THE SOFTWARE DEVELOPERS' MAGAZINE

EXE

SEPTEMBER 1999

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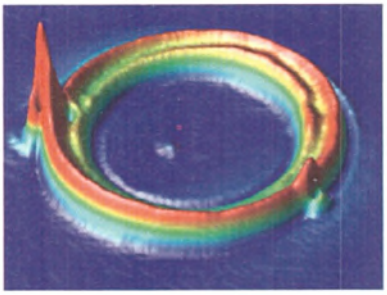

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EXE: The Software Developers' Magazine is independent and not affiliated to any vendor of hardware, software, or services. It is published by: **Centaur Communications Ltd, St Giles House, 50 Poland Street, London W1V 4AX, UK. EXE Tel:** 020 7970 6541 **Fax:** 020 7970 6741 **Advertising email** *advertising@exe.co.uk* **Subscriptions Tel:** 020 7292 3706 **Fax:** 020 7970 4099 **email:** *execirc@centaur.co.uk*. EXE is available by subscription at £35 per annum (12 issues) in the UK: see subs card between pages 2 & 3. The magazine is published around the 1st of the month. To subscribe or if you have a subscription query, please call 020 7292 3706 or write to Gary Markin, EXE (address above). We can invoice your company if an official company order is provided. Back issues £5.00 each, if available. **Editorial.** Address all editorial enquiries and comments to The Editor, EXE (address above) or email to *editorial@exe.co.uk* (press releases by fax or mail only). We welcome letters, opinions, suggestions, and articles from readers. These may be edited. Information contained in EXE is believed to be correct. If errors are found, we will endeavour to publish a clarification in the next issue.

Repro & Typesetting: Atelier Dataset Ltd **Printer:** St Ives (Roche) Ltd. **Front Cover Picture:** PSC Photography **ISSN:**0268-6872

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Best text forward

The power and potential of hypertext seems to be overlooked these days. All the attention paid to the Web and its incorporation of multimedia seems to have eclipsed the possibilities for presenting textual information electronically.

This point came to mind when I bought Scott Meyers' *Effective C++ CD* (Addison-Wesley, ISBN 0-201-31015-5). The CD represents the contents of both his *Effective C++* and *More Effective C++* books, together with some magazine articles. I was impressed. It wasn't just the contents – I was quite familiar with Meyers' work and knew what to expect. Rather, it was the approach taken to the *organisation* of the contents. There are over 2,000 links on the CD: within and between the books, among the books and the articles, and from the books and articles to the Internet. Pure hand-crafted, authorially-intended hyperlinks that help to coordinate information for the reader. Essentially, the CD is a website in its own right – the author has chosen to get his hands dirty with HTML (*Hypertext* Markup Language) to represent his work electronically.

It was clear that with this 'product' – a horrible term, but this isn't just a book – a real effort had been made. The intention was there to present the material in the most meaningful way. The constraints faced would appear to be what was possible via a browser-based interface and the current state of play of HTML itself. (The CD does require at least Navigator 4.0 or IE 4.0). As the author himself repeatedly points out in the introduction, if he could possibly have made it better, he would have. The essential point – and one that reflects the successful use of hyperlinking – is that the final total *is* greater than the sum of the parts.

Navigation of the *Effective C++ CD* is straightforward, and a fine-grain of access is possible because each paragraph on the CD has an associated HTML anchor. With it being possible to integrate the CD with your own HTML documents, you can extend the links of information in your own way. As well as a variety of methods for searching, a neat feature is using an intermediate site to provide logical links to the Internet, helping to prevent the breaking of hard-coded links.

The 85 rules to improve your writing of C++ are chunks of technical information waiting to be interlinked.

Not quite so important, but still acquiring brownie-points, is the configurability available: there are options to control the size of images, diagrams, and files. As much as possible, you are in control of the environment. As Meyers says: 'Call me an anarchist, but when it comes to accessing technical information, I just don't believe that one size fits all. Not one size window, not one size font, not one size image, not one size file.' The simple explanation is redundancy: for example, each diagram is stored five times, one for each size option available.

Of course, the books' original contents suited this organisation. The 85 rules to improve your writing of C++ are chunks of technical information waiting to be interlinked. For instance, having read Item 5, *Be wary of user-defined conversion functions*, which introduces the use of proxy classes, it is natural to jump straight to item 30, *Proxy classes* and its example of implementing two-dimensional arrays. Not all material can be so easily subdivided or lend itself to 'supra-organisation' or the presentation of 'meta-views', call it what you will. But that doesn't mean it was an easy framework to implement – the result was achieved at a cost: significantly, it took Meyers longer to create the CD than the two books combined.

Of course, there are other examples of hyperlinking. From the world of literature, I'd refer you to Geoff Ryman's playful 'Internet novel' *253*, subtitled *Underground theatre* (*http://www.ryman-novel.com*), which coincidentally also caught my eye recently. It's the story of a Bakerloo train heading to Elephant and Castle, where an unpleasant end awaits. With a seating plan for all the carriages, you are able to explore at will the histories and thoughts and feelings of the passengers, and follow the links to uncover the relationships among them. The fact that the first 'life' you can explore is that of the sleepy driver, who has hung his coat on the dead-man's handle, means that the novel is not relying on suspense for its effect. (For those who are curious, but not connected, there is *253: The print remix* ISBN 0006550789.)

I am aware that future developments will inevitably make our current HTML-based technology hopelessly quaint and outdated. Who knows what strange hologrammatic or telekinetic means of absorbing information lie ahead? My point is that right now, with the current state of play, more could be done, and be done better, with the presentation of text. Have we just become complacent? The power of hyperlinks, and the creation of multi-dimensional literature was once regarded as exciting and a new frontier...

Perhaps I am being naive in what latitude publishers will allow their authors, or what resources are available to support the creative organisation of their work. Maybe many authors would like to push at the boundaries of what is possible in presenting their material. Perhaps only big names, such as Scott Meyers, have the clout to exert the necessary control. What I do know is that too often the CD attached to the back cover of the (expensive) technical books we buy remains sealed within its little plastic folder, or if opened, then perused only once. It doesn't have to be so.

I am not suggesting the use of hypertext is applicable in all areas (and it is a moot point whether I would have bought the CD without having handled the books first). But why not experiment and *explore* the possibilities.

As a final note, my initial attempts to get hands on the work failed – a search of local bookshops revealed only its absence. Instead, I bought the CD over the Internet, which somehow seems appropriate. The online bookstore was just another link in the chain of information. ■

Alun Williams

New

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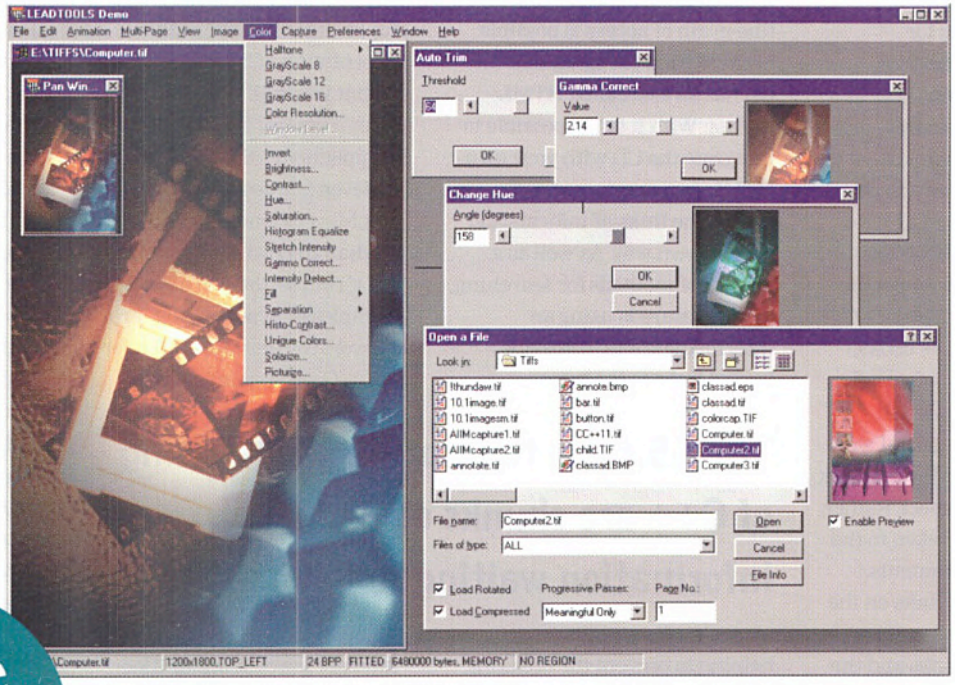

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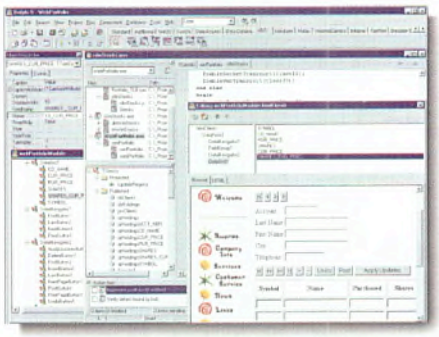
Delphi – now we are five

Delphi 5, the next major release of Borland's Object Pascal-based RAD tool for Windows, is out in three editions: Enterprise, Professional, and Standard. As well as support for HTML 4 and XML, Delphi 5 is targeted at the integration of Windows with browser clients, web servers, middleware, and back-end database systems.

IDE enhancements include a DataModule designer with Tree and Data Diagram Views of application data, the support for project-wide browsing, the use of To-Do lists, and new console application wizards. There is remote debugging for distributed development, whether based on COM or Corba, and multiprocess and cross-process debugging. For serious debugging work with floating point code, an FPU View is provided.

HTML 4 support enables the creation of dynamic thin-clients for the Web, and Internet Express is designed to speed Internet and XML development with the building of web server apps that deliver dynamic data to browser clients. It works by delivering XML data packets that are handled by JavaScript.



For scalable, transaction-based applications, there is Midas 3.

For team development, TeamSource is a new change management tool. It builds on existing versioning engines, such as PVCS, and extends them with a workflow model designed for large distributed teams.

In the realm of database support, ADOExpress is included to provide data access via Microsoft's ADO and OLE DB technology. To support ADO, Delphi 5 includes IE5 as `shell.exe` is required. And InterBase Express is included for applications requiring a low-maintenance, small-footprint relational database. The database engine is not limited to BDE; it can be replaced.

Finally, the Borland Translation Suite allows for the quick internationalisation or localisation of applications.

See *http://www.borland.com/delphi/productinfo/featurelist/* for detailed feature matrices.

The Enterprise edition has an RRP of £1,699, Professional has an RRP of £499, and Standard has an RRP of £69. Upgrades start from £249 for the Professional edition.

w *www.borland.com/delphi*

Three tools for one repository

With the rise of component-based development (CBD) there's a requirement for tools that can store and manage components. This includes interfacing to a number of various systems, interpreting different data formats, and dynamically reflecting changes when they happen, all the while supporting an organisation's development processes. These are the areas addressed by Adaptive Framework, a set of tools for developing and deploying an enterprise-wide repository. As well as managing CBD, version 4.0 sees improved access controls, a (read-only access) Java web client, enhanced support for bulk data exchange, automated process generation, and new features for tasks involved in repository implementation.

The product set comprises Adaptive Workshop, Adaptive Enterprise, and Adaptive Web. Adaptive Workshop enables the following: to build a meta model, integrating with third-party modelling tools; to incorporate data held in the repository in the business processes; to customise user views of information; and to generate automated processes. The Adaptive Enterprise and Adaptive Web products enable the deployment of the Enterprise Repository across the organisation. This involves: automatically reflecting changes made in the underlying repository model; to tailor any presentation and reporting; and to support sharing of information via the Web.

In version 4.0, a new Process Generator component helps users to formalise informal processes and automate new or existing processes. The idea is to help centralise the role of the repository within Enterprise development, rather than it being an afterthought or add-on.

The Adaptive Web component provides new client functionality via a Java applet that can be deployed across intranets.

w *www.adaptive.com/Workshoppage.htm*

Ready for JaCC

The full details are in place for the ACCU and EXE co-organised JaCC (Java and C/C++) conference, to be held at the Oxford Union, September 15 to 18. Speakers include Jim Coplien, Kevlin Henney, Barbara Moo, Andy Koenig, Nigel Warren, and Bertrand Meyer.

Latest news is the addition of two speakers for the initial Platform day. Phil Harman, a Solaris/Performance consultant at Sun, will talk on *Solaris technology*. Simon Horrell, educator for DevelopMentor, will cover *COM as a better C++ and COM+/MTS as a better COM*. Other tracks for the Wednesday comprise: *Trials & Tribulations of Windows development* and *n-tier C++*; *Taking Borland C++ & Corba to Linux*; *Developing for the PalmOS* and *C++ for Palm size PC solutions*; and *Application interoperability and integration*, *Domains and platforms*, and *Real-time Corba*.

Other tracks include C++, OOP, Java, Patterns, Embedded, Games and General Programming.

w *www.exe.co.uk/jacc/* t 0171 9704772

Microsoft has made Windows **NT embedded 4.0** available to OEMs building embedded devices. Version 4.0 sees support for headless operation (no mouse, keyboard, or display), **diskless** operation (users operating from read-only media, such as CDs), and remote management. There is binary compatibility with the Win32 API and NT driver model.
www.microsoft.com/embedded

TrollTech's Qt is a **C++** framework for building **GUIs**. Version 2.0.1 sees support for internationalisation, formatted document display, and UI themes. For Unix/X11 and Windows, it's an OO alternative to the Motif/Xt and MFC libraries. **Qt** forms the basis of the KDE Linux desktop environment. It costs from $1,550.
www.troll.no/announce/qt-201.html

SourceSurf 1.0 is a web-based reporting tool for **Visual SourceSafe**. It allows you to access SourceSafe databases from a **web** browser, enabling you to remotely monitor progress of a project and track cross-referenced symbols. It costs £120 per licence.
www.giant-technologies.com

Borland is inviting developers worldwide to test-drive the beta version of its new developer community **website**. It's intended to provide a forum for communication with the company and access to products and example code (**CodeCentral**).
community.borland.com

For e-commerce, IBM has updated **Net.Commerce** and **Catalog Architect** to V3.2. Continuing the migration of Net.Commerce to the Java environment, its Product Advisor tool uses **JavaServer** Pages and JavaBeans to provide more control of page rendering. The content management tool Catalog Architect V3.2 supports XML.
www.software.ibm.com

Caché 3.1, from InterSystems, is a **post-relational** database and RAD environment. V3.1 sees enhanced SQL and object handling features, simplified database management, Web deployment capabilities, and extended platform support. There is automated synchronisation between **object** and relational views of data. Prices start from £90.
www.intersys.com

MKS has updated its **Unix-Windows** interoperability products: Toolkit 6.2, Toolkit Select 6.2, and **NuTCRACKER** Professional 4.2. **MKS Toolkit** 6.2 sees the introduction of a CShell, there is handling of large files in file and tape utilities, and enhancements to the KornShell.
www.mks.com

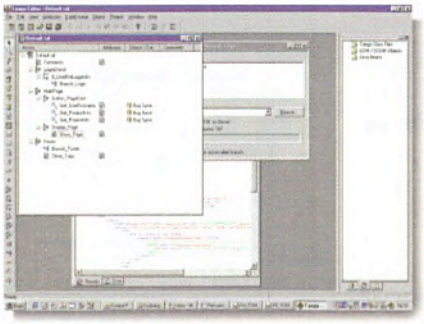
Allegro CL 5.0.1, the Lisp development environment, features performance improvements, support for international character sets, and extended platform support (Linux PPC R4, FreeBSD 3.x, and **Alpha** Windows NT 4.0). It includes the Common **Lisp** Object System (CLOS). Trial Windows and Linux versions are freely available.
www.franz.com

Object Domain 2.5 is a UML **modelling** tool that is implemented in Java for multi-platform use. There are standard ($495) and professional editions ($995), the latter of which adds complete **UML** and multi-user support. V2.5 sees round-trip support for Java, and advanced model searching with regular expression support.
www.objectdomain.com

GD*Pro*, the **UML** modelling tool, is to provide integration with **PVCS** as the result of an alliance between Advanced Software Technologies and Merant. The aim is to provide greater SCM for the versioning of models. For Windows and Unix.
www.pts.com/static/gdpro.html

Tangoing into the new millennium

As we briefly previewed last month, Tango 2000 is the latest version of Pervasive's system for designing, building, and testing database-driven web applications. A new visual development environment includes COM object and JavaBeans support, for dragging and dropping functionality from outside the Tango development environment (such as business-specific code) directly into application files. Other features include the use of Tango Class Files, the Tango Web Analyser suite of components, and an implementation of XML. Included with Tango 2000 is a copy of the Pervasive.SQL database.



For the visual development environment, Tango doesn't use individual pages with embedded logic. Instead, it's designed to visualise business logic and it associates this with the pages generated dynamically by a Tango Application Server. The process of defining the business logic is to drag and drop actions that encapsulate discrete interaction with back-end systems. User Defined Tags allow you to extend Tango's built-in meta tags by referencing logic defined in JavaScript or supported object types.

Tango Class Files allow you to save Tango Code as objects for reuse. They are made available through an Object tab – just like other object types, such as COM and JavaBeans – ready for dragging and dropping into Application Files.

The Tango Web Analyser is a suite of Tango components that allows real-time monitoring of website activity. All collected data is stored in a SQL database for hourly, daily, weekly, and monthly reporting and analysis. A set of provided Tango Class Files lets you integrate information collected via Tango Web Analyser into web applications.

Finally, there is the support for XML: it can be treated as a data type for manipulation of structured data, providing a standard mechanism for communication. In fact, Tango Application Files are saved in an XML format, which means you can edit or create them outside the Tango environment.
w www.pervasive.com

Visualising Computer Associates

In a keynote at CA World, Charles Wang restated his vision that the software Computer Associates produces must 'run a heterogeneous model that looks as if it is one system' (ie have no bias towards any one platform or OS). For example, this year's conference saw the introduction of the TNG Enterprise management solution for Linux, as well as versions for Linux of Master/*T* web server management software and the Ingres II RDBMS. Another raft of announcements concerned the 'e-nfrastructure' to support e-business, these included the eTrust security solution.

The conference saw a big push on neugents, the predictive neural agent technology introduced last year in Unicenter TND. It has found its way into most of CA's products. There are two types of neugents: unstructured ones, based on patterns and genetic algorithm searches, and structured ones, based on iterative processes and neural networks. Neugents have been applied to Windows NT, Unix, and OS/390 to predict when systems will go down. For NT, neugents monitor as many as 1,200 parameters to predict future events. Neugents have also been integrated in Jasmine TND (which includes the Jasmine OO database, a modeller, a builder, and Jasmine Publisher) where they offer prediction by values and by patterns (especially helpful in e-commerce packages).

For the future, Wang sees both bandwidth and computing power becoming commodities. He forecasts personalised 3D interfaces to be a growth area (CA owns Viewpoint, which did animation for the movie Antz, and has created a joint venture with MetaCreations called MetaStream). One impressive demo was representing complex insurance data stored with Jasmine in a 3D view of a room where the quality of the furniture gave an instant visual indication of the income level.
w www.cai.com

Serving Java

Support for XML and Java 2, enhanced SQL functionality, and improved performance are the features of Progress Apptivity v3.1, the Java application server and IDE.

Version 3.1's support for XML takes the form of Apptivity SmartAdapters, which remove the need for external XML servers. Inbound XML data is integrated into local applications as relational data. For SQL, a 'relaxed SQL parser' allows SQL expressions to be created with vendor-specific SQL commands. In addition, parameterised SQL queries are designed to allow more precise and dynamic data filtering.

There is support for conditional HTML tags, to help personalise content on web pages. The example given is a website that tracks the stock market and uses conditional HTML tags to monitor the time and inform buyers how much longer the markets will be open. Finally, for legacy Progress Software 4GL code, the SmartDataObject enables the reuse of business logic for the Web.

Pricing starts from $10,000.
w www.apptivity.com

Java & C/C++ Jacc

the software developer's conference
oxford university union
15-18 september 1999

wednesday 15 september 1999

time	sessions
09.30	**Keynote Address** CORBA State of the Union, *Sean Baker*
10.30	Morning Coffee Break
11.00	**Linux/Unix** Solaris Technology *Phil Harman* · **Windows** Trials & Tribulations of Windows Development *Ken Jackson* · **PDA** Developing Applications for the Palm Platform *Iain Barclay* · **CORBA** Application Interoperability and Integration... *Eric Leach*
12.30/1	Lunch
14.00	**Linux/Unix** Taking Borland C++ & CORBA to Linux *Jeremy McGee* · **Windows** *COM as a better* C++, COM+/MTS as a better COM *Simon Horrell* · **PDA** C++ for Palm Size PC Solutions *Nick Gratton* · **CORBA** Domains and Platforms *Chris Sluman*
15.30	Afternoon Coffee Break
16.00	**Linux/Unix** Cont... from 14.00 · **Windows** *n*-tier C++ *Kieran Mockford* · **PDA** Leveraging Standards in the Development of Hard Real-Time Embedded Systems *Dale Fittes* · **CORBA** Real-time CORBA *Roger Barnett*
17.30	Close of Day One

thursday 16 september 1999

time	sessions
09.30	**Keynote Address** Design after Modernism - Beyond the Object, *Jim Coplien*
10.30	Morning Coffee Break
11.00	**Patterns** Organisational Patterns *Jim Coplien* · **Embedded** Embedded C Traps and Pitfalls *Chris Hills* · **C++** Introduction to UML for C++ Programmers *Mark Collins-Cope* · **C++** Writing Exception Safe Code *Alan Griffiths*
12.30/1	Lunch
14.00	**Patterns** Substitutability - Principles, Idioms & Techniques for C++ *Kevlin Henney* · **Embedded** The CAN Session *Trevor Martin* · **C++** Introduction to the Standard Template Library *Barbara Moo* · **OOP** The Unity of Software & the Revenge of the Programmers *Bertrand Meyer*
15.30	Afternoon Coffee Break
16.00	**Patterns** Cont... from 14.00 · **Embedded** Cont... from 14.00 · **C++** Cont... from 14.00 · **OOP** Cont... from 14.00
17.30	Close of Day Two
18.00	Evening reception, sponsored by Blackwells

friday 17 september 1999

time	sessions
09.30	**Keynote Address** Programming - Traps and Pitfalls, *Andy Koenig*
10.30	Morning Coffee Break
11.00	**Games** What it takes to be a Games Programmer *Jez Sherlock* · **C++** Exploring Objects - a C++ Perspective *Mark Radford* · **Java** Characterising Java Object Distribution *Nigel Warren* · **Programming for non-experts** The Meaning of Code *Jon Jagger*
12.30/1	Lunch
14.00	**General Programming** Cultures of Programming *David Harvey & Peter Marks* · **C++** Recent Ideas in Generic Programming *Andy Koenig* · **Internet/C++** A Case Study in Building Dynamic Websites Using Open Source Software *Mike Banahan* · **Programming for non-experts** C and C++ Gotchas for Java Programmers *Francis Glassborow*
15.30	Afternoon Coffee Break
14.00	**General Programming** Cont... from 14.00 · **C++** Cont... from 14.00 · **Java** Managing Connected and complex Objects via Resource Pools *Nigel Warren* · **Programming for non-experts** Writing Clean Code *Francis Glassborow*
17.30	Close of Day Three

saturday 18 september 1999

time	sessions
09.30	**Keynote Address** Design - Concepts and Practices, *Kevlin Henney*
11.00	Morning Coffee Break
11.30	**Java** The Gotchas of Distributed Computing *Lois Goldthwaite*
13.00	Lunch
14.00	**Software Reliability** Paradigm Shift or Measurement Based Feedback? *Les Hatton*
15.30	Afternoon Coffee Break
16.00	**Debate** Debate: Good Software Development is Only Possible in a Standardised Language
17.30	Close of Final Day

For further information please contact Jenny Lowe on:

t ++ 44 (0) 171 970 4772 e jacc@exe.co.uk

f ++ 44 (0) 171 970 4797 w www.exe.co.uk/jacc/ or www.accu.org

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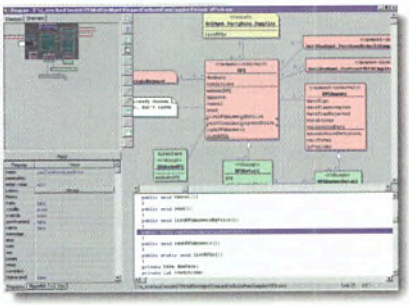
Synchronised visual UML modelling

Together/J3 is a Java-based visual UML modeller that provides 'simultaneous round-trip engineering', ie there is no explicit reverse and forward engineering because models and their implementations are automatically synchronised. The tool from Object International now has an add-in that specifically supports IBM's SanFrancisco Application Business Components. Called TJ-SF, the add-in will help developers build business models and generate the framework to provide an infrastructure between business classes and the various IBM SanFrancisco components.



UML 1.2 support involves Use Case, Class, Sequence, Activity, Package, Component, Deployment, Collaboration, and State diagrams. The details of the models can be documented via HTML, a web-based approach that is intended to help save a few trees on printing. The tool's support for round-trip engineering means that it's always possible to drop down from the visual interface to the code.

Together/J and Together/C++ are available in two editions: Whiteboard and Developer. The Whiteboard Edition is intended for small-scale Java or C++ development, and is meant as an introduction to the Together range. It features a restricted range of UML diagrams (Class and Package) and the support of simultaneous design-and-code editing to help reflect iterative software development. Round-trip engineering is supported only in the Java version.

The Developer Editions feature the range of UML diagrams, an open API for add-in integration with third-party development tools, customisable documentation generation, and Rational Rose import and export capabilities. Round-trip engineering is supported for both C++ and Java in the respective Developer editions. As well as support for the use of patterns, Corba Interface Definition Files (IDL) can be generated from models. You can create links between diagrams and external documents through the use of URL-hyperlinking.

Another product in the Together product line is Together/Enterprise. With its support for simultaneous round-trip engineering for both Java and C++ development, it's intended for analysts and programmers building large-scale applications in multiple languages. It supports entity-relationship modelling and access to SQL databases.

A customised Whiteboard Edition of Together/J has been integrated within the latest Database and Enterprise editions of Symantec's Visual Café. This version will be known as TJ Whiteboard.

The Developer Editions cost £1,950 and Together/Enterprise costs £2,950.

Product specs and the free Whiteboard Editions are available on the Web.

w *www.togethersoft.com*

Get your user-values modified here

There are two new components from Mabry Software. FTPServer/X is for the creation of custom FTP servers that can run on Windows 9x and NT. And PropertiesList/X provides a list box with columns where users can edit program-defined properties or generally edit a range of values.

For FTPServer/X, events notify your program when a user requests to download a file, upload a file, create a directory, delete a directory, etc. It can restrict access to directory contents and files on a per-user basis.

The PropertiesList/X control displays two (or more) columns – one for the property name and one or more for an associated value. Properties can be strings, values selected from a combo box, fonts, colours, and boolean values. The idea is to let you maintain all user-modifiable values in one place. Border styles, headers, and background and text colours of the display can be set through properties. Each cell can have its own background and text colour.

The FTPServer/X component costs $149 + shipping and the PropertiesList/X component $99 + shipping. A package that includes FTPServer/X and its C++ source code is available for $299, as is the package including PropertiesList/X and its C++ source code. Both controls come in ActiveX Control (OCX) and COM Object (DLL) forms. Free demo copies are available from the web.

w www.mabry.com/ftpserv/ w www.mabry.com/proplist/

Tuning TOAD

Quest Software's TOAD v6.2 is a Tool for Oracle Application Developers – a development environment for PL/SQL programming. This version sees tuning and debugging options, and there is support for Oracle8*i*.

The XpertTuning option makes observations about a selected SQL statement and the underlying database environment, then recommends code changes that should help to free-up system resources and generally improve database performance. The PL/SQL Debugger option provides a point-and-click way to identify application errors. You can pinpoint problematic areas statement-by-statement to identify questionable code.

There is optional integration with RevealNet's PL/Formatter. Pricing starts from £360.

w *www.quest.com*

Utility+ v2.1, the Java productivity suite, supports **Javadoc** authoring/editing and namespace management. The release includes a Utility+ Lite edition that integrates with Visual Café, VisualAge, and JBuilder. There's also a standalone version for those developing with the **JDK** and text-based editors. Pricing starts from $149.

www.woodenchair.com

Document! VB is a tool for creating HTML-based **documentation** of code. The utility from **Innovasys** can automatically create a cross-linked, context sensitive HTML Help file from **VB** source code and comments. Costing $199, an evaluation version can be downloaded from the Web.

www.innovasys.co.uk

TeamStudio **Librarian** is the latest addition to the **TeamStudio** suite of development tools for **Lotus Notes** and Domino. It manages a team's reuse of code by providing a simple way to create libraries of sharable design elements, such as subforms, agents, and scripts. It works with Notes R4.x and R5 (beta) and costs $425 per seat.

www.teamstudio.com

There are six '**starter kits**' of software and supporting materials from **Macmillan** Computer Publishing: *VC++6 Programming* (£40), *VB6 Programming* (£40), *C Programming* (3.0) (£40), *JBuilder 1.0* (£40), *Oracle JDeveloper 1.1* (£100), and *Website Construction* (£30).

www.macmillansoftware.com

Computer Manuals is running a **free** books offer through its **Online Bookstore**. Every week a computer tome is chosen to be given away to the first 10 visitors to the site who register their name and emails. Titles are chosen from top-selling subject areas over the previous months.

computer-manuals.co.uk

There is to be a formal test and brand programme for Corba. The Open Group has developed The Open **Brand** Programme for **Corba** to help to ensure Corba-compliance among vendors and to guarantee out-of-the-box interoperability of products. Successfully tested products then receive the X/Open Corba trademarked **logo**. The first recipients of the Open Brand were Fujitsu's ObjectDirector, ThinkOne's Mico 2.2.7, and AT&T's omniORB2.
www.omg.org

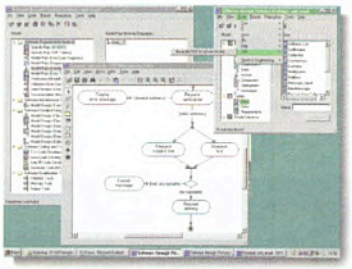
The **OMG**, aiming to meet a demand for real-time middleware, has adopted the **Real-time Corba 1.0** specification. Traditionally, Corba has relieved the developer of focusing on the minutiae of network programming, leaving detailed decisions on priority and task **scheduling** to the Corba implementation. However, Real-time Corba 1.0 addresses the need to be able to override these defaults and exert more control over lower level details.
www.omg.org

Corba itself is developing. Features for version **3.0** include a Corba Component Model, Asynchronous Messaging, and a Minimum Corba (distinct from the Real-time Corba). For integration with the Internet, there will be a specification for passing IIOP through **firewalls** (aka 'IIOP proxy'), and Java-to-IDL reverse mapping will allow the automatic generation of OMG IDL for distributed Java applications.
www.omg.org

Software through Pictures v7.2

Software through Pictures v7.2 (StP) is a multi-user modelling environment and software lifecycle tool. The system from Aonix is designed to integrate visual modelling into the full application development lifecycle: using a SQL Server-based repository, it lets you specify requirements for analysis and design, automate implementation and testing, and document the whole process. The system maintains the consistency of links between elements of the project: requirements, visual models, test plans, test cases, source code, user documentation, etc. Aonix emphasise the customisation possible for StP, particularly support for different development processes.

Object Modelling can take the form of UML, the Object Modelling Technique, or the Booch Notation. The system can generate code in



the following languages: C/C++, Java, Ada 95, Corba IDL, SQL, and Forté (reverse engineering is supported). Validator/Req, or StP itself, can be used for requirements modelling and test-automation. Compatible programming environments include SNiFF+, MS VC++, Javasoft, and ObjectAda. For version control, a completed or partial StP model can be baselined.

Aonix has also released the Lifecycle Desktop, which provides you with a process-oriented view of software lifecycle management. It's an adaptable framework to meet specific development process mandates as IEEE 12207 and D0-178B, or the Unified Process, providing customisable access to lifecycle activities such as requirements analysis definition and management, code generation, and modelling.

StP v7.2 runs on Windows NT, and the LifeCycle Desktop runs on Unix and NT.
w www.aonix.com

Orchestrating an embedded revolution?

It's not often that we write about hardware in EXE. We are, after all, a *software* developer's magazine. But recently we got a preview of a new technology which threatens to blur the line between hardware and software permanently.

Embedded Solutions Ltd (ESL), a spin-off joint venture with Oxford University, was set up to develop and exploit Handel-C, a radical approach to co-design (see *Co-design: where hardware and software meet*, EXE, December 1995). The aim of Handel-C is to bring the flexibility and reconfigurability of software to hardware, using Field-Programmable Gate Array (FPGA) technology. FPGAs contain large numbers of gates – as found in microprocessors and RAM chips – whose logical arrangement can be reprogrammed on the fly. In effect, it's possible to write and rewrite different circuits onto the FPGA at will.

Handel-C itself is a subset of C that is tailored to doing the job of writing hardware. Programs in Handel-C translate *directly* into circuitry on the FPGA. A device using an FPGA doesn't need a microprocessor, or support chips. Functions like driving a display or taking input can be performed by hardware written onto the FPGA itself. ESL uses a demo board consisting of an FPGA and DRAM chip, with some connectors wired direct to the FPGA for video, serial, and mouse. With just this minuscule platform, they were able to show demos of a boat-racing game, a Windows-like GUI, and the fastest version of Conway's Game of Life that we have seen. Despite the relatively slow clock speeds of the FPGA, the total removal of all software layers – OS, drivers, etc – between program and hardware results in dramatic speed gains. Handel-C also delivers true parallel computing; individual parallel tasks within a Handel-C program are implemented as separate logic units on the FPGA and run at the same time.

ESL is keen to stress that Handel-C makes it possible for software developers who know nothing whatsoever about hardware to create hardware implementations using software alone. This creates an easy upgrade route for developers to get into the soon-to-be-huge embedded market.

We're sure that you'll be hearing a lot more about FPGAs – and Handel-C – in future. Meanwhile, you can get your hands on a Handel-C toolkit for £3,500 per seat from ESL direct.
w www.embeddedsol.com

Books received this month

Publisher	Title	Author	ISBN	RRP
SSC	BASH reference card	Arnold Robbins	1-57831-010-5	$4.50
Morgan Kaufmann	Evolutionary design by computers	Edited by Peter J. Bentley	1-55860-605-X	£31.95
Morgan Kaufmann	The inside story of interactive TV and Microsoft WebTV for Windows	David Feinleib	0-12-251570-6	£29.95
SSC	Unix System V command summary	–	1-57831-012-1	$8.00
O'Reilly	Visual Basic controls in a nutshell	Evan S. Dictor	1-56592-294-8	£15.95
Wrox Press	Windows Script Host programmer's reference	Dino Esposito	1-861002-65-3	£21.99

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Lean-back technology

Digital television almost got started with BSkyB. Now, it's trying again, and the gogglebox will never be the same.

When Sky Television first got started, everybody understood what it was. There were adverts on ITV to tell us all about it (and when ITV wouldn't show the ads, the news coverage of the court battle was almost as good), there were dishes appearing on people's houses (which caused a constant barrage of condemnation from people who regarded them as eyesores, yet saw nothing wrong with placing a wire aerial on top of a thatched cottage), and then there were a few, high-profile deals, culminating in the Premier League football solus. Everybody understood what was on offer – 130 channels of gameshows, mud-wrestling, Hollywood movies, and repeats – and the people who wanted such stuff were not disappointed.

Now, of course, anyone who wants quality television is watching a little BBC2 and Channel 4, pretending Channel 5 never happened, and looking wistfully towards the US! Everyone who wants high-volume television has already got a dish, and Sky is now in a bit of trouble, because it still needs sales, and it's not getting any more.

The powers that be are trying to launch digital television. Sky has a digital service, On Digital is advertising all over the south of England, and even the BBC is making noises about BBC Digital. The cable companies are turning into telephone providers, and the telephone providers are turning into cable companies, and soon you'll get to change channel by dialling a convenient 0898 number.

Everybody is excitedly talking digital TV, but unfortunately nobody is buying.

Nobody is buying because there's nothing there to buy. *Family Fortunes Digital* is no better than the original, and digital picture quality hardly improves one's enjoyment (unless the picture fades out altogether). The same goes for most current programming. The Beeb (who used to know quite a bit about good TV) spent loads on ads telling me that I can interact with them and that the adventure starts here, but I have no idea what they want me to tell them that I can't use a phone or a letter for. In any case, most of the inhabitants of planet Earth have no interest in interacting with their telly. They want to flop in front of it at the end of a hard day, and watch something familiar and undemanding. How else can you explain (taking just one example) the continued success of *The Bill*, compared to the early death of *Cops*? Most people take what they're given, and like it – if it were not so, there'd be a video store on every corner, instead of an antenna on every roof.

Digital TV isn't selling because the market for people who watch telly for a hobby is now completely saturated, and a digital set-top box doesn't do anything new. In spite of this, the Home Office wants to switch off the analogue signal in ten years, leaving only digital still operating. If they do, you and I will need a telly, a stack of set-top boxes, a video that can't change channel at all, and a hefty subscription bill every month to decrypt it all. It will cost about four or five times what our present steam-powered tellies do, and it won't work as well. What do we get in return? Not interaction; digital TV through the aerial doesn't work that way. Not choice; someone has to make all these programmes, and with more volume and not much more money, only the cheapest and most popular programmes will get made – that means no expensive drama, no insightful news, and no experimental films. I can't see that we need a technological revolution to make more game shows.

Not everyone vegetates in front of their TV sets. There are people who like new technology, who like the idea of constant interaction and want to be heard, and who are prepared to take the initiative for their own entertainment; they have already bought home computers and Internet subscriptions and are largely happy watching cult movies on their DVD players. In general, they are not the people who bought satellite dishes, and they are not the people who are interested in digital TV. On the other hand, digital TV is not much use to a couch potato either; in a recent test of Internet access through interactive TV (by definition, to non-Internet-users), the content had to be simplified to make it accessible. People who were used to seeing simple and strong graphics with few words couldn't get the hang of scrolling around body copy and keying in text. They understood the News-show and the Teletext models of information provision, and (in general) had no use for anything more. The websites in the trial had to be redesigned to look more like the News.

It used to scare me that we may create a class of people who have no access to information. Now, what scares me is the opposite. If digital TV is forced on everyone, along with delivery systems that make interaction a possibility, we will see the inevitable dumbing-down of the Internet, if for no other reason than to sell more advertising to pay for the TV infrastructure. I saw these issues described, in a pithy soundbite worthy of the best of television, as the difference between lean-forward and lean-back technologies. You lean forward to operate your computer. You lean back to operate your telly. Digital TV, in forcing lean-forward content into a lean-back device, will either go broke itself, or will distort the content to make it fit. Television will do to the Internet and other information networks exactly what it did to popular culture – trivialising real issues into meaninglessness.

In the short term, digital TV is completely pointless, because nobody has any idea who or what it's for. In the medium term, it is downright dangerous, and will do nobody any good except the manufacturers of set-top boxes. Long term, I think it is an immense power for good, but only if it's allowed its childhood, and we are all given a chance to figure out what it is. ■

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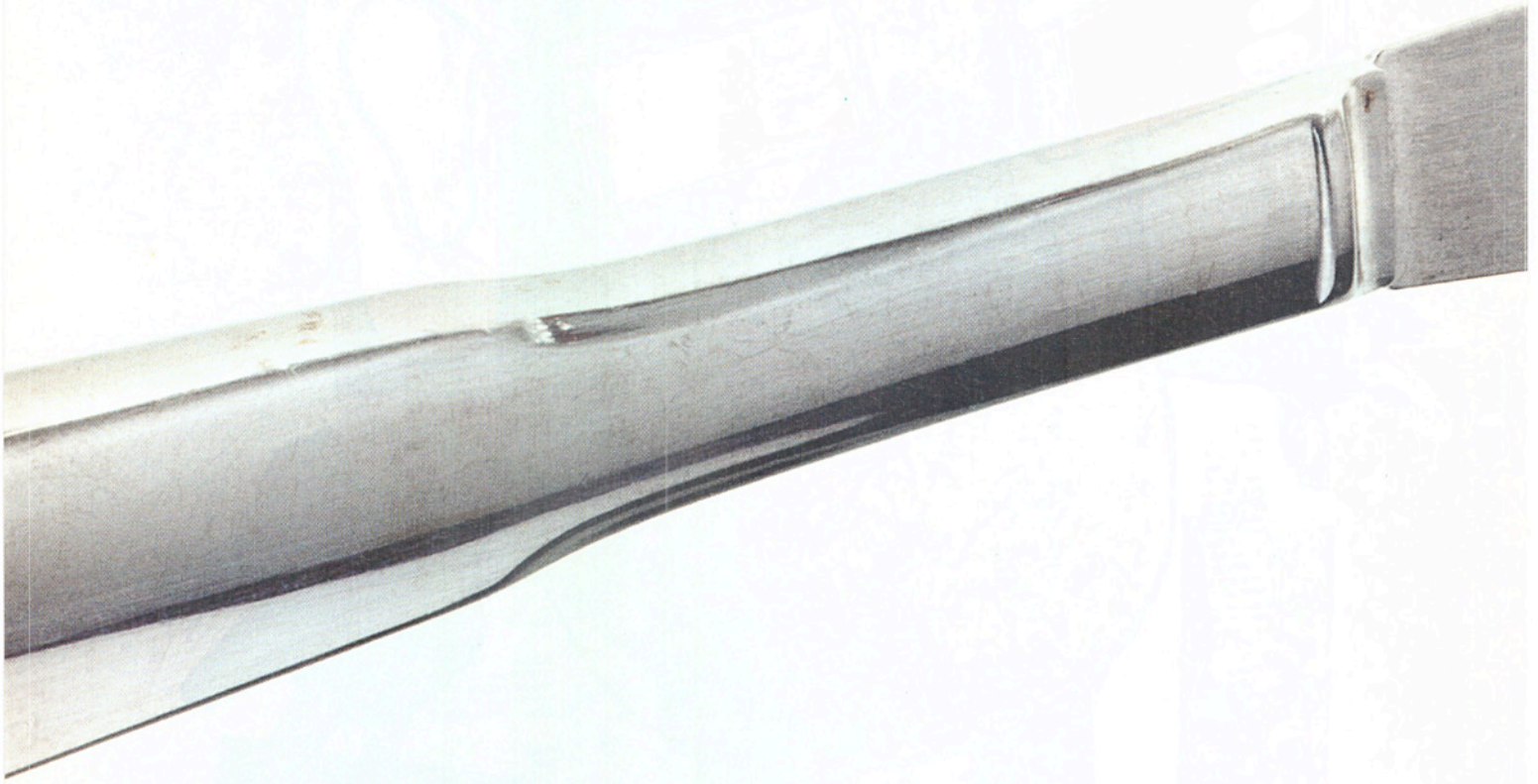

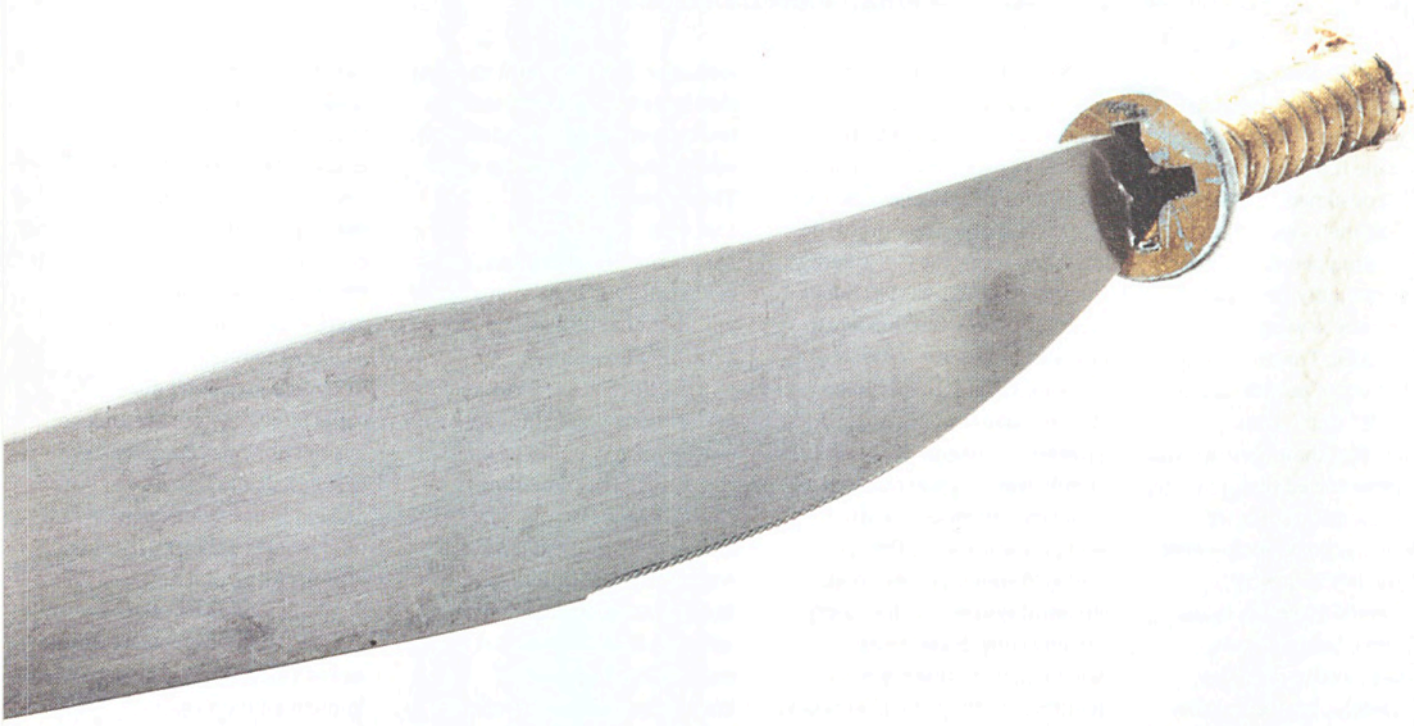

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Dear Sir,

About the article by Alex Telford (*Self-selection of the species?* EXE, July 1999). The point about IQ etc, and who designs languages for whom, is well taken, but it seems to me that a language should be designed properly (hard to define!) – and that's unlikely to happen unless the designer is highly intelligent.

A big issue is what/who/etc a language is for. There are now vast numbers of people creating applications, and I think it's inevitable that their abilities and needs are so varied that no single language could be sufficient.

I see many parallels between maths and languages, which is to be expected given my maths background, but computer languages seem to me to be something else besides maths. They're also about engineering and/or architecture and/or – well, the list goes on. I think at some point you're left with either a very long list or a feeling that languages are something else.

From my experience and study, I'm convinced no one knows how to design a really good language (certainly I don't!). Since the concepts that are useful are still being discovered (quite a while ago things like structured programming, then object-oriented techniques, now perhaps patterns) this is another problem for language designers.

I understand C++ was originally called C With Classes, and was at the time much simpler. As Alex Telford says, it was also severely constrained because computers were still expensive, quite slow, had small memories, etc. Stroustrup found his new language had to compete with C, and would not have a chance if it produced code which required too much more of systems than C. Unfortunately, I think the result now is an awful language, crippled by constraints that are no longer relevant.

Not that I want to defend C++, or attack Telford personally, but I don't think he should've expected C++ to teach him about class design. Plenty of books (and other resources) do that (and some use C++). Sadly, many will be as awful as books in other fields – but that's just the way things are.

Alex Telford's experience does raise something important, however. Somehow programmers should learn a great many concepts, yet many just dive in and pick some up as they go along. Frequently they create dreadful systems. If they carry on long enough and keep learning, they improve to the point where they're embarrassed by their early work – and may at last be good at their craft. Aha! But is it a craft? Yes, and part maths, part science, part engineering (we've been here before).

As I said, I don't wish to attack Alex Telford, but programming is non-trivial to do well and learning the concepts etc is also non-trivial. That's true of many disciplines! Programming is almost unique in that people can still enter it with no qualifications. Quite which qualifications are actually worth having and why are tough issues...

Operator overloading was in a number of languages before C++, but what does that say about those who don't know that and/or haven't used any of the previous languages? Are they to blame or what? Is it their responsibility to learn about their profession (maybe it's a trade!)? We expect doctors to learn about existing drugs and to keep up with new ones.

A comment on the C example: the `*` in `int* pS` is *not* a qualifier on the word `int`. It is a qualifier on `pS`. Alex's way of looking at it is not just wrong but also leads him to assert that the two uses of unary `*` are different, when actually they're the same. The following:

```
int *pS, x;
```

means that `*pS` is an `int`, and `x` is also an `int`. That's consistent with the unary `*`s used in the addition later on.

Despite that, the C syntax for declarations *does* confuse people, especially in complex cases, which suggests something is wrong. At the least, we know almost all of the people have completely inadequate education in computing, so deciding what's wrong is itself awkward. (I keep mentioning their lack of knowledge, but I worry about it not so much because I think they're ignorant in any pejorative sense as because of the extra problems their ignorance and diverse experience and knowledge create.)

Ritchie (C's main designer) himself admitted C's declaration syntax may be an experiment that failed!

The point about character sets is fair, but the reality of standards bodies should not be overlooked. C has 'trigraphs' even for some things you probably would think were uncontroversial – but, as I say, the reality should not be overlooked (and it's harsh). I have to say that using lots of extra symbols would add a high risk that many people would be even more confused and/or unable to cope.

To come back to C++. People don't have to use it; there are much nicer languages around – even ones with classes, automatic memory allocation and garbage collection, and no casts. It's arguable quite why/how C++ has taken over. Clever people making sure it became a standard is one big reason, as is good marketing (and I include the clever name). Getting another to displace it is going to be extremely hard. Java is the only obvious candidate right now, but has quite a number of flaws as a language/system and the marketing is not exactly ideal.

Maybe a really good language (if Python et al don't qualify) could be created via the Internet, but Net projects generally seem to succeed only if there's at least one really committed person (maybe Alex Telford!). It seems obvious to me that any new language should be very expressive, not too concise, be well-defined, have a free portable implementation, and (ultimately) have an ANSI/ISO standard. A lot of keen and happy users are needed, too! In concrete detail, the language should be able to be fast when interpreted, otherwise many people will not use it. It should provide those features mentioned earlier (memory handling etc). Maybe Limbo (from Bell Labs) would be suitable? It sounds good, but I've read too little about it.

Anyway, thanks for the article. This whole subject seems to be discussed far too little yet is surely of huge importance. Thanks also for the references – not that I've found time to look at them yet.

John Skelton
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I did mean to imply that language designers come from the top band of intelligence that I defined, but that also a good deal of the spec should be to fit the requirements of the users below such a band. And I agree there are needs for specialist languages, but I still think there is a 'general purpose' one, like C++, that

fits many needs, perhaps not optimally for applications on the edges of its domain.

In the past, the maths ingredient has been at the foundation of languages and so familiar as to have become invisible to the creators. We have already waited too long to make another 'state of the present art' release of a new or updated language.

Certainly, the requirement for backward compatibility introduces many unfortunate constraints, but I like that core subset of C++ that is logical. I did look for books on class design and could not find any with decent amounts of C++ code.

John Skeltons's point about how programmers 'just dive in' is a key point in educational methodology. With my background in electronic engineering I need frequent recourse to actual physical devices carrying out my procedures to see the concept working in the real world. Only then does it 'stick' hard enough in my growing mental model to act as a solid platform for the launch of the next abstraction. Take this 'hands on' approach away and my mental model becomes frail and volatile.

Of course, the 'hands on' method needs proper supervision and is very much *not* 'learning on the job' (a process encouraged by some employers trying to save on training expense).

The question of which aptitudes and qualifications programmers should possess is where a research project could do some good. However, academic researchers are often loath to commit to a final recommendation. 'We need *more* research' they cry. This tendency should be discouraged. Programming languages need to be designed for ease of learning, at least the basics; there will be a continuum of levels of skill required to master the more abstract concepts.

On the subject of pointer declaration what John says is in K&R and is the rule. But I still think the 'word' `*ps` is actually performing two different operations. In the declaration it is setting aside memory for a pointer to an integer and there is no memory yet for that integer to which it will eventually point. In assignments the 'word' `*ps` actually does dereference to memory where an integer is stored. When the programmer declared `*ps` he wanted a pointer so he could do pointer operations with it, eg `ps++`.

K&R throughout use `int *ps`, but Stroustrup uses `int* ps`, and calls the `*` used here a 'declaration operator' although the rules are the same.

I hope I don't need *lots* of extra symbols to avoid the current confusing reuse of characters. Just enough for: 'one character, one job, and the same job all the time'.

I need a language that allows me to program my lovely desktop PC with truecolor at 1024 by 768 and *fast*. I need to do fast graphic illustrations of maths concepts in a device independent way without fiddling with the innards of graphics boards. With all its steep learning curve C++ with the MFC has eventually got me there!

I am not too keen on interpreted languages – I need every nanosecond. For example, processing every pixel of every frame of a 90 minute film!

I am glad that we agree that the subject seems to be discussed far too little; this was one of my motivations for writing the article.
Alex Telford

Clean Java

Dear Sir,
Alex Telford's article *Self-selection of the species?* (EXE, July 1999) interested me because my experience until recently was similar. However, there seems to be a number of omissions that give a curiously out-dated impression. For example, the code example could be written as Alex Telford required in the language that Borland(.com?) carefully hides in Delphi, although the constraint 'no variants allowed' implies that the variables `S` and `T` cannot themselves be multiplied.

Again he does not mention patterns, but the 'set of constructs' appears to be very similar. Except that it seems totally unrealistic to expect high-level descriptions to generate a single representation of the code: that's why programmers are still in demand.

Another surprising omission is Java, which appears to me to be the 'no pointers clean slate' for which he is asking.

My own doubts started to crystallise when I ran out of paper printing the draft of the new C++ standard. Looking through it later I found that each rule had so many qualifications that guaranteeing the interpretation of a single statement was going to take hours of work.

I have now moved over to Java because I find the syntax almost entirely logical – that is, the number of rule exceptions is small enough to be manageable.
Cecil Wallis.
cpw@zetnet.co.uk

French butchers

Dear Sir,
'Plain wrong,' Huh? (*Practical user groups*, Letters, EXE, August 1999)

I think Matthew Jones has missed the point of my letter.

He may well be right in that user groups are populated by a fair cross section of developers in the IT community and that a well balanced variety of views are in evidence but I believe, however, that it is illogical to suggest that all users groups contain a representative proportion of the development community. User groups are populated by those who have both the time and the inclination to attend; I have the inclination but not the time and I suspect that this does not make me unique.

What is important is that I believe my original point regarding the result of any survey based on the views of members of user groups would return a bias towards the non RAD languages still holds true.

His evidence to the contrary seems to suggest that because his user group (BUG) presents information on real-world applications the user group will be populated by a real-world representation of RAD and non-RAD developers. This is like saying that because Newmarket has lots of horses the area must contain some French butchers.

There will always be exceptions to rules and it would be naive of us to ignore that but, in general, I do not believe the population of user groups represents a significant proportion of the number of IT developers eligible to attend and therefore survey results in those groups would represent the views of the majority of the membership not the majority of the available developers. It is therefore unsafe to accept the results of any user group survey as being representative of the IT industry.

Incidentally, why is the standard retort to an unacceptable comment about a user group always 'try going to such a group'. Maybe attendance has formed the basis of the 'unacceptable' comment.
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Cracking the kernel

Gavin Smyth wants to dispel the myth that writing kernel code is an arcane art, especially when a multi-tasking operating system is involved. He shows how cracking off device drivers can be straightforward with Linux.

In the world of the PC not very many people need to delve into the kernel, but there are times when you have to get close to the hardware. The most obvious case is where you or your team has produced some bit of hardware to plug into a PC and therefore need a device driver. However, occasionally you may want to perform some sort of custom control of existing hardware – effectively displacing the standard handling contained within your operating system. For example, you could be working on some networking application that requires less flexibility but more efficiency than a general Ethernet stack, and replacing the existing general purpose stack or scheduling with your own might be essential. Another example where you might replace or augment existing code is if, say, you want to experiment with robotics by having a number of actuators and sensors attached to your PC's printer port. A standard printer driver is hardly appropriate here.

Device driver code is very close to operating system kernel code, and is the most common starting point for kernel code writing: you can gain a better understanding of the internals of your operating system by writing a device driver.

```
/* Default dynamic allocation */
int major = 0;
/* Default address */
unsigned long baseaddress = 0xD0000;
/* Default interrupt line */
unsigned int irq = 10;

struct file_operations testdriver_fops =
{
  /* Populate only with routines that exist */
  NULL,           /* seek */
  testdriver_read,
  NULL,           /* write */
  NULL,           /* readdir */
  testdriver_select,
  NULL,           /* ioctl */
  NULL,           /* mmap */
  testdriver_open,
  testdriver_release,
                  /* nothing more, fill with NULLs */
};

typedef struct
{
  /* Hardware appears here in memory map */
  char* mem;
  /* Interrupt line */
  int irq;
  /* Is a message ready to read? */
  int ready;
  /* Kernel message buffer */
  char buffer[ MESSAGE_SIZE ];
  /* To suspend on if no data ready */
  struct wait_queue* readq;
} TestdriverDev;

int init_module( void )
{
  int res;
/*
Register *no* symbol table explicitly so that no functions
other than those in the table will be externally visible - this
can't possibly fail, so don't bother to check...
*/
  register_symtab( NULL );

  if( ( res = register_chrdev( major, "testdriver",
                  &testdriver_fops ) ) < 0 )
  {
    printk( KERN_INFO
            "testdriver: can\'t get major number\n" );
    return res;
  }
  if( major == 0 )
    major = res;

  memset( &testdriverDev, 0, sizeof( testdriverDev ) );
  testdriverDev.mem = (char*)baseaddress;
  testdriverDev.irq = irq;

  return 0;
}

void cleanup_module( void )
{
  unregister_chrdev( major, testdriver );
}
```

Listing 1 – Module loading and unloading.

Kernel space

In times of yore, before Windows, life was easy: there was nothing between application code and the hardware, so you could do whatever you wanted. Under DOS you could ignore the rudimentary device driver layer and access any memory or I/O address with impunity – while this did simplify hardware control, it was rather limiting in what else you could do. Other forces were driving PC operating systems to become the complex pieces of software they currently are, and part of that complexity is exhibited in the layers placed between application code and the hardware – all in the interests of making the OS more reliable, robust, and flexible. It is interesting to note that most small embedded systems, while they usually have facilities such as multi-tasking, still permit complete and direct access to any of the memory space, mainly because size and efficiency requirements make anything else impractical and too expensive.

Nowadays, if you have to control some hardware within a PC, you generally have to write a device driver that sits in kernel space to manage interactions between a program (in user space) and the hardware. In the last such project with which I was involved we were fortunate in having the option of choosing our operating system, and picked Linux for reasons that included cost (Linux, without a GUI in the form of the X Window system, runs in a lot less memory than Windows NT or 95/98) and ease of writing device drivers. Elaborating on that last point: a short period of investigation showed that to be able to write a Windows device driver, you need the Windows DDK (device driver kit) for whichever flavour of Windows you are targeting, and probably one or more fat books (such as the excellent *Systems programming for Windows 95* by Walter Oney, Microsoft Press, ISBN 1-55615-949-8) since the extensive DDK documentation is not easy to navigate. In addition, it looks almost impossible to avoid having to write at least some assembler (though toolkits such as Vireo's

VtoolsD will help) – while not unexpected in device driver writing, I would still prefer to steer as clear of assembler as possible. An even shorter investigation into equivalent development under Linux showed that you need, er, no extra tools, and that a slim book such as the very readable *Linux Device Drivers* or *Linux Kernel Internals* will suffice. You definitely cannot survive without a book in this case because there is no equivalent of the DDK documentation available for Linux (but see *Further reading*). After a couple of re-reviews to check that I had not missed anything, I concluded that this really was all you need for Linux – I was almost disappointed at how easy it all appeared to be.

In the rest of this article, I will give an overview of the process of writing a Linux device driver for an Intel processor-based PC clone, but the techniques apply equally well to the other supported Linux architectures. Rather than getting bogged down in details of real hardware, I will use the example of a hypothetical device with an onboard 'message' buffer appearing in the PC's memory space at a particular physical address into which the external hardware will write blocks of data. The hardware will indicate the availability of data by pulling an interrupt line when the buffer is full.

The driver outline requirements were:

- It must be loaded as a module (so that we can change it without rebuilding the kernel, or even rebooting). See *Kernel building and modules*.
- It must ensure only one application can access the device at a time.
- When the message buffer is full, the module interrupts the PC.
- Data is retrieved in fixed size chunks, as quickly after the interrupt as possible, in the order of a few milliseconds (ie less than the standard 10ms kernel tick period).

I must emphasise that the fourth one is a *driver* requirement: the application reads the data as required, and this may be a few seconds after the device has written it. This suggests that the interrupt routine would append messages to an internal queue to be read by the application but, for the purposes of this article, I will forgo the queue and merely maintain a single kernel space buffer. While Linux is not a real-time operating system, it is sufficient for the millisecond timings in this application. Finally, because polling makes little sense, we needed to make a `read` block, but that leads to its own problems: however, it proved to be trivial to implement `select` to make the application programmer's life as easy as the device driver writer's!

Before starting, you need a capable build environment. The good news is that most Linux systems already have it – GCC and associated tools, along with the kernel sources (just the header files are essential). Until kernel 2.2 appeared, it was safest to use GCC version 2.7.2 rather than the current 2.8.1 or EGCS – these apparently are a bit too clever with optimisation and break some earlier (technically incorrect) kernel code assumptions.

```
/* True if the device is open */
int testdriver_opened = 0;

int testdriver_open( struct inode* inode,
                     struct file* filp )
{
/*
Only one of these devices, so whinge if bad (non-0) minor num-
ber.
*/
  if( MINOR( inode->i_rdev ) != 0 )
    return -ENODEV;

  /* The device can be opened only once */
  if( testdriver_opened )
    return -EBUSY;

  if( request_irq( testdriverDev.irq, interrupt_handler,
                   0, "testdriver", &testdriverDev ) )
  {
    printk( "testdriver: can\'t get irq %i\n",
                              testdriverDev.irq );
    testdriverDev.irq = 0;
  }

/*
Access device via file pointer - more in keeping with device
drivers than using the static structure directly, and easier to
extend later.
*/
  filp->private_data = &testdriverDev;

  /* Now lay claim to the device */
  testdriver_opened = 1;
  MOD_INC_USE_COUNT;

  return 0;
}

void testdriver_release( struct inode* inode,
                         struct file* filp )
{
  TestdriverDev* dev = (TestdriverDev*) ( filp->private_data );

  /* Kill the interrupt */
  if( dev->irq )
  {
    free_irq( dev->irq, 0 );
    PRINTK( "interrupt released" );
  }

  testdriver_opened = 0;
  MOD_DEC_USE_COUNT;
}
```

Listing 2 – Opening and closing the device.

```
static void interrupt_handler( int irq, void* devId,
                               struct pt_regs* regs )
{
  TestdriverDev* dev = (TestdriverDev*)devId;

  memcpy( dev->buffer, dev->mem, MESSAGE_SIZE );

  dev->ready = 1;

  /* Now, tell the app... */
  wake_up_interruptible( &dev->readq );
}
```

Listing 3 – The interrupt routine.

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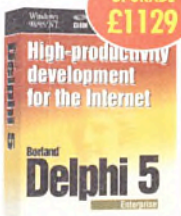

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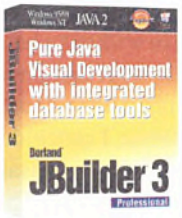

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Implementation

Making a loadable module was my first task, just requiring the two routines `init_module` and `cleanup_module` shown in Listing 1. The first registers the device, and initialises driver-wide data structures. Registering the driver gives it a *major number*, making it addressable by application code via this number, and associates it with a list of driver function pointers, stored in the `testdriver_fops` structure. (A major number implies the existence of a *minor number* – this distinguishes between several devices of the same type: here, since there is only one device, only one minor number – zero – is necessary.) The very first call, `register_symtab`, 'hides' all the code symbols so that we do not have to worry about polluting the kernel name space – without this, any non-static symbols in the code would be visible to all kernel code. We get a bunch of extras for free: rather bizarrely, the module load command `insmod` can access any static integer or string variable. Typically, this is used to let us configure the driver at load-time by overriding default values. In this case, we can assign a different major number, interrupt, or base address (the three variables at the top of Listing 1): for example, `insmod testdriver irq=5` overrides the default interrupt level of 10. Rather lazily, I assume that the device is present at the correct address and do not attempt any probing: a 'real' driver is likely to involve probing and allocating I/O ports as well as space in the memory map. The cleanup code for this module merely unregisters the device: in a real driver it would also release any resources allocated during initialisation.

Registering the driver gives it a *major number*, making it addressable by application code via this number, and associates it with a list of driver function pointers.


```
int testdriver_read( struct inode* inode,
                     struct file* filp,
                     char* buf, int count )
{
  TestdriverDev* dev = (TestdriverDev*)
                ( filp->private_data );

  if( count < MESSAGE_SIZE )
  {
    printk( "testdriver: read - buffer too small " );
    return -EINVAL;
  }

  /* Loop while nothing to read */
  while( !dev->ready )
  {
    if( filp->f_flags & O_NONBLOCK )
    {
      printk( "testdriver: read - nothing (& non blocking)" );
      return -EAGAIN;
    }

    /* Blocking call, so go to sleep until something
       happens */
    interruptible_sleep_on( &dev->readq );

    /* Got a signal unrelated to reading... */
    if( current->signal & ~current->blocked )
      return -ERESTARTSYS;
  }

  /* Copy the data into user space */
  memcpy_tofs( buf, dev->buffer, MESSAGE_SIZE );

  return MESSAGE_SIZE;
}
```

Listing 4 – The read routine.

```
struct fd_set readSet;
struct timeval timeout;

FD_ZERO( &readSet );
FD_SET( fd1, &readSet );
FD_SET( fd2, &readSet );

timeout.tv_sec = 10;
timeout.tv_usec = 0;

if( select( FD_SETSIZE, &readSet, NULL, NULL,
                          &timeout ) > 0 )
{
  if( FD_ISSET( fd1, &readSet ) )
    /* Read from fd1 */
  if( FD_ISSET( fd2, &readSet ) )
    /* Read from fd2 */
}
else
  /* Process timeout (or error) */
```

Listing 5 – Use of select.

```
int testdriver_select( struct inode* inode,
                       struct file* filp, int mode,
                       select_table* table )
{
  TestdriverDev* dev = (TestdriverDev*)
                          ( filp->private_data );

  if( mode == SEL_IN )
  {
    /* Is there anything to read? */
    if( dev->ready )
      return 1;

    /* No, so sleep */
    select_wait( &dev->readq, table );
    return 0;
  }

  /* Don't handle write or exceptions, so always return
     not available */
  return 0;
}
```

Listing 6 – Select within the driver.

When a driver module has been loaded, it must be attached to some device node – an entry in `/dev` – for the application to be able to find it. The old way to do this was to hard code some fixed major number in the driver, but these days it is recommended to dynamically allocate one. The problem with that is determining what number has been allocated: the following two lines will extract the major number by examining all loaded modules and then create a suitable node:

```
major=`cat /proc/devices | awk
                "\\\\$2==\\"testdriver\" {print \\$1}"`
mknod /dev/testdriver c $major 0
```

The next two important functions, in Listing 2, open and close the driver. When an application executes `fd = open("/dev/testdriver",...)`, the kernel will work out that it corresponds to our driver because of its major number and, via the file operations table in Listing 1, execute `testdriver_open`. This function validates that the open is legal – that nothing has already opened it, for example – and then attaches the interrupt handler. (A real driver would almost certainly include extra code to enable the external hardware's interrupt controller, but I'll ignore that here.) The final argument to `request_irq` is passed directly to the interrupt handler, and thus can enable one routine to distinguish between several interrupting sources. In this case, there is a single source, but I pass the address of the device structure anyway. The last thing the open routine does is increment the module's usage count, so that it cannot be removed while it is being used. The close routine, as you would expect, releases the interrupt line and decrements the module usage count.

The testdriver_read routine is complicated by an odd-looking loop to handle blocking reads and dispose of unwanted signals.

Reading data

Having got all that out of the way, it's time to read some data. The basic idea is that the hardware triggers an interrupt routine to read the data to an internal buffer, which is later read by the application. The interrupt routine is shown in Listing 3. One job the interrupt routine must do, omitted in this example, is reset the external hardware. Sometimes this will occur automatically as a side effect of the data read, but more often, there has to be an explicit write to some external location. The PC's interrupt controller itself must also be reset, but this is handled automatically by the operating system. After copying the external data into the driver buffer, any application that might be waiting for the data is made available to run by calling `wake_up_interruptible`. Such an application will have been suspended and placed on the queue by the `testdriver_read` routine (see Listing 4). This will have been invoked by the kernel as a result of the application calling `read(fd, buff, MESSAGE_SIZE)`.

The `testdriver_read` routine is complicated by an odd-looking loop to handle blocking reads and dispose of unwanted signals. If no data is available and the read is non-blocking, as indicated by the `O_NONBLOCK` flag (which would have been specified when the device was opened), the read returns immediately with a failure code – error codes are always negative, while a positive return value contains the number of bytes read into the supplied buffer. If the read is blocking and there is no data, the application is suspended by `interruptible_sleep_on`, to be woken up by the interrupt routine as explained above. It is possible for the read to be awakened by an erroneous signal, hence the following check that causes the kernel to re-suspend the task again if necessary. The loop can exit only when there is some data to read: note the `memcpy_tofs` call – this copies data from kernel space to user space. In Linux on Intel processors, the FS segment register points to the user data segment, hence the name of this routine and the associated copy from user space to kernel space, `memcpy_fromfs`.

Timeouts

There is one problem with the driver presented thus far: if the device has been opened in blocking-mode and an application calls `read`, it can potentially suspend forever if the hardware does not make any data available. An obvious solution is to insert some timeout mechanism, but where? The first option is within the application – have a separate thread whose purpose is merely to suspend for a short interval and kill off the main thread (cancelling the read) if necessary. The disadvantage of this is that the application writer's job is complicated by a detail that should really be hidden from view. At the other extreme, the device driver could employ a kernel timer to effectively perform the same function

```
VER = $(shell awk -F\" '/REL/ {print $$2}'
                          /usr/include/linux/version.h)

CFLAGS = -Wall -O2 -DMODULE -D__KERNEL__

all: testdriver.o

testdriver.o: testdriver.o
  $(LD) -r $^ -o $@

install: testdriver.o
  install -d /lib/modules/$(VER)/misc /lib/modules/misc
  install -c testdriver.o /lib/modules/$(VER)/misc
  install -c testdriver.o /lib/modules/misc

clean:
  -/bin/rm -f *.o core

testdriver.o: testdriver.c testdriver.h testdriver_internal.h
```

Listing 7 – driver make file.

Kernel building and modules

A typical Linux kernel can be viewed as having two types of components: a set of core code that always has to be accessible, and other units, typically device drivers, which do not need to be present on every Linux system. An example of the first class is the scheduler – an operating system is not going to be particularly useful without some notion of tasks and switching between them. An example of the second is a printer driver – if you have no printer, there is little point in having a driver consuming memory and other resources. Runtime loadable and unloadable components, known as *modules*, were introduced as a way to prevent a monolithic Linux kernel from growing by having to include support for all devices.

For standard drivers, you usually have the option of building them into the kernel or as separate modules (or not building them at all). The only advantage of building a driver into the kernel is that it is available as soon as the OS starts – you don't need `insmod`. For new drivers you also have the option of modifying kernel build files to incorporate your driver into the kernel itself or just building it as a module as I have done in this article.

Here's a brief summary of the steps you need to take to build a driver into the kernel:

- Place your driver code in an appropriate directory – for the driver in this article the code will be in */usr/src/linux/drivers/char/testdriver* (assuming the kernel source has been unpacked into */usr/src/linux*).
- Create a suitable `make` file – the easiest way is to copy one from an adjacent directory (this is called 'code reuse').
- Adjust the `make` file above to build your new directory.
- Build the kernel as normal.

For completeness, this is how you build a Linux kernel:

- At the top-level directory (ie */usr/src/linux*) execute `make config`, which will ask which devices you want to build – the default answers are sufficient in most cases. (If you have X running, you can do `make xconfig`, which provides a GUI that is much easier to use than the command line question and answer mechanism.)
- Next, execute `make depend` and `make boot`. Assuming nothing went wrong, this produces a compressed kernel boot image in the *arch/i386/boot* directory.
- The `make modules` command will, not surprisingly, build the modules, and `make modules_install` will copy them to the appropriate */lib/modules* directories.

For more information on kernel building, I suggest having a look at the online Linux documentation, see *Further reading*.

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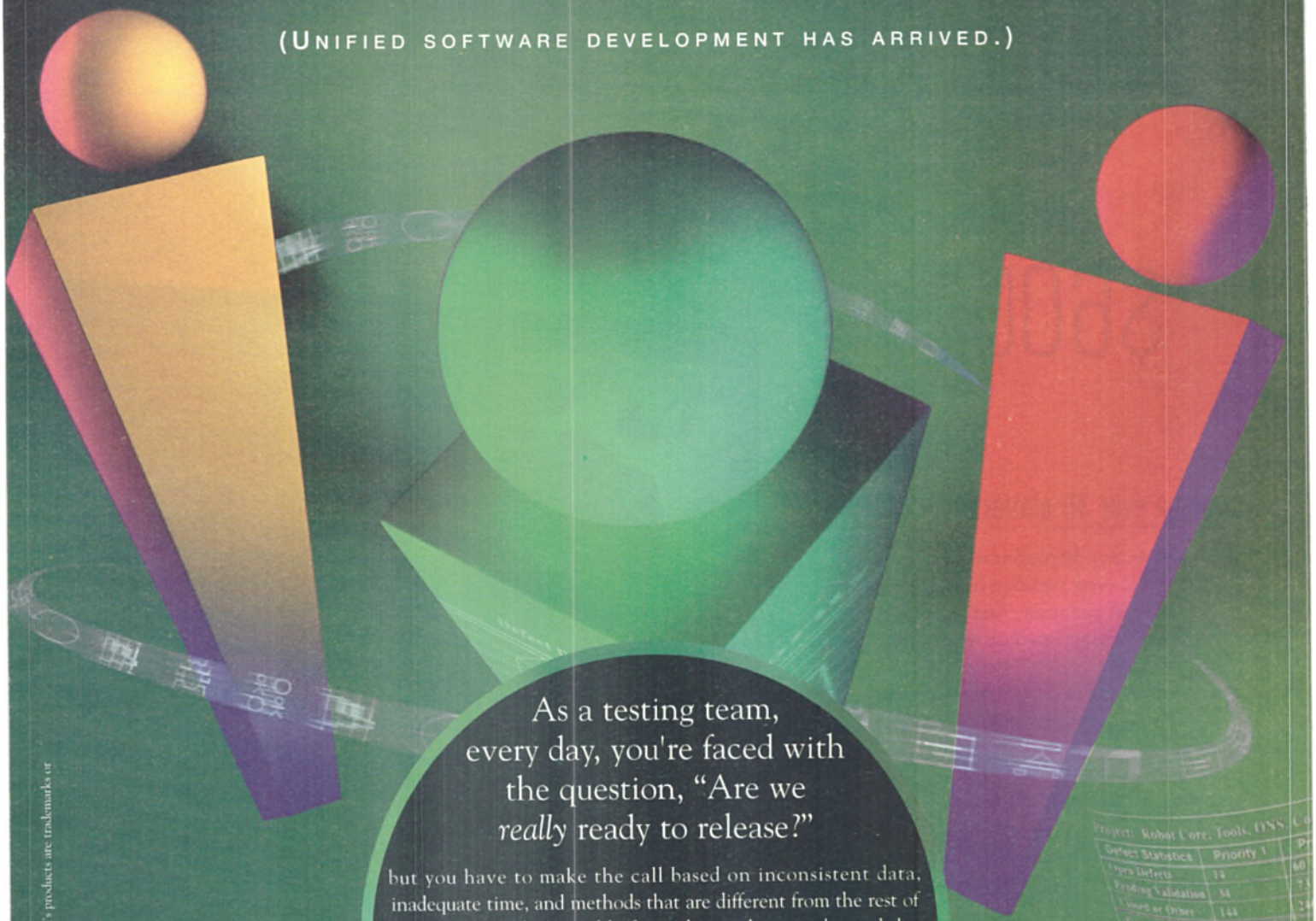

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Further reading

Linux device drivers, Alessandro Rubini (O'Reilly, ISBN 1-56592-292-1)

This books starts off by explaining what a device driver is, and describes the interaction between user space and kernel space. It very quickly gets down to writing some code, showing how to use and create loadable kernel modules. After this, the complexity gradually increases with chapters on: character devices supporting reads and writes, debugging, IOCTLs, timing and scheduler structures, kernel memory management, hardware (yes, it really only does put in an appearance half way through the book!), interrupt handling, the kernel daemon, block devices and file I/O, DMA, network drivers, PC buses, an overview of the kernel source code structure, and a summary of the changes between 2.0.x kernels and 2.1.x. The bulk of the book is concerned with 2.0 structures and functions, but the author does take some care that code is portable to 2.1, and hence 2.2 since that has more or less the same internals as 2.1. The book is easy to read and the copious examples are well explained, though it is difficult at times to understand what the driver is doing without being able to attach some external hardware to view it. The book does not include complete code listings, but the full source is available at the O'Reilly website.

In summary, this is an extremely good book that brings together virtually everything you need to get started with device driver writing. For more advanced work you will have to examine the source, but the techniques explained here should help you on your way.

Linux kernel internals, Michael Beck, Harold Böhme, Mirko Dziadzka, et al. (Addison-Wesley, ISBN 0-201-33143-8)

As suggested by its title, this book is more a tour of the 2.0 kernel than the book above: there is a chapter on device drivers, but the authors really aim to present the internal workings of the operating system. The book starts with the layout of the source code files and how to build the kernel. After this, the authors dive straight into the kernel data structures and the main kernel algorithms. Chapters on memory management, inter process communication, and filesystems follow, and then there is a discussion of device drivers and a brief note on implementing one. The final chapters include network handling, modules, debugging, and multiprocessor systems. About a third of the book is devoted to appendices listing system calls, commands related to kernel access, the proc filing system, and Linux booting. These all read like copies of `man` pages, but they do include examples and it is useful to have them in one place. The package includes a CD with a (rather old) Slackware distribution.

This book is more detailed than *Linux device drivers* and, in my opinion, not quite as readable. However, if you are more interested in how the kernel works than writing a device driver yourself, *Linux kernel internals* is highly recommended.

Linux documentation project

The LDP (*http://metalab.unc.edu/LDP/*) contains gems such as *The Linux kernel*, *The Linux kernel hacker's guide*, and *The Linux kernel module programmer's guide*. These cover a lot of ground but, in my opinion, are not as readable as the books mentioned above. Other useful online sources include the HOWTOs and, of course, the readily available kernel and driver source code.

A third alternative, for a lazy programmer like me, is to let the kernel handle the timeout itself.

within the driver itself. This has the disadvantage that such timers are not completely trivial to use. A third alternative, for a lazy programmer like me, is to let the kernel handle the timeout itself. The I/O select mechanism, familiar to Unix coders, can be used here: it is normally used to determine which of several channels is ready to read (or write), as shown in Listing 5. The `select` statement will exit either when there is something to read on file handles `fd1` or `fd2` (or both), or when the timeout of 10 seconds expires. As `select` returns the number of ready streams, it is easy to check for that latter case.

If only one file handle is pended on, it should be obvious that this is a simple mechanism for the application writer to use to apply a timeout to a particular device: if `select` indicates that the device is ready to read, the read can occur without any possibility of blocking. The device driver side of the select mechanism is not much more complex: see Listing 6. The `testdriver_select` function is invoked behind the application's call to `select` and (ultimately) returns a true value when a read is possible. If nothing is available, the application is suspended, once again on the read queue, but the operating system applies the `select` timeout without any other work by the programmer. The third and fourth parameters to `select` are sets of file handles to check for write-readiness or exceptions: as neither of these are handled by this driver, `testdriver_select` always returns false for any test other than read.

Finally, for completeness, Listing 7 contains the `make` file used to build the driver. The first line extracts kernel version information for the installation process to be able to place the driver module in the correct version-specific directory a few lines later in the `make` file. The next line defines two extra compile-time symbols necessary for virtually all device drivers: `MODULE` and `__KERNEL__`. These affect how some of the Linux header files are processed differently to the usual application-mode. Apart from these, the script looks very similar to a typical Unix `make` file.

Simplicity

I hope I've shown that starting to look into the Linux kernel and writing a device driver is not actually very difficult. While it is not trivial, it need not be a job for wizards with a mastery of operating system incantations. It is true that there are some tricky sections of code (such as the blocking read loop) but they are few in number, at least under Linux. You do not need extra tools in your programming toolkit and you have a vast wealth of knowledge in the available source code and books such as *Linux device drivers*. ■

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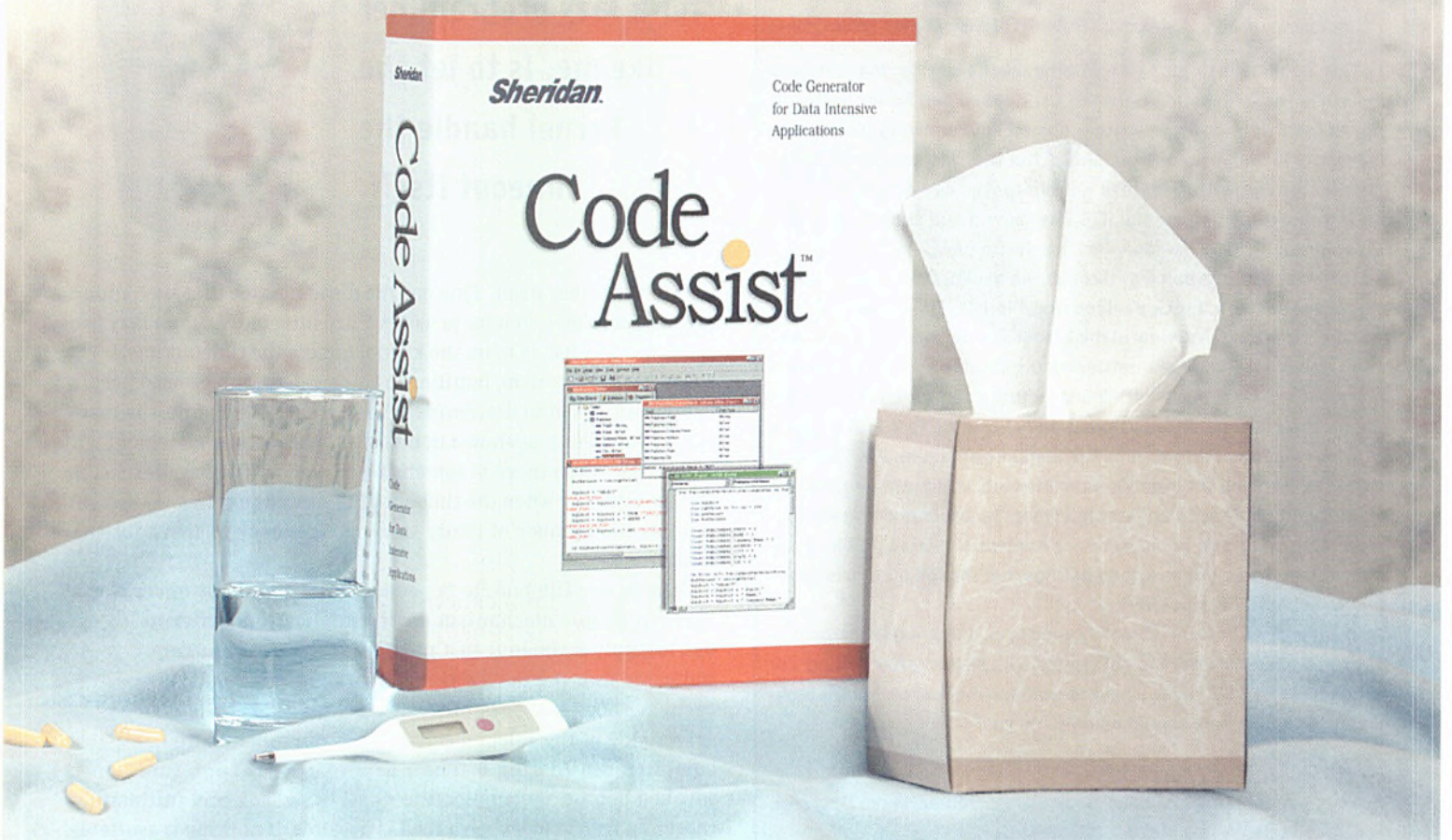

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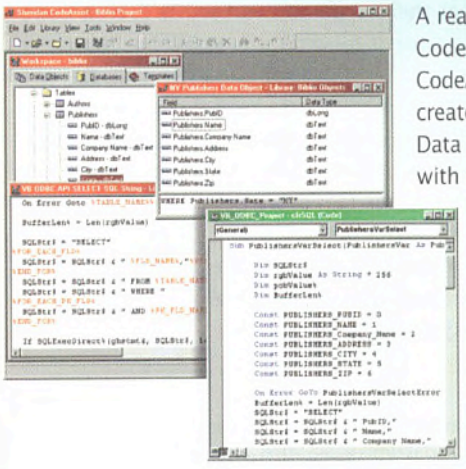

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The programmer's favourite

Programming remains a text creation exercise. Amid the plethora of Unix editing tools, Peter Collinson checks the form of the conspicuous front runners.

I had to use Microsoft's Visual Workshop to create and compile some code for Windows NT recently. I started to wonder whether people who are used to that way of working get a big shock when moving onto a Unix platform, perhaps Linux or one of the BSD systems. Integrated visual environments are fine things. They are easy to use once you have understood the mindset of the person or group of people who created them. Their drawback is that they hide the reality of the underlying programs that are being invoked and this can often be a bad thing – especially when things go wrong.

The press tends to be mystified by the ability of hundreds (or perhaps thousands) of people to create, maintain, and enhance Linux using 'primitive development tools'. I chuckle somewhat when I see this type of statement in print. These people miss the point. As occasional users of many different systems, they want to pick up and to use something quickly, dash off a few thousand words, and move on. Well, their type of usage is actually unusual. Most computer users, if not all, use their systems frequently enough that they become more than novice users, and what may seem fine on a quick exposure can become a pain when you have to do it again and again every day.

Programming remains a text creation exercise. I agree that graphical editors are used to great effect when creating visual templates for GUIs, but in the end, the code is text. We haven't really generated visual models for creating the logic of the code. Yet. People have tried to go from flowcharts to working code, but this has not been too successful.

The basic tool that you need on a Unix system to deal with text is an editor of some form, and there are now a plethora of them, with some conspicuous front runners that you should find bundled on your system. In around 20 years of using Unix, I've passed through many editors, and participated in many 'mine is better than yours' conversations. Editors are a religious topic, so if I manage to light your blue touch paper in this article, please jump into that handily placed bucket of sand. Incidentally, I am ignoring the set of 'simple' GUI-based editors that probably lurk on your system (for example, `gEdit` on GNOME or `textedit` on Suns). These are fine for occasional use, or occasional users, and you may be happily using one of them. You can do better – but it will take some work.

The first editor

The first Unix editor was `ed`, written by Ken Thompson. The Unix Version 7 edition of `ed` was a single source file, of about 3,000 lines of C. The editor or clones of it are still around today on Unix systems, and I often use the editor to make quick small changes to files.

By the next morning Bill Joy had the first version of vi working

Communication with the editor is characterised by terseness. Once you've started `ed`, you will apparently not be given any prompt that says: start typing now. Instead, the cursor will sit at the start of an empty line waiting for you to type something. These days, if you want a prompt, there's often a program argument that says 'use this string as a prompt'. However, starting 20 years ago for about three years, I used `ed` every day, and was pleased to have the terseness. I was never bothered with the absence of a prompt.

The terseness extended to the error messages. There were three: '?' (you have done something wrong), '??' (the search that you started failed), and 'TMP' (I've run out of space on */tmp* for storing my data buffer). The brevity of the error messages caused huge grief to novices, but was fine when you used the editor daily.

The editor is a 'line editor'; its basic unit of currency is the line in the file. You type in commands that are applied to the current line, or range of lines. The general format of a command is: a pair of line addresses denoting a range, followed by a single letter command, possibly followed by some parameters. The command is applied to all the lines in the range. The address pair can be abbreviated to a single line address, or no address can be given, applying the command to the current line.

Although the editor is based on lines, the most-used line address form is a regular expression search. You rarely type in actual line numbers. For example:

```
/fred/p
```

will print the next line containing 'fred'. The C coding style where function names are placed at the start of the line:

```
char *
getstring()
{  int p;
/* etc... */
```

sprang from the need to find the start of routines. With this format, you can find it quickly by typing a regular expression that matches the start of the line (`^`) and the routine name:

```
/^getstring/p
```

Hitting 'return' several times steps you through the file, unfolding the routine down the screen.

Essentially, there are three types of commands in `ed`. The first set manages files: allowing you to open a new file (`e` for edit), read a file into the current buffer after the current line (`r` for read), or write a file (`w` for write). Second, there is a set of commands that operate on the addressed line or lines, like the famous substitute command:

```
s/old/new/
```

which replaces the first occurrence of `old` in the line by `new`. Third, there is a set of commands that allow you to enter new text either after the current line (`a` for append), before the current line (`i` for insert), or replacing the current line (`c` for change). These commands place you into text-entry mode and you leave it by typing a single full stop on the input line.

The power of `ed` came from the use of regular expressions for pattern matching:

```
1,$s/^\(.*\),\(.*\)$/\2 -> \1/
```

This performs the `s` command on every line in the file (`1,$s`). The command looks for any text (`.*`) followed by a comma, followed by any text up to the end of the line (`$`). The backslashed brackets cause the matched text to be stored and it can be reinserted into the buffer using its position in the original regular expression preceded by a backslash. In the example, I recreated the line as column two, a space, `->`, a space, and then column one. The regular expression engine is fast, and this is backed up by intelligent internal data structures that are used for file storage, enabling the data to be accessed quickly by the program.

If you want to try `ed`, then you need to know that `q` is the command that quits the editor. It will complain if you've changed the file, and haven't written it out. Typing `q` again will get you out.

Visual editing

In the early 80s, Bill Joy (then at the University of California, Berkeley) had been hacking on `ed` to remove some of the shortcomings for novices and had created an editor that he called `ex`. George Coulouris from Queen Mary College, London turned up in California with his own version of `ed`, called `em` – editor for mortals (which was in wide use in the UK at the time). This editor had prompts and error messages, but more importantly contained a simple line editor where you could use control keys to move about the line making changes in what we could now call a 'visual' way. Berkeley had acquired some early cursor addressed terminals and Joy immediately saw that the idea of 'visual' editing could be applied to the whole screen, and by the next morning had the first version of `vi` working.

The `vi` editor is actually two editors in one. You enter `ex` mode by typing a colon, and all the `ed` commands are available. The legacy of `ed` is always apparent when using `vi`; it's very much a 'line' editor with commands operating on the current line. When you start `vi`, you are in 'visual' mode, and you will either be looking at a screen containing the first lines of your file, or you will be shown a screen with a tilde character (`~`) at the start of each line, marking an empty line. The bottom line of the screen is used for `ex` commands. The cursor will jump here to tell you things and to allow you to type commands when you hit a colon to enter `ex` mode, or a `/` to search for a string.

If you are editing a file, then you can move about it using keystrokes. Like `ed`, `vi` has modes, and you start in what might be called 'control' mode. These days, it's usual to have keyboards with arrow keys that users expect will move them about the file, and there are other positioning keys like 'Page up' that should work. These keys are interpreted specially by `vi` and should operate as expected. Of course, it depends on how your system is configured. The editor was designed before the appearance of such keyboards and defines other keys to move about the file. The choice of keys seems somewhat random, but they are mostly positioned to make it easy to use the program effectively.

The basic movement keys are move-left one character (`h`), move right one character (`l`), move up one line (`k`) and move down one line (`j`). This choice probably seems weird until you look at your keyboard and notice that these keys are next to each other. My body learnt these keystrokes by playing Rogue, an early text-mode computer game. There are several keystrokes that allow you to move backwards and forwards by words. For example: `w` will take you to the start of the next word, `e` will take you to the end of the next word, and `b` will take you backwards to the start of the last word. I always liked the 'find-character' command: `f+` will skip to position the cursor over the next `+` on the line.

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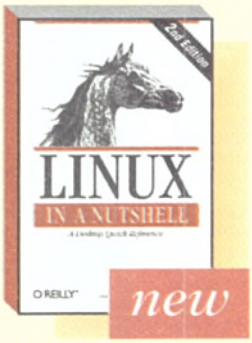

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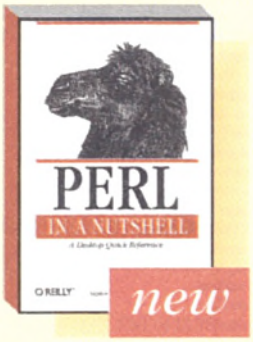

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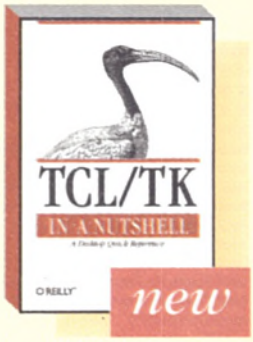

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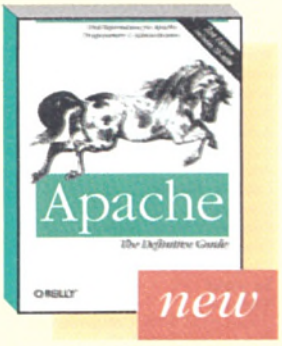

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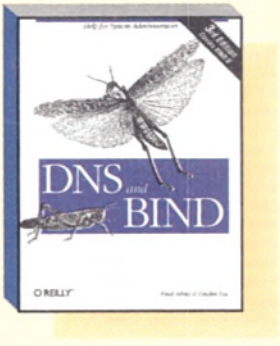

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There are keystrokes that allow you to scroll the screen up and down: `Ctrl-F` takes you forward in the file, `Ctrl-U` (for 'up') back. You can make large jumps by preceding the keystroke with a number, so `10h` will move ten characters to the left. In fact, all commands can be preceded with a number. This means `G` will go to the last line of the file, while `50G` will go to line 50.

Having found the point in the file that you want to change, you can append some text after the character by typing `a`, or insert some text in front of the character by typing `i`. Once you've typed one of these characters, you enter 'insert mode' where any character that you type is entered into the buffer. You exit from insert mode by hitting Esc.

Sadly, escape has become a difficult character to hit easily on modern keyboards. It used to be conventionally located as the top left-hand key in the main block of keys, on the left of the `1` key. It's reachable by your little finger in that position. Nowadays, this key position on PC keyboards is conventionally occupied by a backquote (`), the APL NOT symbol (¬), and a vertical bar (|), while escape is placed just out of easy reach at the end of the function key block. In the meantime, they've also moved the unmentionable Caps Lock key into a position where you are guaranteed to hit it without wanting to.

I program around these problems on the X Window system under Unix by remapping the keys. I turn off Caps Lock, which I never use, and I swap the escape and backquote keys. On my Sun machine, which never runs anything except X, I've moved the plastic key tops on the swapped keys to reflect the settings that X delivers for these keys. All these machinations make it easier to hit Esc when I want to leave insert mode.

Insert mode is also entered by the commands that allow you to insert new text as a new line after the current line (`o`) or before the current line (`O`). To create a new file, you fire up `vi`, hit `o`, and type away.

It's often the case that you want to change, replace, or delete some chunk of text, perhaps a complete word or a section of the line. The commands that make this happen are usually keystroke combinations, a `c` for change or a `d` for delete followed by a movement command specification to express the extent of the change. For example, if you want to delete from the current cursor position to the next `+` on the line, then `df+` will do that. To delete a word and the trailing space after it, use `dw`. To replace just the word use `ce` (remember that `e` takes you to the end of the word). You'll find that `vi` shows you the extent of the change by placing a `$` in the last character position.

There are some shortcuts. To change text starting at the current cursor position until the end of the line, you can type `c$`. But this happens a lot, so typing capital `C` will 'do the sensible larger operation', in this case changing the text up to the end of the line. Capital letters are often used as a shortcut like this. Do beware that the three separate versions of `vi` that I've looked at during the preparation of this article offer different sets of capitalised shortcuts.

Incidentally, if you want to delete a single character under the cursor, you use the `x` command (like using the `x` character on a manual typewriter to black out some text). To change a single character under the cursor, you use `r` (replace) and type the new character – insert mode is not entered.

One complicated aspect of `vi` is what we now call cut and paste. You can pick up a section of a file using the 'yank' command; `yy` copies the current line (irrespective of where the cursor is on the line). You can pick up 20 lines with `20yy`. The second `y` here can be replaced by a movement command as before, so you can pick up words and other line sections. To re-insert the text, you move to where you want to add it, and use `p`. To cut, you just delete the characters using the `d` command followed by a modifier and the characters that have been deleted are placed into the `p` buffer ready for re-insertion.

Most modern versions of vi do have the ability to process and display several files at the same time, so my original main objection has disappeared

This sounds fine, but there are some rough edges. One problem occurs when the region you are cutting occupies several screens, and you want to check before you kill the section of the file. The best solution here is to use the 'mark line' command: `m` is followed by a letter, for example `a`, that represents the 'register' used to store that mark. You can now jump back to that marked place by typing `'a`, and can delete back to that line by saying `d'a`.

My own learning curve for `vi` was reduced because if I got stuck, I could revert to the `ex` commands. I used `vi` for some considerable period, and I still do, on occasion. However, I began to become disenchanted with it for several reasons. First, I feel that its line-based nature gets in the way of the editing. I don't treat text as a bunch of lines, I treat it as larger coherent sections: a paragraph or a routine. Second, I began to want an editor where I could see sections of different files on the screen at the same time, and where I could move text easily between them. I suppose, I began to create more complex programs that consisted of several files, and wanted to look at the definition of a structure in a header file while I was writing the code that dealt with it in another source file.

Incidentally, most modern versions of `vi` do have the ability to process and display several files at the same time, so my original main objection has disappeared. The developments just came too late for me. The strengths of the original `vi` was that it was fast, fairly small, and would therefore load quickly. And I think that once you have mastered the keystrokes, its support for getting the cursor to the right place is very good indeed.

Emacs

About 15 years ago, I began to look at Emacs, which does much of what I felt that I wanted. However, it was big, big, big. I always say 'it took a standalone VAX 11/750 to run'. We were getting around 50 people on one of those machines then, and it was not economic to provide me with one just to support an editor. And Emacs has always relied on using Lisp to permit the user to customise things, and this didn't make for a particularly fast editor.

Several people had come to the same conclusion and created stripped-down clones. They liked the modeless nature of the editor, the fact that control actions are specified either by control keys or by using combinations of keystrokes. A keystroke in Emacs never has a different meaning depending on context.

Actually, the keystroke combinations started life as a chorded keystroke, using a normal key in combination with a special key on the keyboard that added an eighth bit into the normally seven-bit Ascii coding, the 'META' key. However, when the editor was moved off these terminals onto regular VDUs some method was needed to specify the 'special' keystroke, and it became a sequence 'escape' followed by another character. Emacs soon ran out of meta characters and used

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CLARITY

Ctrl-X as another command-introducing character. Modern versions of Emacs use other characters.

The other main input characteristic of Emacs is that you can trivially rebind keystrokes to give them new capabilities perhaps accessing a new Lisp function, or because you simply didn't like that particular key to mean that particular action.

Emacs has always provided the ability to edit several files at the same time, each occupying a buffer that may or may not be visible on the screen at any one time. I think that this aspect of its interface attracted many people.

However, it was, and is, big and slow. The slowness is ameliorated by the advent of fast processors, but it's not lively when compared with leaner editors. The Emacs introductory text still says something along the lines of 'Emacs can do so many neat things apart from edit files, and many people start it up at the beginning of the day and use it as their way to interface with the machine'. Well, you need to do this because there is a perceptible pause before Emacs gets its act together and allows you to edit files.

Several lightweight Emacs clones sprang into existence. The front runners were probably MicroEmacs (or uemacs, which was a compromise way of spelling μemacs) and Jove (Jonathan's Own Version of Emacs). Both offered the Emacs look and feel: the buffers and the modelessness. Neither used Lisp, so didn't offer the extensibility. MicroEmacs didn't allow you to rebind keys, but Jove did. I became a committed Jove user, until quite recently.

Again my life has altered. I now need a safe way of editing the HTML files generated by some WYSIWYG programs. Their output files contain very long lines that defeat Jove, but with which Emacs copes happily (as do most modern versions of vi, it should be said). And modern Emacs versions fit rather better into the window environment supported by my workstation running X. They support mouse interaction, and use X widgets to provide action menus.

I decided to pull and install the most recent version of GNU Emacs to see what it would do. I am now a convert. I am still very much on the learning curve, and often confused. Emacs is somewhat overburdened by features that are turned on by default. And accidental keystrokes can sometimes have an undesirable effect on the file. This is offset by its comprehensive 'Undo' facility, which allows you to retrieve your previous state easily.

Another feature of note is its ability to 'fontify' files, showing different semantic sections in different colours. This means that you can detect missing trailing quotes in programs somewhat more easily than you can with a monochrome editor. This feature exists in Microsoft's Visual environments, but the difference with Emacs is that it's a general purpose ability that can be made to work on a great many different types of files.

Emacs does contain a bunch of stuff that I don't really want, like the ability to read news, send mail, look at the calendar, run telnet sessions, play games – the list seems somewhat endless. There are things that I do use, like the ability to compile a program, and examine and fix any errors by being placed in the right file at the right line number. Everyone wants different things from the program. Emacs was perhaps the first 'visual environment' allowing developers to have a single interface to create, debug, and test programs.

You'll generally find a working version of emacs on your Linux or BSD box. It's become a mainstream standard Unix editor. What you probably won't find is Xemacs, which started life from an older version of GNU Emacs and has evolved into something that's perhaps better integrated into the X Window system than GNU Emacs. I got hold of an RPM package for my Red Hat Linux box, and managed to compile a working version for my BSD system. I could not get it to work properly on my Solaris 2.6 machine, and decided that I had expended enough time. Xemacs is considerably prettier than GNU Emacs, and makes more use of the facilities afforded by the X Window environment.

Xemacs is considerably prettier than GNU Emacs, and makes more use of the facilities afforded by the X Window environment

The online documentation provided by Emacs is fine if you know what you are looking for. Documentation is definitely necessary when the program supports so many features. However, trying to get an overview of facilities as a novice is hard. I resorted to buying O'Reilly's book on Emacs, mostly to read the general introductory stuff to find out what is possible, and to learn how to turn off some of the annoying things that are enabled by default.

I haven't found much space here for an introduction on how to use Emacs, but it comes with a tutorial file that demonstrates its basic capabilities and you are advised to read (and use) that. To get out of Emacs type Ctrl-X followed by Ctrl-C or if your version is X-enabled, then you'll find an exit option in the usual place in one of the drop-down menus.

The learning curve for Emacs is probably much greater than that for vi, and the editors are difficult to swap between. If you are wanting to develop programs then the grief that you will experience in the initial stages of learning Emacs will be outweighed by the use that you will obtain later.

Further information

You can get the latest version of Emacs from your nearest GNU storage facility. Incidentally, by the time you read this, my favourite UK site: *http://unix.hensa.ac.uk* will have transmuted into *http://www.mirror.ac.uk*. There are several vi clones around. My Linux system comes with one called vim by Bram Moolenaar (et al). You should look for nvi by Keith Bostic, who was one of the original Computer System Research Group at Berkeley and was largely responsible for commissioning the set of Open Source BSD utilities that support many of the BSD-based systems that are around. However, these two programs should be present on your machine. I also note that the latest release of the NT 4 Server Resources Kit from Microsoft contains a version of vi.

You'll find Xemacs at *http://www.xemacs.org*. I got my RPM from the contributed section at *http://www.redhat.com*. Jove is FTP-able from *ftp.cs.toronto.edu:/pub/moraes/jove*.

Many books have basic introductions to ed, vi, and Emacs. I would certainly recommend the O'Reilly book on Emacs: *Learning GNU Emacs* by Debra Cameron, Bill Rosenblatt, & Eric Raymond (ISBN 1-56592-152-6). ■

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How small is a bit?

Leaving behind the Y2K Bug and the problems of this millennium, we look ahead to the future. Mark Harman introduces the subject of quantum computing, possibly the biggest revolution in computing since the invention of the transistor.

Gordon Moore, the co-founder of Intel, coined Moore's Law in the 1970s. This states that the memory capacity of a silicon chip approximately doubles every 18 months. As a direct consequence of Moore's Law, the amount of space occupied by a single bit is also decreasing, because the overall size of chips remains largely constant. In 1960 a single bit of information typically required about 10^{16} atoms to represent it. Today the figure is closer to 10^{7}. Assuming that this trend continues, then by 2020 we will have reached a stage where less than one atom is required to store a single bit of information.

What happens when we reach the one atom per bit barrier? When this happens we will be forced to enter the world of quantum mechanics: the often baffling but astonishingly successful world of sub-atomic physics. Based upon this new physics, we can implement computers that may execute exponentially faster than today's classical computers and require exponentially less storage space in which to do so. Welcome to the world of quantum computing.

Quantum computing

Quantum computers are not like ordinary computers. They are built, not using the nineteenth century physics of electro-magnetism, but the twentieth century physics of quantum mechanics. One of the most startling aspects of this new physics is that a particle can exist in many (apparently contradictory) states *at the same time*. In this 'many states in one' situation, the particle exists in what is called a 'superposition' of states. In computing terms, it is as if a boolean register could hold the values `true` and `false` simultaneously. It is because of this superposition of states that there is the possibility of *superfast* and *supercompact* computers based on the principles of quantum mechanics. These new quantum computers will outperform today's computers to such a degree that the theoretical foundations of computation may need to be rewritten, and many existing algorithms may seem sluggish and inefficient.

When applied to the world of computing, quantum physics has bewildering but very exciting possibilities. Not only will we be able to read 2^n different n-bit numbers into n bits, we shall be able to process all 2^n bit combinations at once (this is called quantum parallelism). Obviously, if we can store such an enormous amount of information in such a small space, many of the rules of computing that we have grown comfortable with over the past fifty years will have to be abandoned, or at least revised.

Of course, there is a catch. Although we can process all 2^n bit combinations at once, we shall only be able to inspect a single answer from our computation. Worse, we cannot be exactly sure which answer we will get. There is an uncertainty at the heart of quantum physics that we shall have to tame or circumvent in order to be able to exploit the wonderful potential of this new computing technology. There is also the problem of interaction between our computer and the outside world: quantum computers are very fragile. Even an exchange of a single particle could destroy the entire computation.

Despite all of these drawbacks, there is a real and growing hope that quantum computing may prove to be a realistic means of gaining dramatic improvements in the power of computers that would make today's finest machine appear to be a bloated and boring vacuum tube beast, executing with the speed of geological plate tectonics.

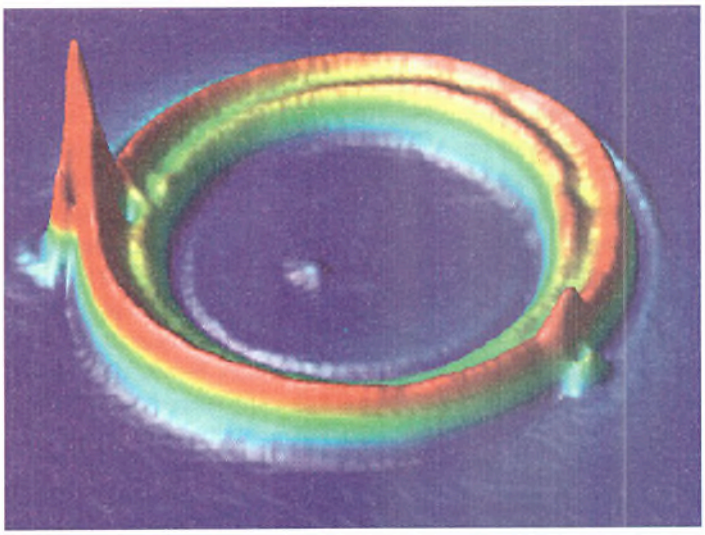
Currently quantum computing is in its infancy. The only quantum computer that has currently been built is a simple NOT gate. A project is underway to implement a computer capable of factoring the number 15 with an expected completion date some time in the year 2000. As with the development of classical computation, the theory of quantum computing is far in advance of the practical development. This article takes a brief look at what could be achieved when the engineering catches up with the science.

The shock of quantum cryptography

In 1994 the world was forced to wake up to the potential of quantum computing, when Peter Shor showed that it was theoretically possible for a quantum computational algorithm to crack the world's most secure encryption systems. All that is required is for the physicists to develop the quantum-level hardware.

Shor's algorithm is by no means the only application of quantum computing. Algorithms have been developed for more prosaic applications, such as fast, massively parallel database searches. The importance of Shor's algorithm was its potential impact on secret and secure communication, because of its implications for public key encryption systems.

Public key encryption systems form the basis for most of the secure communications we rely upon today. These systems are vital for privacy and are obviously important as underpinning technology for the growing e-commerce industry. Public key encryption relies upon the fact that factoring a large number is extremely hard. For example, in a recent contest it was calculated that to success-



fully decrypt a message encrypted with a key 129-digits long it would take a machine capable of running a million instructions per second 5,000 years. If we wait for a computer to crack an encrypted message by finding factors, then the information we get might be a little out of date!

Because factoring is believed to be so hard (even with the most powerful computer) many people felt completely comfortable sending encrypted messages. The factorisation of a number can be achieved (using a little number theory) by finding the period of a related periodic function. Of course, all classical attempts to solve the problem of finding the period of this function turn out to be as computationally demanding as the original problem of factoring. Shor's algorithm proposes the use of Fourier transforms and quantum parallelism to find the function's period, and it does so exponentially faster than any known classical algorithm. Secure communication is no longer so secure.

Shor's algorithm has been investigated by simulating its execution using a classical computer. Of course, this takes a lot longer than it would on a quantum computer, but it provides quantum computer scientists with a technique for analysing the behaviour of the algorithm. An implementation of Shor's algorithm on a real physical quantum computer is still some way off. As mentioned, work is underway to try to implement a specialised quantum computer that will use the algorithm to factor the number 15. If successful, this will not cause an immediate headache for cryptanalysts (who typical rely on numbers with many more digits), but it could signal the beginning of the end for public key encryption.

Shor's algorithm presents a worry for those who rely on existing approaches to encryption, but quantum communication offers a possible remedy to this problem. Because of the way in which a quantum-level piece of information cannot be inspected without disturbing it, it is possible to imagine 'quantum communication channels' on which it is *impossible* to eavesdrop. On these secure quantum channels, even an (unsuccessful) attempt to eavesdrop on a communication will be detectable by both the sender and recipient of the message, making spying not only impossible but also rather dangerous.

Quantum computers thus offer both a severe headache for secure private communication and the ultimate solution to the problem. The severe headache comes from Shor's algorithm. The pain relief may be offered by the panacea of quantum communication.

An experiment

Here is a quantum experiment that you can try at home. Quantum computers are based on qubits. A qubit exists in a superposition of states between zero and one, but collapses to a single state, either zero or one, when measured. It is hard to imagine how a single bit can exist in the superposition of states. However, there's a very simple experiment that you can try, which illustrates the key principle of state superposition. All you will need is a strong light source (say a powerful torch) and three polarisation filters (you can get these from a camera shop).

Let's call the filters *A*, *B*, and *C*, with filter *A* polarised horizontally, *B* polarised at 45°, and *C* polarised vertically. You can achieve the different angles of polarisation by holding the filters at different angles. Photons of light also have a polarisation, so we can use the polarisation of the photons to represent a bit of information. Suppose we choose to represent bit value `zero` by horizontal polarisation and bit value `one` by vertical polarisation. A 45° polarisation represents a bit of information that has a 50:50 probability of being either value `zero` or `one`; it is somehow both `one` and `zero` at the same time and in equal measures.

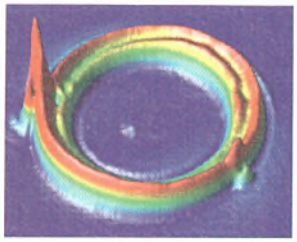
The next step is to shine a beam of light onto a screen and put filter *A* between source and screen. Clearly, you would expect the light beam to reduce dramatically, because the incoming light photons will be in a jumble of randomly selected polarisations, with only a very few being exactly horizontal. In fact the beam is not dramatically reduced, but simply halved in intensity. The filter acts as a measurement of the photons, each of which is in a superposition of polarisation states. In measuring the incoming photon states, the filter collapses these states to either horizontal polarisation (those which pass through and hit the screen) or vertical polarisation (those which are reflected by the filter and do not hit the screen). This situation is illustrated in Figure 1.

A brief history of quantum computing

Quantum computation was born in 1982 when Richard Feynman, the Nobel Prize winning physicist published an article speculating on the implications of quantum mechanics on the world of classical computation. Feynman's inspired observations remained mere conjecture for three years until David Deutsch showed how a quantum computational algorithm could be realised to compute a result faster than could be achieved using any possible classical computer.

Interest in quantum computation increased steadily throughout the late 1980s and early 1990s until 1994. In November 1994 Peter Shor, at AT&T Bell labs, published his paper innocuously titled *Algorithms for Quantum Computation: Discrete Logarithms and Factoring*. This paper shocked and astounded computer scientists around the world. Shor's paper contained the algorithm for factoring based on Fourier analysis and quantum parallelism that promised to turn the world of public key encryption on its head.

As we approach the millennium, the challenge for quantum computer scientists is to build a real quantum computer and to investigate new specialised algorithms (like Shor's) that exploit this technology. An additional goal that I have not had time to discuss in this article is that of providing a more general framework for computing with quantum mechanics, so that new specialised algorithms do not have to be developed for each problem.



Despite these uncertainties and theoretical puzzles, the equations of quantum mechanics have been found to be successful in predicting the outcome of many an experiment.

We can check that those photons that pass through the filter are indeed horizontally polarised by putting filter *C* between filter *A* and the screen (see Figure 2). Filter *C* is vertically polarised, so it reflects all horizontally polarised photons. As we would expect, the addition of filter *C* prevents any light reaching the screen.

So far, it is possible for us to imagine that all the incoming photons are simply in one of two states: `zero`-valued (horizontal polarisation) and `one`-valued (vertical polarisation). In this view of the situation, the polarisation filters simply act like conventional filters. Filter *A* only lets `zero`s through and filter *C* only lets `one`s through. Can you predict the effect of adding filter *B* in-between *A* and *C*? You would expect it to have no effect. That is, because no light can pass through the sequence of filters *A* followed by *C*, none could possibly pass through the sequence *A*, *B*, *C*. How could the addition of another filter increase the amount of light that passes through? Try it. You will find that inserting filter *B* between *A* and *C* *increases* the amount of light that reaches the screen from nothing to about one eighth of the original light beam intensity. Clearly, this astounding result cannot be explained by assuming that the photons coming out of the light source are either `zero`-valued or `one`-valued. What is going on?

In order to understand the result of the experiment we have to view the filters as measuring devices that *change* the state of the photons they measure. We also have to think in terms of *probabilities*. Each filter measures the incoming light with respect to its own polarisation, which we can think of as representing a 'basis', with respect to which the measurement is taken.

Filter *A* measures photons with respect to the `zero` basis. It changes the state of photons that it measures so that those that pass through have a *probability* of being measured as being `one`-valued using a `one`-basis filter (filter *C*, in our case). The probability in this case is zero (ie impossible). Therefore, the sequence of filters *A* followed by *C* cuts out all the light.

However, we have not said what effect filter *A* has on the probability that a photon will be measured as being 45% polarised (that is being in the both-`zero`-and-`one` state) by filter *B*. In fact this probability is exactly 50:50, so half the light passing through filter *A* will pass through filter *B*. Now filter *B* has changed the state of photons so that those that emerge have a 50:50 chance of being measured as being `one`-valued by a `one`-basis filter (filter *C* in our case), so half the light passing through filter *B* now passes through filter *C*. The overall effect of the three filters is therefore that each halves the intensity of the incoming light. The situation is illustrated in Figure 3.

It seems that there is no way of escaping the fact that photons that emerge from filter *B* in this experiment are both in a state of being `zero`-valued and `one`-valued with equal probability. They are in a superposition of states. And there seems to be no escape from the conclusion that the very act of measuring the photons forces them to alter their state, collapsing it in a way that affects future measurements.

We could think about this philosophically. The quantum theory throws up very deep questions about the nature of matter, cause and effect, and measurement. Many eminent scientists have worried about this. Einstein famously remarked that he did not believe that 'God plays dice with the universe' (referring to the probabilistic nature of quantum mechanics). Compton noticed that one might infer from the equations of quantum mechanics that an action could precede its cause. However, this philosophising has yet to produce an intuitive model of the predications of quantum mechanics. In fact, a unification of quantum mechanics and Einstein's equally successful and somewhat counter-intuitive theory of general relativity remains elusive.

Despite these uncertainties and theoretical puzzles, the equations of quantum mechanics have been found to be successful in predicting the outcome of many an experiment like the one we have just carried out with the polarisation filters. There is a prevailing feeling that we should believe in these equations even if we don't really quite understand them.

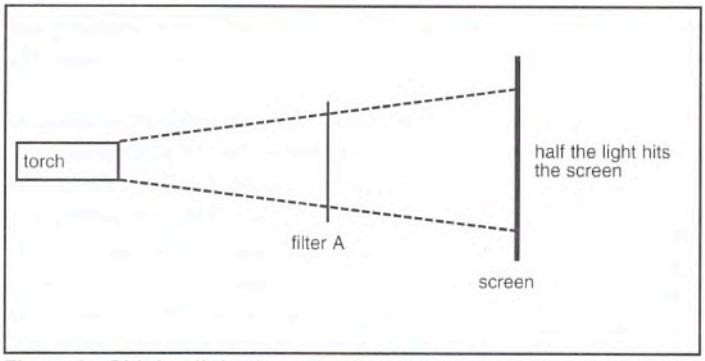


Figure 1 – Shining light through a horizontally polarised filter.

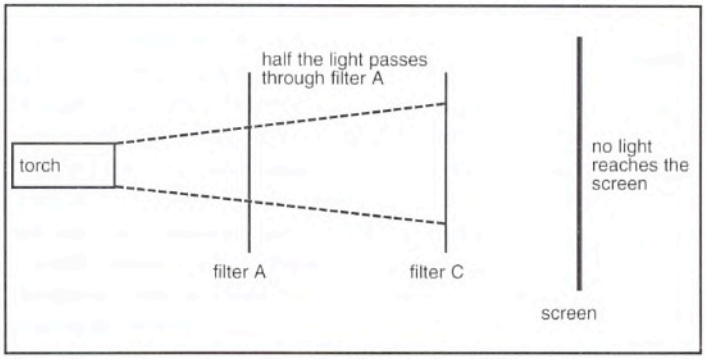


Figure 2 – Horizontally and vertically polarised filters cut out all light.

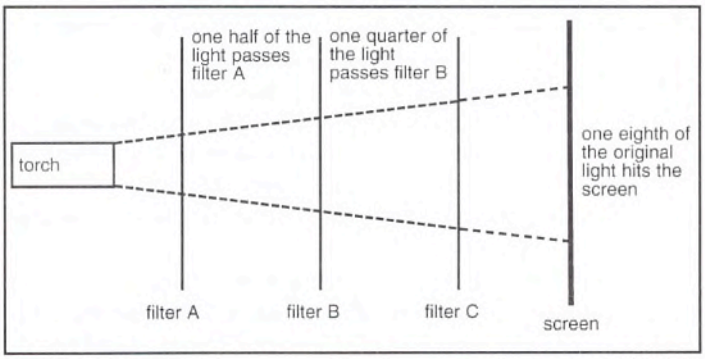
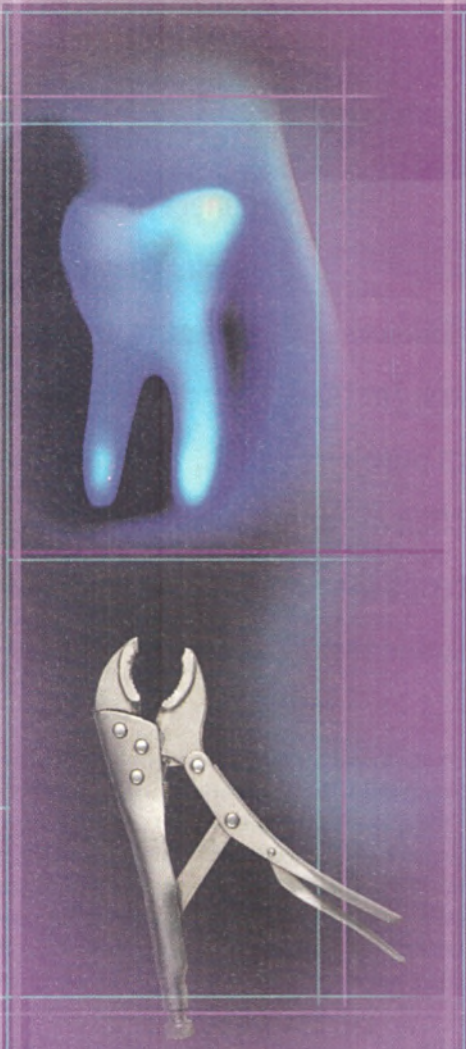


Figure 3 – Introducing an extra filter increases the amount of light.

WOULD YOU PULL YOUR OWN TEETH?



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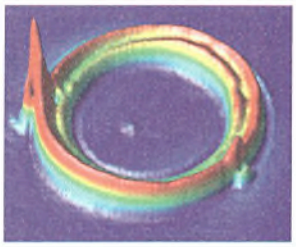


Most random number generators simply do not work. They do not generate *truly* random numbers. Instead, they generate pseudo-random numbers which, for many purposes are sufficient for our needs, but which in some cases may produce surprising and undesirable results.

True randomness

Let's look at another area for quantum computation: true randomness. You would think that generating random numbers is easy. You just rely on the system function `random()`. Generating a random number on a computer seems to be a pretty simple problem and, perhaps, one which is not really that important. This is a misconception on both counts. Most random number generators simply do not work. They do not generate *truly* random numbers. Instead, they generate pseudo-random numbers which, for many purposes are sufficient for our needs, but which in some cases may produce surprising and undesirable results. For example, the 1960s `randu` routine for generating pseudo-random numbers was found to exhibit a correlation that meant that successive triples of numbers produced by `randu` can only occupy equally-spaced planes in 3D space.

Generation of random numbers by computer has been a problem for some time. On 1 June 1957, ERNIE (the Electronic Random Number Indicator Equipment) selected the first one pound premium bond to receive a large prize in the forerunner of the National Lottery. Premium bonds were designed to encourage the public to save, thereby reducing domestic consumption and inhibiting inflation. For the scheme to work, it was crucial that the public believed ERNIE to be fair in picking random numbers. ERNIE uses the frequency instability of a free-running oscillator to select a winning premium bond number each month. This use of a random physical phenomenon avoids the problems associated with pseudo-randomness in algorithms for random number generation.

Generating good random numbers is important because it forms the basis for large-scale statistical simulation used to model complex, dynamic systems, like the economy and the weather. Generating bad random numbers could bias the results of these simulations causing inaccuracies.

Furthermore, random numbers are used in one-time pad encryption and in probabilistic algorithms for solving hard problems that cannot be answered with 100% accuracy in a short time. These probabilistic algorithms are known as Monte Carlo (guaranteed to be quick but only probably correct) and Las Vegas (guaranteed to be correct, but may sometimes take an unacceptably long period to execute). Both Monte Carlo and Las Vegas algorithms rely crucially on good random number generation.

On a quantum computation system, generating random numbers is not a problem, because the underlying computer relies upon the most fundamental physical properties of nature that are (according to the quantum theory) genuinely random.

How to build a quantum computer

Much of the work on quantum computing is theoretical. For example, Shor's algorithm has not been implemented on a real quantum computer, and there is no guarantee that the physical problems of building a computer to factor numbers in this way can be overcome. However, there are grounds for optimism in work currently under investigation using ion trap- and NMR-based (Nuclear Magnetic Resonance) approaches to the realisation of quantum computing.

In an ion trap, radio waves are used to create a sequence of electromagnetic fields that trap ions, creating a linear array of trapped ions – a qubit register, in effect. Each ion can be in a ground state or an excited state, and changes in state are achieved by firing photons at the ion from a laser. Ion traps were successfully used in 1995 to implement a simple quantum computational NOT gate, raising

Further reading

The field of quantum computing is young, but growing fast. There are a number of places you could look for further information.

General introductions to quantum computing can be found in the articles stored on the web pages of the Centre for Quantum Computing, hosted by Oxford University at *http://www.qubit.org*.

A short and very readable introduction, which focuses on Deutsch's algorithm, is provided by Professor Robin Whitty of South Bank University. The URL is *http://www.sbu.ac.uk/~whittyr/quantum/quantum.html*.

The photon polarisation experiment described in this article is taken from the article *An introduction to quantum computing for non-physicists* by Eleanor Rieffel and Wolfgang Polak, which is available at *http://xxx.lanl.gov/abs/quant-ph/*, paper number 9809016.

Bernhard Ömer has developed a programming language in which quantum computing algorithms can be simulated in a 3GL-style notation. The system is available for free on any Linux platform and comes with a manual (in LaTeX and postscript) and an interpreter for QCL (Quantum Computer Language). The URL is *http://tph.tuwien.ac.at/~oemer/qc/index.html*.

There are a growing number of textbooks on quantum computing. *Explorations in quantum computing* (ISBN 038794768X) by Colin Williams and Scott Clearwater, published by Springer in 1997, contains a technical but highly readable account of quantum computing, its applications, and implications. The book comes with a CD-ROM with some simulations of quantum computational algorithms that you can try using the Mathematica package, which runs on several platforms including, PC, Unix, and Macintosh. You do not need to have Mathematica to use the example simulations, because a reduced 'viewer' program is included.

The prize-winning textbook *The fabric of reality* (ISBN 014027541X) by David Deutsch is a worthwhile purchase. Deutsch invented one of the first quantum algorithms, helping to illustrate the potential for quantum computation. His book is an attempt to interweave quantum physics and quantum computation with Darwinian evolution and Karl Popper's theory of knowledge.

There's an Internet discussion group based on Deutsch's book. You can subscribe by sending an email containing the word `subscribe` to the email address *FOR-request@list.to*.

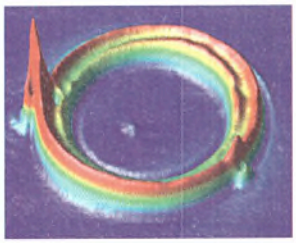
the hope that ion traps might prove successful as implementation mechanisms for more advanced devices.

In the NMR-based approach, a property of atomic nuclei called 'spin' is used as the basis for storing a qubit. Almost any element (or one of its isotopes) can be made to have a spin. Spins have an orientation that can exist only in one of several discrete levels. These levels correspond to the energy levels of the atom and exist in a superposition of levels until they are measured. If energy is supplied to the atom (in the form of radio waves) then an atom may move from one energy level to another. This will happen only if the input energy is at just the right level, and when it does so, the radio wave will be absorbed. Using a series of radio wave pulses, we can thus work out which spin state the atom is in, and this forms the basis for measurement in an NMR-based quantum computer.

With both techniques, many problems remain to be solved, and it is not immediately obvious how the quantum phenomena that they exploit can be harnessed in the form of effective algorithms. However, quantum computer scientists are optimistic that the next ten years may see a breakthrough. After all, even a relatively small quantum computer could revolutionise public key encryption.

An embryonic state

Quantum computing is currently in an embryonic state, but since the mid 1990s interest has dramatically increased because of the theoretical development of several algorithms for superfast database searches, cracking hitherto uncrackable codes, and supercompact storage of data.



We are fast approaching the one-atom-per-bit crunch. At this moment, we will find ourselves in the world of quantum computing whether we like it or not.

The realisation of these dreams is still some way off, but we cannot rely upon Moore's Law to double the power of our classical computers every 18 months. We are fast approaching the one-atom-per-bit crunch. At this moment, we will find ourselves in the world of quantum computing whether we like it or not. If current trends continue, this moment will arrive in approximately 10 to 15 year's time. There is time to prepare and much to be gained. ■

Mark Harman is a lecturer in computer science at Goldsmiths' College, where he works on program manipulation and testing using slicing and transformation. Mark Harman can be contacted by email at m.harman@gold.ac.uk, or by post to Mark Harman, Department of Mathematical and Computing Sciences, Goldsmiths' College, University of London, New Cross, London SE14 6NW.

Greek gifts

They came bearing class libraries – Francis Glassborow warns of one place not to look for examples of good professional programming.

It would seem very reasonable for less experienced programmers to study code produced by major international software developers that has had a long lifetime and to emulate the practices they find in it. It would also seem very reasonable for companies providing development tools for a specific platform to buy-in the relevant libraries to support the platform. Compiler implementors might feel unhappy if they had to deliberately distort the behaviour of their compiler to support such a bought-in library. They might be even less happy if the consequence of marketing pressure was that the out-of-the-box version of their work failed to meet the relevant ISO Standard because of the requirements of a bought-in library.

I think that a good argument could be made in such circumstances that the owner of the library has an excessive and unhealthy domination of the marketplace. Furthermore, I do not think it unreasonable to expect such a dominant force to spend time and resources bringing their product up to scratch. That includes the ability to compile the code free of diagnostics – code that fails this test is not of industrial quality.

You can guess what I am writing about, but let me give you a couple of examples before naming names. What would you think of a programmer who wrote code such as the following?

```
#ifdefined SOMETHING
#define myfunction myfunctionx
#else
#define myfunction myfunctiony
#endif
```

I would hope that you would be highly critical and want to know why the programmer found it necessary to change an identifier in that way. Even in C it is poor practice, in C++ it is, in my terms, unacceptable. It shows no understanding of the concept of scope and the importance of ensuring that the preprocessor does not invade local scopes. I would consider it poor practice even if the preprocessor identifier had been spelt in uppercase. Even if the name in question was relatively long, it leaves code vulnerable.

The correct way to tackle this kind of issue is something like:

```
#ifdefined SOMETHING
#include "x.h"
#else
#include "y.h"
#endif
```

and ensure that the correct version of the library is linked in. Or possibly, in C++, some strategy with overloading will meet the need. For example, get the user to write:

```
myfunction(<argument list>, SELECT_TYPE)
```

and have the following in an appropriate header file:

```
enum X {x};
struct Y {y };
#ifdefined SOMETHING
#define SELECT_TYPE X(0)
#else
#define SELECT_TYPE Y(0)
#endif
```

If the original technique only resulted in errors when it changed my code, I would be unhappy, but it can result in silently changing the semantics of my program. For example, consider:

```
struct X {
   void myfunction(int);
   void myfunctionx(short);
   void myfunctiony(long); };
int main() {
   X x;
   x.myfunction(2);
}
```

However poor my coding style, I should not find that my code does three entirely different things depending on factors that I may be entirely unaware of.

Another question: how should you provide numbers as labels? What about: `typedef int HANDLE;`

I hope your gorge rises at such a proposal. Think of all the potential for harm: `typedef` provides no type safety. Worse still, it exposes these numbers to all the vagaries of arithmetic, something that is entirely inappropriate in this context. Think how much tidier if you wrote:

```
enum handle {firsthandle = 0, lasthandle = <whatever>};
```

Now you cannot do arithmetic on handle values without getting some form of error (at least in C++) because there are no operators on `enum`s (the work is done by converting implicitly to `int`) and there is no implicit conversion from `int` to an `enum` type. Of course, this is only the beginning of an idea, much more can – and should – be done to polish this. But the basics are there and I would expect any respectable C++ (or for that matter plain C) programmer to understand that `enum` creates type variants of the fundamental integral types. C does not give you quite the same protection that C++ does but it is going in the right direction.

Where might you find examples of such defective code as the above? Think about it while I give you a couple more clues.

The same implementor whose standard header files do not compile if you switch off the vendor extensions. As these include such non-extensions as incorrect scope for loop variables, the result makes a fairly good compiler strictly non-conforming.

The same implementor who calmly injects hundreds of names into the global namespace without doing anything to prevent collisions with the names used by other programmers. Look at commercial libraries such as Rogue Wave's and note how its global names are prefixed with RW. Not perfect, but it shows some sensitivity to the needs of the user. It also provides some documentation as to where I should look for declarations and definitions.

While the scope of the loop variable can be fixed by better implementors, the other features of MFC actually *force* others to emulate the same bad habits. Wherever else you look, do not look at MFC for examples of good professional programming.

Metrowerks Pro 5

Those familiar with the development tools from Metrowerks will need no encouragement from me to check out this new release. If you are not

in this group and use C, C++, or Java you should give this product a look. The standard version is for Windows (9x and NT) and the Mac (68K and PPC). It supports cross-compilation between these platforms and mixed-language programming, as well as code generation specifically for the AMD K6 family. It also provides a rather more elegant version of console programming (WinSIOUX on PCs and SIOUX on Macs). There are separately marketed versions for Linux and Solaris.

Metrowerks has done a lot of work on its Java tools, which I guess many Java programmers will appreciate, and its C++ is homing in on the Standard.

Now for the bad news. The documentation is horrific. Too many hyperlinks result in 'The topic does not exist. Please contact your vendor for an updated help file.' The documentation still refers to products that no longer exist, such as their Pascal development tools. There is also extensive coverage of Assembler though the IDE does not appear to support it.

Finally, I was disappointed that they are not yet providing any support for the almost completed new C Standard.

On balance, this is an excellent product marred by some silly faults that I hope Metrowerks will address before its next release.

A caveat and a book

Several months ago I wrote about ideas for including test code with the class. I should point out that this could support only the lowest level of testing, ie that the class code itself is tested. There are many other kinds of test that should be applied that do not fit those schemes. Fully professional development environments will have far more rigorous test requirements already in place. And before you ask, I do believe that if your code can get into a release version (even if only for internal use) without being tested then you are not working in a professional software development environment. Which leads to a book...

Most, if not all, readers of this column are professionally involved in programming or software development. As such, you should be interested in testing the results of your work. We all know how tedious testing is and as a result it is often shirked. This is particularly true of regression testing as evidenced by the number of times old bugs resurface in new releases of products.

Automating software testing goes a long way to alleviate this problem. In this context, *Software test automation* by Mark Fewster & Dorothy Graham (ISBN 0-201-33140-3) should be near the top of your reading list.

Last month's problem

What output should the following short program produce?

```
#include <stdio.h>
int main(){
   unsigned char c;
   unsigned char x = c;
   unsigned char y = c;
   if (x == y) puts ("stable");
   else puts("unstable");
   return 0;
}
```

Some readers may have assumed that the above program might exhibit undefined behaviour because `c` has never been initialised. This would be true were `c` to be of almost any other type. However, there is a special requirement for `unsigned char`: all possible bit patterns must represent valid values. There may not be any 'holes' or special bit patterns that result in unusual behaviour. In practice, this requirement almost certainly means that the other two flavours of `char` will behave similarly. Let me emphasise what this means. Suppose you have an implementation with a 9-bit `unsigned char`. The C Standard requires that in such a system, all possible bit patterns must be valid and (I think) distinct so that the values from 0 to 511 must all be valid.

One consequence of a failure to initialise an `unsigned char` is that the value is not predictable and need not be stable. At first sight most programmers will believe that the program must output 'stable'.

To see why this might not be the case we need to look closely at the way that an implementation might work with the code. First, it might well choose to keep the values of all three variables in registers. It could mark the register used for `c` as free for alternative use as the programmer has placed no requirement on the value it contains (actually, I can see no requirement that it assign storage for `c` and it might randomly generate values at compile-time). Even in this simple case, in a multitasking environment the value in the register might change between the initialisations of `x` and `y`. As a result, the output from the above program is unspecified though it must be either 'stable' or 'unstable'.

Note that this changes if we replace `char` by `int`, `long`, `double`, etc. Now we have undefined behaviour because in these cases the type is allowed to have bit patterns that do not represent a valid value. Some systems use such bit-patterns as trap values that indicate some form of problem. In addition, the next version of C will require support for such things as infinity, which will have their own special behaviours.

This month's problem

The following is the definition of a member function in a book by a well-known author. The code is part of his implementation of a simple string class. The class has two data members: `p`, which is a `char *` to handle a dynamic array to hold the string, and `len`, which holds the current capacity of the string object. Read on:

```
strtype & strtype::operator=(strtype &ob){
// see if more memory is needed
   if (len > ob.len) {
// need to allocate more memory
      delete [] p;
      p = new char[ob.len];
      if(!p) {
         cout << "Allocation error\n";
         exit(1);
      }
   }
   len = ob.len;
   strcpy(p, ob.p);
   return *this;
}
```

There are so many problems with this code that you are unlikely to spot them all. However, I encourage you to try. Send me your analysis (include errors, dangerous programming, and poor style); the author of the best (I get to decide what that means) that I have by the last day of JaCC will receive a copy of *Software test automation*. ■

Association of C/C++ Users subscriptions: Basic £15, Full £25, and Corporate £80. Full-time students get a 50% discount of the membership of their choice. For further information and application forms see http://www.accu.org or write to Francis Glassborow, 64 Southfield Road, Oxford, OX4 1PA, ring 01865 246490, or email editor@accu.org.

JaCC – The Java and C/C++ Seminars (15-18 September 1999, at the Oxford Union). See www.accu.org or tel. 0171 970 4772 for more details.

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Rich and richer

Mark Smith shows how you can use the newer, more powerful features of the Windows rich edit control that aren't exposed by the VCL.

Essentially, the rich edit control is a wordprocessor inside a control. It supports formatting of text, indentation, font control, and the other basic features one expects to see. The underlying Windows control is substantially more powerful than the features exposed by Delphi would have you believe, so in this article I'm going to show how to use the newer, more powerful features. The Visual Control Library does an admirable job of wrapping up the Windows API and making a consistent framework out of it, but over the last few years, some of the Windows controls wrapped by the VCL have been enhanced by Microsoft, without Borland changing the VCL to expose the new functionality.

The first, most basic problem with the current VCL implementation is its reliance on an old version of the control, in `riched32.dll`. If you look in the Comctrls unit, at the `CreateParams` method of `TCustomRichEdit`, you can see the DLL name declared as a constant. The Windows API has evolved since this code was written, and the new versions of the rich edit control are in `richedit20.dll`. There was no change to this in a late beta of Delphi 5 so I would expect the story to be the same in the shipping version.

With Windows and Office 2000 providing rich edit three, Borland should seriously consider revisiting its implementation. In the meantime, the best place for information about the rich edit control is the MSDN website: *http://msdn.microsoft.com/library/sdkdoc/winui/richedit_9d2r.htm*.

Building a new rich edit control

The Delphi class `TRichEdit` provides access to the basic functionality of the control. The most conspicuous properties of the control are: `DefAttributes`, `SelAttributes`, and `Paragraph`. The `DefAttributes` property describes the default font formatting for the control, while `SelAttributes` describes the attributes of the currently selected text. The `Paragraph` property gives access to the non-font characteristics of the current paragraph, such as alignment, indentation, and bullet points. There is a lot that the Delphi team did not expose in such a convenient manner – the ability to easily embed objects such as hyperlinks or graphics being a case in point. The largest single omission is the rich edit OLE interface, which gives access to a programming interface that allows the rich edit control to take part in object linking and embedding, more on which later.

The only way to overcome many of the limitations in the current rich edit control is to create a new one. We need to do this so that we can specify the name of the DLL that holds the executable code for the Windows control, as well as specify the name of the Windows control class that we need to subclass: `richedit20a`. The file `richedit2.pas` (along with a demonstration program to show the new features) is available from EXE OnLine. The first new feature is the correct handling of multi-level undo. The VCL implementation only allows you to undo one operation, but just deriving from the new rich edit control class gives us multi-level undo without doing any further work.

Using Windows messages

Since the rich edit control is a Windows control you normally talk to it by sending Windows messages, most of which are defined in `richedit.pas`. The most straightforward way of extending the rich edit control is to use the messages that Borland has not already turned into properties or methods. Mostly these are rich edit 2 messages. To force the control to undo an operation, send it a message with `EM_UNDO` as the message ID. To redo an operation, send `EM_REDO`. You can check to see if a rich edit 2 control is able to undo or redo by sending (or performing) the `EM_CANUNDO` and `EM_CANREDO` messages, as shown in the demo program. You can also query the type of operation that the control will undo or redo – typing, copying, etc – so that it becomes easy to build hints such as 'Undo typing' or 'Redo paste'. You may notice that I use `Perform` rather than `PostMessage` or `SendMessage` in the example application. The use of `Perform` bypasses the Windows message queue and goes straight to the target control's message handler. There's no benefit here, but I tend to prefer it since it feels more like a normal function call.

Text formatting

The Delphi `TTextAttributes` class describes the font for a section of text in a rich edit control. There are more characteristics available now than in the earlier versions of the control, but getting hold of them requires more work than was needed to get the new undo/redo functionality. As I mentioned, the most common way to manipulate the contents of a rich edit control is through the `DefAttributes`, `SelAttributes`, and `Paragraph` properties. The first two are objects of class `TTextAttributes`, while Paragraph is of class `TParaAttributes`. One property of `TTextAttributes`, `ConsistentAttributes`, is a set describing the properties of the text in question. The `TRichEdit` class has not been updated to take account of the new text attributes (shadow, emboss, URL) that the Windows control now supports. It puzzles me that Borland has already translated the more up to date data structures, in `richedit.pas`, but did not implement them. To support the new functionality, we need to make the control support the new structures. Rather than start from scratch, I've created a new descendent of the existing `TTextAttributes` class that has properties that expose the new functionality.

To set the attributes of some text, you need to fill a formatting structure with the new values, and set a flag to say which parts of the formatting to apply. The formatting structure used by the VCL implementation is `TCharFormat`, which can be replaced by `TCharFormat2A` (or `TCharFormat2W` if you are using Unicode). At the time of writing, I have not had a lot of success with some of the enhanced formatting – the underline styles being an example. This may be due to their being implemented in a more recent version of the DLL than I have installed.

Using the Rich text OLE interface

The rich edit control supports object linking and embedding through an OLE interface, which opens up the rich edit control to more than just text, since you can use the OLE interface to embed objects, documents, or even hyperlinks. Unfortunately, Delphi does not ship with

```
IRichEditOLE = interface (IUnknown)
      function GetClientSite(out clientSite:IOleClientSite)
                           :HResult; stdcall;
      function GetObjectCount:longint; stdcall;
      function GetLinkCount:longint; stdcall;
      function GetObject(iob:longint; var reObj:TRichEditObject;
                           flags:longint):HResult; stdcall;
      function InsertObject(reObj:PRichEditObject):HResult;
                                                stdcall;
      function ConvertObject(iob:longint; var clsID:TCLSID;
                     szUserTypeNew:POleStr):HResult; stdcall;
      function ActivateAs(var clsId:TCLSID; var
                           clsIdAs:TCLSID):HResult; stdcall;
      function SetHostNames(szContainerApp:PChar;
                     szContainerObj:PChar):HResult; stdcall;
      function SetLinkAvailable(iob:longint;
                           available:boolean):HResult; stdcall;
      function SetDVAspect(iob:longint;
                           dvAspect:longint):HResult; stdcall;
      function HandsOffStorage(iob:longint):HResult; stdcall;
      function SaveCompleted(iob:longint; stg:IStorage):HResult;
                                                stdcall;
      function InPlaceDeactivate:HResult; stdcall;
      function ContextSensitiveHelp(enterMode:boolean):HResult;
                                                stdcall;
      function GetClipboardData(var chRg:TCharRange;
        reco:longint; out dataObj:IDataObject):HResult; stdcall;
      function ImportDataObject(dataObj:IDataObject;
        cf:TClipFormat; hMetaPict:HGlobal):HResult; stdcall;
   end;
```

Listing 1 – The IRichEditOLE interface.

```
procedure TRichEdit2.CreateObject(const CreateInfo:TCreateInfo);
var
   Storage : IStorage;
   OleObject : IOleObject;
   OleSite : IOleClientSite;
   RichEditObject : TRichEditObject;
   Data : TOleUIChangeIcon;
begin
   FRichEditOle.GetClientSite(OleSite);
   FRichEditOleCallback.GetNewStorage(Storage);
   case CreateInfo.CreateType of
      ctNewObject:
         OleCheck(OleCreate(CreateInfo.ClassID, IOleObject,
            OLERENDER_DRAW, nil, OleSite, Storage, OleObject));
      ctFromFile:
         OleCheck(OleCreateFromFile(GUID_NULL,
            PWideChar(CreateInfo.FileName), IOleObject,
            OLERENDER_DRAW, nil, OleSite, Storage, OleObject));
      ctLinkToFile:
         OleCheck(OleCreateLinkToFile(PWideChar(
            CreateInfo.FileName), IOleObject, OLERENDER_DRAW,
                  nil, OleSite, Storage, OleObject));
      ctFromData:
         OleCheck(OleCreateFromData(CreateInfo.DataObject,
            IOleObject, OLERENDER_DRAW, nil, OleSite, Storage,
                                    OleObject));
      ctLinkFromData:
         OleCheck(OleCreateLinkFromData(CreateInfo.DataObject,
            IOleObject, OLERENDER_DRAW, nil, OleSite, Storage,
                                    OleObject));
   end;
   FillChar(RichEditObject, SizeOf(TRichEditObject), 0);
   RichEditObject.cbStruct:=SizeOf(TRichEditObject);
   RichEditObject.cp:=SelStart;
   RichEditObject.oleobj:=OleObject;
   RichEditObject.clsid:=Data.clsid;
   RichEditObject.stg:=Storage;
   RichEditObject.olesite:=OleSite;
   RichEditObject.sizel.cx:=0;
   RichEditObject.sizel.cy:=0;
   RichEditObject.dwUser:=0;
   FSelObject:= OleObject;
   if CreateInfo.ShowAsIcon then
   begin
      RichEditObject.dvaspect:=DVASPECT_ICON;
      FDrawAspect:=DVASPECT_ICON;
   end
   else
   begin
      FDrawaspect:=DVASPECT_CONTENT;
      RichEditObject.dvaspect:=DVASPECT_CONTENT;
   end;
   If CreateInfo.CreateType=ctNewObject then
      RichEditObject.dwFlags:= RichEditObject.dwFlags or $010;
   Olecheck(FRichEditOle.InsertObject(RichEditObject));
end;
```

Listing 2 – Creating a new OLE object.

an Object Pascal translation of the rich edit OLE interface, so we need to build one. I enjoy converting C++ files to Pascal as much as the next man, so I was grateful to find that the C++ interface, `richole.h`, is only 170 lines long. I tried using Bob Swart's HeadConv utility (*http://www.drbob42.com*) to do the conversion, but it does not handle interface definitions so I had to do the job by hand. The definition of `IRichEditOLE` that I came up with is shown in Listing 1. It seems to work, even if I might have got some of the parameter definitions slightly wrong.

Once we have the definition of the OLE interface, the next task is to get hold of an instance of it. We do this by sending the Windows message `EM_GETOLEINTERFACE` to the rich edit control and casting the `LPARAM` to our `IRichEditOLE` interface. After this, things get somewhat more involved. To allow our rich edit control to hold OLE objects, we need to allow the control to request resources from the hosting application.

We achieve this by providing the rich edit control with an object that implements the `IRichEditOleCallback` interface. This interface defines several important methods, chief among them being `GetNewStorage`, in which we create a structured storage interface for the rich edit control to store the embedded objects. Once we have the structured storage, we can create a new object and then insert it into our control as shown in Listing 2. The `TCreateInfo` structure passed as a parameter to the procedure is defined in `OLECtnrs.pas` and describes the create type (as in the `case` statement), class ID, and filename of the object to be embedded. Once we have called the appropriate OLE function to create the object described in the `CreateInfo` parameter, we populate a new record structure of type `TRichEditObject` (defined in `richedit2.pas`), which describes the appearance of our embedded object. The demonstration project also shows how to embed URLs in the rich edit control, as well as use some events to detect when the user selects an URL.

Going further

I have deliberately ignored issues of wide strings versus Ansi strings in this article. The `RichEdit2` class in the sample application uses Ansi string functions. These can be changed to their wide string equivalent if that is what you need. Likewise, I have not looked at features offered in rich edit 3, since most people are still using earlier versions of MS Office.

Delphi 4 plus one more

The new release of Delphi should be hitting the shops about the same time as this article. I've been playing around with the betas over the past few months, and it looks like Delphi 5 is a lot more reliable than its predecessor was. Of course, Borland may add more bugs into the final release, and snafu the entire thing at the last minute. I think this is less likely this time round – John Kaster in Borland's Developer Relations has said: 'Quality is the most important thing to our developers.' And other Borland staff have indicated that they have management support for shipping a much better product than Delphi 4. Clearly, no release is ever perfect, but the messages coming out of the new (no longer .com) Borland are promising. Finally, congratulations to Marco Cantù and Bob Swart, winners of this year's Spirit of Delphi award (*http://www.borland.com/delphi/vote/index.html*). ■

Mark Smith is a Delphi contractor. You can contact him by emailing msmitha@cix.co.uk, or say hello at a Borland User's Group meeting. Telephone 01980 630032 for BUG details.

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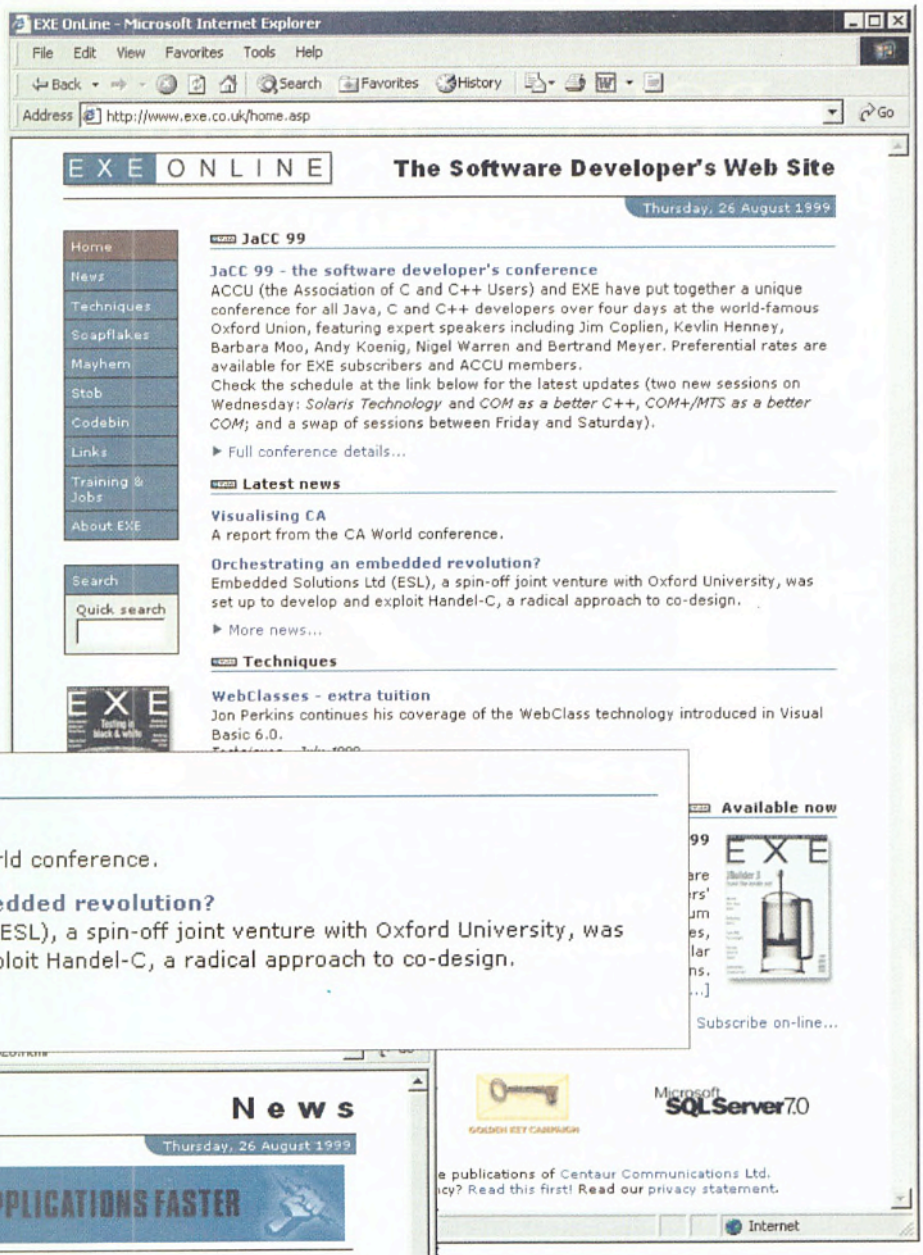

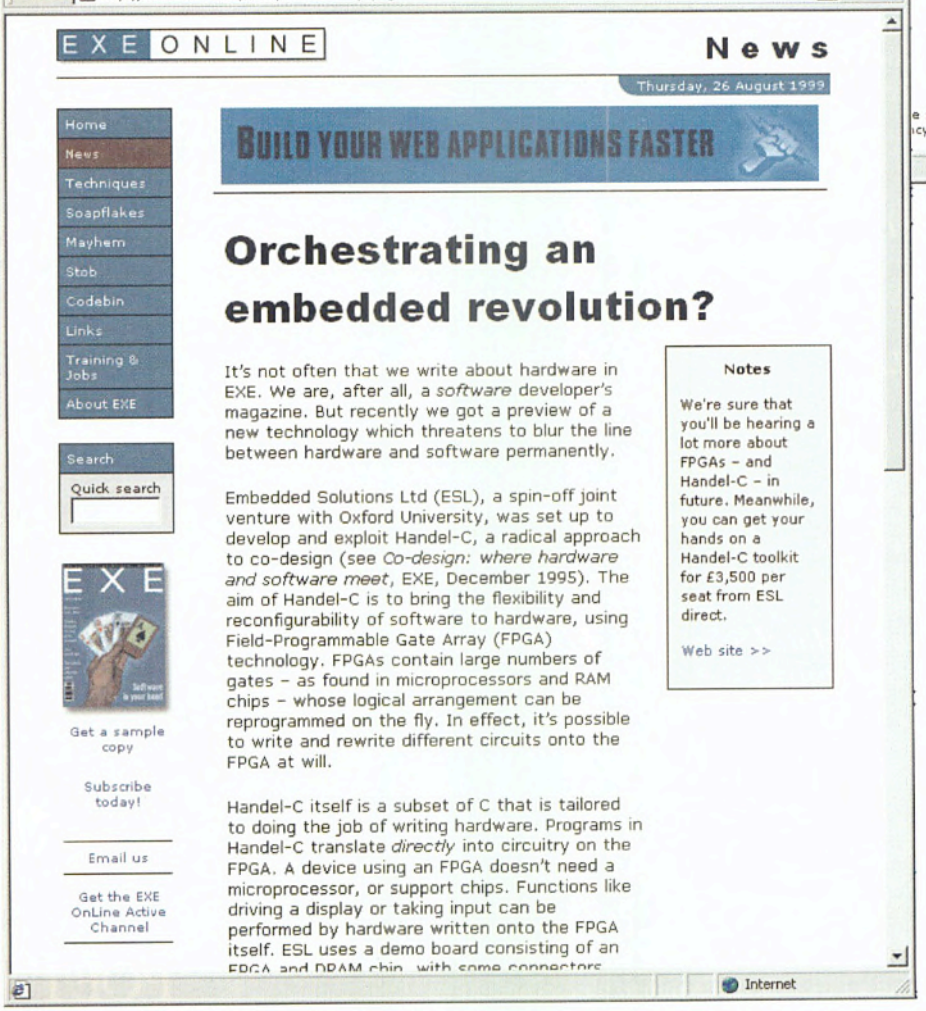

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A new sense of security

Lou Grinzo, our new Java columnist, provides a quick peek at the JDK 1.2 security features.

Security is one of those topics in computer programming that are never truly done. The best approach is to view it as an on-going journey, a philosophy even, and not a simple standalone task that we can do once, cross off our list, and then happily move on to other chores. The evolution of Java's security features are a perfect example of this mindset in action, as Sun has significantly expanded and improved the security support in JDK 1.2.

This month I'll give you an overview of the new security model, and provide a simple demonstration of how to use its features to deal with the most common topic in Java security: controlling access to local files.

What was

Prior to the JDK 1.2, Java's security was a classic example of violating Einstein's observation that we should make things as simple as possible, but no simpler. The 'sandbox', as it's lovingly called, places very tight restrictions on applets, which results in quite good security overall. But it can be very frustrating for programmers not used to dealing with security issues. Many developers want to write applets for use solely within their company, on a LAN for example, but find that the sandbox's restrictions, most notably the inability of applets to read from or write to local files, are a showstopper. By contrast, local applications and the classes they load from local sources, encounter no security restrictions whatsoever. Ironically enough, this can afford less protection than is desired. (I ran into exactly this situation some time back, in fact, in that I had to run an application I'd written that loaded and used classes created by people I didn't know. I wanted to keep the alien code in the tightest possible sandbox, but give my own code free reign of the system. This was difficult with the JDK 1.1, but the new security features in v1.2 greatly simplified matters.)

The core problem with the v1.1 security was that Sun relied too heavily on a heuristic: local and signed non-local code was trusted, while unsigned, non-local code was not. That's simply painting with too broad a brush for a general purpose programming language, even if you can always determine where code is *really* being loaded from.

The older security architecture also presented quite a few challenges if you wanted to create a custom security policy. The methods available required a knowledge of the JVM's call stack, and resulted in error-prone, fragile code.

What is

Luckily, Sun realised the shortcomings of the old model and completely redesigned the security features in JDK 1.2. They created a system that provides fine-grain control, far easier configuration, and no reliance on determining whether code was local or non-local. The new system is also much cleaner and more extensible, since it keeps separated those parts of the design that should be (like the content of the security policy and the implementation). I can't begin to give you more than a taste of the security facilities here, as they include keystores, certificates, signed `jar` files, and cryptography extensions. This is an area I'll revisit in future columns. (See *http://java.sun.com/docs/books/tutorial/security1.2/index.html* for Sun's online security tutorial.)

From a programmer's standpoint, the new architecture is built around an object-oriented hierarchy of permissions, which are controlled via plain-text policy files. These permissions control access to things like files, networking facilities, and configuration information. Perhaps Sun was tired of listening to all the complaints about the all or nothing approach of the sandbox, because the new system provides you with a surprising level of control. You're not limited to allowing or prohibiting a given Java executable access to local files, for example, but you can specify which files in which directories the code can access, and even the type of access allowed (read, write, execute). In addition, programmers can create and manage their own application-specific permissions if the predefined permissions aren't sufficient, much as they can add to Java's exception hierarchy.

The key to managing permissions is two files: `java.policy` and `java.security`. In a normal installation under Windows, both files are stored in *c:\<jdk_name>\jre\lib\security*, where *<jdk_name>* is what you would expect – jdk1.2.1, jdk1.2.2, etc. (Note that this file placement conflicts with Sun's frequent reminders that these files are stored in the *\lib\security* directory under the main JDK directory.)

The `java.policy` file contains the normal, base security settings, and you typically won't have to worry about changing or even looking at this file. However, `java.security` is more useful for our purposes, since it contains some settings that affect the behaviour of the overall security subsystem, including the names of additional policy files to use. By adding your own policy files, as I'll demonstrate shortly, you can create a surprisingly flexible configuration, and control what you allow individual Java programs (both applets and applications) to do.

Policy files are just text files that you could create or modify with any editor. That's definitely not recommended, though, since the syntax is fussy enough to make errors more than a possibility. Instead, you should use Sun's GUI `policytool` program, which is in the *\bin* directory of your JDK installation. This tool is fairly straightforward to use, but it does require some careful attention to how you specify paths, since there is slightly different syntax for specifying whether you're granting access to list the files in a directory, or access to read the files themselves. See *http://java.sun.com/products/jdk/1.2/docs/guide/security/spec/security-spec.doc3.html* for more details.

Doing it

Enough theory – let's see how this all works. You'll need a v1.2-compliant JVM installed to work through these examples, of course. (I used the JDK 1.2.1 for Windows.) If your system doesn't have a *c:\temp* directory, create one, and copy the two files from this article (`TestWrite.java` and `test.policy`) into it. Of particular interest is `test.policy`, which I created with the `policytool`. The entire file is:

```
/* AUTOMATICALLY GENERATED ON Sun Jul 18 10:11:00 EDT 1999*/
/* DO NOT EDIT */
grant codeBase "file:/c:/temp" {
   permission java.io.FilePermission "c:\\temp\\*", "write";
};
```

This policy file grants the ability to write to any file in the directory *c:\temp* to any Java code that is loaded from the local directory *c:\temp* (referred to as the `codeBase` above).

The `testWrite` program (see Listing 1) is a minimal Java application that writes a single line of text to two files: *c:\temp\test.txt* and *c:\text.txt*, in that order. If you compile and run this program as you would any other Java application, it blissfully creates the output files and reports success, as expected. It's not very exciting, but baseline cases aren't supposed to be.

Rerun `testWrite`, but tell the JVM to use a security manager:

```
C:\temp>java -Djava.security.manager testWrite
```

Watch what happens: access is denied. The JVM has used the security manager, as requested, which restricted `testWrite` from accessing local files. This looks suspiciously like our nasty old friend, the sandbox.

Next, edit the `java.security` file for your JDK (*c:\jdk1.2.1\jre\lib\security\java.security* on my system), and you'll find a line that looks like:

```
policy.url.2=file:${user.home}/.java.policy
```

Add a line beneath this one that reads:

```
policy.url.3=file:/c:/temp/test.policy
```

You must use either forward slashes or double backslashes in this line, to prevent the JVM from parsing the line incorrectly, and the path and filename must point to the `test.policy` file above.

Re-run `testWrite` with the `-Djava.security.manager` option as you did above, and this time you'll see that the write to *c:\temp\test.txt* worked, but the write to *c:\test.txt* triggered an exception. If you move `testWrite.class` to another directory and run this last test again, it will fail on its attempt to write to the first file, which is exactly what we should expect – our policy file specifically grants the right to write to any file in *c:\temp*, but only to Java programs run from *c:\temp*. When `testWrite` was run from a different directory, our policy no longer applied to it, and it once again felt the mighty wrath of the sandbox.

If you want to run `testWrite` and use our custom security policy file, you can avoid editing `java.security`, as we did above to add the `policy.url.3` line. Instead, you can specify the policy on the command line, like this:

```
java -Djava.security.manager
    -Djava.security.policy=test.policy testWrite
```

This will work exactly as expected, although it does require a depressing amount of typing even by Java's normally verbose standards.

```
import java.io.*;
class testWrite {
   public static void main(String[] args)
      throws FileNotFoundException, IOException {
      String[] fn = { "c:\\temp\\test.txt", "c:\\test.txt" };
      int num_strings = 2;

      for(int i = 0; i < num_strings; i++) {
         System.out.print("About to write to \"" + fn[i] + "\"... ");
         writeFile(fn[i]);
         System.out.println("success!\n");
      }
   }

   static void writeFile(String fn)
      throws FileNotFoundException, IOException {
      FileOutputStream fos = new FileOutputStream(fn);
      OutputStreamWriter osw = new OutputStreamWriter(fos);
      osw.write("This is a file written by testWrite!");
      osw.close();
      fos.close();
   }
}
```

Listing 1 – Writing a single line of text to two files.

Notice that in `java.security` the `policy.url.2` line pointed to a file called `file:${user.home}/.java.policy`. This is a per-user policy file, and the `${user.home}` is replaced by the user's home directory. Under Windows, this can be *c:\windows*, *c:\windows\profiles\<username>*, or *c:\winnt\profiles\<username>*, depending on the version of Windows you're running and whether you're doing so in single- or multi-user mode.

You could create or edit `.java.policy` (note the leading `.`) with the `policytool` utility and add our custom policy to it, and it would be used whenever your Java system used a security manager. Which brings up yet another interesting wrinkle in our security tapestry: the security manager is always used for applets, whether they're loaded from a local or remote location, but never used for applications unless explicitly requested with the command line options shown above. You could argue that this is just another variation of the local/non-local heuristic, but since it works so much better, I certainly won't complain.

Weirdnesses

When you begin experimenting with the new JDK 1.2 security features, you're likely to run into several issues. In the interest of helping to minimise your frustrations, here are some of the more interesting gremlins I've found.

The command line option `-Djava.security.manager` must appear before the name of your application, or it will be ignored, meaning no security manager will be used, and you'll get no notification.

If you run a Java application (not applet) and specify a policy file on the command line with the `-Djava.security.policy` option, but forget the `-Djava.security.manager` option, then Sun's JVM will run the program without a security manager, ignore the policy you wanted it to use, and not report an error.

When testing with applets, make sure you use the `appletviewer` program that comes with the JDK. Most browsers today don't support JDK 1.2 yet, and therefore won't use its new security features.

A hot topic for the future

Don't be afraid to experiment with and learn about Java's new security model. Computer security will be a hot topic for the foreseeable future, and beyond, making this a worthwhile way to invest your time. And there's the more pragmatic issue of using these tools properly – most programming tasks either work or they fail outright, usually with more than enough pyrotechnics. But security tools can sometimes fail silently, with disastrous consequences, or (almost as bad) be overly strict and prevent people from doing things that should be allowed. It's a good idea to know your way around policy files, permissions, and the rest of Java's security plumbing well in advance of having to use them on a real project.

Hello, EXE

You've probably noticed I'm the new Java guy at EXE. That's why I want to take a minute to say hello from the wooded wilds of the North Eastern US, and ask you to drop me an email at *lou@gizmoDrome.com* about what you'd like to see covered in future instalments of this column. There's no lack of interesting and pertinent things to talk about in this weird and wonderful world of Java, so I'd like to hear your specific suggestions and requests. ■

Lou Grinzo has been working with and writing about desktop computers for more years than he'll publicly admit. He's currently focusing on cross-platform technologies, including Java, Linux, and XML. His website is http://www.gizmoDrome.com and you can email him at lou@gizmoDrome.com.

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Visual Basic in Office 2000

Jon Perkins has a look through Microsoft Office 2000 and discovers... Visual Basic 6.1?

It's been at the back of my mind for a few months to refresh my knowledge of the implementation of Visual Basic that ships with Microsoft Office. This thought came to the fore again recently when I upgraded some of my machines to Office 2000. I was aware from previous tinkerings with the beta copies of the Office 2000 Developer Edition tools that there were some new add-ins, and that a newer version of ADO had been made available (more on this later). However, it was only when I got around to installing the Office 2000-specific version of the MSDN library that I realised that I must have taken my eye off the ball for a bit too long. When I was presented with the setup dialog that asks me which MSDN components to install, I noticed that Visual Basic was described as being version 6.1. What new features had they included to warrant the jump from 6.0? Absolutely everything got installed from this point on.

The answer was a disappointing 'not much really'. Looking through the MSDN documentation reveals that everything is still referred to as Visual Basic 6.0, including the About box for the tool itself. However, once I had managed to dispel the resultant disappointment at the absence of a new version to play with, I dove headlong into the developer areas of the product. I can only assume that the 6.1 reference was a vestige of an initial marketing decision that was then reversed but overlooked on this particular dialog box. However, there are actually some new features that I propose to cover because they are useful to Office developers, and hopefully we shall be seeing them included in the next version of the full-blown Visual Basic product.

New tools

There are several new tools provided to help the developer. A simple but effective one is the VBA String Editor. This add-in removes the tedium of trying to split large strings into smaller units that concatenate together, which is often done in order to display the whole string on the screen and thus prevent any extensive scrolling within the editor. Using the tool prevents the problem often encountered where, for example, a meaty SQL statement can be syntactically incorrect because of missing embedded quote characters. To this end, you are presented with a simple text box in which you can type or paste the entire string. The action of pressing the update button will then break the string down using appropriate concatenation and line-continuation characters.

A couple of related tools are the VBA Code Commenter and the VBA Error Handler. These use predefined templates with macro expansion facilities to paste standard header code into a single procedure, all procedures within a module, or all procedures within a project. This is achieved through the use of template files (with an `eht` extension) that can contain token characters that are expanded at paste-time into meaningful values. For example, `$$A` is expanded into the author's name. While this is a useful tool, I find it disappointing that you need to use an external editor such as Notepad to construct the template. This might sound like whinging, but you are provided with a read-only window in which you can view the template code, so why not allow for editing too?

Having switched to whinge-mode, I'll follow up with another one: you can't use these add-ins within the full-blown Visual Basic because the VBA environment exposes a different extensibility library to the Visual Basic 6.0 product. However, if anybody does become aware of a workaround, then please let me know and I'll post it on my website.

One tool that I really do feel we're overdue is the Code Librarian, shown in Figure 1. This application acts as a repository for pre-existing code that can be pasted into your project. Each repository is contained within an `MDB` file, and new ones can be created as necessary. The repository file that is provided with the Code Librarian contains a whole host of very useful routines. Understandably, some of these are geared to automating Office 2000 objects, but there are many other categories of code, such as file I/O, sort routines, ADO manipulation, error handling, and encryption, to mention a few. Corporate developers who can be sure that the end-users will already have Office installed will be able to integrate the Office Assistant character into their applications, using the provided code as a springboard. The problem that I mentioned with the other add-ins, namely that you can't load them into the Visual Basic 6.0 environment, isn't so bad in this case because it is possible to load the Code Librarian as a standalone module and transfer the code via the clipboard.

The Office 2000 Developer Edition also includes version 1.2 of the HTML Help editor environment. Visual Basic 6.0 only ships with version 1.1, so it's worth copying this over if you've got access to it, otherwise you'll need to download it from the Web. Finally, the Answer Wizard toolkit allows you to create help topics that tie in with the natural language query facility that the Office Assistant provides.

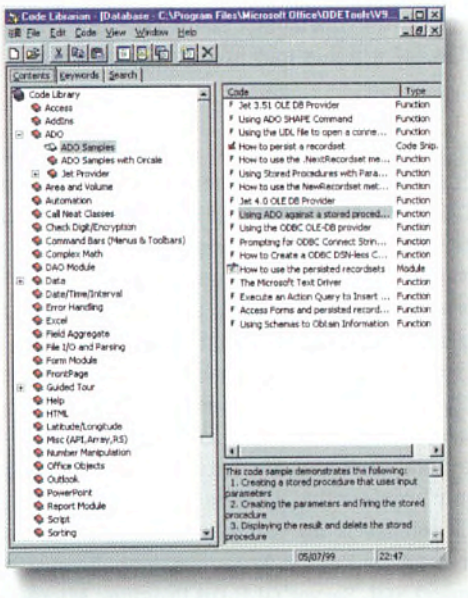

Figure 1 – The Office 2000 Code Librarian utility.

ADO 2.1

Something else that comes along with Office 2000 is a newer version of the ADO libraries. Visual Basic 6.0 includes ADO version 2.0, but Office 2000 includes version 2.1 and so will overwrite your 'older' files. At the time of writing, post-2.1 service packs are available from the Microsoft website at *http://www.microsoft.com/data/download2.htm*.

A quirk of the Microsoft distribution strategy – I suppose it has its reasons – is that the lightweight (ie connection-less) RecordSet components of ADO do not form part of the formal ADO package; new releases are shipped along with successive releases of Internet Explorer. Therefore, if you've got IE5 then you should already have ADOR version 2.1 (although from my own observations you might need to re-register the `msador15.dll` file with the `regsvr32.exe` registration utility in order to make it appear properly in the Visual Basic References dialog).

Apart from a number of important bug fixes, ADO has been extended in several areas to provide increased support for some of the underlying OLE DB providers. Remember that OLE DB is concerned with providing access to some of the more diverse, or at least non-typical, forms of data and so the simplified object layer that is ADO occasionally needs modification in order to keep up.

One such modification is a tie-in with the Microsoft OLE DB Persistence Provider, which saves and restores data to a file – the lightweight-RecordSet concept again. Although this persistence was already available in ADO 2.0, the facility now exists to save the data in XML format so that it can be manipulated across Internet-based environments.

A new `Seek` method, and an associated `Index` property, facilitates fast searches through RecordSet objects. Once the `Index` property has been set for the current RecordSet object – assuming that the underlying provider supports indexes – then the `Seek` method will make use of this and move the cursor to the desired position (which can be just before, on, or just after the matching record).

A new service component called the Microsoft Cursor Service for OLE DB has also been introduced. This facility attempts to introduce a greater degree of standardisation among the underlying data providers by providing consistent `CursorType`, `Lock`, and `Sort` properties regardless of whether they are actually provided.

ADOX library

Furthermore, ADO 2.1 introduces an additional library that is concerned with the manipulation of schemas rather than the data held therein. ADOX, or the Microsoft ADO Extensions for DDL and Security to give it its full title, is a set of management objects that facilitate the modification of a schema definition in a standard way. Essentially, as before, it's an attempt to provide a uniform means of doing a job against different backends. Although this shares the same 2.1 version index as the rest of the ADO set, in reality this is the first release of this specific library and so the implementation isn't as comprehensive as it presumably will be. By this, I mean that there are a significant number of backend environments that are not properly supported yet. In fact, the only provider that appears to have a complete implementation in this release is the Microsoft OLE DB Provider for the Microsoft Jet Database Engine. The other three that are directly supported (Microsoft SQL Server OLE DB Provider, Microsoft OLE DB Provider for ODBC, and Microsoft OLE DB Provider for Oracle) only have specific areas of implementation that are documented in the accompanying `readme` file. In very general terms, these limitations are of the nature of being able to create new tables but for existing table definition objects to be read-only.

ADOX appears to be encapsulated within a single file, `msadox.dll`, and should be referenced from Visual Basic as 'Microsoft ADO Ext. 2.1 for DDL and Security'. In selecting this entry, you will need to select the main ADO library too.

The implementation is headed by the `Catalog` object. This contains collections of groups, procedures, tables, users, and views, all of which represent the schema of the data source. In order to get a `Catalog` object instance up and running you can either directly create a connection to a data source:

```
Dim adoxCatalog As ADOX.Catalog
Set adoxCatalog = New ADOX.Catalog
adoxCatalog.Create _
    "Provider=Microsoft.Jet.OLEDB.4.0; _
    Data Source=c:\My Documents\mydata.mdb"
```

or you can hitch up to an existing ADO connection:

```
Set adoxCatalog.ActiveConnection = adoConn
```

Having associated the `Catalog` object to the data source, you can then perform management (ie non data manipulation) tasks, such as assigning security permissions to user accounts, creating and deleting tables, adding procedures, and so on. Creating a new table, for example, is a case of creating a new table object, adding columns to it, and then adding the new table object to the `Tables` collection:

```
' Define the table object
Dim adoxTable As ADOX.Table
Set adoxTable = New ADOX.Table
adoxTable.Name = "Books"

' Add columns to the definition
adoxTable.Columns.Append "BookId", adInteger
adoxTable.Columns.Append "Name", adVarWChar, 60

' Add definition to tables collection
adoxCatalog.Tables.Append adoxTable
```

Things to come...

That's the run-down on version 2.1 of the ADO set. Beta versions of ADO 2.5 are already widely available. For example, they are present in beta 3 of Windows 2000 (including the lightweight RecordSet library and ADOX). This forthcoming release extends the reach of ADO both towards the Internet and towards the Windows filesystems. In the case of the former, there is direct support for URL-type addresses for connection strings. This facility is added to tie in with the underlying OLE DB providers that already manipulate URLs. For example, the OLE DB Provider for Internet Publishing can work with HTTP addresses. In the case of the Windows filesystems, new record and stream objects provide the ability to work with filesystem entities such as files and directories, and email components such as folders and messages. The stream objects allow for the manipulation of binary and textual data. This can either be in the form of a simple document, or something more complex like a COM structured document. ■

Jon Perkins is a freelance Visual Basic developer and a Microsoft Certified Solution Developer. He is a contributing author of Advanced Microsoft Visual Basic 6.0 by The Mandelbrot Set, published by Microsoft Press. Contact him at www.jonperkins.com.

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AUTOMATING SOFTWARE TEST

Course	Date	Days	Cost	Place	Company
Rational TeamTest v 7.1,	13/15th Sept,	3,	950	Ascot,	RAU
Rational TeamTest v 7.1,	11/13th Oct,	3,	950	Ascot,	RAU
Rational TeamTest v 7.1,	8/10th Nov,	3,	950	Ascot,	RAU
Rational TeamTest v 7.1,	6/8th Dec,	3,	950	Ascot,	RAU
TestStudio,	15/19th Nov,	5,	1850	Ascot,	RAU
Performance Studio,	4/6th Oct,	3,	950	Ascot,	RAU
Automating Software Test,	27/29th Sept,	3,	950	Ascot,	RAU

BUSINESS ENGINEERING

Course	Date	Days	Cost	Place	Company
Business Engineering,	25th Oct,	1,	600	Ascot,	RAU

CASE/DESIGN

Course	Date	Days	Cost	Place	Company
Rose 98i,	24th Sept,	1,	600	Ascot,	RAU
Rose 98i,	1st Oct,	1,	600	Ascot,	RAU
Rose 98i,	22nd Oct,	1,	600	Ascot,	RAU
Rose 98i,	29th Oct,	1,	600	Ascot,	RAU
Rose 98i,	12th Nov,	1,	600	Ascot,	RAU
Rose 98i,	26th Nov,	1,	600	Ascot,	RAU
Rose 98i,	3rd Dec,	1,	600	Ascot,	RAU
Rose 98i,	10th Dec,	1,	600	Ascot,	RAU

CHANGE REQUEST MANAGEMENT

Course	Date	Days	Cost	Place	Company
Project Management, ClearQuest,	20/21st Sept,	2,	840	Ascot,	RAU
Project Management, ClearQuest,	18/19th Oct,	2,	840	Ascot,	RAU
Project Management, ClearQuest,	29/30th Nov,	2,	840	Ascot,	RAU

CLIENT/SERVER

Course	Date	Days	Cost	Place	Company
Client/Server and Distributed Computing	Regularly	3	POA	Call	QA TR
Architecture and Design of Enterprise Systems	Regularly	4	POA	Call	QA TR
Software Testing	Regularly	3	POA	Call	QA TR
IT Infrastructure Implementation and Management	Regularly	4	POA	Call	QA TR
Architecture and Design of Enterprise Systems	Regularly	4	POA	Call	QA TR

CONFIGURATION MANAGEMENT

Course	Date	Days	Cost	Place	Company
ClearCase UNIX Fundamentals,	6/7th Sept,	2,	840	Ascot,	RAU
ClearCase UNIX Fundamentals,	13/14th Sept,	2,	840	Ascot,	RAU
ClearCase UNIX Fundamentals,	4/5th Oct,	2,	840	Ascot,	RAU
ClearCase UNIX Fundamentals,	11/12th Oct,	2,	840	Ascot,	RAU
ClearCase UNIX Fundamentals,	1/2nd Nov,	2,	840	Ascot,	RAU
ClearCase UNIX Fundamentals,	15/16th Nov,	2,	840	Ascot,	RAU
ClearCase UNIX Fundamentals,	6/7th Dec,	2,	840	Ascot,	RAU
ClearCase UNIX Fundamentals,	13/14th Dec,	2,	840	Ascot,	RAU
ClearCase UNIX MetaData,	8th Sept,	1,	600	Ascot,	RAU
ClearCase UNIX MetaData,	15th Sept,	1,	600	Ascot,	RAU
ClearCase UNIX MetaData,	6th Oct,	1,	600	Ascot,	RAU
ClearCase UNIX MetaData,	13th Oct,	1,	600	Ascot,	RAU
ClearCase UNIX MetaData,	3rd Nov,	1,	600	Ascot,	RAU
ClearCase UNIX MetaData,	17th Nov,	1,	600	Ascot,	RAU
ClearCase UNIX MetaData,	8th Dec,	1,	600	Ascot,	RAU
ClearCase UNIX MetaData,	15th Dec,	1,	600	Ascot,	RAU
ClearCase UNIX Administration,	9/10th Sept,	2,	840	Ascot,	RAU
ClearCase UNIX Administration,	16/17th Sept,	2,	840	Ascot,	RAU
ClearCase UNIX Administration,	7/8th Oct,	2,	840	Ascot,	RAU
ClearCase UNIX Administration,	14/15th Oct,	2,	840	Ascot,	RAU
ClearCase UNIX Administration,	4/5th Nov,	2,	840	Ascot,	RAU
ClearCase UNIX Administration,	18/19th Nov,	2,	840	Ascot,	RAU
ClearCase UNIX Administration,	9/10th Dec,	2,	840	Ascot,	RAU
ClearCase UNIX Administration,	16/17th Dec,	2,	840	Ascot,	RAU
ClearCase NT Fundamentals,	20/21st Sept,	2,	840	Ascot,	RAU
ClearCase NT Fundamentals,	25/26th Oct,	2,	840	Ascot,	RAU
ClearCase NT Fundamentals,	22/23rd Nov,	2,	840	Ascot,	RAU
ClearCase NT Fundamentals,	29/30th Nov,	2,	840	Ascot,	RAU
ClearCase NT MetaData,	22nd Sept,	1,	600	Ascot,	RAU
ClearCase NT MetaData,	27th Oct,	1,	600	Ascot,	RAU
ClearCase NT MetaData,	24th Nov,	1,	600	Ascot,	RAU
ClearCase NT MetaData,	1st Dec,	1,	600	Ascot,	RAU
ClearCase NT Administration,	23/24th Sept,	2,	840	Ascot,	RAU
ClearCase NT Administration,	28/29th Oct,	2,	840	Ascot,	RAU
ClearCase NT Administration,	25/26th Nov,	2,	840	Ascot,	RAU
ClearCase NT Administration,	2/3rd Dec,	2,	840	Ascot,	RAU
ClearCase Multi-site,	28/29th Sept,	2,	840	Ascot,	RAU
ClearCase Multi-site,	22/23rd Nov,	2,	840	Ascot,	RAU

DATABASES

Course	Date	Days	Cost	Place	Company
Database Analysis and Design	Regularly	3	POA	Call	QA TR
Building a Data Warehouse	Regularly	4	POA	Call	QA TR
Microsoft Access Development	Regularly	3	POA	Call	QA TR
Introduction to Microsoft Access	Regularly	2	POA	Call	QA TR
Programming with Microsoft Access Basic	Regularly	2	POA	Call	QA TR
SQL Language	Regularly	2	POA	Call	QA TR
Microsoft SQL Server and Transact-SQL Programming	Regularly	3	POA	Call	QA TR
Microsoft SQL Server 6.5 Administration	Regularly	5	POA	Call	QA TR
Implementing a Database Design on Microsoft SQL Server 6.5	Regularly	5	POA	Call	QA TR

GROUPWARE AND OFFICE SYSTEMS

Course	Date	Days	Cost	Place	Company
Lotus Notes/Domino R4.5 Application Development 1	Regularly	3	POA	Call	QA TR
Lotus Notes/Domino R4.5 Application Development 2	Regularly	4	POA	Call	QA TR
Lotus Notes/Domino R4.5 Application Development 3 and LotusScript	Regularly	4	POA	Call	QA TR
Lotus Notes/Domino R4.5 System Administration 1	Regularly	4	POA	Call	QA TR
Lotus Notes/Domino R4.5 System Administration 2	Regularly	2	POA	Call	QA TR
Introduction to LotusScript in Notes/Domino	Regularly	3	POA	Call	QA TR
Microsoft Exchange Server 5.5 - Concepts and Administration	Regularly	3	POA	Call	QA TR
Microsoft Exchange Server 5.5 - Design and Implementation	Regularly	5	POA	Call	QA TR
Supporting Microsoft Exchange 5.0 - Core Technologies	Regularly	5	POA	Call	QA TR
Microsoft Exchange Server Performance and Troubleshooting	Regularly	2	POA	Call	QA TR

SOFTWARE TRAINING GUIDE

Course	Date	Days	Cost	Place	Company
Groupware Development with Microsoft Office Technologies	Regularly	5	POA	Call	QA TR
Domino Administration for Lotus Notes 4.6 and the Internet	Regularly	2	POA	Call	QA TR
Internet Development with Lotus Notes Domino 4.6	Regularly	3	POA	Call	QA TR
VBA Programming with Microsoft Excel	Regularly	4	POA	Call	QA TR

GUI DEVELOPMENT

Application Development using Borland Delphi V3	Regularly	5	POA	Call	QA TR
Advanced Programming with Visual Basic Enterprise Edition	Regularly	4	POA	Call	QA TR
Building Object-Oriented Applications with PowerBuilder V5	Regularly	3	POA	Call	QA TR
Fast Track to PowerBuilder V5	Regularly	4	POA	Call	QA TR
Microsoft Visual Basic Primer	Regularly	1	POA	Call	QA TR
Application Development using Visual Basic	Regularly	4	POA	Call	QA TR
The Win32 API – Fundamentals of Creating Great Windows GUI Applications	Call	5	1200	Call	SYNX
The Win32 API – Advanced Techniques in Writing Windows GUI Applications	Call	5	1200	Call	SYNX
The Win32 API – Inside the Windowing System	Call	1	300	Call	SYNX
The Win32 API – Inside the Messaging System	Call	1	300	Call	SYNX
The Win32 API – Inside the Painting System	Call	1	30	Call	SYNX
The Win32 API – Dialog Boxes: Inside & Out	Call	1	300	Call	SYNX
The Win32 API – DLLs: Breaking Up & Making Up	Call	1	30	Call	SYNX
The Win32 API – Inside GDI: Excellence in Drawing	Call	1	300	Call	SYNX
The Win 32 API – The Clipboard: Making it really work for you	Call	1	300	Call	SYNX
The Win32 API – Controls: Making the most of your application	Call	1	300	Call	SYNX

INTERNET

Delphi Internet Programming	Regularly	2	590	Bristol	BRKS
Programming with JavaScript	Regularly	2	POA	Call	QA TR
Creating and Configuring a Web Server using Microsoft Tools	Regularly	3	POA	Call	QA TR
Internetworking with Microsoft TCP/IP on Windows NT 4	Regularly	5	POA	Call	QA TR
Internet Fundamentals	Regularly	3	POA	Call	QA TR
Intranet Design and Migration	Regularly	3	POA	Call	QA TR
Internet and Intranet Security	Regularly	3	POA	Call	QA TR
Building an Effective Web Site	Regularly	3	POA	Call	QA TR
Netscape SuiteSpot Server v3	Regularly	5	POA	Call	QA TR
Internetworking with TCP/IP	Regularly	4	POA	Call	QA TR
Programming with Visual Basic Script	Regularly	2	POA	Call	QA TR

LANGUAGES

Advanced C	Regularly	4	POA	Call	QA TR
Advanced C++ Development Techniques	Regularly	4	POA	Call	QA TR
C++ for non-C Programmers	Regularly	5	POA	Call	QA TR
C++ for C Programmers	Regularly	4	POA	Call	QA TR
C++ Primer	Regularly	2	POA	Call	QA TR
C Primer	Regularly	2	POA	Call	QA TR
C Programming	Regularly	4	POA	Call	QA TR
Developing JavaBeans	Regularly	5	POA	Call	QA TR
Java for non-C Programmers	Regularly	5	POA	Call	QA TR
Java Primer	Regularly	2	POA	Call	QA TR
Java for C/C++ Programmers	Regularly	4	POA	Call	QA TR
Mastering Microsoft Visual Java J++	Regularly	5	POA	Call	QA TR
Database Development using Symantec Visual Café	Regularly	3	POA	Call	QA TR

Course	Date	Days	Cost	Place	Company

NETWARE

NetWare 3 Support and Administration	Regularly	4	POA	Call	QA TR
IntranetWare Support and Administration using Windows NT	Regularly	5	POA	Call	QA TR
IntranetWare: NetWare 4.x Administration	Regularly	5	POA	Call	QA TR
IntranetWare: NetWare 4.x Advanced Administration	Regularly	3	POA	Call	QA TR

NETWORKING

Understanding ATM	Regularly	2	POA	Call	QA TR
Introduction to Data Communications	Regularly	2	POA	Call	QA TR
Enterprise-wide Communications and Networking	Regularly	4	POA	Call	QA TR
Local Area Network Implementation & Management	Regularly	4	POA	Call	QA TR
Network Primer	Regularly	1	POA	Call	QA TR

OBJECT ORIENTED TECHNOLOGY

Practical Object Oriented Analysis and Design Using UML (Up to 12 students)	Call	5	7,500	On-site	CRaG
E-business Object Oriented Analysis and Design Using UML (Up to 12 students)	Call	5	7,500	On-site	CRaG
Advanced IBM Smalltalk	Regularly	5	1375	London	OBJE
Advanced IBM Smalltalk	Regularly	5	1375	Southampton	OBJE
Advanced IBM Smalltalk	Regularly	5	1375	London	OBJE
Building Applications using VisualAge for Smalltalk Technology	Regularly	5	1375	Southampton	OBJE
Building an Application Server using VisualAge/Smalltalk Server	Regularly	3	895	Southampton	OBJE
Building an Application Server using VisualAge/Smalltalk Server	Regularly	3	895	Southampton	OBJE
Introduction to VisualAge	Regularly	5	1375	London	OBJE
Introduction to VisualAge	Regularly	5	1375	Southampton	OBJE
Introduction to VisualAge	Regularly	5	1375	Southampton	OBJE
Introduction to VisualAge	Regularly	5	1375	Southampton	OBJE
Introduction to VisualAge	Regularly	5	1375	London	OBJE
Programming in IBM Smalltalk	Regularly	5	1375	London	OBJE
Programming in IBM Smalltalk	Regularly	5	1375	London	OBJE
Programming in IBM Smalltalk	Regularly	5	1375	Southampton	OBJE
VisualAge for Smalltalk Programmers	Regularly	5	1375	Southampton	OBJE
VisualAge for Smalltalk Programmers	Regularly	5	1375	Southampton	OBJE
Round-trip Engineering with VisualAge/Smalltalk UML Designer	Call	3	call	Southampton	OBJE
Enabling Persistence with VisualAge/Smalltalk Object Extender	Call	3	call	Southampton	OBJE
MVS Smalltalk:Transaction Managed Objects	Call	3	Call	Southampton	OBJE
Building & using Java Beans	Regularly	2	650	Southampton	OBJE
Building Distributed Applications with VisualAge for Java	Regularly	2	650	Southampton	OBJE
Building Distributed Applications with VisualAge for Java	Regularly	2	650	ptSouthamon	OBJE
Building Applications using VisualAge for Smalltalk	Regularly	5	1375	Southampton	OBJE
Building Applications using VisualAge for Smalltalk	Regularly	5	1375	Southampton	OBJE
Building Applications using VisualAge for Smalltalk	Regularly	5	1375	Southampton	OBJE
Team Programming using VisualAge for Smalltalk	Regularly	2	650	Southampton	OBJE
Team Programming using VisualAge for Smalltalk	Regularly	2	650	Southampton	OBJE
Team Programming using VisualAge for Smalltalk	Regularly	2	650	Southampton	OBJE
OO Programming with VisualAge for Java	Regularly	5	1250	Southampton	OBJE
Building Applets & Applications with VisualAge for Java	Regularly	5	1250	Southampton	OBJE
Building Applets & Applications with VisualAge for Java	Regularly	5	1250	Southampton	OBJE
Building Applets & Applications with VisualAge for Java	Regularly	6	1250	Southampton	OBJE

SOFTWARE TRAINING GUIDE

Course	Date	Days	Cost	Place	Company
Team Programming using VisualAge for Java	Regularly	2	650	Southampton	OBJE
Object-Oriented Modelling with VisualAge/Smalltalk UML Designer	Regularly	4.5	1450	Southampton	OBJE
Object-Oriented Modelling with VisualAge/Smalltalk UML Designer	Regularly	4.5	1450	Southampton	OBJE
OO Programming with VisualAge for Java	Regularly	5	1250	Southampton	OBJE
Team Programming using VisualAge for Java	Regularly	2	650	Southampton	OBJE
Building TOPLink Enabled Java Applications	Regularly	3	1150	Southampton	OBJE
Building TOPLink Enabled Java Applications	Regularly	3	1150	Southampton	OBJE
Object-Oriented Concepts Analysis & Design	Call	3	Call	Sothampton	OBJE
Object-Oriented Analysis and Design using the Booch Method	Regularly	4	POA	Call	QA TR
Object-Oriented Analysis and Design using Rumbaugh's OMT	Regularly	5	POA	Call	QA TR
Developing CORBA Applications	Regularly	3	POA	Call	QA TR
Object-Oriented Design for C++ Development	Regularly	5	POA	Call	QA TR
Overview of Distributed Objects	Regularly	1	POA	Call	QA TR
Object-Oriented Primer	Regularly	1	POA	Call	QA TR
Object-Oriented Software Development	Regularly	3	POA	Call	QA TR
Object-Oriented Analysis and Design using the Unified Modelling Language	Regularly	5	POA	Call	QA TR
Object Oriented Analysis and Design/UML,	13/16th Sept,	4,	1450	Ascot,	RAU
Object Oriented Analysis and Design/UML,	20/23rd Sept,	4,	1450	Ascot,	RAU
Object Oriented Analysis and Design/UML,	27/30th Sept,	4,	1450	Ascot,	RAU
Object Oriented Analysis and Design/UML,	11/14th Oct,	4,	1450	Edinburgh,	RAU
Object Oriented Analysis and Design/UML,	11/14th Oct,	4,	1450	Ascot,	RAU
Object Oriented Analysis and Design/UML,	18/21st Oct,	4,	1450	Ascot,	RAU
Object Oriented Analysis and Design/UML,	25/28th Oct,	4,	1450	Ascot,	RAU
Object Oriented Analysis and Design/UML,	8/11th Nov,	4,	1450	Ascot,	RAU
Object Oriented Analysis and Design/UML,	15/18th Nov,	4,	1450	Bristol,	RAU
Object Oriented Analysis and Design/UML,	22/25th Nov,	4,	1450	Ascot,	RAU
Object Oriented Analysis and Design/UML,	29/2nd Dec,	4,	1450	Ascot,	RAU
Object Oriented Analysis and Design/UML,	6/9th Dec,	4,	1450	Ascot,	RAU

PC SUPPORT

Advanced PC Support	Regularly	4	POA	Call	QA TR
PC Fundamentals	Regularly	3	POA	Call	QA TR
PC Support	Regularly	4	POA	Call	QA TR

PROCESS & PROJECT MANAGEMENT

Lifecycle Process, RUP Overview ,	31st/1st Sept,	2,	840	Ascot,	RAU
Lifecycle Process, RUP Overview,	27/28th Sept,	2,	840	Ascot,	RAU
Lifecycle Process, RUP Overview,	18/19th Oct,	2,	840	Ascot,	RAU
Lifecycle Process, RUP Overview,	8/9th Nov,	2,	840	Ascot,	RAU
Lifecycle Process, RUP Overview,	9/10th Dec,	2,	840	Ascot,	RAU

PROGRAMMING

C++ Builder Fundamentals	Regularly	5	1280	Bristol	BRKS
Delphi Professional Fundamentals	Monthly	5	1280	Bristol	BRKS
Delphi Professional Fundamentals	Monthly	5	1280	London	BRKS
Delphi Database Development	Monthly	5	1280	Bristol	BRKS
Delphi Database Development	Regularly	5	1280	London	BRKS
Delphi Web Application Development ,	Regularly	5	1280	Bristol	BRKS
Delphi Object Programming	Regularly	3	790	Bristol	BRKS
Delphi Distributed Object Programming	Regularly	3	790	Bristol	BRKS
Developing Windows NT Server Applications	Regularly	5	POA	Call	QA TR
Mastering Web Site Development using Visual InterDev	Regularly	5	POA	Call	QA TR
Win32 Programming Essentials	Regularly	5	POA	Call	QA TR
Developing ActiveX Controls and Components	Regularly	5	POA	Call	QA TR
Windows Programming in C	Regularly	5	POA	Call	QA TR
Windows Programming with Visual C++ and the MFC Library	Regularly	5	POA	Call	QA TR
Building Applications with MS Transaction Server	Regularly	5	POA	Call	QA TR
Fasttrack Windows NT 5 for Developers	Regularly	2	POA	Call	QA TR
Windows OLE Programming with the MFC Library	Regularly	5	POA	Call	QA TR
Developing OLE/ActiveX Controls with the MFC Library	Regularly	5	POA	Call	QA TR
Windows OLE System Programming	Regularly	5	POA	Call	QA TR
Requisite Pro,	16th Sept,	1,	600	Ascot,	RAU
Requisite Pro,	14th Oct,	1,	600	Ascot,	RAU
Requisite Pro,	11th Nov,	1,	600	Ascot,	RAU
Requisite Pro,	9th Dec,	1,	600	Ascot,	RAU
The Win32 API – Fundamentals of Creating Great Windows GUI Applications	Call	5	1200	Call	SYNX
The Win32 API – Advanced Techniques in Writing Windows GUI Applications	Call	5	1200	Call	SYNX
The Win32 API – Inside the Windowing System	Call	1	300	Call	SYNX
The Win32 API – Inside the Messaging System	Call	1	300	Call	SYNX
The Win32 API – Inside the Painting System	Call	1	300	Call	SYNX
The Win32 API – Dialog Boxes: Inside & Out	Call	1	300	Call	SYNX
The Win32 API – DLLs: Breaking Up & Making Up	Call	1	300	Call	SYNX
The Win32 API – Inside GDI: Excellence in Drawing	Call	1	300	Call	SYNX
The Win 32 API – The Clipboard: Making it really work for you	Call	1	300	Call	SYNX
The Win32 API – Controls: Making the most of your application	Call	1	300	Call	SYNX

PROJECT MANAGEMENT

Managing Enterprise Software Development Projects	Regularly	3	POA	Call	QA TR
DSDM Practitioner	Regularly	3	POA	Call	QA TR
Project Management Skills	Regularly	4	POA	Call	QA TR
Project Management, ClearDDTS,	15/15th Dec,	2,	840	Ascot,	RAU

REAL-TIME SYSTEMS

Real-time Object Oriented Analysis and Design Using UML (Up to 12 students)	Call	5	7,500	On-site	CRaG
Structured Analysis and Design for Real-time Systems (Up to 12 students)	Call	4	6,000	On-site	CRaG
Rose for Real Time,	4/8th Oct,	5,	1850	Ascot,	RAU
Rose for Real Time,	15/19th Nov,	5,	1850	Ascot,	RAU

SOFTWARE DEVELOPMENT

APEX,	13/15th Dec,	3,	950	Ascot,	RAU

SYSTEMS ANALYSIS

Requirements Management with Use Cases,	13/15th Sept,	3,	950	Ascot,	RAU
Requirements Management with Use Cases,	11/13th Oct,	3,	950	Ascot,	RAU
Requirements Management with Use Cases,	8/10th Nov,	3,	950	Ascot,	RAU
Requirements Management with Use Cases,	6/6th Dec,	3,	950	Ascot,	RAU

WINDOWS API PROGRAMMING

The Win32 API – Fundamentals of Creating Great Windows GUI Applications	Call	5	1200	Call	SYNX
The Win32 API – Advanced Techniques in Writing Windows GUI Applications	Call	5	1200	Call	SYNX
The Win32 API – Inside the Windowing System	Call	1	300	Call	SYNX
The Win32 API – Inside the Messaging System	Call	1	300	Call	SYNX
The Win32 API – Inside the Painting System	Call	1	300	Call	SYNX
The Win32 API – Dialog Boxes: Inside & Out	Call	1	300	Call	SYNX

SOFTWARE TRAINING GUIDE

Course	Date	Days	Cost	Place	Company
The Win32 API – DLLs: Breaking Up & Making Up	Call	1	300	Call	SYNX
The Win32 API – Inside GDI: Excellence in Drawing	Call	1	300	Call	SYNX
The Win 32 API – The Clipboard: Making it really work for you	Call	1	300	Call	SYNX
The Win32 API – Controls: Making the most of your application	Call	1	300	Call	SYNX
WINDOWS NT					
Administering Microsoft Windows NT 4.x	Regularly	3	POA	Call	QA TR
Supporting Windows NT Server 4.x - Enterprise Technologies	Regularly	5	POA	Call	QA TR
Supporting Windows NT 4.x - Core Technologies	Regularly	5	POA	Call	QA TR
Supporting Microsoft Systems Management Server	Regularly	5	POA	Call	QA TR
Supporting Microsoft SNA Server V4	Regularly	5	POA	Call	QA TR
Windows NT 4.x Essentials	Regularly	4	POA	Call	QA TR
Windows NT 5 Essentials	Regularly	5	POA	Call	QA TR
Supporting Windows NT 4.x Servers	Regularly	4	POA	Call	QA TR
Implementing Windows NT 5 Active Directory	Regularly	3	POA	Call	QA TR
UNIX					
UNIX Fundamentals	Regularly	4	POA	Call	QA TR
UNIX Programming	Regularly	5	POA	Call	QA TR
UNIX Systems Administration	Regularly	4	POA	Call	QA TR
Mastering UNIX Shell Scripts	Regularly	4	POA	Call	QA TR
Solaris Systems Administration	Regularly	4	POA	Call	QA TR

COMPANY DETAILS

Key BRKS Brooks Associates

Bismore,
Glos
GL6 7DG
Tel: 01452 770060
Fax: 01452 770078
Email: admin@brooksassociates.com
Web site: www.brooksassociates.com

Brooks Associates deliver IT consultancy, software development services and world class technical training for developers. As an authorised Inprise/Borland Education Centre we run a comprehensive programme of public courses at our fully equipped, air conditioned training centre in the middle of Bristol, and at our city training centre by the Monument in central London. All our courses are also available as closed company courses, on-site or at one of our training centres.

Key CRaG CRaG Systems

178 Bath Road,
Thatcham,
Berkshire, RG18 3HJ
Tel: 01635 873670
Fax: 01635 868557
Email: exelist@cragsystems.co.uk
Web Site: http://www.cragsystems.co.uk

CRaG Systems provides on-site training courses and consultancy for the object oriented and structured analysis and design of both business information and real-time embedded systems. The object oriented methods are based on the industry standard syntax of the Unified Modeling Language (UML). The structured method is based on the industry standard Yourdon method with Ward-Mellor real-time extensions. Stress is placed on the practice of defining requirements and turning them into an integrated model that can be implemented in a specified target environment. Students spend a large part of each course creating models of real requirements and solutions using a suitable case tool.

Key OBJE, The Object People Limited

Epsilon House, Chilworth Science Park, Southampton, SO16 7NS
Tel: 01703 769996
Fax: 01703 766066
Email: ukinfo@objectpeople.com Web: http://www.objectpeople.com/uk/

The Object People have a world-wide reputation in assisting clients adopt and make successful progress with object technology. Services include: general Java and Smalltalk Training/Consultancy/Migration. We also specialise in VisualAge and VisualWorks. In addition, we provide courses to cover Object-Oriented Analysis and Design techniques, as well as Object Technology Management Overviews.

Our consultants/trainers are highly skilled in a wide range of development environments. We therefore offer a tailor-made Migration Service to assist transition to Java or Smalltalk from other OO languages or between different Smalltalk systems.

Key QA TR QA Training Ltd

Cecily Hill Castle, Cirencester, Gloucestershire, GL7 2EF
Email: responsecentre@qatraining.com
Web: http://www.qatraining.com
Tel no 01285 883388
Fax no 01285 883399

QA Training is widely recognised as the premier IT Training company in the UK and the largest provider of technical training to IT professionals. From over 70 classrooms at 7 dedicated training centres around the UK we offer over 150 programming and support courses. We are major business partners and accredited trainers of Compaq, Lotus, Microsoft, Novell, Oracle and Powersoft amongst other key industry players. More than that, we actually provide internal training to companies like Microsoft on their own products in advance of release. This makes us the first to understand and provide training and consultancy on the latest technologies to our customers.

Key RAU Rational University

Kingswood, Kingsride, Ascot, SL5 8AJ
Tel: 01344 295007
Fax : 01344 295001
Email: training-uk@rational.com
Web: www.rational.com/uk

Rational University provides you with a unique role-based and team-based curriculum that combines proven software development process and best practices within a structured professional educational curriculum.

For more information, including full course descriptions and on-line booking, please see. Alternatively, call Sonia Sims on 01344 295007, or email training-uk@rational.com.

Key SYNX Synaptix Ltd

160 Aztec West, Almondsbury, Bristol BS32 4TU
Tel: 01454 851563 Fax: 01454 414331
Email: kimwilson@compuserve.com
The Windows API Developer Training Specialists

Kim Crouse-Wilson is Technical Director of Synaptix Inc (USA), probably the most expert Windows API training company in the world. Kim was formerly Microsoft's Senior Trainer and knows the Microsoft Win32 SDK backwards (especially the undocumented stuff!). She is available in the UK from July to September to improve your fundamental or advanced Win32 API programming. It's for all 'C' programmers, and also for C++ programmers who need better GUI than MFC can offer. Kim's latest GUI creation is MicroProse Inc's 300,000-selling game, 'Magic:The Gathering'. Try this GUI for yourself! Find out why Microsoft, Intel, Hewlett-Packard, IBM, Novell, Nintendo, Motorola, 3M, Lotus etc all used Kim. Training at our place or yours. For a real boost to your talent, this is a unique opportunity.

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Talented Software Developers will love G.I.S.

GIS is one of the most exciting areas of IT. It combines object oriented data management, graphics and spatial data analysis with an ever-increasing focus on Internet integration. The good news is that many of my clients will forego experience of G.I.S. in favour of solid software development skills in industry-standard products such as Visual Basic, Access and Java. The six jobs below represent just a small fraction of the total number of systems development vacancies currently being handled by Concurrent Appointments.

Access/VB Development

c. £30K plus bonus — *West London*

The brief calls for a graduate with at least 18 months experience of building applications in MS Access. You should be fluent in Visual Basic or Visual C++ and most importantly apply rigorous quality standards to your work. You will be joining a "fun" young development team whose experience will complement your specialist skills. The project is to build a market leader in analysis and modelling applications for the desktop G.I.S. industry. A fluency in one or more European languages is highly desirable.

Visual C++ Software Engineer

To £28K+car — *N Home Counties*

Does the opportunity to extend your experience in Windows-based applications development combined with travel within Europe appeal to you? You will be using your Visual C++ skills to customise clients GIS software and once established you will handle the more challenging components of the projects. You must be competent in MS Access and also ODBC. Fluency in French and/or German is welcome though not vital.

Applications Programmers

To £30 — *Central London*

This is a fun place to work if you are a highly motivated young programmer with fluency in C and Visual Basic under MS-Windows. The client is a young, hugely successful MapInfo partner able to offer challenging new development work for an extremely wide range of commercial clients, many of whom are themselves new to GIS.

Software Engineers

To £28K — *Home Counties*

A degree qualification in Computer Science or similar is the ideal foundation for these newly released vacancies. Although the client is a G.I.S. vendor, the work is 100% new applications development, based on-site and in the office. Technology is leading edge and includes Web-based applications, Oracle7, Delphi and other OO tools. To qualify you must have a minimum 12 months experience in one or more of C, C++, VB or Pascal.

Applications Developer

To £30K — *West Country*

The client is a young, dynamic Oracle partner with a very healthy order book!! They are market leaders in G.I.S. applications software and can offer an experienced software developer the opportunity to work on one of the most challenging projects around. You must know Oracle and have fluency in C and/or C++ programming under Windows or Windows NT. Experience of one specific GIS is not essential although ArcView or MapInfo would be beneficial.

ArcView/Visual Basic Developers

£Truly negotiable — *Numerous UK Locations*

ArcView is really taking off and this has created several job opportunities. If you are proficient in a recognised OO language and you have experience of programming in Windows then they are willing to send you on an ArcView training course!!. Applications vary from local government to insurance and retail and locations from London, Bristol, Nottingham and Edinburgh.

Concurrent Appointments International

To apply for one of the advertised vacancies or if you just wish to have a chat, call **Alan Carnell** on **01582 712976**.
Alternatively you can e-mail your CV to alan_carnell_2@compuserve.com in total confidence.
All applications will be acknowledged.

27 Field Close, Harpenden, Herfortdshire AL5 1EP UK.
National Tel: (01582) 712986 Fax: (01582) 764858
International Tel: +44 1582 712976 Fax: +44 1582 764858

We want to secure your future

C • C++ • MFC • ATL • Device Drivers • NT • ActiveX • COM

Salaries up to £50k plus benefits inc. share options **Location: Woodley, near Reading**

Ç-Dilla is the world's leading developer of copy protection and rights management technologies for CD-ROM, DVD and Internet delivered software products. Used by major companies such as Addison Wesley Longman, Lotus Development, Microsoft, Ordnance Survey and the Financial Times, our innovative technologies are at the forefront of one of today's hot application areas - electronic publishing!

Now part of the Macrovision Corporation, the world's leading developer of copy protection technologies for video, audio and consumer multimedia, we are accelerating our development of new products to meet the demands of today's digital revolution. As a result, we have created the following opportunities:

DEVELOPMENT TEAM LEADER

£40k-50k + benefits

C or C++, Windows Internals, VxDs, Device Drivers

You will lead a small team in the development of new functionality for our world-beating software products. With a background in software product development using C or C++ ideally under Win32, you will take a key role in the software development process as well as mentoring the team to produce outstanding new software.

SNR SOFTWARE DESIGN ENGINEER

£35k-45k + benefits

C or C++, Windows Internals, VxDs, Device Drivers

As a talented software designer, you will apply your strong windows internals experience to a number of complex projects as part of a small tightly-knit team. Knowledge of VxDs and NT device drivers would be useful. An understanding of computer security techniques would be an advantage.

SNR GUI DESIGNER/DEVELOPER

£35k-45k + benefits

C++, MFC, ATL, COM

With your knowledge of Microsoft toolkits and your flair for GUI design, you will develop attractive and easy-to-use interfaces for our range of products. You should have strong application development experience using Visual C++ ideally with MFC and ATL. An understanding of COM and a knowledge of computer ergonomics and usability would be an advantage.

Our appetite for continually breaking new ground means that you can look forward to projects that will really challenge you in an informal, flexible working environment where your contribution will be recognised and rewarded.

ç-dilla A Macrovision Company

To apply, please email your CV to our advising consultant Chris O'Grady at cdilla@netobjectives.co.uk. Alternatively, write to him at netObjectives Ltd, PO Box 2741, Reading RG1 8XW. To find out more, call him on 01252 727799.
www.netobjectives.co.uk

netObjectives recruitment for distributed computing

SOFTWARE ENGINEERING

SOFTWARE ENGINEER

Our client is a world leader in mobile telecommunications. They are looking for a software engineer with C and UNIX experience to join a team of developers working on GSM and UMTS systems. Various levels of experience will be considered and opportunities for travel will be available for those candidates who are interested. Any previous knowledge of telecoms, or low level programming would be helpful. Relocation and excellent benefits.

Up to £35K **Swindon**

0800newjob 639562

sanderson recruitment plc

email:mail@sanderson-recruitment.co.uk
www.sanderson-recruitment.co.uk

SOFTWARE ENGINEERING

SOFTWARE TEAM LEADER X 2

This large multinational group is looking for two software team leaders to join its telecommunications division. To perform all team leader functions including setting objectives, performing reviews/appraisals, setting development plans, managing/participating in testing and documentation as well as the full development lifecycle. 5 years of commercial development experience and some team leading experience would be ideal although it is emphasised that anyone with real potential would be appointed.

£27K - £35K **Bristol**

0800newjob 639562

sanderson recruitment plc

email:mail@sanderson-recruitment.co.uk
www.sanderson-recruitment.co.uk

SOFTWARE ENGINEERING

SOFTWARE ENGINEER

Our client is a world leader in the provision of software to the games console industry. They are looking for a Windows Analyst Programmer proficient in Visual C++ and using some of the latest application development kit. Knowledge of COM, Active X and Atl would be beneficial as would any low level experience. The opportunity for travel to exhibitions and conferences worldwide exists as well as a career that would bring your name to the forefront of this fast-growing industry.

Up to £35K **Bristol**

0800newjob 639562

sanderson recruitment plc

email:mail@sanderson-recruitment.co.uk
www.sanderson-recruitment.co.uk

SOFTWARE ENGINEERING

VC++ TEAM LEADER

You will have several years experience of VC++, MFC, ATL including at least 1 year's development of NT Multi Threaded applications in an OO environment. Desirable skills include OO Design knowledge and experience of working in a real time comms environment. Leading a team of 8, you will have to show teamworking skills gained as a member of teams in the past. There are numerous opportunities in this market leading company.

£35k **Wiltshire**

0800newjob 639562

sanderson recruitment plc

email:mail@sanderson-recruitment.co.uk
www.sanderson-recruitment.co.uk

SOFTWARE ENGINEERING

SECURITY CLEARED DEVELOPERS

To work for a software house on a client site. If you are looking for very rapid career progression, upper quartile salary, and a refreshing long-term attitude to training, whilst being flexible and motivated, then look no further! Skills-sets required include C/C++/Java/VC++ among other development languages, and security clearance, preferably DV, is required.

To £40k **Gloucestershire**

0800newjob 639562

sanderson recruitment plc

email:mail@sanderson-recruitment.co.uk
www.sanderson-recruitment.co.uk

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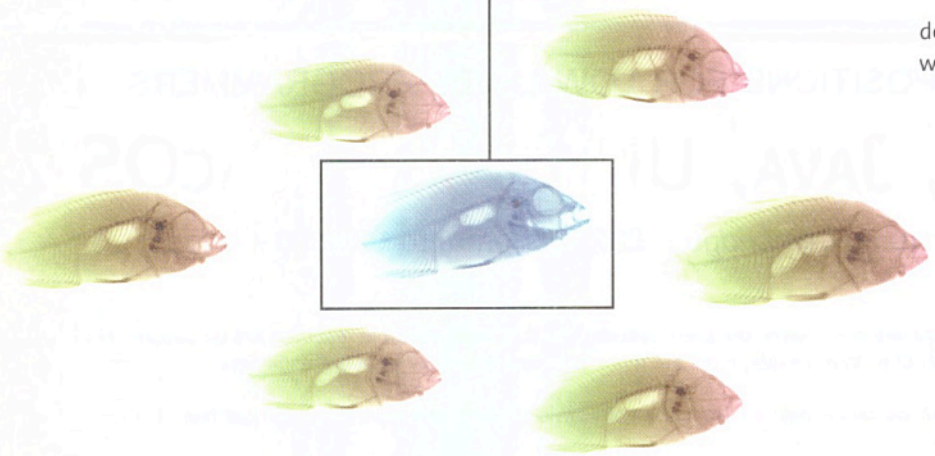

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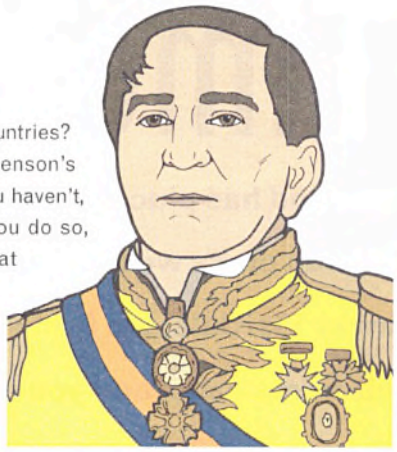
Virtual banana republic



Are you dissatisfied with your lot? Unhappy with the society in which you are forced to live? Do you believe *you* could do a better job? Then, my friend, welcome to CyberYugoslavia. One of dozens of virtual countries to spring up on the Web in recent years, CyberYugoslavia (*yuga.com*), which will open its doors in September, takes the premise just that little bit further. For when (and if) the count of signed-up citizens reaches five million, the leaders of CY intend to apply to the UN for recognition as a genuine, bona-fide country, along with 20 square metres of territory – where the country's servers will live – to call its own.

We reckon the virtual country will be big business in a few years' time, especially in the unlikely event that the UN actually decides to recognise some of them. Perhaps the most appealing aspect of the whole process is that you – yes, you – can create a country populated with nothing but people you approve of. And you can be the President! Although, to keep people happy, it is common for every citizen of these virtual nations to hold government posts. Which means you could actually *be* the Minister for Silly Walks.

Extraterritorialised virtual countries? Anyone who's read Neal Stephenson's excellent *Snow Crash* (and if you haven't, we heartily recommend that you do so, ISBN 0553562614) will find that rather creepily familiar. Meanwhile, we invite interested software developers to apply for citizenship in the newly founded Distributed Republic of Exedonia. Perks for citizens include free compilers and SDKs, and a chunk of Noosphere big enough to let you scratch *any* itch. We're looking for a flag for our fledgling breakaway republic, by the way – send designs on a postcard to:

The Great Exedonia Flag Competition. EXE Magazine, St Giles House, 50 Poland Street, London, W1V 4AX.

The best suggestion will win a prize. Probably.

Yes! Yes! Yes!

Which is better? Chocolate, or code? Chances are you can't make up your mind, because biochemically they stimulate more or less the same response in software developers. Which just goes to show what a sad lot we really are. For years, developers have sat late at night hunched over glowing screens, lines of exquisitely-handcrafted code painted on their faces in the reflection from the screen, while letters appear on the display one by one accompanied by the sound of a dot-matrix printer... hang on, I think I've been watching *Hackers* again. But no late night coding session would be complete without copious quantities of Jolt (or some inferior low-caffeine cola, at a push) and other comfort foods (some prefer pizza. Me, I'll take a bar of Galaxy any day). And guess what? At least one of them is actually good for you!

Researchers recently discovered that chocolate – oh Prince of Foods – contains more catechins than tea or coffee. Which is good, because catechins are supposed to help protect the body against heart disease and cancer. This has led the researchers in question to issue the sterling advice that a cup of tea accompanied by a chocolate biscuit is good for your health. Now, they haven't come out and actually said that a gallon of cola accompanied by a pack of chocolate Hob-Nobs is good for you, but I don't feel bad about making that assumption, and neither should you.

We'd like to appeal (again) to the software millionaires out there – please fund some research into proving, once and for all, that a Big Mac actually helps lower cholesterol. If you're willing to spend enough money, we're sure it can be proved. Blank cheques to the usual address, please.

Awards special

We haven't given out any Ctrl-Break gongs for a while (because, obviously, they weren't funny anymore), but this one just cries out for recognition. This year's IBM OS/2 Memorial Award for Shooting Yourself in the Foot goes to Microsoft, for the class act of putting up a Windows 2000 test server (*www.windows2000test.com*), inviting the world to come and have a go if it thought it was sufficiently hard, and then blaming the almost instant crash that followed on thunderstorms in the Seattle area.

Now, anyone who's spent time in Seattle knows that it rains there a lot. Thunderstorms are by no means uncommon. So you'd imagine that Microsoft's servers are forever going up and down with every mighty lightning bolt that falls to earth. Not so. In fact, microsoft.com has, to the best of our knowledge, never been *completely* down since time immemorial. Might this in fact have been an *excuse*? Hmm...

This, of course, is not the first time that Microsoft has had pie, sorry, egg on its face. But it is a very embarrassing and public failure, guaranteed to energise the hacker community that the company wanted to challenge in the first place. To add insult to injury, a Linux server running on PowerMac hardware that the LinuxPPC porters put up as a response to Microsoft's challenge (*crack.linuxppc.org*) has yet to go down, let alone be cracked.

At the time of writing, the Windows 2000 server was back up and apparently well; Microsoft had either (as they promised) started filtering the TCP/IP traffic to get rid of denial of service attacks – which the company specifically said at the start of the process would not count as a genuine hack – or else the hacker community had lost interest. Since the server will probably still be up as you read this, you might like to have a go at it yourself – just so long as you agree to sell the exclusive rights to your story to us at Ctrl-Break. Now, where's that port scanner...

Time was

Borland has placed early versions of Turbo Pascal on its website, Dan Bricklin is giving away VisiCalc, the first spreadsheet, from his home page, and you can even pull down the original Space Invaders ROM, complete with suitable emulator. Verity Stob previews the next crop of retro downloads.

DatabaseFOUR (1983, 112 KB zip) and DatabaseTWENTYTHREE (1988, 472 KB zip)

In its time **the** standard in desktop databases, Ashton-under-Lyme originally launched DatabaseFOUR in 1983. It rapidly achieved success and wide usage, partly thanks to the company's legendary marketing skills (there never was a DatabaseTHREE, the name was just a scam intended to suggest stability), and partly because nothing else existed.

Ashton-under-Lyme's bosses always made a virtue of their lack of programming knowledge and *laissez faire* approach to technical management, but this proved to be the company's undoing. The long-delayed upgrade from DatabaseFOUR-and-one-third plus plus to DatabaseTWENTYTHREE failed because the 876 programmers hired to produce it spent most of their time arguing over who should get the coffee, and none at all doing design, or quality assurance. Not like you at all.

In the end DatabaseTWENTYTHREE shipped in an appalling condition – for example, some modules were omitted because they could not be made to compile – because it was thought that the striking increase in version number would conceal the product's other deficiencies. In the event, perhaps surprisingly, nobody was fooled. Nobody, that is, unless you count the man who went on to buy the company...

Exciting things to try when you have downloaded these programs: Run up DatabaseFOUR and see the much-admired 'user-friendly' environment, ie a full stop with a cursor after it. List the contents of the example Contacts database. Sort the database by Zip code. List its contents again. Get bored. Quit. What else did you expect from an obsolete database tool?

Run up DatabaseTWENTYTHREE. Admire the BSOD. Reset your machine. Delete DatabaseTWENTYTHREE.

CB-Basic (1983, 4 KB)

A home-grown competitor to the American Gee-Whiz Basic, Cor Blimey! Basic was the power in the ROM behind a string of fine British computers in the early- to mid-eighties. Great machines such as the Oxford Incompatible 80, the ITV 2, the Welsh Spaniel, the Smith-Nuttley Quantum Limp and the Oxford Incompatible 83 Colour Upgrade with 12 KB Option Pack *[that's quite enough fine British computers – Ed]* all booted up with CB-Basic's familiar `WOT?>` prompt.

CB-Basic was most advanced for its time. It allowed three-letter variable names instead of just two, as had previously been standard Basic interpreter practice. Soon programs featuring exciting and clearly-named variables such as `CAT` and `DOG` joined the legions of programs with less exciting variable names like `CT` and `DG`. Also, CB-Basic allowed (in fact required) all its keywords to be entered with single keystrokes. This was a great boon to a generation of hobbyists who had yet to acquire speedy typing skills. Instead of having to bash in the word 'FOR' as F-O-R, one simply pressed Ctrl-Esc-Fn-#.

Things to try: Type in a program to compute biorhythms, copied out from any issue of *Practical Computing* you can find in the loft. Run it. Enter your date of birth and today's date. The program prints out three meaningless numbers. Are these the correct meaningless numbers, or does the program need debugging? Now remove all the spaces and comments from the program. Also remove any unnecessary line numbers, renumber those remaining so that they are consecutive, and shorten variable names to one letter. Run the program again. See how much faster that is? I knew you would.

Big Blue's Top Dog (1985, 35 MB)

Long before we had the loveliness that is Windows, it was discovered in the top secret Laboratoire Grand Bleu near Winchester that it was theoretically possible to 'multi-task' two or even three programs at once on a single PC. After many years of extensive research, Top Dog was launched to exploit this theory.

An engineering triumph, Top Dog literally allowed you to run up to *six* copies of EDLIN at once in 15 character by 3 line text mode windows, plus one copy (or two or three if you liked!) of the special Top Dog 'clock' application. But all this proved too heady an experience for most punters, and in due course Top Dog was superseded by Big Blue's own fine new operating system 'Two', which allowed you to run up to one MS-DOS program at a time, rather slowly.

Things to try: Secretly install Top Dog on a colleague's machine. When he comes back, say you have just installed the latest Windows 2000 trial CD. Watch his face while he wrestles with Top Dog under the misapprehension that it is the latest technology from Redmond. Explain the joke to him. Have a good laugh together. Stop laughing, suddenly.

Supermarket Adventure (1980, 28 KB)

In these days of multi-player shoot-em-ups, youngsters wonder how the folks of olden times passed away the long evenings after silent television closed down at 6.00pm. The answer was, of course, that Father plugged the television aerial into the Smith-Nuttley Quantum Limp, and the family all gathered round for a satisfying game of Supermarket Adventure. To give you a flavour of the game, I can do no better than reproduce a little of the dialogue that it produces:

```
> GO NORTH
Verity, you are in an aisle with dog biscuits and cat
food
> GET DOG BISCUITS
Verity, don't understand 'GET'.
> BUY DOG BISCUITS
Verity, cannot buy, not at checkout
> GRAB DOG BISCUITS
Verity, don't grab it's rude!
> DOG BISCUITS IN BASKET
Verity, you are in an aisle with pet food
> PUT DOG BISCUITS IN BASKET
Verity, don't understand 'PUT'
```

Things to try: Sadly, we found that our Smith-Nuttley Quantum Limp emulator crashed when we tried to load this game. However, a modern equivalent is freely available; it's called 'Buying a Virgin cheap day return to Stockport'. Boom-boom. ■

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