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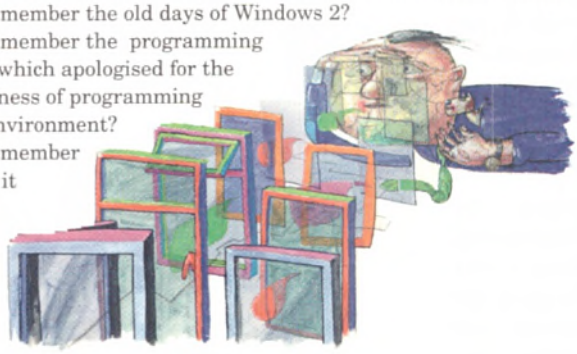

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SoapFlakes

Polymorphism – is it overrated?

It is well established that the 'holy trinity' of object orientation comprises encapsulation, inheritance and polymorphism. While I have no trouble at all with the first two I really am beginning to wonder if polymorphism can continue to justify its deification. While it is useful, it is by no means as significant as encapsulation and inheritance. This was recently brought home to me by a chapter on the subject in an otherwise excellent textbook, *Object-Oriented Programming with C++* (DP Publications, 1994). This book falls into the trap of giving polymorphism a high profile and drowning in the confusion of justifying it. The argument seems to go, 'if it is a pivotal part of object technology then I must devote space to it'. Variations on this theme are 'if it is that important I must master it, spend significant time teaching it, etc'. You cannot join the object technology club until you can put your hand on your heart and say you have mastered polymorphism.

Definers of the term fall into two camps. The narrow definers equate it with dynamic binding using virtual functions. Alternatively a wider definition and classification scheme is used (often by texts aspiring to greater academic rigour). The most frequently cited one is by Cardelli and Wegner. It appears in their article *On understanding types, data abstractions and polymorphism* (Computing Surveys, December '85). The trouble with this, well illustrated by the book mentioned above, is that it makes a mountain out of a molehill. In essence it categorises polymorphism as universal (eg parametric and inclusion) and ad hoc (eg overloading and coercion). What this all boils down to is overloading of functions and operators, use of virtual functions and templates.

Overloading is a programming convenience and hardly merits more than 2/10 on any scale you care to dream up. Virtual functions rate more highly but their importance has been diminished by the advent of templates. Before templates we had to use a dynamic binding wheeze to build generic container classes. The container class (which might include a method to print out information from the objects in the container class) would contain a class such as `Record` with very basic functionality. The class we wanted to put in the container class, would then be derived from `Record` and its `print` method overridden. If `print` was defined as a virtual function in `Record` the container class would downcast to find the right version to use. But thanks to templates, all this is history.

Of course dynamic binding is not just used to build container classes. It still provides a powerful mechanism for building in extensibility. It also enables designs that remove dependencies between clients and servers. Dynamic binding may be useful but it does not merit putting polymorphism at the top of the table.

The final part of the classification, ie templates, now generally stands on its own merits and tends not to be regarded as a type of polymorphism.

I suspect that book writers and teachers, who are more prone to be doctrinally correct, support the high profile of polymorphism, whereas the rest of the world has let it slip. For instance Delphi, which has lots of good object technology features, but is unconcerned about its object purity passes polymorphism by with barely a mention. There is no reference to it in the indices of the various manuals and as far as I can see there is no use of the term in the text. However the main mechanism for what is usually meant by polymorphism, ie virtual methods with dynamic binding, are described and can give Delphi polymorphic features. But it is treated as just one of those many things that you expect a modern language to do.

My plea is that we redefine the key characteristics of an object-oriented language as being encapsulation and inheritance. Polymorphism then gets relegated to being one of the other useful features that the language will have along with templates, exception handling, some easy to use GUI classes, mechanisms for creating dynamic link libraries, OLE etc. It no longer merits its place at the top.

Mary Hope teaches software development at Thames Valley University and can be emailed at hope_m@kennet.tvu.ac.uk.

Seeing the information wood from the data trees

If your job is anything like mine, what matters is not the amount of data I need, it's finding the right kind of information. Recent research from Spikes Cavell has highlighted the fact that people see the way that management information is delivered as irrelevant, just so long as it meets their needs. During 1995, another force majeure – data warehousing – has been thrust upon us as the panacea for quick and easily accessible information. Whatever the approach, the key question is how do you deliver maximum return on investment.

Before rushing headlong down the data warehousing route, take a step back and assess what information is already there. Use business process and data modelling techniques – because tools like these offer simple and easy-to-use graphical interpretations – to scope out an overall view of the organisation, and in particular a well-documented map of the information already held. Only then can a decision be made as whether to opt for a data warehouse. For some organisations, it may be a case of simply adapting the existing information system to users' needs in which case a large saving is already made. Whatever the direction chosen, data modelling provides a firm foundation on which to start.

Many organisations have already taken the step and have well-defined data environments along with excellent documentation. Data modelling provides a flexible informa-

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tion infrastructure where changes in the business can be easily reflected in the IT system which can drastically reduce maintenance costs. For example, modelling enables the migration of information from legacy systems and different databases.

Where the data warehouse really comes into its own is those situations where decisions need to be made centrally and are based on large volumes of data. Airlines, financial services, telecommunications and retailing are prime examples. In these scenarios, users need quick replies to large queries if they are going to be able to make the right decision and react quickly to changing market conditions.

In the face of increased competition following market deregulation, Pacific Bell recently implemented what is arguably the largest data warehouse in the US. But before launching into the project, Pacific Bell used data modelling to find out what information was held in the organisation and then used it to develop the most effective way to store the data and get information to where it was most needed. It gave users greater flexibility in terms of what information the user could extract.

IT can be costly and if it is to succeed in delivering business benefits, the rationale must be considered carefully. Objectives must be clear. Ask yourself what information have you already got and evaluate the best route to take. Remember, the design model is integral to any application whether it is based on a data warehousing architecture or not.

Nigel Hopkinson is managing director of Logic Works, an independent vendor of client/server business process and database design tools. You can contact him on 0171 323 4770.

Software reselling

Often in the enjoyment of developing the next earth-shattering application you can be inclined to forget about important things such as selling it for cash at the end of the day. If you pick up one of the trade publications, you will see a range of terms such as direct, channel, indirect sales methods. What do these methods mean and which one is best?

Direct – Well, this is the simplest model and therefore not used by many software manufacturers unless revenue is down. It involves selling directly to the customer, it also means you have to pay for advertising, promotion, and maybe even sponsor a fleet of Mondeos with jackets hanging in the back! It does mean that if your software retails at £100 then that is what you get for it.

Indirect – Now things get a little more complex. You sell to dealers who then sell to the customer. The good news is that the dealer will pay for either all or some of the advertising, and he already has his own fleet of Mondeos. The bad news is that these Mondeo drivers may have a 100 different products to sell, some of which may compete with yours. How do you get focus? The best way is an in-depth bonding session with the sales force, usually in a seedy part of town and always with you being totally sober and armed with a camera! Of course your £100 retail now becomes £70 to you because the dealer needs a margin but you theoretically have a larger sales force that you do not pay for.

Channel – This is like indirect but you have a distributor who sells to dealers who sell to end users, your £100 retail now becomes £60-55 to you and you have a larger group to entertain and take photos of .

The main difference is that if you sell direct you are restricted as to the number of people you can talk to about your product. This is fine if your software is only used by a small group but if you have a more general application you need 'feet on the street' and channel/indirect will get you that.

Some people mix the direct and indirect methods which makes the model even more complex as you are now competing with your resellers as well as with your competition. To do this you need to have clear rules and punish any reseller who breaks them and call it a special strategic account when you break them. Of course you then need to have a specialist management team to control these diverse sales channels. With such a team of high flyers you won't be sponsoring a fleet of Mondeos but a fleet of BMWs. This is called progress.

Gary Wood
Visual Components

Happy new APIs

Each year witnesses the arrival of new APIs and the death of old ones and not-so-old ones. Software developers are faced with tough decisions, develop for which operating systems, with which language, for which hardware? It can usually be summed up as a choice of APIs. Why is it an especially hard choice?

Long gone are the times when an SDK could fit on a floppy disk and the number of pages of its documentation was less than three digits in decimal base. To master fully, let's say Win32, you'll need time just to go through the documentation, the examples and practice. Even more important, you'll need to have some understanding of software concepts which might be obvious to the Computer Science student but which are not to someone whose main background is developing for an old simple file operating system. Concepts such as semaphores, call-backs, paging, queues are more and more considered known notions. Hence deciding to develop for a new API must be a well thought out decision.

With the increased complexity of development, the time to market can be long enough for changes of popularity of APIs to happen during the development phase. And the changes can be dramatic. Did you believe Microsoft when it told the world that all programs should be developed first for OS/2 and then for Windows? More recently, did you think that Taligent's frameworks would be on every desk? Did you expect the – current – success of the Web? Will you bet on a future with applets travelling in an integrated phone and computer network, where the bandwidth of the network will be bigger that the one in your local machine?

Very happy new APIs...

David Mery

Productivity Headache #69: Check-list items that don't check out.

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Mayhem!

Do you remember the old days of Windows 2?

Do you remember the programming manuals which apologised for the awkwardness of programming for this environment?

Do you remember the crummy compilers and the flaky debuggers?

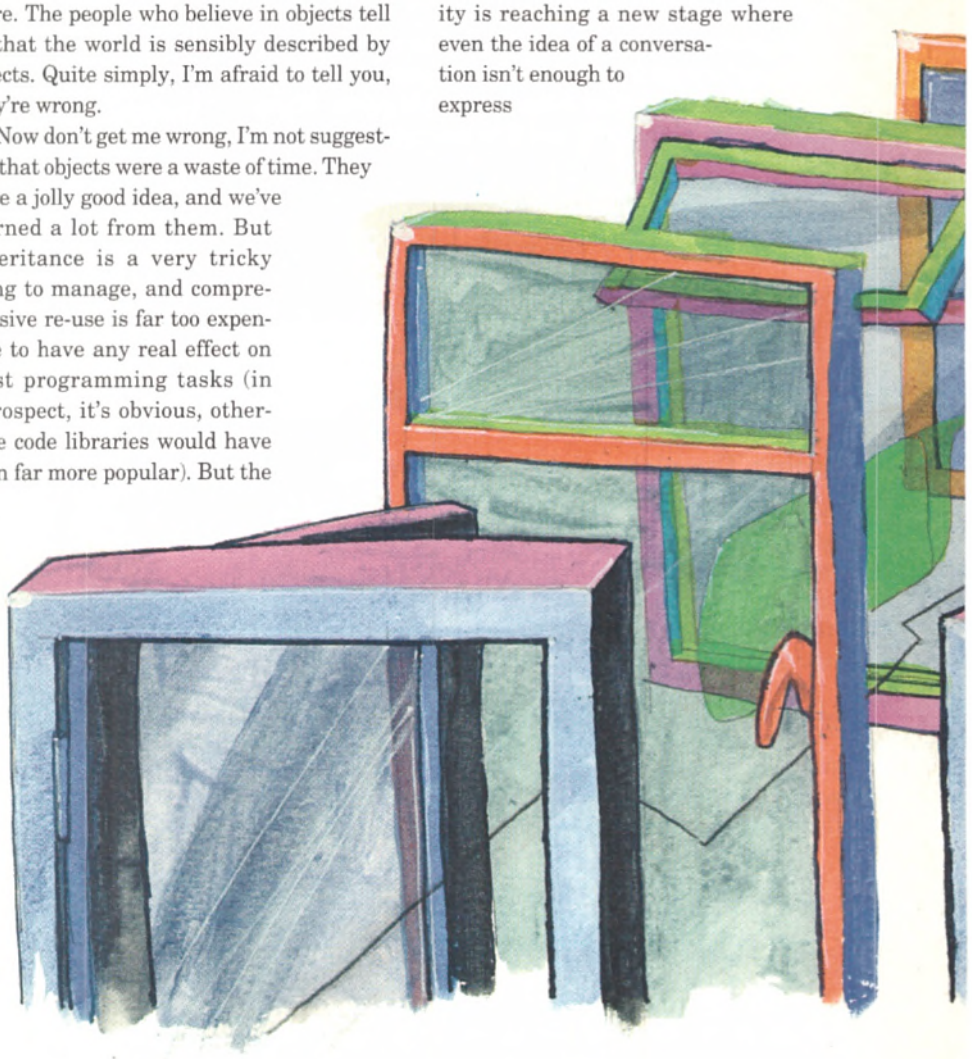
Do you remember how easy it all was?

Windows has grown loads of new protocols since then. Each one was harder to program for than the one before. That's all right, we were assured, these sexy new object-oriented languages will come to our rescue. The sexy new object-oriented languages arrived, but somehow it didn't get any easier – it just kept on getting harder. It's just a matter of getting the libraries right, we were assured. But, still, it gets harder.

I've been patient. I've been waiting, along with all of you, for object-orientation to deliver on its promises. I've been waiting so long I'd even stopped noticing I was waiting. But now, I've decided, I don't buy it anymore. The people who believe in objects tell us that the world is sensibly described by objects. Quite simply, I'm afraid to tell you, they're wrong.

Now don't get me wrong, I'm not suggesting that objects were a waste of time. They were a jolly good idea, and we've learned a lot from them. But inheritance is a very tricky thing to manage, and comprehensive re-use is far too expensive to have any real effect on most programming tasks (in retrospect, it's obvious, otherwise code libraries would have been far more popular). But the real problem is that the world isn't described by objects at all: it's described by conversations, and all objects exist in some more or less controlled context.

Again, spelled out, it seems obvious. If you're sending a message to an object, it seems reasonable to ask where the message came from. Where you have several objects co-operating (as widgets have to), classes have to understand each other, and the basic object metaphor doesn't have any real way of expressing this. We need to think in terms of conversations between objects. Even this is not so bad where all you have to manage by hand is conversations, but now the complexity is reaching a new stage where even the idea of a conversation isn't enough to express



what goes on in a program.

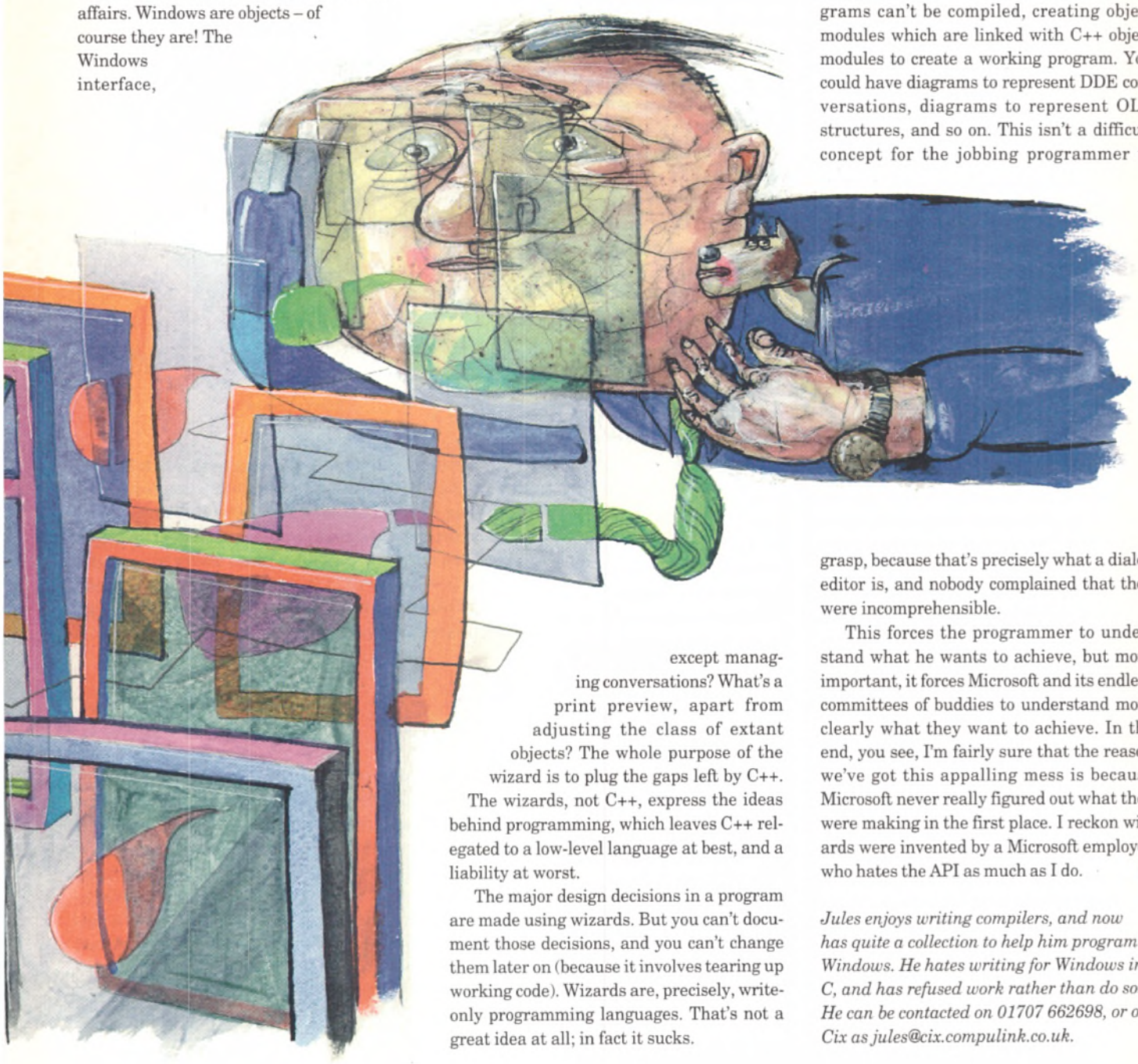
Let's step back for a moment, and look at what a programming language is. We use a programming language to talk in terms of what we want to achieve. We don't have to know which registers are doing what, or where the memory is. We just talk about what we want to achieve. A low-level language, which places you close to the metal, is very expressive, at the expense of some considerable cost in programming effort (and tedium). A high-level language allows you to gear your ideas so you don't have to program all the details, but only if you're prepared to play by the language's rules. Where the ideas in the language are antithetical to the problem in hand, you have a far, far tougher job than you would have had if you'd stuck with a low-level language.

Let's return to the present state of affairs. Windows are objects – of course they are! The Windows interface, though, seems to go to extraordinary lengths to make it difficult to subclass its base classes, and though we're being exhorted to use C++, there's no C++ mechanism to achieve that subclassing. C++, then, is silent about the single most important object classes in a program. What good is the C++ mechanism?

OLE is what it's good for. OLE is based on C++ virtual function tables. The only trouble is, C++ is not enough to write OLE apps - you need the help of *wizards*. Now we must pause again to look at wizards. Great idea, in principle: you tell the wizard what kind of program you want to make, it writes a skeleton program, and then you fill in the details. You can add toolbars, print previews, and so on, just by pressing a few buttons.

But wait! What's toolbar manipulation except managing conversations? What's a print preview, apart from adjusting the class of extant objects? The whole purpose of the wizard is to plug the gaps left by C++. The wizards, not C++, express the ideas behind programming, which leaves C++ relegated to a low-level language at best, and a liability at worst.

The major design decisions in a program are made using wizards. But you can't document those decisions, and you can't change them later on (because it involves tearing up working code). Wizards are, precisely, write-only programming languages. That's not a great idea at all; in fact it sucks.



It's no wonder that writing modern software is so hard! The closest thing we have to an apposite language with which to express programs is stuck onto what appears to be an entirely inappropriate language, an afterthought to patch up the mess.

You can't think of an object in isolation: you have to be able to deal with it in context. Those old favourites, dialog editors, were wrestling with this very problem, and they solved it with a welter of semi-automatically-generated include files. For the simple contexts of old programs, this just about worked. Now contexts are more complicated, and wizards are handling the same thing, rather less successfully.

It doesn't have to be this way. In order to use these tools, you have to write down, in some form, what you want to achieve – I use diagrams. There's no reason why these diagrams can't be compiled, creating object modules which are linked with C++ object modules to create a working program. You could have diagrams to represent DDE conversations, diagrams to represent OLE structures, and so on. This isn't a difficult concept for the jobbing programmer to grasp, because that's precisely what a dialog editor is, and nobody complained that they were incomprehensible.

This forces the programmer to understand what he wants to achieve, but more important, it forces Microsoft and its endless committees of buddies to understand more clearly what they want to achieve. In the end, you see, I'm fairly sure that the reason we've got this appalling mess is because Microsoft never really figured out what they were making in the first place. I reckon wizards were invented by a Microsoft employee who hates the API as much as I do. ■

Jules enjoys writing compilers, and now has quite a collection to help him program Windows. He hates writing for Windows in C, and has refused work rather than do so. He can be contacted on 01707 662698, or on Cix as jules@cix.compulink.co.uk.

Sun kicks off Java Cup!

Sun Microsystems has announced the Java Cup International, a contest which aims to promote the creation (and public availability) of small platform-independent 'applets'. The contest begins immediately and ends March 31 of this year. The most innovative and creative applets will be announced in May. Business, academic and individual developers may submit applets for consideration, in one of six categories: productivity tools, Internet/Web agents, educational tools, developer tools, entertainment and games, and 'unlimited'. A total prize pool of $1 million in Sun hardware and software will be shared by the winners. More on *http://javacontest.sun.com*.

ODBC Conference

A one-day conference on ODBC is to be held on 23rd of this month at Microsoft UK in Winnersh. The conference, which includes a buffet lunch, covers the key issues of ODBC use, such as tool support, testing, performance, and the relationship of the forthcoming OLE/DB to ODBC. Michael Pizzo of the original ODBC development team will talk about why ODBC was conceived, its history, and its future direction. The event is organised by The ODBC User Group and normally costs £95 for non-members. However, EXE readers are able to attend the conference at the member's price of £80. Call Rob Macdonald on 0181 993 8080 for details.

Got your anorak?

The University of Westminster is co-hosting the Professional Awareness in Software Engineering conference on the first two days of February. Keynote speakers include Tom DeMarco, the inventor of systems analysis, and Fred Brooks, of *The Mythical Man Month* fame. For more details email paseconf@westminster.ac.uk or browse *http://scsise.wmin.ac.uk/SED/pase/cfp1.html*.

Comdex/UK '96

American IT event Comdex comes to Europe for the first time this year, and is likely to be a big show. Held at Earl's Court 2, London, on April 23-26, the event will offer the usual array of exhibitors showing off their latest products. Conference programmes cover IT management strategies, networking, multimedia, Windows, the Internet, software development, open systems, and selling channels. For updated information, or to register, visit *http://www.comdex.com*, or ring 01203 694131. Price: £100 (exhibits only), from £220 for the conference.

CGI launches BIRD method

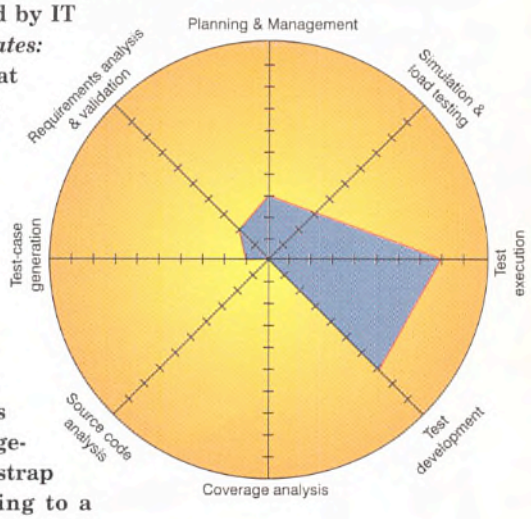
IBM's software and services subsidiary CGI has published BIRD, a new object-oriented methodology for developing client/server applications. BIRD supports all stages of the project lifecycle, from business process re-engineering to delivery of the final product, and operates alongside object-oriented tools and languages such as PowerBuilder, Smalltalk and C++.

BIRD builds on users' experiences of object-oriented methodologies such as Rumbaugh's Object Modelling Technique (OMT). BIRD draws on other practices too, including the Rapid Application Development (RAD) method and prototyping techniques. The framework offered by BIRD is open, allowing other techniques to be used simultaneously.

As well as supporting standard iterative object-oriented development, BIRD models application partitioning right from the start, instead of appending it to the implementation stage. CGI hopes BIRD will reduce the level of mismatch between the design and the implementation of an application. BIRD will be documented in book form, and will also be supported by PACDESIGN, CGI's front-end CASE tool. Call CGI on 0181 643 4443.

Ovum hatches testing strategy

A new continuous service that evaluates testing tools has been launched by IT consultancy Ovum. *Ovum Evaluates: Software Testing Tools* claims that dramatic improvements in software quality are possible by implementing processes that ensure that good practices are adhered to throughout a project. 'This requires the operation of a testing strategy spanning the whole of the software development cycle,' said George George, Managing Editor of the service. Process improvement and quality management models such as Spice, Bootstrap and ISO 9001 all confine testing to a phase at the end of the project.



The service provides 30-40 page evaluations of leading testing tools, with 30 such products being evaluated during the first year of the service. Ovum employs a reference model which grades tools along eight dimensions (see Kiviat diagram) corresponding to testing activities that can be supported, to some extent at least, by a software tool. Each evaluation includes an overview of the tool's underlying architecture and philosophy, and reports on vendors' priorities for enhancing the tool.

***Ovum Evaluates: Software Testing Tools* costs £1495 for a year's subscription. Call Ovum on 0171 255 2670, or email info@ovum.mhs.compuserve.com.**

Fuzzy algorithms or genetic logic?

An intensive tutorial on the application of neural networks, fuzzy logic and genetic algorithms to business problems is to be held at the Mayfair Conference Centre, London, on 26-27 February 1996. The two-day tutorial, presented by experts from Recognition Systems, Inform and SearchSpace will evaluate key areas in which these advanced technologies can be used.

The tutorial is split into three sessions. The first one covers corporate data mining using neural networks, with the emphasis on practical guidelines and comparisons with classical techniques. The second session looks at fuzzy logic and neurofuzzy systems (fuzzy logic/neural network hybrids), with case studies ranging from risk assessment to customer targeting. Technical issues include fuzzy logic inference and fuzzy clustering. The last session covers genetic algorithms in such diverse areas as finance and aircraft design. Again, hybrid systems are explained.

The course costs £699. To register call Katy Searles on 0171 637 4383, fax 0171 636 1976, or email katy_searles@ibcuklon.ccmail.compuserve.com.

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Developers have more time for challenge

It's funny how some things happen. Last month, after we published the story on the challenge *EXE* is organising, we received a number of comments complaining about the short development time allowed for the competition. We admit that eight hours is an unreasonable timescale to develop a full-fledged application. If any of us could knock together something in eight hours we'd all be very rich. The process of creating a complete application takes more time especially if you want to mimic all the factors, commercial or otherwise, facing software developers during their day-to-day work.

With this in mind, we have taken a close look at last year's competition. While it was certainly frantic but fun for the competitors, with hindsight, there was room for improvement. The challenge was testing the speed at which participants could churn out code using their chosen development tool, rather than the skills of the individuals.

After last month's response, we have decided to change the focus of the competition from the tool to the developer. To reflect this we are changing its name. The competition is now called the *EXE Software Developer of the Year*. However, in this age of rapid application development, choosing the right tool can make the difference between winning and losing. So the tools used by competitors have their place on the podium too, and will be judged separately for the *EXE Development Tool of the Year* award.

EXE Software Developer of the Year

To improve on last year, the specifications for the application to be built will be provided six weeks before entries are judged. Code must be developed beforehand and submitted on diskette *before* 14th of February. Developers thus have more time to develop, and we have more time to judge! All in all, we believe this will lead to a far closer competition, where developers are judged on their individual skills rather than on the speed at which they can bang out code. An added bonus is that, since we have thankfully lost the eight-hour marathon, the competition can be opened to far more developers.

Below is an outline of the application that must be built to qualify for entry in the EXE Software Developer of the Year competition. The application is a system for keeping track of donations at The Big Issue Foundation.

- **Record names, addresses and telephone numbers of donors.**
- **Print names and addresses onto standard labels.**
- **For each donor, keep a log of the amount the gift is worth and the date it was donated.**
- **Record history and type of communication with donors.**
- **Facility for writing personalised letters and thank you's.**
- **Produce simple reports to track donation histories.**
- **Provide a simple and transparent method for signposting correct data entry.**
- **Sort database on a special code.**
- **Import ASCII into database.**
- **Export database to pre-specified formats.**
- **Backup system.**

THE BIG ISSUE

Ovum

A fee of £850 is required to enter the competition. On the 2nd January 1996, the full specifications will be available for a non-refundable deposit of £100 from the contact given at the bottom of the page. The remaining £750 is due when competition entries are submitted. Code must be provided on PC-readable 3.5" diskette, along with printed user and implementation documentation. Participants will also be required to complete a questionnaire judging their chosen development tool. All entries, complete with documentation, software and questionnaire must arrive at our office no later than *14th February 1996*.

After the first stage of judging, which will be undertaken by *EXE* and *EXplodE* editorial staff and Ovum, a short list of competition entries will be exhibited at the Windows Show on 27th February 1996 in the Pillar Hall. Visitors to the show will be able to judge for themselves how the completed applications compare side-by-side.

EXE Development Tool of the Year

In the last year we have seen the launch of a brand-new mainstream 32-bit operating system and a raft of innovative development tools. The choice of development tool is more difficult than ever, especially with the growth in popularity of second-generation client tools. However, the message is still the same: developers need to choose the right tool for the job. To encourage software companies to build better tools we are running a separate EXE Development Tool of the Year award. As part of the EXE Software Developer of the Year competition, we have asked candidates to complete a questionnaire assessing the power, flexibility and ease-of-use of the development tool they used to create their entry for the award. Armed with this questionnaire, our panel of experts on the *EXE* and *EXplodE* editorial teams will pick an overall winner in the tools category. The EXE Development Tool of the Year will also be announced at the Windows Show on the 27th February 1996.

Cliff Saran

To request a copy of the specification phone Robert Bateman on 0171 4343711

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For example, to use a timer Oblet from within a class:

```
Dim MyTimer as New ssTimer
MyTimer. Interval = 250          'milliseconds
MyTimer. Connect Me, "Alarm"     'calls the 'Alarm'
                                 method of your class
                                 'when the timer expires
MyTimer. Enabled = True          'starts the timer
```

- The heart of the ClassAssist IDE is the Class Explorer. It shows the relationships between all classes in the current library in an easy to read outline view
- Right-click the mouse in the Explorer to derive a new class, edit properties and methods of an existing class or checkin/checkout classes in a shared library
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SQL Anywhere 5.0

Sybase Inc. has released Sybase SQL Anywhere 5.0, the latest version of the database previously known as Watcom SQL. The RDBMS is a member of the Sybase System 11 family of products. New features include enhanced interoperability with other Sybase products, Sybase SQL Remote replication technology for occasionally connected users, and a new SQL Central database administration tool. Concurrent license price: £400 for four users; £3,300 for unlimited users. Call sybase on 01628 597100 for per-seat licensing prices.

WAN support for PVCS

PVCS Tracker 3.0, a central component of Intersolv's PVCS Software Configuration Management series, now supports wide area network (WAN) development. Leveraging Intersolv's DataDirect technology, Tracker 3.0 allows users to store project information in open client/server databases. This means that distributed, possibly world-wide, teams can synchronise change requests, bug reports and other data. Platforms: Windows 3.1, NT and 95. Price: £350 per user.

Open door to data warehouse

A data warehouse 'starter kit' from tool provider Valstar offers a 'low-cost' way to embark on the development of a data warehouse system. The kit comprises Powersoft's PowerBuilder Enterprise 4.0 for Windows plus a single-user version of Valstar's BusinessMetrics 1.5 relational data warehouse development tool. The bundle also comes with three days' data warehouse development consultancy and 90 days' BusinessMetrics support. Price: £7,500. You can reach Valstar on 01734 886698 or by email at info@valstar.co.uk.

Fortran Futures '96

After 25 years competing, two suppliers of Fortran software have joined forces to host an event dedicated to the Fortran language. Visual Numerics and The Numerical Algorithms Group have organised Fortran Futures '96, a two-day international conference to be held in London this April. The programme features lectures, tutorials and product presentations, covering Fortran 90, Fortran 95, High Performance Fortran and even Fortran 2000, as well as user applications. Venue: Ramada Hotel, near Heathrow Airport. Date: 25/26 April 1996. For more information contact: Visual Numerics (01753 790600), or The Numerical Algorithms Group (01865 311205).

Borland to deliver Java tool

Borland has announced that it is licensing Sun Microsystem's Java programming language with the aim of producing a Delphi-like RAD environment for the new language. The product, code-named Latte, will be developed in Java itself.

Java is a platform-neutral programming language based on C++. Designed with Internet programming in mind, Java provides security and networking features as well as portability. Marc Andreessen, co-founder and vice president (technology) of Netscape Communications, which has incorporated Java support into the latest version of its Navigator Web browser, believes the language will catalyse the growth of the Internet as a platform for corporate IT.

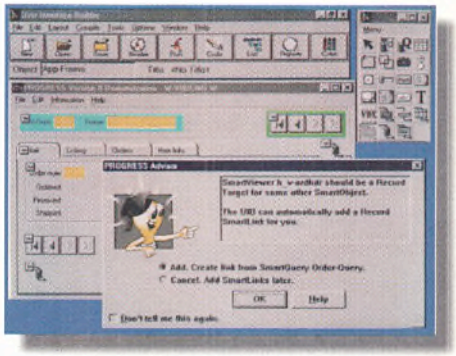
'Following the release and enthusiastic market response to Delphi, we are excited about Borland applying its core technology and expertise to a Java development environment,' said Eric Schmidt, Sun's Chief Technology Officer. Borland's new tool, the first commercial release of which is scheduled to ship in the first half of 1996, will focus on the following areas: visual RAD programming for the Web; object-oriented, component-based architecture; high-performance compilation, and scalable/distributed database access.

Sun hopes the tool will position Java as a serious choice for distributed applications programming. Borland Java site is at *http://www.borland.com/Product/java/java.html*.

In the name of PROGRESS

Progress Software has released version 8.0 of its PROGRESS Application Development Environment (ADE) for Windows. The new tool introduces SmartObjects, reusable application components for client/server development. Programming with SmartObjects is aided by an 'active' development framework called the Application Component Environment, or ACE. The ACE automatically creates links between components visually inserted into an application, generating the appropriate transaction processing and data management code. Wizards, cue cards and 'advisors' (see figure) guide programmers through the development process.

Single-developer prices are £3,326 for the standard version, and £4,066 for the Enterprise version, which includes StarBase Corporation's Roundtable software management system. Progress Software is on 01256 816668.



SCO charts course to merged UNIX

After its recent acquisition of Novell's UnixWare product, SCO has revealed some of its plans for a merged operating system code-named Gemini. The new product will integrate SCO OpenServer, Unixware, and NetWare file, print and directory services (licensed from Novell), while maintaining backward compatibility for existing code. According to Mike Shelton, SCO's director of product marketing, 'Developers can create a single application today that will run on all three platforms: SCO OpenServer, SCO UnixWare, and the forthcoming Gemini.'

The next release of SCO UnixWare, code-named Eiger (to ship in Q1 1996), and the next release of SCO OpenServer, known as Comet, are milestones along the road to Gemini. Importantly, Eiger and Comet will provide binary compatibility between the two platforms. Following their release, SCO plans to release a Compatibility Toolkit, which developers can use to run a single version of their applications on both UnixWare and OpenServer.

The Compatibility Toolkit will also serve as a development toolkit for Gemini, and includes tools to identify interfaces used in an application that might require changes with Gemini. Migration documents will be provided that illustrate the differences between Gemini and the Open Server and UnixWare environments. Gemini's SDK will feature a spec 1170 compliant API that the press release was presenting as 'UNIX *95*'. Will this label be on the box when Gemini ships in 1997?

SCO is on 01923 816344 and on *http://www.sco.com*.

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Letters

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

Hot skills revisited

Dear Sir,

With reference to Laurence Holt's SoapFlake article 'Hot Skills' (in the November issue of *EXE*), how right he is in emphasising the difficulty of learning concepts, but how rarely is this difficulty addressed, or even aided by the books and course on offer.

The steps in learning any system are understanding the concept, then comes learning what it can do, then how do I make it do what I want it to do. Each step should be separate and adequate with simple and multi-views of explanation (ie '...another way of looking at it is...').

Yet how few are the books and course which follow this route. The concept is described or introduced by examples of how the system works, and one is left to deduce what the concepts are rather than receiving a clear description. How many times are examples complicated by irrelevant accretions; and very rarely are comparisons made with other similar products. The author or tutor appears not to know the difference between a simple explanation and a trivial one.

Finally when we come to the 'How do I make it do...' the index rarely includes synonyms (ie what I call it) but only system nouns (ie what this system calls it).

Perhaps in this technically variable world we need a degree in the psychology of learning and communication.

Secondly, with reference to the 'Installer for Windows 95' in the same issue, please keep your artist away from his new graphics program toy when he is preparing the figures. There is little point in including figures which are unreadable Picassos, you may as well give a bullet list of the captions. Or is he trying for the Turner prize?

Alan Lloyd,
Farnborough, Hants

Not all testing is a good idea!

Dear Sir,

As one of the world's foremost providers of automated software testing tools, I conduct my life on an evangelical crusade to convince software developers to adopt a discipline of automated testing throughout the entire development lifecycle. However, there is one testing programme happening today which I would like to see eradicated ie nuclear testing by the French Government in the South Pacific.

To date the French have adopted the usual intrinsic view but, in circumstances like this, if enough individuals joined together to administer their complete abhorrence of the programme, perhaps the French may begin to listen. As a result, I thought your readers would like to know of an initiative begun in Japan to develop a worldwide petition against nuclear testing. Anyone wishing to register their support in banning nuclear testing please register on the Web at *http://www.iijnet.or.jp/nuke/*

Jill Godett
Director, Marketing Communications
CenterLine Software Inc.

This initiative is commendable but it teaches us a few other lessons regarding testing. First, this Japan-initiated petition started as an email chain letter, but the system used for this purpose had never been tested with such a high throughput of email. Soon after, requests to stop the email flood were sent out.

Secondly, I wonder if you 'tested' the Web address that you gave in your letter? It does provide some interesting information and pointers about nuclear testing around the world (French and Chinese are the latest) but the petition itself has been closed since August 15 '95!

Windows Help Authoring Tools

Dear Sir,

I read with interest Kevin Townsend's article on help authoring tools (*EXE* December '95), and agree that they do have great value when developing serious help systems. Having said this, it ought to be known that Word does not contain some magic that enables it to be the only word processor capable of creating source files for the help compiler. A perfectly respectable help system which may not contain all the gimmicks that can be packed in with an expensive help authoring tool, but which nevertheless does the job of providing well formatted documentation with popups, jumps to topics etc. can be created with any word processor having the following features:

- Ability to save a document as an RTF file.
- Text attributes of single underline, double underline and hidden text.

AmiPro is one word processor having the necessary features, and I have no doubt that there are many more.

Dave Nicholls
Email address supplied

Christmas quiz

Dear Sir,

In the Xmas quiz (EXE December '95), the question D.3 was rather tongue in cheek but it does raise several important issues. First, in a meta-recursive definition should one allow oneself access to all the features of the underlying language? The Lisp definition in D.3 would have been much more interesting if the use of `eval` had been forbidden. Secondly, what are the implications in terms of expressiveness and performance of meta-recursive definitions? Should the fact that Delphi has been written in Delphi (after an initial bootstrap process) be considered a technical and/or marketing advantage for the language?

Sarah Patel
Email address supplied

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Remote

Remote Procedure Calls let you call functions residing in the address space of a remote process. **Roland Perera** explains how to get two C++ programs interoperating using RPC.

Remote Procedure Calls, or RPC, is a mechanism for inter-process communication based on C-language procedure calls. Using RPC, a C program can call functions that reside in a server-hosted process as though they were implemented locally. This article will present an approach to writing distributed applications in C++ .

RPC is a key part of the Distributed Computing Environment (DCE), an architecture for distributed computing defined by the Open Software Foundation (OSF). The author of an RPC server application must define an *interface* to each set of remote procedures he implements, using a special C-like language called the Interface Definition Language, or IDL. Implementations of RPC provide an IDL compiler to process this interface and generate code for both client and server that will translate data, send it across the network, and retrieve results for each remote procedure call. RPC does all the network dirty work for you, allowing you to partition software without embedding network-specific code in the application.

The C++ classes and sample interfaces presented here were developed for Win32 using Microsoft Visual C++ 4.0 and MIDL, Microsoft's version of the Interface Definition Language. However, Microsoft's implementation of RPC is mostly compatible with the DCE standard, so you should have little trouble porting the code to other platforms. Win32 API calls are identified by the comment '`// Win32`'.

RPC++

The DCE RPC model supports only C-language interfaces to remote procedures. If we could extend this to enable the creation and manipulation of remote *objects*, we would be able to build C++ applications which interoperated fairly seamlessly with other RPC-enabled C++ programs. Yet for two C++ programs to interoperate, there needs to be some glue to bind them together. The IDL compiler will only generate C-language glue for us, so the rest of the mucilage we will have to provide ourselves, in the form of an additional stub layer on both the client and the server which will 'wrap' these C calls in C++ method invocations.

Figure 1 summarises the architecture. The boxes shaded green in the diagram correspond to the stub code generated by the IDL compiler. The yellow boxes represent the extra stub layer required for client and server to interoperate using C++ objects. For the moment, let's ignore the yellow layer, and consider the standard RPC model in which a client application calls the MIDL-generated stubs directly. Instead of implementing the remote procedure itself, this stub:

1. retrieves the procedure's parameters from the client's address space;
2. translates the parameters into a format suitable for network transmission;
3. calls RPC client run-time functions to send the request and its parameters to the server.

On the server side, the following steps are then taken to process the incoming remote procedure call:

1. the RPC server run-time library accepts the request and creates a thread to execute the corresponding server stub procedure;
2. the server stub retrieves the parameters from the network buffer and converts them to C-language format;
3. the server stub calls the actual remote procedure.

The process is reversed to return the result of the remote procedure call to the client. As client stub functions have the same names, parameters and return types as their corresponding remote procedures, the fact that the procedure executes remotely is completely transparent to the client program.

This article presents a set of classes and functions for writing distributed C or C++ applications that communicate through C function calls. These classes and functions encapsulate the RPC initialisation process, allowing a program to function as an RPC client or server.

After finding out exactly what a program needs to do in order to start communicating via RPC, I'll demonstrate a technique that allows two C++ programs to talk to each other in their own terms. This involves the manual implementation of a second stub layer on both sides of the process boundary (the yellow boxes of Figure 1). The technique makes use of a *proxy*, a local object that acts as an agent or intermediary for a remotely-hosted object. Instantiating a proxy class effects the construction of a corresponding remote object on the server; calling a proxy method invokes the corresponding method on the remote object.

Server initialisation

To function as an RPC server, a program must do the following:

- Define **`midl_user_allocate()`** and **`midl_user_free()`**, memory management hooks called by the MIDL-generated stubs when parameters are passed to the server. These will usually be implemented as simple wrappers around **`malloc()`** and **`free()`**.
- Call one or more of the **`RpcServerUseAllProtseqs()`** family of API functions to register *protocol sequences* with the RPC run-time library. A protocol sequence is a character string formed by concatenating the names of an RPC protocol (such as **`ncacn`**), a transport protocol (such as **`tcp`**), and a network protocol (such as **`ip`**). For each protocol sequence registered in this way, the RPC run-time library creates one or more *binding handles* through which the server receives RPC requests. Every binding handle contains an *endpoint*, a number identifying the specific process that is the RPC server.

Possibilities

- Advertise its binding handles in the *name service* database, a network-global component of the DCE architecture which stores information about distributed applications in a portable manner. Alternatively, clients can bypass the name service and construct their own binding handles. This is the approach taken in the C++ classes developed in this article.
- Register its endpoint information in the local endpoint map. Endpoints allow client calls to reach the correct server process. However, endpoint registration is optional as the RPC run-time library can locate them anyway.
- Call **RpcServerRegisterIf()** to register the interfaces offered by the server with the RPC run-time library.
- Call **RpcServerListen()** to start listening for incoming remote procedure calls.

RPCServer.h and **RPCSever.cpp** (Listing 1) define one class and four functions, in a namespace called **RPC,** that encapsulate the server initialisation process. **Server.cpp** shows how they can be used in a simple server. First, **RPC::Initialise()** is called to register a protocol sequence and allocate an endpoint. We're not using the name service or the local endpoint map (steps 3 and 4 above), so the next step is to create an **RPC::Interface** object for each RPC interface that we want to 'export' to clients. The only argument to the **Interface** constructor is a MIDL-generated variable, of type **RPC_IF_HANDLE**, that identifies the interface to be registered. The interface is registered by the **Interface**'s constructor, and unregistered by its destructor, allowing us to use the scope of an **Interface** object to control an interface's visibility.

Once all the interfaces have been registered, we can start listening for remote procedure calls. As the RPC function **RpcServerListen()** suspends its calling thread until the run-time library is told to stop listening, I've defined a function **RPC::StartListening()** which creates a *new* thread to do the listening and then returns immediately. This allows the server to carry out more processing after listening has started. However, to prevent the main thread of the process – and thus the process itself – terminating, the main thread must at some point call **RPC::WaitTillStopped()**, which only returns after a call to **RPC::StopListening()** has told the RPC run-time library to stop listening.

To allow a server to be shut down manually, **RPC::Initialise()** also installs a function of type **HandlerRoutine** (a Win32 callback type) which is called when the process receives a control signal such as a CTRL+C event. This handler then calls **RPC::StopListening()**.

If at any point during initialisation or listening an RPC API call returns a non-zero **RPC_STATUS** value, an object of type **RPC::Exception**, containing the non-zero **RPC_STATUS** and a description of the error, is thrown. As **Exception** objects are also thrown by the client part of the library, the class is defined in a separate file **Exception.h** (not shown). An **operator<<()** is also defined in **Exception.h** to allow **Exceptions** to be dumped straight to **cout**.

Client initialisation

The client's main concern is ensuring that each RPC reaches the correct server process. This is achieved by means of a binding handle. Binding information includes a protocol sequence, a host name, and an endpoint (process address). The initialisation that a client needs to carry out depends on the type of binding used. The DCE RPC standard defines three kinds of binding:

- *Automatic*: the client stub obtains binding information automatically from the name service database. No manual initialisation is required.
- *Implicit*: a binding handle is declared in the global area of the client stubs. The application must obtain the binding information, either from the name service database or by some other non-portable means, and initialise this binding handle itself.
- *Explicit*: as implicit binding, but each RPC passes a binding handle explicitly as its first parameter, allowing you to target each call at a particular server.

The code in this article employs implicit binding handles. A client program must therefore manually initialise a binding handle for each remote interface that it wants to call. As we are not using the name service, a client must use **RpcStringBindingCompose()** to create a string containing binding information, passing it a protocol sequence and the network address of the host server. Then **RpcBindingFromStringBinding()** is called for each binding handle to initialise it. Once this is done, we can start making remote procedure calls.

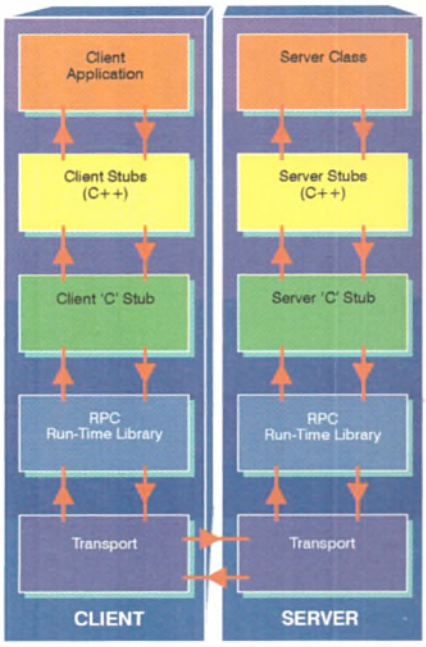

Figure 1 – RPC between two C++ applications.

A **RemoteInterface** class that encapsulates this process is defined in **RPCClient.h** and **RPCClient.cpp** (Listing 2). **Client.cpp** shows a simple client application. For each binding handle that requires initialisation, a **RemoteInterface** object is constructed. Again, the scope of these objects can be used to control the dynamic extent of their associated binding handles, as the **RemoteInterface** destructor frees the attached binding handle. That's all the client needs to do in order to start issuing RPCs.

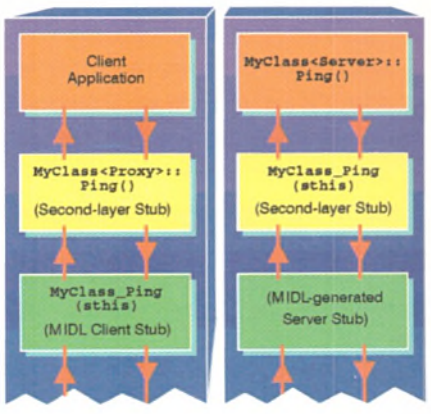

Figure 2 – Translating C++ methods to RPCs

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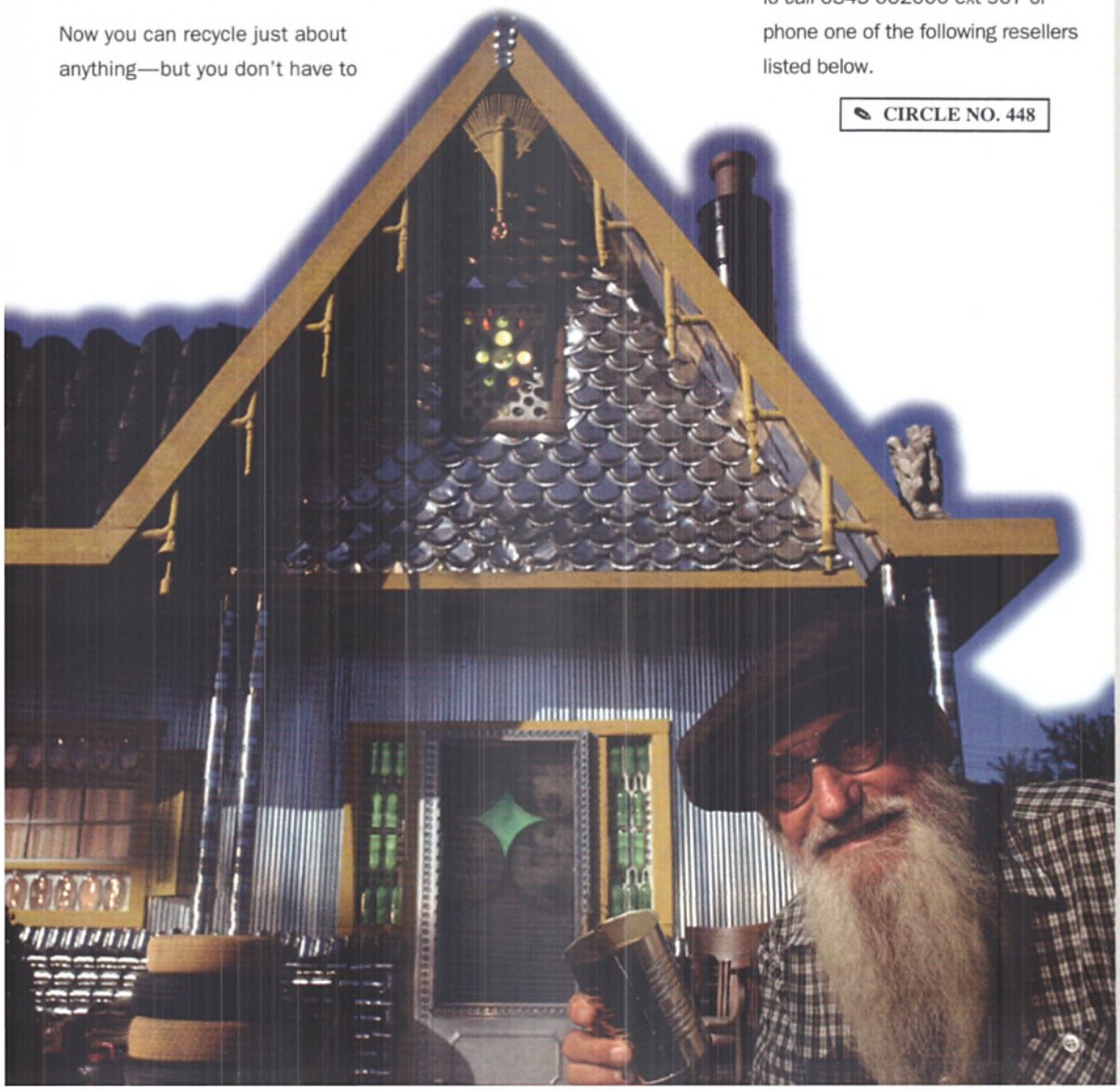

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We now have a handy set of classes and functions for setting up both the client and server ends of an RPC application. Using MIDL to generate client and server stubs, we can write a C++ program that calls functions residing in a remote address space. We're still some way away from creating and performing operations on remotely-hosted *objects*. It's time to revisit the concept of a proxy.

A proxy class is a class that 'stands in' for a server-hosted class, and must therefore have the same functional interface as the class it maps to on the server. Proxy member functions (the left-hand yellow box of Figure 1) are simple stubs which call standard C RPCs. These RPCs are implemented on the server as stubs which call the actual methods of the server-hosted class. There are therefore two stub layers that need implementing: the proxy layer on the client, and the corresponding server stub layer.

The proxy class and the server-hosted class must have the same interface, but different implementations. We can have these two 'flavours' of the same class by using templates to parameterise the class's inheritance path, deriving server classes from **Server** (defined in **RPCServer.h**) and proxy classes from **Proxy** (defined in **RPCClient.h**). For example, given the definitions in **MyClass.h** (Listing 3), **MyClass<Server>** is derived from **Server**, and **MyClass<Proxy>** is derived from **Proxy**.

MyClass<Server> implements the class exactly as it would be normally; see the server version of **MyClass2.cpp** in Listing 3. However, being derived from **Server**, every server object contains a **pthis** data member which stores the address of its proxy. Ensuring that each server object knows of its proxy's address means that, on the way back to the client, references to server objects can be converted by server stubs into references to the correct proxy. Similarly, every proxy object stores the address of its corresponding server object in its **sthis** data member, so that client stubs can convert proxy references on their way to the server into references to remote objects. In this way, client applications only ever deal with proxy addresses, and server applications with server addresses.

Figure 2 traces through a call to a remote C++ object. When the client stub (ie a proxy method, yellow in the diagram) is called, it in

```
// RPCServer.h:

namespace RPC {
   class Interface {
   public:
      Interface (RPC_IF_HANDLE hInterface);
      ~Interface ();
   private:
      RPC_IF_HANDLE m_hInterface;
   };

   void Initialise (UCHAR szProtSeq, UCHAR szEndPoint);
   void StartListening ();
   bool StopListening ();
   void WaitTillStopped ();

   class Server {
   public:
      const long int pthis;
   protected:
      Server () : pthis(NULL) {}
   };
}
#define SERVER

// RPCServer.cpp:

void __RPC_FAR* __RPC_API midl_user_allocate (size_t len) {
   return malloc(len);
}

void __RPC_API midl_user_free (void __RPC_FAR* p) {
   free(p);
}

namespace {
   HANDLE hThrListen;

   DWORD __stdcall Listen (LPVOID) {
      cout << "Starting listening..." << endl;
      RPC_STATUS nStatus = RpcServerListen(1,15,false);
      cout << "...Stopped listening" << endl;
      return nStatus;
   }

   bool CALLBACK CtrlHandler (DWORD dwCtrlType) {
      return dwCtrlType == CTRL_C_EVENT ? RPC::StopListening()
                                        : true;
   }
}

using namespace RPC;

Interface::Interface (RPC_IF_HANDLE hInterface)
:  m_hInterface(hInterface) {
   RPC_STATUS nStatus;
   if (nStatus = RpcServerRegisterIf(hInterface,NULL,NULL))
      throw Exception(nStatus,"Unable to register interface");
   cout << "Registered interface" << endl;
}

Interface::~Interface () {
   RPC_STATUS nStatus;
   if (nStatus = RpcServerUnregisterIf(m_hInterface,NULL,true))
      throw Exception(nStatus,"Unable to unregister interface");
   cout << "Unregistered interface" << endl;
}

void RPC::Initialise (UCHAR* szProtSeq, UCHAR* szEndPoint) {
   SetConsoleCtrlHandler(CtrlHandler,true);  // Win32
   RPC_STATUS nStatus;
   if (nStatus = RpcServerUseProtseqEp(szProtSeq,15,
                                       szEndPoint,NULL))
      throw Exception(nStatus,"Unable to initialise");
   cout << "Initialised RPC run-time library" << endl;
}

void RPC::StartListening () {
   DWORD dwID;
   hThrListen = CreateThread(NULL,0,Listen,0,0,&dwID); // Win32
}

bool RPC::StopListening () {
   return !RpcMgmtStopServerListening(NULL);
}

void RPC::WaitTillStopped () {
   DWORD dwExitCode;
   WaitForSingleObject(hThrListen,INFINITE);    // Win32
   GetExitCodeThread(hThrListen,&dwExitCode);   // Win32
   if (dwExitCode)
      throw Exception(dwExitCode,"Listening thread failed");
}

// Server.cpp:

int main () {
   int nExitCode = 0;
   unsigned char szProtSeq[]   = "ncacn_np";
   unsigned char szEndPoint[]  = "\\pipe\\server";
   try {
      using namespace RPC;
      Initialise(szProtSeq,szEndPoint);
      Interface MyClass(MyClass_If_v1_0_s_ifspec);
      Interface MyClass2(MyClass2_If_v1_0_s_ifspec);

      StartListening();
      // other code goes here
      WaitTillStopped();
   }
   catch (const RPC::Exception& Except) {
      cout << Except;
      nExitCode = Except.GetErrorCode();
   }
   return nExitCode;
}
```

Listing 1 – Server initialisation classes and sample server

turn calls the corresponding remote procedure via the MIDL-generated supporting layer (green). The proxy's **sthis** data member is passed as the first argument. When the call arrives at the server, the remote procedure (yellow) invokes the appropriate member function (orange) using the value of **sthis** to identify the correct object for the call.

So the job of implementing a distributed class like this can be summarised as follows:

- Define a templated class as shown in Listing 4. Enclose any data and private member functions that are not to be exported to the client in an **#ifdef SERVER...#endif** block. This works because the **SERVER** macro is always (and only) defined when the **Server** class is defined.
- Create an IDL file for the class similar to the files shown in Listing 4, defining one remote procedure per method. The procedures for non-static methods will require an extra parameter **This** to receive the address of the object for which the method is being called. You'll also need to run the Win32 UUIDGEN utility to create a unique identifier for the interface and create an ACF file as shown to specify implicit binding handles. Then run the MIDL compiler on the IDL file to generate the lower layer of client and server stubs (green in Figures 1 and 2).
- Implement these RPCs on the server as stubs that call their corresponding methods. The files **MyClass_stubs.cpp** and **MyClass2_stubs.cpp** in Listing 4 show how this should be done.
- Implement the **Proxy** version of your class, as per the client versions of **MyClass2.cpp** in Listing 3. In the constructor, call a remote procedure that creates a new object on the server, and store the address of this object in the proxy's **sthis** member. This procedure must be passed the proxy's address so that the server object's **pthis** can be initialised.
- Implement the **Server** version of your class as normal.

Note that both **Server** and **Proxy** store addresses as **long** integers. This allows us to avoid the complexity of the 3 kinds of pointer, *reference*, *unique* and *full*, supported by the RPC model, but means that we are responsible for ensuring that the addresses are valid. The integers are **long** to match the IDL interfaces (Listing 4), as IDL does not allow unqualified integers to be used as parameter types.

Future directions

I've only had space to touch on the issues that arise when writing distributed C++ applications using RPC. The solution presented is really a framework which can be fleshed out as needed. Here are some issues that the interested reader might like to explore:

- Inter-process exception handling – propagating an exception across a process boundary;
- Implementing (or prohibiting) copy construction and assignment for proxies;
- Inheritance – if **Class1<Server>** inherits from **Class2<Server>**, does **Server** need to be a **virtual** base?

The main limitation of the RPC approach is its dependence on C. True interoperability requires a language-neutral solution, such as an Object Request Broker (ORB). However, using objects to hide the minutiae of RPC is a small step in that direction. If we were able to automate the generation of the C-C++ translation layer described above, our small step towards ORBdom would perhaps be more of a giant leap. ■

(There are more code listings overleaf)

```
// RPCClient.h:
namespace RPC
{
   class RemoteInterface
   {
   public:
      RemoteInterface (handle_t& hInterface, unsigned char*
szServer, unsigned char* szProtSeq);
      ~RemoteInterface ();
   private:
      handle_t& m_hInterface;
   };
   class Proxy
   {
   public:
      const long int sthis;
   protected:
      Proxy () : sthis(NULL) {}
   };
}
#define RPC_TRY(x)                                          \
   __try                                                    \
   {                                                        \
      x                                                     \
   }                                                        \
   __except(EXCEPTION_EXECUTE_HANDLER)
\
   {                                                        \
      throw RPC::Exception(RpcExceptionCode(),"RPC failed");
\
   }
// RPCClient.cpp:
using RPC::RemoteInterface;
using RPC::Exception;
RemoteInterface::RemoteInterface (handle_t& hInterface,
unsigned char* szServer, unsigned char* szProtSeq)
:  m_hInterface(hInterface)
{
   unsigned char* szBinding = NULL;
   RPC_STATUS     nStatus;
   if (nStatus =
RpcStringBindingCompose(NULL,szProtSeq,szServer,NULL,NULL,&s
zBinding))
      throw Exception(nStatus,"Unable to compose string bind-
ing");
   if (nStatus =
RpcBindingFromStringBinding(szBinding,&m_hInterface))
      throw Exception(nStatus,"Unable to creating binding
handle");
   if (nStatus = RpcStringFree(&szBinding))
      throw Exception(nStatus,"Unable to free string");
}
RemoteInterface::~RemoteInterface ()
{
   RPC_STATUS nStatus;
   if (nStatus = RpcBindingFree(&m_hInterface))
      throw Exception(nStatus,"Unable to free binding");
}
// Client.cpp:
int main ()
{
   int nExitCode = 0;
   unsigned char szServer[]   = "\\\\EXE";
   unsigned char szProtSeq[]  = "ncacn_np";
   try
   {
      using RPC::RemoteInterface;
      using RPC::Proxy;
      RemoteInterface ifMyClass(hMyClass_If,szServer,szProt-
Seq);
      RemoteInterface
ifMyClass2(hMyClass2_If,szServer,szProtSeq);

      MyClass<Proxy> MyObject;
      MyClass2<Proxy> MyObject2;
      MyObject.Ping();
      MyObject2.SetMyClass(&MyObject);
      MyObject2.GetMyClass().Ping();
   }
   catch (const RPC::Exception& Except)
   {
      cout << Except;
      nExitCode = Except.GetErrorCode();
   }
   return nExitCode;
}
```

Listing 2 – Client initialisation class and sample client

```
// MyClass.h:
template <class BASE>
class MyClass : public BASE {
public:
   MyClass ();
   ~MyClass ();
   void Ping ();
};

// MyClass2.h:
template <class BASE>
class MyClass2 : public BASE {
public:
   MyClass2 ();
   ~MyClass2 ();
   void SetMyClass (MyClass<BASE>* pMyClass);
   MyClass<BASE>& GetMyClass ();
private:
#if defined SERVER
   MyClass<BASE>* m_pMyClass;
#endif
};

// MyClass2.cpp (server):
MyClass2<Server>::MyClass2 () {
}

MyClass2<Server>::~MyClass2 () {
}

void MyClass2<Server>::SetMyClass (MyClass<Server>* pMyClass)
{
   m_pMyClass = pMyClass;
}

MyClass<Server>& MyClass2<Server>::GetMyClass () {
   return *m_pMyClass;
}

// MyClass2.cpp (client):
MyClass2<Proxy>::MyClass2 () {
   RPC_TRY(const_cast<long&>(sthis) =
           MyClass2_new(reinterpret_cast<long>(this));)
}

MyClass2<Proxy>::~MyClass2 () {
   RPC_TRY(MyClass2_delete(sthis);)
}

void MyClass2<Proxy>::SetMyClass (MyClass<Proxy>* pMyClass) {
   RPC_TRY(MyClass2_SetMyClass(sthis,pMyClass->sthis);)
}

MyClass<Proxy>& MyClass2<Proxy>::GetMyClass () {
   RPC_TRY(return *reinterpret_cast<MyClass<Proxy>*>
                   (MyClass2_GetMyClass(sthis));)
}

// MyClass_stubs.cpp:
using RPC::Server;

extern "C" long MyClass_new (long pThis) {
   MyClass<Server>* pMyClass = new MyClass<Server>;
   const_cast<long&>(pMyClass->pthis) = pThis;
   return reinterpret_cast<long>(pMyClass);
}

extern "C" void MyClass_delete (long This) {
   delete reinterpret_cast<MyClass<Server>*>(This);
}

extern "C" void MyClass_Ping (long This) {
   reinterpret_cast<MyClass<Server>*>(This)->Ping();
}

// MyClass2_stubs.cpp:

using RPC::Server;

extern "C" long MyClass2_new (long pThis) {
   MyClass2<Server>* pMyClass2 = new MyClass2<Server>;
   const_cast<long&>(pMyClass2->pthis) = pThis;
   return reinterpret_cast<long>(pMyClass2);
}

extern "C" void MyClass2_delete (long This) {
   delete reinterpret_cast<MyClass2<Server>*>(This);
}

extern "C" void MyClass2_SetMyClass (long This,
                                     long pMyClass) {
   reinterpret_cast<MyClass2<Server>*>(This)
   ->SetMyClass(reinterpret_cast<MyClass<Server>*>
                (pMyClass));
}

extern "C" long MyClass2_GetMyClass (long This) {
   return const_cast<long&>
          (reinterpret_cast<MyClass2<Server>*>
           (This)->GetMyClass().pthis);
}
```

Listing 3 – Example distributed classes

```
// MyClass.idl:

[
   uuid(77169f00-f4cc-11ce-a3db-080000393269), /* unique id */
   version(1.0),
   endpoint("ncacn_np:[\\pipe\\server]")       /* named pipes */
]
interface MyClass_If
{
   long int MyClass_new ([in] long pThis);
   void MyClass_delete ([in] long This);
   void MyClass_Ping ([in] long This);
}

// MyClass.acf:

[
   implicit_handle(handle_t hMyClass2_If)
]
interface MyClass2_If
{
}

// MyClass2.idl:

[
   uuid(eb2bca40-283f-11cf-8407-e773e865641a), /* unique id */
   version(1.0),
   endpoint("ncacn_np:[\\pipe\\server]")       /* named pipes */
]
interface MyClass2_If
{
   long int MyClass2_new ([in] long pThis);
   void MyClass2_delete ([in] long This);
   void MyClass2_SetMyClass ([in] long This, [in] long pMyClass);
   long int MyClass2_GetMyClass ([in] long This);
}

// MyClass2.acf:

[
   implicit_handle(handle_t hMyClass2_If)
]
interface MyClass2_If
{
}
```

Listing 4 – Sample IDL interfaces, with corresponding ACF files

The full code for this article can be obtained by sending an SAE with a disk labelled RPC++ or on our FTP site ftp://ftp.exe.co.uk/pub/exestuff/ ■

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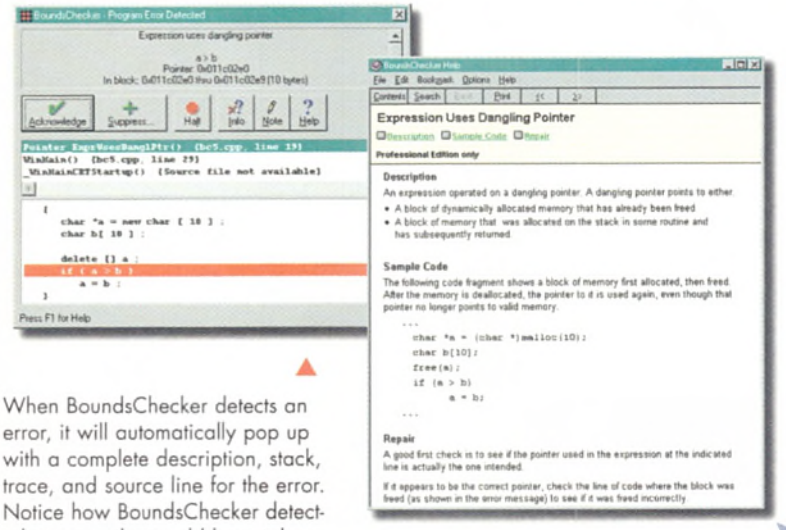

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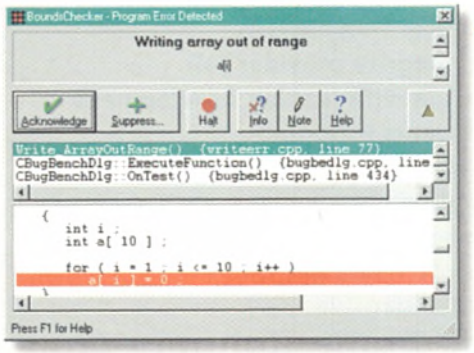

Here the array has a range of 0 to 9 rather than 1 to 10. As a result, some piece of memory would have been overwritten leading to unpredictable behavior.

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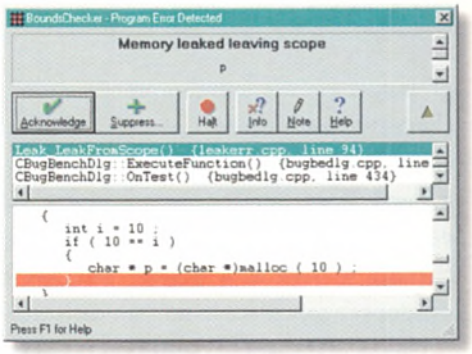

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Spinning threads

When multiple threads access shared resources, timing is everything. **Peter Collinson** explains some of the synchronisation mechanisms standardised by POSIX.

One of the great spectres in computing is the notion that at some point we are going to reach the limits of technology and CPUs will get no faster. There doesn't seem to be much sign of this happening yet: the present bottlenecks are disk and network throughputs. One way to get faster machines with current technology is to use several closely-coupled CPUs to create one system.

When systems with multiple CPUs started to appear, people saw UNIX as a vehicle to take advantage of the real parallelism suddenly made possible. Running co-operating processes on different CPUs, increasing overall processing speed, seemed viable. Since the UNIX kernel had been created to run on a single processor, the obvious approach was to run the kernel on one processor and user processes on others. A typical application at that time was the multiprocessor `make`, which allowed different parts of the compilation task to run on different CPUs.

Experience showed that this approach was successful, but many felt that UNIX processes were too 'heavy': the time taken to switch between processes was too long because of the considerable state carried by each process. This lead to the idea of *threads*, also known as *lightweight processes*, which essentially are parallel paths of execution within a single process' address space.

Also, paging systems became widespread, which made sharing memory between processes much easier. Memory can be shared by mapping a section of memory into the address spaces of several processes. It's just a matter of supplying a pointer in a page table. But sharing memory does have its drawbacks. You must take care that processes do not step on other processes' work in the shared memory area. Compared to Unix, a fundamental problem of both DOS and Windows 3.1 is that programs are not protected from each other. A single write through a pointer can crash another program.

The kernel

I mentioned above that in early multiprocessor systems, the kernel had to run on a single processor because it wasn't amenable to being run on multiple CPUs. Why?

First you should realise that the UNIX kernel actually has several distinct threads of control. Process zero traditionally manages process swapping, plus there's usually a process called `pagedaemon` which manages paging. These processes operate much like any other processes, except that they don't have any code in user space: they are really kernel threads.

When the kernel is dealing with peripherals, two distinct logical threads of control are involved. This is because peripherals are managed using interrupts that occur *asynchronously*. When an interrupt fires, the hardware drops whatever it's doing and zooms off to an interrupt service routine. Two separate threads are involved: the control path executed by user processes, and the path executed when an interrupt is posted. Thread purists will note that a new interrupt thread is re-instantiated on every interrupt. To allow the two threads to communicate, characters are normally passed between them using a simple queue.

When sending output to a character device, such as a terminal, a user process will open the device and write some characters to the device using the `write()` system call. This will cause a switch into the kernel to execute some code in the same logical thread that is executing the user process. After some decoding and jumping, the user process will execute the device driver's `write()` routine for the device. The code will be something like:

```
while (output_queue_is_full)
   sleep();
while (data_to_write) {
   get character from user;
   place character on output queue;
   if (device_not_busy)
      start_device();
}
```

Consider the second `while` loop above. If we have some data to write, we need first to pull it into the kernel using the magic kernel routine that gets a character from the user's address space. Once we have the character, it is placed on the output queue using a standard queuing routine. Then, if the device is not busy, we can start output to the device.

The first `while` loop ensures that we don't end up with too much data in the kernel. If the output queue is full, we must suspend the user process until some of the contents of the queue has been flushed to the output device. We use the `sleep()` routine to tell the kernel to suspend the process, allowing the kernel to go off and find some other process to run.

While all this is going on, the interrupt routine is draining the output queue. The routine looks like this:

```
if (data_on_output_queue)
   start_device();
else
   set device_not_busy;
wakeup_the_process;
```

As the wake-up call is made each time the interrupt occurs, excessive wake-ups may result. We can use a low water mark to ensure that the user code is run less often. Then when the user process is woken up, it will process several characters from the user. This results in less sleep and wake-up calls, reducing the frequency with which the user process is stopped and restarted.

You'll notice that both user code and interrupt routine code call `start_device()`. This routine simply takes the first character from the output queue and sends it to the peripheral. At a later stage, an interrupt from the device will occur and the interrupt service code be executed.

The logic behind the code above should be easy to follow. However, I have ignored a problem. Consider what happens when a

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QBS Software News. Volume 5 Issue 2 is out now. Jam-packed with the latest information on developer products from QBS. And it's free. If you haven't received your copy through the post yet, write, fax, phone or email us right away.

At last! A C++ grid. So far, for C++ programmers, it's been 'use this VBX or write your own'. Selling like hot cakes in the US, Objective Grid 1.0 by Stingray differs from other grids because it has been designed and implemented with MFC developers in mind, using OO techniques from the ground up. Includes a full-featured grid control that supports a variety of cell types. Full ODBC support provided. Flavours are for Visual C++ v 1.5x (16 bit) and v. 2.2 & 4.0 (32 bit). Both 16 and 32 bit versions come with source and cost £299 each.

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user process writes *two* characters to the device. The first character will find its way onto the output queue and from there to the device. However, once we have called `start_device()`, it's possible for an interrupt to occur indicating that the device is ready for another character. Thus the interrupt routine can be executed at any time.

The problem is that the routine that manages the queue is likely to consist of a number of machine instructions which the user thread could be in the middle of executing when the interrupt occurs. If this happens, the queue will likely be in an inconsistent state, causing the interrupt routine to fall over when it calls `start_device()` to pull data from the queue. The code that places the data in the queue is therefore a *critical section* of the code. In other words, once started, it must be completed before an interrupt can be allowed to happen.

The code that removes a character from the front of the queue in `start_device()` is a critical section too. However, this is not a problem if we know that the hardware will not allow an interrupt to occur when we are already executing an interrupt routine. But it's this kind of assumption that goes out of the window when we start looking at multiprocessing architectures.

The PDP-11 architecture, for which UNIX was originally created, had a priority-based interrupt scheme. Each device was assigned an interrupt priority level; the processor stored the current interrupt level in its Processor Status Word (PSW). An interrupt from a device would only be handled if the device's priority level was greater than the current interrupt level in the PSW. When an interrupt *was* eventually handled, the current interrupt level in the PSW would then be set to the interrupt level of that device. This prevented further interrupts from the device (or similar devices) while still allowing higher-level interrupts to be serviced. Blocking interrupts like this is called *masking*: the interrupt is not ignored completely, but will be serviced as soon as the current interrupt level is lowered below the priority level of the device. Interrupts could also be locked out explicitly by loading the PSW, to manually set the current interrupt level.

The routine that adds characters to the queue must start with a call to `spltty()` to set the current priority level to that of the peripheral, locking out interrupts of equal or lower priority. The `spltty()` routine returns the *old* priority level, which can then be used at the end of the critical section to restore the PSW. By locking out interrupts during the execution of the critical section, the code section becomes *atomic* as far as the terminal interrupt handler is concerned. An interrupt from the terminal is masked until the current priority level is reset to its previous value.

We also need to incorporate this strategy into the pseudo-code for our device driver routine, yielding:

```
s = spltty();
while (output_queue_is_full)
   sleep();
splx(s);
while (data_to_write) {
   get character from user;
   place character on output queue;
   s = spltty();
   if (device_not_busy)
      start_device();
   splx(s);
}
```

There are a few things to notice about this code. First, interrupts are masked for as little time as possible. I could have simply turned off interrupts for the whole routine, but this would be unnecessarily greedy. To allow interrupts to be serviced as efficiently as possible, we must avoid masking them when we don't need to. Second, reading the value of `device_not_busy` is also a 'critical' operation. Finally, we need to protect the test for a full queue at the start of the routine. The `sleep()` call lowers the current interrupt priority so that the device's interrupt routine can process characters in the output queue. The corresponding `wakeup()` call will reset the priority level so that when `sleep()` returns the masking level will be at its original value.

This discussion has shown that, even on a single processor, we can get race conditions that must be prevented by software mechanisms. A kernel executing a single user process can still be considered to have at least two threads of control and must be designed to handle any associated problems. Such problems are solved by ensuring mutual exclusion, where only one thread may change important data structures at a given time. In the code above, the interrupt priority level is used to prevent interrupts from changing the character queue while it is already being modified. The sleep/wake-up mechanism is used to synchronise the two threads so that the queue does not overflow.

The priority interrupt mechanism relies on the PSW register of a single processor. It's time to look at some general-purpose synchronisation mechanisms that will work in a multiprocessor environment.

Spin locks

The simplest mechanism that can be used to ensure short-term mutual exclusion is the *spin lock*. This technique is used when several threads wish to gain control of a resource, but we want only one of them to be able to change it at a time. The idea is to put each waiting thread in a loop which continuously examines a shared memory location. This will perhaps be clearer if we look at some code:

```
typedef int Lock;

void lock (Lock *lk) {
   while (TestAndSet(lk) == 1)
      ;
}

void unlock (Lock *lk) {
   *lk = 0;
}
```

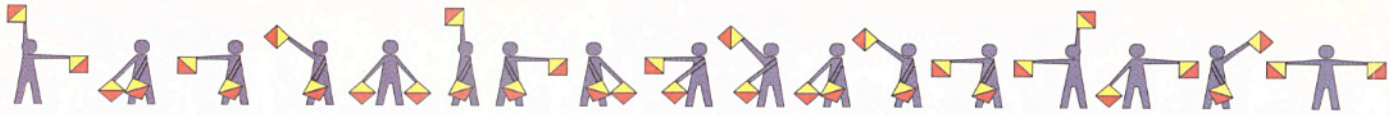
There's a little bit of magic here. We need the architecture to provide some form of atomic *read-modify-write* operation that let a single processor read a value from memory, modify it and write it back to the same location, all in a single instruction. This instruction must be atomic so that no other thread can alter the value at the location until the operation is complete. Such an operation is often provided by a *test-and-set* machine instruction: the CPU reads a value from memory, compares it with zero, sets condition codes, and writes a 1 back to the location.

Many RISC processors don't provide an instruction with this level of complexity. Instead, they provide a single instruction that atomically swaps the contents of a register and a memory location. We can use this swap operation to create a `TestAndSet()`:

```
int TestAndSet (int *pt) {
   int old;
   old = SwapAtomic(pt, 1);
   return (old == 0) ? 0 : 1;
}
```

Because the `TestAndSet()` routine is an atomic operation, only one processor may own the lock. Of course, we need to guarantee that locking and unlocking operations will occur in pairs. To use a `lock()` and `unlock()` pair, we would write:

```
lock(&spin_lock);
/* critical section */
unlock(&spin_lock);
```



The spin lock must be initialised to zero (unlocked). If the critical section is small, then spin locks work well. They do, however, use up processor time fruitlessly, by repeatedly testing the status of a lock.

You might be getting the idea that I'm suggesting you implement this kind of lock when writing a multi-threaded program. In fact, you'll generally use a system API function that does all the hard work for you. The POSIX standards committees have put a lot of work into this area. The draft standard was originally called POSIX.4, but since then the API functions have moved to an extension of the basic POSIX API standard called POSIX.1b. This became a standard in 1993. POSIX.1b provides a synchronisation mechanism called *mutex* (or *mutex lock*) used to protect critical sections of code and serialise access to resources.

Semaphores

To enable long-term exclusion, in 1965 E.W. Dijkstra invented a software device that he called *semaphore*. A semaphore is a shared memory location containing a non-negative integer, on which only two operations can be performed. The locking operation, called *P*, decreases the value of the semaphore by 1 as soon as the resulting value will be non-negative. The corresponding unlocking operation, *V*, simply increases the value of the semaphore by 1. (Dijkstra took the letters *P* and *V* from two Dutch words: *passeren* and *vrijgeven*. The literal translations are 'to pass [a checkpoint]' and 'to make something available again' or 'to freely give'.) In the C language, *P* and *V* can be implemented as follows:

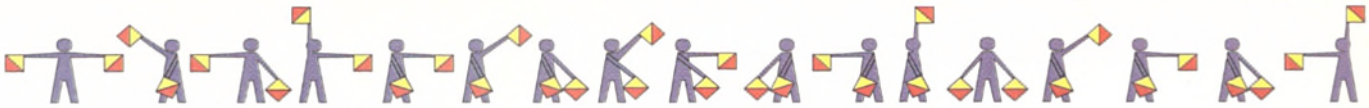
```
typedef int Sema;

void init_sem (Sema *sp) {
   *sp = 1;
}

void P (Sema *sp) {
   while (*sp <= 0)
      ;
   (*sp)--;
}

void V (Sema *sp) {
   (*sp)++;
}
```

The `P()` and `V()` operations can be used to provide simple mutual exclusion by enclosing a critical section like this:

```
P(&sema);
/* critical section */
V(&sema);
```

The semaphore must be initialised to 1, otherwise the first call to `P()` will wait forever. Note that we can only guarantee exclusion if the *P* and *V* operations are atomic. For this reason, semaphores are usually implemented by system calls that are effectively atomic for all threads that call them. It's also important to note that the system call will replace the continuous loop in the `P()` routine by some code that blocks the thread, allowing the CPU to be used for productive work by some other thread.

Semaphores might not seem much of an advance on the simpler methods described earlier. This is because I have only really described *binary* semaphores. However, semaphores are more general than this: the value of a semaphore is not limited to just 0 or 1. If a program calls `V()` several times, the semaphore value can be used to give *go-*



aheads to the caller. Dijkstra illustrated this by what he called the 'Producer-Consumer' problem.

Consider a typical situation where one thread is getting data from somewhere while another thread is writing it. The threads share a buffer that has a number of slots. The 'producer' thread is executing:

```
while (true) {
   get next portion;
   P(buffer_control);
   add portion to buffer;
   V(buffer_control);
   V(number_of_portions);
}
```

while the consumer thread is executing:

```
while (true) {
   P(number_of_portions);
   P(buffer_control);
   get portion from buffer;
   V(buffer_control);
   process the buffer;
}
```

Here the `buffer_control` semaphore ensures that reading and writing operations on the buffer are serialised. The interesting semaphore is `number_of_portions`. First of all, it's being used to have the consumer wait for work: the consumer is suspended until the producer puts something into the buffer and calls `V()`. Secondly, it allows the buffer to contain several 'portions'. If the producer is faster than the consumer, then the semaphore will contain a count of how full the buffer is. Dijkstra didn't worry about the buffer getting full, because he was illustrating the use of semaphores rather than worrying about practicalities.

The POSIX committees have defined semaphore primitives for UNIX as part of POSIX.1b. Their definition is based on the System V semaphore specification, which has found its way into the current UNIX standard Spec 1170. The POSIX definition is somewhat different but can be implemented in terms of the System V primitives.

Further reading

First, some thanks: to Keith Bostic of BSD Inc, for reading and commenting on the article, and to Geert Jan de Groot of RIPE, Amsterdam, for help with the Dutch language.

I used several reference books for this article. First, there's E.W. Dijkstra's original paper *Co-operating Sequential Processes*. It was published by the Academic Press in London in 1965 (or 1968 depending on which bibliography you consult), but you can also find it in a book called *Programming Languages*, edited by F. Genuys and published by Academic Press in 1968. Second, there's a more recent book on programming for UNIX with concurrency and multi-threading: *Practical UNIX Programming*, by Kay A Robbins and Steven Robbins. It's published by Prentice Hall and is ISBN 0-13-443706-3. Finally, I looked at a book on how UNIX is mapped to parallel machine architectures: *UNIX Systems for Modern Architectures*, by Curt Schimmel. It's published by Addison-Wesley and is ISBN 0-201-63338-8. ■

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.

Tony Stone Images

Decision support in JAVA

Palle Simonsen develops a simple rule-based decision support system to illustrate some of the features of the Java programming language.

This article describes a rule-based decision support system built in the Java programming language. Rule-based systems – once used almost solely in the context of expert systems – provide a convenient way of encoding both expert-level decision rules and the more mundane, but equally important, rules underlying common business practices. In many applications, business rules are encoded implicitly, in the form of user-interface validation triggers, 'C' functions and whatnot. Rule-based systems provide a means of making the representation of business logic explicit. As Java is advocated as a tool for publishing 'real' applications on the Internet, it seems a natural platform for a decision support system.

The applet of Sun's eye

Java is an object-oriented programming language created by Sun Microsystems. It was originally intended as an easy-to-learn, 'fail-safe' language for writing embedded applications. It is becoming increasingly popular as an extension language to World Wide Web browsers, and is currently available for Sun's HotJava and Netscape Navigator.

As many will have noticed, the user interface of the Web (nice pictures aside) bears much resemblance to that of a 3270 mainframe terminal: you fill in a form, press the 'enter' key, and wait patiently for the application to process the entire page of input and return a response such as 'error in field #12 – number expected'. The situation is even more baroque with applications normally associated with a fair amount of graphics and reasonably short response times, such as most forms of computer game. Even a simple game of tic-tac-toe can be painstakingly slow, given the right (or rather wrong) circumstances.

The Java language allows programmers to extend Java-enabled browsers with features such as field validation, interactive graphics, and sound, thus transforming the somewhat 'mainframish' user interface of most Web applications into a more up-beat and responsive interface. In order to accomplish this feat, the browser need not only interpret standard HTML but also have a built-in byte-code interpreter for compiled Java modules. These modules are loaded over the Net whenever the browser encounters the special tag `<APP CLASS="<classname>">`, and will use facilities provided by the local system in order to accomplish the desired task. Executing downloaded code on local

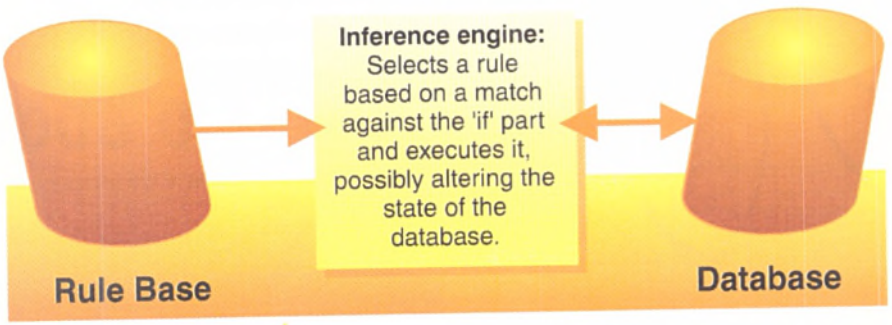


Figure 1 - A forward chaining system

machines raises serious security issues (Sun claims to have created a secure environment), but these are beyond the scope of this article.

Java has a C/C++ style syntax and should not therefore present a very high learning curve to people conversant in these programming languages. Unlike C++, Java is a pure object-oriented language: everything has to be expressed using objects. To simplify the use of Java, a number of features present in languages like C++ deemed to be error-prone, obscure, or of little use were not implemented. The most notable of these absent features is arguably pointers.

This article, however, will not touch on Java's Web features but will instead focus on Java as a programming language. A number of white papers, the language definition document, sample applications and other documentation can be found at the URL *http://java.sun.com*. A Windows 95/NT version of the Java libraries, compiler and HotJava browser are also present at the Web site.

Rule-based decision support

Most decision support and expert systems are built around a rule-based architecture. In short, a rule-based system consists of three parts: an inference engine, a knowledge base encoded as 'if-then' rules, and a database containing the data on which the rules reason (see Figure 1). Whenever the inference engine selects a rule for execution – ie the 'if' part matches an entry in the database – the 'then' part is executed, possibly transforming the database and thus opening the door for other rules to fire. If at any point no rule matches the data of the database, the reasoning is done. This form of reasoning is known as *forward chaining*. Another, more goal-directed, form of reasoning is *backward chaining*.

A backward chaining system can be described as a set of rules for proving (or disproving) a specific goal. For example, to prove that your car needs repair, you (or your mechanic) may have to prove that the motor needs repair and/or that the brakes need repair, and so on. A prime example of backward chaining can be found in the Prolog programming language. Backward chaining, however, can also be conveniently implemented in other programming languages, such as Java.

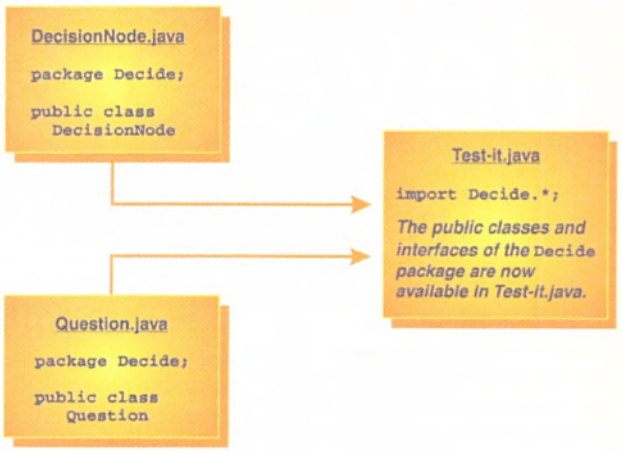


Figure 2 – Module structure of a decision support system

Decision support in Java

The implementation centres around a single class: `DecisionNode`. An instance of this class is able to prove (or disprove) itself, and explain the underlying reasoning. Furthermore, a `DecisionNode` is aware of its own state, which can be either *unknown*, *true* or *false*. A state of *unknown* signifies that the node has not yet been visited during the current run of the inference engine. Apart from methods implementing decision node chores, the class also provides `static` methods and variables to keep track of an entire system of decision nodes. The main methods of a `DecisionNode` are summarised in Table 1. Class methods have names which begin with a capital letter.

```
import Decide.Question;
import Decide.DecisionNode;
// We could have used import Decide.*
class CreditP extends DecisionNode {
   // If you have an existing account or own assets
   // you're all right
   public boolean antecedent () {
      AccountP ap = (AccountP)(GetInstance("AccountP"));
      AssetsP as = (AssetsP)(GetInstance("AssetsP"));
      return (ap.proof() || as.proof());
   }
   public void consequent () {
   }
   CreditP () {
      szPosExplain = "We can extend you credit because:";
      szNegExplain = "We cannot extend you credit because:";
   }
}
class AccountP extends DecisionNode {
   public boolean antecedent () {
      Question q = new Question
                   ("Do you have an existing account");
      return q.ask();
   }
   public void consequent () {
   }
   AccountP () {
      szPosExplain = "You have an existing account";
      szNegExplain = "You do not have an existing account";
   }
}
class AssetsP extends DecisionNode {
   public boolean antecedent () {
      Question q = new Question("Do you own any assets");
      return q.ask();
   }
   public void consequent () {
   }
   AssetsP () {
      szPosExplain = "You own assets";
      szNegExplain = "You do not own assets";
   }
}
// Main
class Decide {
   static public void main (String argv[]) {
      CreditP cp = (CreditP)
                   (DecisionNode.GetInstance("CreditP"));
      cp.proof();
      cp.explain();
      DecisionNode.Reset();
      cp.proof();
      cp.explain();
   }
}
```

Listing 1 – A sample decision support system

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In Java, the main building block of a program, apart from the source code module, is the *package*. In C/C++ terms, a package can be thought of as a library of classes. The decision support system is implemented as a Java package `Decide` consisting of two source modules, each containing one exported (`public`) class. The `Decide` package can be used in any Java program by issuing an `import` statement (see Figure 2). The Java `import` statement can be thought of as combining C/C++'s `#include` directive with object-code linking.

As illustrated in Figure 2, a Java source module may only contain one `public` class, and the source module's name must be identical to the class name, or a compile-time warning results. Not illustrated in the diagram is the fact that compiled files (with extension `.class`) must reside in the directory named by the CLASSPATH environment variable. This is necessary for the Java compiler to compile successfully.

To use the `DecisionNode` class, one has to *subclass* `DecisionNode` to implement *each rule* of the particular system. Reasoning is started by invoking the `proof()` method on a selected `DecisionNode` – usually the root node. Listing 1 shows a simple test system.

As can be seen, the syntax of Java is very similar to that of C++. The test program defines a class `Decide` which contains a method `main()` much like the C `main()` function. This class tacitly becomes the interface to the module, and the program is consequently started from the command prompt by invoking the Java byte-code interpreter with `Decide` as its argument:

```
%java Decide
```

The DecisionNode class

The inference engine of `DecisionNode` works as follows:

- Execute the antecedent.
- If the antecedent returns `true` – ie the node is proved correct – push the positive explanation of the node onto the stack of explanations, set the state of the node to *true*, and execute the consequent.
- If the antecedent returns `false` – ie the node is disproved – push the negative explanation onto the stack of explanations, set the state of the node to *false*, and do not execute the consequent.

The reason for maintaining state in a `DecisionNode` is, of course, to prevent an already-proved antecedent from being re-evaluated. For this reason, only one instance

```
// A simple Java decision support class
// Copyright (c) 1991,1995 Palle S. Simonsen
package Decide;
import java.lang.*;
import java.util.*;
import java.io.*;
/** DecisionNode class **/
public class DecisionNode {
// Class variables and methods --
  // Positive explanations:
  static Stack PositiveExplain = new Stack();
  // Negative explanations
  static Stack NegativeExplain = new Stack();
  static Hashtable instanceCache = new Hashtable(11);

  // Get or create an instance of the specified class
  static public DecisionNode GetInstance (String str) {
     Class cls = Class.forName(str);
     if (instanceCache.containsKey(cls.getName())) {
        return (DecisionNode)
               (instanceCache.get(cls.getName()));
     } else {
        DecisionNode newBorn = (DecisionNode)
                               (cls.newInstance());
        instanceCache.put(cls.getName(), newBorn);
        return newBorn;
     }
  }

  static public void Reset () {
     for (Enumeration e = instanceCache.elements();
          e.hasMoreElements();) {
        DecisionNode dc = (DecisionNode)e.nextElement();
        dc.reset();
     }
  }

  static void SetExplain (String exp, Stack where) {
     where.push(exp);
  }

  static void GetExplain (Stack where) {
     String szExplain;
     if (where.empty()) {
        System.out.println("*** No explanation ***");
     } else {
        try {
           System.out.println("Explanation:");
           for (;;) {
              szExplain = (String)(where.pop());
              System.out.println(" " + szExplain);
           }
        } catch (EmptyStackException e) {
              System.out.println("End of explanation");
        }
     }
  }

// Instance variables and methods --
  protected String szPosExplain;
  protected String szNegExplain;
  int state;

  final public boolean proof () {
     if (state == 0) {
        if (antecedent()) {
           consequent();
           state = 1;
           SetExplain(szPosExplain,
                      DecisionNode.PositiveExplain);
           return true;
        } else {
           state = 2;
           SetExplain(szNegExplain,
                      DecisionNode.NegativeExplain);
           return false;
        }
     } else {
        return (state == 1);
     }
  }

  final public void reset () {
     state = 0;
  }

  public void explain () {
     if (state == 1) {
        DecisionNode.GetExplain(DecisionNode.PositiveExplain);
     } else {
        DecisionNode.GetExplain(DecisionNode.NegativeExplain);
     }
  }

  protected abstract boolean antecedent ();
  protected abstract void consequent ();

  public DecisionNode() {
     state = 0;
  }
}
```

Listing 2 – The DecisionNode class

Method	Purpose
`proof`	The inference engine for `DecisionNodes`.
`Antecedent`	The 'if' part of a decision node.
`Consequent`	The 'then' part of a decision node. In this implementation the consequent does not necessarily assert new knowledge, but may cause various side-effects.
`Explain`	Prints out the explanation associated with the result of the inference.
`GetInstance`	Returns the single instance of a `DecisionNode` subclass.
`Reset`	Resets all `DecisionNodes` to their initial state.

Table 1 – The main methods of a DecisionNode

of a given `DecisionNode` subclass may exist in the system; hence the `GetInstance()` class method. (If Java treated methods as first-class citizens we could have dispensed with subclassing altogether.) The body of the `DecisionNode` class is shown in Listing 2.

Listing 2 illustrates a few additional points concerning Java. Most conspicuous are the keywords `final` and `abstract`. Like a pure virtual function in C++, an `abstract` method is simply a place holder waiting to be 'fleshed out' in a concrete implementation in a subclass. A `final` method is a method which cannot be overridden in any subclass.

The `GetExplain()` method illustrates the use of `Stack`, one of Java's library classes, as well as exception handling. The `GetInstance()` method shows how to access run-time type information. The reader already conversant in Java will notice the somewhat inelegant way of representing state – but time suddenly became a scarce resource!

Round up

Most C/C++ programmers will initially miss some of the features absent in Java, such as macros and pointers. The resulting language, however, still has enough expressive power to be truly useful, as illustrated by the decision support example, and is – compared to C++ at least – easy to master. Compared with interpreted languages such as Tcl and Lisp, Java, being compiled, falls short in the area of development speed and freedom of expression. It is a matter of opinion whether the static type checking of Java counters this in larger projects.

As it stands, Java is a language easily picked up by the large population of programmers accustomed to C and C++. In my view, it is a language which warrants serious attention and deserves to be used for more than flashy World Wide Web applets. ■

Palle Simonsen works as a project manager for the Danish software house Ambrasoft A/S, and – still – has a degree of curiosity towards new developments within the industry. He previously worked for an AI consultancy firm, hence his interest in inference engines.

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CIRCLE NO. 464

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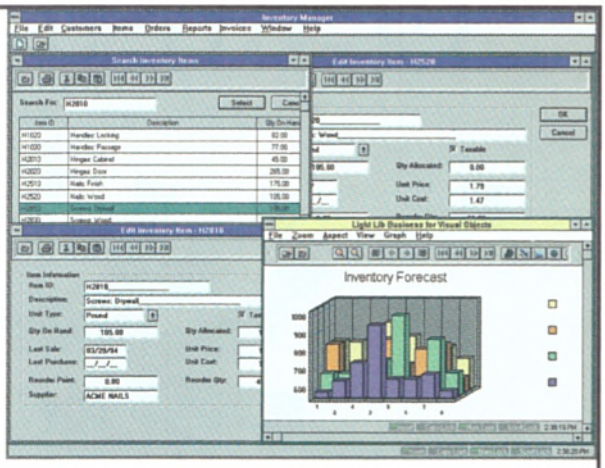

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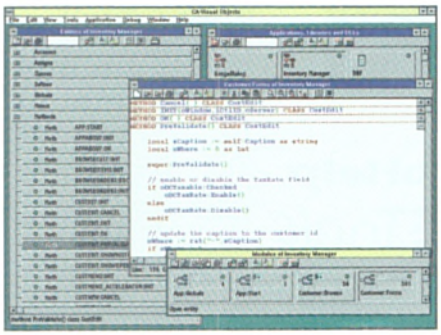

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CIRCLE NO. 465

Development of a C++ library

From templates to libraries. **Gerard Moloney** goes through the development process of a C++ library for geometric transformations.

The library outlined below evolved from experimenting with templates in C++. Originally, the idea was to develop a general matrix class, as matrices appeared to be an ideal candidate for implementing in terms of templates. It was envisaged that matrices could be declared as: `matrix<int,6,4> matrix1;` and the concept developed further to allow matrices of different type and size to be manipulated in an intuitive fashion.

Eventually, however, it was decided to concentrate on a specific application, namely geometric transformations as there was an immediate requirement for development in this area. The resultant library for two-dimensional transformations is outlined within this article.

Considerations prior to design

When studying matrices, one of the most classical examples given is the graphics transformation of geometric objects. Transformations usually consist of the moving and/or resizing of an object. All the standard transformations can be expressed in terms of matrices. Likewise the co-ordinates of a point in space can be expressed as a matrix. This enables matrices and their associated algebra to be presented in a familiar and visual setting. As an illustration, Figure 1 shows the rotation of a point about the origin. It is the set of standard transformations and their associated algebra which we wish to map intuitively onto our classes.

Prior to the design phase, a number of factors emerged which we thought were of practical importance. To begin with, there was a requirement for the library to parallel very closely the algebra of linear transformations. The second requirement concerned optimisation: unnecessary pointer de-referencing and calls to the standard maths library were to be avoided. In a number of respects these mirror general library development considerations. In all cases there must be some compromise between performance and generality. Bearing this in mind, the set of classes for two-dimensional transformations was developed taking as a starting point a general matrix class that had been previously prototyped.

The library's hierarchy

The hierarchy for the library is shown in Figure 2. It forms a simple inheritance structure with all classes being derived ultimately from the `matrix` class. This class forms the basis from which both geometric primitives and transformations are derived. The `matrix` class, which is a class template, provides a very basic matrix implementation as follows:

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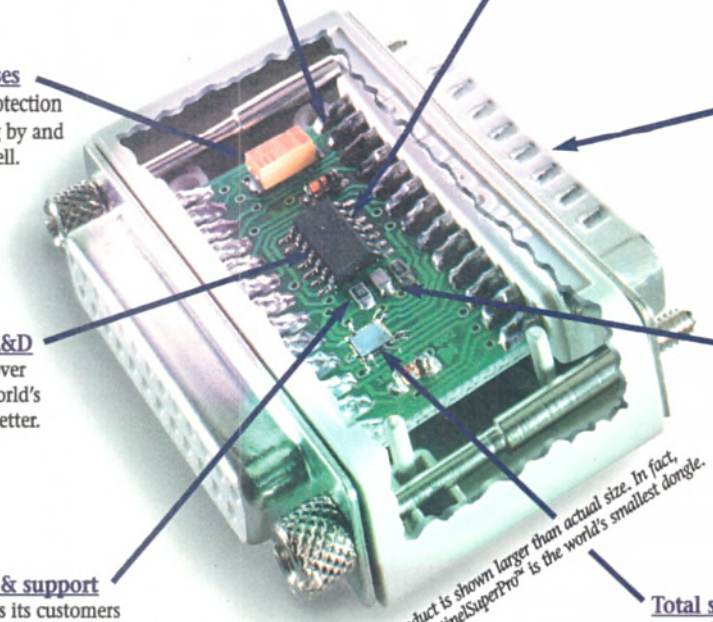

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CIRCLE NO. 466

```
template <class T, int x, int y>
class matrix {
protected:
   T data [x][y];
   int row;
   int col;
public:
   matrix() : row(x), col(y) {}
   virtual ~matrix() {}
};
```

This allows matrices of any type and size to be declared. The two integer arguments specify the rows and columns of the matrix.

Using this as a base, specific matrix types can be derived to represent both geometric primitives and transformations. In this instance, the combination of templates and derivation provides a very powerful mechanism, allowing precise specialisation to be applied to a very generic concept. It should be noted that minimal functionality is provided by the base class. Support for the multiplication of matrices is provided in the derived classes; we chose this organisation to ensure that only valid operations are performed without resorting to some type of run-time type checking.

Geometric primitives

The fundamental geometric primitive is a point:

```
class point : public matrix<float,3,1> {
public:
   point()
   : matrix<float, 3, 1>() {
      data[0][0] = 0;
      data[1][0]=0;
      data[2][0]=0;
   }
   point(int a, int b)
   : matrix<float,3,1>() {
      data[0][0]=a;
      data[1][0]=b;
      data[2][0]=1;
   }
   ~point() {}
   friend class transformation;
};
```

Default arguments are provided for the template and thus a point is defined as a 3 by 1 `float` matrix. This approach is used throughout. It provides a solution to the perennial problem of declaring arrays of varying sizes and is equivalent to explicitly declaring an array as follows:

```
float point [3][1];
```

As both non-homogeneous and homogeneous transformations are provided for, points are defined as 3 by 1 as opposed to 2 by 1 matrices. (See the box on page 39 for an explanation of homogeneous and non-homogeneous transformations.)

Having defined a point, other objects are specified by their vertices. Two approaches are taken, whereby both a general polygon class and specific object classes are provided.

```
// General base class for 2D objects.
// Polygons are arrays of points.
class polygon {
   point* pt;
   int size;
public:
   polygon() {}
   polygon(point* p, int sz)
   : pt(p), size(sz) {}
   virtual ~polygon(){};
   point operator[](int x) {
      return *(pt+x); // return vertex
   }
   friend class transformation;
};


// A triangle: array of points
// explicitly declared.
class triangle : public polygon {
   point vertices[3];
public:
   triangle() {}
   triangle(point a, point b, point c) {
      vertices[0] = a;
      vertices[1] = b;
      vertices[2] = c;
   }
   ~triangle() {}
   point operator[](int x) {
      return vertices[x];
   }
   friend class transformation;
};
```

This way it is possible to avoid the need to de-reference pointers where this is a requirement, and users may likewise derive their own classes in a similar fashion. A flexibility in approach is thus maintained while the underlying principle, namely that all objects are defined by their vertices, is adhered to.

Transformations

Having defined all our geometric primitives in terms of points, it is now only necessary to implement transformations on points. A base transformation class is declared as follows:

```
class transformation
: public matrix<float,3,3> {
public:
   transformation();
   ~transformation(){};
   virtual point operator*(point& pt);
   virtual _line operator*(_line& ln);
   virtual triangle operator*(triangle&);
   virtual polygon operator*(polygon&);
   virtual transformation
      operator*(transformation& xform);
};
```

Operators are provided for the multiplication of points, polygons, lines and triangles, and for composite transformations which can be combinations of any of the derived transformations. By explicitly providing these operators it is ensured that illegal operations are not allowed, for example the multiplication of two primitives together.

With the algebra of the library in place, we can proceed to declare a full list of standard transformations including rotations, reflections, enlargements, shears and translations. Also where possible optimisations are provided, in order to avoid calls to sine and cosine functions.

The derived classes are very simple and require only constructors and destructors:

```
// The rotation class: rotation
// by angle theta in radians
class rotation:public transformation{
public:
   rotation():transformation() {}
   rotation(angle theta);
   ~rotation(){}
};
```

The constructors simply supply the appropriate values for the matrix data. All multiplications are dealt with by the base transformation class.

We can now create and manipulate our primitives in a highly intuitive manner, and output the results to an appropriate device:

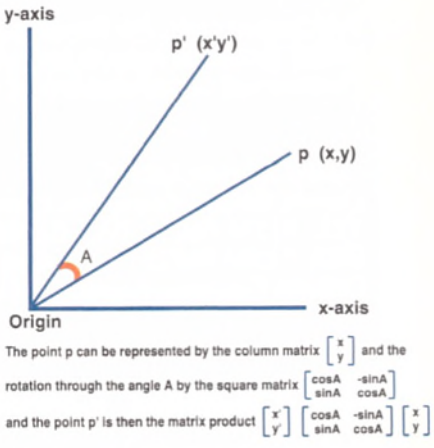

Figure 1 - Rotation about the origin

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```
// Create a point and rotate it
point pt1(100, 100);
rotation r1(pi/4);
pt1 = r1*pt1;

// Create a line and move it
_line ln1(point(0, 0), point(100, 100));
translation t1(40, 60);
ln1 = t1*ln1;

// Do composite transformations
triangle tr1(point(100, 0),
             point(150, 50),
             point(150, -50));
tr1 = t1 * r1 * tr1;
```

Arithmetic operators

As stated at the outset, the library evolved from investigating templates and by using a combination of templates and derivation. We were able to develop a very intuitive solution fairly quickly in this particular area. This development has also been extended in a very short space of time to three-dimensional transformations.

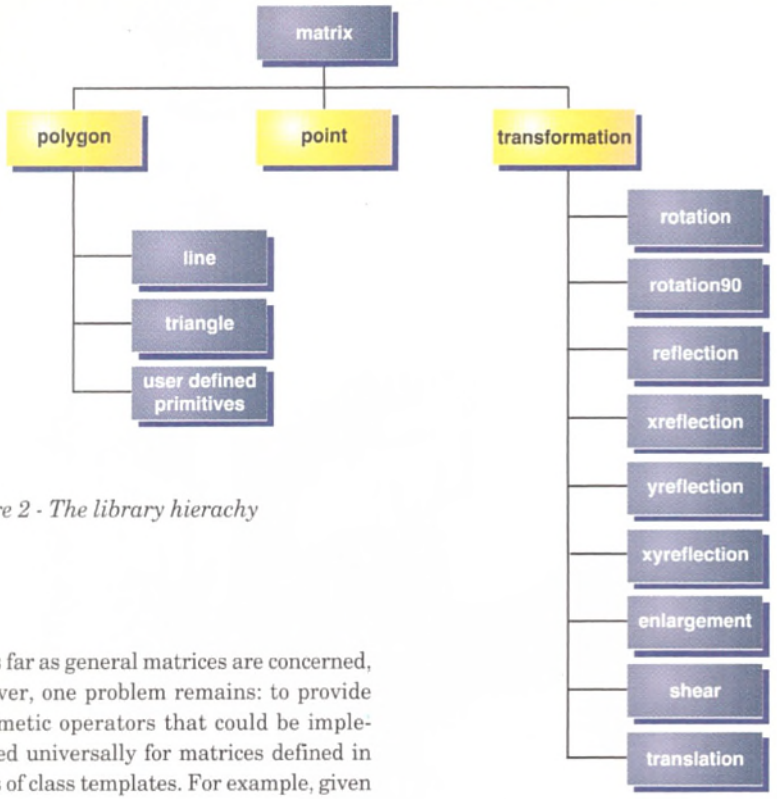

Figure 2 - The library hierachy

As far as general matrices are concerned, however, one problem remains: to provide arithmetic operators that could be implemented universally for matrices defined in terms of class templates. For example, given two matrices of different types and size how can multiplication – or any similar operation – be simply implemented? In addition, in many cases the resultant will be of a different type. As an example, given:

```
matrix<int, 3, 5> marix1;
matrix<float, 5, 4> matrix2;
```

how can the following be best achieved:

```
matrix3 = matrix1 * matrix2;
```

A partial solution for complex numbers was achieved using conversion operators:

```
// A complex number
template<class T, int x=2, int y=2>
class complex : private matrix<T, x, y> {
   T data[x][y];
public:
   complex() : matrix<T, x, y>() {}
   complex(T real, T imag);
   ~complex() {delete [] data;}
   operator complex<int>() {}
   operator complex<float>() {}
   complex operator+(const complex& comp1);
   complex operator-(const complex& comp1);
   complex operator*(const complex& comp1);
```

However this doesn't deal with the general case. Especially as in this instance all the matrices are of the same size.

Class templates may be a straightforward solution to designing general C++ libraries for algebraic types or a better technique may lie in an algorithmic approach similar to that taken in the Standard Template Library. Algebraic operations would be defined in terms of function templates, their arguments being matrices; they would be extended to cater for a range of algebraic structures to which a given set of operations could be applied. ■

References: Geometry by Transformations, EA Maxwell, Cambridge University Press; Matrices and Transformations, Anthony Pettofrezzo, Dover Publications; The Standard Template Library, Alexander Stepanov & Meng Lee, Hewlett-Packard Laboratories.

Homogeneous and non-homogeneous transformations

By its very nature, a transformation may or may not map the origin onto itself. Those that do, such as rotations, are termed *homogeneous*, while those that displace the origin to another point, such as a translations, are termed *non-homogeneous*. Intuitively it can be seen that if the origin is rotated it remains at the same point, whereas if moved by so many x and y units it obviously does not. To represent both these type of transformations for two dimensions it is necessary to employ 3 by 3 as opposed to 2 by 2 square matrices. Whereas for homogeneous transformations we have:

$$x' = ax+by \text{ and } y' = cx+dy$$

with non-homogeneous transformations the formula also contains a third constant value:

$$x'=ax+by+e \text{ and } y' = cx+dy+f$$

The matrix algebra needs to reflect these changes as can be seen in Figure 3.

$$\begin{bmatrix} x' \\ y' \end{bmatrix} = \begin{bmatrix} a & b \\ c & d \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix} \text{ to } \begin{bmatrix} x' \\ y' \\ 1 \end{bmatrix} = \begin{bmatrix} a & b & e \\ c & d & f \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ 1 \end{bmatrix}$$

Figure 3 - Change matrices

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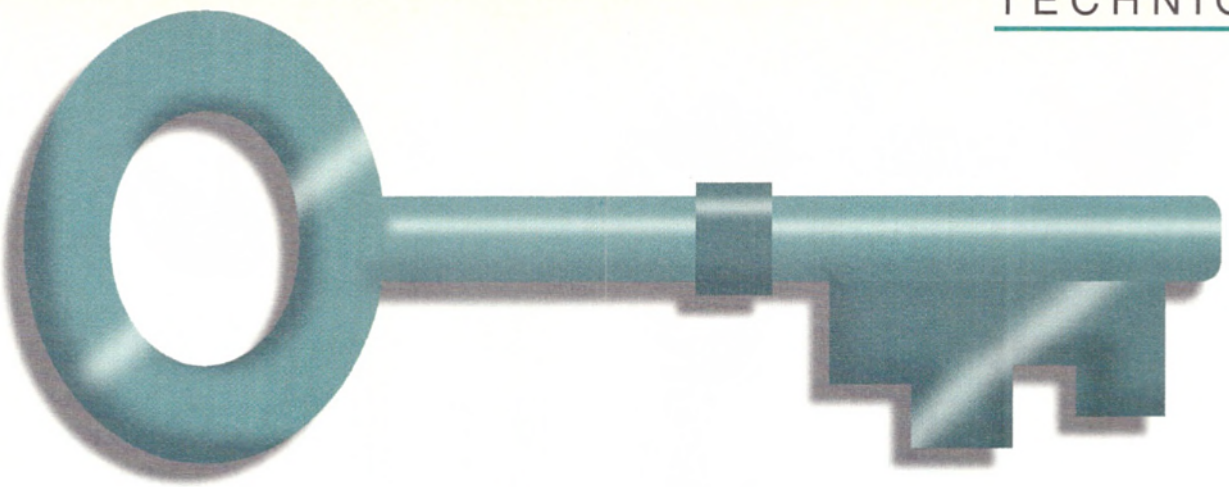

Exclusive volume locking

Robert Stimpson explains how to lock up your disk drives with the Windows 95 exclusive volume locking API.

The ability to 'go anywhere' and 'do anything' is commonly associated with DOS and real-mode code which many software developers currently possess. To rewrite or redesign this 'legacy code' to work reliably under Windows 95 presents a sizeable burden. Frequently, the DOS facilities are no longer available when converting an application to run under Windows, unless of course you are prepared to embark on creating and testing a VxD – a virtual device driver – to handle unfriendly tasks shunned by normal Windows programs.

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Register	Function	Value
AX	Volume locking API ID	440Dh IOCTL function call
BH	Lock level (functions 4Ah and 4Bh) 0 otherwise	0, 1, 2 or 3
BL	Drive number – Logical drive (functions 4Ah, 6Ah, 6Ch, 6Dh, 6Eh and 70h) – Physical drive (functions 4Bh and 6Bh)	 0h-1Ah 0h-7Fh floppy, 80h-FFh HDD
CH	IOCTL device category	Always 08h – hard disk
CL	Function code	4Ah, 4Bh, 6Ah, 6Bh, 6Ch, 6Dh, 6Eh or 70h
DX	Permissions (functions 4Ah,4Bh) ■ Bit 0: level 1 lock write operations ■ Bit 1: level 1 new file mapping ■ Bit 2: level 0 (2nd time) Filename path buffer offset (functions 6Dh and 6Eh)	 0 (failed) or 1 (allowed) 0 (allowed) or 1 (failed) 1 (lock volume for formatting)
DS	Filename path buffer segment (functions 6Dh and 6Eh) (1)	
SI	FileIndex (function 6Dh)	Zero-based
DI	EnumType (function 6Dh)	0 (all open files) or 1 (open unmovable files)
Notes:	(1) The buffer length can be obtained from Int 21h Function 71A0h	

Table 1 – Volume locking API Int 21h call register allocation

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CIRCLE NO. 469

VxD code requirements for volume locking API under Windows 95

Volume locking is simultaneously available as a Windows 95 API, but only for writers of Win32 code. All aspects of your exclusive access must be achieved within the code for one message process, preferably using a dynamically loaded VxD which acts as a `DeviceIoControl` interface to your program code. The caller and VxD code must be designed so that no segment transfers are requested by the system while operating the locks – so keeping the code for the various levels in one module is also a high priority. Microsoft says you cannot call Windows or C runtime functions within the level 3 routines (other than `ReadFile`, `WriteFile` and `SetFilePointer`), nor must Windows messages or GUI or screen functions be carried out – all what is needed to process your direct disk access must be provided by you! (Is this what redundant DOS TSR programmer's will do with Windows 95?)

enhance some DOS application code which was produced to take advantage of this routine so that with minimal modifications it would function transparently under Windows 95. Yes, it should be totally rewritten under Windows 95, but the long term benefits are just that – long term – and I needed an immediate pay-back.

Windows does not let applications 'tinker' with disk drive hardware above the VxD level, but the arrival of Windows 95 has provided an Int21h routine API which allows generic DOS code to 'lock out' the disk from all but the application's own usage.

Using this process, which Microsoft refers to as 'exclusive volume locking', allows continued access to Int 13h, 25h or 26h DOS and BIOS calls and direct I/O port access with minimum code modification. This article concentrates on the API from the perspective of generic DOS code – providing a tutorial on the VxD aspects cannot be covered here.

Since the DOS volume locking call is interrupt based, I personally doubt if it will remain as an open path in future enhancements to Windows – if the Windows NT / Windows 95 merger actually takes place in the future then this facility may disappear.

Levels of locking

Volume locking is divided into two regimes: physical drive locking and logical drive locking. Since the physical drive may host multiple logical drives, when a physical lock is obtained the associated logical drive locks are provided at the same time. Within each regime four levels of locking exclusivity are provided. To gain the highest level, all lower levels must be possessed by the calling program. In addition, all drives must be local to the PC host – these functions will not work on network drives.

The locks will also fail if you attempt to apply them to the system drive – the one containing the Windows directory and the Windows swap file (if present). Overall system integrity must be maintained while your code is floating through 'Gates' Locks'. Windows must be able to access all swappable system code irrespective of the locked drive status.

Before any *serious* work can be carried out on the drive, a level 1 lock must be gained, which sets a semaphore within the operating system preventing any other process from getting to level 1 or beyond on the drive you have specified. (For more on semaphore turn to Peter Collinson's article on page 25 in this issue). When requesting the level 1 lock a single byte representing the *permissions flags* is passed in a register to indicate what degree of access you will allow *others* when you gain your locking handle. At level 1, depending on the permissions flags, other applications may be able to read and write to the drive. From this level and based on your declared intentions, the accesses at levels 2 and 3 for your process and others are determined.

Level 2 locks give you exclusive write access to a disk but also allow other processes to read from it, depending on the permissions flags you have set at level 1. Level 3 locks out all other processes from accessing the disk, granting your process exclusive access to the drive.

Level 0 is the most restrictive, giving the lock owner exclusive read/write access to the drive. The drive targeted must not have any open files or file handles, nor can it contain the Windows 95 system or swap files. Level 0 can be used for drive formatting.

If another process has previously gained exclusive access to the drive you are seeking to lock, the call will return a failure code and you must not proceed any further with your

Register	Function	Value
`Carry`	Error status	Cleared if successful, set on error
`AX`	If carry set, error value (for all functions)	
	Lock flag state (function 6Ch)	0 (no write or mapping since last poll), 1 (write or swap file size changed) or 2 (file mapping since last poll)
	Combined file access and share mode (function 6Dh)	0, 1, 2, 4, 10h, 20h, 30h or 40h
	Type of swap file (function 6Eh)	1 (no swap file), 2 (DOS swap file) or 3 (protected mode)
	Lock level (function 70h)	0, 1, 2, 3 or -1 (for unlocked)
`CX`	File type (function 6Dh)	0 (normal file), 1 (memory-mapped) or 2 (other unmovable)
	Lock permissions (function 70h)	Bits 0 and 1 similar to DX for functions 4Ah and 4Bh

Table 2 – Volume locking API Int 21h return register allocation

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```
;-------------------------------
;Example Code  to  demonstrate
; the calling sequence for the
;Windows 95 Volume Locking API
;For a >DOS< application.
;-------------------------------
;Prepared by Bob Stimpson for
;    EXE Magazine (c)1996
;-------------------------------
;NOTE:   This skeleton example
;     code assumes that the C:
;drive corresponds to physical
;drive 80h.  Project code must
;verify the true physical host
;-------------------------------

.DATA
FileBuffer 256 DB(0)
PathBuffer 256 DB(0)

;equates:
TestDrive     EQU 03h
PhystestDrive EQU 80h

LockPhysVol   EQU 4Bh
UnLockPhysVol EQU 6Bh
EnumOpenFiles EQU 6Dh
FindSwapFile  EQU 6Eh
GetCurLState  EQU 70h

Unlocked      EQU 0FFFFh ;-1
IOCTLFunction EQU 440Dh
DiskDevice    EQU 08h
EnumAllOFiles EQU 0
NoPagerSwap   EQU 1
LockLevel1    EQU 1
LockLevel2    EQU 2
LockLevel3    EQU 3
PermitVal     EQU 0010b  ;flags

.CODE
PROC TestLock

mov ax, IOCTLFunction
mov bx, TestDrive
mov ch, DiskDevice
mov cl, FindSwapFile
lds dx, FileBuffer
clc
int 21h

jc  UnsupportedAPI

cmp ax, NoPagerSwap
jne SwapFileFound

mov ax, IOCTLFunction
mov bx, TestDrive
mov ch, DiskDevice
mov cl, GetCurLState
int 21h

jc  APIeError

cmp ax, Unlocked
jne DriveLocked

;call enumFiles once to
;check no files opened:

mov ax, IOCTLFunction
mov bx, TestDrive
mov ch, DiskDevice
mov cl, EnumOpenFiles
lds dx, Pathbuffer
mov si, 0
mov di, EnumAllOFiles
int 21h

;call fails if no files
jnc  FilesOpened

mov ax, IOCTLFunction
mov bh, LockLevel1
mov bl, PhysTestDrive
mov ch, DiskDevice
mov cl, LockPhysVol
mov dx, PermitVal
int 21h

jc  LockLevel1Failed

;insert code to execute at
;level 1 lock on drive 80h

mov ax, IOCTLFunction
mov bh, LockLevel2
mov bl, PhysTestDrive
mov ch, DiskDevice
mov cl, LockPhysVol
int 21h

jc  LockLevel2Failed

;insert code to execute at
;level 2 lock on drive 80h

mov ax, IOCTLFunction
mov bh, LockLevel3
mov bl, PhysTestDrive
mov ch, DiskDevice
mov cl, LockPhysVol
int 21h

jc  LockLevel3Failed

;insert code to execute at
;level 3 lock on drive 80h

mov ax, IOCTLFunction
mov bx, PhysTestDrive
mov ch, DiskDevice
mov cl, UnLockPhysVol
int 21h

jc BadUnlock3to2

mov ax, IOCTLFunction
mov bx, PhysTestDrive
mov ch, DiskDevice
mov cl, UnLockPhysVol
int 21h

jc BadUnlock2to1

mov ax, IOCTLFunction
mov bx, PhysTestDrive
mov ch, DiskDevice
mov cl, UnLockPhysVol
int 21h

jc BadUnlock1ToNone

.

UnsupportedAPI:
;code here to handle
; non-Win95 API support

SwapFileFound:
;a swap file was on the
;drive so it's likely to
;be the Win95 drive

APIeError:
;lock state call failed

DriveLocked:
;someone beat us to it!
;try again later?

FilesOpened:
;will stop level 0 lock
;continue in 1,2 or 3

LockLevel1Failed:
LockLevel2Failed:
LockLevel3Failed:
;The locking action
;was not successful
;- retry or abandon

BadUnlock3to2:
BadUnlock2to1:
BadUnlock1toNone:
;The unlocking action
;was not successful
;- retry or abandon

.

ENDP TestLock
```

Listing 1 – Sample code to lock the physical drive 80h to level 3 and then release it

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CIRCLE NO. 471

direct access code – failure to observe this fundamental requirement will cause the disk to be reported by as write-protected or unavailable. If your program cannot handle this error state, it will crash.

Deadly embraces

Accessing the disk using increasing levels of exclusivity requires careful design of the code to avoid possible 'deadly embraces'. In this scenario, your program requires code located on the disk, the system tries to load it and waits for the disk you have just locked to be unlocked, your code keeps waiting for the new code to be loaded, and there you stay happily ever after....

As an MS-DOS process you can call the Int 21 functions as you might do for any others, but with the added effect that the act of calling these new DOS functions from a DOS session will cause your application to be made full screen. This is to avoid screen driver lockups since no dynamic segment loading (eg paging a video driver DLL) can be carried out when the disk is locked. Only as an exclusive DOS session will these calls always work (ie lock availability is guaranteed) since in the general case your DOS session will be multi-tasked with the other processes within the OS.

Other application calls to the locked drive will be stacked up awaiting for your code to remove the locks in the same way as they were applied – gracefully. If you do not, Windows 95 will only free the locks when your application ends.

Whenever you release a system disk lock, all pending disk access activities permitted at the locking level now reached will be carried out by the system. When you need to use this locking API your 'well behaved' Windows 95 program must be aware of this possible activity and be prepared to tolerate other disk accesses.

The best way to visualise the locking hierarchy and the good programming practice required is as a pyramid with a prize at the top. You can only carry off one prize at a time, so you are continually running up and down the locking level pyramid to get the prize of exclusive access. Retaining the level 1 lock ensures you can proceed unhindered, and careful selection of the other process permissions when you gained this lock allows other processes access only when you decide them to be safe. After you have completed your prize collecting activity you must then release the final, level 1 lock.

Calling sequence

The volume locking API is consistent with 'Ye Olde DOS' – logical drives are enumerated from 1, with 0 being the default drive, and physical drives are numbered from 00h to 7Fh for floppy drives and 80h to FFh for fixed drives. It is therefore important to call the logical and physical locks using their applicable numbering convention.

The API uses the AX, BX, CX and DX registers plus the carry flag. It may also modify DS, DI and SI on some calls, so your code should save these if they are important to you. Tables 1 and 2 shows register usage. The API is summarised in Table 3. The three tables should be a big help because if you do finally find the Microsoft information carefully hidden among the SDK/DDK for Windows 95, it is so badly written that it is not immediately clear how any of it should be used effectively.

AX	CL	Function	Notes
440Dh	4Ah	Lock logical volume	
440Dh	4Bh	Lock physical volume	
440Dh	6Ah	Unlock logical volume	
440Dh	6Bh	Unlock physical volume	
440Dh	6Ch	Get lock flag state	
440Dh	6Dh	Enumerate open files	This function should be called incrementing SI to retrieve information on all active files but only on a locked volume since an active volume may return inconsistent results due to other applications' disk activity.
440Dh	6Eh	Find swap file	
440Dh	70h	Get current lock state	
710Dh		Reset drive	CX is the flush type flag (0 flush file buffers, 1 flush buffers and invalidate cache)

Table 3 – Volume locking API summary for generic DOS applications operating under Windows 95

The example code in Listing 1 attempts to lock the physical drive 80h to level 3 and then release it. The code first calls the `FindSwapFile` function to see if proceeding with the attempted lock is worthwhile – if the drive is used for a swap file you cannot lock it.

If this call returns a cleared carry flag, then the `GetCurrentLockState` call is made to see if any other process has beaten us to it. Again, if the drive is already locked at level 1 you cannot lock it.

If this also returns a cleared carry flag, then the `EnumerateOpenFiles` function is called to determine if the volume has any open files. If the drive has open files on it you could get their names and prompt the user to close down the applications using them since you cannot lock a drive with open files to level 0. Although not strictly required here, it is shown for completeness.

Finally, if all these actions are successful, the locks are applied sequentially and then released in reverse order. Every call to lock a volume must be matched with a corresponding unlock call.

This technique allows legacy code to be modified with minimal impact to allow it to co-exist safely in a Windows 95 environment, and offers hard-pressed project managers a possible solution to maintaining some of their old DOS code before they bite the bullet and order a total re-write. ■

Bob Stimpson is a Chartered Mechanical Engineer who has long worked astride the computing and mechanical engineering divide and is currently working on the development of CADAM expert systems operating simultaneously under Windows 95, 3.11 and also HPUX for a company in the process products industry. His other achievements include making radiators run under windows at home.

Big problems are easy to solve; it's the little details that need attending to, claims **Francis Glassborow**. As if to prove the point, Francis follows up with a discussion of some of the details a C++ programmer has to attend to.

Surprises

First, something to get your intellect functioning after any seasonal over-indulgence. What is the problem with the following code?

```
struct B {
    int i;
    virtual void report () const {cout << i;}
    virtual ~B () {}    //does nothing
};
struct D: public B {
    int j;
    void report () const {cout << i << " " << j;}
    virtual ~D () {}    // does nothing
};
int main () {
    B * bp;
    B * abp;
    B & yabp ();
    bp = new D;
    abp = new D[100];  //rest of program
}
```

I have used `struct`s rather than classes to simplify the code and allow you to focus on potential problems. Leaving code quality aside, there are at least two nasty surprises hidden in this code for most C++ programmers. One case may be less surprising to experienced C programmers.

A New Year's resolution

Looking back over the major time-wasters of 1995 I have noticed that many (indeed most) of them have resulted from minor faults in otherwise good products. When I installed IBM's Warp Connect everything went fine until the final reboot, when it began to report a problem with starting the network support (drivers etc had apparently loaded correctly). It took me almost a day to discover that the 3COM driver installed by Warp was a 2.x version, while that on the network card's own disk was for version 3.0. Replacing the Warp driver with the 3COM one fixed the problem, but why was the older version on the Warp CD?

Later I was upgrading to the latest OS/2 drivers for my Diamond Stealth VRAM card. Everything went fine till almost the end, when the disk I provided in response to a prompt was soundly rejected. It took me far too many hours downloading alternatives before I remembered that an earlier version had had specific instructions regarding the volume labels of the installation disks. Using the DOS `LABEL` command fixed the problem.

So here is my New Year's resolution for software developers. Make sure that all the little details are correct, because if you do not, your otherwise excellent product will not be well received.

Big problems are easy to solve. Unusual hardware configurations may be beyond your ability to anticipate, but little things like correct date stamps on files and supplying complete installation instructions are details you should get right.

exit(0) versus return 0

In the November issue of *EXE*, I expressed the belief that calling `exit(0)` from `main()` was the same as using `return 0;` from `main()`. I am indebted to Kevlin Henney for providing a counter-example. Consider:

```
int main ()
{
    char buffer [BUFSIZ];
    setbuf(stdout, buffer);
    ...
    exit (0);
}
```

Perhaps it is a bit eccentric to attach your own locally-declared buffer to `stdout`, but no more so than many other techniques that programmers occasionally find useful. However it has a vicious sting in its tail. Your C++ expert reflexively replaces `exit(0);` with `return 0;` to ensure that the stack is properly unwound. Surprise, surprise: your program may now do anything it likes. You are the arena of undefined behaviour brought about by a subtle case of 'hanging pointer'. Of course, in practice the program will continue to behave for many years, but the defect is there waiting to bite.

What happens on exit

This November, WG21/X3J16 finally realised that the list of things that happen on exit from `main()` was poorly ordered. Until then, functions registered with `atexit()` were first called in reverse order of registration, followed by destructors for static objects, in reverse order of construction. It may not be obvious that there is a problem here, but there is certainly a conceptual error. There is no reason to distinguish between destructors for static objects and other (explicitly) registered functions. In Tokyo, the committees took the logical step and ruled that all functions called on leaving `main()` are invoked in reverse order of their registration, regardless of whether that registration was via `atexit()` or implicit, as with destructors of static objects.

Actually, C++ does not need `atexit()`, although I think that using destructors to force execution of particular functions before leaving a block of code can be overdone. For example you could write a class whose constructor imposes pre-conditions and whose destructor imposes post-conditions. Even in the context of an exception being thrown, such code would always be executed at the relevant place. This seems to provide new potential for spaghetti code.

Thinking about exceptions reminds me that many programmers grumble about not having resumable exceptions without asking themselves what they can do about it. The Standard C++ Library

already contains examples of mechanisms for sensible error handling. Take a look at the mechanism for dynamic memory allocation. Many programmers focus on the fact that, by default, `new` throws an out-of-memory exception when unable to allocate memory. However, they might be better off considering the potential provided by `new_handlers`.

Exceptions are often described as a solution to the problem of code detecting a problem but not knowing how to solve it. The problem is thrown from its point of detection to a point of solution. But exceptions are not the only way of handling abnormal conditions, and in many cases should be a last resort. At the point that the problem occurs the programmer has a choice between throwing an exception and calling a handler. Where appropriate, the use of a handler is preferable, as this allows the user to attach a suitable function, which could then throw an exception if that were how the user wanted to handle the problem. I will come back to this later in the year.

Linkage problems

In last month's column, I was mooting the use of template classes to provide file-specific information. Roland Perera, *EXE*'s resident C++ apprentice guru *[an interesting oxymoron - RP]*, spotted a flaw in the code presented. The rules of C++ require not only that non-type parameters of template classes be of built-in or pointer type, but also that they have external linkage. (Actually the distinction between external and internal linkage was an early C hack to help the dumb linkers of the 1970's, but that's yet another story.) In order to avoid breaching the One Definition Rule my `char *` pointer initialised to `__FILE__` had to be `static` (ie have internal linkage). The Borland compiler I tested the code on was quite happy because it instantiates templates at the point of declaration, but unfortunately this is not the way C++'s model of template compilation works. With separate template compilation the `static` variable is not acceptable. However, there is a fix for this problem, and one that is powerful enough to enable WG21/X3J16 to use to abandon the distinction between internal and external linkage. We need to use an unnamed namespace. The following modified code should do what I wanted:

In file pause.h:

```
template < const char * file>
struct Pause {
    Pause () {cout << file << endl;}
    ~Pause () {cout << file <<
                "globals destroyed" <<endl;}
};
```

And in each `.cpp` file:

```
#include "pause.h"
namespace {
    const char y [] = __FILE__;
    Pause <y> t;
}
```

Until compilers correctly implement namespaces it will be difficult to check such code. I will not be surprised if this still needs some work. For example, I am not sure if I need to add `extern` before the `const char` to force external linkage. It will be pretty silly if this is needed because the whole point of an unnamed namespace is that it prevents identifiers from being referenced from outside the translation unit, *without* resorting to the hackery of internal linkage.

Last month's problem

If you remember, last month I asked you to think about the following two functions:

```
void test1 (const int *cip, int * ip){
    *ip += *cip;
    printf ("%d ", *cip);
}
```

versus:

```
void test2 (const int * cip, int *ip){
    printf("%d", *cip);
    *ip += *cip;
}
```

Did you spot the problem? It is often called the *aliasing* problem because it arises from the fact that a single object may be referred to by more than one name. When the compiler compiles either of the above it cannot assume that `ip` and `cip` point to different storage (ie refer to different lvalues). In `test1()`, it must re-fetch the value held in `*cip` before printing it, even though the value is apparently the one fetched for the previous line. In `test2()` the compiler can securely optimise away the second fetch because it can determine that the value of `*cip` cannot have changed.

This is a nasty little problem in C, and one that WG14/X3J11 has chosen not to fix. (Remember, they hate new keywords and the proposed solution involved the introduction of `noalias`.) In C++, with `const` reference parameters substituting for value parameters, the problem is even worse. For example, how is the compiler to know that code such as:

```
void alias (const MyType & mt, int & ir)
{
    ir = 4;
    // other code
}
```

does not hide a quiet change to an `int` member of `mt`? Did I hear you say that the compiler can see that `MyType` does not contain an `int`, or that we could make a rule which says that the compiler can assume that private data cannot be aliased? Bad luck - the object bound to `mt` might not be a `MyType`, but instead something *derived* from `MyType`. This is deeply unpleasant. If a function has a non-`const` reference or pointer parameter, then writing to the parameter's referent can potentially alter the state of the function's `const` parameters. I am tempted to suggest that changing the state of a `const &` parameter via a non-`const` (partial) alias should be ruled as having undefined consequences, but I am not certain. What do you think?

Solving problems like this one can consume a great deal of time when specifying a language. In real programming they hardly ever bite. In a way, this is even worse news, because when they do bite they are very difficult to diagnose. ■

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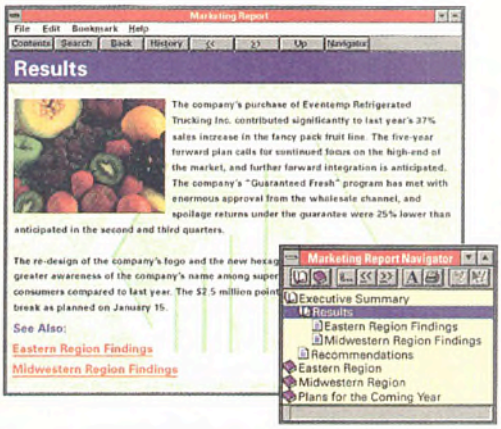

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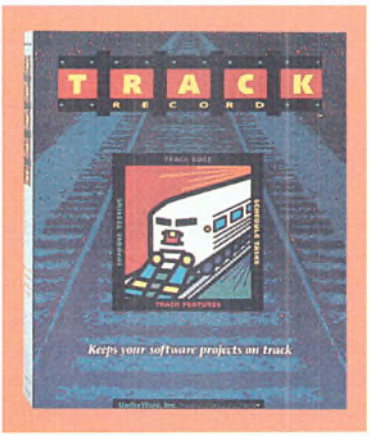

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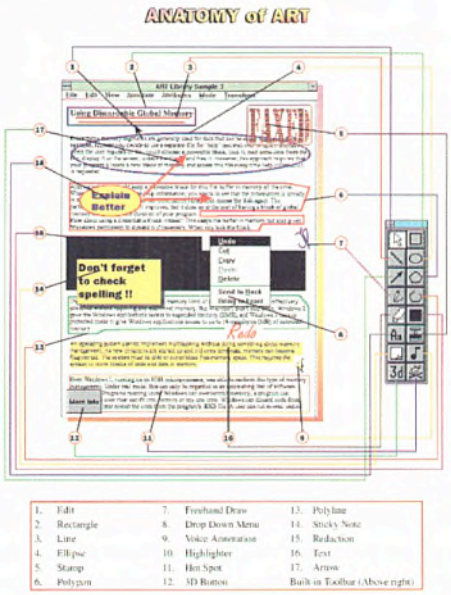

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CodeGuard

When your program crashes and you have no idea where the bug hides, a debugger is of little use. **Dave Jewell** reviews Borland's CodeGuard V1.0, a 'bug locator' for BC++.

Most respectable Windows development systems come with some sort of debugger. Borland supplies Turbo Debugger for Windows while Microsoft provides a copy of its CodeView system. Different debuggers have differing strengths and weaknesses but most of them have one thing in common – they're built on the assumption that you know approximately what sort of bug you're dealing with and where it's located. The basic idea is that you step through a relatively small chunk of code, examining variables and setting breakpoints until you've found exactly what's going wrong.

Now admittedly, this is something of a sweeping generalisation, but it's largely true. A debugger can only help if you have some idea of what you're looking for, and roughly where the problem can be found. This isn't too much of a problem if you've written the program yourself, but it can be hell when you're trying to debug someone else's code, or when you're faced with mountains of C++ code that have been generated by your friendly neighbourhood Wizard or Expert.

CodeGuard and BoundsChecker are designed to address this sort of problem. Traditional debugging tools such as Turbo Debugger and CodeView are great for finding out *exactly* what's gone wrong, but they're not so good as bug locators. That's where CodeGuard and BoundsChecker excel – these products lurk in the background waiting for something to go wrong and when it does, they pinpoint the problem. BoundsChecker was reviewed in the July '95 issue of *EXE*. In this article, we take a look at the relatively new CodeGuard system.

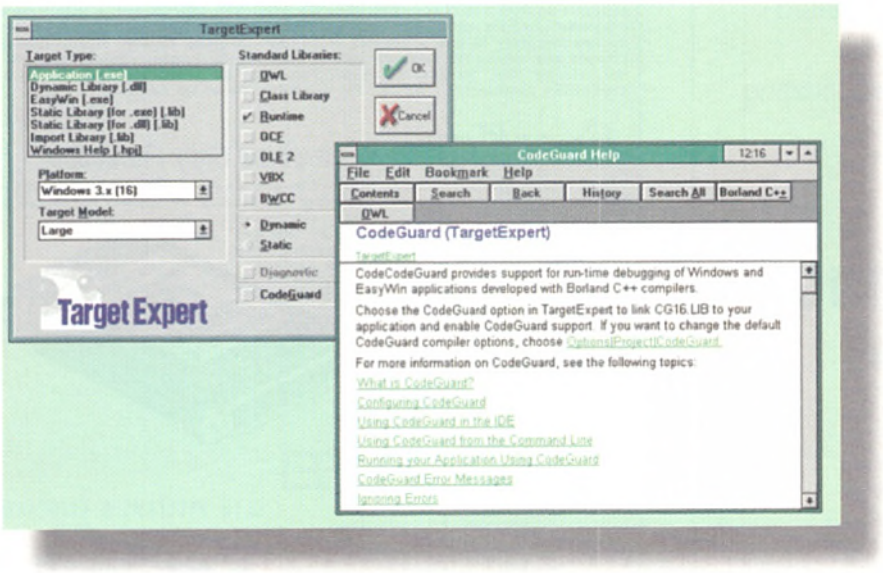

Figure 1 – CodeGuard integrates seamlessly into Borland's TargetExpert and help system. It's partly as a result of this integration that you need a reasonably recent version of Borland C++, since only the later stuff has the needed hooks

CodeGuard for Borland C++ 4.5

As the name suggests, CodeGuard is aimed fairly and squarely at Borland C++ programmers. Unlike BoundsChecker, it won't work with any other development system. It should also be said right at the start that CodeGuard is – at present time – for debugging 16-bit applications only. A 32-bit version of CodeGuard will be released around the same time that Borland C++ 5.0 (the latest invocation of Borland's flagship development system) starts shipping and both these products are scheduled to be available early 1996. Of course, if you're stuck with a really intractable bug in your 32-bit software and you need to find the problem *now*, there's nothing to stop you from recompiling your application for 16-bit (you did write it in a portable way, didn't you?) and going bug-hunting with 16-bit CodeGuard.

CodeGuard is quite fussy about which particular version of Borland C++ its going to use. Although the blurb on the box states 'requires Borland C++ 4.5', you actually need 4.51 as an absolute minimum. Fortunately, the CodeGuard CD includes a patch utility to upgrade your development system to version 4.53. This all sounds rather wonderful, (especially if you happen to be stuck with 4.5) but the patch utility is anything but wonderful. It can't be used under Windows NT, requires you to enter a series of arcane arguments on the DOS command line (it took me several goes to get this right) and can take anything from twenty minutes to two hours to do the business. It actually took just over twenty minutes on my DX4/100. You *must* perform the patch *before* trying to install CodeGuard itself, a fact which isn't mentioned in the documentation.

Once you've patched your development system, installing CodeGuard is relatively uneventful although you do get all sorts of dire bleatings about the need to boot from a 'clean' system before continuing. I decided to ignore the warnings of impending doom, lit

CodeGuard's hall of shame

CodeGuard can detect a wide range of programming bugs and run-time errors. This section lists some of the types of problems that CodeGuard detects.

- *Memory overruns.* This is the classic problem of trying to copy a 21 character string into a 20 character buffer. When a program is compiled with the CodeGuard option enabled, the compiler generates special descriptor information which specifies the size of each global or local variable. When the program actually executes, these descriptors are made available to the CodeGuard version of the RTL so that the wrapper around `strcpy`, for example, can determine if a memory overrun is going to occur.
- *Access to deallocated memory.* CodeGuard keeps track of what memory is allocated, unallocated or has been deleted. Any attempt to access unallocated/deallocated memory, or deleted C++ objects results in a run-time error. Attempting to access deleted objects is a common problem in C++ programs. A nice feature here is CodeGuard's ability to show you where a memory block or object was first allocated (and subsequently deallocated) when such an error occurs.
- *Memory and resource leaks.* Another classic problem is the failure to deallocate all memory or resources that have been allocated. CodeGuard will even detect 'mixed library' anomalies where you allocate a resource in a DLL using a static version of the RTL and then try to deallocate it in your application using a dynamic RTL.
- *Function parameter and return verification.* As mentioned in the main text, CodeGuard can perform input parameter validation on all RTL calls and many Windows API calls and will validate return values for success or failure. The configuration utility (see Figure 2) can be used to enable/disable validation on a function by function basis, and to enable logging of specified calls for later examination.
- *'This' pointer verification.* With CodeGuard enabled, the compiler will generate special prologue code for every C++ member function. This performs automatic validation of the implicit 'this' pointer on entry to every member routine. Thus, if an object reference gets trashed, a C++ program will catch the error very quickly.
- *System exceptions.* CodeGuard detects system exceptions such as *Divide by Zero*, *General Protection fault*, *Coprocessor not Present*. Unfortunately, this doesn't work properly under Windows 95 because the new operating system gets to trap the exception itself and prevents CodeGuard from detecting it. In such cases, Borland recommend running your program under NT or Windows 3. in order for CodeGuard to trap the exception and make more diagnostic information available to you.

the blue touch-paper and kicked off the install. Everything went fine, but I was left with the overall impression that CodeGuard's installation process isn't up to Borland's usual standard. A full installation of CodeGuard 1.0 takes about 9 MB. As a bonus, a second CD is included in the package – Borland Programmer's Resource CD. This is basically a compilation of developer-oriented shareware and freeware taken from InfoMagic's CICA distribution.

Seamless integration

The installation completed, I fired up my shiny new 4.53 IDE and looked around to see what was different. (Borland states that the 4.53 patch should be replaced by a normal system upgrade as soon as possible, so presumably it's only 4.5299 or some similar, but it does include new import libraries and header files for Windows 95.) Like PowerPack for DOS, CodeGuard integrates seamlessly into the Borland IDE, installing a new checkbox for CodeGuard into the TargetExpert (see Figure 1). In the same way, CodeGuard also integrates neatly into the on-line help system.

A big benefit of CodeGuard is its ability to run entirely within the IDE, making for a very quick and convenient debugging session. You can just click the CodeGuard checkbox in the IDE, then build and run your application. When something goes wrong, CodeGuard pops up a dialog box which displays information on the nature of the error, at the same time the editor window highlights the offending line of source code to show you exactly where and how the prob-

```
_strcpy   proc   far
   1.0299  55           push  bp
   1.029A  8B EC        mov   bp,sp
   1.029C  68 5A57      push  seg ___org_strcpy
   1.029F  68 07CE      push  offset ___org_strcpy
   1.02A2  9A FFFF0005  call  far ptr __CG_STRCPY
   1.02A7  83 C4 04     add   sp,4
   1.02AA  5D           pop   bp
   1.02AB  CB           retf
_strcpy   endp
```

Listing 1 – strcpy replacement routine

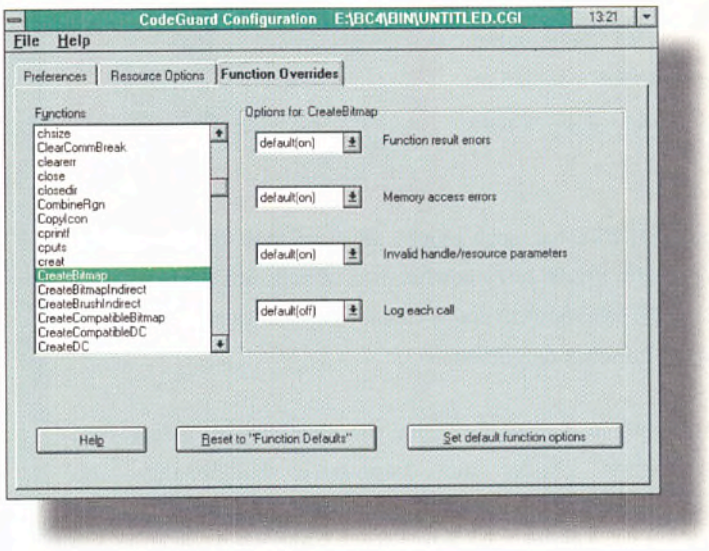

Figure 2 – Using the supplied utility, you can configure CodeGuard on a function by function basis. You can also turn on logging for specific routines and even turn off CodeGuard altogether without having to rebuild the executable

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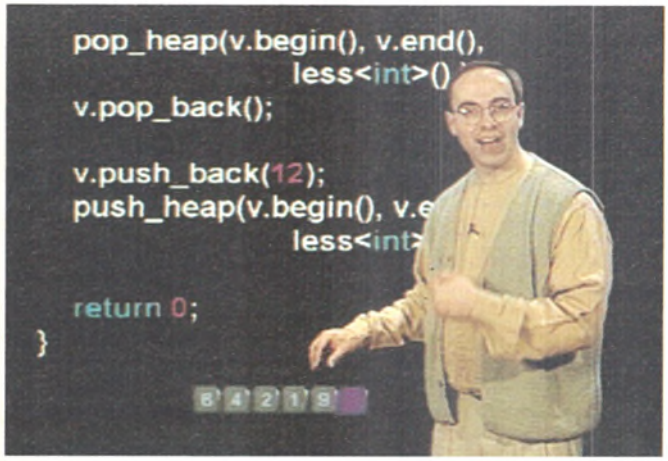

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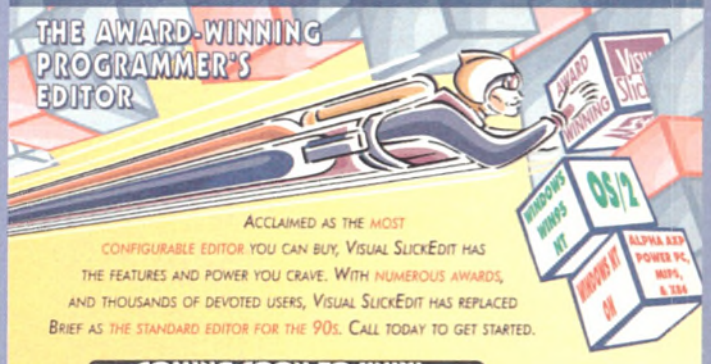

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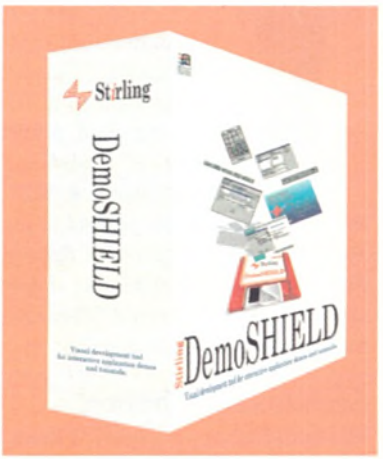

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How does it work? A peek behind the scenes...

To get some idea of how CodeGuard works 'behind the scenes', I compiled one of the sample programs, generated a map file, and took a look at the resulting code using the ever-faithful 'Windows Source' disassembler from V Communications. I examined the state of play for the simple case of a buffer overrun – attempting to write a large string into a small buffer using the RTL `strcpy` routine.

Each and every original RTL routine in a CodeGuard-enabled program is renamed so as not to conflict with the CodeGuard wrapper function of the same name. For example, the `strcpy` routine, which corresponds to a function called `_strcpy` at the level of the run-time library is now replaced with a function called `___org_strcpy`. (That's three underscores before the function name). If you wanted to perform a CodeGuard-proof string copy in your program, I guess you could do so by calling this function directly, but without the initial underscore.

The code for the replacement `strcpy` routine looks like the one in Listing 1. This is the code that's called when you invoke the `strcpy` routine in a CodeGuard enabled program. Basically, all it does is push the address of the original `strcpy` routine onto the stack (so that it can be executed from within CodeGuard) and then calls the `__CG_STRCPY` entry point in CodeGuard itself.

What's perhaps a little surprising about CodeGuard's implementation is the fact that CodeGuard itself doesn't actually get linked into the application at all. The call to `__CG_STRCPY` is a call to one of numerous entry points in a DLL called CG16.DLL. This DLL is actually quite large: 330 KB. Of course, it doesn't get any smaller even when you're only developing a small shareware application. Given this sort of implementation, you should be able to appreciate why CodeGuard will only work with large memory model applications! It also needs to be borne in mind that if you are going to ship CodeGuard enabled applications to your end users, you'll also have to give them a copy of this rather large DLL, something that doesn't seem to be mentioned in the documentation – at least, I haven't found it.

This leaves the question of where CodeGuard picks up its debugging information, the type and size descriptors for the program being 'guarded', and so forth. Although I haven't verified it, I imagine that this is all part of the debug information that's tacked onto the end of the .EXE file image by Borland's development system. However, even after running TDSTRIP, CodeGuard still appeared to operate as advertised so perhaps this information isn't strippable in the normal way.

Finally, there is one other good reason for not shipping a CodeGuard-enabled application. Such an application is very easy to disassemble since every single call to an RTL function is visible to a disassembler. It's even simpler than usual to figure out what your application is doing.

You've been warned...

lem occurred. All this happens without making any change to the source code of your application. Among other things, building a 'CodeGuard-enabled' application will cause your code to be linked with a special version of the run-time library (RTL). The CodeGuard version of the RTL includes validation of both input parameters and function results and optionally triggers a CodeGuard error in the right circumstances – or wrong ones, depending on your point of view! Many Windows API calls are validated in the same way as for the RTL. Note, though, that CodeGuard is only available to large memory model applications – this is the only memory model for which CodeGuard-enabled run-time libraries are provided.

To change CodeGuard's behaviour on a function by function basis, a configuration utility is provided. You can specify which RTL or API calls you wish to write to a log file, and you can set up other aspects of CodeGuard's behaviour such as whether to log multiple errors, whether to write errors to the AUX device and so forth. All configuration information is stored in a file with the extension .CGI and the same name as your application. When the CodeGuard-enabled RTL in your program starts executing, it looks for and loads the configuration information from this file.

The benefit of this approach is that you can set up different configurations for different applications. You can run a CodeGuard-enabled application outside the IDE and even ship it in that state, although run-time performance will be somewhat reduced because of the increased RTL overheads. (And see my warnings about adopting this approach in the box entitled 'How does it work?') The benefit for your customers (and for you) is one of improved error reporting, and at the end of the day, CodeGuard can be completely disabled by making a one-line change to the .CGI file. The current cost of CodeGuard is £69, and you can get more details from Borland on 0800 973139. ■

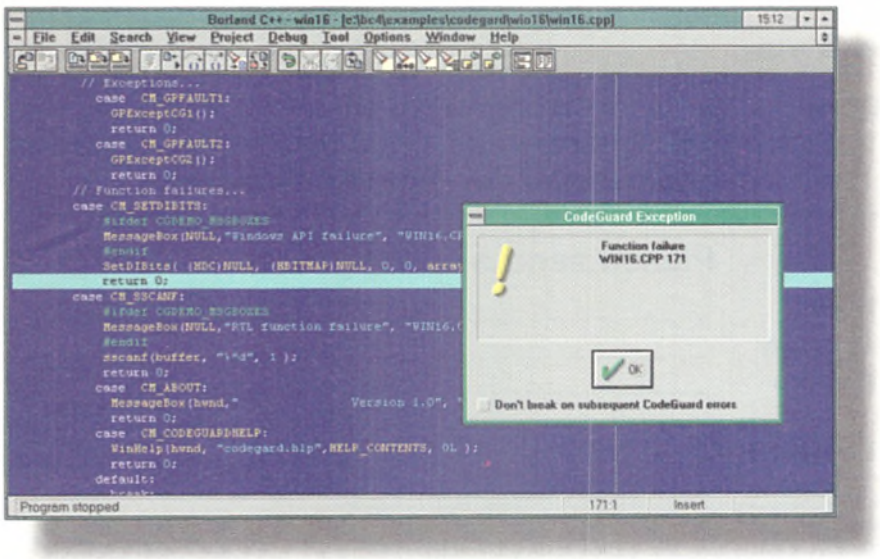

Figure 3 – Whenever an error occurs, CodeGuard pops up a dialog box indicating the nature the error and highlighting the offending line of source code. Well, very nearly the offending line of source code...

Dave Jewell is a freelance consultant, Windows developer and technical journalist. He is writing a new book about Delphi components to be published in early 1996. You can contact Dave as djewell@cix.compulink.co.uk.

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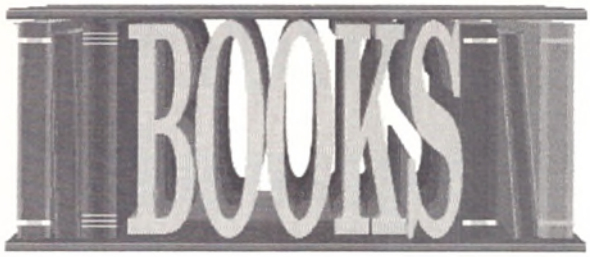

Game Graphics in C++ reviewed by **Colin Smith**

Only 33 pages of this book actually explain something; the rest is code. More than half of these code pages are static arrays of numbers that define sprites. I haven't seen so many printed numbers since the days of the Spectrum, when magazines printed machine-code listings as blocks of numbers! So when it comes down to it, you are basically getting a C++ bit-plane animation class (roughly 28 pages), and a sprite editor (60 additional pages).

The code makes use of the standard VGA graphics mode (640 x 480 pixels in 16 colours). The author's justification for choosing this mode is that 320 x 200 pixels in 256 colours is 'blocky'. He neglects the fact that the majority of games in the real world do use 320 x 200 x 256.

The bit-plane animation class has a major flaw in its design: each sprite has only one colour. A big deal is made about moving a three-coloured sprite around the screen. This 'technique' consists of creating three separate sprites (each one of a different colour), and displaying them at the same position on different VGA planes so that they overlap, thus fudging the desired effect.

Len Dorfman totally avoids the issue of sprites overlapping a background or other sprites: there is no transparent *blting* or double-buffering code. Instead he relies on the planing effect of the VGA graphics mode to allow a sprite on one plane to pass one on a different plane without being affected. For sprites that exist on the same plane, it's tough: 'I chose speed...over object flutter.'

The sprite editor uses a text video mode, so the 'pixels' are rectangular, making your sprite look as if it's been in a torture chamber. Sprites are limited to 47 x 46 pixels and four colours, which happens to coincide with the number of VGA planes available. In the author's own words, 'it's a tad kludgy'.

The code uses a strange mix of inline `_asm`, int86XX calls, and external assembler. Dorfman makes unnecessary calls to external assembler routines, the majority of which could easily have been accomplished with int86XX calls.

The last demo program completes the maze game 'chase the ghosts' begun in previous examples. The game consists of a maze made out of four squares, pacman monsters (that have two animation frames), a tank (which defies description) and bullets. Because of the animation scheme adopted, the ghosts dematerialise – ie flicker – when they get close to each other, and when the tank shoots, the 'bullet' seems to come out of thin air because it is misaligned with the tank sprite's barrel.

This book doesn't really tackle any game development fundamentals. There isn't a single diagram or class hierarchy – you expect this sort of thing when you're dealing with graphics and C++ topics. Dorfman also keeps apologising for having done things the way he has – there are some strange justifications indeed.

✗ **Verdict: one to avoid**

Title:	*Game Graphics in C++*
Author:	*Len Dorfman*
Publisher:	*McGraw-Hill*
ISBN:	*0-07-911951-4*
Price:	*£28.95*
Pages:	*386 (softcover) with code disk*

Advanced Windows The Developer's Guide to the Win32 API reviewed by **Chris Cant**

Advanced Windows is one of those whoppers, almost a kilo-page long, suitable for being that handy book under your wrist to stop you getting RSI. It covers several core Win32 API areas, as implemented in Windows 95 and NT. The code examples come on the not-quite-so-large 4 MB CD-ROM, with executables for x86, MIPS and Alpha architectures.

The book assumes that you already know Win16 and Win32 basics. It's based on Win32's C interface and not on C++ or MFC. However do not dismiss *Advanced Windows* for this reason, as it certainly helps to know what's going underneath the bonnet. The book *does* cover processes and threads, synchronisation mechanisms, thread local storage (TLS), memory (virtual memory, memory-mapped files and heaps), message handling, local input states, DLLs, files, exceptions and Unicode. It does *not* cover the registry, VxDs, named pipes, graphics, ODBC, OLE, OCXs, MAPI, TAPI...

Advanced Windows identifies 16- to 32-bit porting issues, pointing out which 16-bit functions are available in Win32 but won't work as expected. It highlights the differences between Windows 95 and NT, and the minor differences between NT platforms. All Win32 functions exist in Windows 95, it's just that some aren't implemented. I understand that there are functions in Windows 95 that aren't in NT 3.5x yet. There's lots of wacky functionality: for instance you can ask for a file to be moved, but only at the next system re-boot! Win32 is not a Reduced API OS.

As well as full coverage of relevant topics and programming implications, Richter comes up with several example scenarios to show you when to use the available functions.

One example of thread synchronisation corrects bugs in an earlier edition of the book. This just goes to show that using all these terrific new features is fraught with danger. Moving to event-driven programming was a big step, but using co-operating threads, processes, DLLs and asynchronous I/O seems almost as difficult, not to mention long filenames, Unicode and OLE. For example, you should design a DLL so that it can cope with being called from multiple threads within a process. However using the recommended thread local storage (TLS) to do this has its problems, as Win32 does not make static TLS work if the DLL was loaded with `LoadLibrary`. I could not find this information in the VC++ 2.2 on-line help files.

While partly aimed at moving you from 16-bit to 32-bit programming, *Advanced Windows* does not cover enough of the new API to do this job completely. However it will help you with the nitty-gritty of advanced Win32 development, and give you some pointers into that 38 MB Win32 on-line help file. Can someone produce an API chart for Windows, with a count of functions in each API, a Venn diagram...

✓ **Verdict: Recommended, if you need to use advanced Win32 features**

Title:	*Advanced Windows The Developer's Guide to the Win32 API*
Author:	*Jeffrey Richter*
Publisher:	*Microsoft Press*
ISBN:	*1-55615-677-4*
Price:	*£41.99*
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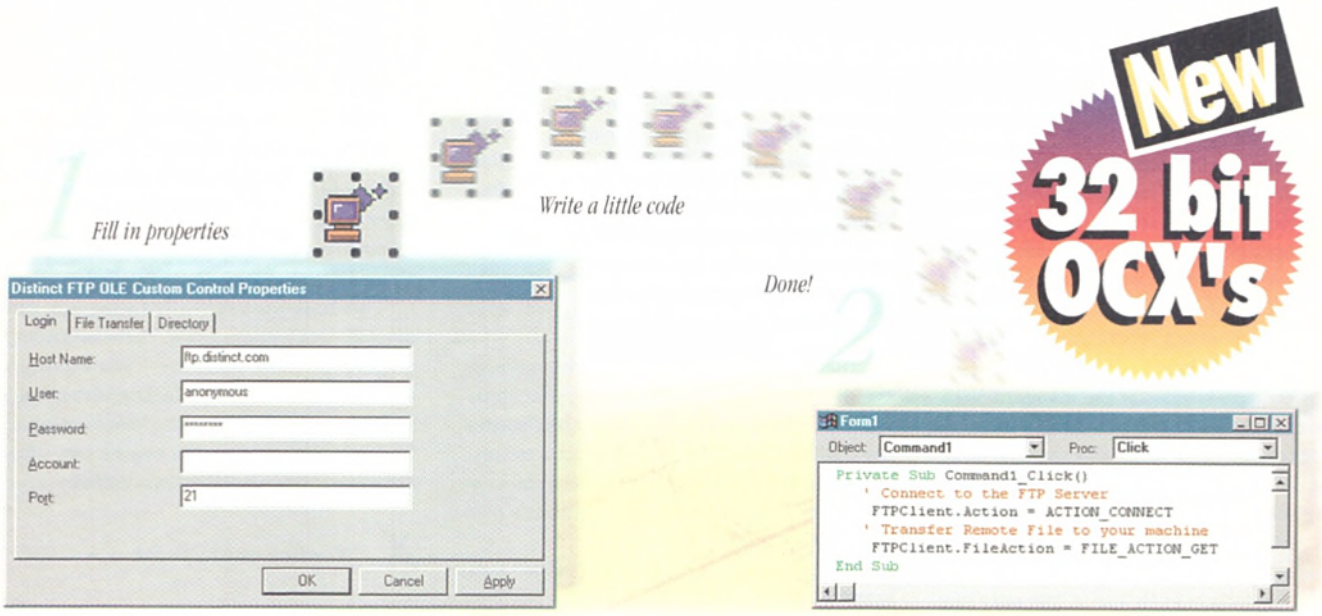

New 32 bit OCX's

OLE Custom Controls

Just ask any OCX expert. With Distinct's Visual Internet Toolkit, adding TCP/IP connectivity to your application is not much farther than a drag-and-drop away. Whether you need a customised FTP client or any other Internet application, you can simply embed an OCX into your program and ***Visual Internet will do the rest.*** It's that easy. And you'll have great looking, powerful applications.

32 Bit Performance

The power of our new 32 bit Visual Internet Toolkit is simply unsurpassed. More custom controls. More protocols. More sample code. More Documentation. Which makes your job easier and leaves the competition in the dust.

Protocols	
• Windows Sockets	• Telnet
• TCP/UDP/ICMP	• VT 220
• PPP/SLIP/CSLIP	• WinSNMP
• E-mail/SMTP	• ONC RPC/XDR
• POP 2/POP 3	• rcp
• News/NNTP	• rexec
• FTP	• rlogin
• TFTP	• rsh
• TCP Server	• And many more

Interfaces*	Environments
• 32 bit (95 and NT)	• Visual Basic
• 16 bit (Windows 3.x)	• Visual C/C++
• C++ Class libraries	• Delphi
• DLL's	• C/C++
• OCX's	• Access
• VBX's	• FoxPro

distinct®

The world leader in Internet development tools.

001.408.366.8933

Fax: 001.408.366.0153
E-mail: exe@distinct.com
Fastfacts: 001.408.366.2101

Distributed by:

HIGHLANDER Software Ltd

Tel: 0181 316 5001
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The Software Training Guide

JANUARY TO JUNE 1996

Welcome to EXE's Software Training Guide, containing courses from January to June 1996. We all know the importance of proper training, especially in the software development field. Make a good start to the year by establishing a training schedule for 1996. The course categories are defined below - simply look up the subject below and turn to the relevant page to find course dates, details, location, company and cost. The company and contact details are at the bottom of this page.

KEY TRAINING COMPANY CONTACT DETAILS

INFM Informator
59 New Kings Road, London SW6 4SE Tel: 0171 4055115 Fax: 0171 3715005

KIBW *Kibworth Computer Training*
68 Springfield Crescent, Kibworth Beauchamp, Leicester LE8 0L11
Tel: 0116 2792653 Fax: 0116 2792653 100537.2133@compuserve.com

LTRE *Learning Tree International*
3 Swan Court, Leatherhead, Surrey KT22 8AD Tel: 01372 364600 Fax: 01372 364611

PLAT *Platinum Technology*
Platinum House, North Second Street, Milton Keynes MK9 1BZ Tel: 01908 248000 Fax: 01908 274888

PRIN *Prince*
Brook House, 229/243 Shepherds Bush Road, London EC3N 1LS
Tel: 0181 2377220 Fax:0181 7410040 lyndab@prince.com

QATR *QA Training*
Cecily Hill Castle, Cirencester, GL7 2EF Tel: 01285 655888 Fax: 01285 650537

UNIS *UniSys*
Unisys Education Centre, Fox Milne, Milton Keynes, Bucks MK15 0DN Tel: 01908 213000 Fax:01908213030

The Software Training Guide

Client/Server

Date	Title	Days	Location	Company	Cost£
TBA	SQL Fundamentals	1	Milton Keynes	UNIS	295
TBA	Object Oriented Analysis & Design	3	Milton Keynes	UNIS	985
TBA	Delphi client/server application development	5	Market Harb.	KIBW	1025
8/1	System Admin for MS SQL Server for MS Win NT	5	Hammersmith	PRIN	1475
8/1	SQL Server Database Implementation for NT	5	Hammersmith	PRIN	1475
9/1	Application Development Using Borland Delphi	4	Cirencester	QATR	1195
9/1	Client/Server Design Using Relational Methodology	4	London	QATR	1295
11/1	Client Server Fundamentals	2	Milton Keynes	UNIS	695
11/1	Client Server Fundamentals	2	Milton Keynes	UNIS	695
15/1	SQL Application Programming for DB2	5	Milton Keynes	PLAT	1100
22/1	PowerBuilder 4.0 Fundamentals	4	Milton Keynes	PLAT	1100
22/1	SQL Server 4.2 Database Administration	5	Milton Keynes	UNIS	1195
22/1	System Admin for MS SQL Server for MS Win NT	5	City	PRIN	1475
22/1	ORACLE Basic Design & Development	5	Milton Keynes	PLAT	995
22/1	SQL Server Database Implementation for NT	5	City	PRIN	1475
23/1	Object Oriented Prog with Gupta SQLWindows	4	London	QATR	1175
25/1	Client Server for Business Managers	1	Milton Keynes	UNIS	295
29/1	Effective GUI Design	1	Milton Keynes	UNIS	325
29/1	Client Server Concepts & Components	2	Milton Keynes	PLAT	550
5/2	SQL Server Database Implementation for NT	5	Hammersmith	PRIN	1475
5/2	Delphi client/server application development	5	Market Harb.	KIBW	1025
5/2	System Admin for MS SQL Server for MS Win NT	5	Hammersmith	PRIN	1475
6/2	ORACLE Reports 2.5 for Developers	3	Milton Keynes	PLAT	675
12/2	ORACLE 7 Server for Developers	4	Milton Keynes	PLAT	850
19/2	SQL Server Database Implementation for NT	5	City	PRIN	1475
19/2	System Admin for MS SQL Server for MS Win NT	5	City	PRIN	1475
21/2	Client/Server Computing	3	Ascot	QATR	995
22/2	Re-engineering Fundamentals	2	Milton Keynes	UNIS	695
28/2	Windows for Developers	1	Milton Keynes	UNIS	325
29/2	Relational Data Design	2	Milton Keynes	UNIS	695
4/3	Client Server Concepts & Components	2	Milton Keynes	PLAT	550
4/3	Advanced SQL & Tuning Techniques	4	Milton Keynes	PLAT	975
11/3	Client Server for Business Managers	1	Milton Keynes	UNIS	295
11/3	SQL Application Programming for DB2	5	Milton Keynes	PLAT	1100
12/3	Effective GUI Design	1	Milton Keynes	UNIS	325
18/3	PowerBuilder 4.0 Fundamentals	4	Milton Keynes	PLAT	1100
26/3	Object Oriented Prog with Gupta SQLWindows	4	Cirencester	QATR	1175
9/4	PowerBuilder 4.0 Advanced Techniques	4	Milton Keynes	PLAT	1100
7/5	Application Development Using Borland Delphi	4	London	QATR	1195
20/5	PowerBuilder 4.0 Fundamentals	4	Milton Keynes	PLAT	1100
22/5	Client/Server Computing	3	London	QATR	995
28/5	Object Oriented Prog with Gupta SQLWindows	4	London	QATR	1175
30/5	Client Server Concepts & Components	2	Milton Keynes	PLAT	550
18/6	Client/Server Design Using Relational Methodology	4	London	QATR	1295

Comms

Date	Title	Days	Location	Company	Cost£
26/1	Introduction to Data Communications	4	London	INFM	1125
13/2	Introduction to Data Communications	4	London	INFM	1125
12/3	Introduction to Data Communications	4	London	INFM	1125

Databases

Date	Title	Days	Location	Company	Cost£
TBA	ORACLE 7 Server Database Administration Concepts	0	Milton Keynes	PLAT	675
TBA	Paradox	3	Market Harb.	KIBW	650
TBA	The Kibw Delphi Course	5	Market Harb.	KIBW	1100
TBA	Delphi client/server application development	5	Market Harb.	KIBW	1025
2/1	Programming with MS Access	3	Hammersmith	PRIN	885
8/1	Introduction to Microsoft Access	2	Cirencester	QATR	495
8/1	Application Development Using MS Access	4	Hammersmith	PRIN	1180
15/1	ORACLE 7 Server Performance Tuning	2	Milton Keynes	PLAT	550
15/1	Developing Applications in MS Access	3	Milton Keynes	UNIS	775
15/1	Programming with MS Access	3	City	PRIN	885
22/1	Database Design for DB2	3	Milton Keynes	PLAT	750
22/1	Application Development Using MS Access	4	City	PRIN	1180
22/1	The Kibw Delphi Course	5	Market Harb.	KIBW	1100
23/1	DB2 V4 Implementation Techniques	3	Milton Keynes	PLAT	890
23/1	Sybase Database Administration	4	London	QATR	1165
29/1	What's new with DB2 V3	1	Milton Keynes	PLAT	270
1/2	Introduction to DB2	2	Milton Keynes	PLAT	475
5/2	PL/SQL for ORACLE	1	Milton Keynes	PLAT	299
5/2	Delphi client/server application development	5	Market Harb.	KIBW	1025
7/2	Microsoft SQL Server & Transact-SQL Programming	3	Cirencester	QATR	895
12/2	Programming with MS Access	3	Hammersmith	PRIN	885
12/2	Application Development Using MS Access	4	Hammersmith	PRIN	1180
12/2	Database Administration for DB2	5	Milton Keynes	PLAT	1100
26/2	Programming with MS Access	3	City	PRIN	885
26/2	Programming in MS Access	3	Milton Keynes	UNIS	760
26/2	Application Development Using MS Access	4	City	PRIN	1180
4/3	Developing Applications in MS Access	3	Milton Keynes	UNIS	775
4/3	DB2 V4 Implementation Techniques	3	Milton Keynes	PLAT	890
4/3	The Kibw Delphi Course	5	Market Harb.	KIBW	1100
18/3	Paradox	3	Market Harb.	KIBW	650
4/4	Introduction to DB2	2	Milton Keynes	PLAT	475
15/4	DB2 V4 Implementation Techniques	3	Milton Keynes	PLAT	890
15/4	Database Administration for DB2	5	Milton Keynes	PLAT	1100
16/4	Sybase Database Administration	4	Cirencester	QATR	1165
22/4	Database Design for DB2	3	Milton Keynes	PLAT	750
13/5	Introduction to Microsoft Access	2	Ascot	QATR	495
20/5	DB2 V4 Implementation Techniques	3	Milton Keynes	PLAT	890
22/5	Microsoft SQL Server & Transact-SQL Programming	3	Cirencester	QATR	895
18/6	Sybase Database Administration	4	Cirencester	QATR	1165

Groupware and Office Systems

Date	Title	Days	Location	Company	Cost£
2/1	Lotus Notes Application Development I	2	City	PRIN	590
2/1	Supporting MS Excel	3	Hammersmith	PRIN	885
2/1	Supporting MS Word	4	Hammersmith	PRIN	1180
8/1	Lotus Notes Basic Concepts	1	Hammersmith	PRIN	295
8/1	Implementing MS Mail	5	Hammersmith	PRIN	1475
9/1	Lotus Notes Technical User	1	Hammersmith	PRIN	295
10/1	Lotus Notes Systems Administration I	3	Hammersmith	PRIN	885
15/1	Groupware and Office Systems System Admin 2	2	Milton Keynes	UNIS	660
15/1	Lotus Notes Application Development I	2	Hammersmith	PRIN	590
15/1	Supporting MS Excel	3	City	PRIN	885
15/1	Supporting MS Word	4	City	PRIN	1180
16/1	Programming in Lotus Notes Version 4	4	Cirencester	QATR	1295
17/1	Groupware and Office Systems Development 2	3	Milton Keynes	UNIS	985
17/1	Lotus Notes Application Development II	3	City	PRIN	885
18/1	Lotus Notes Systems Administration II	2	Hammersmith	PRIN	590
22/1	Lotus Notes Application Development II	3	Hammersmith	PRIN	885
22/1	Implementing MS Mail	5	City	PRIN	1475
23/1	Lotus Notes Basic Concepts	1	City	PRIN	295
24/1	Lotus Notes Technical User	1	City	PRIN	295
25/1	Lotus Notes ViP	2	City	PRIN	590
29/1	Lotus Notes Systems Administration I	3	City	PRIN	885
29/1	Supporting Microsoft Exchange	5	Cirencester	QATR	1395
31/1	Design and Development of Workflow Systems	3	London	QATR	995
1/2	Lotus Notes Basic Concepts	1	Hammersmith	PRIN	295
5/2	Lotus Notes ViP	2	Hammersmith	PRIN	590
5/2	Groupware and Office Systems System Admin 1	3	Milton Keynes	UNIS	985
5/2	Supporting MS Excel	3	Hammersmith	PRIN	885
5/2	Implementing MS Mail	5	Hammersmith	PRIN	1475
7/2	Lotus Notes Application Development I	2	Hammersmith	PRIN	590
12/2	Lotus Notes Systems Administration I	3	Hammersmith	PRIN	885

12/2	Supporting MS Word	4	Hammersmith	PRIN	1180
19/2	Lotus Notes Systems Administration II	2	City	PRIN	590
19/2	Supporting MS Excel	3	City	PRIN	885
19/2	Implementing MS Mail	5	City	PRIN	1475
21/2	Lotus Notes ViP	2	City	PRIN	590
22/2	Lotus Notes Basic Concepts	1	City	PRIN	295
23/2	Lotus Notes Technical User	1	City	PRIN	295
26/2	Lotus Notes Application Development II	3	City	PRIN	885
26/2	Supporting MS Word	4	City	PRIN	1180
27/2	Lotus Notes Systems Administration I	3	City	PRIN	885
4/3	Groupware and Office Systems System Admin 2	2	Milton Keynes	UNIS	660
6/3	Groupware and Office Systems Development 2	3	Milton Keynes	UNIS	985
11/3	Supporting Microsoft Exchange	5	London	QATR	1395
27/3	Groupware and Office Systems Basic Concepts	1	Milton Keynes	UNIS	330
28/3	Groupware and Office Systems Technical User	1	Milton Keynes	UNIS	330
30/4	Programming in Lotus Notes Version 4	4	London	QATR	1295
10/6	Supporting Microsoft Exchange	5	London	QATR	1395
12/6	Design and Development of Workflow Systems	3	Cirencester	QATR	995
25/6	Programming in Lotus Notes Version 4	4	London	QATR	1295

GUI development

Date	Title	Days	Location	Company	Cost£
TBA	Designing a Graphical User Interface	2	London	INFM	650
TBA	Designing a Graphical User Interface	2	London	INFM	650
8/1	Win32 Programming for Microsoft Windows 95	5	Cirencester	QATR	1345
15/1	GUI Design Fundamentals	2	Milton Keynes	PLAT	950
22/1	Application Development using MS Excel using VBA	5	City	PRIN	1475
12/2	Application Development using MS Excel using VBA	5	Hammersmith	PRIN	1475
4/3	Windows OLE 2 System Programming	5	Cirencester	QATR	1475
18/3	Win32 Programming for Microsoft Windows NT	5	London	QATR	1345
25/3	Win32 Programming for Microsoft Windows 95	5	London	QATR	1345
1/4	GUI Design Fundamentals	2	Milton Keynes	PLAT	590
3/6	GUI Design Fundamentals	2	Milton Keynes	PLAT	590
3/6	Windows OLE 2 System Programming	5	Cirencester	QATR	1475
3/6	Win32 Programming for Microsoft Windows NT	5	Cirencester	QATR	1345
17/6	Win32 Programming for Microsoft Windows 95	5	Cirencester	QATR	1345

Internet

Date	Title	Days	Location	Company	Cost£
8/2	Using the Internet Effectively	2	London	INFM	650
13/2	Doing Business on Internet	1	Milton Keynes	UNIS	295
1/3	Internet TCP/IP Fundamentals	2	Milton Keynes	UNIS	595
7/3	Hands-on Guide to Internet	2	Milton Keynes	UNIS	595
13/3	Connecting your Business to Internet	2	Milton Keynes	UNIS	695
28/3	Using the Internet Effectively	2	London	INFM	650
16/5	Using the Internet Effectively	2	London	INFM	650

Languages

Date	Title	Days	Location	Company	Cost£
TBA	Foundation course in C++	3	Market Harb.	KIBW	650
TBA	C++ and object-orientation	5	Market Harb.	KIBW	1050
TBA	The Kibw Delphi Course	5	Market Harb.	KIBW	1100
TBA	Delphi client/server application development	5	Market Harb.	KIBW	1025
2/1	Introduction to Programming in Visual Basic	3	Hammersmith	PRIN	885
8/1	Programming in Microsoft C++	5	Hammersmith	PRIN	1475
8/1	C++ and object-orientation	5	Market Harb.	KIBW	1050
8/1	Introduction to C++ and OOP	5	Milton Keynes	UNIS	1360
9/1	Visual Basic	4	London	INFM	1125
16/1	C++ Programming	4	Cirencester	QATR	1075
17/1	Introduction to Programming in Visual Basic	3	City	PRIN	885
22/1	Developing Applications in Word Basic	3	Milton Keynes	UNIS	760
22/1	Programming in Microsoft C++	5	City	PRIN	1475
22/1	Programming in Visual Basic	5	City	PRIN	1475
22/1	The Kibw Delphi Course	5	Market Harb.	KIBW	1100
23/1	C Programming	4	London	INFM	1035
24/1	Advanced Visual Basic	3	London	INFM	850
30/1	C++ Programming	4	London	INFM	1125
5/2	Delphi client/server application development	5	Market Harb.	KIBW	1025
5/2	Programming in Microsoft C++	5	Hammersmith	PRIN	1475
7/2	Introduction to Visual Basic	3	Milton Keynes	UNIS	760
7/2	Introduction to Programming in Visual Basic	3	Hammersmith	PRIN	885
12/2	Programming in Visual Basic	5	Hammersmith	PRIN	1475
12/2	C Programming Fundamentals	5	Milton Keynes	PLAT	995

13/2	Advanced C++	4	London	INFM	1125
13/2	Visual Basic	4	London	INFM	1125
19/2	Programming in Microsoft C++	5	City	PRIN	1475
19/2	C++ and object-orientation	5	Market Harb.	KIBW	1050
20/2	C Programming	4	London	INFM	1035
21/2	Introduction to Programming in Visual Basic	3	City	PRIN	885
26/2	Visual Basic Fundamentals	4	Milton Keynes	PLAT	950
26/2	Programming in Visual Basic	5	City	PRIN	1475
27/2	C++ Programming	4	London	INFM	1125
4/3	The Kibw Delphi Course	5	Market Harb.	KIBW	1100
11/3	C++ Programming Fundamentals	5	Milton Keynes	PLAT	995
13/3	Advanced Visual Basic	3	London	INFM	850
18/3	Programming in Visual Basic	5	Milton Keynes	UNIS	1195
19/3	Visual Basic	4	London	INFM	1125
19/3	Advanced C++	4	London	INFM	1125
19/3	C Programming	4	London	INFM	1035
19/3	C++ Programming	4	Ascot	QATR	1075
25/3	Visual Basic Advanced Techniques	4	Milton Keynes	PLAT	950
26/3	Developing Applications in Excel Basic	4	Milton Keynes	UNIS	965
26/3	C++ Programming	4	London	INFM	1125
15/4	C Programming Advanced Techniques	5	Milton Keynes	PLAT	995
22/4	Visual Basic Fundamentals	4	Milton Keynes	PLAT	950
8/5	Advanced Visual Basic	3	London	INFM	850
13/5	C++ Programming Fundamentals	5	Milton Keynes	PLAT	995
14/5	Advanced C++	4	London	INFM	1125
10/6	C Programming Fundamentals	5	Milton Keynes	PLAT	995
11/6	C++ Programming	4	Edinburgh	QATR	1075
24/6	Visual Basic Fundamentals	4	Milton Keynes	PLAT	950

Management

Date	Title	Days	Location	Company	Cost£
29/1	Personnel Management	1	London	INFM	295
25/3	Personnel Management	1	London	INFM	295
13/5	Personnel Management	1	London	INFM	295

NetWare

Date	Title	Days	Location	Company	Cost£
TBA	Netware 3.12 System Administration	3	London	INFM	850
TBA	Netware 3.12 System Administration	3	London	INFM	850
TBA	Netware 3.12 System Administration	3	London	INFM	850
15/1	Netware Service & Support	5	Edinburgh	QATR	1695
23/1	Netware 3/x Administration	4	Cirencester	QATR	1315
13/2	Netware 4.02 System Administration	4	London	INFM	1095
25/3	Netware Service & Support	5	Ascot	QATR	1695
9/4	Netware 4.02 System Administration	4	London	INFM	1095
22/4	Netware 4/x Installation and Configuration Workshop	2	Ascot	QATR	765
21/5	Netware 4.02 System Administration	4	London	INFM	1095
5/6	Netware Service & Support	5	London	QATR	1695
18/6	Netware 3/x Administration	4	Ascot	QATR	1315
27/6	Netware 4/x Installation and Configuration Workshop	2	Edinburgh	QATR	765

Networks

Date	Title	Days	Location	Company	Cost£
TBA	Netware 4.1 Advanced Administration	3	Milton Keynes	UNIS	985
TBA	Networks & Communication Concepts	3	Milton Keynes	UNIS	555
2/1	Internetworking MS TCP/IP on MS Windows NT	4	Hammersmith	PRIN	1180
3/1	Supporting MS SNA Server	3	Hammersmith	PRIN	885
6/1	Netware 4.1 Installation & Configuration	2	Milton Keynes	UNIS	655
8/1	Supporting MS Windows for Workgroups	3	Hammersmith	PRIN	885
16/1	Internetworking MS TCP/IP on MS Windows NT	4	City	PRIN	1180
17/1	Supporting MS SNA Server	3	City	PRIN	885
29/1	Netware 3.1x to 4.1 Update	3	Milton Keynes	UNIS	985
1/2	Netware 4.1 Installation & Configuration	2	Milton Keynes	UNIS	655
5/2	Supporting MS SNA Server	3	Hammersmith	PRIN	885
5/2	Supporting MS Windows for Workgroups	3	Hammersmith	PRIN	885
6/2	TCP/IP & Data Communication	4	London	INFM	1125
13/2	Internetworking MS TCP/IP on MS Windows NT	4	Hammersmith	PRIN	1180
19/2	Supporting MS Windows for Workgroups	3	City	PRIN	885
20/2	TCP/IP for Windows NT 3.5	4	Milton Keynes	UNIS	1095
20/2	Internetworking with Microsoft TCP/IP using Micros	4	London	QATR	1195
20/2	Netware 4.1 System Administration	4	Milton Keynes	UNIS	1310
21/2	Supporting Microsoft Windows for Workgroups	3	Cirencester	QATR	995
21/2	Supporting MS SNA Server	3	City	PRIN	885
26/2	Internetworking MS TCP/IP on MS Windows NT	4	City	PRIN	1180
18/3	Netware 3.1x to 4.1 Update	3	Milton Keynes	UNIS	985
21/3	Netware 4.1 Installation & Configuration	2	Milton Keynes	UNIS	655
26/3	Netware 4.1 System Administration	4	Milton Keynes	UNIS	1310
23/4	Internetworking with Microsoft TCP/IP using Micros	4	Ascot	QATR	1195
24/4	Building a Secure Internet	3	Cirencester	QATR	995
7/5	TCP/IP & Data Communication	4	London	INFM	1125
29/5	Supporting Microsoft Windows for Workgroups	3	Cirencester	QATR	995
29/5	Building a Secure Internet	3	London	QATR	995

Object-Oriented Technology

Date	Title	Days	Location	Company	Cost£
TBA	C++ and object-orientation	5	Market Harb.	KIBW	1050
TBA	Delphi client/server application development	5	Market Harb.	KIBW	1025
TBA	The Kibw Delphi Course	5	Market Harb.	KIBW	1100
8/1	C++ and object-orientation	5	Market Harb.	KIBW	1050
15/1	Object-Oriented Analysis & Design	5	Birmingham	LTRE	1565
22/1	The Kibw Delphi Course	5	Market Harb.	KIBW	1100
29/1	Detailed Design Using Rumbaugh's OMT	3	London	QATR	995
29/1	Object-Oriented Analysis & Design	5	London	LTRE	1565
1/2	Object-Oriented Project Management	2	London	QATR	630
5/2	Delphi client/server application development	5	Market Harb.	KIBW	1025
6/2	OO Systems Analysis & Design	4	London	INFM	1125
6/2	Prog. MS Visual C++/ Foundation Classes	4	London	INFM	1125
19/2	C++ and object-orientation	5	Market Harb.	KIBW	1050
20/2	Advanced Object Orientation	4	London	INFM	1125
26/2	Object-Oriented Analysis & Design	5	London	LTRE	1565
4/3	The Kibw Delphi Course	5	Market Harb.	KIBW	1100
19/3	OO Systems Analysis & Design	4	London	INFM	1125
25/3	Object-Oriented Analysis & Design	5	London	LTRE	1565
16/4	Advanced Object Orientation	4	London	INFM	1125
23/4	Prog. MS Visual C++/ Foundation Classes	4	London	INFM	1125
2/5	Object-Oriented Project Management	2	London	QATR	630
7/5	OO Systems Analysis & Design	4	London	INFM	1125
28/5	Advanced Object Orientation	4	London	INFM	1125
11/6	Prog. MS Visual C++/ Foundation Classes	4	London	INFM	1125
12/6	Detailed Design Using Rumbaugh's OMT	3	Cirencester	QATR	995

OS/2

Date	Title	Days	Location	Company	Cost£
15/1	OS/2 Presentation Manager Programming	5	Cirencester	QATR	1345
20/5	OS/2 Presentation Manager Programming	5	London	QATR	1345
10/6	Introduction to OS/2 Warp	1	Cirencester	QATR	255

PC support

Date	Title	Days	Location	Company	Cost£
17/1	Compaq Technical Certification for Servers	3	Ascot	QATR	750
29/1	PC Tech. with Maintenance & Debugging	5	London	INFM	1400
12/2	Advanced PC Tech	5	London	INFM	1400
4/3	PC Tech. with Maintenance & Debugging	5	London	INFM	1400
13/3	Compaq Technical Certification for Servers	3	Ascot	QATR	750
15/4	Advanced PC Tech	5	London	INFM	1400
22/4	PC Tech. with Maintenance & Debugging	5	London	INFM	1400
20/5	Advanced PC Tech	5	London	INFM	1400
26/6	Compaq Technical Certification for Servers	3	Ascot	QATR	750

Project Management

Date	Title	Days	Location	Company	Cost£
8/1	Software Project Planning and Management	4	London	LTRE	1335
8/1	Specifying & Managing Software Requirements	4	London	LTRE	1335
22/1	Identifying & Confirming User Requirements	4	London	LTRE	1335
22/1	Software Configuration Management	4	London	LTRE	1335
30/1	Project Management A Goal Oriented Approach	4	London	INFM	1125
12/2	Software Project Planning and Management	4	London	LTRE	1335
19/2	Identifying & Confirming User Requirements	4	Edinburgh	LTRE	1335
4/3	Identifying & Confirming User Requirements	4	London	LTRE	1335
4/3	Specifying &Managing Software Requirements	4	London	LTRE	1335

18/3	Software Configuration Management	4	London	LTRE	1335
26/3	Project Management A Goal Oriented Approach	4	London	INFM	1125
26/3	Software Project Planning and Management	4	London	LTRE	1295
14/5	Project Management A Goal Oriented Approach	4	London	INFM	1125

Quality Assurance

Date	Title	Days	Location	Company	Cost£
8/1	Software Quality Assurance	4	London	LTRE	1335
19/2	Software Quality Assurance	4	London	LTRE	1335
8/4	Software Quality Assurance	4	London	LTRE	1335

Systems Analysis

Date	Title	Days	Location	Company	Cost£
5/2	Software Systems Analysis & Design:Methods&Tools	4	London	LTRE	1295
26/2	Software Systems Analysis & Design:Methods&Tools	4	Edinburgh	LTRE	1525
25/3	Software Systems Analysis & Design:Methods&Tools	4	London	LTRE	1525

Systems Management

Date	Title	Days	Location	Company	Cost£
15/1	Supporting MS Systems Management Server	5	City	PRIN	1475
5/2	Supporting Systems Management Server	5	Milton Keynes	UNIS	1195
12/2	Supporting MS Systems Management Server	5	Hammersmith	PRIN	1475
26/2	Supporting MS Systems Management Server	5	City	PRIN	1475

Testing

Date	Title	Days	Location	Company	Cost£
1/1	Practical Software Testing Methods	4	London	LTRE	1335
12/2	Practical Software Testing Methods	4	London	LTRE	1335
25/3	Practical Software Testing Methods	4	London	LTRE	1335

UNIX

Date	Title	Days	Location	Company	Cost£
TBA	UnixWare OS Fundamentals	2	Milton Keynes	UNIS	695
TBA	UnixWare Advanced Administration	2	Milton Keynes	UNIS	695
TBA	UnixWare Installation & Configuration	2	Milton Keynes	UNIS	695
TBA	UnixWare System Administration	3	Milton Keynes	UNIS	985
8/1	Introduction to UNIX Part 1	3	Milton Keynes	UNIS	555
8/1	C++ and object-orientation	5	Market Harb.	KIBW	1050
17/1	UNIX Fundamentals	3	Milton Keynes	PLAT	675
30/1	Introduction to UNIX	4	London	INFM	1035
31/1	Korn Shell Programming	3	Milton Keynes	PLAT	675
5/2	SVR4 Administration Fundamentals	2	Milton Keynes	UNIS	370
7/2	Introduction to UNIX Part 2	2	Milton Keynes	UNIS	370
12/2	SVR4 System Administration	5	Milton Keynes	UNIS	1200
12/2	OSF/Motif Programming	5	London	QATR	1295
19/2	UNIX Fundamentals	3	Milton Keynes	PLAT	675
19/2	Shell for Administrators	3	Milton Keynes	UNIS	555
19/2	C++ and object-orientation	5	Market Harb.	KIBW	1050
4/3	Introduction to UNIX Part 1	3	Milton Keynes	UNIS	555
6/3	UNIX Fundamentals	3	Milton Keynes	PLAT	675
12/3	Introduction to UNIX	4	London	INFM	1035
26/3	Effective Use of the Shell	4	London	QATR	1045
23/4	Introduction to UNIX	4	London	INFM	1035
1/5	UNIX Fundamentals	3	Milton Keynes	PLAT	675
7/5	Korn Shell Programming	3	Milton Keynes	PLAT	675
21/5	Effective Use of the Shell	4	Cirencester	QATR	1045
17/6	OSF/Motif Programming	5	London	QATR	1295

Windows

Date	Title	Days	Location	Company	Cost£
TBA	Programming Window NT/95/3.11 Interface	4	London	INFM	1125
TBA	Window NT/95 Systems Programming	4	London	INFM	1125
9/1	Windows 95 The Operating System	4	London	INFM	1125
17/1	Windows Systems Management & Optimisation	3	London	INFM	850
24/1	Advanced Windows 95	3	London	INFM	850
26/1	Introduction to Windows 95	1	Milton Keynes	UNIS	295
30/1	Programming Window NT/95/3.11 Interface	4	London	INFM	1125
5/2	Introduction to Windows 95	1	Milton Keynes	UNIS	295
6/2	Windows 95 The Operating System	4	London	INFM	1125
13/2	Window NT 3.5X The Operating System	4	London	INFM	1125
13/2	Window NT/95 Systems Programming	4	London	INFM	1125
1/3	Introduction to Windows 95	1	Milton Keynes	UNIS	295
5/3	Windows 95 The Operating System	4	London	INFM	1125
12/3	Programming Window NT/95/3.11 Interface	4	London	INFM	1125
15/3	Introduction to Windows 95	1	Milton Keynes	UNIS	295
20/3	Advanced Windows 95	3	London	INFM	850
26/3	Window NT/95 Systems Programming	4	London	INFM	1125
26/3	Window NT 3.5X The Operating System	4	London	INFM	1125
2/4	Advanced Windows 95	3	London	INFM	850
2/4	Windows Systems Management & Optimisation	3	London	INFM	850
7/5	Window NT 3.5X The Operating System	4	London	INFM	1125
28/5	Windows Systems Management & Optimisation	3	London	INFM	850

Windows and Windows NT Support

Date	Title	Days	Location	Company	Cost£
TBA	The Kibw Delphi Course	5	Market Harb.	KIBW	1100
TBA	Delphi client/server application development	5	Market Harb.	KIBW	1025
22/1	The Kibw Delphi Course	5	Market Harb.	KIBW	1100
4/3	The Kibw Delphi Course	5	Market Harb.	KIBW	1100

Windows NT Server

Date	Title	Days	Location	Company	Cost£
8/1	Supporting MS Windows NT Server	5	Hammersmith	PRIN	1475
15/1	Supporting NT Server 3.5	5	Milton Keynes	UNIS	1195
18/1	Windows NT Management Overview	1	Milton Keynes	UNIS	330
19/1	Windows NT Security	1	Milton Keynes	UNIS	330
22/1	Supporting MS Windows NT Server	5	City	PRIN	1475
30/1	Windows NT Server 3.5X Adminiatrator	4	London	INFM	1125
19/2	Supporting NT Server 3.5	5	Milton Keynes	UNIS	1195
19/2	Supporting MS Windows NT Server	5	City	PRIN	1475
20/2	Advanced Window NT Server 3.5X	4	London	INFM	1125
12/3	Windows NT Server 3.5X Adminiatrator	4	London	INFM	1125
18/3	Supporting NT Server 3.5	5	Milton Keynes	UNIS	1195
16/4	Windows NT Server 3.5X Adminiatrator	4	London	INFM	1125
23/4	Advanced Window NT Server 3.5X	4	London	INFM	1125
18/6	Advanced Window NT Server 3.5X	4	London	INFM	1125

Windows support

Date	Title	Days	Location	Company	Cost£
8/1	Support Fundamentals for MS Windows NT	3	Hammersmith	PRIN	885
8/1	Support Fundamentals for Windows NT 3.5	3	Milton Keynes	UNIS	995
10/1	Supporting NT Workstation 3.5	2	Milton Keynes	UNIS	665
11/1	Supporting MS Windows NT Workstation	2	Hammersmith	PRIN	590
15/1	Supporting MS Windows 95	5	Hammersmith	PRIN	1475
15/1	MS Windows 3.1 & MS DOS for Support Prof's	5	Hammersmith	PRIN	1475
22/1	Support Fundamentals/MS Windows NT	3	City	PRIN	885
25/1	Supporting MS Windows NT Workstation	2	City	PRIN	590
29/1	Supporting Windows 95	5	Milton Keynes	UNIS	1195
5/2	Supporting MS Windows 95	5	Hammersmith	PRIN	1475
12/2	Support Fundamentals for Windows NT 3.5	3	Milton Keynes	UNIS	995
12/2	Support Fundamentals for MS Windows NT	3	Hammersmith	PRIN	885
12/2	MS Windows 3.1 & MS DOS for Support Prof's	5	Hammersmith	PRIN	1475
14/2	Supporting NT Workstation 3.5	2	Milton Keynes	UNIS	665
14/2	Supporting MS Word	3	Milton Keynes	UNIS	760
15/2	Supporting MS Windows NT Workstation	2	Hammersmith	PRIN	590
19/2	Supporting MS Windows 95	5	City	PRIN	1475
20/2	Supporting Windows 95	4	London	QATR	1095
26/2	Support Fundamentals for MS Windows NT	3	City	PRIN	885
26/2	Supporting Windows 95	5	Milton Keynes	UNIS	1195
29/2	MS Windows 3.1 & MS DOS for Support Prof's	5	City	PRIN	1475
4/3	Supporting MS Excel	3	Milton Keynes	UNIS	760
11/3	Support Fundamentals for Windows NT 3.5	3	Milton Keynes	UNIS	995
13/3	Supporting NT Workstation 3.5	2	Milton Keynes	UNIS	665
25/3	Supporting Windows 95	5	Milton Keynes	UNIS	1195
29/3	Supporting MS Windows NT Workstation	2	City	PRIN	590
1/4	Supporting Windows 95	4	Edinburgh	QATR	1095
6/11	Supporting MS Word	3	Milton Keynes	UNIS	760

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WEB BARGAINS

As each day passes and more players join in, it's getting more difficult to get onto the Web and be commercially successful. You need an edge. This month's selection of books will help to give you the expertise you need to keep one step ahead of the pack.

Internet World 60 Minute Guide to VRML

by Sebastian Hassinger and Mike Erwin

218 pages

Normal Price: £18.99

Price to You: £14.25

Are your Web pages old hat? Virtual Reality Modeling Language (VRML) is the next dimension in Web interface design. This book teaches you how to use this new Web publishing language in easy-to-follow 60-minute bites. Get to understand VRML basics and then zoom in on structure, syntax, concepts etc. Explore the VRML run-time environment and discover the power that VRML brings to the Web, including interactive 3-D, fully hyperlinked scenes and objects. Check out cool VRML sites using the authors' expert guidance and URL roadmap.

World Wide Web SECRETS

by Paul J Perry

710 pages

Normal Price: £38.99

Price to You: £29.25

No stone is left unturned in this book that explores the vast opportunities of the Web. Sony Electronic Publishing engineer Paul Perry takes you on a personal tour of the World Wide Web, demonstrating the best and fastest Web connection software & data retrieval tools, the easiest to use HTML editors and browsers, expert design tips and techniques. You'll find everything you need to know, from selecting your own Web hardware and software to designing exciting and inviting Web pages that will attract customers. Why make mistakes? The most common pitfalls to avoid are all here too. Includes CD-ROM containing a selection of Web access and server software, HTML editors & templates, sound & video editors and more...

Internet World 60 Minute Guide to Java

by Ed Tittel and Mark Gaither

253 pages

Normal Price: £18.99

Price to You: £14.25

What's this Java everyone's talking about? Well, it's a high-powered, object-oriented and architecture-neutral language that enables you to build Web pages that execute distributed code across 'Net platforms — securely. And this book will tell you all about it: how to write, compile and run stand-alone Java apps; the relationship between the Java language and the HotJava Web browser; what Java brings to the Web - embedded systems, new data types and protocols, animation, 'chat' capabilities; how to write a Java applet and add it to your HTML document; and more.

Information supplied by the publishers.

Selection	*RRP*	*Your Price*
Internet World 60 Minute Guide to VRML	*£18.99*	*£14.25*
World Wide Web SECRETS	*£38.99*	*£29.25*
Internet World 60 Minute Guide to Java	*£18.99*	*£14.25*

Descriptions of all books below can be found in EXE Magazine, Feb to Dec.

Selection	*RRP*	*Your Price*
Windows 95 Secrets	£38.99	£29.25
Power PC Programming for Intel Programmer	£48.99	£36.75
Foundations of Visual C++ Progr for Windows 95	£38.99	£29.95
201 Principles of Software Development	£20.95	£16.80
Oracle: The Complete Reference, Third Edition	£25.95	£20.80
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Visual FoxPro Developer's Guide	£41.67	£31.25
Heavy Metal Visual C++ Programming	£37.99	£28.50
Delphi Programming for Dummies	£18.99	£14.25
5 OLE Wizardry	£28.95	£23.30
C: The Complete Reference	£25.95	£20.80
The Visual C++ Handbook	£25.95	£20.80
Guide to the Best UNIX Tips Ever	£23.95	£19.20

Selection	*RRP*	*Your Price*
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Crucial Competitions

£15 Discount to EXE readers at the ODBC Conference

The ODBC Conference will take place on January 23 at the UK Headquarters of Microsoft (at Winnersh in Berkshire). The Conference has been organised by the ODBC User Group.

The event, which includes a buffet lunch, will cost EXE readers and ODBC User Group members £80. The normal price is £95.

This one-day conference has assembled an international panel of ODBC experts to present the key issues facing the use of ODBC today, and to answer your most pressing questions. It is the first time such an event has been organised in Europe. It provides a unique opportunity to keep abreast of developments in this popular middleware technology.

To reserve a place call the user group on 0181 993 8080, quoting EXE to receive the discounted price.

Summary of topics to be discussed

Introduction - Rob Macdonald, Information Systems Associates Ltd
As Chairman of the ODBC User Group, Rob will set the scene for the day.

ODBC in perspective - Michael Pizzo, Microsoft Inc.
Michael was part of the original ODBC development team at Microsoft. He will talk about why ODBC was conceived, its history, the problems it has aimed to solve, and its future direction.

How tools use ODBC - Vaughan Brant, Access Data Ltd
ODBC is only as good as the tools that drive it. Vaughan will look at the major development tools, with reference to how they interface and perform with ODBC.

OLE/DB - Paul Doleman, Microsoft UK
Paul is Microsoft UK's OLE/DB specialist. He will talk about the forthcoming OLE/DB product and its relationship to ODBC. This presentation will be given under a non-disclosure agreement.

Testing ODBC - John de Longa, Data Aware Ltd
Many people are unaware of the range of tools available for testing ODBC applications, drivers and configurations. John will introduce some of these tools, explain where to find them, and show when and where to use them.

Improving performance with ODBC 2 and ODBC 3 - Ronald Laeremans, Belgium
Ronald's development expertise with ODBC is second to none. He will share his experience with enhancing the performance of ODBC applications, as well as previewing the new features of ODBC 3.

Performance panel
Get your questions on ODBC answered. Your questions will be collected in the morning, considered by the panel throughout the day, and answered in this interactive session.

Free books

Cultural Treasures of the Internet
Even software developers take time out from programming occasionally. If your other interests happen to include reading, art, films or music there is now no reason ever to leave your PC. Using this book and your Internet connection you can explore the cultural treasures of the Internet in the comfort of your own office.

To win a copy send a post card marked 'Culture' to the EXE office to reach us no later than January 31.

Rise of the Robots - The Novel
This novel is based on the ground-breaking computer and video game Rise of the Robots. On fourth millennium T1 Creda, the robots are in revolt. Controlled by the faceless female Supervisor, droids all across the planet break their routines. From high in the sealed Electrocorp tower she issues the ultimate threat. Only Coton, the Service's best Decrypt man, can stop her.

To win a copy send in a post card marked 'Robots' to the usual address to arrive by January 31.

Bundle of books

Three of the most popular books offered as prizes last year have been bundled together. The Whole Internet User's Guide and Catalog has become the Internet user's Bible, covering everything from the basics to the newest developments. There's also a discussion of how to get your own connection to the net, including a greatly expanded list of Internet service providers. Hackers is the classic underground history of the computer age. They understood that the future would be built on the free exchange of information and enriching the world's knowledge of computing by increasing accessibility. Insanely Great is the story of the Apple Macintosh. The book covers everything from its humble beginnings in someone's garage to how the Macintosh came to revolutionise personal computing.

To win this bundle send in a post card to the usual address to reach us by January 31. Please mark your postcard 'Book Bundle'.

Competition winners November 1995

C++ Standard Template Library - Jose Louvet, Salford
Advanced C++ - David Shinkins, Leeds
Totally Twisted Screen Saver - Andrew Simms, Wallingford
WEBSITE - Richard Prosser, Kenilworth
Crossword - Bernadette F Heals, Cirencester

JOB
'C'/UNIX

LOCATION	SALARY
N. Home Counties	£18K -£32K

High Calibre Software Engineers are required by our client, a leader in Open Systems Technology. Suitable candidates will have at least two years 'C' programming experience in a UNIX environment. Knowledge of UNIX operating system development (kernel, utilities), assembler level programming or compiler writing, although not essential, will be highly desirable. Working in a small, dynamic team, you will be involved in the development of new products and the support of existing products by investigating problems and creating solutions.

REF: LC/EXE/1

JOB
C/UNIX/TELECOMMS

LOCATION	SALARY
Cambs	£18K - £25K

Our client is searching for highly professional and committed Software Engineers with a minimum of one years experience of writing 'C' code under Unix. Any experience of C++ and OOD would be advantageous. The ideal candidates will have experience of working in a large, well-structured development environment. There are also opportunities for those Software Engineers with experience of real-time embedded software systems. Successful candidates will be working on leading edge network management systems. There is also the opportunity for limited European travel. REF: DE/EXE/2

JOB
C++ & UNIX/WINDOWS

LOCATION	SALARY
Bucks	£20K - £35K

Seeking experienced C++ and Unix software engineers, our client is a leading supplier of software to the oil and petroleum industry. Working on one of several projects applicants must demonstrate an excellent academic background, preferably in a science based subject and have at least two years experience of developing with C++ under Unix. These are excellent opportunities to join an expanding and successful organisation.

REF: JK/EXE/3

JOB
UNIX SUPPORT SPECIALISTS

LOCATION	SALARY
Surrey / Germany	£Negotiable

Our client, a world-wide supplier of voice processing systems, require two technical support specialists. Successful applicants will join the support team to act as central point of contact for customers, distributors and field engineers requiring technical advice. Based in Northern Germany or Surrey, candidates must have sound knowledge of UNIX, preferably within a telecomms environment and be a German speaker.

REF: JK/EXE/4

JOB
'C'/C++ UNIX DEVELOPER

LOCATION	SALARY
Berks	To £23K

A rapidly new expanding supplier of EIS solutions is now investing in new development products targeted at the UNIX and 32bit Windows platforms. Suitable candidates must be educated to degree level and have in excess of one years 'C' and/or C++ under UNIX (HP-UX or SunOS of added interest). You must also have the creative ability to make a major contribution to the design and shaping of the products and have an understanding of the PC/Windows development environment. Challenging technical work and the opportunity to be part of a highly successful organisation are on offer.

REF: PP/EXE/5

JOB
UNIX/C++ TECHNICAL SUPPORT

LOCATION	SALARY
Surrey	£22K-£30K

Our client is searching for a software engineer with excellent Unix/C++ experience of Motif to work for an international leader in the development of graphical development tools. They need a technical guru to support the sales force in a pre and post sales role, as well as providing technical support to the customer base. Excellent written and oral communication skills are needed for presentations and training. If you would like a technical role with customer liaison; this is ideal!

REF: DE/EXE/6

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PERMANENT OPPORTUNITIES

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The development of PC based applications has increased massively across all business sectors in recent years and this growth is set to continue given exciting developments such as Windows 95 and the continuing links between RDBMS and PC GUI applications.

The increased activity in this sector has resulted in progressive, dynamic organisations requiring staff with a variety of skills for a similarly varied range of roles/responsibilities. Ranging from pure Programmers up to Senior Project Managers (and beyond!) Elan can give suitably qualified professionals windows of opportunity which will provide a challenge and stimulus enabling you to reach your full potential.

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- Windows API
- Multimedia Systems
- Delphi etc.

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For further information please contact:
Paul Jones or Paul Slough on 01442 870 770.
You may also fax your C.V. to the same telephone number at any time, or write with C.V. to this address: Highfield House, 26 Lower Kings Road, Berkhampstead, Hertfordshire HP4 2AB
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£14-£35K + benefits **REF: SC/06/EXE**

UNIX/VMS/WINDOWS 3.1/95/NT MFC/C/C++ **ALL LEVELS**
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£12-£25K + benefits **REF: SC/09/EXE**
VISUAL BASIC SKILLS MUCH IN DEMAND - PLEASE CALL TO DISCUSS **REF: SC/10/EXE**
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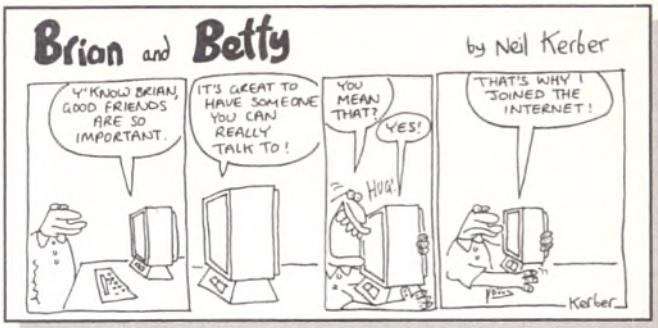


Another first for the Information Superhighway

With an ear constantly to the ground when it comes to important technological developments, Ctrl Brk was pleased to hear that 'the acknowledged leader in thin film barrier technology' has at last launched its own web page. Who?

Durex, of course.

Following Ctrl Brk's swift reporting of Dr Ruth's new seminal publication Sex For Dummies, we felt it only proper to conduct some serious investigation into the subject. Who better to turn to for help than the Durex company?

The site is comprised of five main areas: *Romance*, *The ins and outs of sex* (sic), *Dr Dilemma*, *Com.unique* and *Durexcetera*. Together they offer a plethora of information on everything you could possibly wish to know about your little friend's macintosh.

The 60-year history of the brand plus top romantic stories involving condoms to be found at http://www.durex.com

Five days walking, two days off?

The Solo Antarctica site offers lucky netsurfers the chance to follow Roger Mear's race against Norwegian Borge Ousland to become the first man to cross Antarctica solo and unsupported.

'The race has created intense excitement around the world,' commented Planet marketing director Phil Wade, 'we expect unprecedented levels of interest in the site.' Ctrl Brk is puzzled as to why information on the position of Mear is not available for two days of every week. Does he take his weekends off?

http://www.theplanet.net/soloantarctica/

Local Government Information for Sale

When filling out the electoral roll register recently, Ctrl Brk failed to notice any clause mentioning the fact this information would then be sold to the highest bidder. Presumably Ctrl Brk wasn't looking hard enough as we now discover that GB Mailing Systems Ltd has become the proud owner of the names and addresses of 43 million UK voters based on 'the latest electoral roll'. All of which are being offered to financial institutions, retail companies and emergency services.

Knowing a little of the business of 'list broking' Ctrl Brk is fairly certain that a database of this size would have cost a fair wedge. Of which this is probably just the thin end.

What next? MI5 offering past files to companies who wish to target the security minded? Ctrl Brk would prefer its personal details to be kept as just that.

The bleeding obvious?

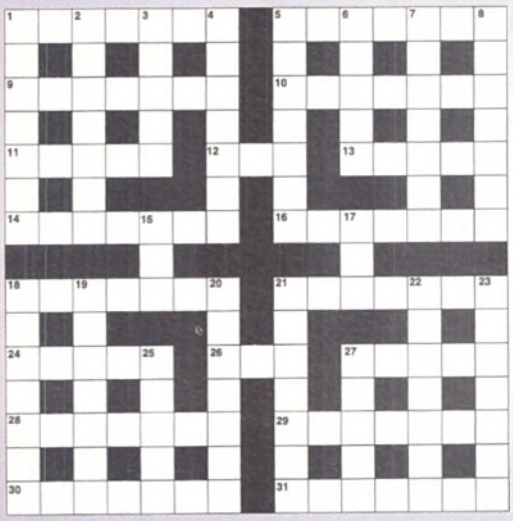
NASA is planning to create 'the Database of the Century', an environmental monitoring effort entitled Earth Observing System Data and Information System. It will eventually grow at a rate of one trillion bytes per day. Its mission? 'To monitor how human behaviour is affecting the Earth's environment.'

Call Ctrl Brk picky if you will, but do we really need that much computing power to calculate that the arrival of *homo sapiens* on the planet was not exactly a red letter-day for the ecosystem?

Big brother is watching you watching us watching you

Novell recently announced plans to become a partner of Stellar One Corporation and integrate Novell's Nested NetWare into Stellar's 1000 range of TVs. Applications will include live video transmission from a camera in the home with remote camera control and remote operation of home systems, including security. Mmm, thought Ctrl Brk – kind of *2001* meets *1984*. Interesting.

PRIZE CROSSWORD



ACROSS

1. What the operator operates on (7)
5. Discs holding data units? (7)
9. Linguistic formula translator (7)
10. Too much on the net means you need lights? (7)
11. What a fool for Amin to return (5)
12. Plan of net or virtual world (3)
13. Real fast language, we suppose (5)
14. To do with human selective breeding (7)
16. They love hurting you! (7)
18. Complete chunk of software (7)
21. Describes the cd-rom and worm principally (7)
24. Such was the barrier between England and Wales (5)
26. Negative logic circuit (3)
27. Wheat used for pastas (5)
28. Magazine - so charming to carry out (7)
29. Most average or "ornery" (7)
30. Retail income (7)
31. Keep an eye on the display (7)

DOWN

1. Separate from the network (7)
2. Getting an income or yield (7)
3. Frightened Shakespeare (5)
4. Lively as ever-changing data (7)
5. Uses the keyboard for data verification (7)
6. 12 of structure of 18 ac (5)
7. Changes the shape of everything, for the better? (7)
8. Whole chunks of disc surface (7)
15. Gate 26 or ... (3)
17. ... unit of matrix printer output (three here) (3)
18. What passwords should do without an Act (7)
19. Quiet time when there's less need to be 1 dn (7)
20. What you get with paying peanuts (7)
21. The best turned pot I follow with mother (7)
22. Physical flow behind all IT (7)
23. Device that prevents overflow (7)
25. Sneeringly reject (5)
27. Output of FET (5)

SOLUTION TO DECEMBER'S CROSSWORD

ACROSS: 1. INTEGER 5. NUMBERS 9. QUIET 10. AUTOMATIC 11. INVERTS 12. ORDERER 13. YES 14. CHECK DIGITS 17. BLINDFOLDED 19. TWO 21. ON TERRA 23. PACKAGE 24. ENROLLING 25. TAFIA 26. NUMERIC 27. SPRUCED

DOWN: 1. INQUIRY 2. THIEVES 3. GET TRACED 4. REALS 5. NETWORKED 6. MIMED 7. ENTER PI 8. SECURES 15. EGOMANIAC 16. INDICATOR 17. BOOLEAN 18. INTERIM 19. TRAFFIC 20. OPERAND 22. RULER 23. PAGES

STOB

The All-New Adventures of Verity

Email & Femail

What criteria should you consider when selecting an electronic mail system? Verity Stob is our well-wired woman.

What are the main types of email?
That depends on whether you work in a large or small organisation. A large organisation will have seven independent email systems: the system that runs on the mainframe, the system that works on the old proprietary mini, the Unix package, the groupware package, the strategic cross-platform package, the freebie that came with the PC operating system and The Solution That The Technical Department Prefers.

And a small organisation?
A small organisation will have nine independent systems: the Windows stuff, the cut-down copy of cc:Mail that Jim picked up for a song at a show two years ago but which won't run on Dave's machine for some reason, the program that does the CIX connection, the freeware that we pulled off the cover disk of *PC Today! Today!* originally written for the Mac by Germans whose knowledge of English and the PC is in question, the program that does the CompuServe connection, the useless bit of freeware that came with the Internet provider's package, the rather better bit of freeware pulled off the Net to replace the former which occasionally ignores a message so we have to revert, and the cut-down copy of Notes that Jim picked up for a song at a show a year ago but which won't run on Christine's machine.

Hold on - you said nine. That's only eight.
There is also The Solution That The Technical Department Prefers.

There you go with this 'solution' business again. What distinguishes it from all the other packages?
TSTTTDP has the ability to append random homilies, sometimes known as 'cookies', to the bottom of each message. Stuff like: 'Thought for the day: A man is as old as he's feeling, A woman as old as she looks - Mortimer Collins'.

Cracking stuff! But why the need for a preferred solution? Surely all these packages can communicate with each other?
I thought you were allowed to go to the bathroom by yourself these days.

Ok, ok - just kidding. Do you have any guidelines, Verity dearest, on what we should be looking for?
The first rule of good email is that it is nothing to do with X.400.

Look, if you are going to burn up column inches stating the bleeding obvious, I still haven't read last week's* Mole *yet.
The second rule is that it must have some mechanism for handling attachments.

This sounds more like it. Double-ewe tee eff are 'attachments' about then?
Attachments allow the user to mail a binary file by 'attaching' it to a message.

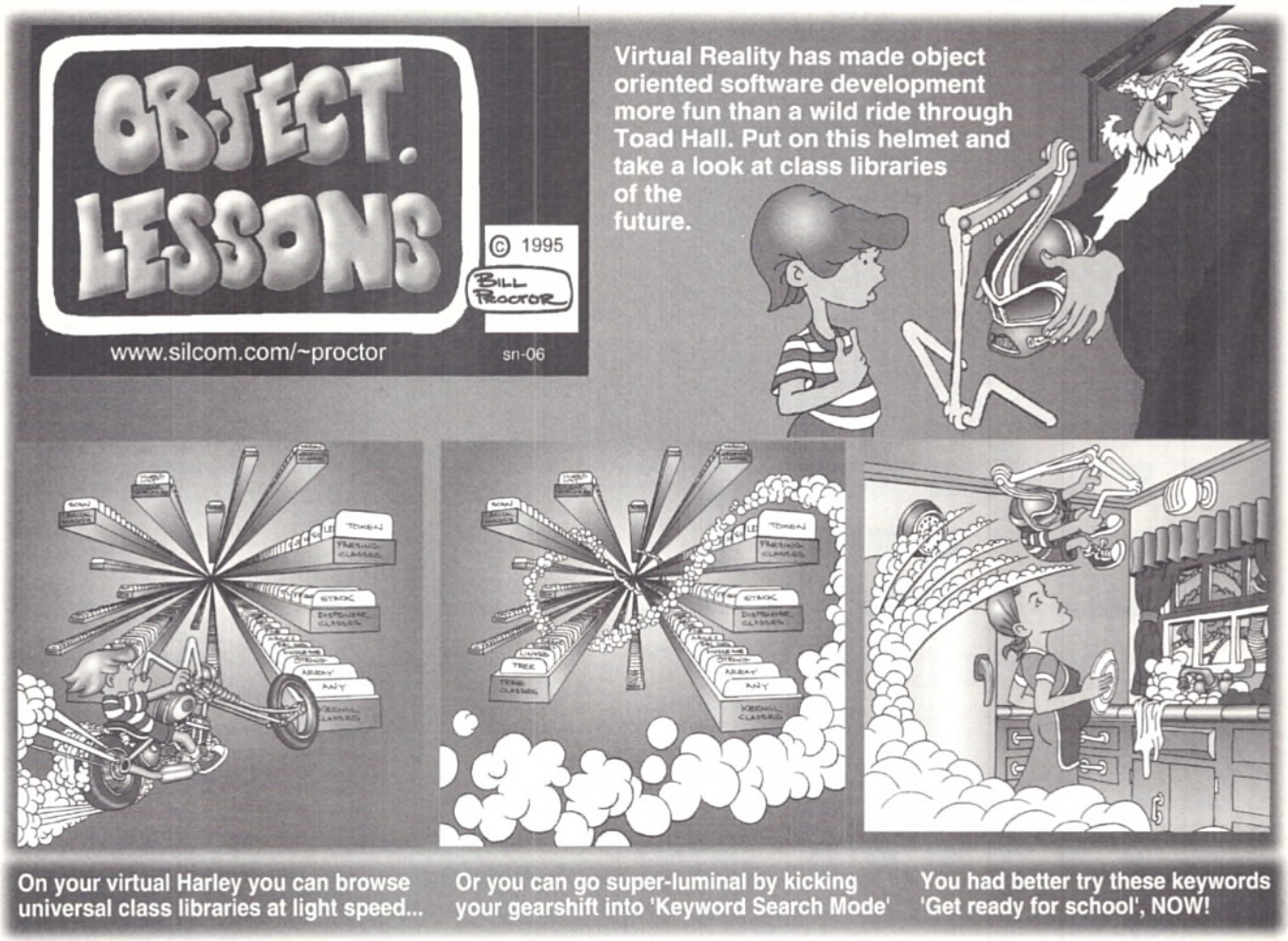
And what, I suppose this allows you to send programs and things wherever you like?
No, it allows you to mailbomb people you hate with successions of huge messages containing complete gibberish and get away with it. An independent expert recently estimated that only one in five uuencoded messages are ever successfully uudecoded, one in eight MIME messages are EMIMed, and that nobody has ever, ever hexbinned anything.

Hmm, that's impressive. Where did you get those statistics from?
I just made them up, silly. The third rule is: the usability of an email system is inversely proportional to the amount of money it costs.

Wow - that's almost good enough to be a cookie!
I can't remember why I thought I liked you.

Two more before you go. What means 'consolidation of email systems'?
It means purchasing another piece of software which interacts with existing email systems in such a way that they all fail in exciting new ways.

And how do you stand on RFC822?
A not unpleasant RFC, although it lacks the power and clear narrative structure of the earlier ARPA document RFC733, which it obsoleted. And there's not enough sex in it.



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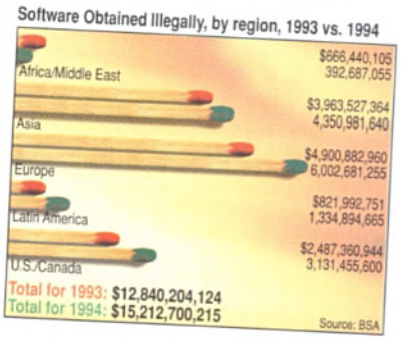

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Ease of Use	8.3	7.2	6.8	6.3
Versatility/Features	10	8.7	8.8	8.6
Compatibility/ Power Consumption	6.7	6.5	6.6	7.4
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Final Score	**8.5**	6.5	7.5	6.6

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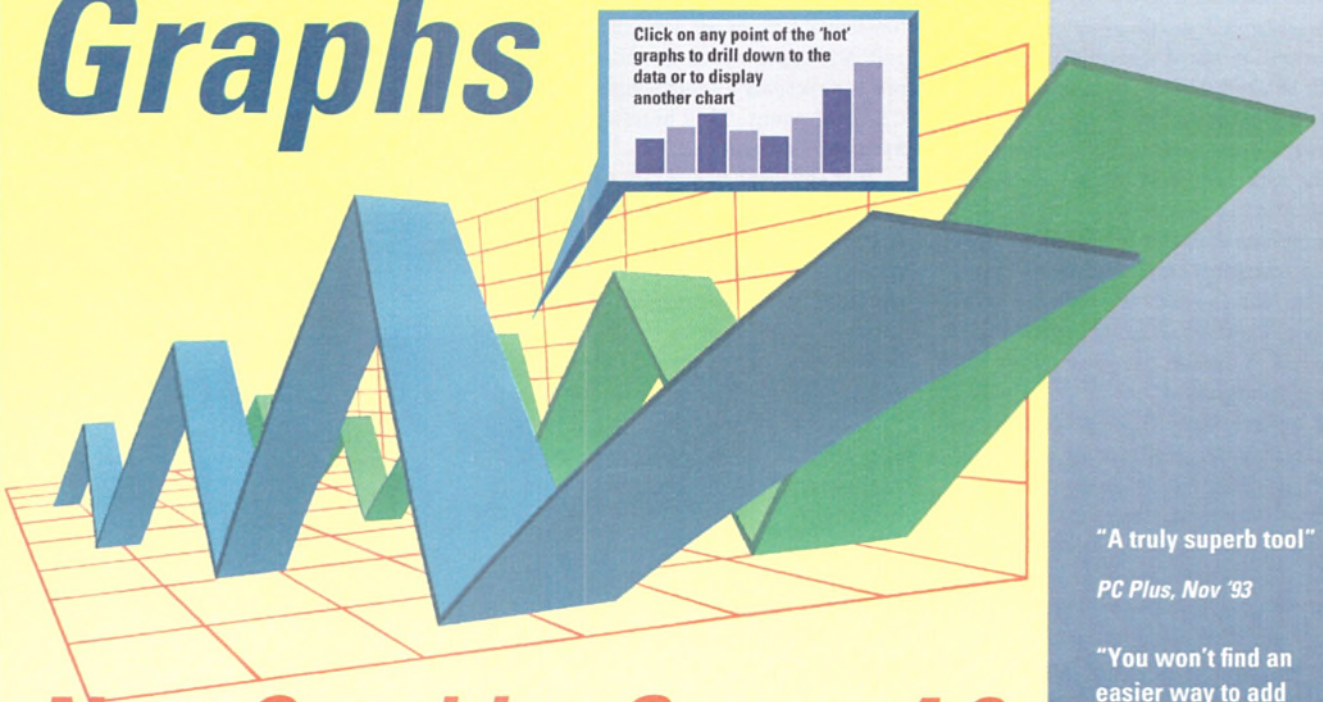

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