawling between them. In Figure 3b, we've taken a different approach. Here, we've selected just one of the dimensions of the control polygon, (say, the *y* co-ordinate), and plotted that against the time line. Because the precise co-ordinate we choose doesn't matter, and the value actually stands for a vector, this is called a *t-v* graph.

Figure 4 shows the same pair of graphs for the running case; you can see the time interval between the two central control points is much shorter, so we've got to cover the distance much faster. In order to do that, the spline has had to swing around in order to take aim at the interval and accelerate into it; once it's out of the interval, it has to slow down again to find the next segment. In the discussions that follow, we're going to need to use both views. (Incidentally, Figures 3 and 4 show the *y* co-ordinate of the *x-y* graph as *v*. As an exercise, try sketching the *t-v* graphs using the *x* co-ordinate).

What makes a good spline?

There are obviously all kinds of ways to make curves out of control polygons, but some are better than others. In order for a spline to be useful, it must have a number of properties.

Firstly, moving the control polygon around should move the spline around in the same way, without causing it to change shape. This should be true whether you're translating (sliding around in space, as with sprites), rotating, or scaling the control points. This property is called *frame invariance*. Secondly, the curve should be smooth, and should not have extra wiggles which are not there in the original control polygon. Not only that: the wiggles that are present should be minimised as far as possible. This is called *variation diminishing*. Finally, though the curve should be smooth, moving one control point should affect its shape only in the vicinity of the point being moved. We will explore in more detail later what is meant by 'vicinity', but it's clear that if moving a single point changes the shape of the entire curve, it will be almost impossible for a user to tune a control polygon to get the curve he wants. This property is called *local control*.

In order to fulfil all these requirements, a strategy called *piecewise curve fitting* has been invented. Instead of trying to construct one long curve from all the control points, a set of short curve segments is created, each segment being controlled by a small number of points. The individual segments are then joined end to end. If the spline designer has done his job right, the joints should be invisibly smooth.

The smallest number of points we can use to make a curve is, of course, two. Since we're limited to linear interpolation between the two points, all we can expect to find is the original control polygon. Let's try to find the position of the spline at some time *t* which is within the knot range of the control polygon. First of all, we work out which segment *t* lies within. Then we interpolate in *t-v* space, using the classic linear interpolation formula *(t-t2)/(v-v2)=(t1-t2)/(v1-v2)*. If we do this for every value of *t* we will find that the spline segments meet at the joints, so the curve has no breaks in

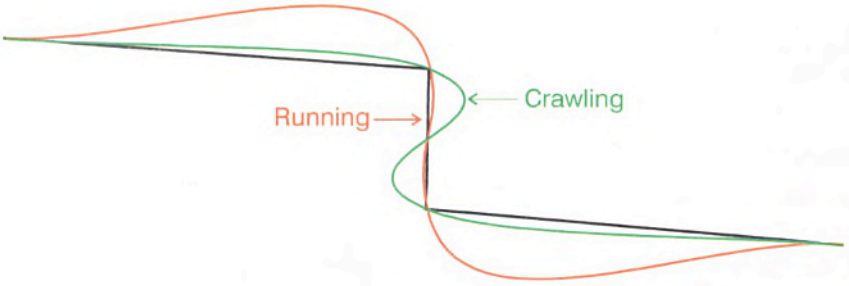

Figure 2 – Changing the time to cross the centre section.

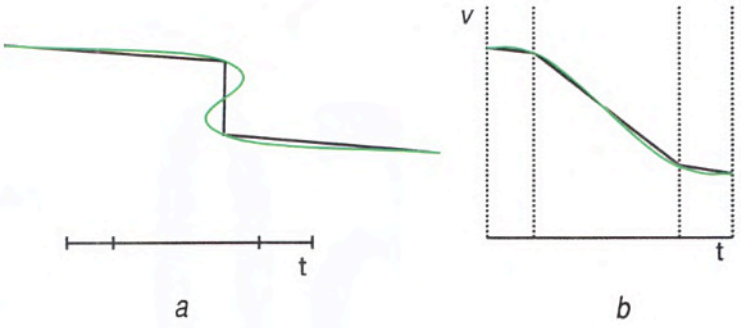

*Figure 3 – x-y and t-**v** graphs of a control polygon and its spline, with a certain knot sequence.*

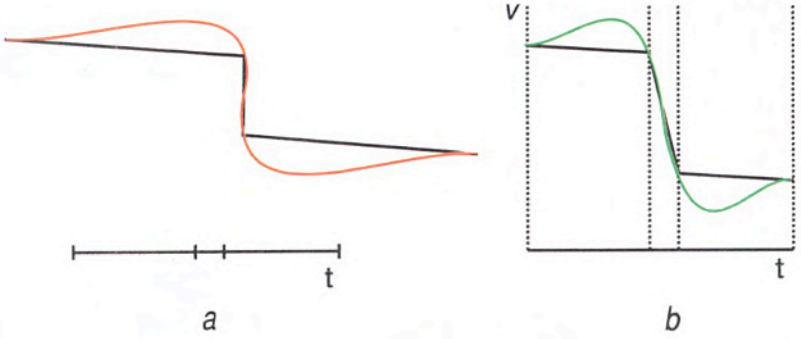

*Figure 4 – x-y and t-**v** graphs of the same control polygon and its spline, but with different knots.*

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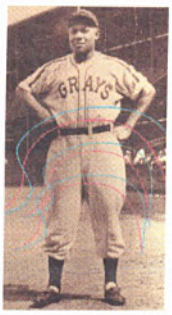

it, but that the joints are 'kinked'. In terms of the equations, the first derivative $\partial v/\partial t$ of the spline curve (and all the higher derivatives) are discontinuous at the joints. We express this by saying the spline as a whole is C(0) continuous – it is continuous at the joints only in the zeroth derivative. To get a better idea of what this means with respect to curves, take a look at the separate *Refresher on derivatives* box.

If, instead of using straight line segments, we used quadratics, we could do better. Three points are needed to control a quadratic, but they provide control of both the position at each joint and the first derivative. We can thus make the spline as a whole C(1) continuous. That is, we wouldn't see any kinks. On the other hand, we can't control the second derivative, so an object travelling along the spline would appear to change speed abruptly at the joints (which would be deeply objectionable if the spline was modelling movement). There's a worse objection too: just as two control points forced the segment to lie on a straight line, three control points force the segment to lie in a plane. We can't have curves that wander through three-dimensional space freely. In order to get true space curves we need to use C(2) continuous segments. That means we need cubic segments, and cubics need four control points each.

In general, cubics are about right. They allow the line to move freely in space, and C(2) continuity is plenty for most purposes. Each control point exerts its influence over four segments, which is sufficiently local control that the lines are easily editable.

In fact, we can get whatever continuity we want. Every quadratic can be written as a linear interpolation between two straight lines, and every cubic can be written as a linear interpolation between two quadratics. Most spline algorithms are written in a recursive form so that you can interpolate as many times as you like. C(20) continuous splines are possible, if you've got enough control points!

$$q_0 = \frac{(p_0 - p_1)(t - t_1)}{(t_0 - t_1)} + p_1 \qquad r_0 = \frac{(q_0 - q_1)(t - t_2)}{(t_0 - t_2)} + q_1 \qquad s = \frac{(r_0 - r_1)(t - t_3)}{(t_0 - t_3)} + r_1$$

$$q_1 = \frac{(p_1 - p_2)(t - t_2)}{(t_1 - t_2)} + p_2 \qquad r_1 = \frac{(q_1 - q_2)(t - t_3)}{(t_1 - t_3)} + q_2$$

$$q_2 = \frac{(p_2 - p_3)(t - t_3)}{(t_2 - t_3)} + p_3$$

Figure 6 – Aitken's algorithm as math (cubic case).

Aitken's algorithm

Let's now put all this into practice. Aitken's algorithm is a simple and reliable interpolator, which can be coded easily and used in a variety of applications. Figure 5 shows the geometrical construction of the cubic version.

Briefly, it works like this. As Figure 5a shows, we have four points, *p0* to *p3*, whose knots are *t0* to *t3*. The time of the point we're trying to find, *t*, is somewhere between *t1* and *t2*. To calculate our point, *s*, we linearly interpolate or extrapolate each of the line segments to the time *t*. (Here, interpolating means that the point we're trying to find lies within the line segment, and extrapolating means it is outside, so we have to extend the line in one direction or the other). For example, the line from *p0* to *p1* extends only from knot *t0* to *t1*, so we must extrapolate to time *t*.

Since we have three line segments, this gives three points, *q0* to *q2*, and two new lines: *q0* to *q1*, and *q1* to *q2*. Now, consider the line from *q0* to *q1*. *q0* has been influenced by *t0* to *t1*, and *q1* has been influenced by *t1* to *t2*, so the line from *q0* to *q1* has been influenced by the points *p0*, *p1* and *p2*. It follows that the time range of this line must be *t0* to *t2*. Thus, when we come to interpolate this line, this is the range we must consider. Figure 5b shows these two lines with their correct knots.

We have two lines, *q0* to *q1* and *q1* to *q2*, so we now arrive at two new interpolated points, *r0* and *r1*. By similar reasoning to before, the time range of the line from *r0* to *r1* is *t0* to *t3* (as shown in Figure 5c), so we interpolate over the entire time range, giving *s*, the point we're looking for. Figure 5d shows the *x*-*y* graph of the same process.

By sketching the *t*-*v* graphs for $t = t1$ and $t = t2$ (or by evaluating the formula in Figure 6), you should have no difficulty convincing yourself that, if we ask for *s* at *t1*, we get *p1*, and if we ask for *s* at *t2*, we get *p2*. You should also have no difficulty convincing yourself that, if you have five control points, you can evaluate *s* for *t* between *t1* and *t2*, or for *t* between *t2* and *t3*, and that at $t = t2$, the joint is smooth (look at what happens when *t* is very close to *t2*). Finally, you should be able to generalise the process to higher continuities; for a C(4) continuous spline, six points will

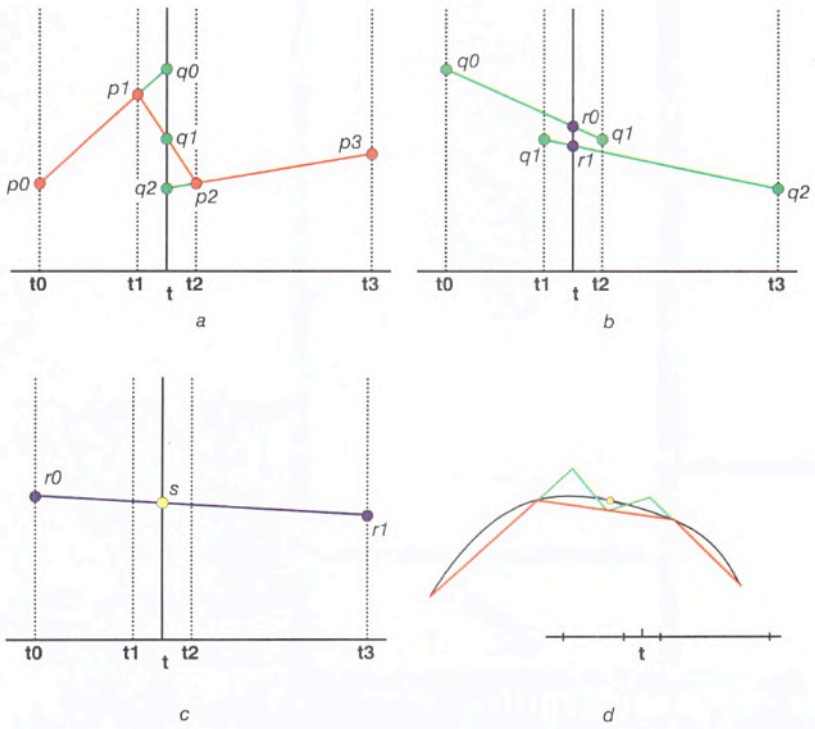

Figure 5 – Aitken's algorithm in pictures (cubic case).

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contribute to each segment, for C(6), eight points will contribute to each segment, and so on.

Boundary conditions

What are we going to do if we want to know *s* for *t* between *t0* and *t1*? In theory, we can't do it, because we'd need a knot at *t(-1)* , and probably a point there too. Many people take exactly this approach, and claim the spline isn't defined between *t0* and *t1*. For an interpolating spline, this is not satisfactory, and something better must be found.

One solution is to duplicate the first point and knot, providing a fake *p(-1)* and *t(-1)*. If you draw the *t-v* graph of this case, you'll see that the duplicated knot causes problems for the interpolator (it tries to divide by zero), so you must provide protection against this in the interpolation procedure. Another

Refresher on derivatives

Imagine yourself in a car, at some point *p*. Suppose five minutes later you find yourself four miles away. What was your average speed? Since we express speed as miles/hour, your speed was *(4 miles) / (5/60 hours)*, or 48 mph. Now, if we draw a graph of this journey, it will look something like Figure A. We start off stationary, drive at 48 mph, and then stop again. You can see the four miles (on the vertical axis), you can see the five minutes (on the horizontal axis), and you can see that if we continued driving for longer than five minutes, the sloping part of the journey would continue, at the same slope, for a longer time, giving more distance. The slope of the line tells us how the distance changes with time, and that the magnitude of the slope is 48mph. If we draw a graph of our speed compared with time, we'll get something like Figure B.

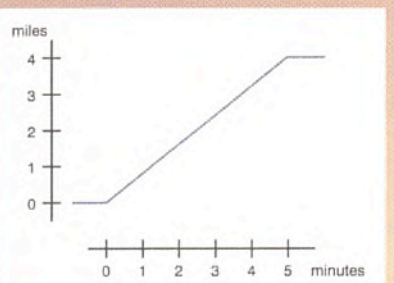


Figure A.

Differentiation

This graph of speed compared with time is called the derivative of the distance, or more precisely ∂s/∂t (notice, distance 'divided by' time, hence miles/hour). The process of turning a distance/time plot into a speed/time plot is called differentiation. In general, when you differentiate something, you're finding its rate of change – speed is the rate of change of distance.

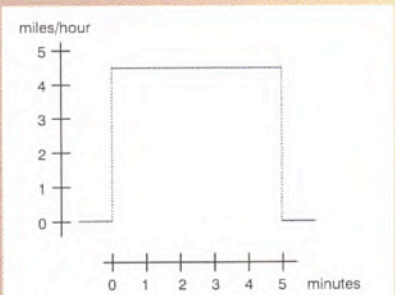


Figure B.

The driver shown in Figures A and B is not one you'd want to share a car with! He has instantly moved from rest to a staggering 48mph (presumably using explosives), and then instantly decelerated from 48mph to rest, presumably by guiding the vehicle into a brick wall. At the stroke of the third minute, you can see that his speed was 48 mph, and at the stroke of the sixth minute it was zero, but at the stroke of the 5th minute, what was his speed? That sudden step is called a discontinuity, and it is what gives rise to the two kinks in Figure A.

Average vs. actual speed

Real cars, of course, don't move that way. Our bad driver enrols on a driving course, and the next time he drives the four miles in five minutes, he accelerates smoothly for one minute, holds a constant speed for three minutes, and then brakes smoothly for one minute until he comes to a halt. Now, his position and speed graphs are as shown in Figure C.

You can see that his constant speed is slightly higher than before (because the slope of the distance graph is steeper in the middle), but you can also see that the slope of the distance graph is changing over time. That makes sense; his speed is low just after he starts moving, and then high when he starts to brake. Now we can see why we wrote ∂s/∂t before, instead of just s/t; s/t is his *average* speed, but ∂s/∂t means that his *actual* speed is changing from moment to moment.

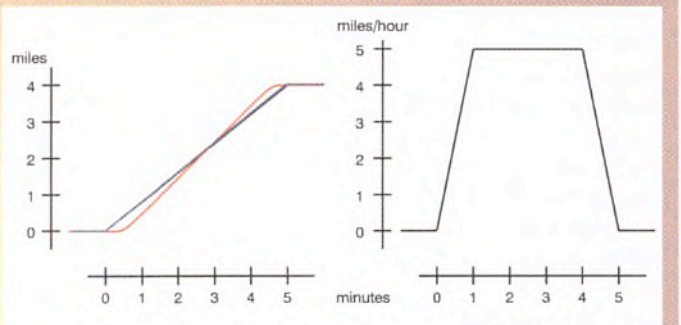


Figure C.

Rate of change

But, this driver's passengers are still frightened. Look at the graph of his speed – it has kinks in it. That's because the rate of change of speed (his acceleration) is not smooth, but discontinuous. The graph is as shown in Figure D. The passengers are thrown back in their seats as he starts to accelerate, then thrown forward when he finishes. The ride is smooth until he starts to brake, when the passengers are thrown forward again, and the car finally comes to a halt with a jerk, when the passengers are thrown backwards for (thankfully) the last time.

Notice that the rate of change of speed is acceleration, so the units of acceleration are miles/hour/hour (or miles/hour^2), and that speed is itself the rate of change of distance. We'd write this more formally as $\partial^2 s/\partial t^2$, and it is the second derivative of s.

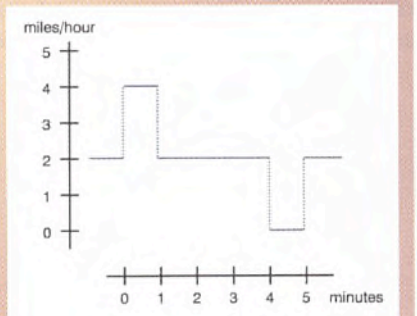


Figure D.

The driver goes on a second course, to teach him how to drive smoothly. His passengers are anxious because his acceleration is discontinuous, so this course teaches him how to change his acceleration smoothly. That is, the rate of change of acceleration, the third derivative of his distance, or $\partial^3 s/\partial t^3$, is what he must control.

approach is to *pretend* that t is in $t1$ to $t2$, and proceed exactly as before. A rather neater solution is to calculate as much of the sequence as is possible. There would be no $q0$, for example, though we could find $q1$ and $q2$. Because we don't have $q0$, we can't get $r0$, though we can get $r1$. We could claim that $s = r1$. Effectively, this would make the first segment quadratic instead of cubic.

You can eliminate boundaries altogether, by making the sequence cyclic. If you have n points, $p(0)$ to $p(n-1)$, make a fake $p(n) = p(0)$, $p(n+1) = p(1)$, and so on. The only number you will have to invent is $t(n)$, because $t(n+1)-t(n) = t(1)-t(0)$. Figure 7 shows a cyclic spline; the top control point is $p(0)$ and $p(n)$; you can see that there are four knots on the time line.

Computing with Aitken

Once you've defined the spline you want to work with, there are three approaches you can take to finding the curve. Each approach is best suited to different applications.

The first approach is the one we've been taking until now. You choose a moment on the time line, and find the value of the spline at that time. It is easy, and (for simple splines) fast. For more complex curves, or where the same segment is to be investigated many times, it may be possible to compute a more efficient formula.

Every cubic can be written as $s = at^3+bt^2+ct+d = ((at+b)t+c)t+d$. Using a bit of algebra, it is possible to calculate the coefficients once for each segment, and then evaluate the cubic directly. This approach is useful in animation (for animating sprite or camera positions), where you want to walk along the spline in equal time steps. In addition, once you've entered a segment, you know that you're going to stay there until you enter the next segment in sequence.

Again, we'll explore the cubic case, with the method known as Newton's forward difference evaluator. Work out a, b, c, and d as before. Assume the time step is h. For the value of t at which you first enter the segment, initialise the four variables

$$s0 = at^3 + bt^2 + ct + d$$
$$s1 = 3aht^2 + (3ah^2+2bh)t + (ah^3+bh^2+ch)$$
$$s2 = 6ah^2t + (6ah^3+2bh^2)$$
$$s3 = 6ah^3$$

The value of s at time t is, of course, $s0$. To get the next value of s at time $t+h$, evaluate $s0 = s0+s1; s1 = s1+s2; s2 = s2+s3; s = s0$ and repeat for as many steps as are desired.

A technique which is somewhat equivalent to this is used when you want to step along a spline drawing pixels as you go. You don't want to visit each pixel more than once, but you do want to make sure you catch every one, and so both the time steps and the distance travelled along the spline curve will vary from pixel to pixel. It is possible to implement this with a midpoint evaluator (see *EXE* December 1996), working entirely in integers with the original a,b,c and d coefficients from the cubic equation.

Good crack

The final technique is called polygon refinement, or *cracking*. It is used where you don't know in advance which part of the spline you want to investigate, for example when you want to find out where two splines cross (in ray-tracing), or when stepping along the spline in steps of equal length instead of equal time. Briefly, we don't deal with the spline at all; instead, we work solely with the control points.

We start with our four control points, which define a cubic line. We find two new sets of control points, which each define one half of the original cubic line. We end up with more points, but each set is thinner and flatter than the original. If we continue, eventually the sets become so thin and flat that we can treat them as straight lines. Different kinds of splines crack in different ways. Cracking an Aitken's spline is easy: evaluate v for the midpoint of each time interval, giving three new points (with their knots), which we call $p½$, $p1½$, and $p2½$. Now, our two spline halves are defined by $p½$, $p1$, $p1½$, $p2$ and $p1$, $p1½$, $p2$, $p2½$. You can see from the x-y graph in Figure 8 that the refined polygon converges to the spline very quickly, often requiring only three or four cracks to produce a usable polygon.

There are two ways you can use cracking. If you want to handle the curve as a whole, you can apply the method repeatedly to a sequence of control points, until the straight-line polygon is sufficiently smooth to be used directly. Alternatively, if you're trying to home in on a specific point on the spline, you can find which segment of the polygon bounds the area of interest. Crack just that polygon, giving exactly two new polygons, then decide which of these new polygons bounds the area of interest, throw the other one away, and repeat.

The object of this exercise is to create polygons (either one big polygon or several small, disconnected polygons) which are locally flat. What is meant by flat? Again, the rule will be different depending on the application. Sometimes it's curvature which is interesting, sometimes it's the length of the sides of the polygon. One rule which is generally successful is to look at the points $p½$, $p1½$, and $p2½$, and see how close they are to the segments in whose intervals they lie. For example, if $p½$ is sufficiently close to the midpoint of the line from $p0$ to $p1$, (and similarly for the other two points) then further cracks are unlikely to flatten the polygon much further. ■

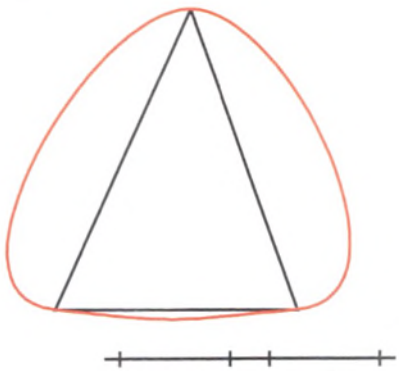
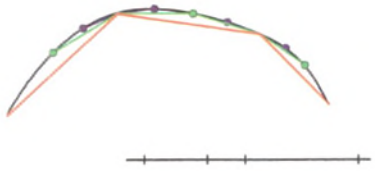


Figure 7 – A cyclic spline.



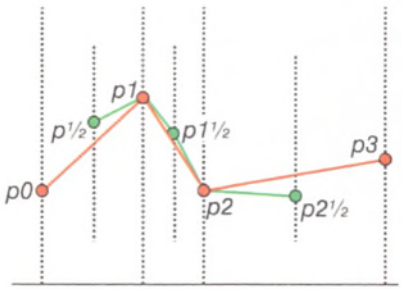


Figure 8 – Cracking an Aitken spline.

Next month: Hermites, Béziers, basis functions, and spline surfaces.

Jules May is a programmer who works more hours than is healthy. He can be contacted at jules@cix.compulink.co.uk.

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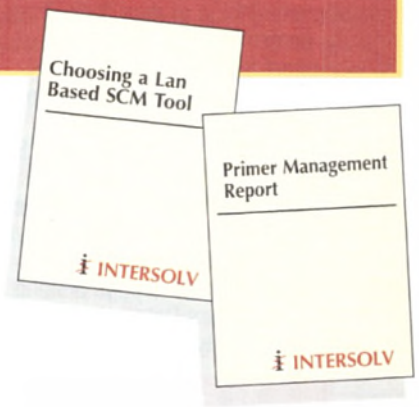

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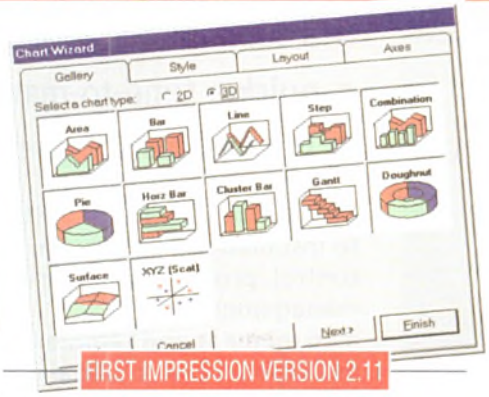

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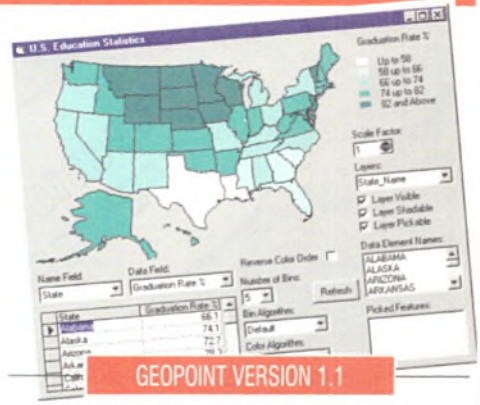

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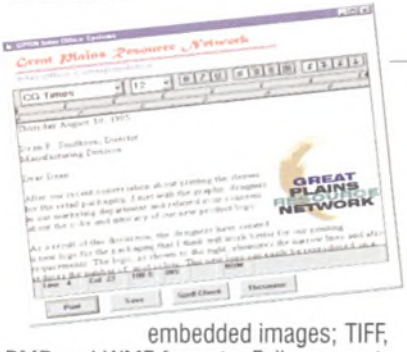

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CIRCLE NO. 177

Making a spectacle

When trying to find a good way to examine his fonts, **Peter Collinson** was confronted with the task of writing his first Windows application. Sun's SpecTcl showed him the way.

My love/hate relationship with Windows NT continues. I've recently spent some time organising all the fonts that I have on my machine. I guess that I've got over 1100 in total, mostly TrueType fonts from Corel Draw 7. But it's no use having all these fonts if I can't browse them easily to find one that suits the job in hand. I've spent an inordinate amount of time trying to find a program that can display the fonts at different point sizes (preferably allowing me to type my text to see what it looks like in a particular font), with little success.

The standard NT font browser leaves a lot to be desired. The output shows a small subset of the ASCII character set (missing many characters in the full TTF set) at one size, with the hoary old 'Quick brown fox' string beside it at various point sizes. As I said, I'd like to be able to type in my own string, and I'd also like to compare fonts on the screen. The NT browser is no help with this either, since it opens a huge window for every font, and uses up acres of screen real estate with the name of the font and other sundry information.

There are a whole host of font browsers around, both those bundled with other packages, and independent commercial programs. I've got the Corel Draw 6 font manager, but it turns out to be broken on Windows NT 3.51. Corel's reaction for version 7 seems to have been to remove it entirely rather than try to fix it. There are a few freeware and shareware font display utilities to be found on the Net, most of which started life on Windows 3.1. Windows' font handling has changed radically since 3.1, and these programs often don't work too well on NT or Windows 95.

In addition, most of the simple font display programs only work with fonts that are installed on the system. Ideally, I want to be able to display a TTF font file residing in some random place on a disk – I don't want to have to manually install and uninstall a font just to look at it. On NT and 95, you can install a font into the system table with a single Win32 API call (without having to put the font file into some central cluttered Windows system directory), so a utility for browsing random fonts should not be hard to implement.

After about two or three days of searching the Net and trying different programs, I came to the conclusion that nothing was available to do what I wanted, and I would have to write my own program. I began to wonder about climbing the learning curve represented by my release of Visual C++

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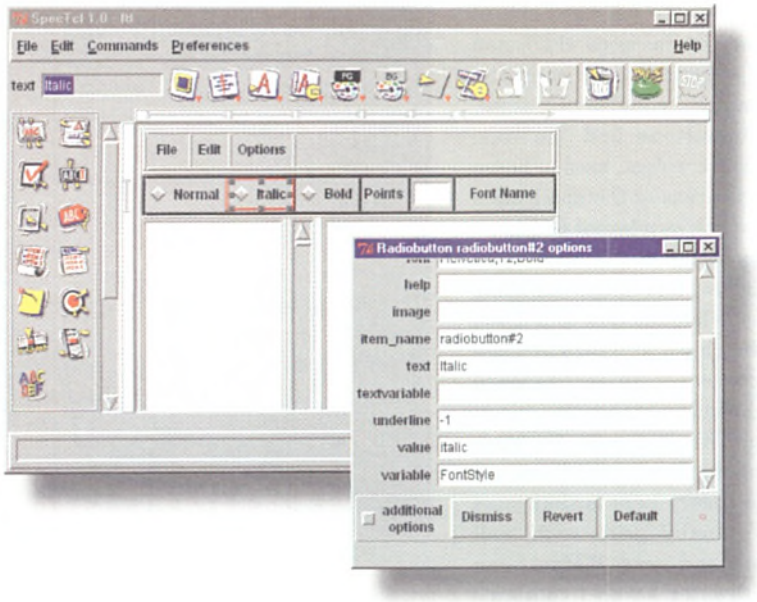


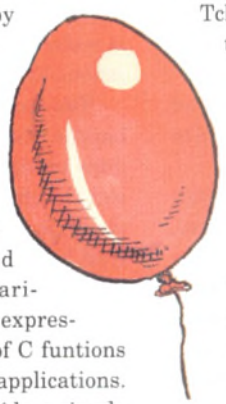
Figure 1 – SpecTcl in use designing the font viewer application.

4.2 with a view to writing my first Windows application.

Tcl/Tk

At this point, in a seemingly unrelated event, Brent Welch announced a new version of his excellent **exmh** mail reader for Unix. I've used **exmh** for some time, largely because it handles MIME well, which is what I seem to need these days in a mail program. It's written in Tcl/Tk (which we are encouraged to pronounce Tickle-Tee-Kay).

Tcl stands for *Tool Command Language*. It's an embeddable scripting language orignially developed by John Ousterhout at the University of California, Berkeley. Ousterhout moved to Sun a couple of years back, where he heads a team developing and exploiting the language.



Tcl/Tk is actually two things. Tcl is an interpreted shell-like language with variables, procedures, loops and expressions, implemented as a set of C funtions that can be embedded within applications. The original idea was to provide a simple common scripting language that could be plumbed into many different applications, making them extensible in the same way that Emacs Lisp supports the Emacs editor. In reality, it has not been used in its intended role that often, however several stand-alone machines have incorporated it as a standard scripting language. Tcl is mostly used with its stand-alone interpreter and shell, **tclsh**, which is available on practically all common platforms.

Tk is an extension for Tcl that provides a simple set of commands for constructing GUIs. Its API has been abstracted into several environments: there's a Perl extension that implements Tk, and the latest operating system offering from the research group at Bell Labs, (known as Inferno) uses Tk primitives in its own language to implement user interfaces.

The core of Tcl/Tk remains freeware, and you can FTP or Web to the main development site and pull the source (and some pre-compiled binaries) for nothing. Sun seems to be following the Java model with Tcl/Tk – the basic language is free, but there are 'paid-for' addons.

I tend to use new versions of **exmh** as an excuse to catch up with Tcl/Tk releases. Brent codes his program to support old versions of Tcl/Tk, but usually tips you the wink that a new version of Tcl/Tk is out there and is worth looking at. The latest release of Tcl is version 8.0, and to make life easier, they've decided to renumber the Tk release to match. Tk was developed after Tcl, and up till now had a much lower release number. Since any particular release of Tk is usually dependent on a particular Tcl release, you had to know both numbers. Anyway, the renumbering makes things easier. As I write, the latest versions are both version 8.0, and the release is 8.0 Alpha 2 (8.0a2 for brevity).

The 8.0 release is interesting. First, it contains a byte-code compiler for Tcl allowing it to run code much more speedily than before – I'll guess the idea is a cross-fertilisation from the Java group at Sun. I noticed a huge improvement in speed when running **exmh** with the new release of Tcl/Tk. Previously, if I received a large MIME message, my Sparc 2 ground to a snail's pace while **exmh** processed the contents. Now, there's a wait, but it's a bearable one.

Second, the release provides support for many more platforms than had previously been the case. Tcl/Tk was originally developed for Unix, with Tk using the X Window system. This time last year, I considered reviewing the Tcl/Tk port that had just been distributed for Windows. I decided against it, because the Windows release was basically still a toy: you could not do much with it. For example, you could only run one application at a time on a Windows system. Also, crucial bits of the system were missing – you could not use the **exec** command to get results from other programs, which is the standard way of getting system information into a Tcl/Tk application. Finally, Tk-based interfaces looked like X programs using the Motif toolkit, but running on a Windows box. I felt that the effect was likely to be counter-productive: things running on Windows ought to look like Windows applications. Now, a year later, the Windows release is hugely improved, conquering these problems.

The 8.0 package makes considerable use of an HTML formatter written in Tcl/Tk. The **exmh** program can display mail sent in HTML format in-line, meaning that those people who send messages in HTML have not wasted their efforts. HTML is used widely for help information, with a browser that runs as a Tcl/Tk application, although on Windows, Tcl/Tk comes with a standard help file that is browsed using the normal Windows help tools.

There's a Mac port as well of Tcl/Tk, so it is fast becoming a very viable way to write platform-independent programs. This is emphasised by the availability of a Netscape plugin that understands Tcl/Tk scripts. And yes, it does implement a security policy. Overall, Tcl/Tk is beginning to look like an interesting and relatively painless way of developing quick programs with visual front-ends which run equally well on Unix under X, on the Mac, and Windows.

SpecTcl

While I was pulling the source of release 8.0a2, I noticed that Sun has developed a GUI building program called SpecTcl (a deliberately 'cute' name: Spec-tickle pronounced Spectacle, yuckerooni). This removes considerable drudge work when creating Tk interfaces, and can actually generate AWT-based Java interfaces as well. SpecTcl costs a little under $150, but

comes with a free 90-day evaluation period, so you can see if you like it.

Using Tcl/Tk on NT seemed a good way of doing my font viewer project with minimum pain, so I pulled the Windows binary of SpecTcl and installed it on my machine. It doesn't need to have Tcl/Tk installed, since it comes with its own version of `wish` (Tk's windowing shell) based on the current 'stable' release of Tcl/Tk (Tcl 7.6 and Tk 4.2). It only installs its version of Tcl/Tk if it cannot find the stable version on the machine. In fact, I had installed the 8.0a2 release, and later loaded the earlier release as well. Both versions co-habit with no problem, although you do have to decide which version to run when you double-click on a file with a `.tcl` extension.

When you start SpecTcl, you are presented with a window that looks like the image in Figure 1, although I've filled in some of the workspace. The program is itself written in Tcl/Tk, so you can see that Tk GUIs fit in well with other Windows applications coexisting on the screen. The top line contains the usual Windows menu bar, hosting drop down menus that have no real surprises. Underneath this is a toolbar, replicating many of the commands that are available as menu options. There are buttons to change the settings on the available widgets (or in Windows terms, controls). You select a widget and can then change its text string, how it is placed in the current space, aspects of the fonts that it uses, its colour, and various properties of its borders. Tk supports multiple types of borders, allowing each widget to have a flat, sunken, raised or grooved appearance.

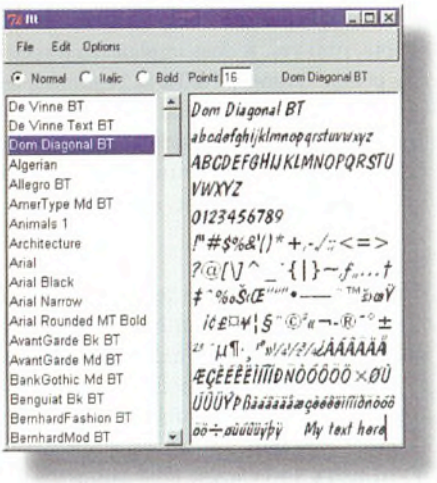
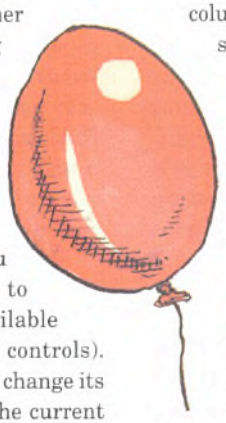


Figure 2 – The font viewer application.

The toolbar down the left-hand side of the main window contains icons which map onto the set of widgets that Tk supports. There are the buttons, editable text areas, listboxes, radio-buttons and the like. There's also a frame widget, used to house other widgets, so areas of the application screen can have their own layout policies.

When you move the mouse cursor over the SpecTcl window, text in the box along the bottom on the left changes to tell you the name of the object at which you are pointing. It's consequently easy to learn where things are and what they do.

SpecTcl uses Tk's grid geometry manager to control the screen that you are designing. The theory here is that most windows are actually grids with well defined columns and rows. Widgets can span several rows or several columns. When you start the program, you are presented with a two by two grid, into which you can drop widgets, or add rows and columns. You can stretch widgets over several rows or columns, depending on what effect you are looking for.



As I said, the frame widget is itself a geometry manager that will fit into a rectangular space on the window and arrange its children with a separate layout policy that the programmer can establish.

If you look at the example that I am building in Figure 1, the underlying grid is actually three by three. The top two rows are frames which span all three columns, containing buttons that are left justified. The bottom row of widgets sits directly in the underlying grid. First, there is a listbox that I have created with a minimum size; second, a vertical scroll bar to scroll the listbox; and finally, an editable text area that is used to display the font that I want to look at.

The default layout policy is that widgets try to shrink to their minimum size, unless you specify otherwise. We may be trying to fit a widget into an area that is being maintained at a certain size because another widget in the same column or row has already reached its minimum size. If necessary, widgets will be padded to fit the grid. For example, a scrollbar will fill the available area, retaining its horizontal size but spreading vertically up and down the length of the window.

Of course, there need to be some rules for what will happen to the widgets when their parent window is made larger or smaller. Typically, when you grow the window, you want some of the widgets to stay the same size in one direction but stretch in the other to fill the newly available space.

More information

All the code from this article is available online at my web site: check out the link from *http:// www.hillside.co.uk/articles/exe.html*.

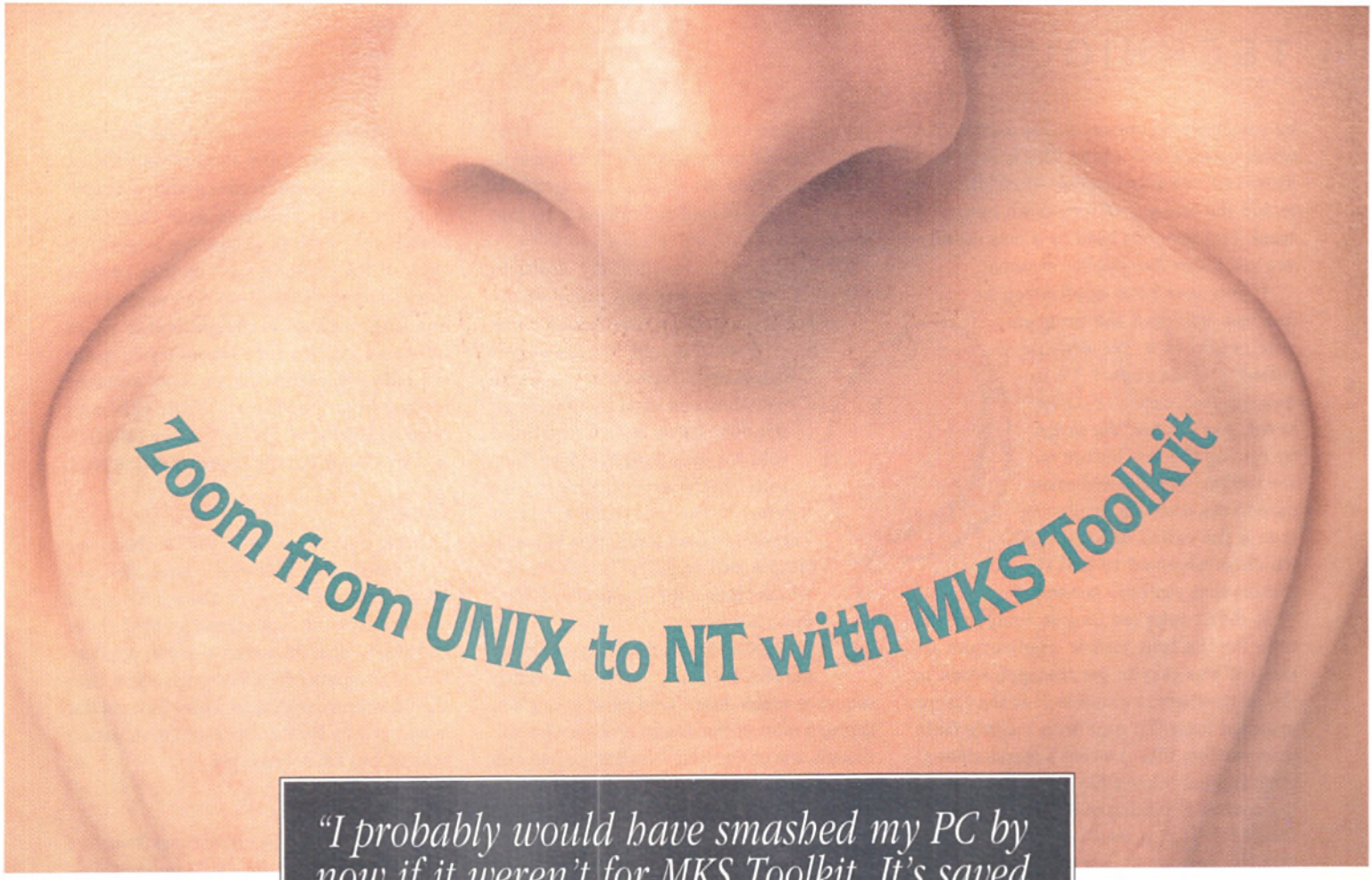
To get Tcl/Tk, SpecTcl and the Netscape plugin, you should access *http://www.sunlabs.com/research/tcl/*. The definitive Tcl/Tk book is *Tcl and the Tk Toolkit* by John K Ousterhout, ISBN 0-201-63337-X, published by Addison-Wesley. You should beware, though, that the many changes to recent versions of the toolkits mean that the book is somewhat out of date.

The menu bar is a good example: when the window is resized, you want the menu bar to stretch across the screen but stay the same height. SpecTcl allows you to define exactly what the widgets will do in this situation. Most elements of the grid should remain fixed in size, but you can specify that some widgets will stretch to fill the available space or contract to absorb the new smaller size. You can see this in Figure 1. I've selected the middle row which is a frame containing some buttons and labels. The horizontal resize policy for the frame is shown by the small grey lines that appear under the top tool bar. The vertical policy is shown in the grey lines on the left, in the white band between the design area and the scrollbar. I've specified that the label widget containing the font name will stretch horizontally when the outer window is resized, but that its vertical size should remain the same.

You need to set a policy for what will happen when widgets change size, which is done using a widget property. You may want to left or right justify the contents: I've chosen to have the text in the label stay centred in the area. You can affect certain attributes of widgets by clicking in the toolbar or you can bring up a property sheet by double clicking (or using a menu selection). I'm looking at the property sheet for a radio-button in Figure 1.

Generating the application

Once you have finished a basic design for the GUI, then you will want to test it, save it, implement the functionality and do all the other good things that you do when developing programs. SpecTcl saves your design as a single text file (with the suffix `.ui`), and generates a single Tcl/Tk routine that can be included in the remaining application code. You can include your own code in this routine



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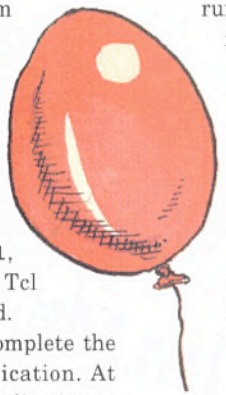
Managing Change With Integrity

CIRCLE NO. 179

by selecting an option on the Edit menu which opens a code editor. This is necessary for several tasks: for example when, you have to add the contents of drop-down menus by hand. This is not as hard as it may sound – you just follow the supplied example.

If you save your application as `design.ui`, then the program will generate a Tcl routine called `design` in `design.ui.tcl`. Once saved, you can test the script by hitting the *test* button on the toolbar. You can add extra code to the program by placing it in a file called `design.tcl`, which is assumed to call the Tcl routine that you have generated.



It didn't take me long to complete the code for the font viewer application. At least, it was easy to get the application to the point where it would look at the extant installed fonts. To cope with loading fonts from random files, I wrote a stand-alone C program that takes a file name and does all the necessary talking to the Win32 subsystem. I felt that it was necessary to check that the font is not already loaded, which was a little complex: I needed to open the TTF file to find its name and then look in the registry. Microsoft did supply me with sample code that was enough to tell me what I needed to know – once I had found it, of course. This stand-alone program is called from Tcl to load and unload fonts into the system table.

You can see the result of my efforts in Figure 2, which is a screen dump of the running application. I've loaded three fonts from disk and I'm looking at the last one. Notice how the X-like radio-buttons used in the design window have been translated into the standard Windows buttons. Incidentally, this is also true of the file finder that I needed to load fonts, this is just a simple call to a Tcl/Tk dialog box which maps onto the standard Windows file finder.

I got up to speed with SpecTcl very quickly, following the online training sequence which does a good job of taking you through most of the design process. Overall, though, the online help is rather sparse and could do with being expanded. I'd also like an undo command to reverse any bad mistakes I make while changing the interface. I reported this desire, and I've been told that it's on the list of things to be done – in general the support team was very responsive to my suggestions.

The design that you see in the example was perhaps my third attempt, but then I guess it was up and running after a couple of hours work. This was from installing SpecTcl through to producing a working GUI, so the program can't be that hard to use. The time I spent on this part of the application paled to insignificance when compared with the time I spent trying to dig out relevant information on fonts and font loading from the various MSDN CDs supplied by Microsoft. To be fair, the information was there, but the indexing of it is poor.

Finally

I think that if you use Tcl/Tk then you should definitely look at the latest release. It's generally a win, even though it's alpha code and there are some small problems here and there. SpecTcl seems a useful application, with admittedly a few rough edges, that should improve with time. I may fork out the money to buy it after my evaluation period expires, but I'm not sure yet. ■

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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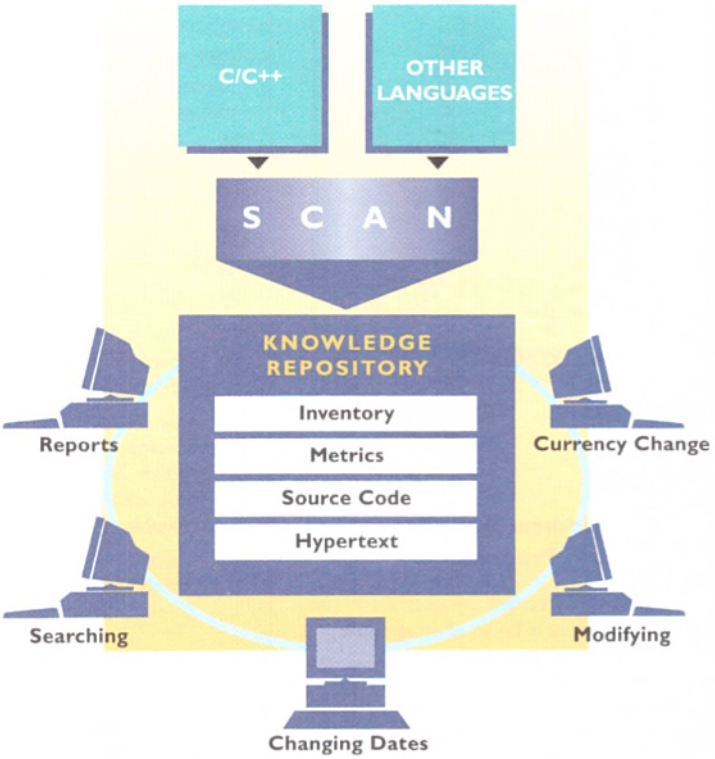

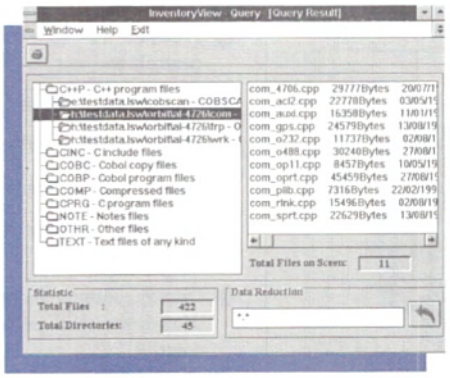

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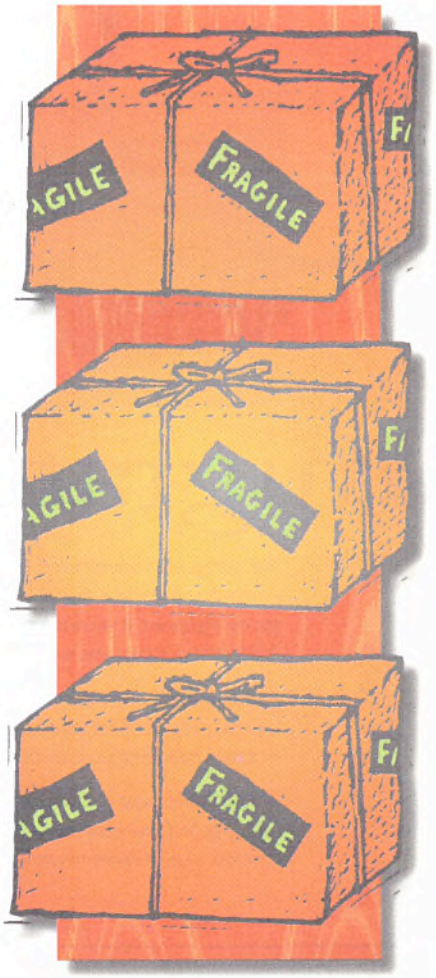
Exception to the rule

The efficiency-oriented design of STL containers can make exception throwing a risky business. **Francis Glassborow** offers some advice.



There are many minor issues with the current draft C++ Standard Library (as described in Committee Draft 2, or CD2), most of the 'it may not be ideal but we can live with that' variety. In anything as large as the C++ language and standard library, there are going to be a multitude of 'bugs'. Some can be fixed before release if those commissioning the work (the ISO and national bodies) require it, but others we will have to live with. This is nothing new: C has its own share of problems. If you doubt that fact, go and look at the specification of `gets()`, which most experts consider to be unusable in polite society.

Before writing about the current hot issue in C++, a reminder of some C history. Useful programming languages need some provision for creating 'collections' or 'containers'. The most fundamental type of container available in C is an array, largely designed with raw speed in mind. For example, objects in a C array are defined as contiguous and of fixed size, which results in efficient 'random' access to the array. C also places the responsibility for boundary checking on the programmer.

Overall, the rules governing C arrays are such that it is the programmer who is responsible for whatever trade-offs are desirable between speed, resource usage and robustness. The fundamental C arrays (both static and dynamic) are lightweight data structures designed so that programmers can add whatever fault tolerance and robustness is required.

The designers of C++'s containers (part of the STL), not only aimed at efficiency, but had specific performance targets, in as 'constant time' functions (for random access to a vector, or insertion into a linked list) and 'linear time' functions (for insertion into a vector or finding an entry in a linked list). They wanted to provide for users adding their own containers (eg hash tables), as well as the concept of *adaptor* containers, which allow more complex data structures (like binary trees and maps) to be built on top of whichever basic container types are selected as best for a particular application. To assist this, they shifted the functions that implement particular algorithms for data structures into discrete template functions. All this is fine and, in my opinion, works very well. However we now hit the C++ analogue of boundary checking in C.

STL and exceptions

Consider:

```
vector<string> vs[10];
```

You would expect that to work, and in just about every case that you will ever come across it will. Very rarely during the process of constructing `vs`, however, one of the string constructors will result in a `bad_memory` exception. In other words, the standard allocator has failed to find enough memory. What happens now? Should `vector<string>` try to handle the exception? Well, there are two reasons why it shouldn't. Firstly, building in exception handlers would make this class more resource-hungry and less efficient. Second, how does the designer of `vector<>` know what the user will want to do? Remember that the key idea of exceptions is to pass a detected problem back to a level where the appropriate course of action is known.

The decision that the STL's designers made was to ignore exceptions and leave the problem to be handled by the user of the containers. When someone commented that this left STL containers vulnerable to possible corruption, the response was 'How is that different from a world without exceptions?' In other words, however much exceptions may buy us elsewhere, we will be no worse off from not using them in an STL context than we would be if they did not exist. We could require that objects placed in STL containers should not leak exceptions. It would then be up to the designer of the contained objects to determine what should be done in the case of errors. Actually this is not a bad concept in general. Most problems that occur are ones that both should and can be contained within the objects.

Unfortunately there are two specific types of exception that cannot be so contained: constructor failure and out of memory. (Anyone who has a destructor that throws an exception should be asked to justify such a dangerous coding decision.) Worse still, these are exactly the kind of exceptions that are most likely to occur during the processes of re-arranging a data-structure or inserting new objects into it.

We can certainly fix these problems. One technique is to use commit-or-rollback, and decree that every dangerous action must first copy the container (or otherwise prepare for re-instatement). Then if there is a failure during the action the working version can be destroyed and the original re-

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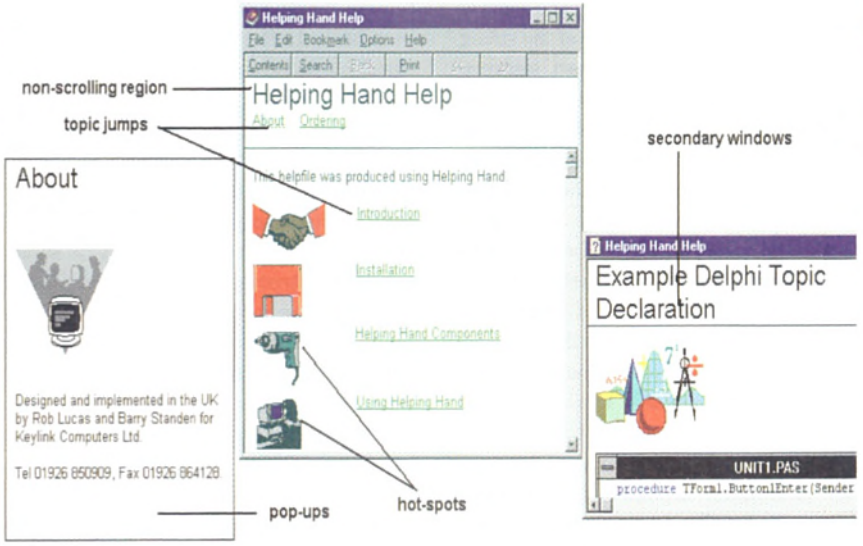

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instated. In the case of the constructor of a container failing (such as in the above example) all the contained objects which have been successfully created must be destroyed before an exception designating failure is thrown.

The problem with this strategy is that most of us do not want the overhead incurred by this level of robustness. We are working in environments where an out of memory condition is almost certainly fatal and we should be closing the application down after recovering whatever we can. We should however note that the result of an exception leaking from a container may be that the container becomes unstable and can not be safely destroyed (without, for example, the operating system pre-empting the application, preventing a proper cleanup). As programmers become more sophisticated the problems with damaged containers that cannot be destroyed safely becomes ever more serious.

At the moment we have one school of programmers declaring that a non-exception safe STL is unusable, while others are saying 'nonsense, I and hundreds of my colleagues use it regularly'.

Personally, I think the correct solution would be to have two levels of the STL, a performance-oriented lightweight version that can be used for non-mission critical work and a robust version that pays the price in performance when other priorities dominate.

Low cost C++ for Windows 95

In an earlier column I claimed that the only genuine C++ compiler that would run reliably on Windows 95 was that from Symantec. Microsoft has in the past been more interested in ensuring that I know about its high end development tools, with the result that I had completely missed its move from the Visual C++ 1.x-based 'Standard Edition' to a newer release based on Visual C++ 4.0. Furthermore, they seem undecided whether to call this product 'Standard Edition' or 'Learning Edition'. While I welcome the provision of a reasonably up-to-date low cost development tool, I think all concerned would be helped by a more consistent and informative product naming convention. In addition, many people do not have Windows 95 on their machines, or enough machine resources to support VC++ LE efficiently (or in some cases at all): I can still imagine more than a few dissatisfied customers.

On the Borland front, I was recently informed by an ACCU member that attempting to use Turbo C++ for Windows 4.5 on Windows 95 to compile and execute a short program using floating point arithmetic locked up his machine, and that Borland Customer Support had been no help with the problem. I forwarded the details to Borland. Basically it replied that it had never claimed the product would work with Windows 95. Had it passed the query on to its technical experts, they just might have wanted to look further into the matter.

In general, the product works fine unless you have a Diamond Stealth graphics card and happen to have its tools loaded. I have no idea why these two pieces of software interact so disastrously but they do. The fix is simple, though: unload the tools. It is pure chance that the machine I chose for checking the original problem has a Diamond Stealth card and the tools loaded at boot up time.

While I think I should shoulder some of the blame for the misinformation on the Microsoft front (some but not all) I certainly think that Borland needed no assistance from me.

Last month's problem

Assuming that the array boundaries have not been transgressed the following code would always work in C:

```
s[i] = s[j];
```

Is this still true in C++?

To understand why there should be a problem you need to know that in order to increase efficiency, the `string` type implements a lazy copying strategy. When a copy of a string is taken, it can simply alias the original until it becomes necessary to change the copy (the exact mechanism is not important here, but it is not through reference counting).

In combination with the various order of evaluation rules, this could mean that, if `s` is an iterator into a `string` object, evaluating either the LHS or the RHS of the above expression may invalidate the iterator being used to evaluate the other side. If you think that the version of `operator[]` called for the RHS should be the `const` version of the member function you are wrong, but in excellent company (not a few members of X3J16 thought so too). The only time that that version is called is if `s` is a `const` iterator, but if it were it could not be placed on the LHS of an assignment.

This problem will be fixed, but it is yet another example of why class design is expert territory. I think that the standards committees made a mistake in attempting to specify an all-purpose string class (even more so by lumping the functionality into a vaguely STL-like template class).

Note that the problem is not one that is inherent to C++, but just another manifestation of trying to over-extend a specification while retaining tight constraints on efficiency. You simply *cannot* design something that meets *every* conceivable need efficiently. I have lost count of the number of software projects that have failed because of optimistic over-reaching.

Now to the second part:

In C `x[y]` *always evaluates to the same as* `y[x]`. *Is it possible to maintain this symmetry in C++?* Is `s[i]` equivalent to `i[s]` in C++?

This is only one of a number of places where operator overloading for user defined types cannot provide the same facilities that are provided by the built-in types. In this case the rules require that `operator[]` be provided by a member function. As it is the left-hand operand that determines the class scope of the member function, symmetry could only be maintained in some rare case where the index was of the same class type as the container. The original symmetry (in C) was a pure artefact of the decision by K&R to define the subscripting operator as equivalent to `*(s+i)`.

This month's problem

Can you come up with two distinct meanings for the following:

```
x*y;
```

One is rather bizarre, but it is the simplest case that demonstrates the need for another keyword in C++ (the statement has two interpretations in C, but they do not matter as they can always be resolved in context). What is the keyword and why is it necessary when C manages without it?

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CIRCLE NO. 187

C++BUILDER

Finally, C++ gets Visual!

Is Borland's new environment C++ or is it Delphi? Is it Delphi masquerading as C++? **Dave Jewell** lifts the mask.

When Delphi first appeared, the Borland marketing machine (wrongly, in my opinion) put far too much emphasis on the database aspects of the product. So much so, in fact, that it took many programmers a long time to realise that Delphi was actually a full strength general purpose development system, and not just some sort of cute database front-end. Once people began to wake up to the productivity benefits of combining a RAD-based interface with a fast native-code compiler, C++ devotees started hotly asking why Delphi hadn't been based around their language from the beginning. That's a hard question to answer, but in any event 'Delphi for C++' is here now in the shape of C++Builder.

First things first: this review is based around a late beta of C++Builder, and although I'll draw comparisons between the Delphi and the C++ implementations, I'll also endeavour to explain some things from the perspective of those who haven't encountered Delphi before.

The development environment

When you first launch C++Builder, you might be forgiven for thinking that you're running Delphi. The main window runs across the top of the screen and contains the development system menus, a configurable 'speedbar' of common functions and the obligatory component palette. You'll also see an object inspector window and an initially empty form designer complete with grid.

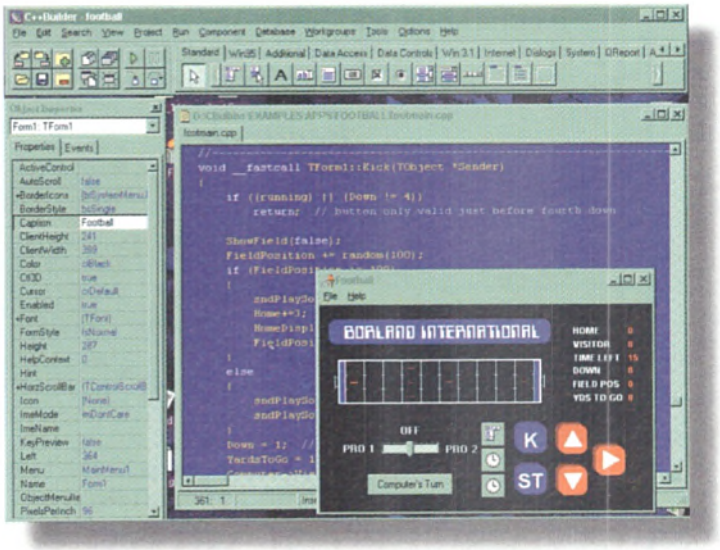


Figure 1 – Is it Delphi or is it C++? Pretty well the only thing that gives the game away is the source code listing behind the form window. C++Builder looks and feels like Delphi – which is hardly surprising, given that much of the design-time code in the component library is shared with the Delphi IDE.

As with Delphi and Visual Basic, you build an application (for the most part) by selecting components from the component palette, placing them onto a form, modifying their properties as desired and writing the bite-sized event handlers which glue the different parts of the form into a composite whole. Not all components are controls, and they don't have to be visual: as with Delphi, there are a selection of non-visual components which implement such things as timers, common dialogs and Internet support. A component is at heart just a chunk of 'canned' functionality which you add to an application by dropping it onto a form.

C++Builder comes with an incredibly rich set of around 114 different components, split up into multiple tabs on the component palette to avoid taking up half the usable screen area. Does this mean that Borland has been hard at work, laboriously converting all of Delphi's components to work in the C++ world? Actually, no. C++Builder is based around exactly the same VCL (Visual Component Library) framework as used by Delphi, and in actuality the supplied components have all been built with Delphi. Delphi has been able to generate OBJ files since version 2, and the Delphi 3 compiler can now produce OBJ files suitable for plugging into a C++ program. Thus, you can take your existing Delphi units, components and forms and use them in a C++Builder application with no extra effort.

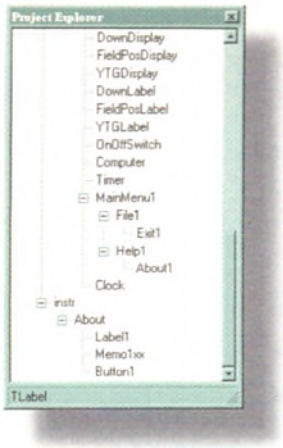


Figure 2 – The new project explorer window is unique to C++Builder. Using it, you can get a hierarchical view of the forms and components in your project, and you can also delete or rename individual items.

Perhaps even more surprisingly, it's interesting to note that large parts of the C++Builder development environment are likewise written in Delphi. As with the Pascal product, much of the design-time code is actually contained inside the component library (a specialised DLL) as a number of proprietary, undocumented units. By simply recompiling these units as OBJ files, Borland was already well on its way to implementing the C++Builder IDE.

Marriage made in Scott's Valley

The upshot of all this is that you get a terrific amount of synergy between C++ and Pascal, and things work almost transparently to boot. To add an existing Delphi form to a project, you simply select the form file and the associated PAS files from within 'add file to project', and the DFM form file and Pascal source code are automatically brought in. Yes, I did say Pascal source code: C++Builder can natively compile Pascal as well as C++. It has to do this to be able to import Delphi code. A messy approach, you might think, but don't worry – the C++ compiler hasn't been hacked beyond all recognition. The development system includes two completely separate compilers, one each for C++ and Delphi Pascal.

From this, you might start to get the impression that C++Builder isn't just a C++ development system, but a combined C++/Delphi Pascal system. That's absolutely true. Once you've imported a Pascal unit, you can edit the Pascal code to your hearts content just as if you were using Delphi – the IDE's syntax highlighting even works for Pascal units.

C++Builder won't allow you to create a Pascal source file from scratch, and it won't let you load an entire DPR (Delphi Project file) into the environment, but these are only artificial restrictions imposed by the IDE. You can easily create 'pure' Pascal programs from scratch (or build Delphi projects) with the command line Pascal compiler, if that's what you want to do.

Of particular interest is the way in which Borland has extended C++ to cope with RAD-based development. As an example, let's look at the structure of a very simple C++Builder program. Listing 1 shows the business end of the SWITCH example application, which simply displays a single push-button in a form, and 'switches' the button to a different event handler each time that it's pressed.

```
//---------------------------------------------------------------------------
#include <vcl.h>
#pragma hdrstop

#include "Switch1.h"
//---------------------------------------------------------------------------
#pragma resource "*.dfm"

TForm1 *Form1;
//---------------------------------------------------------------------------
__fastcall TForm1::TForm1(TComponent *Owner): TForm(Owner)
{
}
//---------------------------------------------------------------------------
void __fastcall TForm1::Button1Click (TObject* Sender)
{
    MessageBox(NULL, "Event Hander # 1", "Hey", MB_OK);
    Button1->OnClick = Button1Click2;
}
//---------------------------------------------------------------------------
void __fastcall TForm1::Button1Click2 (TObject* Sender)
{
    MessageBox(NULL, "Event Hander # 2", "There", MB_OK);
    Button1->OnClick = Button1Click;
}
//---------------------------------------------------------------------------
```

Listing 1 – Creating a basic form.

As with Delphi programs, a form file (extension DFM) is used to store a list of the components placed on a particular form, together with positional information and properties which have been set to non-default values. In C++, this is handled through the *pragma resource* compiler directive, as you can see in the code.

The next interesting line declares `Form1` as a pointer to a `TForm1` object, the default type associated with a new form. Like Delphi, C++Builder is based around the idea of 'two way tools': change the name of a new form to `Wombat` (for instance) and you'll see the form declaration statement automatically change to:

```
TWombat *Wombat;
```

All other references to the type and name of the form file will also be changed. Despite the fancy name, though, I've really only ever found these 'tools' to operate one way! If you change the name or type of your form in the source file, the object inspector won't take a blind bit of notice, and you'll get compilation errors as soon as you attempt a compile. The same criticism can be made of Delphi itself.

Incidentally, you'll notice from Listing 1 that every time the IDE creates a new method or event handler, it uses a hyphenated comment line to separate it from other methods. You can safely remove these comments without any complaints from the IDE. As with Delphi, if you want to delete an existing method, you *don't* just erase it – doing so will generate an error message next time you compile. Instead, remove everything between the opening and closing curly braces of the method, and the routine will then be silently deleted next time you compile or save the project.

Where Delphi Pascal scores over C++ is in its ability to hide unwanted implementation details. In both languages, an instance of an object is simply a pointer to the instance data associated with it, and the first four bytes of the instance data are always a pointer to the virtual method table of that object's class. However, the inherently 'pointer-ish' nature of an object is hidden in Delphi – you just use the '.' operator to reference fields and methods of the object. References to objects don't look like pointer references, but they are.

In the case of C++, Borland doesn't have the freedom to alter the core semantics of the language for the sake of convenience, so C++ developers lose out on the syntactic niceties which Delphi programmers are used to. The interface between C++ and the

VCL framework is implemented with the aid of a number of extension 'keywords' (each preceded by a double underscore). It works, but it looks a little messy.

Going back to Listing 1, you'll see the class constructor for the `TForm1` type. In C++, the default calling convention is `__fastcall` which passes as many parameters as possible using processor registers, with the rest on the stack. For obvious reasons, this is the same calling convention used by 32-bit versions of Delphi.

If you peek inside a Delphi project (DPR) file, you'll see that it's simply a small Pascal source file containing the `PROGRAM` directive which identifies it as the outer block of the program. In C++Builder, a project file has the extension of MAK and (unsurprisingly) comprises an automatically generated make file. The outer block of the application (the bit containing the `WinMain` entry point) exists as a separate source file. You can see a typical example in Listing 2. Notice the `USEFORM` macro which takes the place of the special extended `USES` syntax from Delphi project files. The program start-up is identical: a call is made to initialise the global `Application` object, an instance of the main form (specified through the *project options* dialog box) is created, and then the `Run` method is called. This method implements a conventional message processing loop, and exits when the application terminates.

Acquiring some property

But what about creating components and dealing with their properties? As an example of the sort of language constructs required, cast your eye over Listing 3, which is a stripped-down excerpt from one of the standard include files supplied with the package. The standard `private`, `public` and `protected` keywords have the usual meanings, but the VCL implementation requires the use of a new 'published' area where properties reside. This is identified with the `__published` keyword. (Actually, it's perfectly possible to declare a property inside the `public` area of a class declaration, and reference it internally within the application source code. However, if you want the property to appear in the object inspector, then you must put it in the published section. This causes the compiler to generate special RTTI information which is made available to the object inspector at design-time – see *EXE* February and March 1997 for more details.) As you can see, things are very Delphi-like.

All but one (`Margin`) of the listed properties are simply references to the corresponding property in the ancestor class. Redeclaring properties in child classes this way exposes them to the object inspector, which gives you a neat way of picking and choosing which properties you want to make visible when creating a custom component. The non-inherited `Margin` property is declared as type `int`, and the stuff between the braces tells the compiler how to treat read and write operations on the property. In this case, read operations are mapped onto a direct read of the private instance variable `FMargin`, and write operations are directed through the private `SetMargin` method, which can validate changes to the property's value before making them. A default value can be supplied in order to eliminate streaming of default values.

```
//---------------------------------------------------
#include <vcl.h>
#pragma hdrstop
//---------------------------------------------------
USEFORM("Switch1.cpp", Form1);
//---------------------------------------------------
WINAPI WinMain(HINSTANCE, HINSTANCE, LPSTR, int)
{
    Application->Initialize();
    Application->CreateForm(__classid(TForm1),
&Form1);
    Application->Run();
    return 0;
}
//---------------------------------------------------
```

Listing 2 – The SWITCH sample application's main procedure.

Out of the dark ages

Technology-wise, C++Builder is at about the same level as Delphi 2. For example, it lacks support for packages (although the command-line Pascal compiler does offer this option, it's not clear from the documentation how easily this could be integrated into a C++Builder application). The integrated debugger includes a CPU view panel, as with Delphi 2 onwards, and the environment supports form inheritance, but you can't save a set of components onto the component palette as a group, something that's possible in Delphi 3. In this respect, it's amusing to see that Borland is continuing its long-established practice of keeping its Pascal development systems one step ahead of C/C++. And why not? After all, wasn't it Turbo Pascal which built the company in the first place?

On a slightly more serious note, it needs to be remembered that this is a review of a beta product and this 'one step behind' impression may disappear in the final release. There's certainly one area in which C++Builder is *miles* ahead of Delphi 2 – the online documentation. Over the years, Borland has received a lot of stick from irate Delphi programmers about the documentation. The Delphi 1 documentation wasn't anything to write home about, but it was useable. With Delphi 2, however, it was an unmitigated disaster, sporting numerous broken links and non-existent topics. To be fair, Borland worked hard to fix the problems and made a number of corrected help files available as jumbo-sized downloads from various sites.

The new online documentation is excellent, including a comprehensive reference for the various VCL classes, and the properties, methods and events associated with each class. I imagine that Delphi 3 will be released with a 'Pascalised' version of the same information.

C++Builder comes with largely the same toolset as Delphi. In addition to the database explorer and image editor programs, you get IDETOMAK (a utility for converting Borland C++ IDE projects into C++Builder MAK files), TDUMP, TOUCH and an SQL monitor. A conspicuous absentee is the 32-bit Turbo Debugger for Windows program which previously shipped with Borland C++. As I've observed more than once in the past, 'soft-mode' integrated debuggers are great 99% of the time, but there will always be times when a 'hard-mode' debugger is required, such as when debugging DDE conversations and other client/server interactions which employ time-outs. Maybe the hard-mode debugger will be supplied as an extra cost option, as was the case with the original Delphi RAD Pack.

Like most modern C++ development systems, C++Builder uses an incremental linker

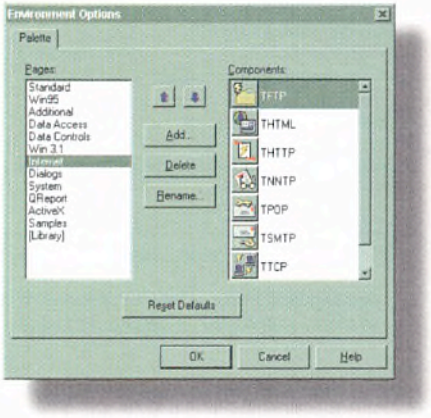
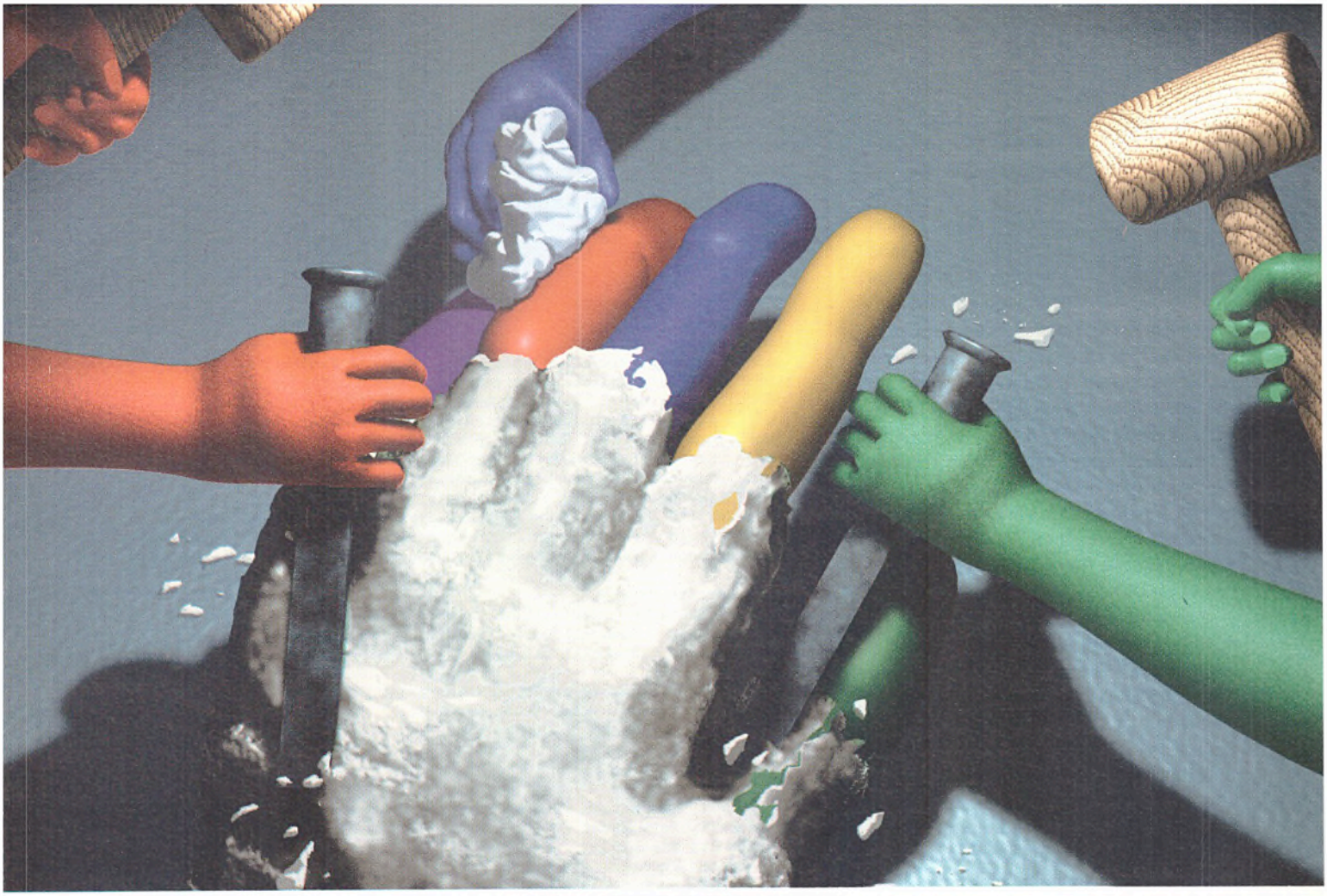


Figure 3 – C++Builder includes substantially the same components as are present in Delphi 2, including the Internet controls which appeared with Delphi 2.01.



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to speed up build time. The first time you compile and link a new project, the wait can be excruciatingly slow while the system spits out a few megabytes of ILF, ILS, ILC and ILD files (what *are* all those different files for?). Things get much snappier the next time round, but (inevitably) C++Builder's compile/link time isn't in the same league as Delphi – if you're hoping it is, then you'll be disappointed. On my Pentium Pro, a first-time build of the component library took around 55 seconds. This dropped to a more reasonable 17 seconds on subsequent rebuilds, but it's still nothing like the five-second library rebuild times I get with Delphi 2.

For database developers, one potential fly in the ointment concerns the licensing of 32-bit Local InterBase and InterBase Server for NT. In recent weeks, there's been a lot of talk on the Net concerning the contents of the DEPLOY.TXT file which ships with Delphi 2.0 and which (apparently) will also be included in C++Builder. Put simply, this file states that the purchaser has no automatic rights to deploy 32-bit InterBase components as part of an application. Borland tells me that the same situation will apply to C++Builder. If you want to deploy a 32-bit InterBase application, then you'll need to talk to Borland about the purchase of deployment kits.

```
class __declspec(delphiclass) TSpeedButton;
class __declspec(pascalimplementation) TSpeedButton :
                    public Controls::TGraphicControl
{
    typedef Controls::TGraphicControl inherited;
private:
    int FGroupIndex;
    void *FGlyph;
    bool FAllowAllUp;
    TButtonLayout FLayout;
    int FSpacing;
    int FMargin;
    void __fastcall GlyphChanged(System::TObject* Sender);
    void __fastcall UpdateExclusive(void);
    Graphics::TBitmap* __fastcall GetGlyph(void);
    void __fastcall SetGlyph(Graphics::TBitmap* Value);
    TNumGlyphs __fastcall GetNumGlyphs(void);
    void __fastcall SetNumGlyphs(TNumGlyphs Value);
    void __fastcall SetDown(bool Value);
    void __fastcall SetMargin(int Value);
    MESSAGE void __fastcall CMFontChanged(Messages::TMessage &Message);
    MESSAGE void __fastcall CMTextChanged(Messages::TMessage &Message);
    MESSAGE void __fastcall CMSysColorChange(Messages::TMessage &Message);
protected:
    TButtonState FState;
    virtual HPALETTE __fastcall GetPalette(void);
    virtual void __fastcall Loaded(void);
    virtual void __fastcall Paint(void);
public:
    __fastcall virtual TSpeedButton(Classes::TComponent* AOwner);
    __fastcall virtual ~TSpeedButton(void);
    virtual void __fastcall Click(void);
__published:
    __property Caption ;
    __property Font ;
    __property int Margin = {read=FMargin, write=SetMargin, default=-1};
    __property ParentFont ;
    __property Visible ;
    __property OnClick ;
    __property OnDblClick ;
    __property OnMouseUp ;
};
```

Listing 3 – Declaring a custom component class.

Great, but not Delphi...

Great though C++Builder is, it doesn't stand up to a close comparison with Delphi itself. The underlying C++ compiler can't compete with Delphi's awesome speed, and the language constructs that have been added to support RAD-based development are not as 'clean' as those used in Delphi, primarily because of Borland's desire to distinguish between the industry-standard language and its proprietary extensions.

There are other ways in which Delphi Pascal is a better 'fit' with RAD-based development than C++. I've already mentioned the fact that fields and members of objects have to be explicitly de-referenced through the `->` operator. Another issue is the `with` statement which (in Pascal) allows you to create a temporary (hidden) pointer to some object which is potentially deeply nested inside one or more other objects. It's primarily a syntactic shortcut for concise coding, but it generally results in smaller object code too. The VCL framework contains many examples of deeply nested fields, and without the `with` statement, you'll often find yourself writing code that looks like Listing 4.

You can always 'fake' the behaviour of the `with` statement by setting up an intermediate pointer yourself, but why bother? After all, even Visual Basic now has `with`! Isn't it time that C++ got it too? I feel that Borland should bite the bullet and properly integrate the RAD extensions into the language without all those messy double underscores, and add the `with` statement while it's at it. After all, if you want to carry on programming in industry-standard C++, you can always isolate your Borland-specific code in well-defined modules.

You do need to balance all my comments by remembering that they are all from the viewpoint of a Delphi zealot! Frankly, if Delphi had never existed, then I would *kill* to get my hands on C++Builder! I have every confidence that it will cause as much of a stir in the C++ community as Delphi did when it first appeared. If you're not interested in Pascal programming, and you want to use a version of C++ that really *is* 'visual' then look no further. ■

```
void __fastcall TForm1::DrawItem
      (TWinControl *Control, Integer Index, TRect &Rect, TOwnerDrawState State)
{
  ListBox1->Canvas->FillRect(Rect);
  ListBox1->Canvas->Font->Name = ListBox1->Items->Strings[Index].c_str();
  ListBox1->Canvas->Font-> Size = 0;
  ListBox1->Canvas->TextOut(Rect.Left+1, Rect.Top+1,
                            ListBox1->Items->Strings[Index].c_str());
}
```

Listing 4 – Another example from one of the sample programs.

Dave Jewell is a freelance consultant, programmer and technical author. You can contact him as DSJewell@aol.com, DaveJewell@compuserve.com or DaveJewell@msn.com.

Borland's ESP's (Estimated Street Prices) for C++Builder are £69, £399 and £1299 for the Desktop, Professional and Client/Server flavours of the product. The usual upgrade deals from Borland C++ and from Delphi, and C++Builder should be available by the time you read this.

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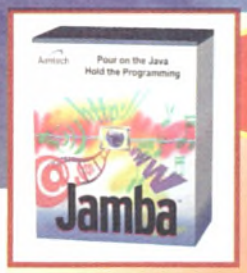

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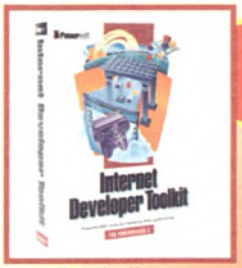

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Gamelon Files

Developers looking for a robust way to store their data without using heavy-footprint commercial databases can have a hard time. **Colin Hume** looks at Menai Corporation's Gamelon file library, an object lesson in how to do it.

While relational databases have retained their position as the predominant medium of storing data, object databases are making inroads into their once seemly unassailable territory. One of the blocks to the more rapid advance of object-based data storage is that there has been no easy way to take advantage of it from popular languages such as C/C++, Delphi and Visual Basic. Menai corporation's Gamelon Files persistent object store changes that, but it isn't just an object based data storage extension for mainstream development tools: it can encompass static data (like the things usually stored in configuration or system files) as well, as a potential replacement for all other forms of data storage. A notable advantage of using Gamelon in this context is that its data files, in comparison to say the Microsoft MDB format, are extremely compact. This alone would justify its use in many situations.

The facility to mix objects and static data is not unique to Gamelon: most relational databases will now store binary data in forms such as BLOBs (Binary Large Objects) and OLE objects. The difference is that this facility has been essentially retrofitted on, with no change to the fundamental rigid structure of records and fields. And while this relational paradigm fits many situations, it is less suited to applications where more flexible representation and ordering of data is required. Of course, any object based storage method which sets out to rival relational databases needs to match the industrial strength features of the heavyweight alternatives, such as indexing, many-user support, user permissions and transaction processing.

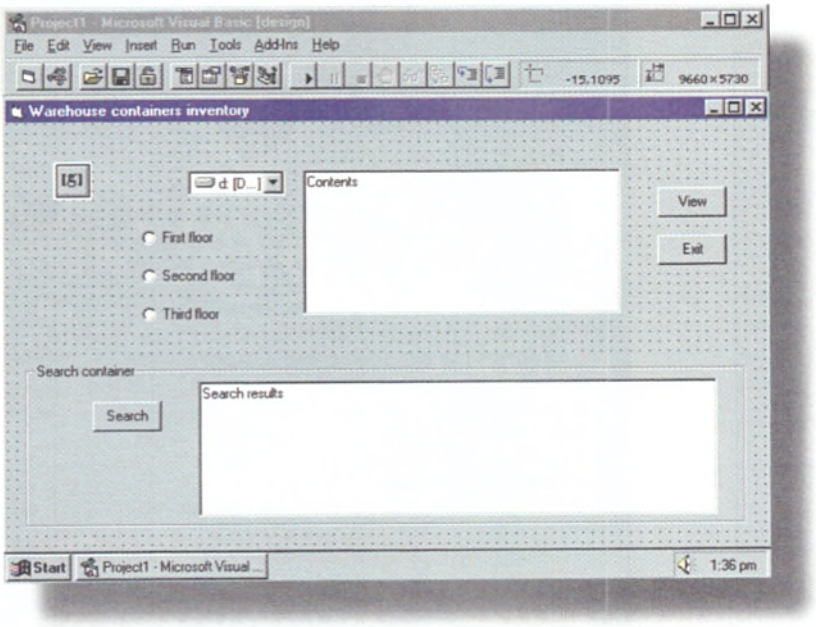

Figure 1 – The Gamelon ActiveX control can be added as an invisible control to a Visual Basic form.

Origin of the species

Gamelon started life as a file i/o library for OS/2, and has since developed into a range of products available for OS/2, Windows 95 and NT, Mac, and Unix platforms. All of the versions of Gamelon use the same file format, and this (in conjunction with the compactness of Gamelon files) takes on new significance in the context of the Internet. Menai is taking full advantage of this: in addition to the C/C++, Delphi and VB bindings, it has ActiveX and Java interfaces for Gamelon in beta, with CORBA IDL support to follow. The Java interface may even become obsolete: Menai is in the process of porting the whole library to Java (expected to be finished by this Summer).

The key to Gamelon files' platform independence is that the structure and contents of a data file can be defined in what Menai describes as a visual language. This language provides a relatively simple method of setting out the structures within a Gamelon file, the relationships between these structures and (optionally) their contents. The structures can comprise an outline without data, or a whole or initial data set. Each language variant of Gamelon includes a compiler for transforming this text file into a data file, and a corresponding decompiler. A platform-specific browser is included with the library for viewing the structure and contents of a data file. These utilities are used only while developing a Gamelon-based application, and are separate from the actual Gamelon API which provides the full range of compiled data file handling capabilities within applications.

Access to the API varies according to which product you are using – the ActiveX control, for example, can be dropped onto a form in VB and works as a hidden control like the timer. That said, the same API calls are used across all platforms.

Gamelon is intended as an 'enabling technology', which in the real world means that when developing your application you will have to write a set of file handling routines to interface with the library. This is simplified considerably by the excellent documentation, which covers the concepts and their use in some depth, extending to setting out the basic routines required (in both pseudo-code and language-specific versions). The same applies to setting out file structures: only a small set of instructions is involved, and the process is reasonably easy once the principles behind Gamelon have been fully grasped.

One thing that stands out about Gamelon is that its design is based around a relatively simple concept which has been thoroughly thought through and implemented. It might have been easier to implement it as a storage medium for binary data only, but by allowing for extensions it has the potential to become an all-purpose method of storing data.

Placing cursors

Applications access data in a Gamelon file through *cursor* objects, which allow insertion, deletion, reading and editing of objects within a file. Cursors can be moved around a file with the familiar back, next, first, and last operations, and you can have multiple cursors related to the same file.

Cursors provide object-based equivalents of the validation and security features that developers used to traditional databases expect. You can set a validation property on cursor objects to indicate errors, and there are other properties covering such things as read and write permissions, with the familiar controls on access, like setting the write permission to allow editing but not deletion. Navigation rights can be defined, to allow a cursor access only to a certain range of specific objects within a file.

With a traditional relational database, constructing a data file typically involves defining a record, which consists of a series of field names and definitions of field types (or the type of data that can be stored in the field). With Gamelon, you simply create a *data object*, which can contain any type of data (including binary data, such as a file). Data objects are type-safe: once a particular type of data has been stored within a data object, it can only be replaced by data of the same type. In contrast to many common databases (which can set limits on field size), Gamelon data objects can be of any size, from a single byte to many megabytes. In comparison with relational concepts, data objects are an approximation to fields in the sense that they store data of only one type, but different in that they are not tied to a rigid record structure. Gamelon supports *aggregate objects* which can have a completely flexible structure, with differing numbers and types of data objects within them.

In addition to data and aggregate objects, Gamelon provides *reference objects*, which use unique object identifiers (OIDs) to access other objects regardless of their position in the data file. Like data objects, reference objects are referenced through cursors. The OID is also used by another of Gamelon's utility objects, the *index object*, which allows efficient random access to objects within a file. Previously, Gamelon only accepted a single primary index for a file, but this has been extended to support a secondary index. Navigating a data file with an index is similar to relational databases, with facilities to move to the first, last, next and previous objects in a particular index. Indexes are automatically updated as objects they refer to are edited, added and deleted, and you can instruct indexes to specifically include or exclude a particular object.

While these navigation facilities can impose some structure on data in Gamelon files, most applications will require more, and this is supplied by Gamelon's annotation facilities. Objects store annotation data alongside the object data, and this data can consist of a name, a comment, and a unique object ID generated by Gamelon. While the name annotation could be thought of as equivalent to a field name in a relational database, the important difference is that the same name can be applied to objects of totally different types. This is also true of comment annotations. Gamelon data files can be searched for objects with name or comment annotations including a particular value, or for objects matching a certain ID. Name and comment annotations can be added to a data file after its creation as part of normal editing or updating.

A major problem which all databases must contend with is data file corruption, particularly minor corruption affecting only part of a file. Some databases ignore such corruption and carry the risk that even with a careful backup regime, data can be irretrievably lost. Gamelon's approach is to identify corrupt data and attempt to repair it automatically. If a repair is not possible, then an error message is generated, and the object is flagged as bad and barred from being accessed by a cursor. A better approach, if only because it alerts users to the existence of a problem at the earliest stage and allows a restore from an uncorrupted backup to resolve it.

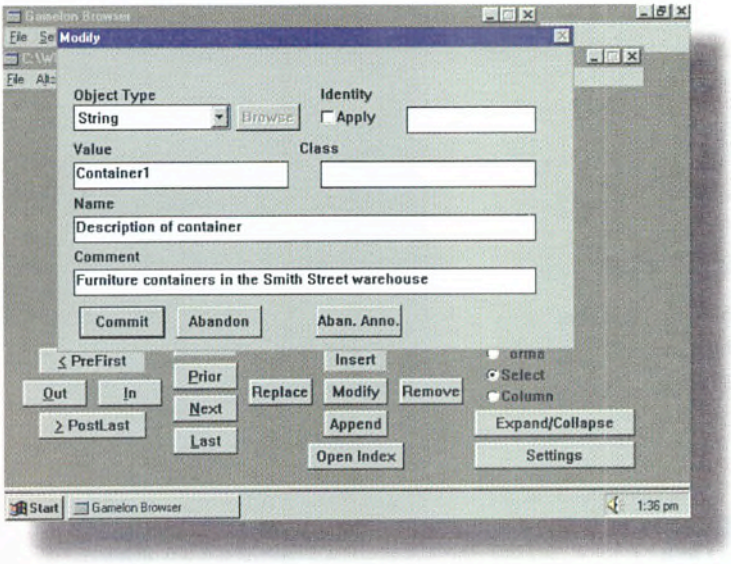

Figure 2 – You can view and modify compiled data files within the Gamelon browser, for example to add a name or comment annotation.

Transactions

One of the key aspects of any database in terms of its suitability for so-called 'mission-critical' applications is support for transaction-based processing. It is of course

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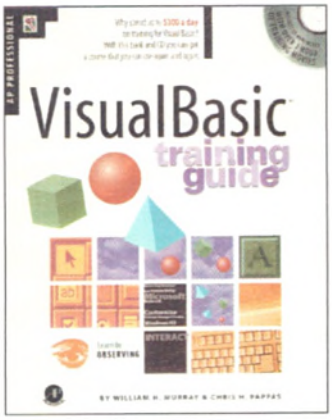

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possible to manually program transactions on those database products which do not have it as an integral feature, but this does not carry with it the same assurance as built-in transaction capabilities. The purpose of a transaction is to process a series of changes to linked fields, files or (in the case of Gamelon) objects, and to make sure that the process is either completed in full (ie all the changes are actioned) or not completed at all. It prevents situations such as, say, a debit against a customer's account being processed without the balance of the account being updated to reflect it.

Gamelon's approach is to copy all the objects involved in a transaction to a temporary file, and make all the changes there. If all changes are completed successfully, a *commit* action writes the updated copies of the objects to the main file, otherwise the objects are discarded with no damage to the original data. Menai describes this form of transaction processing as *fixed*, since Gamelon supports another form, known as a *wandering transaction*.

A wandering transaction lets you commit or abandon changes in the same way, but does the work in the original data file: you can select any set of objects and have your changes delayed until a commit action is issued. It is effectively a form of delayed block updating, useful when, say, a comment annotation that applies to a series of objects is being changed. Dealing with transaction processing in such a way is not just a useful aid to maintaining data consistency, it is a mandatory requirement where significant data is being handled. Gamelon's elegant handling of this is one of the many examples of the careful consideration that has gone into its design.

Locking and blocking

As with other databases, Gamelon can control access to the data as required by the developer, including blocking access at file or object level. Opening a file for exclusive use rather than shared access is potentially disruptive in a multi-user situation, and is normally unnecessary with Gamelon, because it automatically handles multiple uses of a data file. While an object is being modified, other cursors still have read access but are locked out in terms of writing – this is a standard approach at the level of a single file, but in Gamelon this locking occurs at the object level, and multiple objects can be updated concurrently within a Gamelon data file.

The question of how to handle locking of aggregate objects could be tricky, but Gamelon adopts an intelligent approach, whereby the containing object and the currently edited object are locked, but other objects in the same container are not. Thus objects within the same container can be edited simultaneously, and still allow read access to any object regardless of the writing locks that may be in place.

In addition to its equivalent of file and record locking, Gamelon has a keyed access

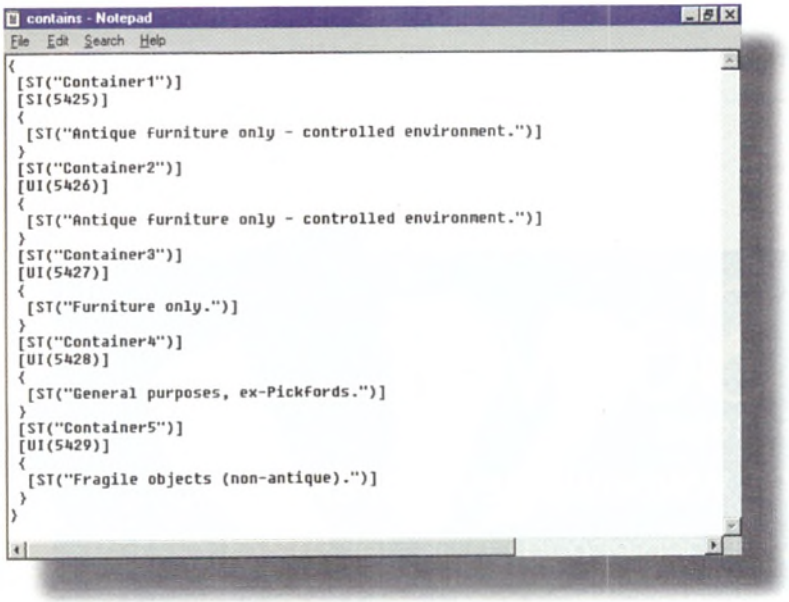

Figure 3 – A Gamelon file's structure, and (if required) data, can be defined using any text editor.

mode, based on the cursor which opens the file including a key (numeric or character). It operates by restricting access only to those cursors which provide the same key. This has some obvious uses, for example for controlling access to a set of sensitive data at the file level.

It may be desirable to limit the cursor's navigation to a specific area of a data file, for example to protect sensitive data. Gamelon handles this with a 'seize' feature, which limits navigation to the current aggregate object and any other objects that can be accessed from it. Hence a mix of data of varying sensitivity can be conveniently included within one data file without the complexities of access control that can apply in a relational context.

These are not the only issues related to file navigation to be dealt with: some relational databases make it possible to access positions in a file immediately before or after the data records begin. There are some advantages in being able to identify and move to these regions, partly because it is a way of ensuring that a set of data is fully accessed or queried. Gamelon has an equivalent, specific to its object structure which enables a cursor to be moved to *pre-first* or *post-last* positions within a containing object. As with non-object data files these positions are a starting point for a move forwards or backwards.

There's a need for some way to deal with empty and null values in data. Empty values are handled in Gamelon by the 'absent data' token, which is distinct from null data. Any object can be null, and is handled by Gamelon automatically. The most common situation is a null object within a series of objects in a containing or aggregate object, but it is also possible to specify an aggregate object without specifying its contents. Gamelon can even handle a null aggregate object without generating an error.

The rewards of persistence

The major strengths of Gamelon lie in its cross-platform, language-independent nature, which gives it a potentially very wide scope of application. Its most obvious appeal will be to developers who want to explore alternatives to database engines or need compact data files, without losing critical features of relational databases such as indexing and transaction support. Once you have grasped the concepts behind Gamelon, and produced the set of routines necessary to create and maintain your data in some specific format, it is very easy and flexible to use.

With any database application a planned approach is always to be recommended, and in the case of Gamelon this should include fully exploiting its object annotation features, not just to document the data but also to explain why particular features such as seize have been implemented. It is worth noting in this context that some relational databases have little or no facilities for self-documenting data storage in this way.

Menai is constantly expanding Gamelon's capabilities, and it certainly looks set to go from strength to strength in the future. ■

Colin Hume is a Web consultant and journalist. He can be contacted at chume@cix.compulink.co.uk

Gamelon pricing starts at $149 for a single license for Windows 95 & Intel NT, OS/2 and Mac platforms, and $449 for Solaris, HP/UX, AIX, Alpha NT and SCO Unix. More information about Gamelon, its licensing and software downloads including the ActiveX control are available from Menai's web site at http://www.gamelon.com.

Gamelon and on and on...

At the time of writing, version 3.0 of the library is in testing. According to Menai, the improvements include enhanced transaction management, nested encryption, key value indexing and facilities for support of distributed object replication.

Another member of the family, Gamelon Base is predicted to be finished within the next few months. It provides direct call (non-OQL) object database functionality that accommodates run-time changes to object structure. Unlike Gamelon Files, it places some limits on the programmer's control over how files are laid out, in order to reserve data areas for state information about the database (such as meta-data). When the end-user product is released, it will probably include a component API, so that developers can supplement its capabilities. Menai has not yet announced details of how it will operate, but the intention is to give end-users full access to Gamelon Base's capabilities. ***Ed.***

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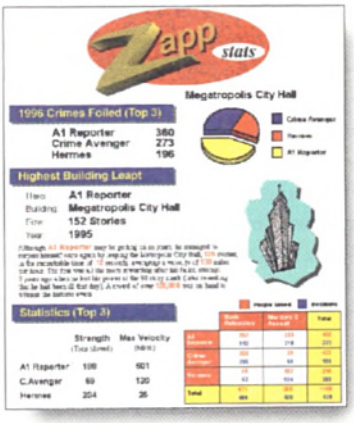

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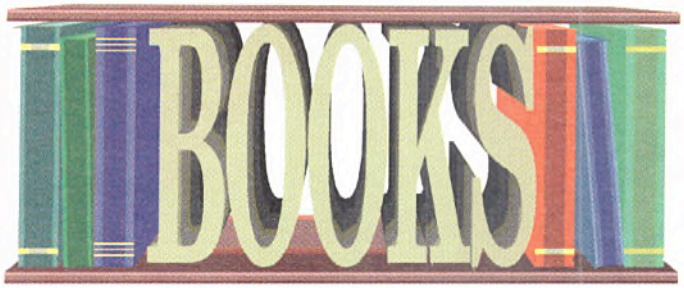
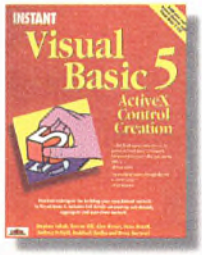


Instant Visual Basic 5 ActiveX control creation reviewed by **Mary Hope**



What an excellent book! For months I have been struggling to get to grips with the what, why and how of ActiveX and now, thanks to this book, my battle is over. The mystery is gone, and I can hold my head up when the word is mentioned.

It is essentially a guide to building ActiveX components with the Visual Basic Control Creation Edition (CCE), a standalone subset of VB5 currently freely downloadable from Microsoft's Web site. As the name suggests, VB5 CCE is exclusively for creating ActiveX components, and cannot generate straight executables, but it's great if you want to test out your ideas for controls without the sweat of C++.

The 'getting started' section assumes some familiarity with VB but handholds you through your first control. Initially I had a minor difficulty moving from design mode to run mode but I suspect this was due more to me rather than the book. Having sorted that out, the wonders of drag and drop and Wizards made the whole thing unbelievably easy. The book's first example control is simply a tool to convert decimal numbers to binary and vice versa. More useful controls described in the book include a custom list box, a control using DAO and a 'user-drawn' control for a card game. User-drawn controls are those in which the appearance is not derived from any of the standard Window controls, so they can have an un-Windows-like appearance, such as a playing card, or no visual interface at all.

Having created a control, the next question is how to distribute it. The book conveniently distinguishes between distributing to developers who may wish to use your controls, and end-users such as application installers and people browsing the Web. As well as describing how to organise the physical distribution using the Setup Wizard, the book covers related issues such as licensing and security with digital signatures.

Altogether this is a book every software developer must have. The subject matter is 'can't be ignored state of the art' and the treatment is comprehensive, clear and a pleasure to read. You might also be interested to know that one of the book's authors is Dave Jewell, one of *EXE*'s regular contributors.

✔ **Verdict: Highly recommended**

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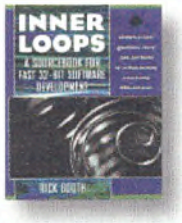
Author:	*Stephen Jakab et al*
Publisher:	*Wrox Press Ltd*
ISBN:	*1-861000-23-5*
Price:	*£27.49*
Pages:	*333*

Inner loops: a sourcebook for fast 32-Bit software development reviewed by **Gavin Smyth**



This book deals with Intel code optimisation, claiming to be 'for programmers who can at least read through PC assembly language listings, if not confidently write them', but I feel that you will not gain very much from 'Inner loops' unless you are fairly fluent in assembler.

It can be split into four parts: a brief introductory section which may be of use to competent 16-bit programmers who are just entering the 32-bit world, but of limited value otherwise; a section on the details of programming the different Intel processors; a couple of chapters on applying optimisation techniques; and several carefully examined case studies, with complete source code on the obligatory CD-ROM.

In the introduction, Mr Booth partitions the Intel processor instruction set into categories from efficient RISC operations to costly instructions that should generally be avoided: in the rest of the book, he concentrates on wringing the most out of the first class.

The following chapters are devoted to the 486, Pentium and Pentium Pro, listing instruction timings and pairing rules, and providing guidelines for effective use of the cache and pipelines. Much of this information can be found in the bowels of the Intel documentation, but here it is much more digestible, and has the advantage that errors and omissions in the original documents have been corrected. Because these chapters are more or less self-contained, they are slightly repetitive. The Pentium MMX is featured, but since the book was written before MMX was widely available, the material is less well developed as for the other Intel processors.

The section on applying optimisation covers techniques for respecifying and simplifying algorithms and the advantages assembler has over C, as well as less obvious speed-up mechanisms, such as use of indexed addressing modes and working with the cache. This chapter culminates in ways to avoid processor stalls by reformulating code as coiled and tandem loops. There follows a brief description of how C maps on to assembler, perhaps of value in estimating timings for high level code.

The final third of the book, is taken up with extended optimisation examples, covering such areas as memory copying, hash tables and Huffman data compression. These chapters contain many general purpose tips and tricks, such as how to perform both an addition and a subtraction in a single instruction cycle. Although the optimisations are well described, the book will be more useful in optimising specific routines rather than a general class of operation.

This is a very readable book with only a few flaws, well worth a look by anyone concerned with squeezing speed out of Intel processors. If you want the numbers, I actually managed to increase the speed of my sprite drawing code (see 'Go-faster sprites' *EXE*, August 1996) by about 35% thanks to this book.

✔ **Verdict: Recommended**

Title:	*Inner Loop: A sourcebook for fast 32-bit software development*
Author:	*Rick Booth*
Publisher:	*Addison Wesley Developers Press*
ISBN:	*0-201-47960-5*
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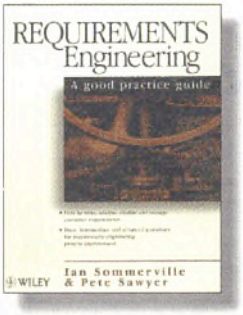

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Candidates must possess excellent C++ programming skills on any UNIX platform. Any communications or networking skills would be considered a plus, along with any previous experience of real-time development.
A financial background is not necessarily required as full training will be provided.
Ref:JK/10

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Ctrl Break

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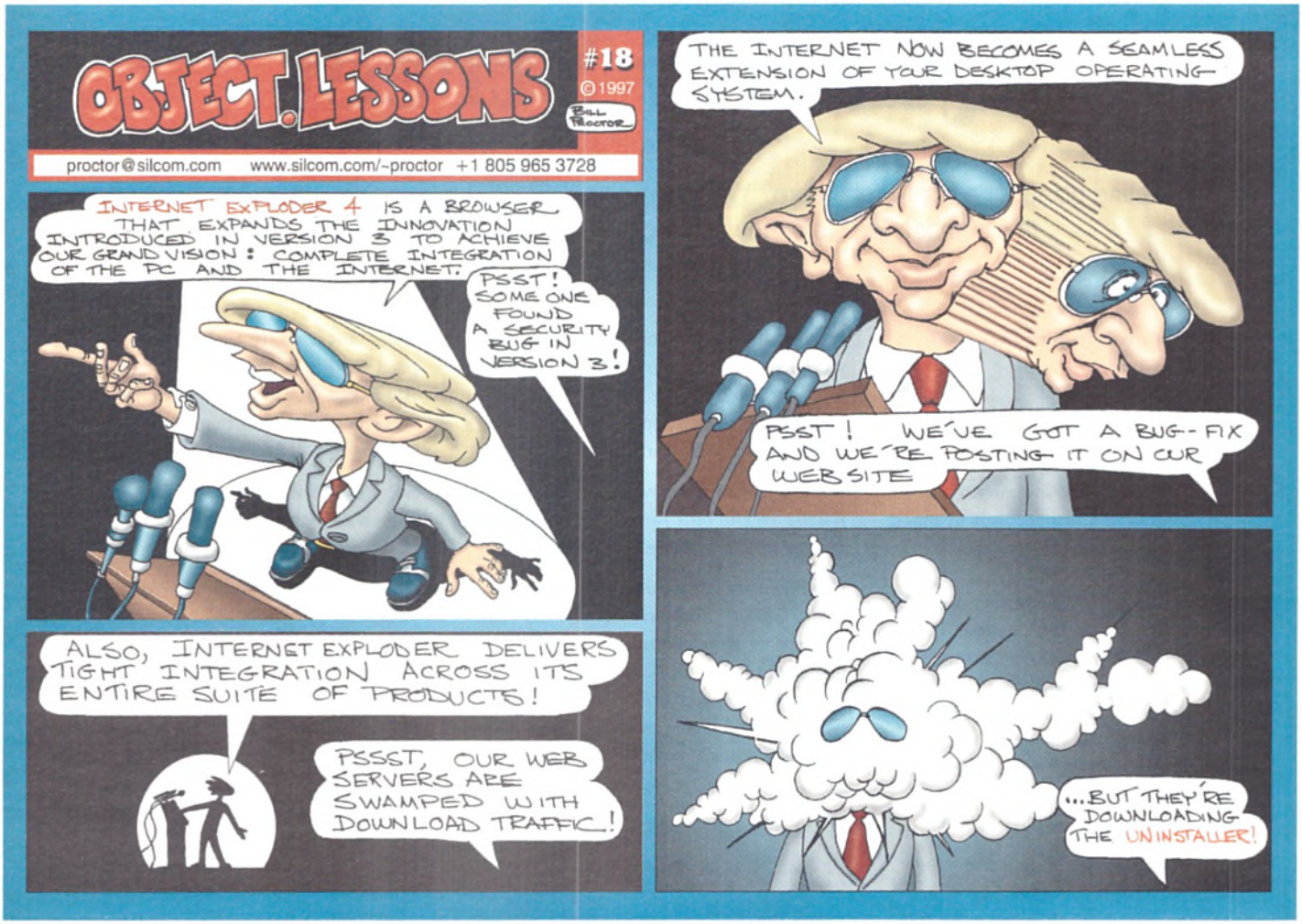
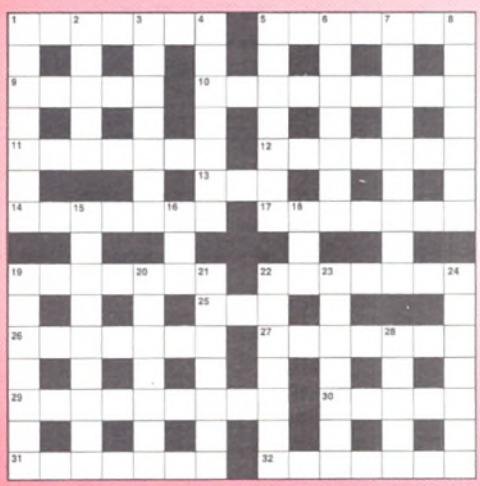


CROSSWORD



ACROSS:

1. Makes permanent copy of db file contents (7)
5. Line of same slope may make the chap brown ... (7)
9. ... or TAB somehow to give up the run (5)
10. Intend to say loop start as time passes (9)
11. Recording medium store of distant past ... (7)
12. ... before these singers were looking for something special (7)
13. Type of network made from closed interfaces (3)
14. Set up a firewall and watched ... (7)
17. ... the roms break down in the soup holder (7)
19. No-one can stop it increasing with time (7)
22. Puts the boot into the male child (not really)? (7)
25. From the chief terminal, passing money round the network (3)
26. Starting, say your name (7)
27. Free-standing chunk of code is nothing special (7)
29. The study of tension, perhaps, to say it twice (9)
30. Concept fifty make perfect (5)
31. Puts on female garb ... (7)
32. ... and becomes less superficial (7)

DOWN

1. Getting stored data in our Silicon Valley (7)
2. Many bar the way to a timer chip (5)
3. Walk again a new tyre cover (7)
4. Chose a subset of the data as Samuel begged for mercy (7)
5. Van where Gloria was sick on Monday (7)
6. At this point of space-time? Not in the Universe at all! (7)
7. Protective outer layer of you or plant (9)
8. Locks resulting from loss of 31's head for tea, I hear (7)
15. Characteristic of an entity (9)
16. Initially IT ... (3)
18. ... initially Hollerith's IT gives success in search (3)
19. Radiated from the transistor source (7)
20. Moo in US? That could be worrying! (7)
21. As a sign of age, moves towards the brightest part of the spectrum (7)
22. King stuck around? No - wandered off (7)
23. Hard to find in the tunnel (US) I've dug (7)
24. Keeps making sly digs off the Isle of Wight (7)
28. Goodnight lady, with anger in Tyneside (5)

SOLUTION TO MARCH'S CROSSWORD

ACROSS: 1. MOST 3. OVERLOADED 10. SCANNER 11. CATHODE 12. LISP 13. IRRADIATE 15. DUNGEON 16. SEALANT 18. RESISTS 21. GALVANI 23. STATEMENT 25. CODE 27. INITIAL 28. ATTRACT 29. GIGACYCLES 30. TEST

DOWN: 1. MASK 2. STATION 4. VERSION 5. RECORDS 6. OPTED 7. DIORAMA 8. DIELECTRIC 9. SNAPPERS 14. ADDRESSING 17. ALLOCATE 19. SCALING 20. SHELLAC 21. GET LATE 22. AND GATE 24. ENIAC 26. STET

Quality Street

Contemplating going for a quality standard? Want to put an ISO 9000 logo on your letterhead and garner a few of those Big Company contracts? Verity Stob would like a word.

Verity, what exactly does ISO 9000-and-thingy involve?

Nothing at all. That's the beauty of it. You just continue doing exactly what your are already doing, going about your business. Occasionally you may make a note. Which takes a few seconds at most.

What, really?

Good grief, what time yesterday did you fall off the Christmas tree, angel? '*Course* not really. ISO 9000 is the millstone around the neck of the weary traveller as he attempts to wade the quagmire of bureaucracy, it is the packet of dry roasted peanuts offered to the parched and blackened lips of the man dying of thirst in the desert of paperwork, it is...

OK, so you don't like it. But the nice consultant-man we are paying 600 smackers a day has given us a leaflet...

This would be the DHS-style leaflet written in baby language with embarrassingly badly drawn cartoons and a passage explaining how to encourage employees to 'think quality' during their lunchbreaks?

I admit the artwork is perhaps not up to snuff, but that's hardly a reason to dismiss the whole thing out of hand. After all, as soon as we get up to speed, we will soon feel the benefit from the improvement in our working practices. Time benefits, cost benefits.

Nonsense. ISO9000 does nothing at all to improve working practices. It just adds more work to your existing working practices. If you have good working practices then you will have less time to do the work because you have to spend all the time documenting them, and having meetings to review the documentation, and further meetings to review the documentation procedures. If you have ho-hum working practices, you will be so completely up the creek that your boat will be touching north and south banks simultaneously.

Surely you are not really claiming that filling in the odd form as you go about your work is so time consuming?

No. Filling in 'the odd form' as you go along is pretty unbearable, but the real killer is forging retrospectively all the documentation that you didn't have time to fill in when you were supposed to. And don't pretend that you won't find yourself in this position, because you will.

You're such a kidder Verity. Since we are to write our own quality manual, we will control what has to be done. There will be none of this bureaucracy.

Ah, now there you have put your finger on one of the Big Lies upon which the quality racket depends. This 'you write your own manual' business is a trap. What happens is they give you their manual as a template and have you write your company's name on the front, and add your working practices expressed in their language. In the warm glow of producing a fat A4 folder entitled 'Joe Blogs Ltd Quality Assurance Manual', you completely fail to notice the home-spun web you are entangling yourself in.

So, what are you saying, Verity: that it is bad to keep proper records?

Not at all. Keep records where you need to. Don't where you don't. Work for yourself, not *Them*.

You keep mentioning* Them. *You Anti-Quality people...

Actually, these days we are known as the Pro-Thought lobby...

You people have a conspiracy theory explaining ISO9000?

Oh yes. There are essentially two types of human being: the real person (like me and maybe you) and the middle manager...

And I suppose the quality fad is an attempt by middle managers to regain their control over the likes of programmers, who as a consequence of their quicker wits and the emergence of a technology that requires thought in order to use it, have displaced large numbers of management in the social and economic hierarchy?

I see it's all clicking into place for you too.

Verity, I just want you to sit there calmly still while I pick up this phone and call an ambulance.

Just one more thing.

What?

Your cost code for reading this article. It's VER/13382-970472!EXEMAG.

Oh, thanks. ■

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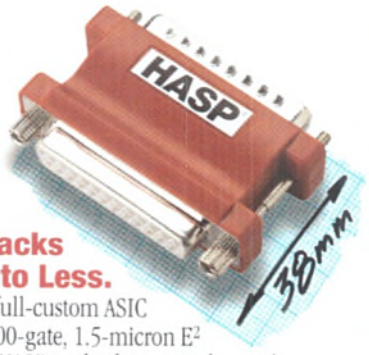

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Ease of Use	8.3	7.2
Versatility/Features	10	8.7
Compatibility	6.7	6.5
Speed of API Calls	0.9	1.2
Final Score	**8.5**	6.5

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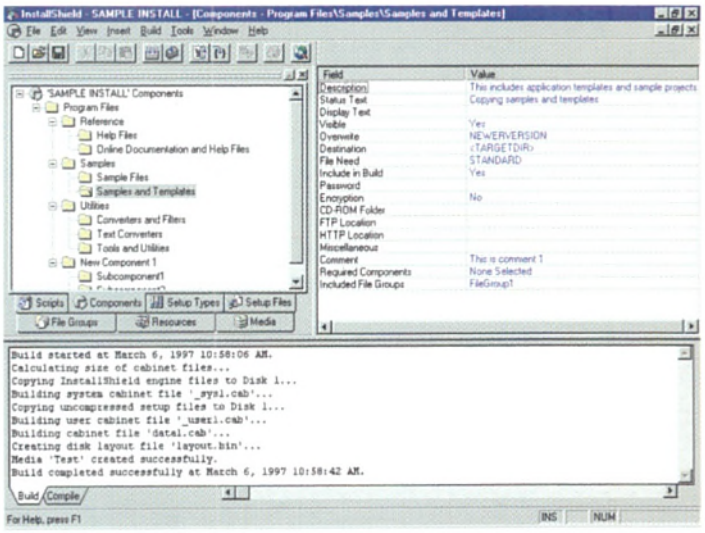

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