

# ELECTRONICS

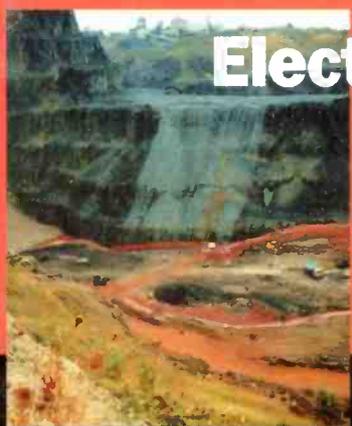
and Beyond

Will Not Compute... What is the answer to the ultimate question

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**Software Agents**  
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extending Moore's Law for the next 20 years

**Tech Watch** affordable DAB receivers

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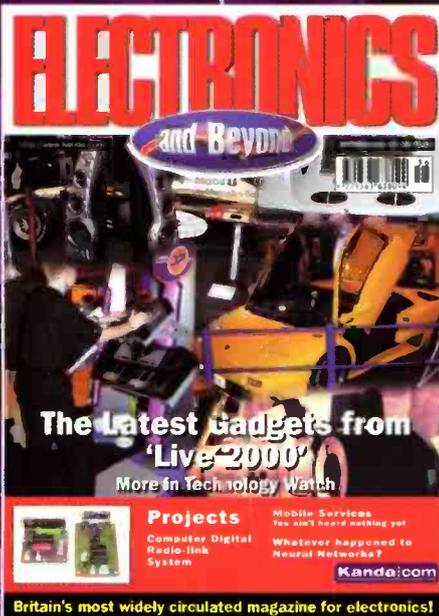
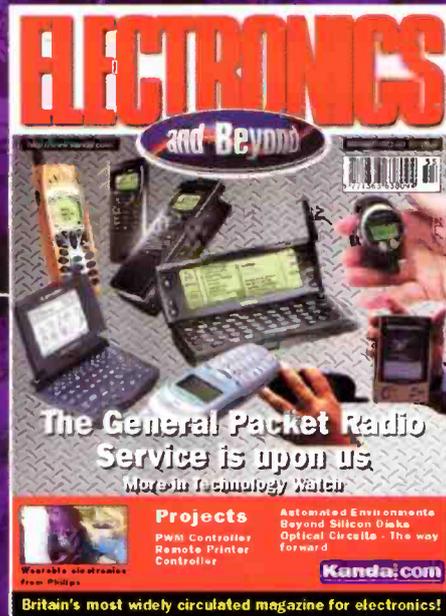
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**Solid State Sound Recorder**

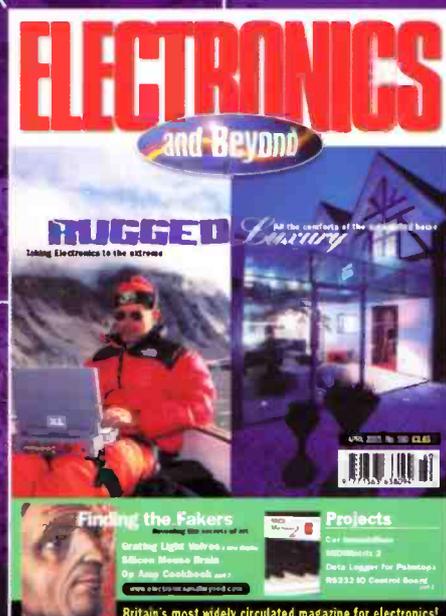
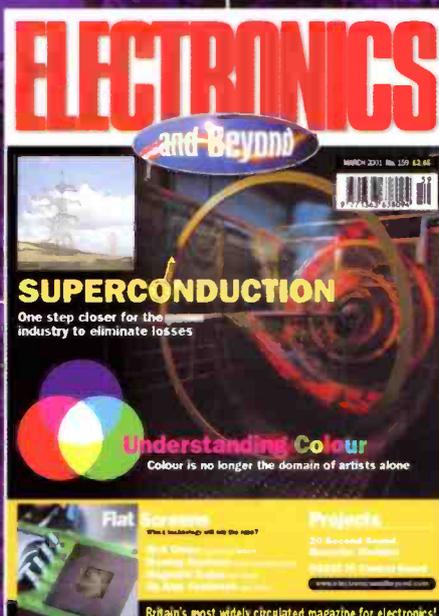
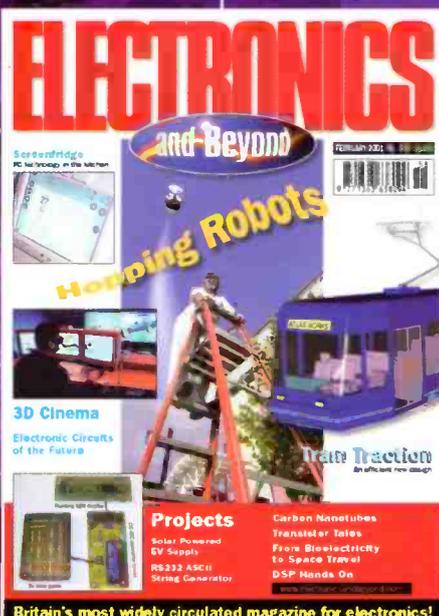
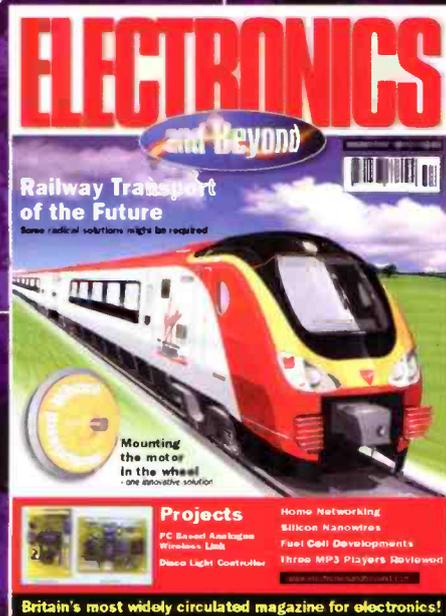
**MIDIMatrix 2** part 2

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and Beyond

May 2001

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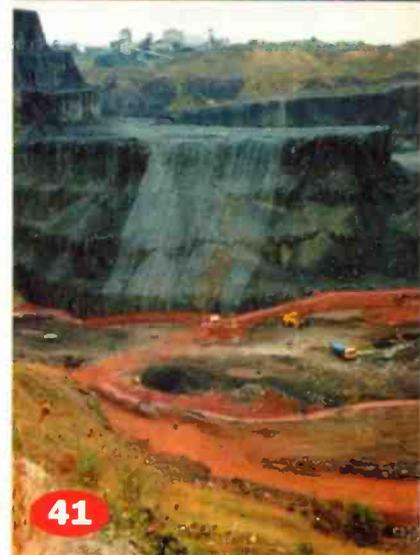
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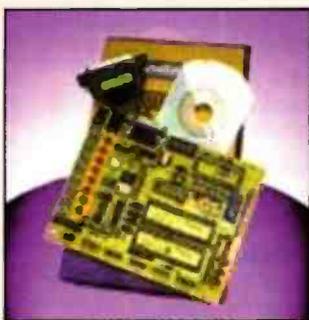


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# ELECTRONICS and Beyond

## Some things change

Are you one of those creative types that will doodle whilst talking? Perhaps you are inspired by colour, shape and form. If you are, then maybe you would like to design the new E'n'B, E&B or ENB logo for us, the one that will appear on the front cover. We are going to change the cover logo and shorten it from Electronics and Beyond to E'n'B, E&B or ENB. Your design can be sketched on paper showing a suggested colour scheme or you can use a graphics package and send us the print out. If we think the design is good enough to adopt, then the winning entry will be sent an Atmel STK200 Starter kit – A complete development system for AVR Microcontrollers.



Entries must be sent to Kanda Systems at the address shown on the contents page labelling it 'Logo Competition' and to be in by 17th April 2001.

Talking of competitions we also have another one on page 57 and you could be the lucky winner of a pair of tickets to the Royal International Air Tattoo at RAF Cottesmore on 28th/29th July 2001. All you have to do is complete the simple competition on page 57 and send you entry in. We have 15 pairs of tickets to give away.

Your E and B team



**Paul Freeman-Sear**  
Editor



**Natasha Nagaoka**  
Marketing



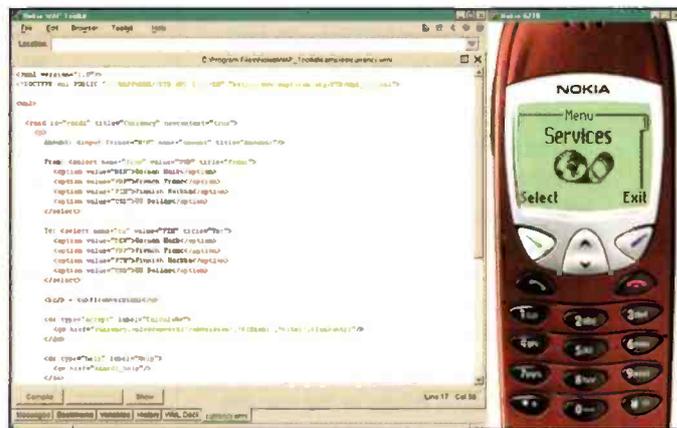
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# NEWS REPORT



## Nokia Launches WAP Toolkit

Nokia has announced the immediate availability of its updated WAP Toolkit for network operators, application developers and content providers. The Nokia WAP Toolkit 2.1 is a free software tool that provides a PC-based environment in which developers can write, test and de-bug WAP applications.

For further details, check: <[www.nokia.com](http://www.nokia.com)>.

## Apax Partners Raises European €2 Billion Fund



Apax Partners, has raised £2 billion in the first closing of Apax Europe V, a new pan-European private equity fund.

The fund will support investment in targeted

industries throughout Europe and Israel, with approximately 25% allocated to investments in early-stage companies.

For further details, check: <[www.apax.com](http://www.apax.com)>.

## Revolve Design Launches RoadWriter

RoadWriter is one of the first product that allows users to turn their Palm handheld quickly and easily into a low cost mobile office/communications solution.

RoadWriter developed by Revolve Design uses an integrated Touch-Type Keyboard, for fast data entry and access, as well as a dual DB9 Serial pass-through ports at its base for use with external peripherals, such as GPS receivers for navigation or modems for two-way wireless



communications.

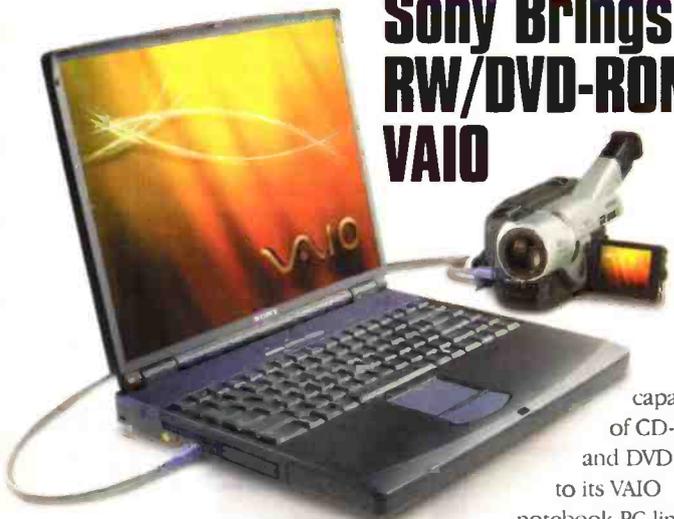
With RoadWriter, users enjoy close proximity and secure placement of the Palm organiser in a vehicle, while relying on continuous usage when used in conjunction with a GPS receiver and mapping or with a modem for two-way wireless communication.

RoadWriter can be easily

installed into the vehicle with a quick release, easy latch pedestal, with no need for drilling or permanent placement. The Palm handheld is also quickly installed and removed from RoadWriter with the touch of a button.

For further details, check: [www.revolvedesign.com](http://www.revolvedesign.com).

## Sony Brings All-In-One CD-RW/DVD-ROM Capabilities to VAIO



capabilities of CD-RW and DVD-ROM to its VAIO notebook PC line.

Sony's new combination drive is featured on four FX models. The PCG-FX190 and

Sony Electronics is bringing the powerful entertainment and storage

the PCG-FX170 feature a Windows Me operating system, while the PCG-FX190K and the PCG-FX170K offer the Windows 2000 operating system. Included in the entire FX series is Sony's 3MAX+ notebook system, offering consumers increased screen size, maximum battery capacity and maximum mobility in a notebook PC. For further details, check: [www.sony.com](http://www.sony.com).

## Intel Enhances Network Processor Family

Intel has enhanced the Intel Internet Exchange Architecture with more robust software tools and a faster network processor to handle the expanding responsibilities of equipment that processes Internet traffic.

In the second major enhancement to both the Intel IXP1200 Network Processor line

and associated software development tools in less than a year, Intel has introduced the Intel Microengine C Compiler and a new software developer kit to streamline development of feature-rich networking equipment.

Intel also introduced a third version of the Intel IXP1200

Network Processor that features faster embedded processors and buses. In addition, the control store for each of the network processor's six microengines has been doubled to allow developers to add more complex features.

For further details, check: [www.intel.com](http://www.intel.com).

## ETHERchip Bluetooth Enables Household Products

The MediaSolv Bluetooth ETHERchip can be integrated into any appliance or device, to provide instant Internet enabled personal information management functionality.

ETHERchip is a complete system on chip (SOC) with embedded processor, memory, control circuitry, system software and Bluetooth radio for fast and secure Internet connectivity.

ETHERchip is bundled with either bisOA or xSolv, MediaSolv's server applications that will provide access to the same personal and group information management capabilities via any Web or WAP device. The server side functionality is market ready and ETHERchip is currently a working prototype.

For further details, check:

[www.mediasolv.com](http://www.mediasolv.com).

## Joint Venture to Focus on Organic Displays

Pioneer has established a new company for the production and sale of TFT substrates for an active matrix type of Organic Electroluminescence (OEL) display.

The new company combines the technical strengths and core competencies of the partners that will bring to market a unique display for use in screen-based applications such as mobile phones and personal digital assistants.

Active-matrix organic EL displays possess the essence of organic EL displays with self-generated luminescence and high-resolution quality on a par with traditional cathode ray tubes (CRT).

In addition to being thin and lightweight, active-matrix organic EL displays also have a rapid response for displaying moving images and offer such advanced features as low-voltage operations and low power consumption.

The displays expect to be incorporated into a wide range of screen-based applications, including next-generation mobile phones and personal digital assistants (PDAs).

Pioneer, who was the first licensee of emergent patents for OEL from Kodak, has been developing Organic EL technology since 1988. In 1999, Pioneer Electronics Incorporated this brilliant, low power consuming, 3D display into car audio CD players.

For further details, check: [www.pioneer.co.jp](http://www.pioneer.co.jp).

## Intel Breaks Through Power Consumption

Intel has announced two new mobile PC microprocessors including the industry's first to operate under 1V, while consuming less than half a watt of power.

Enabled by Intel's advanced processor design and power-reduction technologies, the new processors are designed to deliver high performance, minimal power consumption and extended battery life for the smallest mobile PCs.

The new Ultra Low Voltage mobile Pentium III processor 500MHz featuring Intel SpeedStep technology brings high performance to mobile PCs weighing less than three pounds and measuring one inch in height.

The processor operates at less than 1V and consumes less than half a watt of power in battery optimised mode at 300MHz.

Intel also introduced the Ultra Low Voltage mobile Celeron processor 500MHz, delivering the industry's highest performance for the value sub-notebook segment.

For further details, check: [www.intel.com](http://www.intel.com).

## Actiontec Makes Anyone a Home Networking Wizard

Actiontec's Home Networking Wizards eliminate the usual difficulty of interconnecting PCs and peripherals in consumers' homes by turning the home's existing telephone wiring into a high performance HPNA2.0-compatible 10 Mbps network.

In addition to sharing files and peripherals, users of the USB Home Networking Wizard and Internal PCI Home Networking Wizard can simultaneously share a single analogue (dial-up), Cable, or xDSL Modem-based Internet connection to independently surf the Web.

Supporting multiple PC's up to 500 feet apart, the advanced network technology does not interfere with telephones or fax machines.

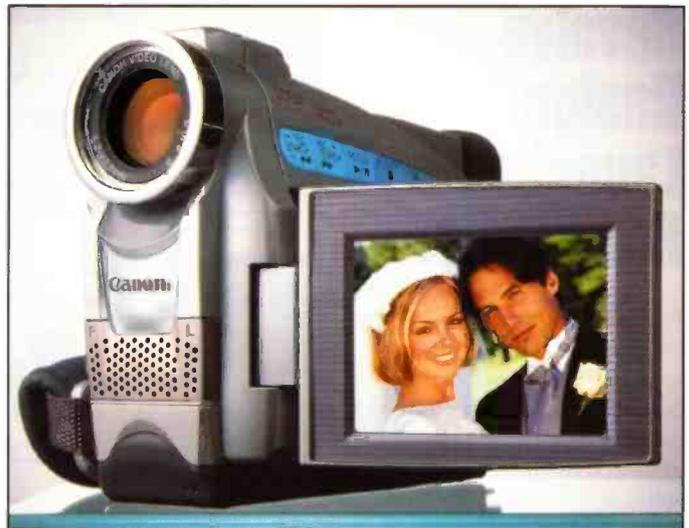
The high performance enables users to run demanding applications such as multimedia, voice, and video that have traditionally only been compatible with conventional networks with dedicated cabling.

For further details, check: [www.actiontec.com](http://www.actiontec.com).

## Canon Announces Three New Digital Camcorders

Three new digital camcorders with advanced features and lower prices have been added to the popular SR series by Canon. The new feature-rich models are priced attractively for consumers just entering the digital video revolution, or for anyone seeking greater versatility with the latest digital video technology in a compact design.

The three new models - SR20, SR25 MC and SR30 MC - create a progression of prices and



features, helping consumers to choose the best model that meets their needs and budget. The SR30 MC boasts the most unique features and accessories, but all three models have capabilities that,

until now, were found only in more expensive digital camcorders. The SR series will be available at authorised Canon dealers.

For further details, check: [www.canon.com](http://www.canon.com).

## Scottish Parliament Upgrades to 21st Century

Wipro Technologies has won a five-year, \$4.6 million dollar contract by the Scottish Parliament to provide Information Technology support services and consultancy.

The contract involves end-to-end infrastructure management services for the two-year-old Scottish Parliament. The Scottish Parliamentary Corporate Body approved the contract to replace the existing service that supported the Parliament through its initial set-up period.

The contract involves internal and external network management, systems administration, messaging and end user support, enterprise systems security, and providing consultancy on technology shifts. The agreement will also involve transitioning the IT infrastructure to the new facilities at Holyrood, Edinburgh expected to be ready by the end of 2002.

For further details, check: [www.wipro.com](http://www.wipro.com).



A new desktop customer support application developed by K2 Digital, the strategic digital services company, could cut millions of dollars of customer support expenses and reduce electronic customer relationship management (eCRM) development time by as much as six months.

Known as K2 HELP, the application enables consumer and industrial product manufacturers to deploy a desktop 'help' application that can be delivered on a CD with their product, giving marketers distinct product and branding advantages. The application brings together the capabilities needed to

## Application Looks and Acts Like Product It Supports

deliver a complete customer-facing help, demonstration, training, and documentation tool. K2 HELP includes an integrated browser and a search engine, features that allow users to navigate through local and Internet-based information.

K2 HELP can self-install from a CD and can update content automatically over the Internet. For further details, check: [www.k2digital.com](http://www.k2digital.com).

## Ford and Vodafone Team on Telematics

global positioning system technologies.

The service will debut with the Ford Focus model, but the company expects that within five years, nearly all Ford models will be fitted with some type of telematics capability.

For further details, check: [www.ford.com](http://www.ford.com).



Ford and Vodafone have forged a partnership to develop an in-car telematics system that will enable drivers

to access emergency and roadside assistance, traffic information, and route planning via GSM mobile and

## Sensormatic Joins Forces with MIT

Sensormatic is sponsoring the Massachusetts Institute of Technology (MIT) Auto-ID Centre, a not-for-profit research organisation dedicated to advancing the use of identification technology throughout the retail supply chain.

"The ability to identify and access the complete history of a product will bring enormous benefits to every aspect of the supply chain from manufacturers to distributors to retailers and consumers, especially in terms of product security," said Per-Olof Loof, president and chief executive of Sensormatic.

"The MIT Auto-ID Centre, with its unique approach to developing and utilising identification technology, provides an opportunity for Sensormatic to discover new ways to manage information and create new security solutions for our customers."

By joining the Auto-ID Centre, Sensormatic will collaborate with other industry leaders to develop future applications for identification technology.

Sensormatic is currently developing and testing its own radio frequency identification system called smartEAS that incorporates its UltraMax anti-theft system with RFID technology. The system is currently being tested by Movie Gallery, the nation's third largest video rental chain, for use with automated inventory returns and RFID tag programming, with future plans for inventory counting and reading and writing data at the point of sale.

For further details, check: [www.sensormatic.com](http://www.sensormatic.com).

## Giga-tronics Establishes UK R&D Facility

Giga-tronics has established a development centre for microwave instrumentation, Giga-tronics Instruments based in Luton.

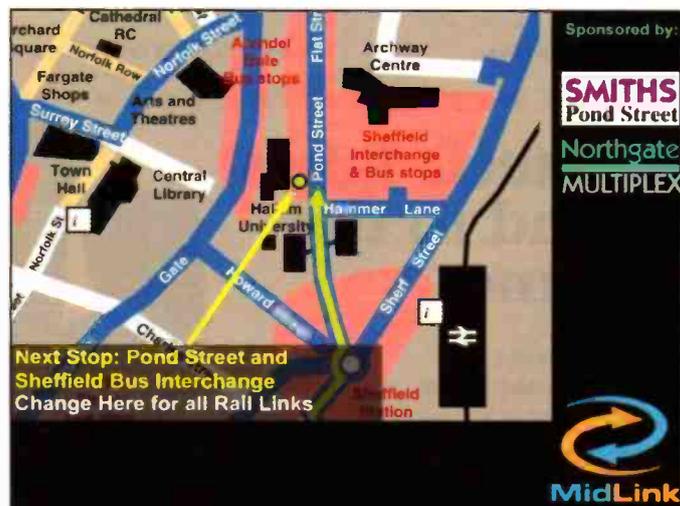
During 2001, Giga-tronics Instrument Division will be making a significant investment in the new design centre and which will be responsible for developing new products in the power measurement market sector focusing on the wireless industry.

For further details, check: [www.gigatronics.com](http://www.gigatronics.com).

## Gatwick Trials Vehicle Location System

Infocell Telecom is using Wind River's embedded software technology in its Centurion, automatic vehicle location (AVL) system to bring predictability to public transport systems. The system is currently running field trials with the bus service at Gatwick airport.

A bus service using Centurion will monitor up to the second, real-time information on how the fleet is performing. With this information, the bus company



can issue timetables based on how their fleet really performs.

Passengers waiting at the bus stop can be told accurately when their service is due to arrive based on bus position and traffic conditions. More than this, Centurion also enables passengers to receive useful information about their travel destination while onboard the vehicle.

Centurion is composed of embedded control and

database systems that communicate via the TETRA Professional Mobile Radio network. Onboard each fleet vehicle resides an iBUS unit. This unit contains a GPS system, for location tracking, an instant voice connection between the driver and the depot, a smart ticketing system and a passenger empowerment system.

For further details, check: [www.infocell-telecom.com](http://www.infocell-telecom.com).

## Sony Takes Giant Leap For DVD



Sony Electronics has taken on-the-go entertainment to the next frontier - literally. Its DVP-FX1 portable DVD player is on the Space Shuttle Discovery, which was launched at the beginning of March.

The portable DVD player is the first in space, playing movies and music for the three astronauts aboard the International Space Station, where it will be housed for an extended period of time.

Five Sony portable DVD players are on board, along with about 50 DVDs and CDs, forming the first A/V entertainment system in space. For further details, check: [www.sony.com](http://www.sony.com).

## Philips Launches Natural Language Recognition for Phone

Based on natural language understanding and TrueDialogue technology, Philips SpeechMania 7.0 allows people to use normal human conversation when interacting with fully automated telephone-based information and transaction systems.

SpeechMania systems recognise user requests by identifying the relevant information and interpreting it in the context of the user's statement.

SpeechMania 7.0 includes powerful new features, including mixed acoustic model support, channel independent speech recognition, and support for 22 different languages.

This enhanced speech recognition platform is suitable for implementing a wide range of high-end dialogue-based information and transaction services, and is especially suited to telephony applications.

For further details, check: [www.speech.philips.com/telephony](http://www.speech.philips.com/telephony).

## Cisco to Enable BT Cellnet 3G Mobile Services

Cisco is to provide to BT Cellnet the Internet Protocol (IP) and Asynchronous Transfer Mode (ATM) infrastructure for its third-generation (3G) mobile telecommunications network.

The deployment of the 3G IP+ATM core network underpins BT Cellnet's strategy to deliver multimedia content and applications to customers via 3G mobile devices.

The provision of an IP+ATM core will allow BT Cellnet to deliver advanced voice, data and mobile Internet services to its customers through the implementation of the UK's first UMTS technology.

For further details, check: [www.cisco.com](http://www.cisco.com).

## Duracell Ultra Targets Digital Cameras

A new battery from Duracell called the Ultra CR-V3 meets the power demands of digital cameras. It lasts up to twice as long as any other commercially available battery chemistry in digital cameras, delivering superior power to LCD displays, built-in flashes, built-in zoom lenses and auto-focus features.

For further details, check: [www.duracell.com](http://www.duracell.com).

## Microchip Technology Shows Internet Demo Board

Microchip Technology has introduced the PICDEM.net Internet/Ethernet Demonstration Board with a TCP/IP stack to enable embedded connectivity over industrial, automotive, and consumer networks.

The PICDEM.net Internet/Ethernet Demonstration Board provides engineers with the tools to explore Microchip's various TCP/IP solutions.

The PICDEM.net board uses the 40-pin PIC16F877 Flash microcontroller and TCP/IP firmware for the network interface. After the initial set-up of the IP Ethernet address, engineers can access the various functions on the board through a network or the Internet.

The PICDEM.net board has an Ethernet and RS232 interfaces. A standard Web browser such as Microsoft Internet Explorer or Netscape

Navigator is used to display inputs from the board (potentiometers and switches) and drive the LCD display and control LEDs. The PICmicro device acts as a webserver that can serve HTML Web pages.

The initial board configuration is performed via the RS232 port using a standard terminal program to configure the IP and Ethernet addresses. The demo board is also equipped with a 6-pin modular connector to interface directly with Microchip's MPLAB In-Circuit Debugger (ICD).

For further details, check: [www.microchip.com](http://www.microchip.com).

## Logitech Takes Sound to the Xtreme

Logitech is cranking up its SoundMan speaker line-up with the release of its flagship product, SoundMan Xtrusio DSR-100.

At around £120, SoundMan Xtrusio DSR-100 can be purchased online at [www.logitech.com](http://www.logitech.com) and at a limited number of retail outlets.

SoundMan Xtrusio DSR-100 delivers 100 watts of bone-jarring sound to games and DVD movies on the PC. Using

patented LIMAD (Linear Magnetic Drive) technology, DSR-100 provides high-fidelity sound reproduction from full, deep bass to soaring highs. SoundMan Xtrusio DSR-100's four-channel digital surround sound system offers world-class industrial design, with a sleek

extruded aluminium subwoofer and four satellite speakers whose stylish, contemporary shape represents a pleasing change from the rigid, institutional look of competing systems.



Scientists at Keele University in the UK have developed four new storage techniques capable of squeezing the entire contents of the British Library onto an area the size of a credit card.

The first invention involves a method for compressing text

stored in binary form to an eighth of its normal size. The second involves a different way of recording and reading information that increases four-fold the amount of data that can be written to magneto-optical disks.

## UK Academics Expand Storage Options

The third provides new kinds of coatings and materials that can be used in disks that increase their capacity 30-fold. And the final invention produces a memory system that crams up to 10.8 terabytes of data into an area the size of a credit card.

The company formed to commercialise the technology, Keele High Density, says it should be available within two years.

For further details, check: [www.keele.ac.uk](http://www.keele.ac.uk).

# MIDI MATRIX 2

## PROJECT

*Neil Johnson describes the design and construction of a versatile eight-channel MIDI routing unit for the home or small studio.*

## PART 2



The hardware described last month is only half the story - without the software it is just a box of bits. This section describes what the software does, how the various menus work, and what the

various modes of operation do.

The overall structure of the software is presented in Figure 10. Do not be put off by the appearance of a scheduler - far from adding complexity, it actually reduces

complexity by helping separate the various software tasks and managing all timing-related activities. It is a small co-operative multi-tasking real-time operating system (RTOS), and in this application provides timing accuracy of approximately 1ms.

Each task responds to events sent to them from other tasks in the system, in a manner similar to the way Microsoft Windows operates. However, each task runs to completion before handing control back to the scheduler, so there are no overheads and headaches associated with pre-emptive multi-tasking RTOSes (resource locking, priority inversion, critical sections, semaphores, etc).

The purpose and function of most of the drivers should be fairly self-evident - the EEPROM driver talks to the EEPROM, the MIDI driver receives and decodes MIDI messages, and the Mux driver manages the MIDI routing multiplexers.

The button task/driver and the display task/driver are complicated by crossing the boundary between the two levels. The button driver interfaces with the button scanning hardware, while the button task repeatedly scans and debounces the states of all the buttons, posting events to the user interface (UI) task whenever it detects a button press.

The display driver likewise manages the low-level interface of the display driver, while the display task manages the multiplexing of the display data, as well as providing a range of services to the UI task for managing the display.

Both these tasks use the scheduler to

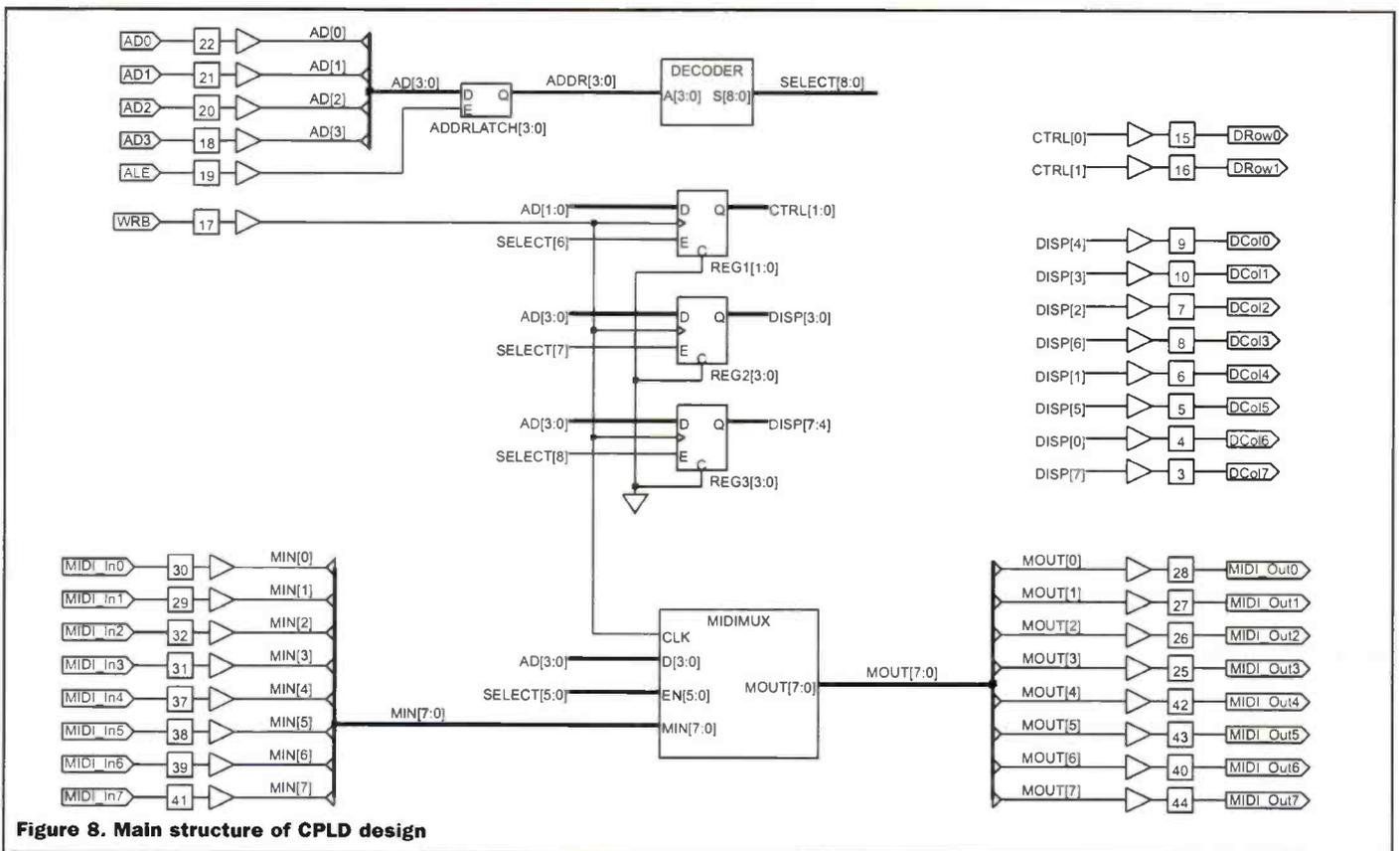
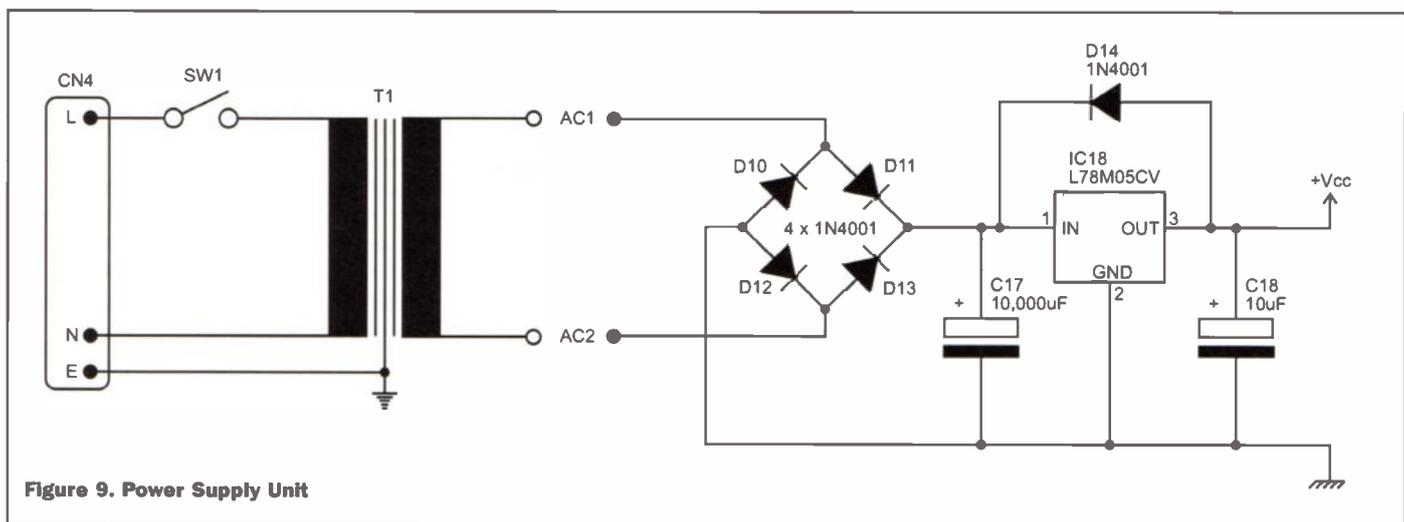


Figure 8. Main structure of CPLD design



**Figure 9. Power Supply Unit**

provide timing control, either for scanning buttons or multiplexing the display. The button task repeatedly posts itself an event every 6ms, each time scanning another row of buttons. The upshot of this is that the buttons are debounced over a period of 48ms, allowing for switching transients due to the mechanical nature of the buttons. Likewise, the display task multiplexes the display every 4ms, completely refreshing

The four main modes of operation are MIDI, Patch, Edit and Save, as shown in Figure 12. The MIDI mode shows the current MIDI channel on the display, and allows the user to select a new MIDI channel on which to listen for patch change commands. The Patch mode is for recalling a patch from the internal memory. The Edit mode is for editing the MIDI routing pattern, and Save mode is for saving a patch

in the internal memory, and is reloaded when the unit is turned on.

The MM2 is configured to listen to the MIDI messages coming in through input channel 8. MIDI Patch Change messages, which have the format 0xCn mm (where n is the MIDI channel number, and mm is the new patch number, in the range 0 to 63), will select a new patch if the MM2 is in Patch mode.

### Patch Mode

This is the default mode of operation. To add a little bit of complexity to the program, there are two patch modes - Patch Select mode and Patch Query mode. The default is Patch Select mode, and is entered whenever you change to Patch mode. It is indicated by the Patch mode button LED being continuously lit.

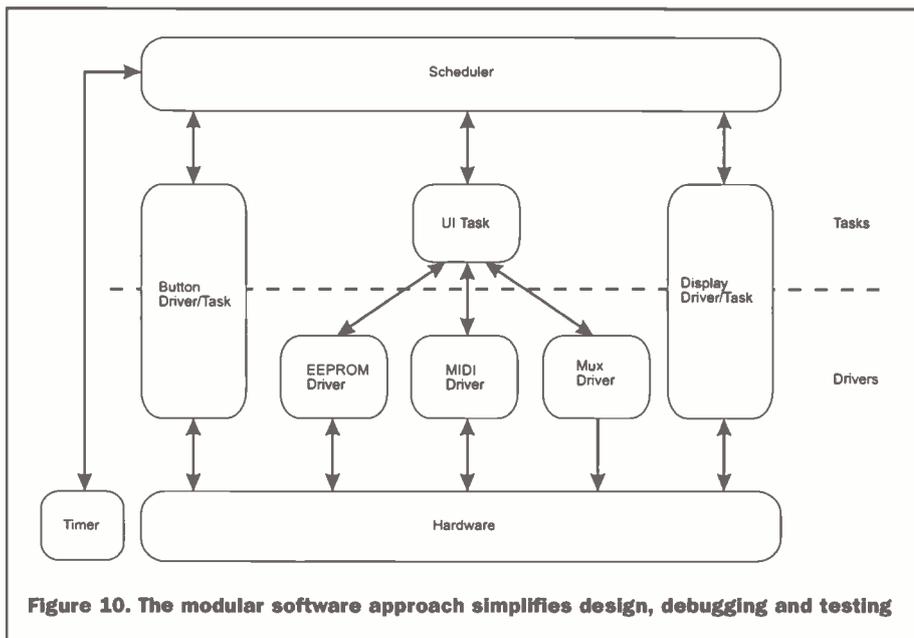
The selection buttons allow you to select one of the sixty-four patch memories, and the display shows the currently selected patch. The current version of software does not store the last used patch in memory, so the unit always starts with patch 11 loaded. The sixty-four patches are numbered in a slightly funny manner, using the digits 1 to 8. The patch numbers start at 11, 12, 13, 14, 15, 16, 17, 18, then jump to 21, 22, 23, and so on, all the way to patch 88. The first digit is selected from the top row of buttons, and the second digit from the bottom row.

The Patch Query mode shows the routing arrangement for the patch. Pressing the Patch button moves the unit back and forth between Patch Select and Patch Query mode. Patch Query mode is indicated by the flashing Patch button flashing. In this mode, pressing one of the output select buttons highlights that button and the corresponding input that is routed to that output.

### Edit Mode

Configuring the MM2, and being able to store those settings in non-volatile memory available for instant recall, is the heart of the system. The Edit mode, together with Save, manages this part of the system.

The Edit mode is entered by pressing the Edit button. The patch number display flashes to show that you are editing the



**Figure 10. The modular software approach simplifies design, debugging and testing**

the display every 16ms.

The UI task is where the real meat of the software sits, and where everything to do with the user is concerned. The design of the UI covers both hardware (buttons, displays, LEDs) and software (menu pages, information display, prompting). A good UI combines these two in a way, which makes the equipment as easy to use as possible. Well, that's the idea anyway!

### Today's Special

The heart of the UI system is a set of menu pages. Menu pages are displayed using a combination of the 2-digit 7-segment LED display, the two main mode select buttons to the left, and the sixteen channel select buttons on the right. Figure 11 shows the front panel layout.

into the internal memory. Each of these modes is described in more detail in the following sections.

### MIDI Mode

MIDI mode is entered by pressing the MIDI mode button. The button lights up to confirm the mode selection. The display shows the current MIDI input channel for receiving patch change messages, and the corresponding selection button lights up. In this mode the top row of buttons corresponds to MIDI channels 1 to 8, and the bottom row corresponds to channel 9 to 16.

A new MIDI channel is chosen by pressing one of the selection buttons. The new MIDI channel will be shown on the display and the corresponding selection button will light. The setting is also stored

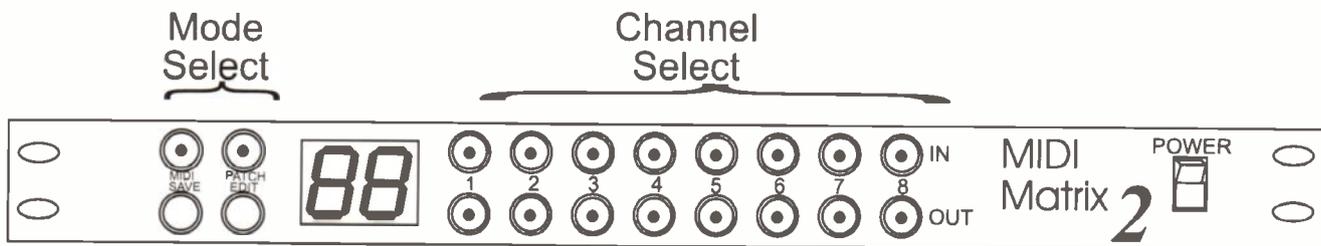


Figure 11. The MIDI Matrix 2 front panel

patch routing. Editing itself is quite simple - select an output, then choose the input that you want connected to that output. The selected buttons will light up to confirm the new configuration. Editing changes can be abandoned by pressing the Patch mode button, putting the unit back into Patch Select mode. Any changes to the patch will be lost and the original patch will be reloaded from memory.

### Save Mode

Saving the patch requires two steps. First, pressing the Save button puts the unit into Save mode, indicated by all the select buttons and the patch number display flashing. In this mode you can select the patch location into which the new patch

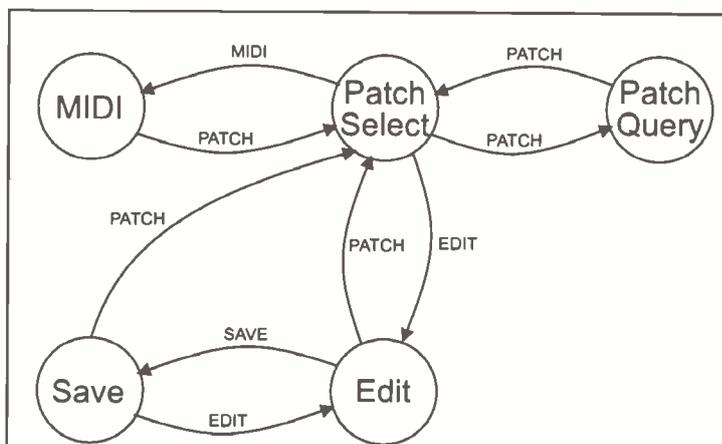


Figure 12. The operating modes of the MM2

will be stored; it does not have to be the same as the one you started from.

Once the new patch number is selected, the patch data is saved in memory by pressing the Patch mode button. Pressing the Edit button puts the system back into Edit mode without saving

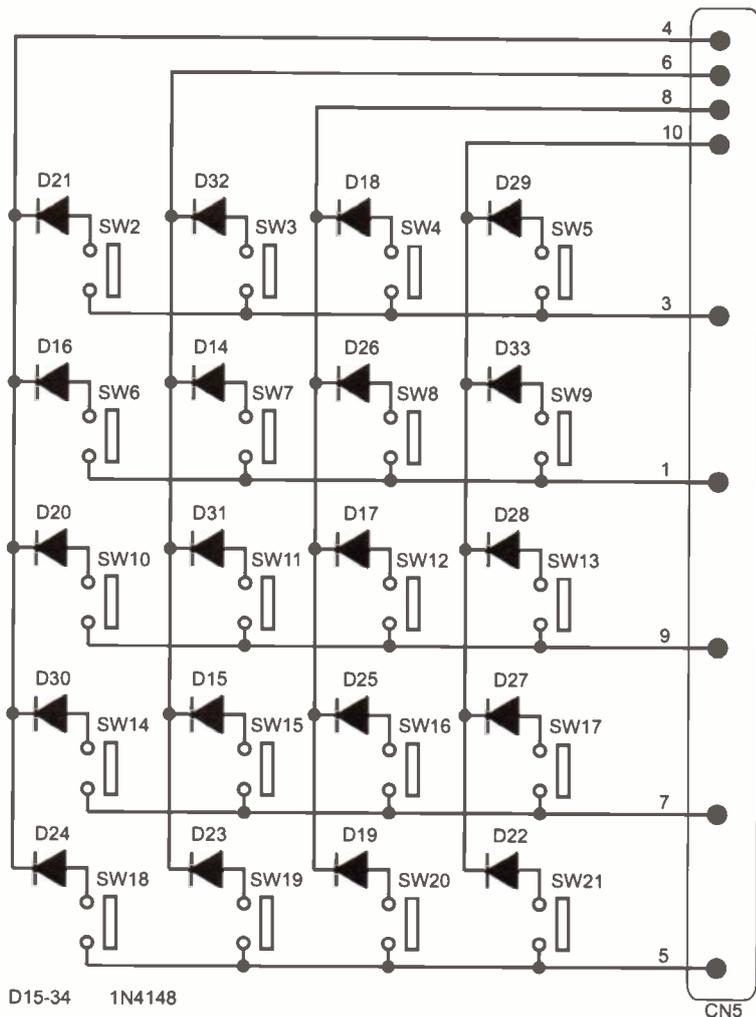


Figure 13. Front panel push button matrix

the patch. From there you can either continue editing, or abandon the changes and return to Patch Select mode.

The Patch Select-Edit-Save sequence can also be used for copying patches from one location to another. Start in Patch Select mode and choose the source patch. Then press Edit followed by Save, enter the new patch number, and press Patch. The patch has now been copied into the new location. Unedited patches default to all outputs connected to input 1.

### Remote Control

The MM2 can be controlled remotely as well as from the front panel, albeit in a simpler manner. When the unit is in Patch Select mode patches can be selected by Program Change messages transmitted on the programmed MIDI channel connected to input channel 8. Of the 128 possible Program Change messages, the bottom half (0-63) are used directly, while the top half (64-128) are mapped onto the bottom half by subtracting an offset of 64. So, for example, patch number 64 maps onto patch number 0, number 65 onto number 1, etc.

Also, remember the strange patch naming system starting at 11 and finishing at 88? This can lead to some confusion, in that to change to MM2 patch number 12 you need to send a Program Change message with the value 1. Ouch! Why is this?

The patches are arranged in eight banks of eight patches, giving a total of 64 patches. The eight banks are numbered 1 to 8, and each patch in the bank is also numbered 1 to 8.

Some synthesisers (for example, the Roland Super JX) use a similar scheme, numbering the banks A through H and the individual patches 1 through 8, producing a

naming scheme like A7, H4, etc. Others, including the Yamaha SY77, split the patches into four banks (A to D) of 16 patches (1 to 16).

The formula for calculating what the decimal equivalent number is for each MM2 patch location is shown below.

$$\text{Patch} = 8 \times (\text{LeftDigit} - 1) + (\text{RightDigit} - 1)$$

So, for example, MM2 patch "47" corresponds to decimal patch number 30. If using a keyboard, either a synthesiser or a master keyboard, using the front panel patch select buttons reduces the whole affair to button jabbing.

### Up Front and Personal

The front panel is built up from a second PCB. Figures 13 and 14 show the button and LED scanning circuits respectively.

The button scanning matrix (Figure 13) connects directly to the microcontroller through CN5. Each button has a blocking diode to stop any current flowing through the switch if it accidentally pressed while a neighbouring row is being scanned.

The LED matrix (Figure 14) is similar in design, with the thirty-two LEDs arranged in four blocks of eight. None of these LEDs are identified in the parts list - they are combined as parts of other components. Fourteen of them make up the two seven-segment displays, with the remainder being part of the push buttons.

### Construction

The MM2 consists of three distinct parts - the main PCB, the front panel PCB, and the case and associated internal wiring. We will start with the simplest part - the front panel PCB, then follow with the main PCB, and complete the project with the case and remaining wiring.

The front panel PCB component layout is shown in Figure 15. It is recommended that a through-hole plated (PTH) PCB is used for ease of construction, although this is not necessary for successful completion of this project (all the author's PCBs are double-sided but not PTH).

The board is populated with twenty push buttons (two of which do not have internal LEDs), fifteen through-board links (for non-PTH boards) and continue with the resistors and small capacitors. Then follow with the larger capacitors and connectors.

Begin with the through board links and the diodes. Follow with the two displays, making sure they are seated (a) the right way round, and (b) evenly aligned with respect to each other and the surface of the PCB - otherwise they will look wonky and uneven when mounted behind the front panel. Complete the component side with the twenty push buttons. Note that items SW20 and SW21 are different from the others in not having internal LEDs, and that items SW18 and SW19 have red LEDs, while the remainder has green LEDs.

The two IDC connectors are mounted on the rear of the front panel PCB to allow easy routing of the connecting cables from the main PCB. All solder joints to the two connectors are made on the component side.

The component layout for the main PCB is shown in Figure 16. It is of a more

heatsink - find something suitable from your junk box. At the least, something about 1-inch square with some fins, painted matt black.

The third PCB is used for mounting the mains transformer. The component layout is shown in Figure 17. The transformer itself is soldered directly to the board, with the connections made as both ends. The terminal pads are designed to accommodate 10mm-spaced PCB screw terminal blocks, but these are optional and the wires can be soldered direct to the PCB, or PCB pins.

### Driller Killer

The next major stage of construction is drilling out the various round and rectangular holes in the case. Three of the case's six panels require holes: the front

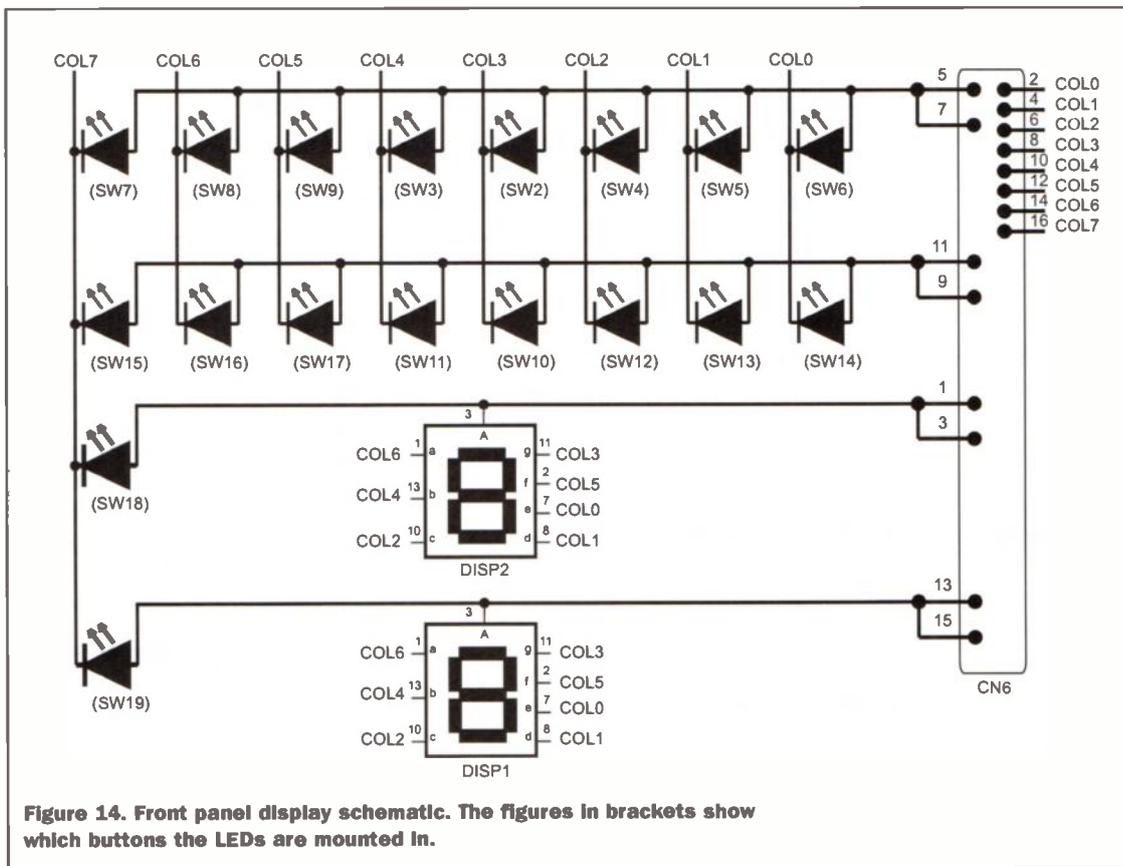


Figure 14. Front panel display schematic. The figures in brackets show which buttons the LEDs are mounted in.

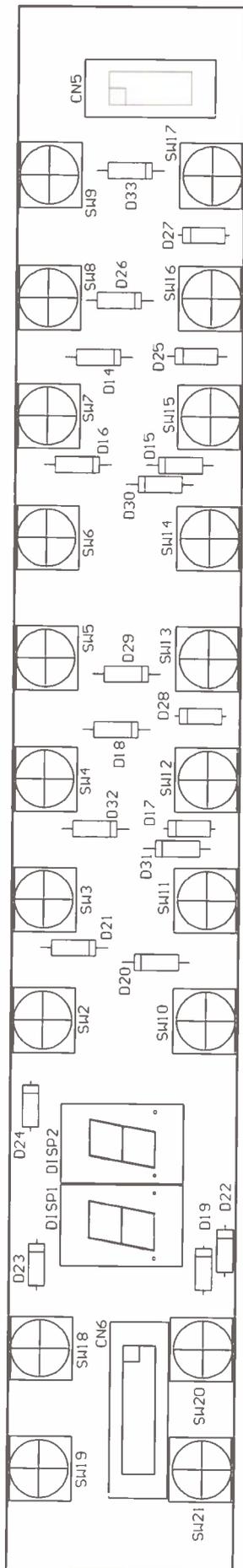
traditional construction, with all components mounted on one side and solder applied to the other. Start with the through-board links (for non-PTH boards) and continue with the resistors and small capacitors. Then follow with the larger capacitors and connectors.

Leave out the semiconductor devices until last. It is recommended that a socket is used for IC15 (the EPROM), and one is definitely needed for IC16 (the CPLD). Again, start with the smaller diodes, then the transistors, the direct-soldered devices, finishing with the two sockets.

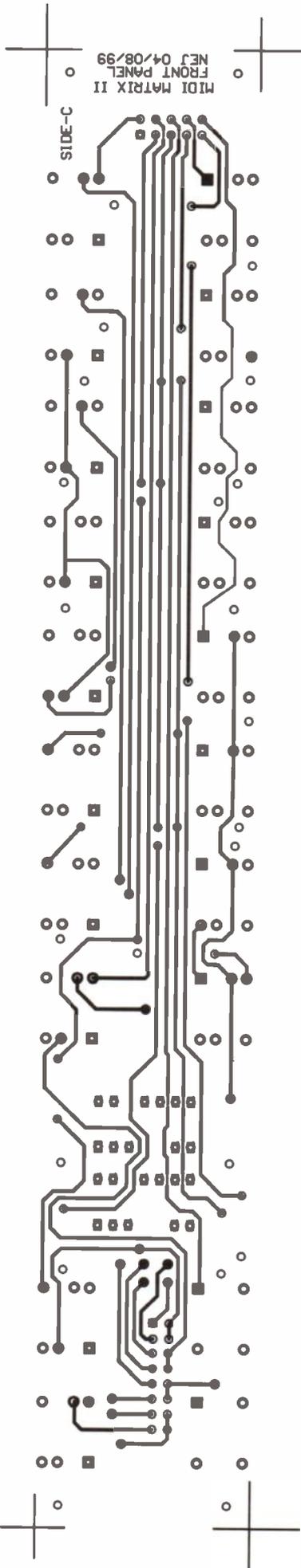
At the end of soldering give the board a careful examination for solder bridges and splashes, poor solder joints and other debris. Ideally, give the board a clean with flux remover. The voltage regulator, IC18, should be mounted on a small aluminium

panel needs holes for the mains switch, push buttons, seven-segment LED display and the mounting holes for the front panel PCB; the bottom panel needs mounting holes for the main PCB and the transformer. The rear panel needs holes for the sixteen MIDI connectors and the mains power connector.

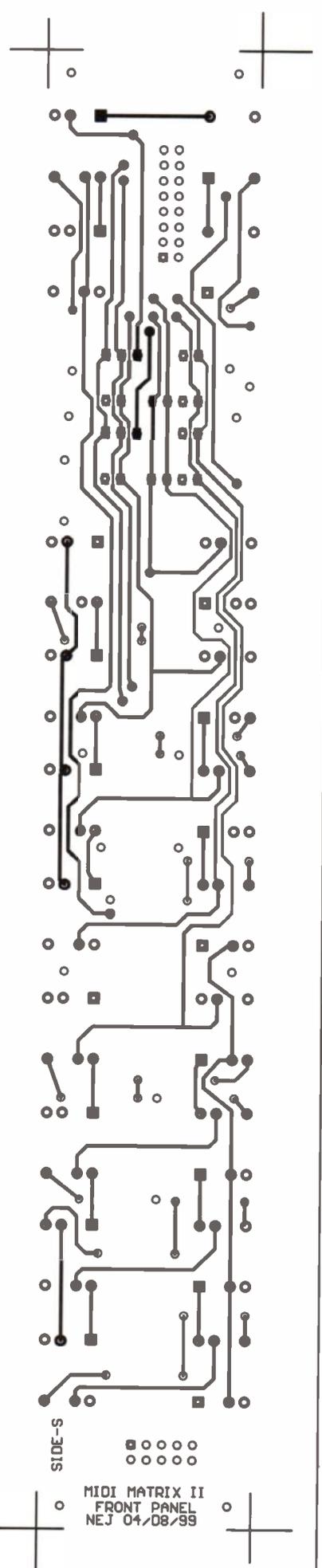
Taking the front panel first, the complete mechanical drilling detail is shown in Figure 18. There are a total of thirty holes to drill - twenty push buttons, eight mounting holes, one display cutout and the mains switch cutout. A distinction is made between a hole (made with a drill) and a cutout (a non-round hole). Also note that because the majority of the holes are related to component positions on the front panel PCB extra care must be taken in the preparation of the front panel.



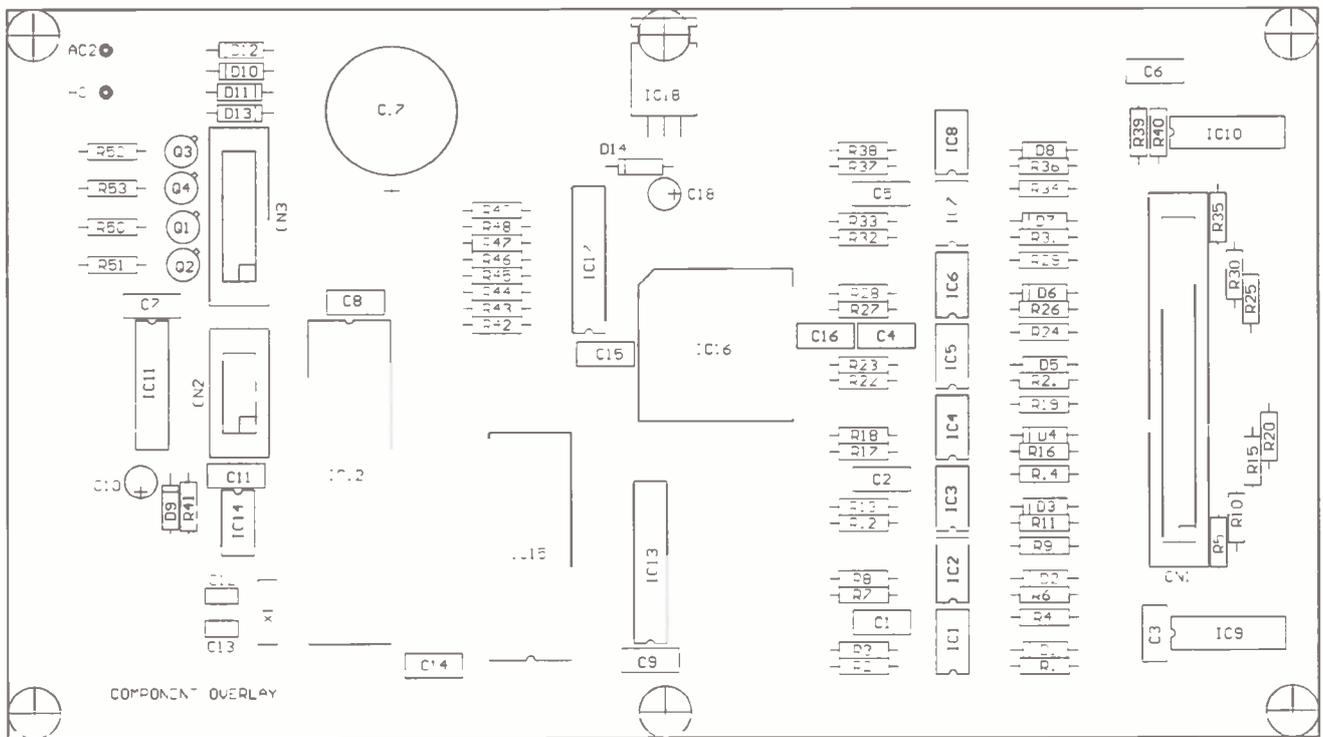
**Figure 15. Front panel PCB component overlay. Note that CN5 and CN6 are mounted on the solder side of the PCB**



**Figure 15a. Component side foil pattern**



**Figure 15b. Solderside foil pattern**



**Figure 16. Component overlay for the main PCB. Take particular note of the orientation of the ICs, diodes and electrolytic capacitors. Note: Figure shown at 85%**

Having said that, the key is in the marking out - taking extra time to make sure the hole marks are in the right place prior to drilling will be time well spent. It is especially recommended that a surface plate and surface gauge be used to mark out the front panel. These two tools used together will ensure that your scribing lines will run parallel to each other and to the sides of the panel.

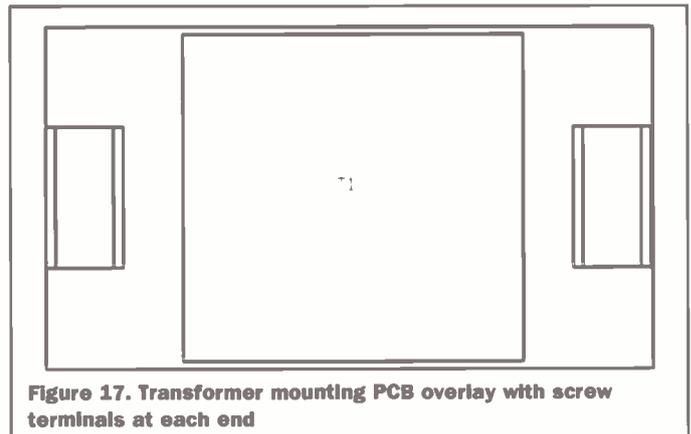
The author's unit, as seen in the photos, uses a second front panel for cosmetic appearances. This thinner panel is glued on to the front of the main unit, covering the mounting screws. It is engraved and machined from precise computer-generated drawings to give a professional appearance. The panel is available from the author at the address given in the Parts List.

The rear panel, Figure 19, shows the location and dimensions of the sixteen MIDI sockets and the mains input connector. Again, time spent in marking out will help avoid mistakes, and produce a

cable tie. It should be wired to the PCB with two short lengths of heavy (32/0.2mm) wire.

The internal wiring schematic is shown in Figure 21. Take special care with the mains wiring, and it is **STRONGLY** recommended that the wiring is checked by a qualified electrician before any mains voltage is applied.

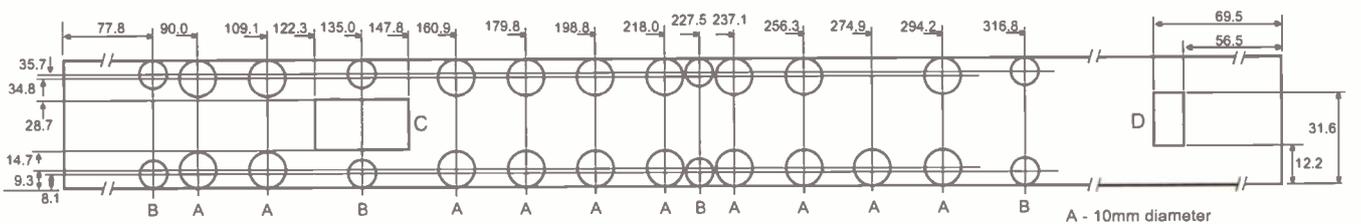
**CAUTION:** this unit uses mains voltage for its internal power supply. **MAINS KILLS—TAKE CARE.** Following the wiring diagram exactly, and check the circuit carefully **BEFORE** connecting it to the mains. Too many musicians have been killed by mains electricity already—making music is supposed to be lively, not deadly.



**Figure 17. Transformer mounting PCB overlay with screw terminals at each end**

professional-looking unit. messages, and configures the routing matrix for each patch. With everything under computer control there is no setting up to do.

The main source of potential problems is in the wiring between the back panel MIDI sockets and the main PCB. A total of forty wires are soldered onto the backs of DIN sockets, so there is ample opportunity to



**Figure 18 Front panel mechanical detail The two hole sizes A and B are as indicated. The cut out for the display is marked 'C' and mains switch 'D'. All holes are deburred before final assembly.**

professional-looking unit.

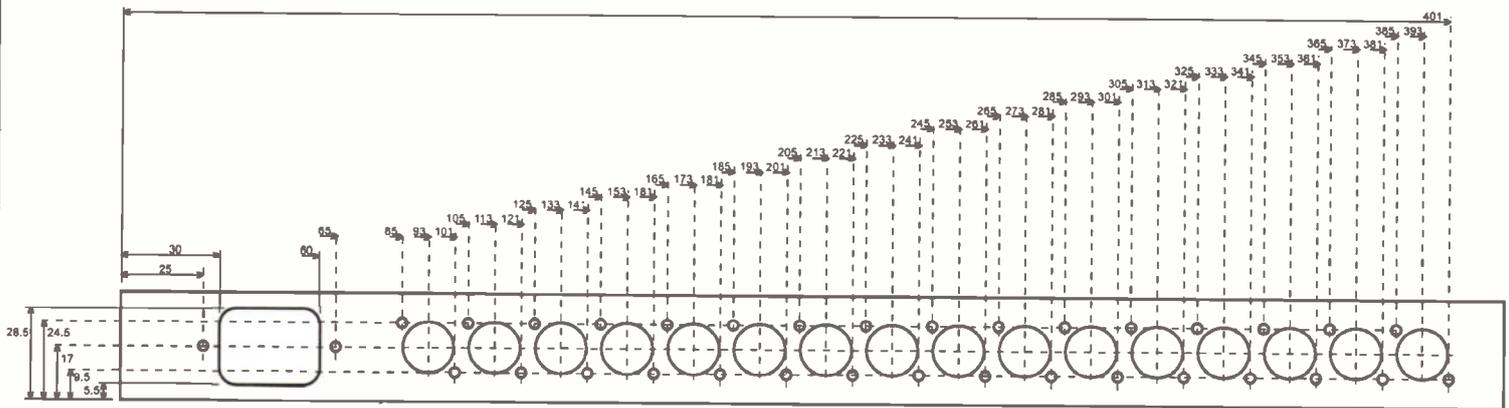
Finally, Figure 20 shows the internal layout of the case, showing the main PCB, the mains transformer, and the wiring between the PCB and the front and rear panels. The large smoothing capacitor, C17, is fixed to the bottom with a sticky pad and

### Testing

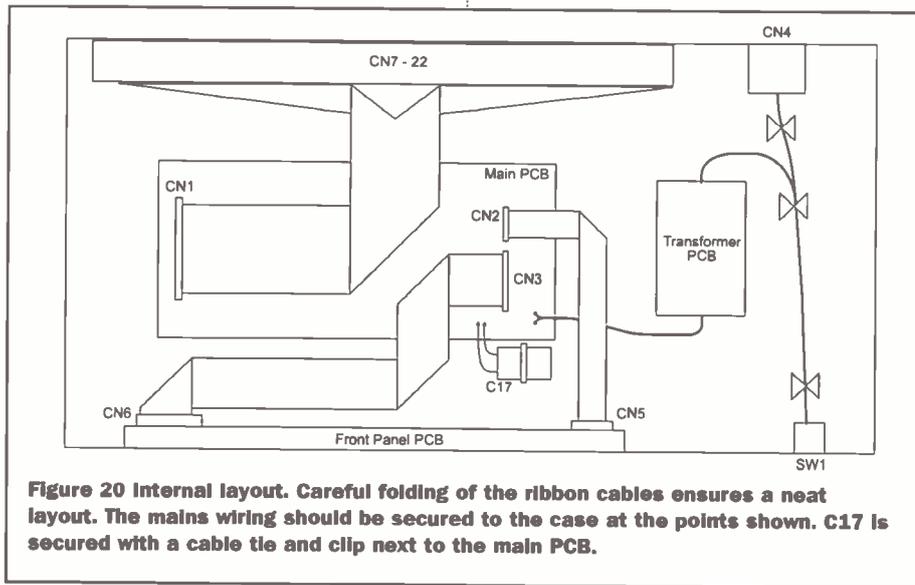
The MM2 routes digital MIDI signals from eight inputs to eight outputs, employs an eight-bit microcontroller to control the user interface, keep a set of sixty-four patch configurations in non-volatile memory, receives and interprets MIDI patch change

get some of them wrong. A good test is described here.

Turn the unit on and check the display does a one-second lamp test (all LEDs on) then shows Patch mode with patch 11 loaded. At first, the data in the EEPROM will be uninitialised; the MM2 will set this to



**Figure 19** Rear panel mechanical drilling details. All small holes are 3mm in diameter; the larger round holes are 15.5mm in diameter. The cut-out for the IEC mains connector has 5mm radiused corners.



**Figure 20** Internal layout. Careful folding of the ribbon cables ensures a neat layout. The mains wiring should be secured to the case at the points shown. C17 is secured with a cable tie and clip next to the main PCB.

the default of input 1 connected to all outputs. Enter Edit mode and route each input to its corresponding input (1 to 1, 2 to 2, etc). Then with a MIDI keyboard and a synthesiser, connect them in turn to each input-output pair and confirm that the synthesiser receives messages from the keyboard - pressing a few keys should trigger the synthesiser into making a sound.

Since all MIDI inputs and outputs are electrically isolated thanks to the opto-isolators, any problems with the MM2 will not harm the keyboard or synthesiser.

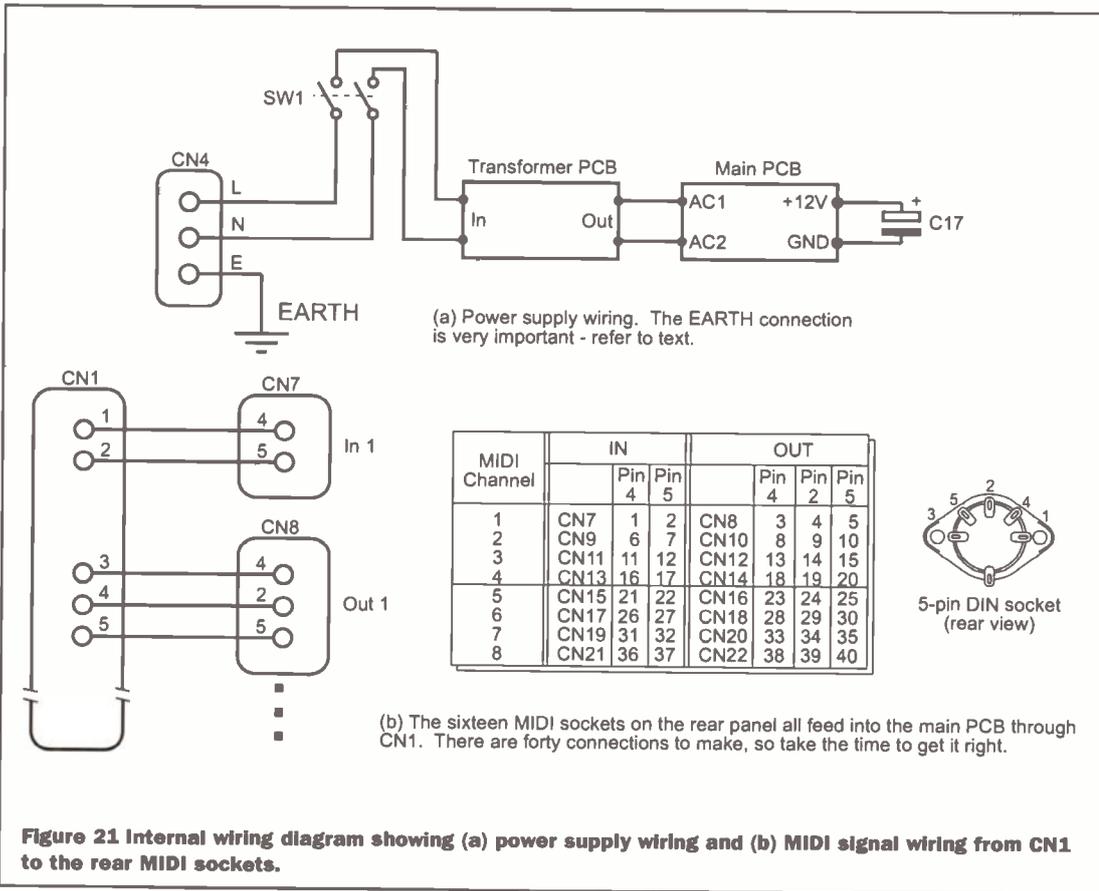
### Applications

The MM2 is a very flexible programmable MIDI routing unit. It can store up to sixty-four patches of routing information, any of which can be selected either from the front panel or remotely via MIDI. It solves one of the major problems of MIDI - any studio with

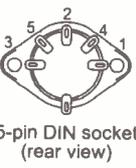
two or more MIDI masters (anything from a master keyboard, synthesiser, computer, sequencer, etc) will at some point need to change the MIDI data path (it's "topology" in techno-speak).

The simplest use of the MM2 is between several MIDI masters and slaves. However, some devices can be both master and slave. For example, a workstation includes a synthesiser, keyboard, sequencer and, typically, a disk drive. The keyboard or sequencer generates MIDI data to drive the synthesiser, or it can be disabled to allow the internal synthesiser to be operated from an external master.

Another example is a sampler. Normally, it is operated from a keyboard or sequencer. However, transferring samples from a computer to the sampler requires the computer to be the sampler's MIDI



**Figure 21** Internal wiring diagram showing (a) power supply wiring and (b) MIDI signal wiring from CN1 to the rear MIDI sockets.



5-pin DIN socket (rear view)

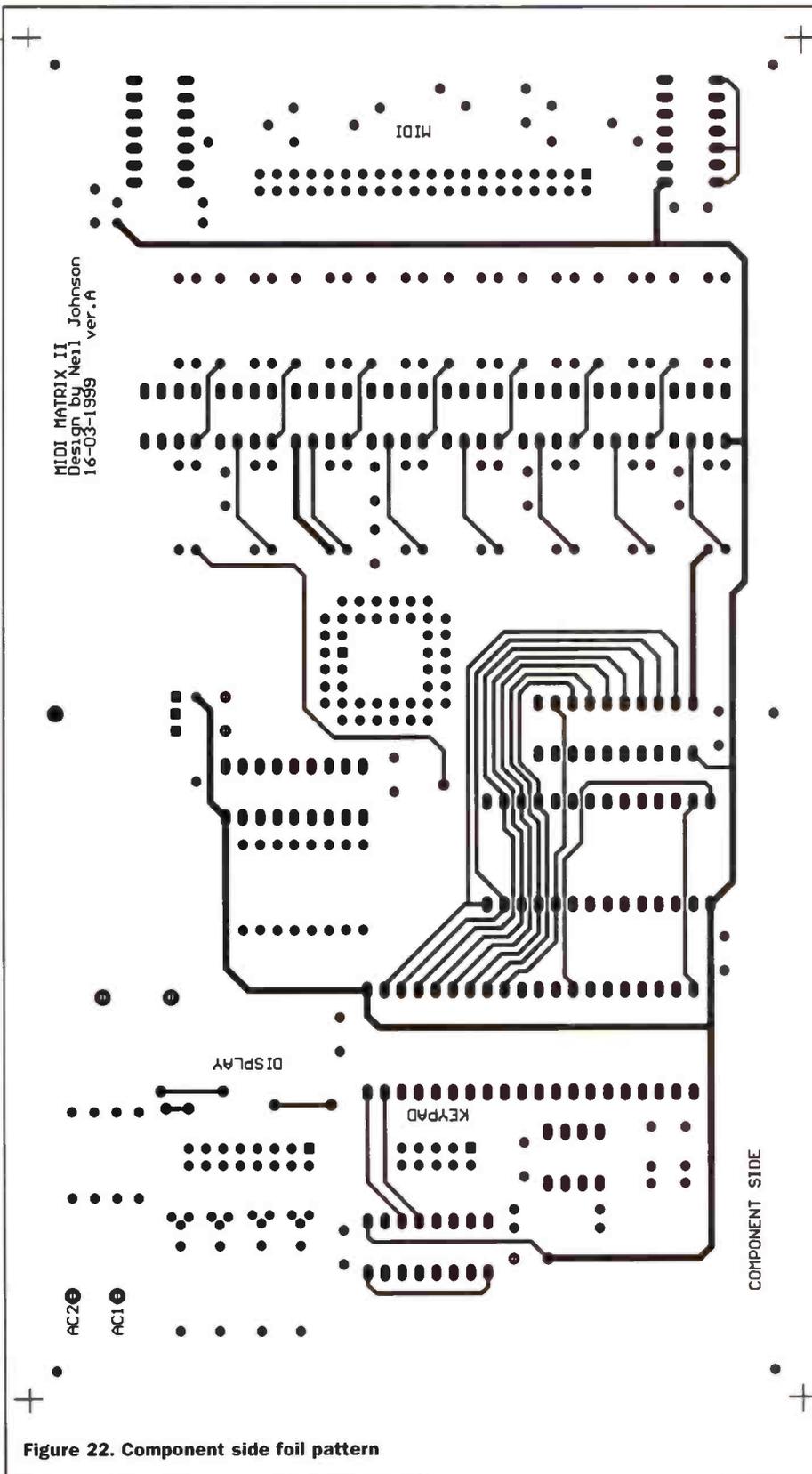


Figure 22. Component side foil pattern

master, not the keyboard.

MIDI, like any form of data, can be processed to add, remove, or change some components of that data. There are MIDI processing units that operate on MIDI data to filter out or change the MIDI messages - everything from transposing a MIDI channel, moving data from one MIDI channel to another, blocking out certain MIDI messages, or adding new ones.

One approach taken to MIDI processing consists of arranging small blocks that do one thing well, so that a number of these blocks, when suitably arranged, can implement any MIDI filtering function

required. This is where the MM2 could be used - by connecting each mini-processing module to an input-output pair it should be possible to arrange these units in any desired order simply by changing the routing path through these modules. Better still, if input eight is used for the MIDI input the current configuration can be remotely controlled. In theory, with seven separate processing modules, there are 127 different combinations of the modules (assuming that the order of the modules is irrelevant) - far more than there are patch locations to store them in, and certainly enough to accommodate most small studio uses.

## PARTS LIST

### Resistors (5%, 0.25W)

R1, 4, 5, 6, 9,	220R
10,11, 14, 15,	
16, 19, 20, 21,	
24, 25, 26, 29,	
30,31, 34, 35,	
36, 39, 40	
R2, 7, 12, 17,	330R
22, 27, 32, 37,	
42-49	
R3, 8, 13, 18, 23,	10k
28, 33, 38, 41	
R50-53	680R

### Capacitors

C1-9, 11, 14-16	100n ceramic
C10, 18	10 $\mu$ F 16V tantalum bead
C12, 13	33pF ceramic
C17	10,000 $\mu$ F 25V electrolytic

### Semiconductors

IC1-8	6N139
IC9, 10	74HCT04
IC11	74HCT139
IC12	80C32
IC13	74HCT573
IC14	X25640P Famell 563-845
IC15	27C512 see below
IC16	ispLSI 1016E-LJ80 see below
IC17	ULN2803A
IC18	L78M05CV
Q1-4	BC559
D1-9,15-34	1N4148
D10-14	1N4001
DISP1,2	HP 5082-7750 display Famell 324-360

### Miscellaneous

X1	12MHz crystal
T1	Mains transformer Famell 899-422
CN1	40way IDC header
CN2,5	10way IDC header

CN3,6	16way IDC header
CN4	IEC chassis plug
CN7-22	5-pin DIN chassis socket
SW1	Mains rocker switch
SW2-17	SPST green illum. push button
	Farnell 678-030
SW18,19	SPST red illum. push button
	Farnell 678-041
SW20,21	SPST push button
	Farnell 674-825
Case	Schroff 1U rack case – see below
Front Panel	Custom engraved panel – see below

### Special Parts

Three items for this project are specialised or require special ordering details.

The recommended case for this project is available from Electrospeed. The case is item 20860-002. The top and bottom covers are item 30860-002 (two will be required). The custom engraved front panel seen in the photos is available from the author at the address below for £70 + postage. It is designed to be glued to the drilled-out front panel as described in the text.

The other two items are the programmed EPROM and the CPLD. For those with suitable programmers the data files obtained either from the author's website [www.njohnson.co.uk](http://www.njohnson.co.uk) in the Download section, or on disk from the author (free + postage). Otherwise the two parts are available ready-programmed from the author for £25 + postage.

Postage is £5 for the UK, £7 for Europe, and £10 elsewhere. Send cheques to:

**Neil Johnson,**  
Dept. MIDIMUX2,  
2 Chapel Field, Dixter Road, Northiam,  
East Sussex, TN31 6PQ. UK.

### Supplier Addresses

Below are the addresses for the suppliers used for this project. Website addresses are also provided for further reference.

Maplin Electronics Plc  
[www.maplin.co.uk](http://www.maplin.co.uk)  
PO Box 777  
Rayleigh  
Essex  
SS6 8LU UK  
Farnell Electronic Components Ltd

[www.farnell.com](http://www.farnell.com)

Canal Road  
Leeds  
LS12 2TU UK

Electrospeed  
[www.electrospeed.co.uk](http://www.electrospeed.co.uk)  
Boyatt Wood  
Eastleigh  
Hants, SO50 4ZY, UK

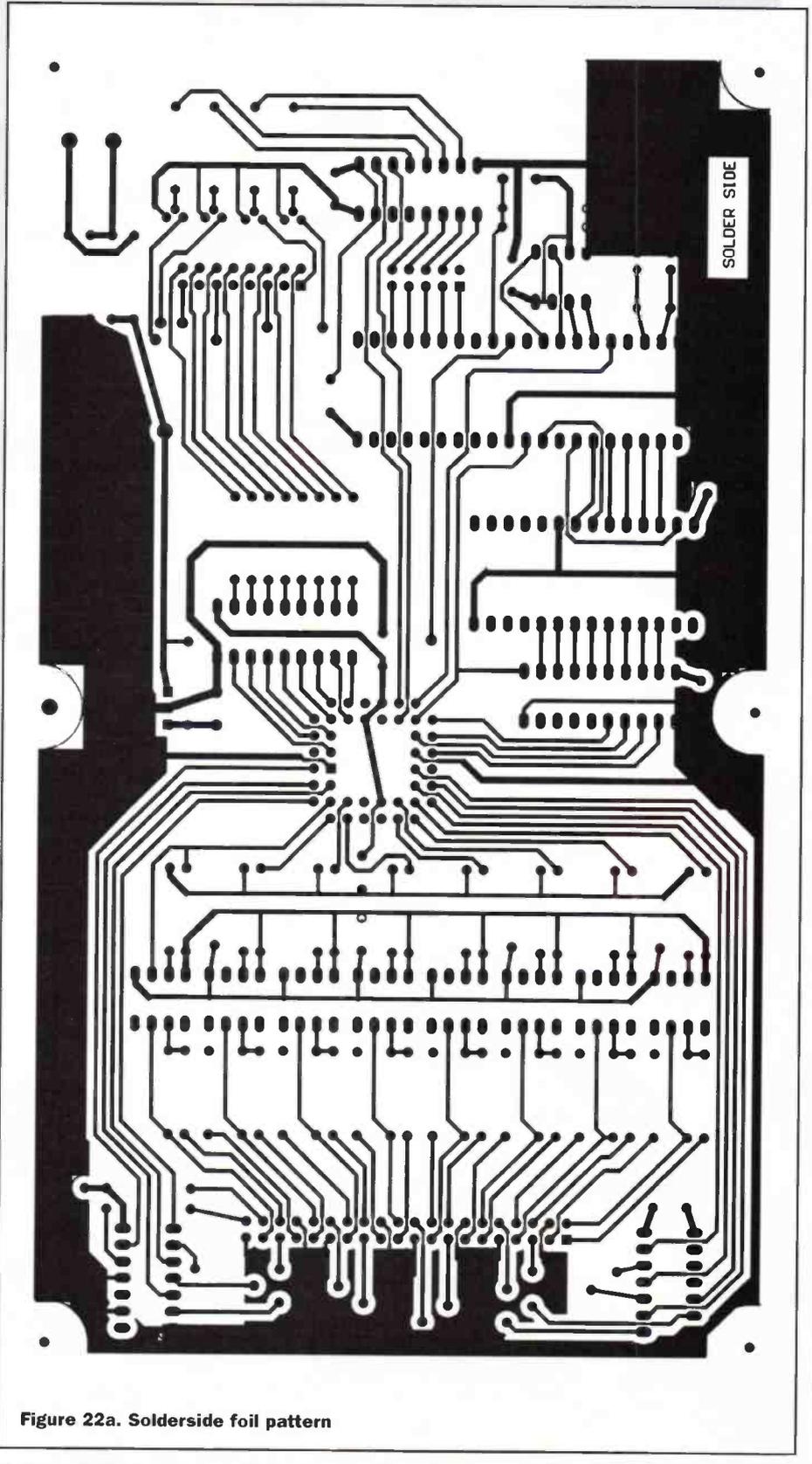


Figure 22a. Solderside foil pattern

at a time, but it does give you remote control of when to change instruments.

### It's a Rap

Puns aside, this just about ends this project for now. However, this does not end the continuing development of the MIDI Matrix. This project is a snapshot of an ongoing development of the MIDI Matrix theme. Over the coming years there will be software upgrades, newer versions with enhanced features, more channels, greater patch storage memory, and so on. For updates keep an eye on the author's website: [www.njohnson.co.uk](http://www.njohnson.co.uk)

# The Royal International Air Tattoo

# 2001



## RAF COTTESMORE 28/29 JULY 2001

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- *Alces High* – sensational performances from some of the world's leading Top Guns
- *Ground Alert* – 250 aircraft in the static-line display, plus a fantastic showground party with stalls, exhibitions, roadshows, celebrities, entertainers, buskers, marching bands, and flight simulators.
- *Salute to Women in Aviation* – RIAT 2001 pays tribute to women pilots, aircrew and ground staff, representing the Royal Air Force and other air arms across the world.
- *Training.com* – The Tattoo will be a unique insight into the training techniques that prepare air and ground crews for the increasingly complex demands of modern airpower.

#### Timetable

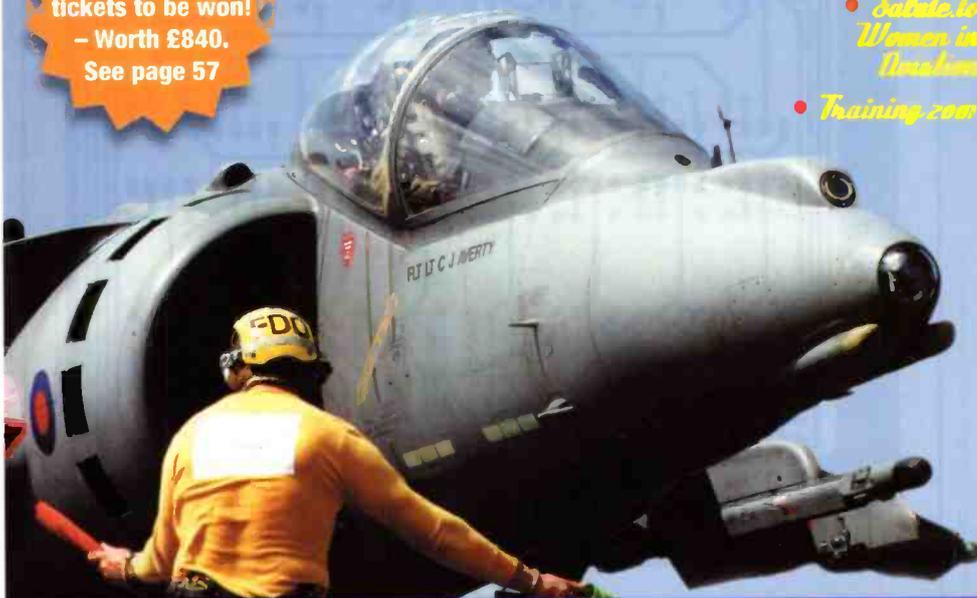
The public gates to RAF Cottesmore, located off the A1 near the market town of Oakham, open at 7.30am on Saturday and Sunday 28/29 July. The eight-hour flying display starts at 10.00am.

#### Tattoo Admission

Advance adult tickets £23-95, on-the-day £29-00. Children under 16 free.

Website [www.airtattoo.com](http://www.airtattoo.com) - regularly updated with the latest Tattoo news

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## Soar away 30th Anniversary Celebration

# SOFTWARE AGENTS

*If enthusiasm is anything to go by software agents are going to take the world by storm.  
A report by Reg Miles*

The term software agent may well be an unfamiliar one, but it is worth remembering because in the near future it will become commonplace. A software agent, or autonomous agent, or just agent, is an autonomous component that will provide one or more tasks - such as providing an interface between a user and an item of equipment or a piece of

However, although everyone is very enthusiastic about agents, there is actually no precise definition of what an agent actually is - there are as many definitions as there are experts in this growing field. And the names, such as software agent, autonomous agent, or just agent can have specific meanings to some

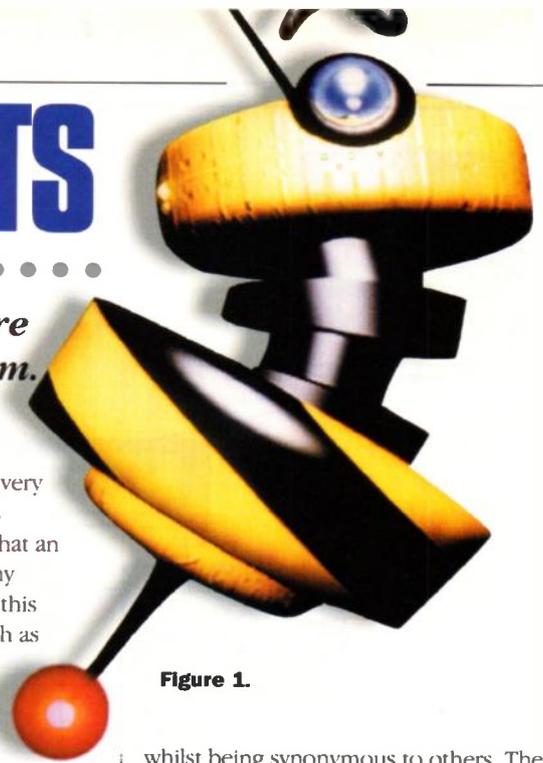


Figure 1.

whilst being synonymous to others. There are certainly differences between agents and their degree of autonomous action; so there probably is a need to arrive at some generally understood categorisation, at least for the benefit, or just satisfaction, of those who deal with them on a professional basis. However, to their general users everything is likely to be lumped under the umbrella term of 'agent'.

One guise of software agent that will be familiar to all is that of the Internet bot (short for robot), or web crawler or spider. It is a fairly primitive version of agent software, being more of an automated programme rather than something that 'knows' its user's mind, but is still capable of functioning with the minimum of human intervention. The function in this case being to search the web for information on all the web pages, which is then collected into a database, which is what a search engine actually searches when it is presented with keywords. This is the basic form of the bot. One variation on this is the



Figure 2.

software, that can communicate with other agents, software and people in the course of carrying out those tasks. And those tasks will include facilitating e-commerce, business-to-business applications (B2B), and generally simplifying man-machine interactions. Not only will they be a convenience, but a money-spinner as well.

It is not surprising, therefore, that a lot of time and effort is being applied to the development of agents and their operational environments. Both companies and universities are participating, a lot of projects have been or are working either directly on some aspect of agent technology or on projects that incorporate agents to serve particular functions, and the number of conferences and workshops devoted to the subject is increasing dramatically.

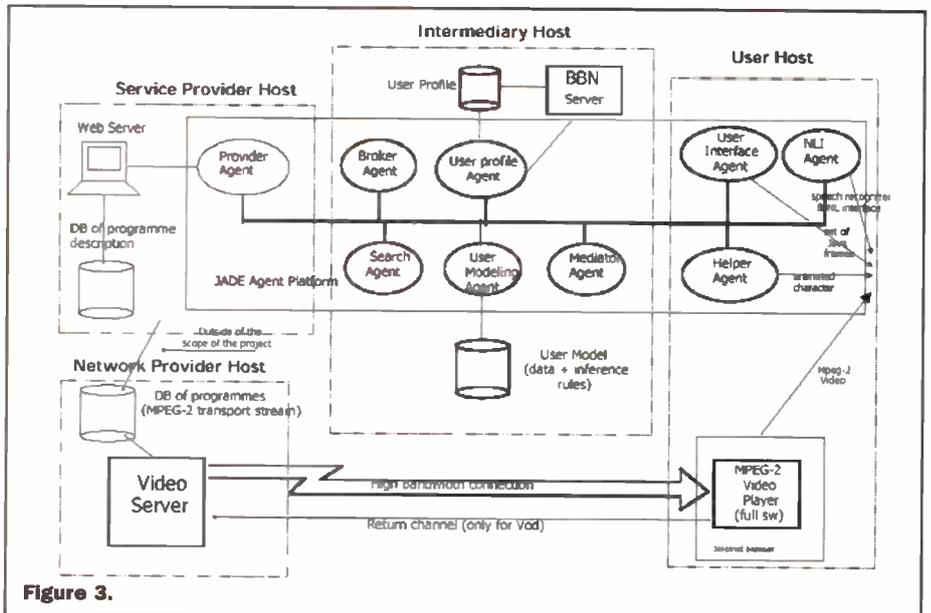


Figure 3.

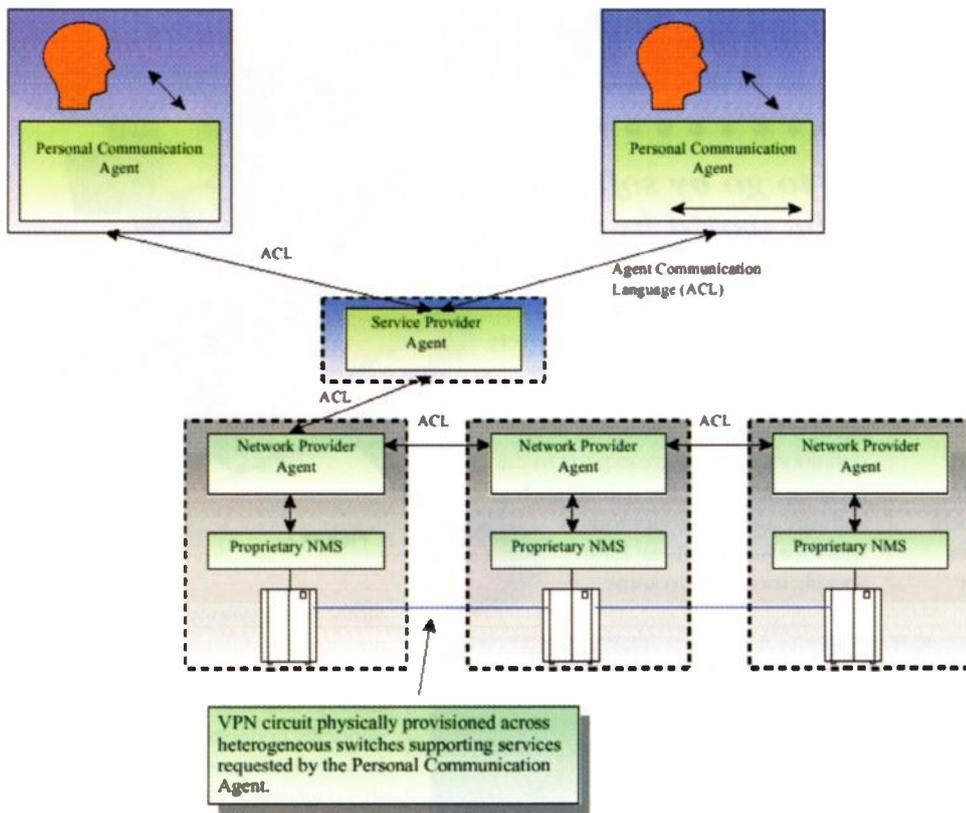


Figure 4.

intelligent agents that have been and are being developed to search and locate not in response to keywords or inherent programming but to user preferences. This is achieved by the agent monitoring the users search and browsing habits to infer the interests of the user. It can function as an assistant to a user who is browsing the Web by autonomously exploring links from the current page and site to other pages and sites and suggesting those that it 'believes' will be of particular interest. With the advantage to the user, if it is correct, of saving time. Alternatively, an agent can act completely autonomously once it has the user's preferences; going out to find sites, or news, or images and videos for the user's approval (their approval or rejection will further refine the agent's ability to match the user preferences). The likely

bot that searches the search engines: a scavenger approach that has the advantages of not requiring a database and making use of existing ratings. Because it does not require a database it is ideally

the web. A news bot, for example will, as the name implies, search for web pages that are dedicated to news, and download the latest updates on a regular basis. Or financial news - again, with frequent

scenario is that a list of some form will be presented for selection with each item containing the URL.

If you are a regular reader of 'Electronics and Beyond' you will have also come across

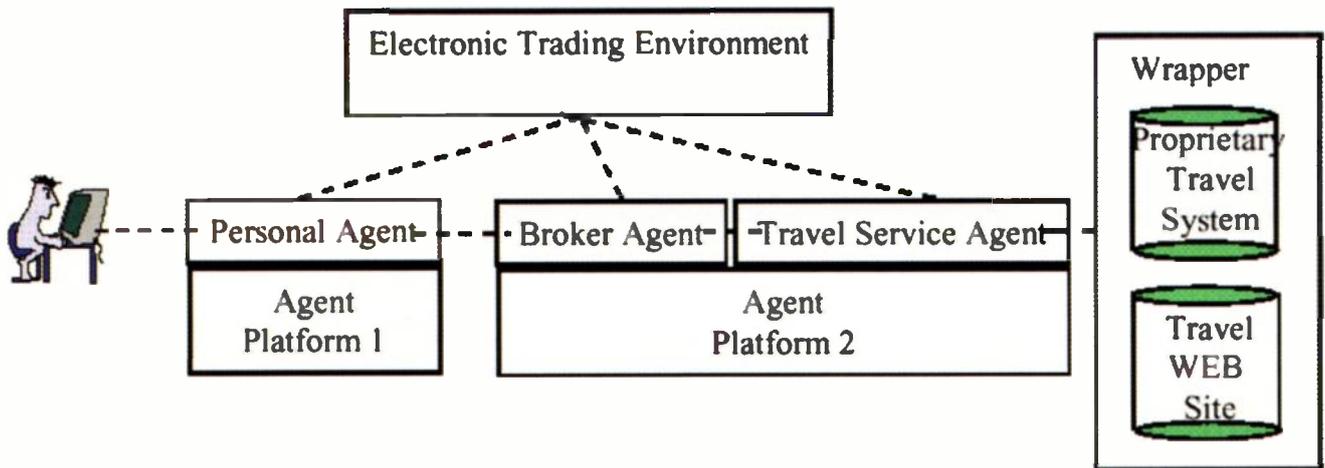


Figure 5.

suitable for personal use. WebFerret is just such an agent: I came across this one while in the process of researching this article, downloaded the 732kB executable file, and found that it has useful features and provides more web pages of relevance than would a single search engine site - check [www.ferretsoft.com](http://www.ferretsoft.com) if you are interested.

Bots are also available that are tuned to search for specific types of information on

updates. It being the updates that are relevant to the user, not the sites themselves. Bots have also been developed that can search web pages for images and/or video material in specific categories. These are going from being merely automated programmes to true agents that respond to the needs of the user and excel in particular areas.

Further up the evolutionary scale are the

agents in previous articles. Such as the 'Multimedia Selection & Storage' article in the February 2000 issue; where mention was made of the STORit Project (Storage interoperability technologies) which investigated how viewers could cope with a multiplicity of TV channels pouring out programmes 24 hours a day. The result was the STORit Box: a hard disk recorder, like the TiVo personal video recorder (PVR), but

with the additional facility of automatically selecting and recording programmes based on the user's preferences. It presents those choices to the user in a manner that would indicate how closely the programmes matched the preferences - a guide to the Electronic Programme Guide, in other words. A connection to the Internet was also provided to make available additional information on programmes.

The process began with a gathering agent that searched for likely programmes 24 hours a day using accompanying metadata (brief descriptions of the programmes) to make its choice. This choice was then screened by other agents whose algorithms each matched a particular aspect of the users' profile - sports profile, movie profile, etc. Each then rated the programme.

Another agent then weighted the ratings in favour of those agents whose selections had been more acceptable to the user in the past (the user's preferences having been

communicated to the system by what was actually watched). There were a number of default filtering agents to start things off, which covered most things: movies, entertainment, sports, news and documentaries, music, specialist, and childrens programmes. The user was able to alter, remove and add agents. With each having a range of factors that could be altered: genres and sub-genres, languages and subtitle languages, countries of origin, programme names, channel names, keywords, days of the week, and timespan - the starting and finishing times of programmes.

The choices made by the 'filtering engine' were then offered to the user by the 'presentation engine' which took the form of a personal Lifestyle Icon (L-icon) which the user had previously chosen to represent their preferences (a selection appeared when the STORit Box was first used and stated their name and personal interests. In programme terms; the users' choice of L-icon then began the process of biasing the STORit Box to the users' preferences - different users would each select their own L-icon, the selection of which changed the bias of the filtering

agents and broadened the selectivity of the gathering agent.

L-icons were 3D animated agents of differing appearances that expressed their opinions on the value of the programmes through a range of emotional attributes (Figure 1 shows a L-icon being enthusiastic), possibly with a few words of text to reinforce the display (see Figure 2).

Incidentally, Philips Research (the main participant in the STORit project) experimented with a human guide in an earlier project. However, they found that using a human guide increased people's expectations to an unrealistic degree - people thought of the guide as a real person and expected a much greater degree of communication as a result.

which circumstance. And different aspects of the user's profile are best served by different algorithmic methods. Thus, a balance of methods will probably be used. A balance that will be characteristic of each user.

Another, recently concluded, European project was aimed at the use of agents in three main roles, including their use for the above. This was FIPA Agent Communication Technologies and Services (FACTS) - FIPA being the Foundation for Intelligent Physical Agents, a standards organisation. The purpose of FACTS was to validate the work of FIPA and other standards groups by constructing a number of demonstrator systems based on their proposed standards for software agents; testing the overall

technical approach, identifying the strengths and weaknesses, and providing suggestions for changes and enhancements.

The FACT Audio Visual Entertainment and Broadcasting application (AVEB) was also a multi-agent system (MAS) like the STORit Box. In this case a 'universal' set top box (STB), combining TV, telecomms, Internet and personal computing capabilities. Because the goal of the demonstrator was to test the MAS rather than the MPEG infrastructure the STB was simulated by a PC

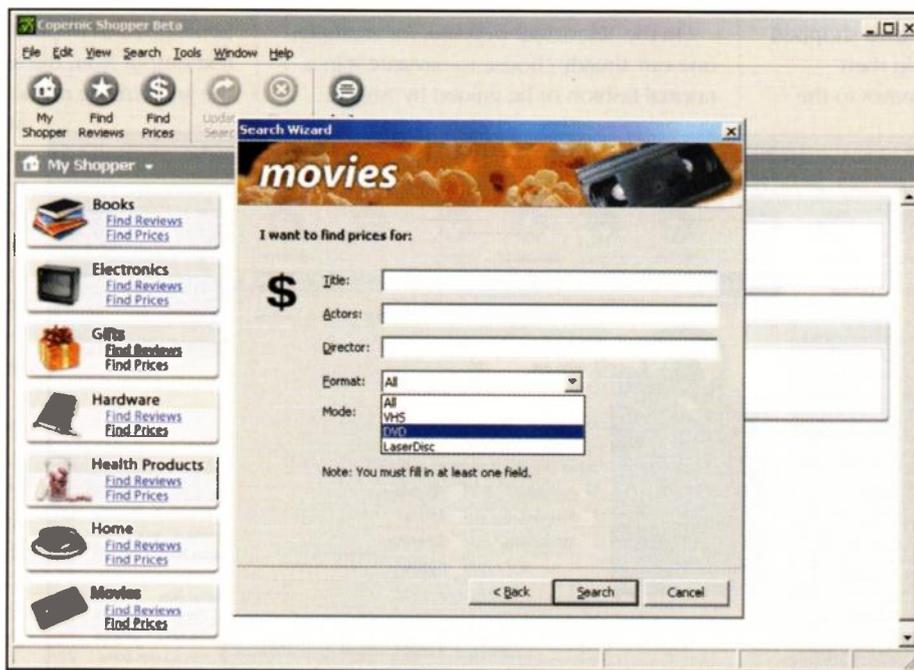


Figure 6a.

Recording all possible reactions and showing them at the right times would be impracticable - at least until the technology is further advanced. The L-icon, by having a limited range of human characteristics, reduced people's expectations to what could be fairly easily achieved, while still providing sufficient information for the user to be able to make a choice.

Broadcasters are already taking agents seriously: by thinking of ways in which they might influence them to show preference for their own programmes. This, of course, would defeat the purpose of filtering agents. But then programmes are much of a muchness anyway, so as long as it did not result in all soaps or all sports, or whatever your particular dislikes are, it would probably not be too apparent.

Several algorithmic methods can be used to match the programmes to the user's preferences: decision trees, generic methods and neural networks. Apparently, each has its advantages and disadvantages in specific circumstances, and it is not necessarily clear which is appropriate for

and the network providers by a web server with MPEG-1 program files (the STORit box was also simulated).

Generally, the FACT AVEB followed the STORit operation quite closely, although there were some differences with the MAS being central rather than just an aspect of the whole - there was no internal recording facility for example.

One difference was the use of 'innovative suggestions', in which the system tried to collect programmes that the user did not typically watch but that might be of some interest. One way of doing this was by referring to another user with similar preferences, if one existed, and propose that user's TV programmes to the first user (they might be the same types of programmes but on different TV channels, for example). The algorithm to achieve this was based on a similarity function defined between the users that extracted the distance between the probability distributions encoded in their Bayesian Belief Networks (BBN). The distance functions then took into account 35

context variables, so those 2940 values of probability for each user were used to compute the distance values. Users were required to fill in a basic questionnaire to provide the initial outline for their preferences (interestingly, this static profile often conflicted with the dynamic profile of preferences learned from the user's actual choices of programmes).

Another difference was the use of a broker agent: this acted as an intermediary between provider agents - each representing a service provider and its various offerings - and the gathering agent. These provider agents held a description of the services they offered and their availability to the user, taking into account the delivery system, any subscriptions and conditional access, the languages used, and the countries served. Having thus shopped around the broker agent could then present the available programmes to the gathering agent.

Additionally, the broker agent could be involved in negotiating service terms. The quality of service is one such example: the agent weighing the cost against the bit-rate and the urgency, to arrive at the best quality with the shortest delay at the minimum cost - again by shopping around between competing broadcasters (this assumes that in real life they will not institute a cartel for the purpose of price fixing).

The final difference was the use of automatic speech recognition (ASR) and speech synthesis - also known as text-to-speech (TTS) - as one means of user communication with the system. The equivalent of the L-icon was used to give explanations about the usage of the system and about the motivations for some agent choices - why the agents suggested that the user should watch a particular programme, for example. The character, which was based on the Microsoft Agent technology, also exhibited 'emotional' characteristics - anxiously waiting, clapping, thanking, etc; and was also able to point to objects in the screen in order to give detailed information, such as the functions of specific buttons that comprised the graphical user interface (GUI). This character agent provided a front for two other agents - the User

Interface Agent (UIA) and the Natural Language Agent (NLA). The former generally requested that the character perform particular actions, although other agents could also make such requests. If this entailed speech, then it was passed through the NLA with its bi-directional Natural Language Interface (NLI). And the NLA could also request tasks of other agents. Incidentally, speech recognition was only 70-80 percent efficient even when the system was fully trained, so that left something to be desired.

Some users also found the character agent's mannerisms irritating. But everyone is going to have to get used to various forms of these interface agents; because that is being perceived as the best means of interacting with people.

On the Televirtual web site, for example, one can already choose to navigate it in a normal fashion or be guided by 'Angel',

Lesley in a Turing test. Another MayBot chatterbot, 'Victoria' appeared on the last programme of the Royal Institution Christmas Lectures shown on Ch4. This time two children conversed with 'Victoria' and real Katie via a graphical interface. Afterwards, their creator, MayBot founder Dr David Hamill, explained to the television audience how his program works. It has no real understanding of English and no common-sense knowledge, but is able to hold its own when discussing topics as diverse as Christmas presents and football by picking on words such as 'Santa' or 'goalkeeper' and generating a response relevant to the subject. It runs as a CGI script, built with the Perl programming language; and its responses are generated from a database, using a heuristic set of rules to produce the appropriate text output from the text input. Because the answers are not always sensible, the

MayBot software is aimed at the entertainment market; and the company will provide custom chatterbots for commercial web sites, in the belief that it will make them 'sticky'.

Returning to the FACTS AVEB demonstrator; the MAS uses the Java Agent Development (JADE) Platform for its functions (see Figure 3). This is a FIPA-compliant platform developed by CSELT, which includes the Agent Management System (AMS), Directory Facilitator (DF) and

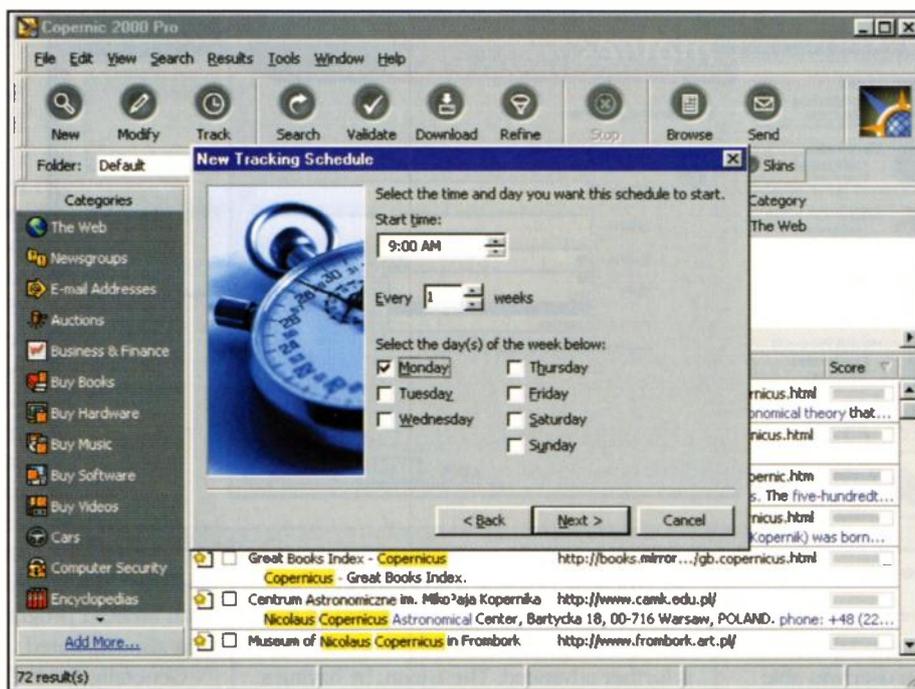


Figure 6a.

who claims to be one of the first of a new breed of professional Internet hosting agents. If you have Internet Explorer or Netscape 4+ you can download her and take her up on the offer (www.televirtual.com). The program will stay resident, and be activated every time you visit the Televirtual or an Angel-compatible site. Televirtual is, or was, also offering a 30-day trial version of Face-Mail, which provides characters that will read your e-mail to you and make funny remarks!

On the subject of fun, the MayBot web site is offering a free chatterbot service that anyone can include on their homepage (www.maybot.com). These MayBot chatterbots have been in the news recently. 'Mabel' appeared on the BBC's 'Tomorrows World' programme along with open source 'ALICE' (www.alicebot.org) and human

Agent Communication Channel (ACC). The AMS is an agent that manages the creation, deletion, suspension, resumption, authentication and migration of agents; and keeps a directory of their Globally Unique IDs (GUID) and local transport addresses. The DF stores descriptions of the agents and the services they offer. While the ACC routes messages between agents using the FIPA Agent Communication Language (ACL) and information provided by the AMS. All three of these basic agents are automatically activated at platform start-up.

The other demonstrators that FACTS developed were Service Reservation and Electronic Trading.

Service Reservation was intended to meet the growing demand for dynamic broadband virtual private network (VPN) services among business users. In this case a conferencing service was used for the

trails. A Personal Communication Agent (PCA) acted as a personal organiser to arrange a mutually agreeable time for the conference (see Figure 4). The initiating user's PCA negotiated with one or more Service Provider Agent (SPA) to get the best terms at the desired time; the SPA then negotiated with one or more Network Provider Agent to actually supply the VPN. At the arranged time the selected SPA contacted the contracted NPAs; and the PCAs were informed once the VPN was established. Once the conference was completed then the bills were sent out.

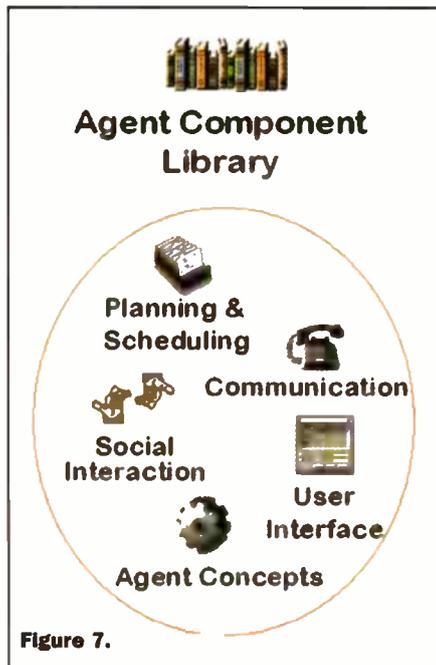


Figure 7.

The Electronic Trading demonstrator used the personal travel industry to validate the standards, although any commerce would have been suitable. As Figure 5 shows, the user was represented by a Personal Agent (PA), that contacted a Travel Broker Agent (TBA) - the equivalent of a travel agent, that contacted a Travel Service Agent (TSA) acting on behalf of airline companies, hotel owners, etc, and replying back to the PA with the details. If agreeable, then the Electronic Market Facilities were brought into operation for secure payments to be made.

Shopping agents already exist; although the infrastructure described above is not yet in place, and will presumably take some time to achieve. At present it is mostly confined to agent sites. These either represent a particular range of shops, which may be all the same type - bookshops, computer resellers, etc - or diverse types, or they search the web sites of shops. Either way the user will enter a description of whatever it is they wish to buy, and the agent site will present a list of the shops that have the product with details such as price, delivery times, carriage charges, etc. There are also agent

sites that specifically search for the best price for a product, updating them as frequently as every thirty minutes.

Personal agents are few and far between - but do exist. One such is Copernic 2000 from Copernic Technologies ([www.copernic.com](http://www.copernic.com)). This can be set to search for reviews or prices, using specific content sites or online stores. Results may be filtered for price, delivery times or lowest carriage rate. Prices can be converted to local currencies, with exchange rates updated daily. And it offers a range of customisation options. Figure 6 shows a couple of screen shots. A similar product is Shopping Explorer from Ulrich Graffe ([www.graffe.dk](http://www.graffe.dk)). While Clickthebutton from Clickthebutton ([www.clickthebutton.com](http://www.clickthebutton.com)) is a price comparison tool that puts a 'button' beside the clock on the Taskbar and in the Start menu. When a user finds a product for sale

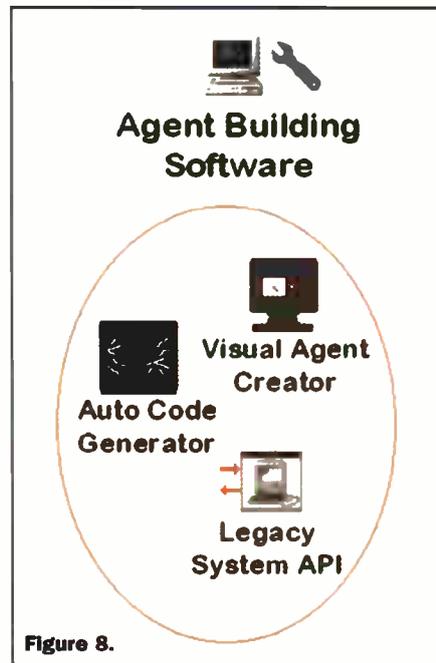


Figure 8.

on the Web, Clickthebutton provides a list of other sites selling the same product (along with their prices), making it easy to visit different stores. Which is why it is also being promoted to merchants as a 'customer acquisition tool'.

If you are interested in shopping agents, or any others, the best place to visit is BotSpot <[www.botspot.com](http://www.botspot.com)>.

Remaining on the subject of travel and tourism, the Creation of User-friendly Mobile services Personalised for Tourism (CRUMPET) caught my eye while searching the web. This organisation is, as the full name implies, exploring the use of mobile communications to give value-added services to tourists - information, directions, etc, and is evaluating the possibility of using software agents for services.

The Lightweight Extensible Agent Platform (LEAP) is a development and

run-time environment for agents that will run on small devices such as mobile phones and PDAs, using a combination of the lightweight and extensible properties of JADE and the design-time features of BTs ZEUS.

ZEUS is implemented in Java, is FIPA ACL compliant, and will run on all major hardware platforms. It consists of an Agent Component Library (see Figure 7), which is a collection of Java classes that enable a developer to create an agent with the minimum of code. Agent Building Tools, that facilitate the rapid development of agent applications using graphical development tools (see Figure 8). And Visualiser Tools that enable the user to analyse the MAS and debug it (see Figure 9). In addition to their award winning ZEUS Agent Building Toolkit, BT is researching a number of agent uses.

FACTS also became involved with mobile usage, and developed a means for translating ACL messages to and from WAP messages. Thus enabling WAP devices to use FIPA agent applications.

The FIPA agent platform has been made available as open source software, in order that everyone can work on the code. FIPA

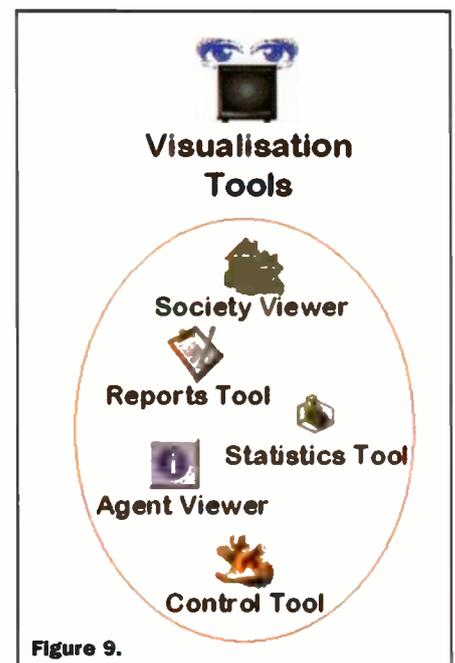


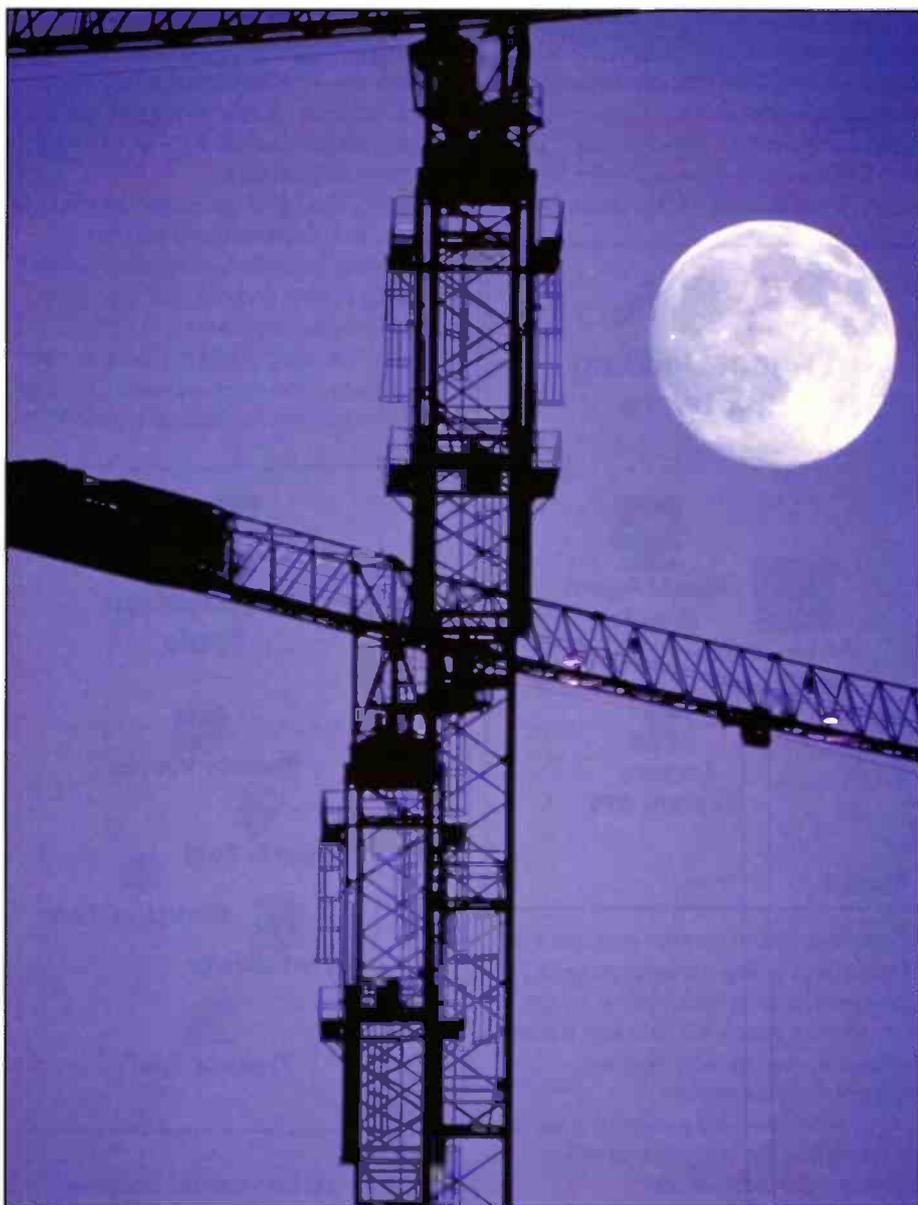
Figure 9.

is also having talks with the other major standards organisation the Object Management Group (OMG), whose main concern is the mobility of agents to move from one environment to another.

I've only been able to scratch the surface of agent technology in this article; a thorough look would have filled the magazine. Also, I've concentrated on the few projects that seem to represent the potential of agent use, but there are dozens of projects that could have been mentioned. If the enthusiasm is anything to go by agents are going to take the world by storm.

# DISPLAYS *in the dock*

By *Richard Cobbold,*  
*Managing Director, Digital View Ltd*



Until recently, LCD technology has seen relatively little use in the industrial market. Essentially, this is because LCDs were originally developed to meet the low-power needs of the laptop PC, rather than the somewhat more demanding requirements of the industrial environment. And the result is that over 95% of LCD production ends up in the laptop market.

Now, though, this is beginning to change, and the industrial and desktop LCD

monitor market is becoming a much more significant market for LCD producers. In fact, a whole range of new more industrial panels became available in 1998 - a revolution led by technology-leader, Sharp, which introduced very high brightness displays (over three times as bright as the standard laptop product). Overnight, using LCD panels for industrial applications became a real possibility.

An excellent example of the questions asked of LCDs by the "real world", and how

they have begun to be answered, is that of Hong Kong and Felixtowe Docks. Both are owned by Hutchinson Wampoa (which owns docks across the world), a company which had recognised that, with computer technology in their cabs, crane operators could not only monitor the exact loading positions of individual containers - thus enabling more accurate and faster loading - but could also stack up jobs. This would result in greater efficiencies across the whole dock.

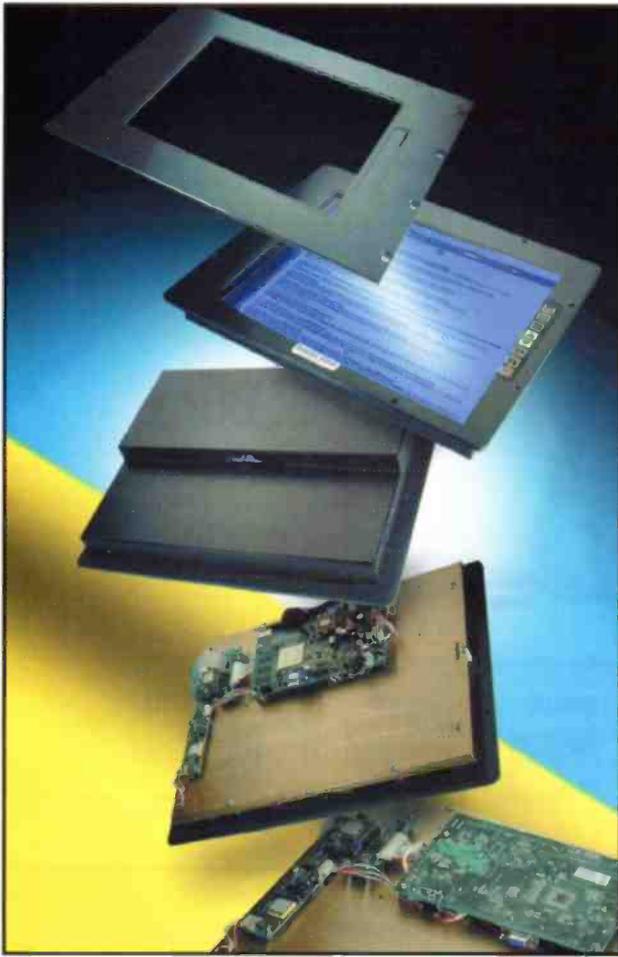
But bringing computer technology to a dock crane was likely to be no easy task. The cranes are over 80ft high, with a cramped glass bubble, designed to accommodate 24-hour operation, atop a long vertigo-inducing ladder. Clearly, the computers would be best located remotely. But this would mean that the only effective way to drive the display would be by using the analogue signals of a standard CRT graphics system - and installing CRTs into the crane cab was simply not viable. This was because space was at a premium in the cab - an already claustrophobic and cramped work place. Flat panel was the only possibility.

But this introduced another problem. The cabs are a place where temperatures vary dramatically, and where bright sunlight gives way to pitch darkness and hard frost to blistering heat. Hardly a place for LCD technology.

Enter Digital View, a specialist in LCD solutions. The company had been contacted by Hutchinson to look at possible solutions for both the HK and Felixtowe locations, each with different priorities. With an office both in HK and the UK, Digital View was well placed, technically and physically, to supply a solution for each.

The first technical issue was a result of the fact that the processing units were to be located some 100 meters from the displays. This kept the power requirement out of the cab, and left less equipment to be protected against the specific environmental conditions of the cab. Crucially, it also left more room for the operator. But, if flat panel were to be used, this meant there was an interfacing problem. Why? Because flat panels are digital devices, and digital signals can only be driven over short distances. True, the latest LVDS digital driver chips were available to extend the traditional 1~2 metre limitation, but by nowhere near enough. The only solution was to place a local analogue to digital interface card at the monitor end of the display to convert the CRT analogue signal, produced by the PC graphics card, to the digital signal required by the LCD.

Next, it was necessary to decide how the operators were to control the PCs. As cabs



the system was a lightweight industrial monitor offering complete protection from water and dust (to IP55).

Felixstowe however was another question. Temperature range was a real issue, and there was a concern that the more expensive TFT technology would not prove viable. Also with the sun lower in the sky, reflection and direct sunlight was even more of a problem. TFT, it was felt, was not the right answer. However, there was another alternative - transfective STN technology. A completely different, and older, type of LCD technology, such panels could, with the help of a reflective coating, actually use ambient sunlight to enhance the brightness of the display, rather than rely on the LCD panel backlight to project light through the display and produce the image. With this

applications. This is because it is a slower display (unable to react to fast moving graphics) and the viewing angle is poor (so it is only suitable for one person, who must sit pretty well in front of the display). But, for Felixstowe, it made sense. There was no intention to use fast moving graphics, and only one operator was required to look at the screen at any one time. So viewing angle was not an issue.

Thus, STN technology was implemented, incorporating a switch to allow the backlight to be turned off during times of high sunlight, and then back on at night and in other low light environments. To combat the low temperatures tiny heater pads were built into the monitors, which warmed up the system to an operable limit before the start of the shift. To overcome the display-PC distance problem, Digital View combined the Sharp LM64P83K 10.4" VGA Transfective STN display with its AM-28 Analogue 28 greyscale analogue controller interface. This kit was then provided to the integrator (ARCOM Controls) to build the complete integrated system.

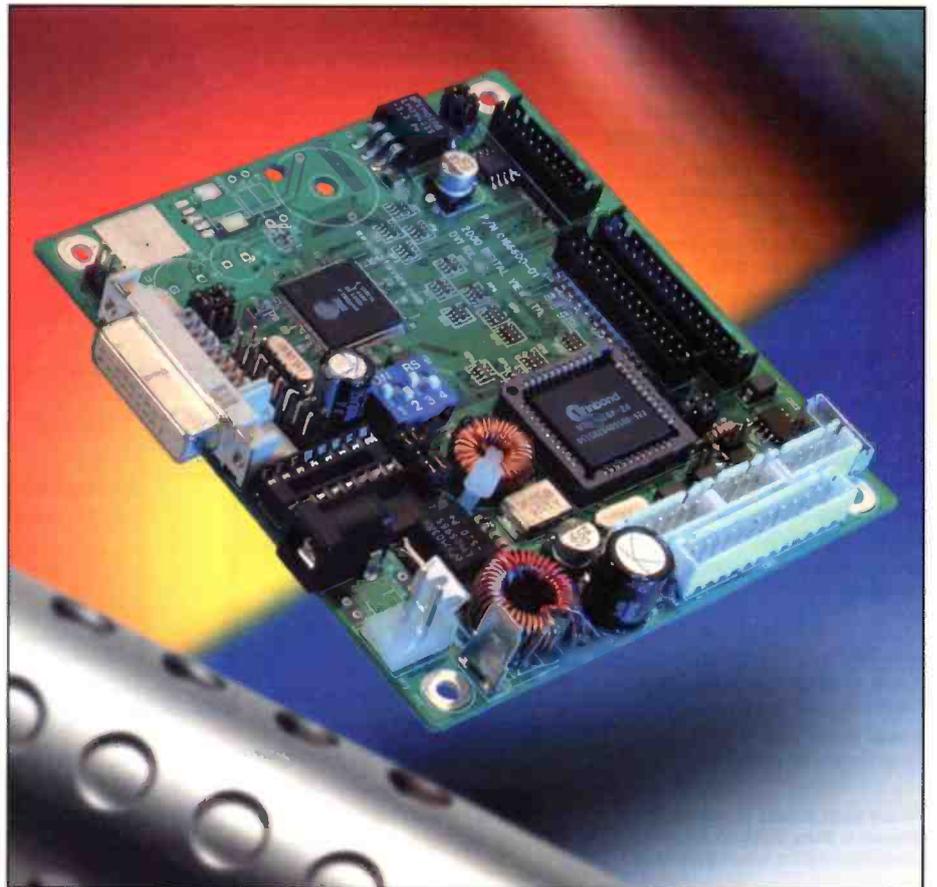
As a final - but critical - part of the solution, the monitors were then tested for ability to cope with the vibrations caused at the top of the cranes by the containers banging into each other. This required special mounting plates to be constructed by Digital View. The tests were a complete success, and the new monitors are now installed and operational all over HK and Felixstowe docks.

are designed to give the operators uninterrupted fields of vision, it was out of the question to mount the display, and especially a keyboard, where it would cause an obstruction. Therefore, the display must be mounted at foot level, and would be operated via a touch screen interface. In itself, adding a touch screen to a flat panel is a straightforward task but, in this case, there was a problem. A touch screen not only reduces the light coming direct from the display, therefore reducing its brightness but, in bright sunlight, increased reflection from the glass overlay could seriously affect the contrast - and therefore readability - of the display. In this situation it is important to choose a non-reflective overlay with the highest possible translucency.

So what was the solution for Hong Kong? Actually, Digital View approached the problem by developing a complete LCD monitor with touch screen especially for the application. The display itself was based on a sunlight-readable colour TFT LCD, as temperature range was not a major concern. Although extremely hot, the temperature swing in Hong Kong is not nearly as dramatic as that in Felixstowe - you rarely get a frost in Hong Kong. The LCD - Sharp's latest 300 cd/m<sup>2</sup> wide-viewing angle unit - was combined with one of Digital View's own analogue controller electronics and signal kit, and used an integrated touch screen. In effect,

arrangement, the greater the direct sunlight, the more readable the display. Cost saving was another bonus.

Of course, pitching STN against TFT side by side, no user would choose STN for most



## Diary Dates

Every possible effort has been made to ensure that information presented here is correct prior to publication. To avoid disappointment due to late changes or amendments, please contact event organisations to confirm details.

### April 2001

**5 April.** Mobile Location Based Services, Holiday Inn London - Victoria. Tel: (020) 7368 9300.

**9 April.** Convergence, Olympia National Hall, London. Tel: (01244) 881777.

**9 April.** SoHo Show, London Olympia National Hall. Tel: (01244) 881777.

**9 to 11 April.** Convergence, Olympia, London. Tel: (01244) 881 777.

**10 April.** Comms Dealer Expo, NEC, Birmingham. Tel: (01932) 779100.

**24 April.** Webcom 2001, Excel, London. Tel: (020) 8987 7745.

**24 April.** Customer Service and Support, Olympia 2, London. Tel: (01273) 836 800.

**24 April.** Infosecurity Europe, National Hall, Olympia, London. Tel: (020) 8449 1007.

**24 to 26 April.** Webcom ExCel, London. Tel: (01732) 377 646.

**25 April.** Web-Enabled Collaborative, London. Tel: (020) 8879 3355.

### May 2001

**11 May.** SoHo Show Birmingham, Birmingham. Tel: (01244) 881777.

**11 May.** Small Office Home Office Show, Birmingham. Tel: (01244) 881777.

**16 to 17 May.** The Embedded Systems Show, ExCel, London. Tel: (0207) 681 1000.

**16 to 17 May.** European Cable Communications, ExCel, London. Tel: (020) 8910 7910.

**17 May.** E-Tax 2001, Conrad International, Dublin. Tel: (020) 7840 2700.

**21 May.** MediCast, ExCel, London. Tel: (020) 8449 1007.

**21 May.** e-CAST, ExCel, London. Tel: (020) 8449 1007.

**21 May.** E-Channel 2001, ExCel, London. Tel: (020) 8910 7766.

**21 to 23 May.** Mediacast Communications & IT, ExCel, London. Tel: (020) 8910 7910.

**21 to 23 May.** Cable & Satellite Mediacast, ExCel, London. Tel: (020) 8910 7910.

**22 to 24 May.** Mobilexpo, NEC, Birmingham. Tel: (020) 8910 7910.

### June 2001

**1 June.** Small Office Home Office Show, Glasgow. Tel: (01244) 881777.

**5 June.** Internet World UK 2001, Earls Court, London. Tel: (020) 8232 1600.

Please send details of events for inclusion in 'Diary Dates' by e-mail to: [swaddington@cix.compulink.co.uk](mailto:swaddington@cix.compulink.co.uk).

# What's On?

The screenshot shows the Apple website interface from March 19, 2001. The main headline reads "Rip. Mix. Burn." with the subtext "The new iMac With iTunes + CD-RW drive." Below the headline is a photograph of a white iMac G3 with a colorful, abstract pattern on its top half. The website navigation bar includes links for Store, iTools, iCards, QuickTime, Support, and Mac OS X. A secondary navigation bar lists categories like Hot News, Hardware, Software, Made4Mac, Education, Creative, SmallBiz, and Developer. Below the main content area, there are four promotional boxes: "PowerBook G4", "A new spin on music.", "Pre-order Mac OS X today.", and "Presenting iDVD."

## Apple Unveils New iMacs

Apple chief executive Steve Jobs used his keynote speech at Macworld in Tokyo, Japan at the beginning of February to launch a new line of iMacs. The new machines feature CD-RW drives and iTunes, jukebox software that lets users create and manage their own music library and burn their own custom audio CDs.

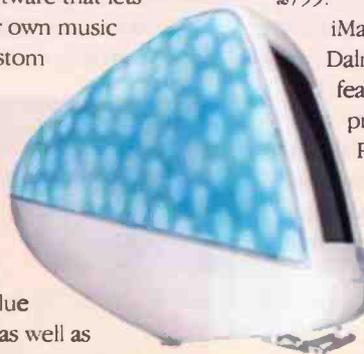
With fast new PowerPC G3 processors running at up to 600MHz, up to 40 GB hard drives, FireWire ports and iMovie software on all systems, the new iMac family comes in two new patterns, Blue Dalmatian and Flower Power, as well as the two most popular iMac colours, Indigo and Graphite.

"iMac has evolved into an entertainment centre, where you can create desktop movies, manage your digital music library and burn custom music CDs," said Steve Jobs, Apple's CEO. "iMovie and iTunes are so easy to learn and use, even your parents can use them without getting confused."

The new iMac models are available immediately in three standard configurations:

iMac, available in Indigo, features a 400MHz PowerPC G3 processor and contains 64MB of PC100 SDRAM, 512K backside cache, a 10GB

Ultra ATA hard disk, a slot loading CD-ROM drive, ATI RAGE 128 Pro with 8MB of SDRAM, a built-in 56K V.90 modem, two FireWire ports and two USB ports, VGA video mirroring and is AirPort ready for a suggested retail price of £799.



iMac, available in Indigo, Blue Dalmatian and Flower Power, features a 500MHz PowerPC G3 processor and contains 64MB of PC100 SDRAM, 512K backside cache, a 20GB Ultra ATA hard disk, a slot-loading CD-RW drive, ATI RAGE 128 Pro with 8MB of SDRAM, a built-in 56K V.90 modem, two FireWire ports and two USB ports, VGA video mirroring and is AirPort ready for a suggested retail price of £999.

iMac Special Edition, available in Graphite, Blue Dalmatian and Flower Power, features a 600MHz PowerPC G3 processor and contains 128MB of PC100 SDRAM, 256K on-chip backside cache, a 40GB Ultra ATA hard disk, a slot-loading CD-RW drive, ATI RAGE 128 Ultra with 16MB of SDRAM, a built-in 56K V.90 modem, two FireWire ports and two USB ports, VGA video mirroring and is AirPort ready for a suggested retail price of £1,199.

For further details, check: [www.apple.com](http://www.apple.com).



# Does not COMPUTE

by Mike Bedford



In Douglas Adams' quirky science fiction novel, the Hitchhiker's Guide to the Galaxy, Deep Thought, the largest computer ever built, was set to work to determine "The Answer to Life, the Universe and Everything". After churning over the problem for millions of years, it eventually declared that the answer was 42. But this isn't just a bit of nostalgia for those who were addicted to the 70s cult TV series based on the novel; there's an important lesson to be learned here. Computers are not a universal panacea because some questions, and this is a classic example, are non-computable. In this case, it's easy to see why that is – the question is totally nonsensical – the difficulty lies in understanding just what the question means. But even if we stick with properly formulated questions, the meanings of which are well understood, there are certain categories which will defy all attempts at computing an answer. In other

**"What's the answer to life, the universe & everything?"**  
**Will an atom of interstellar gas ever pass through a given point in space?**

words, some problems are non-computable. And I'm not just talking about practicalities here; I'm not just saying that nobody has yet figured out how to compute an answer to certain problems. What I am saying is that there are

fundamental reasons why nobody ever will be able to compute an answer to some questions. Is this a failure of computer technology? Is it a failure of logic? In fact how can we possibly be sure that there are valid problems for which nobody will ever be able to compute an answer? These are some of the questions I hope to answer in this investigation of computability and non-computability.

## The Church-Turing Theorem

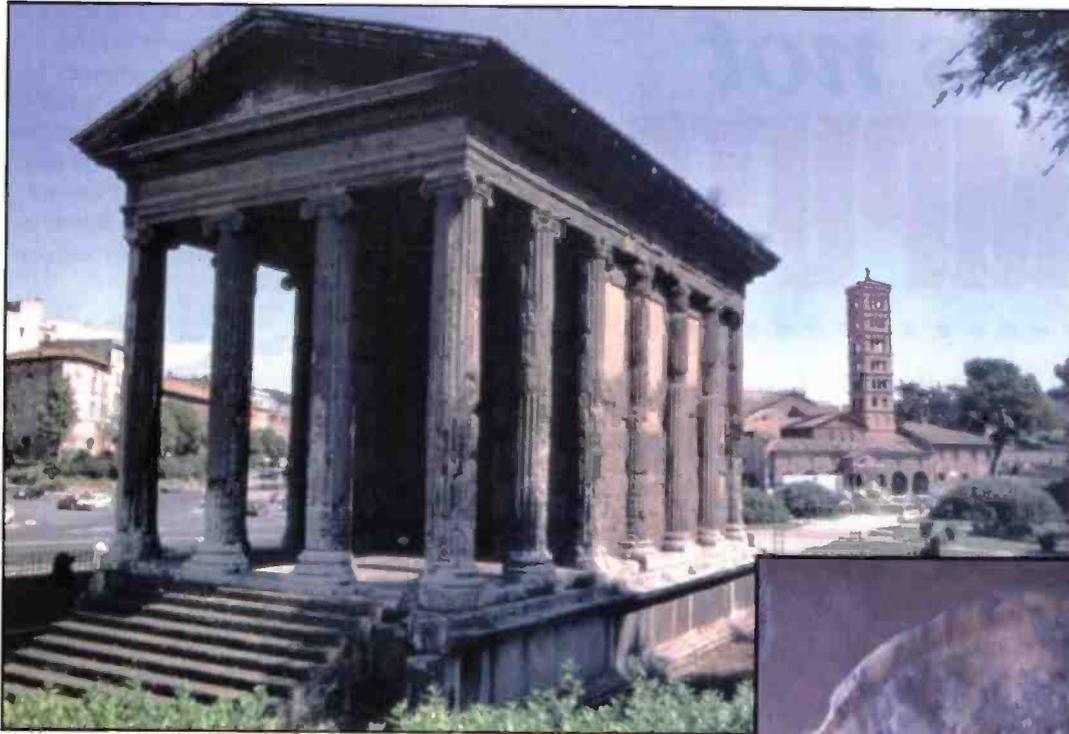
Alan Turing, one of the twentieth century's foremost mathematicians and logicians, pioneer of computing, and wartime code-breaker, conceived of a computing device called the Turing Machine. We'll have cause to look at this in a bit more detail later but, for now, just let's say that, like today's computers, the Turing Machine is a universal computer. Interestingly, though, that doesn't mean that it can compute the answer to any question. According to Turing, a universal computer is a machine, which can provide an answer to any question that is computable. The obvious implication is that there are certain questions that are not computable. But is this just a failure of technology? Apparently not, as a look at the Church-Turing Thesis reveals. Jointly devised by Turing and Alzono Church, another eminent logician of the last century, the theorem can be expressed in the following way: "Any problem that is human-computable is machine computable." If we assume that the theorem is correct, therefore, we can see that non-computability isn't a technological issue – it's more fundamental than that. However we're really still no closer to defining what we mean by computability. Fortunately, Church and Turing give some guidance here – for a problem to be computable there must be some fixed method, that always yields the same result, and produces that result in a finite period of time. And immediately we have this definition we can start to think of problems which are clearly not computable. How about the following, for example?

*Will an atom of interstellar gas ever pass through a particular spot in space?*

*Does God exist?*

*Determine whether a given statement is true or false.*

The first one is a pure guessing game. There really is no thought process that will lead us to determine whether an atom of interstellar gas will ever pass through a

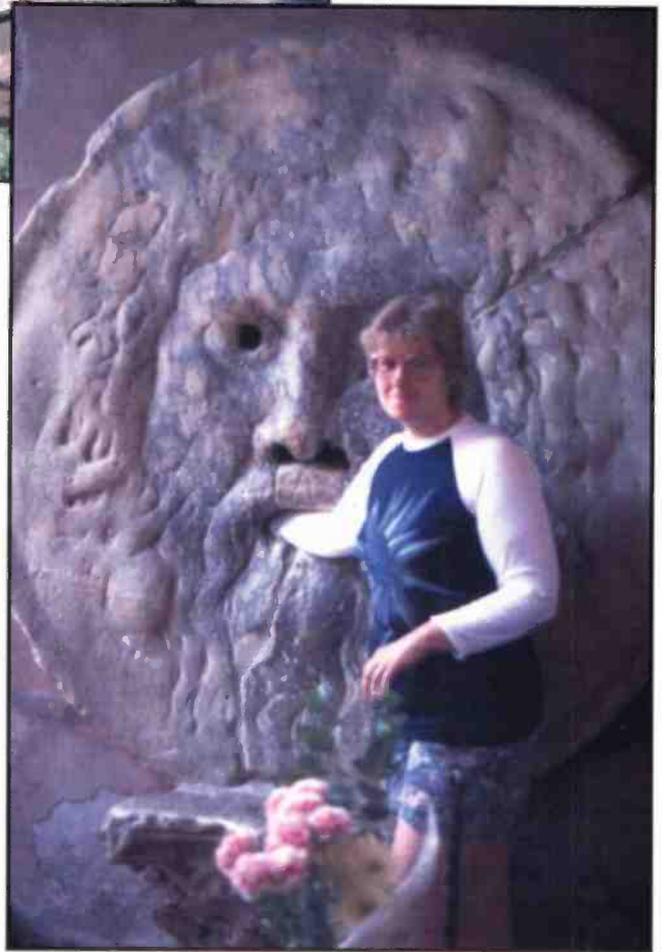


**Left:** Perhaps ancient Rome isn't the most obvious place to find a universal truth detector. According to legend, though, this is exactly what's contained in the church, Santa Maria in Cosmedin, in the background.

particular point in space. For a start, we'd have to have complete knowledge of every single atom of matter in the whole universe. The only way to find out for sure is to wait forever – but our definition of computability requires that a solution must be forthcoming in a finite time. The second question is rather different. Whereas few people would suggest that they could predict the exact movement of every atom of interstellar gas with any degree of certainty, many people will be able to state whether or not God exists. What's more, many of those people will be able to describe how they came to their conclusion and provide evidence. The fact that different people will give a different answer, though, suggests that there's no universally accepted logical process that will always give the same answer. And for a question which relies on faith, this is hardly surprising. The third question is an interesting one. I think we can easily see that there can be no means of determining whether any given statement was true or false. If there was, we'd have to conclude that all problems were computable. For example, if there was a means of determining the truth of any statement, we could input the statements "An atom of interstellar gas will, eventually, pass through this spot in space." and "God does exist" to

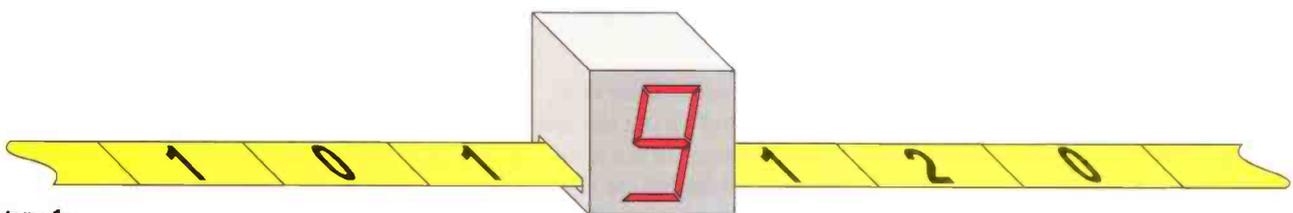
obtain a true or false answer. This would, therefore, give us an answer to a couple of questions that we've already agreed are not computable. In fact, there's a rather intriguing tale which proves the impossibility of a universal truth algorithm.

In the Romanesque church of Santa Maria in Cosmedin, in Rome, there's a grotesque looking stone face with an open mouth. The carving is called the Bocca della Verità which means the Mouth of Truth. It's name relates to a legend which states that anyone who places a hand in the mouth and makes a false statement will have that hand severed by the statue. People suspected of lying were sometimes subjected to a trial by the mouth and, apparently, a priest hiding behind the mouth would sometimes whack the hand of those known to be guilty in order to give some credence to the legend. For the sake



**Below:** This, the Bocca della Verità, is supposed to chew your hand off if you tell a lie. Just try telling it "you will chew my hand off", though, and you'll discover why there can be no such thing as a universal truth detector.

of argument, though, let's assume that the legend was true and that the carving was genuinely able to differentiate truth from falsehood. Let's also assume that someone approaches the face, places a hand in the mouth and states "this statue will bite off my hand". Obviously there are two possible



**Figure 1.**

outcomes – either the fingers are bitten off or they aren't. Let's assume that the mouth snaps shut and the fingers are gone. This would suggest that statement had been false but, in fact, the person had correctly predicted that this would be the outcome so the statement had been a true one. So let's assume the converse then; let's assume that the mouth doesn't snap shut and the speaker's hand remains intact. This suggests that the statement had been true. In reality, though, the statement had suggested that the hand would be bitten off so it was false. So, as soon as that statement had been uttered, the universal truth detector is doomed to failure – it just can't win. So much for being able to compute whether or not any statement is true.

### A Mathematical Problem

What we've discussed so far is little more than philosophy. Hopefully you've found it interesting and thought provoking but it really doesn't have much of a bearing on the sorts of problems we might hope to solve by computer. And if these are the only sorts of question which are not computable you might be of the opinion that there's really no problem. Unfortunately, these philosophical problems are not the only ones which are non-computable. Indeed some very down-to-earth questions defy all attempts at computing an answer.

Input		Output		
Initial State	Initial Symbol	Final State	Final Symbol	Move
1	O	1	O	R
1	X	2	O	R
2	O	3	X	R
2	X	2	X	R

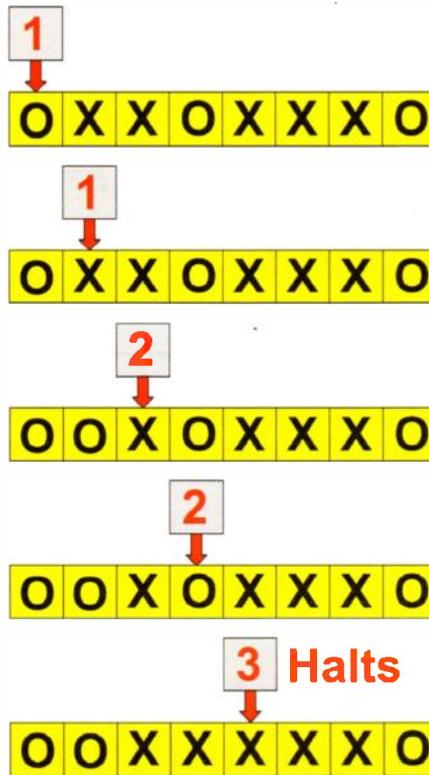


Figure 2.

A trivial example is the following "determine the exact value of pi". We know that pi is a transcendental number so to

express it exactly we'd have to calculate an infinite number of decimal places. We can write a computer program to do the job, certainly, but we'd have to wait forever to get the answer. And we can think of lots of other problems which, although it's easy to write a program to do the job, a solution will never be forthcoming because the problem is infinite.

But we don't have to restrict ourselves to infinite problems to find a simple question that just can't be answered. In a famous lecture, given in 1900, the mathematician David Hilbert posed 23 questions to which, at the time, no solutions were known. One of these, Hilbert's Tenth Problem, referred to Diophantine equations. Such an equation is one in which a polynomial with integral coefficients and exponents, is set to zero. The following are a few examples:

$$x^3 - 27 = 0$$

$$x^2 - 2 = 0$$

$$5x^5 + 17y^{12} - 244 = 0$$

The problem posed by Hilbert was to find a general algorithm that would determine, in a finite number of steps, whether there was an integral solution to a given Diophantine equation. In some instances it's trivial to figure out if there is such a solution. In the first of the equations above, for example, it's obvious that  $x=3$  is a solution so an integer solution does exist. In the second example, it's equally clear that no integer solution exists. But what about the third example? Although Hilbert probably hadn't suspected it, mathematicians went on to give a mathematical proof that no general algorithm can exist. Despite the innocuous nature of the problem, therefore, it's not computable.

### The Halting Problem

We'll now take a look at one of the most famous of all non-computable problems, Turing's Halting Problem that relates to the execution of a Turing Machine. Figure 1 shows a Turing Machine. It's not a practical suggestion for a computer but Turing found this conceptual machine a very useful tool in thinking about the theory of computation. The data on which the computer operates is written on an infinite strip of paper tape and is represented by one symbol, from a fixed set of symbols, in each position along its length. A Turing machine is defined to perform a particular task but Turing went on to show that a Universal Turing Machine could be built. This, like a modern day computer, reads its program in the same way as it reads data, i.e. from the paper tape. The processing unit moves along the tape, one position at

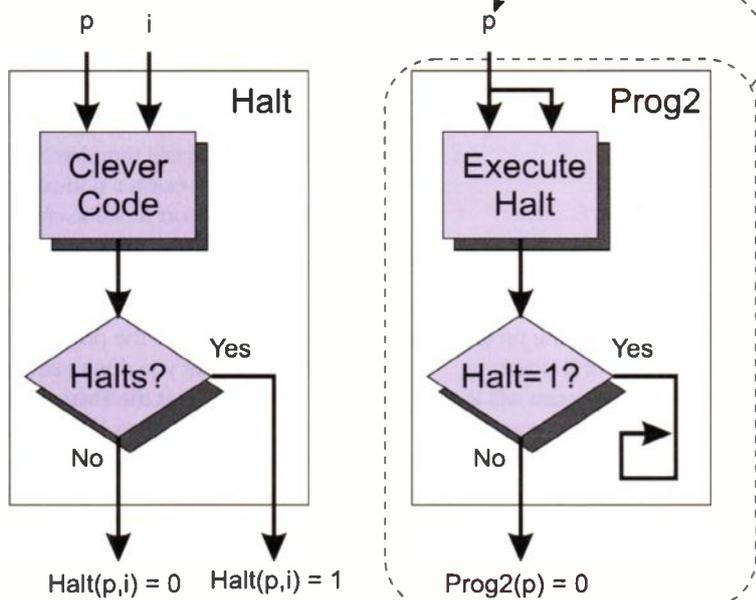


Figure 3.

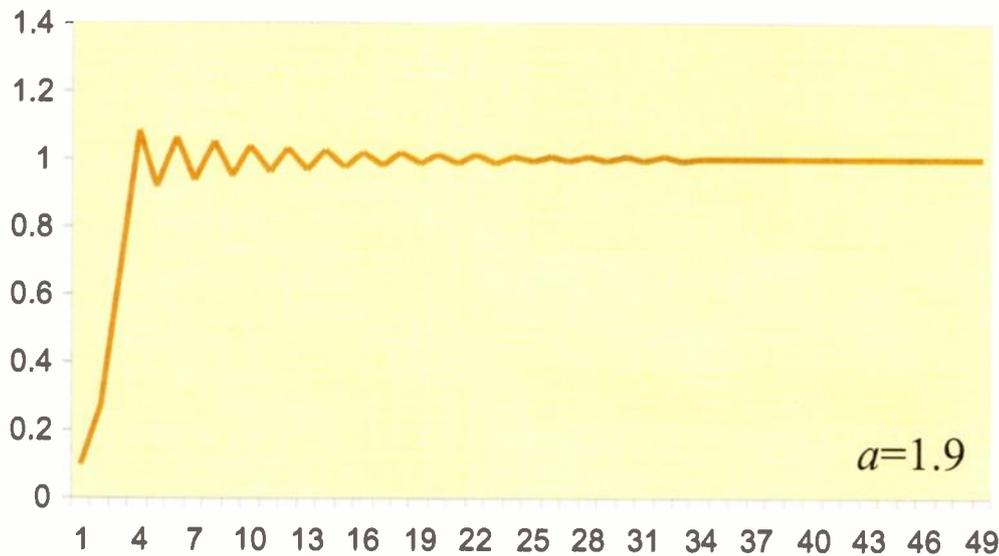


Figure 4.

a time, and can be in one of a fixed number of internal states. Each time the processing unit lands on a new portion of the tape it reads the symbol at that position. It then looks up the action to be taken for the specific combination of its internal state and the symbol read. This action will specify (1) what symbol to write on the tape in place of the existing symbol (this can, of course, be the current symbol in which case there will be no change), (2) what internal state to adopt, and (3) whether to move one position to the left or one position to the right on the tape after writing the symbol. As soon as the processing unit has moved, the process is repeated. This continues until a combination of internal state and tape symbol is encountered for which no action has been specified. At this point, the computation is complete and the computer halts. An example is shown in Figure 2. Here we see the rules for a Turing Machine designed to add together two numbers, each represented as a string of Xs, separated by Os (e.g. 3 is represented by OXXXO), plus the state of play throughout the computation.

The Halting Problem which Turing posed asks whether there can be a Turing Machine which will analyse another Turing Machine and its input tape to determine whether it will halt or whether it will continue processing forever. Although Turing talked in terms of Turing Machines, it's been proved that all computing devices are logically equivalent to a Turing Machine so we can ask, instead, whether there can be a program which will analyse another program and its input to decide whether or not it will halt. And anyone who has ever

programmed will be familiar with the fact that some combinations of program and data halt eventually whereas others loop forever. Take the following BASIC program, for example:

```

10 INPUT X
20 X = X + 1
30 IF X = 0 THEN 10
40 STOP

```

Clearly if the initial value of X is less than zero then, sooner or later, the program will halt. If the initial value of X is zero or greater, however, the program will loop forever. We can tell this by common sense but Turing's problem asks for an algorithm which will determine whether any program / data combination will halt. One way of finding out, of course, is to try it and see. With the above program, for example, if you enter -10 as the initial value of X you'd find it would halt very quickly. However, if

doesn't halt or, if it does, it takes longer to do so than we're prepared to wait. And if you eventually give up and decide that it's not going to halt, there would be no guarantee that had you executed one more

you were to enter 1 as the initial value of X or if you were to enter -1 x 1090 you'd observe that neither would halt. Of course logic tells us that in the former case the program never would halt whereas in the latter case it will, sooner or later (well, later actually), but our experiment reveals no difference between the two. The fact is, if the computer can execute one billion instructions per second, the program would churn away for countless billions of years, with that initial value of -1 x 1090 before eventually halting. So the trial and error approach really isn't too useful. If we observe the program halt then we know the answer for sure but if we don't, all we can say is either that it

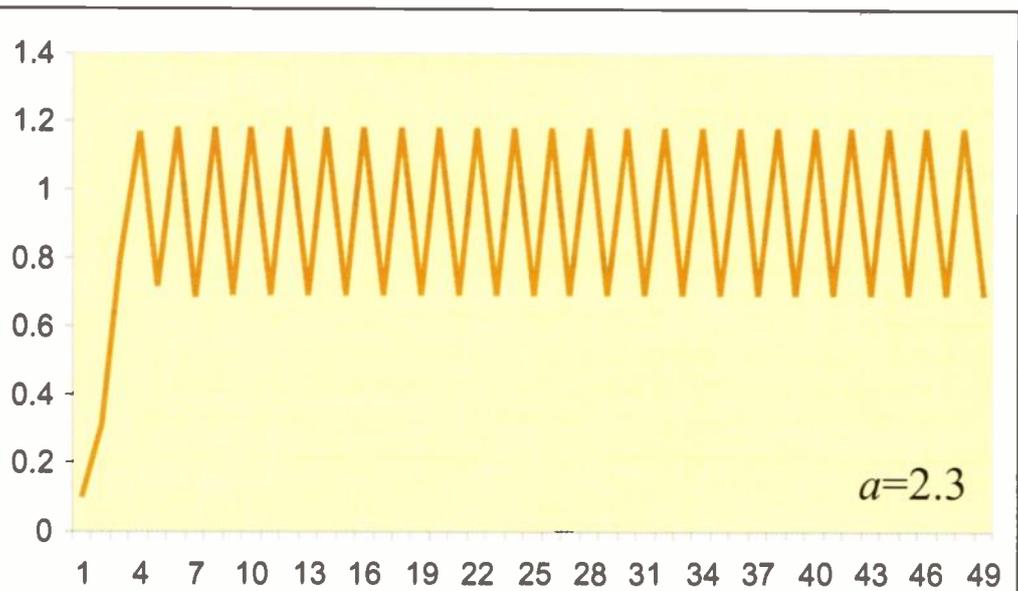


Figure 5.

instruction, it would then have ground to a halt. So trying it out is a non-runner so we'll have to resort to some clever program that will analyse the program and data to determine the final outcome. The amazing thing is that, according to Turing, no such program can exist - the problem is non-computable. But you don't just have to take it on trust that the Halting Problem has no solution. Here is how Turing came to that famous conclusion.

First of all, we must assume that there is a program which determines whether the combination of another program, which we will call p, and its associated input, i, halts. This program is called Halt and is defined as follows:

```

IF program p with input i halts THEN
  Halt(p,i) = 1
ELSE
  Halt(p,i) = 0
ENDIF

```

Now we'll define a second program, Prog2, as follows:

```

IF Halt(p,p) = 1 THEN
  Loop forever
ELSE
  Prog2(p) = 0
ENDIF

```

Note that Prog2 takes just one input, a program, and it supplies that to Halt as both the program and the data. However, since all programs can be thought of as data, in fact the programs which run on a PC are just strings of binary numbers, this is a perfectly acceptable approach. If you prefer to think in terms of a flow diagram, these programs are represented in Figure 3.

Now let's think about what will happen if we use Prog2 as the input for Prog2. Clearly Prog2 is quite capable of looping, but will it? That's the \$64,000 question. Let's make a guess, namely that Prog2 loops when Prog2 is input as its data. For it to have looped, the program Halt would have had to output 1 which means that Halt had decided it would halt. Doesn't sound too promising. What about the alternative – that Prog2 halts with Prog2 as its input. For this to happen, Halt would have had to output 0 but this means that Prog2 loops forever. It's rather like the Bocca della Verità – whatever the outcome it's got the answer wrong. And if we've found one program that fools the Halt program, how can we be sure there aren't others. In short, we can't, and the conclusion must be that the Halting Problem is not computable.

In fact, there are more similarities with the Bocca della Verità than you might have thought and the consequences of the Halting Problem being non-computable are probably more far fetching than you would have imagined. Remember how, if there was such a thing as a universal truth detector, then every other question – no matter how bizarre or far-fetched – would be computable? Well a similar conclusion would have to be drawn had the Halting Problem been computable. According to mathematicians, if there was a solution to the halting problem then all questions in number theory would also be computable. Let me give an example. Christian Goldbach, a Prussian amateur

mathematician and historian who lived in St Petersburg and Moscow, stated in a letter to Euler dated 16th February 1745, that every even number equal to or greater than 2 is the sum of two odd primes in one or more ways. This has become known as the Goldbach Conjecture but it remains unsettled to this day, despite a \$2 million award, which is on offer for the first person who comes up with a formal proof. But although nobody has managed to prove the conjecture, computers have certainly made extensive searches and, so far, have not managed to find a number that would disprove it. But although we can now say that all even numbers up to  $4 \times 10^{14}$  are the sum of two odd primes, this isn't to say that a non-compliant number isn't lurking out there somewhere. If we had a halt predicting program, though, we would immediately have the proof we need. Write a program to check out all numbers, in ascending sequence, halting if and when an even number which can't be represented as the sum of two primes is reached. We

Caribbean. But what actually is chaos, theory, how does it explain the implausible sounding butterfly effect, and what bearing does this have on computability?

The following equation is a rather simplistic model of population growth:

$$x_{N+1} = x_N + Ax_N(1 - x_N)$$

Here,  $x_n$  is the population in time period  $n$  (a time period can be a day, a week, a month, a year etc. depending on how rapidly the species breeds),  $x_{n+1}$  is the population in the next time period, and  $a$  is a constant which defines the rate of growth. Populations are normalised over a range 0 to 1 where 1 is the maximum population the environment can support. The population can go over 1, as we'll see, but such a population is not sustainable and it will soon diminish due to overcrowding or lack of food. Obviously the population value could be converted to an actual population by multiplying it by

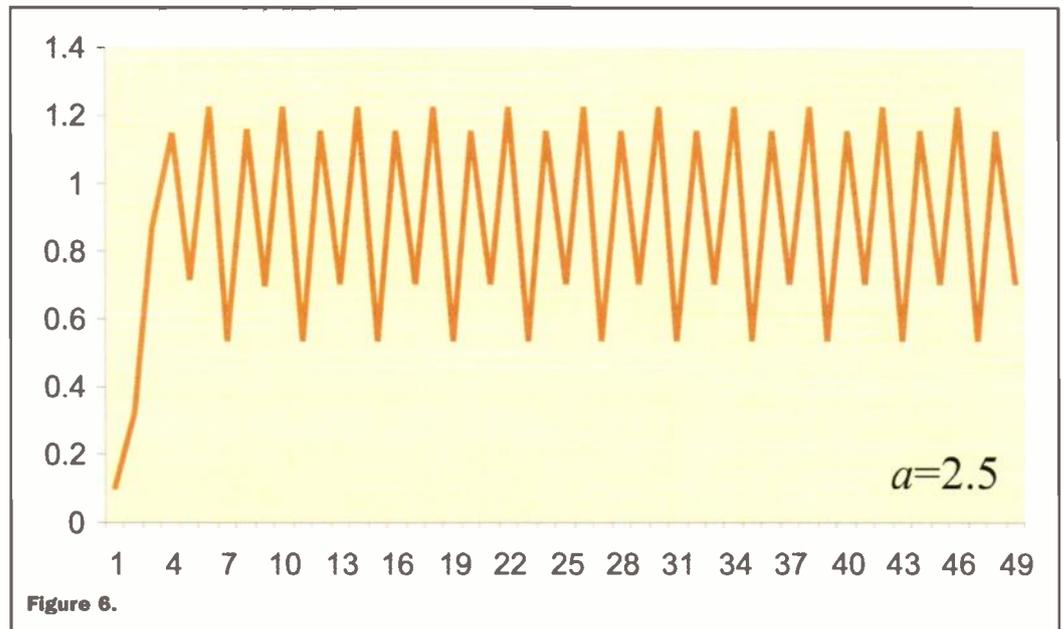


Figure 6.

wouldn't even have to run the program, just input it into the halting predictor. If the halting predictor states that the program will halt then the Goldbach Conjecture is disproved, if it states that the program won't halt, we have that elusive proof.

### Chaos Rules

All the examples of non-computable problems we've seen so far are non-computable according to the rules of logic. But there are other reasons why an answer to a question may not be computable. No doubt you've heard the phrase chaos theory bandied around, and you may have heard it described in terms of a butterfly. It's been suggested that a result of chaos theory is that a butterfly moving its wings on the slopes of Mount Fuji, Japan, could affect the atmosphere in such a way that a hurricane could form in the

the maximum sustainable population. Figure 4 shows how the population varies over time for a value of  $a=1.9$ . You'll see that there's an initial sharp rise, followed by a period of instability and, after this, the population levels off at a value of 1. This is much as we'd expect. We might also expect that, as  $a$  increases, that final value of 1 would be reached more quickly. Well that does, happen, however, the faster the population rises the more it overshoots so the longer the period of instability before it eventually settles down at a population of 1. For values of  $a$  up to 2 the population always does stabilise in this way, after an increasingly long period of instability. Above  $a=2$ , though, things are very different as we can see in Figure 5 which is for  $a=2.5$ . What we have here is a "boom and bust" scenario. After the initial rise and

be quite different from the one which would have applied had that butterfly had never existed.

### Weather Forecasting

And we can immediately see how this impacts computability. Since the weather has already been mentioned as a chaotic system, let's stick with meteorology, and in particular with weather forecasting. Forecasting the weather involves modelling the atmosphere as a set of differential equations, measuring the atmospheric conditions now, and then running the model forward in time using the measured values as the initial conditions. Despite the layman's lack of confidence in weather forecasting, let's assume that

there's nothing here, which is inherently non-computable, and that the equations that make up the model are correct. Whether or not these are valid assumptions doesn't affect our line of argument. Now let's assume that we measure the initial conditions – the air temperature, the wind speed, the barometric pressure and so forth – at various points in the atmosphere, with instruments capable of measuring to within  $\pm 1\%$ . So we run the model and we get a forecast for 12 hours, 24 hours, 3 days

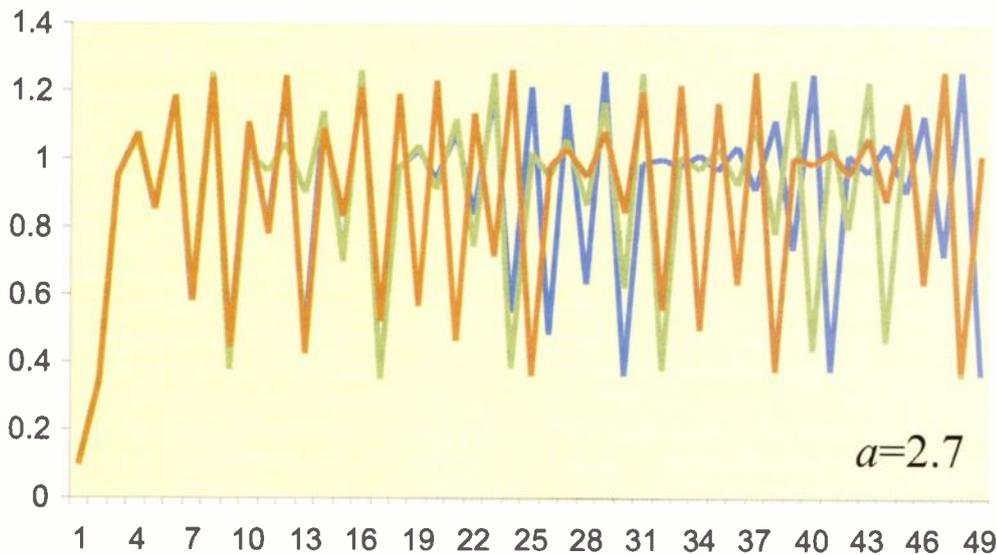


Figure 7.

fluctuations, the population does settle down but now that stable behaviour is an oscillation between a pair of values. At about  $a=2.45$ , the number of possible final population values doubles again and, as we can see in Figure 6 which is for  $a=2.5$ , the final population cycles between four values. As  $a$  increases, we get further doublings to 8, 16 and so forth until, at around  $a=2.575$ , the population appears to fluctuate randomly. This is the situation illustrated in Figure 7 which is for  $a=2.7$ . This is chaotic behaviour although that doesn't just mean that the behaviour appears random, there's a much more important characteristic of chaotic behaviour than that.

With the graphs for  $a=1.9$ ,  $a=2.3$  and  $a=2.5$ , the population would settle down into the pattern shown whatever the initial value of  $x$ . However, for  $a=2.7$ , a tiny change in the initial conditions will result in totally different long-term behaviour. To illustrate this, Figure 7 actually has three traces, one for a starting value for  $x$  of 0.1 (brown) and the other for an initial value of 0.101 (green) and one for an initial value of 1.1001 (blue). The initial values used for the brown and the blue traces differ by only 0.1% but by time period 25 the two are behaving in wildly different ways. Had I used starting values for  $x$  of 0.100001 or even 0.100000000000000001 the graph would still have been different from the one which starts with  $x = 0.1$  although the closer together the two starting values the longer it takes for the two graphs to diverge. Yet they will eventually diverge and once this

happens, the subsequent behaviour will be completely different. So a chaotic system is one which, in the language of mathematics, displays super-sensitivity to the initial conditions. The weather is known to be a chaotic system and this is why that Japanese butterfly could impact the weather in Jamaica in such a big way. Although the change in air pressure brought about by the movements of such a small creature is minuscule, by the time a few weeks has elapsed, the outcome could

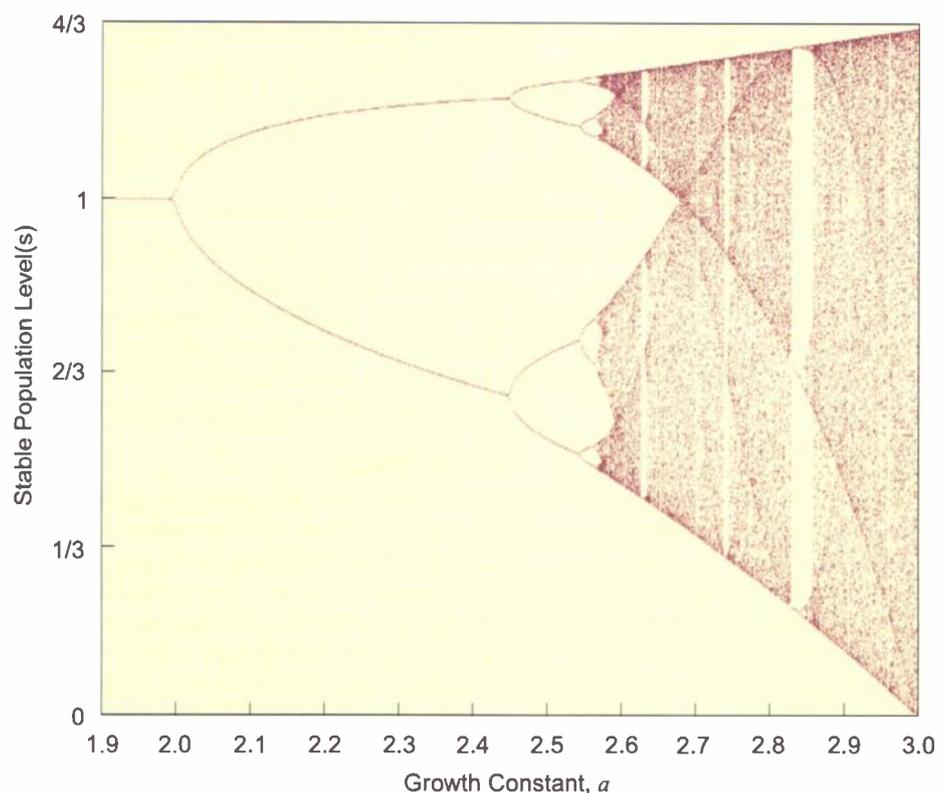


Figure 8.

and 1 week. Let's now do the same but this time we use instruments capable of measuring to an accuracy of  $\pm 0.1\%$ . So we'll start with slightly different initial conditions, almost certainly. And since the weather is a chaotic system, the results for the two runs will diverge at some point. We may find, for example, that the two runs agree to 12 hours, are slightly different at 24 hours but, beyond this, are completely different. The fact is, however accurate our instruments, the starting values we use will be somewhat different from reality so there will be a limit to how far we can see into the future. The better the instruments the longer our window of confidence will

point at which chaos once more asserts itself. In fact, there are an infinite number of non-chaotic bands, of varying width, buried within the chaotic region. All this is summed up in Figure 8, which is referred to as the bifurcation diagram. This shows the value(s) of the final population for a given value of  $a$ . The change from a single final population to a cycling between a pair of values, the subsequent doubling up to 4, 8, 16 etc. and the onset of chaos can all be seen here. But to return to the weather, the fact that the sensitivity to initial conditions depends on so many factors means that we can't even say how far into the future a forecast is valid. This will vary from place to

particularly chaotic region and we can give a high degree of confidence in the forecast. A wide variance between the individual results in the ensemble, on the other hand, suggests a low degree of confidence in the forecast. So although there's nothing that can be done to overcome the effects of chaos theory, at least we can judge how chaotic the atmosphere is at a given time and in a given place and, accordingly, indicate how much reliance can be placed on the forecast. In reality, since the confidence varies from place to place, the result of an ensemble forecast is often a map with different colours indicating the degree of confidence. Such a map,

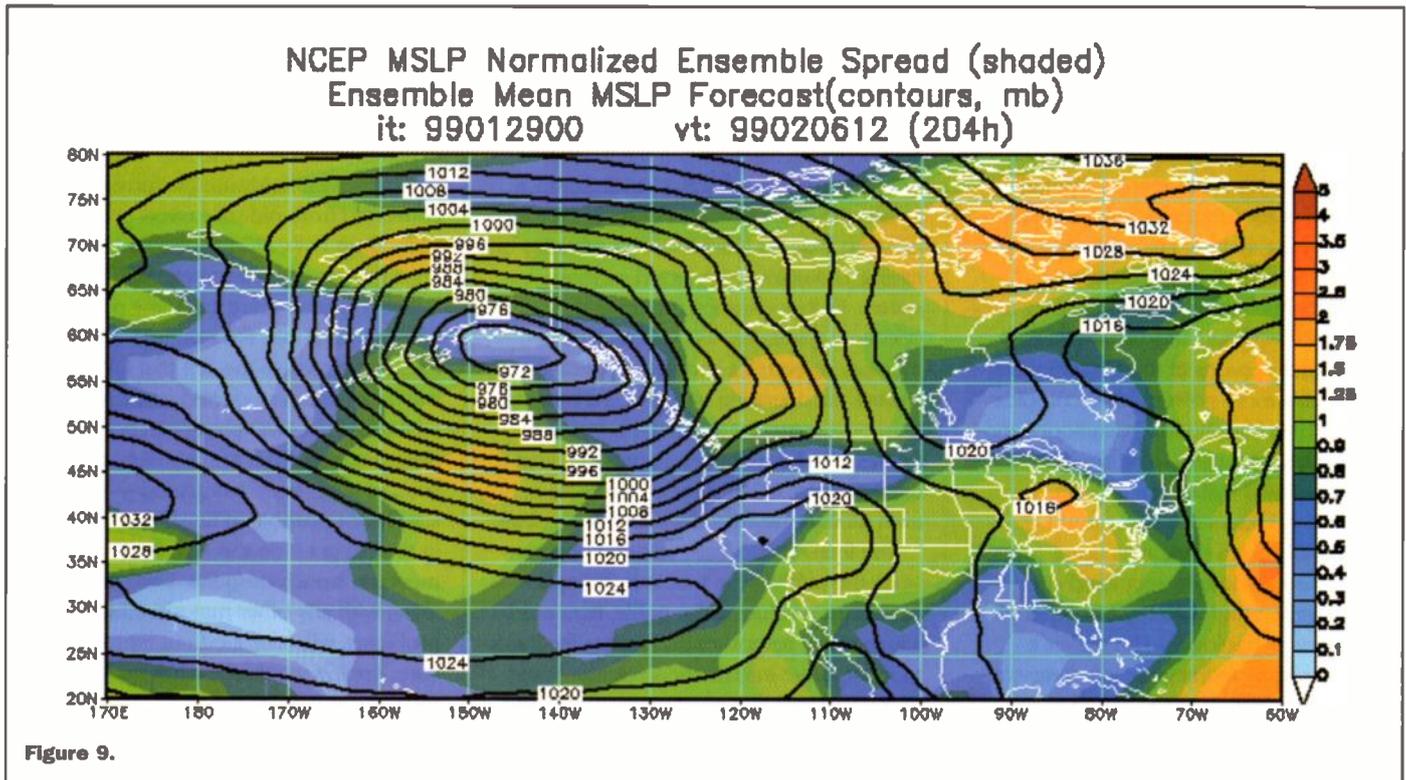


Figure 9.

extend but we can never measure an absolutely accurate set of starting conditions so there will be a point in the future for which we just can't forecast the weather. To all intents and purposes, therefore, it's not computable.

So is that all there is to be said on the subject? Isn't there something that can be done to alleviate the situation? Well, yes and no. The equations that describe the behaviour of the atmosphere are chaotic, yes, but to a variable extent. In our model of population growth, for example, the system was chaotic for some values of  $a$  but not for others. But it isn't simply the case that the system is chaotic with values of  $a$  greater than 2.575. Even above this threshold, there are some values of  $a$  at which a sense of order prevails once again. At around  $a=2.83$ , for example, we find, once more, that the population cycles between just a few values – specifically three. For higher values of  $a$  we see a doubling to 6, 12, 24 etc. until we get to a

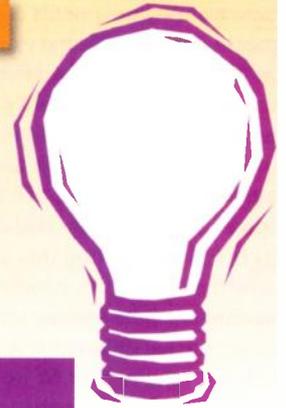
place and from time to time, none of which sounds too promising. We can get a clue, though, and this is the essence of ensemble forecasting. Let's see how it works. First of all we run the model in the normal way, using the measured values of all the initial conditions, to obtain a forecast for some time in the future. Then we do just the same, a number of other times, but with slightly different values for the initial values. The amount by which the variables are altered depends on the accuracy of the instruments used to measure them. Weather forecasting is a very processor-intensive task which is why the meteorological institutions have many of the world's fastest supercomputers, so performing the task many times is very expensive in computer time. Nevertheless, at the end of the exercise, we have a number of possible forecasts. These are then compared. If there were a good degree of agreement between them, this would suggest that we're not in a

generated by the USA's National Oceanic and Atmospheric Administration, is reproduced as Figure 9.

### In Conclusion

So you thought that computers were the universal panacea? You thought that the only thing that was preventing a solution to some problems was that nobody had yet devised an algorithm? Well I'm sorry to disillusion you, and I'm sorry to undermine your confidence in computer technology. And what's worse, that loss in confidence isn't just in today's technology. Had that been the case you could have held out the hope for a technological solution in the future. But since the issue of non-computability relates to the fundamental laws of mathematics, logic and nature, there's really no escaping it. I wouldn't suggest throwing your PC in the bin just yet, but it would be wise not to expect the answer to 'life the universe and everything' to be forthcoming in the near future.

# COMMENT



by KEITH BRINDLEY

As this month's issue of *Electronics and Beyond* hits the streets, so does a brand-new personal computer operating system — Apple's Mac OS X (pronounced Mac Oh Ess Ten). While the operating system borrows unquestionably on previous Macintosh personal computers' operating systems, it is also unquestionably a totally new operating system. Previous versions of the Mac OS were simply updates and improvements of prior versions, dating back to the Mac's original introduction in 1984. Yes, the later versions of the Mac OS were considerably more powerful and complex than the 1984 Mac, but the techniques and core technologies used were similar throughout all the Mac's early years.

Mac OS X breaks the Mac mould considerably. For a start, at its heart, Mac OS X is built around industry-standard core technologies, rather than the Mac's prior proprietary technologies. This makes it inherently easier to integrate into large-scale computer systems than the Mac ever has been before. The core of the new operating system is called Darwin — so named after Charles Darwin because it represents the next stage of the Mac's evolution. Unlike any major computer company, Apple open-sourced Darwin two years ago, to ensure that it incorporated input from software engineers other than Apple's own. The move paid off: Darwin features reliability and performance previously unknown in a mainstream operating system. Darwin's kernel is based on Mach 3.0 from Carnegie-Mellon University and FreeBSD 3.2 (derived from the University of California at Berkeley's BSD 4.4-Lite), the most highly regarded core technologies from two of the most widely acclaimed operating system projects of modern computing. What this proves is that Mac OS X is built upon standard Unix techniques. That means, for the first time, the Mac OS can feature a command line interface if the user so desires, and what's more, the command line interface is a standard Unix one. The fact that the Mac graphical user interface is built on top of the Unix base only gives the operating system more power.

Stability of Mac OS X is already renowned, even before final release. Even when the public beta of Mac OS X was released in September last year stability was excellent — there have been several reports of the public beta powering Macs around the world that have not been shutdown or restarted since installation six months ago, despite constant daily use. Mac OS X achieves this reliability by having a completely protected memory system. Each application run using the operating system has its own block of memory, so even if a particular application crashes the operating system keeps running — no requirements for a restart, no system freezes. By all developer accounts, the final release of Mac OS X (due on March 24) is even more stable than the public beta release.

The final release features other changes since the public beta, too. Part of Apple's reason for producing the public beta was to gauge users' responses and gather feedback to incorporate into the final release. Some of the feedback obtained was positive, and allowed Apple to improve the operating system, but some of the feedback was indeed critical about how the operating system worked. Mac users have deep convictions about 'their' operating system. The public beta of Mac OS X featured so many differences from previous versions of the Mac OS that many responses Apple gathered as feedback pointed several things that Apple should not change. The final release is reported to do away with many of those changes, which should make existing Mac users even happier.

Introduction of a new operating system inevitably brings problems with it. Existing software can be incompatible. Apple has gone out of its way to ensure that this is not necessarily so with Mac OS X. Most current Mac software producers are committed to releasing Mac OS X compliant software at the earliest possible opportunity (much of it to coincide with the March 24 launch date). But even existing Mac software will be usable with Mac OS X, as Apple includes with the operating system a means whereby older software can be run — the Classic environment. Naturally, Classic software will

be slower to operate than native Mac OS X software, but the ability to run it at least provides users with the breathing space needed to obtain the updated software. Classic works well — Apple has had experience before in this sort of thing; when the Mac hardware platform was converted from old-style 68xxx processors, to modern PowerPC processors a similar approach worked extremely well.

Nevertheless, there are some minor exceptions to this. For example, Apple has already pointed to the fact that DVD playing will be as yet unsupported at the Mac OS X final launch. A DVD player will however be downloadable from Apple's Web site as soon as it has been completed — it was simply not possible to finish the DVD player in time to get it on the Mac OS X CD to meet the launch deadline. This though, along with any other minor teething problems, will be ironed out rapidly. To date, Apple's whole drive has been to get the CD out the door.

In truth, Mac OS X represents a massive undertaking. When the original Mac operating system was released back in 1984, it changed the face of personal computing. Every version of every other operating system in the world saw it as the future. Successive versions of every other operating system in the world attempted to emulate it in appearance, if not in performance. To date, none has yet matched the Mac's ease of use and inherent power. Recently, Microsoft announced its future operating system Windows XP, which is as close to the Mac as a personal computer can get while not infringing copyright I guess.

Apple's whole aim with Mac OS X is to make the personal computing environment easier, faster, safer, more powerful, and yet — simply — fun. I'd advise anyone who uses a personal computer to check Mac OS X out, either at a local Mac re-seller or main Apple dealer, or on a Macintosh near you. For any current Mac users, Mac OS X is the next step in personal computing. For users of any other operating system, Mac OS X is simply a different world, and one which I can only recommend you move to.

# @internet special



## Opera Makes an Overture

For long enough, two Web browsers — Microsoft Internet Explorer, and Netscape Navigator — have ruled the personal computer desktop roost. Initially, Web browsers were paid-for items of software, and users readily paid the purchase price for the ability to surf the World Wide Web. In the old days, Netscape Navigator was the most popular Web browser, but then Microsoft released Internet Explorer as a free utility, which it gave away as part of its Windows operating system. This has forced Netscape's hand to give away Navigator as a free product too.

Effectively, by giving away Internet Explorer, Microsoft eliminated any competition in the Web browser market in a stroke. Nowadays, few other Web browsers make it to the light of day, simply because most companies don't have the ability or desire to create free software — budgets have to balance after all, and companies have to make money or there's little point in them being in existence.

One Web browser that managed to overcome this difficulty is Opera. It has done this by making its software sort of free, although you can pay for it if you want. To do this, Opera uses banner advertising in its free form. Users see banner adverts while they use the free software (geared to the users personal requirements), but by paying for Opera (\$39, or around £27) the banner adverts can be removed. It's an interesting concept that has worked reasonably well to some extent in the email client marketplace, and one that looks as though it might work for Web browsers too. If you want to try Opera for yourself, checkout details at: <[www.opera.com](http://www.opera.com)>. It's available in several operating system flavours: BeOS, EPOC, Linux, Mac and Windows, and is soon to be released on OS/2. So it can be used by more-or-less any personal computer user.

Opera offers several advantages over the more traditional Web browsers. For a start, it's significantly smaller in size and operation, taking up considerably less disk space in storage and RAM in usage. Probably because of this, it's significantly faster

when launching and in general operation — however, this particular advantage depends rather on pages visited, as Opera's Java usage and jpeg display are both rather slow (although will presumably be optimised in the near future). Other pluses are Opera's support for common Internet standards such as; cascading style sheets, XML, Wap, plug-ins, newsgroups, email, and instant messaging.

Whatever Web browser you currently use, it's well worth a look at Opera — it could change your browsing life completely.

## Desktops Galore

There's nothing like changing your personal computer's desktop or wallpaper to make a computer look different. Apart from your computer's in-built patterns and pictures though, it's sometimes not so easy to locate decent pictures that you'd want to use.

Checkout Webshots, at: <[www.webshots.com](http://www.webshots.com)> for what is probably the best resource for

desktop or wallpaper pictures ever. A search facility allows you to locate pictures of just about anything or anywhere in the world.

Pictures in the Webshots gallery are freely downloadable, and there's even a free download and control utility (in both Windows and Mac versions) to do the job and install the pictures for you. The Windows version also features a screen saver option, which displays



pictures you download as a screen saver — this feature is to be included in the upcoming release of the next Mac version too.

If you take your own digital pictures, you can even opt to upload them for others to share. This has a bonus, in that you can access them on the Webshots Web site yourself — wherever you happen to be in the world. All you need to do is log on to Webshots and download your own photos.

All in all, Webshots is a brilliant tool and resource combination for anyone who likes to change their computer's personality. Given the added ability to store your own photos for later use anywhere, it's a must-have for many people.

## Measure Service Levels with Keynote



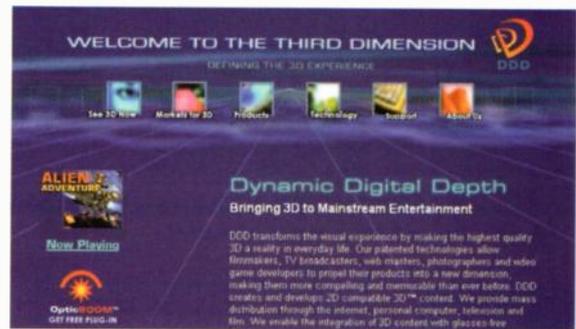
Keynote, a US company that is positioning itself as a performance authority for the Internet has announced SLA Perspective the first service level agreement (SLA) verification solution designed for content delivery networks (CDN), Internet service providers, Web hosting companies and their customers.

The SLA performance measurement service is customised and designed to meet the exacting measurement requirements CDNs need to better demonstrate and prove the value of their technology to customers and prospects.

Keynote SLA Perspective provides the only accurate independent service that verifies a service level agreement has been met.

For further details, check: [www.keynote.com](http://www.keynote.com).

## Graphics Tools Cut Costs for 2D Special Effects



Dynamic Digital Depth (DDD) has developed an intelligent tool to automate the process of depth mapping, which calculates 3D data for existing 2D images.

Depth maps are widely used in post-production to create and integrate animated computer-generated images and historical footage into live-action sequences.

DDD engineers developed the tools, an intelligent depth map key framer and an automated depth map tweener, to improve the process of converting 2D content to 3D.

The tools are based on an expert system that learns the steps that a human operator would normally perform.

The key framer enables a graphic artist to create depth maps using an innovative 3D airbrush. With just a few broad-brush strokes by the artist, the software system is able to produce a detailed depth map in seconds.

For further details, check: [www.ddd.com](http://www.ddd.com).

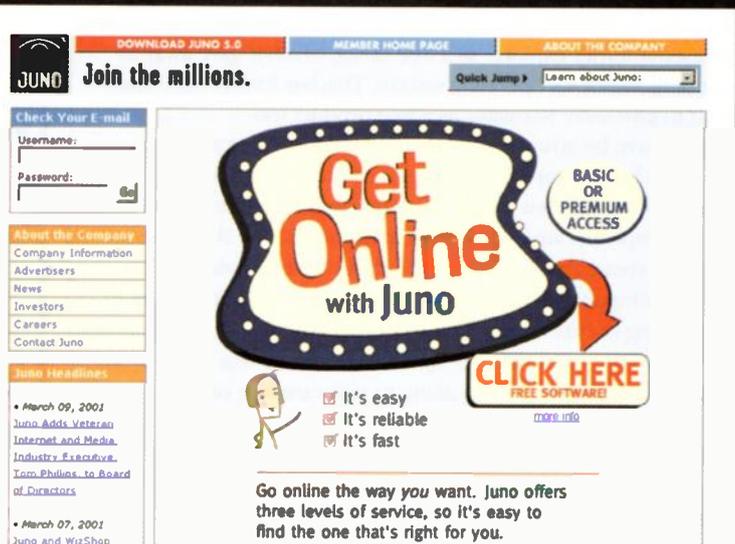
## Distributed Computing to Harness Unused Subscriber Resource

Juno Online Services has launched the Juno Virtual Supercomputer Project, a distributed computing effort of unprecedented scope that aims to harness unused processing power associated with the free portion of its subscriber base in order to execute computationally intensive biomedical and other applications on behalf of commercial clients and research institutions.

Juno is one of the largest Internet access providers, with 14.2 million total registered subscribers worldwide.

While the personal computers owned by different Juno subscribers have different performance characteristics, preliminary studies suggest that if the computers of all of Juno's active free subscriber base were simultaneously working on a single computational problem, they would together represent the world's fastest supercomputer, and might approach or break the petahertz-barrier.

Although the achievable effective computing power are likely to be significantly lower in practice for a variety of reasons, Juno's management believes that the unused computing power of its free subscriber base represents a potentially valuable asset from the viewpoint of both



potential revenue generation and potential contribution to society.

The company expects to focus particular attention on prospective clients involved in bio-informatics research who are beginning to confront such computationally demanding applications as the determination of the structure of proteins encoded by gene sequences. These were discovered through recently completed efforts to sequence the human genome, and searching through millions of virtual molecules to find promising candidates for new pharmaceutical products.

For further details, check: [www.juno.com](http://www.juno.com).

## Sonic Announces Sound Forge



Sound Forge 5.0 includes 20 DirectX Audio Plug-Ins, including XFX1, XFX2 and XFX3, and an Acoustic Mirror which can be used for acoustic simulation and microphone modeling.

The entire suite of audio effects includes: amplitude modulation, chorus, delay/echo, distortion, dynamics, compression, enveloping, flange/wah-wah, gapper/snipper, noise gate, pitch bend/shift, reverb, and vibrato; three equalisers - graphic, parametric, and parabolic and time compression/expand.

In addition, Sound Forge 5.0 provides support for 24-bit/192 kHz audio files, track-at-once CD burning, and CD Ripping. These features allow the user to produce high-quality audio CDs as well as the ability to transfer music to a hard drive with saving options in MP3, WAV, and WMA formats.

The software includes dozens of editing features including: cut, paste, move, delete, mute, reverse, fade, crossfade, trim, normalise, fade, pan, resample, enhance, insert silence.

Sound Forge 5.0 is available in full beta format for download at [www.sonicfoundry.com](http://www.sonicfoundry.com).

## Discreet Introduces Web Studio CD Set



Discreet has announced details of its Web studio set, consisting of Discreet's 3D modeling, animation and rendering program.

The Web studio set is a collection of integrated plug-ins and tools from Cycore, Ideaworks3D, Pulse, RichFX and Viewpoint on individual CDs with unique solutions that streamline the process of bringing 3D models and animations to the Web.

For further details, check: [www.discreet.com](http://www.discreet.com).

## Create New Communities With Yahoo! Groups



Sharing interests and exchanging ideas among online community members is now even easier with Yahoo! Groups at [groups.yahoo.com](http://groups.yahoo.com).

Yahoo! Groups provide powerful communications tools, including the ability to share photos and files, plan events, and send newsletters.

This announcement marks an important milestone in the ongoing integration of the eGroups service, acquired by Yahoo! in August 2000, into the Yahoo! platform.

Yahoo! Groups will allow former eGroups users to continue to enjoy all of its previous features while also providing the benefit of integration with Yahoo!'s extensive network of services.

Yahoo! plans to integrate Yahoo! Clubs into Yahoo! Groups later this year.

### Yahoo! Groups Highlights:

- **Communicate via e-mail and Web-based tools**  
Yahoo! Groups offers people a way to access and share information with others via e-mail and Web-based tools
- **You choose – interact online or via e-mail only**  
Users have a choice when deciding on how to stay connected with their Yahoo! Groups
- **See who's online**  
See when group members are online and communicate with them in real-time using Yahoo! Messenger
- **Create your own look**  
Yahoo! Groups make it easy to add a photo or a splash of colour to a group page all without having to know HTML.

## Vivendi and Sony Online Music Venture is Close

In a development that shows that the music industry is looking beyond the Napster battle, Vivendi Universal and Sony have announced that they are developing an online subscription service called Duet for music and video. The system to be rolled out by the summer will work across several platforms besides PCs, including wireless devices and set-top boxes.

For further details, check: [www.sony.com](http://www.sony.com).

## Internet Filtering Protects Against Dodgy Web Content



Biodata Information Technology has announced that it has unveiled I-Watch, its firewall content filtering technology.

Through fully automated image and text analysis, I-Watch, which was developed by Cobion and Biodata, uses a family-filter to protect children against offensive material such as pornography, violence and illegal content, on the Web.

In contrast to conventional filters where key words are manually searched for, I-Watch identifies images and symbols, so that Web pages that contain nudity or subversive symbols are immediately recognised and filtered.

A black list that is updated automatically blocks access to 'unwelcome Web sites.'

The automated high-speed analysis of textual and visual components of Web sites is quicker, more efficient and cost effective when compared to manual detection. The Web filter is updated daily and its range is individually configurable by the user.

For further details, check: <[www.biodata.com](http://www.biodata.com)>.

## MapQuest Extends European Services with UK Portal



MapQuest.com has launched a new Web portal for the UK at <[www.mapquest.co.uk](http://www.mapquest.co.uk)>.

The launch of the new Internet site brings the flagship MapQuest brand to the UK with easy-to-use maps, detailed driving directions, cutting-edge location services and the introduction of MapQuest Direct.

MapQuest Direct is a free online mapmaking tool that allows individual organisations, small businesses, Webmasters, and Web site owners to provide an unlimited number of maps and door-to-door directions directly from their own Web sites.

## 'Sex' Most Popular on the Web



A two-year study by Alexa Research shows that an alarming number of Web users are not particularly efficient at reaching their online destinations.

Rather than entering a URL into the address field of their Web browsers, millions of Internet users enter the name of the site they want into the search box of their home page or other search engine. The study also found that the most popular term people search for online is 'sex.'

These findings are based on an examination of more than 42 million search pages viewed in aggregate by users of the Alexa toolbar at ten of the Internet's leading portals and search engines - altavista.com, aol.com, excite.com, go.com, google.com, goto.com, lycos.com, msn.com, netscape.com, and yahoo.com - between March 1999 and January 2001.

Sex-related terms were quite popular. 'Sex' was the most popular term for which people searched. Of all the terms searched for online, 0.3289% - or roughly 1 of every 300 terms - were 'sex.'

The most popular celebrities searched for were Britney Spears, Pamela Anderson, Backstreet Boys, Jennifer Lopes and Eminem. Pokemon was the most popular specific toy or game searched. Playboy was the most popular media property.

sex (0.3289%)  
 hotmail/hotmail.com/www.hotmail.com (0.2131%)  
 yahoo/yahoo.com/www.yahoo.com (0.2044%)  
 porn/porno/pornography (0.1402%)  
 chat/chatrooms (0.1233%)  
 mp3 (0.0935%)  
 horoscopes/horoscope (0.0800%)  
 ebay/ebay.com/www.ebay.com (0.0731%)  
 aol/aol.com/www.aol.com (0.0714%)  
 games (0.0659%)  
 map/maps (0.0585%)  
 pokemon (0.0549%)  
 nude/nudes (0.0541%)  
 music (0.0505%)  
 xxx (0.0473%)  
 travel (0.0470%)  
 screensaver/screensavers (0.0458%)  
 lyrics/song lyrics (0.0455%)  
 playboy (0.0430%)  
 free (0.0426%)

For further details, check: <[www.alexaresearch.com](http://www.alexaresearch.com)>.

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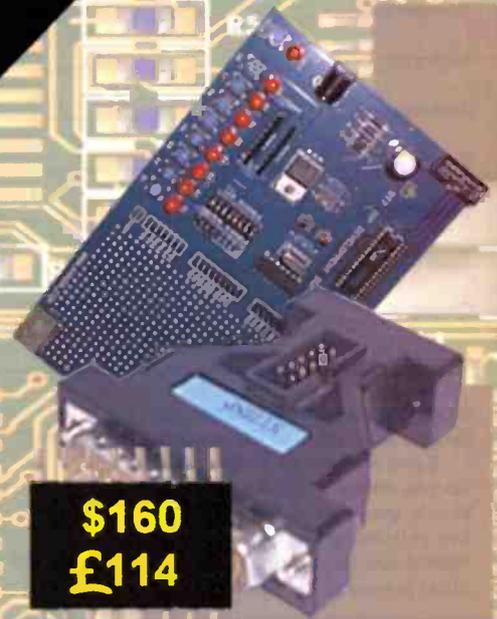
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ST7 Flash Starter Kits  
Available in 32, 42, & 56-pin  
p. 4

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(Check out p.4 for details on the ST7 STK's)

What must one do for a shot at one of these? Not much, just clip and complete the form below, mail it to one of the addresses below. Done. We will draw the names of the five winners and notify them, as well as the rest of the world, in the June issue of Electronics and Beyond. NOTE! You could put the same information on a post card and send it to us. In fact do that, pretty picture post cards, they'll brighten our day.

ST7 Starter Kit Drawing

Name: \_\_\_\_\_

Company: \_\_\_\_\_

Address: \_\_\_\_\_

Address cont: \_\_\_\_\_

City: \_\_\_\_\_

State/Province: \_\_\_\_\_

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Country: \_\_\_\_\_

Email: \_\_\_\_\_

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Send Me info on EnB? Y N

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# FPGA TOOLS

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VASCO (TM) - RTL VHDL Application on Synthesis - Course Online represents the next generation in distance learning for engineers seeking to further develop their VHDL design skills. It is intended for designers who are already familiar with VHDL and concentrates on developing specific application areas, such as synthesis issues and coding style. Everything you want to know about VHDL constructs in the context of synthesis: what can and can't be. Concise descriptions in the way engineers like the most: practical issues with examples - well over one hundred. Over forty topics, covering

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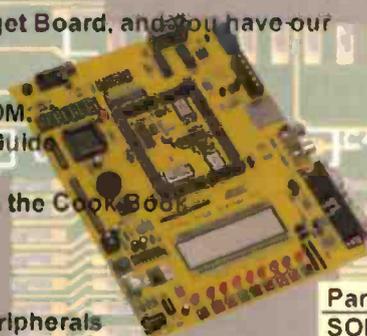


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## STK AVR Development Systems



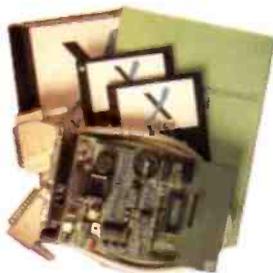
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STK-ST7-42	42-pin ST7 Dev System	160.00	114.00

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## ChipMaster 6000

### Intelligent Universal Programmer

The ChipMaster 6000 is a PC based Universal Programmer that connects through any standard Parallel Port. The 6000 features a 48-pin universal pin driver and expandable TTL pin driver. With its on-board processor and FPGA the 6000 has the power and flexibility to handle many of today and tomorrows complicated DIP package silicon PLD's, Microprocessors, and High Density FLASH without the need for programming adapters.

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The 6000 is designed for mass-production or laboratory applications, supporting nearly 3000 devices including PAL, PEEL, MACH, EPROM's, FLASH memories and a multitude of Microprocessors.



Protect your pocket book by preventing accidental, expensive, time consuming chip damage by enabling the 6000's pin contact and insertion tests on a device before a programming operation. 6000 can detect poor pin contact or devices inserted upside-down or in the wrong position.

Part #	Description	US\$	UK£
PRG-CM6-000	ChipMaster 6000	1,195.00	854.00
PRG-CM5-000	ChipMaster 5000	695.00	496.00
PRG-SPD-000	Speed-Pro	549.00	392.00



### Speed-Pro 40-pin Universal

Speed-Pro is a cost effective, high quality industrial-grade 40-pin device programmer with a parallel port interface perfect for most programming situations without the need for adapters or modules.

- \* Flexible and easy to use menu-driven software
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- \* Distribution of 16-bit and 32-bit data into 8-bit portions



### ChipMaster 5000 48-pin Universal

The 5000 is a low-cost, compact, software expandable Universal Programmer. Based on its bigger sisters design, the 5000 has the same functions as the 6000, but does not support as many devices and is a third smaller in size leaving more room on your work bench.

- \* 48-pin ZIF socket with Insertion/Contact checking
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- \* Supports 2.8 and 3.3v devices
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- \* ATtiny22/22L
- \* AT90S2313
- \* AT90S/LS2343
- \* AT90S4414
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Part #	Description	US\$	UK£
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ISP-ST7-42	ST7 42/56-pin Prog	125.00	89.00
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ISP-ST7-000	ST7 ISP Programmer (1)	45.00	32.00



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AVR-KEY-FSP	Keyfob Field Sv Pack	399.00	285.00
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# GANG PROGRAMMERS

## GangStar-Pro

### Turbo Gang Programmer

The GangStar is a one of a kind PC based parallel port GANG programmer with 8 fully isolated 48-pin ZIF sockets. Each of the GangStars' sockets are designed with dedicated FPGA's for independent control. This independent design gives the GangStar its semi-concurrent programming capabilities. For example you can program four devices while removing/inserting devices in the remaining four sockets. And with the modular design of the GangStar, in the event one, two-socket module ever fails you still have three modules to continue your programming while the other is returned for repair or replacement.

The GangStar has been dubbed the Turbo Gang Programmer for a reason, use the GangStar to program eight, 8-mb parts in under one minute. Programming times may vary slightly from PC to PC depending on the PC's processing capabilities (programming time based on a 486dx 66 system).



Part #	Description	US\$	UK£
PRG-GSP-000	GangStar-Pro	3,495.00	2,496.00



### LC Series Mini-Gang Programmers

Low cost, light weight and portable, multiple variations of these desk-top programmers allow you to program up to 4, 8Mb devices at one time! Talk to the programmer via "X-link" software, use it's features to edit your file, configure devices even print out labels. Husky-LC is limited to PC operation, through "X-link" or "dumb terminal" program of choice, while Shooter-LC is capable of performing all program/copy operations independent of a host.

Part #	Description	US\$	UK£
PRG-HLC-D11	Husky 1Meg/1Dip	445.00	318.00
PRG-HLC-D44	Husky 4Meg/4Dip	595.00	425.00
PRG-HLC-D48	Husky 4Meg/8Dip	745.00	532.00
PRG-SLC-D11	Shooter 1Meg/1Dip	595.00	425.00
PRG-SLC-D44	Shooter 4Meg/4Dip	745.00	532.00
PRG-SLC-D48	Shooter 4Meg/8Dip	895.00	639.00

\* call for more configurations



### ChipMaster 7000 E/EPROM Gang

A software expandable universal device programming workstation supports a wide variety of PLD's, in addition to the capability of testing digital IC's. This state of the art programmer offers you the most advanced programming facilities with a user friendly interface, for DOS, Win9x and Win NT. The design of the 7000 makes it possible to swap the standard single 48-pin ZIF module with the available gang module. With the gang module you can program up to 8, 32-pin DIP devices in the same amount of time it takes to program one device.

Part #	Description	US\$	UK£
PRG-CM7-000	ChipMaster 7000	995.00	711.00
OPT-CM7-8G	CM7 8x32 Gang Mod.	595.00	425.00
OPT-CM7-ROM	CM7 Rom Emulator	395.00	282.00

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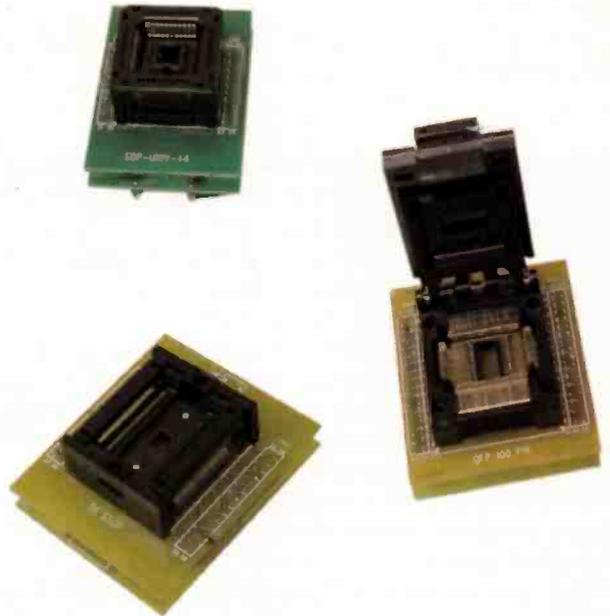


The Shooter III Field Service Pack consists of the compact lightweight Shooter III Copier/Programmer and the PalmErase EPROM eraser plus a handy, Shoulder / Hip-pack to tote them around in.

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- \* Move from station to station
- \* Erase a 32-pin EPROM in under 5 min.
- \* Program from file or copy from master
- \* Pleny of extra pocket space for Cell Phone etc.

Part #	Description	US\$	UK £
ERA-PME-000	Palm Erase	69.00	49.00
PRG-SH3-000	Shooter III Hand-held	375.00	166.00
OPT-SH3-FSP	Field Service Pack	465.00	332.00

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## Free and Easy e-Book Authoring



OverDrive's recently launched [www.ebookexpress.com](http://www.ebookexpress.com) provides immediate and free eBook authoring capabilities that would otherwise cost more than £6 if acquired elsewhere.

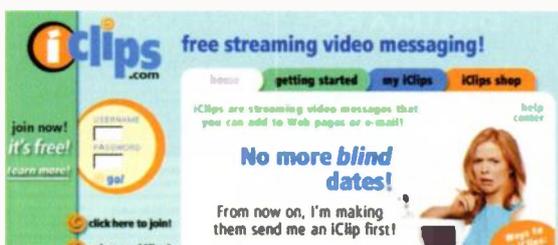
Using a basic text file - in any of a variety of formats - the online service lets users convert content into a Microsoft Reader eBook title while they wait. It also lets users add custom art to an eBook cover page.

Microsoft Reader is a free eBook reading software application that enhances the readability of text and materials by paying strict attention to the traditions and benefits of good typography.

With its innovative ClearType display technology, Microsoft Reader delivers an on-screen computer reading experience that approaches the convenience and quality of reading text on paper. It can be downloaded at [www.microsoft.com/reader/download/default.htm](http://www.microsoft.com/reader/download/default.htm).

For further details, check: [www.overdrive.com](http://www.overdrive.com).

## iClips Creates and Shares Video Clips



iClips Producer 2.0 is a complete in-browser solution that provides the simplest and fastest way for Web users to capture, encode and share streaming video messages without leaving the Web.

The proprietary application allows Web users to capture video directly from a PC camera, camcorder, VCR or convert existing video files without any desktop software.

In three steps the application encodes video into RealVideo format, lets users design and customise templates, and allows users to distribute their messages - all in a single browser window.

Streaming video messages created with iClips Producer can either be distributed via email or published to almost any site on the Internet.

For further details, check: [www.iClipsinc.com](http://www.iClipsinc.com).

## FunMail Renders Images for WAP



The FunMail engine can now dynamically generate black and white animations playable on existing WAP enabled phones. Any content in the FunMail system can now be rendered in black and white as well as in full motion colour animation.

This enables FunMail to leverage its technology and content to create animated messages for millions of WAP users worldwide. FunMail has been successfully tested over-the-air on the NTT DoCoMo i-mode system in Japan.

FunMail's technology creates animations based on text entered by the user. FunMail is capable of creating millions of different animations, derived from words and patterns in the sender's message.

These animations are automatically scaled to fit the receiving device. If this happens to be a WAP phone, then the colour is removed, and sounds and music are delivered only to those phones capable of receiving them.

A demo is available at [demo.funmail.com/wap](http://demo.funmail.com/wap).

## IBM Showcases Electronic Music Distribution



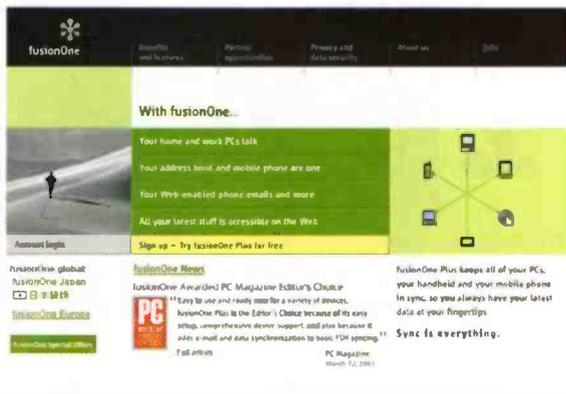
IBM is showcasing the IBM Electronic Media Management System (EMMS) for copyright-protected downloading of music at [www.grammy.com](http://www.grammy.com), the official Web site of the 43rd Annual GRAMMY Awards.

Music fans worldwide who visit GRAMMY.com can download and play selected GRAMMY-nominated and other popular music tracks free of charge.

IBM's EMMS has been adopted by companies worldwide as a leading electronic music distribution and digital rights management (DRM) system and is being showcased for the first time at GRAMMY.com

IBM is also collaborating with RealNetworks to provide RealJukebox, the leading music management software, as the featured application for playback of the downloaded music. This marks the first time that EMMS content will be available through RealJukebox.

## fusionOne Introduces Sync Service



fusionOne, a developer of Internet synchronisation services, has announced the availability of its premium class synchronisation service, fusionOne Plus.

fusionOne users now have the option to upgrade from the basic service, which keeps their personal information in sync across multiple computing devices such as PCs, PDAs and mobile phones, to an expanded service offering that includes AutoSync, fusionOne Mobile Desktop, enhanced user interface controls, banner-ad-free syncing and the ability to sync email and files.

### FusionOne benefits:

#### File and email sync

Access files and email from anywhere, anytime.

#### AutoSync

Select information once on any device with the assurance that it will automatically be updated in all their other devices, eliminating the need to manually sync frequently modified information.

#### fusionOne mobile desktop

Access all personal information - email, contacts, calendar, files and bookmarks - from any Web-enabled phone.

#### Premium interface controls

Modify sounds and icons.

For further details, check: [www.fusionone.com](http://www.fusionone.com).

## Google Extends Search Engine to PDF Format

Google has become the first search engine to index documents in the Portable Document Format (PDF).

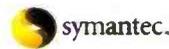
Typically academics and researchers, who want to place their text online but do not have time to convert their files into the standard Web language, HTML, favour PDF files.

Google estimated that it has made 13 million PDF documents available through its search engine, representing about 70% of all PDF documents online.

Users need to download free software from Adobe Systems, which developed the PDF format, to read PDF documents, although Google has made text versions of some of its indexed PDF files available.

For further details, check: [www.google.com](http://www.google.com).

## Symantec Detects 'AnnaKournikova' Worm



Symantec has announced protection for the VBS.SST@mm worm, also known as the AnnaKournikova worm.

VBS.SST@mm or 'AnnaKournikova' worm is a mass mailing worm that spreads via e-mail with the following subject lines 'Here you have, ;o)' and text that reads 'Hi: Check This!' The attachment name is 'AnnaKournikova.jpg.vbs' or a similar abbreviation.

Upon execution this Internet worm copies itself to the Windows directory and then sends the file as an attachment to every address listed in the infected user's Microsoft Outlook address book.

The overriding results could potentially create an effect similar to a denial of service attack due to the high volume of e-mails created.

For further details, check: [www.symantec.com](http://www.symantec.com).

## Explorer Integrates Digital Watermarking



Digimarc ReadMarc allows users the ability to directly access information related to digitally-watermarked images from Windows Explorer on their desktop without requiring the use of image editing applications or opening the image file.

ReadMarc for Windows allows viewers of images to link directly to information about copyrights, licensing requirements and other related information.

Digimarc-enabled images are identified by a small Digimarc logo added to the file icon. Users may now simply right-click on watermarked images and link to information about the image and its creator or distributor.

More information and a free download of ReadMarc for Windows can be accessed at [www.digimarc.com/go/readmarc](http://www.digimarc.com/go/readmarc).

## Shell Opts for Voice over IP



deltathree has signed an agreement with Shell to offer Shell's European customers a new voice-over-IP (VoIP) product.

In the first implementation of the agreement, deltathree will provide the telecommunications infrastructure, customer service support and other back-end services for Shell's branded Phone-to-Phone service, a virtual calling account that provides users with an account number to call any location throughout the world.

This new product allows users in any number of European destinations and using a standard or mobile telephone to call any location throughout the world for substantially less than standard long distance and domestic rates.

Upon purchasing the desired block of minutes, users can place calls from any telephone by entering their PIN, whereupon they are connected to the deltathree network, which routes the call.

For further details, check: <[www.deltathree.com](http://www.deltathree.com)>.

## Central Command Offers Free Virus Protection



Central Command has announced the availability of AVX Scan Online, a free, easy to use, security and virus protection service that changes the way virus protection is being used, delivered and maintained worldwide.

Incorporating the latest virus protection technologies, AVX Scan Online is the world's first online virus scanner accessible entirely through an Internet Web browser.

AVX Scan Online virus scans for over 48,000+ viruses, worms, trojans and other malicious applications.

It includes optional features to virus scan inside of archives, memory, boot sectors, system processes, e-mail databases, and network drives.

For further details, check: <[www.avx.com](http://www.avx.com)>.

## eMarketer Report Reveals Wireless Projection Discrepancy



A new eMarketer report reveals that projections for wireless Internet subscribers and m-commerce revenues from various research firms are so disparate, that it is virtually impossible to offer an informed projection for future usage.

The eWireless Report cites data from more than 100 research organisations and consultancies, offering examples of the gap in projections for a technology that does not yet exist.

According to the eWireless Report, the exact number of wireless Internet users is still very much an unknown. Even the Wireless Data Forum in the nation's capital admits that only rough counts are currently available.

Still, analysts have come up with some very different numbers covering the next four years.

### eWireless Report Highlights

#### Mobile Internet Use

ResearchPortal reported the number of mobile internet users reached approximately 95 million in 2000, with nearly 80% from the Asia/Pacific Rim and North American regions. By 2005, Ovum Research predicts that number to reach 484 million.

#### mCommerce

Of the \$14 billion in worldwide m-commerce revenues forecast for 2005, Jupiter predicts that \$7 billion will derive from shopping, \$4.7 billion from paid content and \$1.9 billion from advertising.

#### mFinance

Celent Communications predicts that 150 million people will use global wireless financial services by 2004, compared to 10 million in 2000. ARC Group forecasts that wireless-banking users will grow to 331 million by 2004.

#### mAdvertising

Advertisers using mobile and wireless devices face a variety of obstacles. In 2000, \$7.8 million was spent globally on mobile advertising while in 2005; forecasts call for \$9.8 billion to be spent on this sector.

#### Europe

Short messaging is sweeping the European wireless Web by storm with Germany leading the way and Italy right behind. In total, there were 15 billion short messages sent throughout the continent during 2000.

For further details, check: <[www.emarketer.com](http://www.emarketer.com)>.

## Pumatech Brings Web-Based Synchronisation to Web Portals



Pumatech has announced Sync-it, a key component of the company's Mobile Application Platform (MAP).

Sync-it enables users to keep multiple devices such as Palm OS handhelds, notebook computers and desktop PCs in sync via the Internet.

In addition to Sync-it, MAP consists of Browse-It software, which enables users to view Web content on- and off-line via Palm OS handhelds, and Mind-It software, which automatically notifies users via email, mobile phone, or pager when changes are made to specific Web content.

For further details, check: <[www.pumatech.com](http://www.pumatech.com)>.

## Record Industry Wants More Cash From Napster



Napster, which is still embroiled in lawsuits for infringing on copyrights, is proposing to pay record companies £1 billion over five years to end the dispute.

By the time this edition of Electronics and Beyond hits the press the online music-swapping service may have well been closed down.

Under the latest Napster proposals, the five major companies would divide up £150 million annually according to what percentage of their works are exchanged by Napster users, and an additional £30 million would be directed to independent music companies and artists. Music industry executives and analysts dismissed the offer as insufficient.

Napster also plans to convert its operation into a subscription-based activity. Users probably will be charged a fee of around £6 per month for computer downloads of an unlimited number of music files.

Napster's 57 million users currently share files for free. Industry experts claim that the music industry benefits from increased interest and predict that the Internet could boost current worldwide music-industry sales from an annual £24 billion up to as much as £60 billion.

For further details, check: <[www.napster.com](http://www.napster.com)>.

# Site Survey



## Destinations of the month



One of the nice things about the Internet and computers, is that you often see funny video clips — TV adverts from around the world, say, or outtakes from TV shows, or even other Internet users' home movies. You may find your friends emailing them to you as attachments to messages, and you may do the

same to them. Finding new video clips though is sometimes a problem. Funny Video Clips is a Web site, at: <[www.video-clips.co.uk](http://www.video-clips.co.uk)> that specialises in maintaining a library of them, free for download.

On a slightly more serious trend, many other Web sites these days are finding that video clips can be used for informational purposes too. For example, the Geneva 2001 International Motor Show, held recently in Geneva, has a site that features many video clips of the cars on display at the Show, along with more traditional information. The site, at:

<<http://motortrend.com/autoshow/geneva01/>> is worth a look if you're into cars, and even worth a look just to view some of the video clips. Take particular note of the Nissan Chappo video clip — it's rather cool.

Harry Potter fans — and there are quite a few of us, aren't there? — will be delighted to note that Warner Brothers has released a preview trailer of the forthcoming film Harry Potter and the Philosopher's Stone, as a video clip. The trailer is viewable at the official Harry Potter Web site, at:

<<http://harrypotter.warnerbros.com/web/home.jsp>>, or on Apple's QuickTime Web site, at: <[www.apple.com/quicktime/](http://www.apple.com/quicktime/)>.

# DISPOSAL OF WASTE

## *from Electrical and Electronic Equipment*

*With relatively short life cycles of computer equipment and telecommunications items such as mobile phones, the volume of discarded items is likely to keep increasing.*

*Douglas Clarkson reports*

landfill and incineration. There are, however, potential intrinsic economic problems of distortions within the 'single market' of the EC where some countries would seek to apply more stringent environmental policies than others.

Based on these perceptions, the next global green issue would very much appear to be that associated with the waste of electrical and electronic equipment (WEEE). In this context the scientific data relates to determination of the environmental impact of WEEE - data which has been accumulated over many years from a broad range of environmental organisations and independent scientific agencies. While the majority of the science of such deliberations is widely accepted,

there is in particular an element of controversy regarding the threat to health posed in general by dioxins and furans - compounds which can readily be produced from incineration of plastic waste from electrical and electronic equipment.

In an enabling role the European Commission has for some time been aware of the increasing amount of waste material from electrical and electronic equipment which makes up municipal waste. An initial EC project group was established in 1994 with a subsequent report being produced by them and presented to the European Commission in 1995. At an

existing level of around 4% of municipal waste, waste from electrical and electronic equipment waste is also increasing annually at around 6%. In the UK around a million tonnes of WEEE is created and disposed of each year with the total for the EC being around 6 million tonnes. With relatively short life cycles of computer equipment

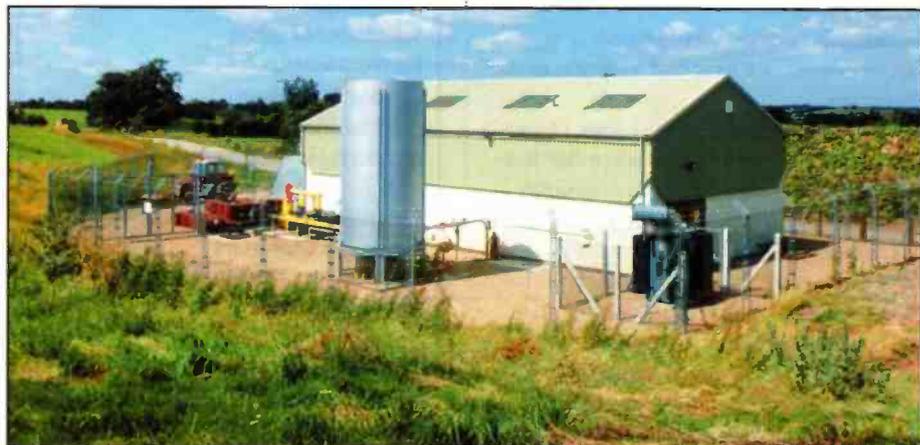


**T**here has already been a global and hopefully adequate response to the problem of ozone depletion through the use of CFC compounds. In respect of global warming, the Kyoto accord is regarded with variations of sincerity and implementation across the developed and developing world. This is partly due to the perceived ambiguity of scientific evidence for global warming - even though the United Nations has recently determined that global warming could cost the world economy \$200 billion each and every year into the future due to associated economic disruption.

The current technological revolution is very much changing the way the world communicates and transfers information. The steadily rising rates of production and consumption of electrical and electronic equipment, however, is giving rise to concerns regarding the appropriate disposal of such waste. Within Europe, there has been awareness within various countries such as the Netherlands, Sweden

**Landfill sites can accumulate vast amounts of waste of all types, including at present items originating from electronic equipment.** (Courtesy ETSU)

and Denmark as to the desirability of safe recycling of such waste. This reflects the reality that within Europe, there are very practical limitations on the options of



**When full, the landfill site will continue to have environmental impact, such as emission of gas and leaching of pollutants below ground level.**

and telecommunications items such as mobile phones, the volume of discarded items is likely to keep increasing.

Also, while only apparently a small percentage of the waste spectrum, such waste constitutes the largest known source of heavy metals and organic pollutants. This presents long term environmental hazards for both landfill and incineration methods of waste disposal.

In June 2000 the European Commission has responded with a proposed Directive on Waste Electrical and Electronic Equipment (WEEE) and a proposed Directive on the Restriction of Use of Certain Hazardous Substances in Electrical and Electronic Equipment.

Comments were invited during a consultation period, which ended on 6th October 2000. The Department of Trade and Industry has acted as co-ordinating body on behalf of England, the National Assembly for Wales and the Northern Ireland Executive. In Scotland, a separate consultation process is being undertaken by the Scottish Executive.

The object of the first directive is to control much more tightly the disposal of such items and encourage a much higher level of recycling. The object of the second directive is to remove certain compounds from manufacture which are deemed to present particular environmental hazards.

A further EC Directive is due on 'green design' of electrical and electronic equipment and which is intended to encourage modification of design to more readily allow component recycling. These proposed directives require to be debated by the European parliament and the Council of Ministers before they can be enacted by member states. The current French Presidency of the Council of Ministers is considered to provide a favourable climate to speed adoption of the Directives.

At the level of international trade blocks, the EC has already attracted some flak from the USA, which has lobbied very strongly against the 'Euroscrap' directive. This opposition has identified that such directives act to implement restrictions into the process of free trade.

There is, however, a measure of overlap between the WEEE directives and the drive to reduce carbon dioxide emissions. If a significantly higher fraction of such materials could be recycled, this would in turn result in reduced energy requirements

for manufacturing processes.

While the general public may consider such enactments entirely reasonable and responsible, industry has generally been very much against such proposals. This is on account of the transfer of cost of safe

so doing. A leading group of countries can at present be identified as the Netherlands, Denmark, Sweden, Austria, Belgium and Italy. Both Finland and Germany are soon to follow with specific national schemes.

Already, however, the UK generally recycles much less than comparable member countries within the EC. Only around 5% of 20 million tonnes of domestic waste is currently recycled. In Germany around 10% is recycled and Finland has achieved levels as high as 20%.

The finer detail of actual implementation of the WEEE directives is in reality determined by each member state and with utilisation in many cases of existing organisational structures. The Danish statutory order, for example, which was implemented in January 1999 placed the responsibility for WEEE processing on local authorities. Similarly in Germany, the proposed system to collect WEEE will be via local municipalities. By

contrast, in the UK, there is little even by way of evidence of discussion of implementation of the announced WEEE directives.

### General Environmental Concerns

As modern environmental science has determined, even the uptake of the environment by 'well understood' pollutants can present many complexities in determining pathways of uptake through the foods chains of diverse species. The pollution from WEEE is more commonly multi component - comprising a broad range of polluting elements.

In the context of pollutants derived from WEEE, the principal methods of existing disposal relate to landfill and incineration. In respect of landfill, the key anxiety is the leaching out of pollutants into the water table to pollute supplies of drinking water and eventually rivers and seas. Also, such sites can also emit gases, which carry a pollution burden. The complex mixture of chemicals within landfill sites can act over time to destroy the fabric of even state of the art plastic lining systems.

In respect of incineration, noxious gases may be released by even approved high temperature methods and toxic residues may contaminate ash products that are widely used as a filler in building applications and also road fabrication.

### Lead Pollution

It is estimated that consumer electronics is responsible for up to 40% of lead in landfill



### Medical equipment also subject of the 'Euroscrap' directive.

disposal of product onto the producer of the product and the problem in use of replacement materials for items considered to present a high environmental hazard. The current proposed date for restriction in use of specific products is 1/1/2008. Previous versions of this directive had indicated an earlier date of 1/1/2004.

### Categories of Equipment Covered by Directive

Table 1 indicates the categories of equipment covered by the Directive.

#### CATEGORY

- Large household appliances
- Small Household appliances
- IT equipment
- Telecommunications
- Radio, Television
- Lighting Equipment
- Medical equipment systems
- Monitoring and control systems
- Toys
- Electrical and electronic tools
- Automatic dispensers

**Table 1: Categories of Electrical and Electronic Equipment addressed by the Directive**

### EC Member States Status

A majority of around 10 of the 15 EC member states have already presented legislation on WEEE or are in the process of

sites. As a pollutant, lead can damage both the central and peripheral nervous system of humans. The risk is perceived as primarily being related to leaching out of lead into drinking water supplies. At particular risk are children up to six years of age and pregnant females. Levels of lead within the general population have fallen following the removal of lead additive compounds in petrol.

### Cadmium Pollution

Cadmium accumulates primarily in the kidneys and once absorbed has a long half-life of around 30 years. The element can both be absorbed by respiration of vapour and also with food intake. Levels of Cadmium are typically higher in industrialised countries. Studies in Belgium have indicated that 10% of the general population have high enough levels of Cadmium to cause some degree of renal dysfunction. It has also shown that low to moderate exposure to Cadmium is associated with skeletal demineralisation - brittle bones.

### Mercury Pollution

It is estimated that around 22% of global consumption of mercury is in electrical and electronic equipment. Inorganic mercury when released within a water environment transforms to methylated mercury that can readily be metabolised by living organisms. In an aquatic environment, mercury can become highly concentrated in fish. Levels as high as 1200 micro gram/Kg have been detected in Mediterranean tuna. Mercury pollution can be passed through the placenta to the embryo - resulting in possible brain damage.

### Hexavalent Chromium (Chromium VI) Pollution

Of topical Hollywood interest - Chromium VI can readily pass through cell membranes and is therefore readily absorbed by most living organisms. The pollutant is considered an important risk within both industrialised and developing countries. The key risk of Chromium VI is considered to be its level of genotoxicity - leading to cancers and birth defects. It is widely recognised, however, that much less is known of the toxic effects of Chromium VI than the better known heavy metals such as lead, mercury and cadmium.

There is awareness that Chromium VI can readily leach from landfill sites that are not adequately sealed. During incineration Chromium VI can readily pass into fly ash where it remains readily soluble. There is a core of scientific opinion which advises that WEEE containing Chromium VI should not be incinerated.

### Brominated Flame Retardant Pollution

Such materials are widely used to provide an element of protection from flammability and are probably the least publicised polluting agents. While WEEE comprises typically 20% plastic, such waste is rarely processed due to the presence of such brominated flame retardant materials which can release highly polluting agents during processes of plastic recycling. Such dangerous compounds include PBDEs, PBDFs (polybrominated disbenso furans) and polybrominated disbenso dioxins (PBDD).

The chemistry of these chemicals, however, is very complex. The most dangerous species, however, is apparently that of lower brominated PBB compounds which produce effects similar to those of chlorinated dioxins and PCB.

The European Brominated Flame Retardant Industry panel has responded, not surprisingly, to oppose the proposed ban on its compounds in electrical and electronic equipment. Factories presently manufacture such compounds in France,

Clinical Condition	Onset lower limit	safety margin (ng/kg)
Chloracne	40	3
cancer	109	8
behavioural effects*	42	3.2
decreased male sex hormone	17	1.3
increased onset diabetes	99	8
Immune system toxicity*	10	0.75

the UK and Belgium though the German industry sector ceased production based on environmental concerns in the 1980s. Specific arguments raised include the lack of certainty that specific brominated flame-retardants detected in the food chain have originated from electronic and electrical equipment. Also, the use of materials with lower fire protection function could lead to increased fatalities. Such strong lobbying on behalf of industry sectors with vested interests in maintaining the status quo indicates the absolute necessity for independent and fair environmental assessments to guide policy.

### PVC

Toxic fumes such as dioxins and furans tend to be given off when PVC is incinerated. Such fumes are also a potential risk in fires involving electrical and electronic equipment. There's also anxieties regarding plasticisers called phthalates that are used in PVC so that it can be extruded. It is considered that these 'gender bending' chemicals can be leached from landfill sites and pass into the water table.

### Dioxins and Furans: A Brief Overview

The reference to dioxins and furans within the context of the framework of disposal of material originating from electrical and electronic equipment is very relevant. All things considered, the only specialists who really understand the complexities of these substances are toxicologists.

Dioxins began to accumulate in the environment from around 1900 when chemical processes were developed to make large quantities of 'free chlorine'. Subsequently in the 1930's and 1940's so called chlorinated hydrocarbons began to be produced in commercial quantities - leading to the availability of pesticides, solvents and plastics.

The incineration of such compounds, however, produces dioxins and furans as by-products - producing around 95% of the total of such agents. The scientific community has been aware of the severe pollutant effects of such compounds since the late 1970's. Recent studies of the presence of dioxins within the population of the USA indicate an average level of

**Table 2: levels of dioxins associated with onset of clinical conditions (\* indicates primate studies) for the USA population.**

13ng/kg and with some 5% of the population having levels double this. One of the worrying aspects of the dioxin debate is that while safety margins with other pollutants are usually set at a factor of 100 above measured levels, comparable values for dioxin and various adverse effects indicate much smaller margins of safety as indicated in Table 2.

Thus within this population group there would appear to be no wide margin of safety, between present exposure levels and levels known to trigger serious clinical conditions. Significant differences in body burden levels are likely to arise due to differences in diet and population distribution. As a pollutant, dioxins become concentrated towards to top of the food chain. Generally a strict vegetarian diet will be associated with a relatively low daily uptake of dioxin levels. There are anxieties that observable quantities such as the reduction in sperm count worldwide, the increased incidence of testicular cancer, the increased incidence of endometriosis and

increased incidence of breast cancer could be related to the increased body burden of dioxin compounds. One of the particular anxieties of dioxin is that the dioxin levels of nursing mothers can be significantly higher than that of cow's milk.

There is currently a debate taking place between environmentalists raising the profile of dioxin/incineration issues and governments worldwide seeking to increase the number of incineration facilities to cope with growing loads of municipal waste. Environmentalists are skeptical of claims that existing facilities are sufficiently non-polluting and that new technologies for clean incineration will finally resolve such issues. Examples are quoted that statutory parameter limits for pollution may only be achieved around 80% of the time and that poor maintenance and inappropriate operating conditions have resulted in numerous episodes of release of high levels of toxins. It is therefore against the background of potentially dangerous incineration of WEEE material that a more broadly based debate is currently taking place.

It should not be imagined, however, that dioxin contamination is the problem for third world countries. The recent dioxin pollution even via animal feed in Belgium will have cost at least \$1 billion to the agriculture/food industry not to mention the potential consequences of dioxin release into the population. The probable source of the contamination was industrial oil which contaminated salvaged cooking oil and which was subsequently used as a component for animal feed.

### Potential Sources of Pollution in WEEE

Table 3 indicates the typical materials composition of a desktop computer.

Developments in manufacturing and levels of integration, have, however, seen steadily reducing weight of computer equipment.

Liquid crystal screens and their associated plastic structures have attracted significant attention from environmental observers. One of the difficulties, however, of undertaking an environmental assessment of such systems is the significant complexity of compounds which make up such systems and the lack of information often available from equipment suppliers.

Cadmium is contained in various electronic components such as SMD chip resistors. The element is present in older types of CRT and has been used as a stabiliser in PVC.

Lead is contained in the glass of CRTs - in order presumably to act as an absorber of low energy x-rays. The CRT of a PC will contain about 0.4kg lead while a domestic TV around 2 kg. A light bulb will contain

around 1.5 g of lead in respect of solder and lead silicates. In printed circuit boards, lead is present at around 50 g/m<sup>2</sup> of circuit.

Capacitors can also contain dangerous PCBs that can be released by shredding of circuit boards.

### An International Perspective

There is some evidence of an increased awareness at an international level of the desirability of implementation of greener policies for manufacturing of electrical and electronic devices.

In 1998 IBM produced the first computer that uses 100% recycled resin (PC/ABS) in all significant plastic parts. Matsushita have made significant developments in the use of environmentally friendly components in production of domestic televisions. Innovations include lead free solder and non-halogenated fire resistant plastics. Metal shielding is increasingly being used in place of halogenated flame retardant plastics.

While there are undoubtedly developments in train to improve the situation, the problems of coping with the existing levels of obsolete electrical and

December 1997. The USA, however, did not sign up to the agreement. Today it remains a cheaper option for the USA to export computer scrap to non-OECD countries.

### More Science - Less Guesswork

It is very much the case that proper environmental policy must be led by proper environmental science. The great number of chemicals released into the environment though the life cycle of electrical and electronic equipment must indicate that the related science to determine environmental impact is itself complex. This raises issues not so much about the cost of reducing pollution but the cost of undertaking sufficient research to safeguard the health of the public.

### Epilogue

It should not be thought by any stretch of the imagination that the issue of pollution of the ecosystem by WEEE will be a localised issue. Once highly dangerous pollutants such as dioxins enter the water environment they - like carbon dioxide emissions - become everybody's problems.

While there is the likelihood of

Material	% by Weight	Use/Location
Cadmium	0.0094	battery, green phosphor,CRT
Chromium	0.0063	decoration/steel hardener
Mercury	0.0022	batteries, switches/housing
Plastics	23.0	various
Lead	6.3	solder joints/radiation shield, CRT glass

**Table 3: Estimations of typical content of potentially hazardous materials in a typical desktop computer.**

electronic equipment are real enough to require urgent attention.

While some states in the USA have introduced policies about disposal of some items of electronic equipment, the trade associations of the USA which relate to the electronics industry are very much against the WEEE directives proposed by the EC and have lobbied extensively against these. There is, however, a growing environmental lobby in the USA that recognises the basic merits of responsible disposal of such waste. Current assessments indicate that by 2004 there will be around 315 million obsolete computers in the USA which represents a very significant disposal problem.

At an international level, the 1994 Basle Convention on the ban of exports of hazardous waste destined for non-OECD countries was adopted by over 60 countries. In a further strengthening of the agreement to cover all hazardous waste (including materials destined for supposed recycling), the Basle Ban was adopted on 31st

improvements in levels of recycling of WEEE within the developed world, there are serious doubts about the levels of safe disposal within the developing world where there is much less in the way of environmental legislation and associated enforcement. There better long term options will be to revise materials in fabrication so that the environmental burden of electrical and electronic goods is made significantly less of a hazard.

One has always to be aware of slogans



### Points of Contact

[www.dti.gov.uk/support/summary.htm](http://www.dti.gov.uk/support/summary.htm)

[www.nema.org/papers/waste.htm](http://www.nema.org/papers/waste.htm)

[http://europa.eu.int/comm/environ/docum/00347\\_en.htm](http://europa.eu.int/comm/environ/docum/00347_en.htm)

[www.epa.gov/ncea/dioxin.htm](http://www.epa.gov/ncea/dioxin.htm)

that sell a thousand products. The catchphrase of the future could well be 'Product XXXX - it won't cost the earth - literally' - as the environmental credentials of new technology is also trumpeted.

# Simulating NANO TRANSISTORS

by Reg Miles

keep Moore's Law in force well into the future. This would give scientists time to investigate and develop entirely new technologies, such as organics, to replace integrated circuits made from silicon. The simulation tool was developed by a research team led by Mark Lundstrom and Supriyo Datta, professors of electrical and computer engineering at Purdue. Dejan Jovanovic, a computational scientist at

Motorola, and Professor Jerry Fossum, an expert on advanced silicon transistors at the University of Florida, were also on the team. The new simulation tool evaluates transistor performance with a sophisticated technique earlier used by Datta to simulate electrical conduction in individual molecules.

The simulation tool tested the performance of an experimental transistor, called a double gate transistor, which carries twice the electrical current and could work more than twice as fast as conventional devices. Researchers were concerned that below 100nm it would be difficult to maintain high performance and fabrication quality. However, simulation, at least, predicted that a double gate transistor would continue to perform well at gate lengths down to 10nm - or even less.

Lundstrom said. 'That

means, if we could learn how to manufacture a device like this, we could extend Moore's Law to the year 2025.' Researchers at Purdue, the University of

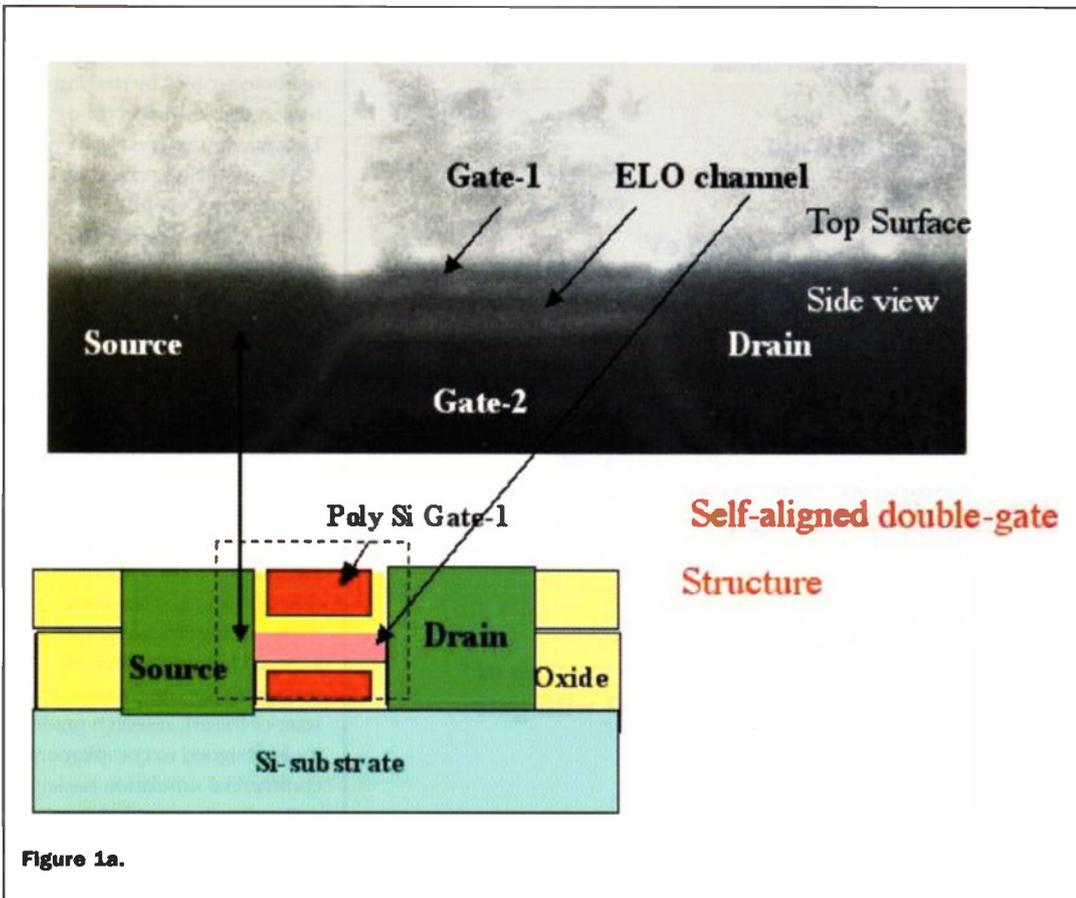


Figure 1a.

Researchers at Purdue University, West Lafayette, Indiana have developed the means of simulating the performance of transistors at nanometre level, and have concluded that rumours of the death of Moore's Law have been greatly exaggerated. For anyone unfamiliar with the aforementioned, it states that the number of transistors on a computer chip doubles every eighteen months. And this translates into a similar increase in performance. The problem with this doubling of device density is that it requires a decrease in the size of the devices: eventually making them so small that either they can no longer function properly or the means necessary to make them function properly will prove too expensive for viable manufacturing.

This is because at these sizes cross-talk will become an increasing problem. Eventually, the layer of insulating material in such a small transistor will become so thin that it

will fail to stop electrons from flowing at all, and it will no longer function as a switch.

However, the researchers have shown that an innovative type of transistor could

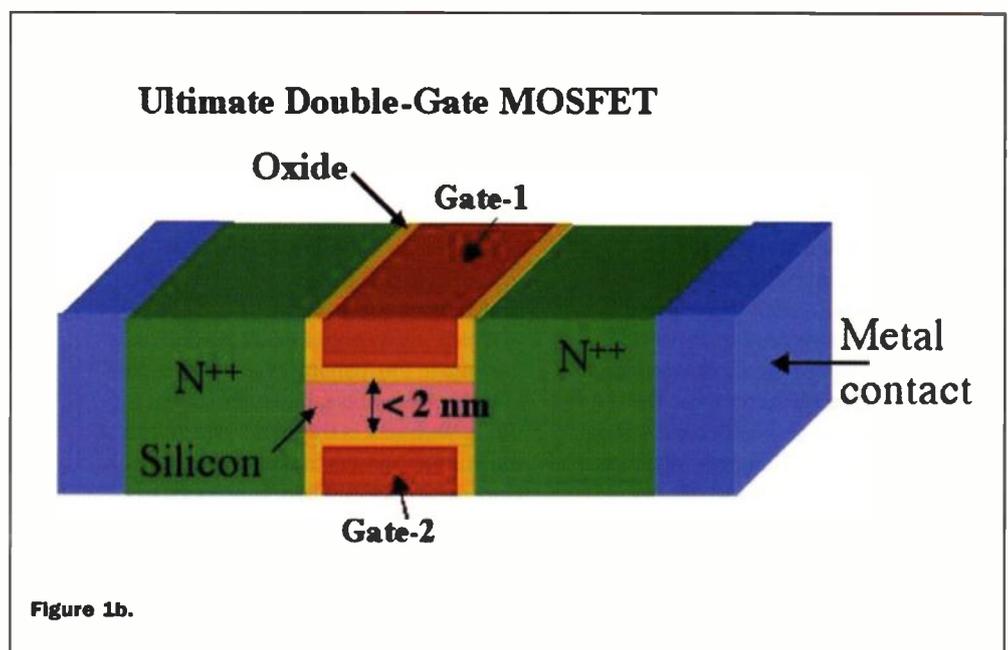


Figure 1b.

## Idealized SOI-Si Double Gate NMOSFET Device

Rev. 12-8-00

Z. Ren, R. Venugopal, S. Datta, M. Lundstrom,  
Purdue University  
D. Jovanovic, Motorola  
J. Fossum, University of Florida

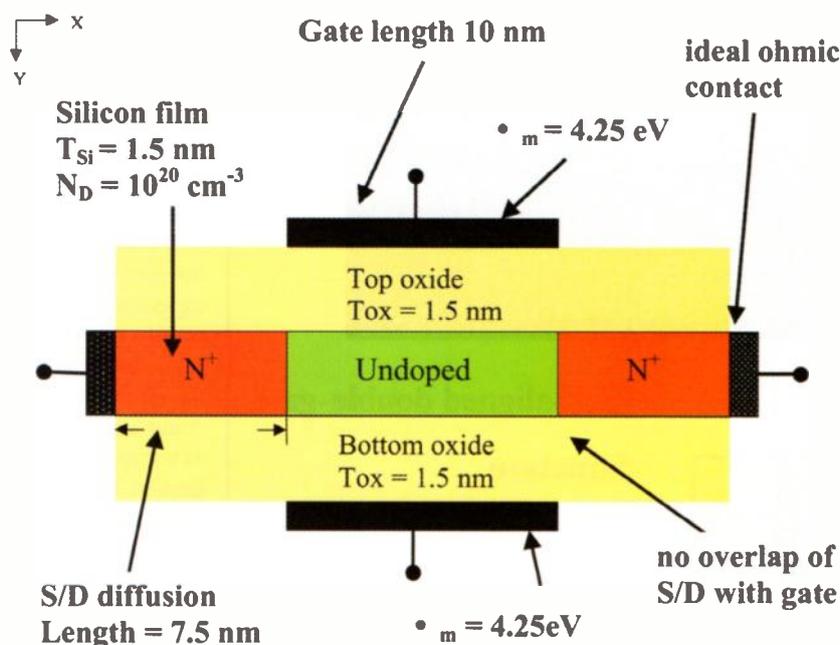


Figure 2.

California at Berkeley and the IBM Watson Research Center have already demonstrated working double gate transistors (see Figure 1a/b).

Double gate MOSFET's with 10nm channel length have been designed for two purposes: as a vehicle for examining device design/performance issues at that scale, and as a computational bench mark for comparing the various advanced simulation tools that are being developed.

The device design and physics issues of ballistic double gate (DG) MOSFETs were explored using both semi-classical and quantum simulations (Figure 2 shows a schematic diagram of the model device). A 10nm channel length seems to be the rough dividing line between classical and quantum operation: above that MOSFETs essentially operate as classical devices; below that, quantum effects largely take over. It was found that tunnelling from source-to-drain increased the off-current but decreased the on-current for a 10nm model transistor. It was also found that

source-to-drain tunnelling set a scaling limit of less than 10nm, but achieving these extremely small channel lengths will require the controlling of classical two-dimensional electrostatic short channel effects by the use of ultra thin silicon layers with precisely controlled thicknesses. And these must have a near ballistic mobility in order to be able to meet the performance targets at low supply voltages. The observation was made that these requirements represent a significant technological challenge to future device designers.

Which is why engineers at Purdue have now made the 'nanoMOS' simulation tool available to any researcher who wants to use it. With access through a system called the Purdue Nanotechnology Simulation Hub, or nanoHub. There is no need to download the simulation software or learn new operating codes because the nanoHub uses a network-computing platform that automatically enables computer users to run programs with conventional Web

browsers. They simply acquire an account and begin using the software.

Purdue researchers say they know of only two other teams in the world who have created similar "full quantum" simulation tools. But those tools were developed in the private sector and are not accessible to the research community at large. 'We want to accelerate progress in nanoelectronics by making this tool available to everyone,' Lundstrom said.

The nanoHub project was launched in December last year, as an initiative designed to promote the application of computational science to nanotechnology. Using PUNCH, a network-computing software infrastructure, researchers and educators can access and operate simulation tools: computational scientists can share tools with colleagues, experimentalists can operate simulations tools without downloading and installing them, and users can access supercomputing resources transparently. The focus is on state-of-the-art, research grade tools designed to complement commercial simulation packages.

Funding is provided from Indiana's 21st Century Fund for Research and Technology. The nanoHub also serves as the technology transfer and

outreach vehicle for research projects funded by the National Science Foundation and the Semiconductor Research Corporation. Partners in this shared initiative are now being sought. Interested parties can participate in several ways:

Computational scientists can contribute tools to the nanoHub and help install and support them.

Companies may donate computing hardware to run simulations. An affiliates program is being formed to provide companies with a way to support the effort and gain preferred access to tools and computing services as well as to participate in the evolution of the underlying network computing platform. At the same time, Universities and National Laboratories can make any under-utilised CPU resources available through mechanisms such as Condor pools.

**For more information contact:**  
Emil Venere, (765) 494-4709,  
<evenere@uns.purdue.edu>

# Solid-State SOUND RECORDER

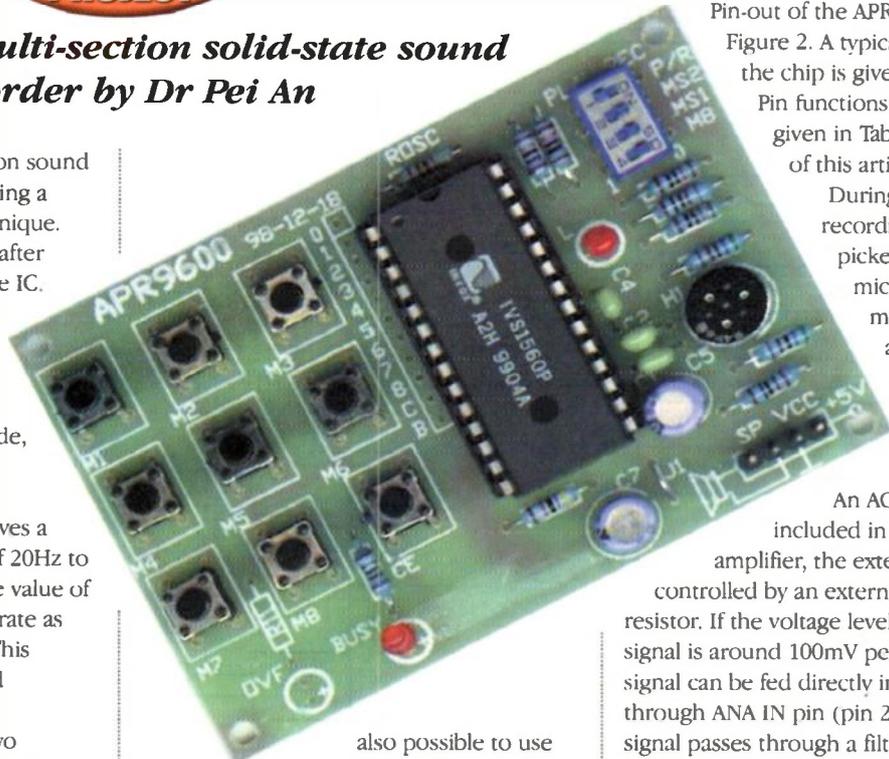
## PROJECT

### An APR9600 multi-section solid-state sound recorder by Dr Pei An

The APR9600 is a multi-section sound record/replay IC incorporating a flash analogue storage technique. Recorded sound is retained even after power supply is removed from the IC. The APR9600 has a 28 pin DIP package. Supply voltage is between 4.5V to 6.5V. During recording and replaying, current consumption is 25mA. In idle mode, the current drops to 1mA.

Sampling rate for a 60 second recording period is 4.2kHz that gives a sound record/replay bandwidth of 20Hz to 2.1kHz. However, by changing the value of an oscillation resistor, a sampling rate as high as 8.0kHz can be achieved. This shortens the total length of sound recording to 32 seconds.

The IC can operate in one of two modes: serial mode and parallel mode. In serial access mode, sound can be recorded in 256 sections. In parallel access mode, sound can be recorded in 2, 4 or 8 sections. The operation of the IC can be controlled using push button keys. It is



also possible to use external digital circuitry such as micro-controllers and computers.

The APR9600 experimental board is an assembled PCB board consisting of an APR9600 IC, an electret microphone,

support components and necessary switches to allow users to explore all functions of the APR9600 chip. The oscillation resistor is chosen so that the total recording period is 60 seconds with a sampling rate of 4.2kHz. The board measures 80mm by 55mm. Figure 1 shows the experimental board.

#### APR9600 IC

Pin-out of the APR9600 is given in Figure 2. A typical connection of the chip is given in Figure 3.

Pin functions of the IC are given in Table 1 at the end of this article.

During sound recording, sound is picked up by the microphone. A microphone pre-amplifier amplifies the voltage signal from the microphone.

An AGC circuit is included in the pre-amplifier, the extent of which is controlled by an external capacitor and resistor. If the voltage level of a sound signal is around 100mV peak-to-peak, the signal can be fed directly into the IC through ANA IN pin (pin 20). The sound signal passes through a filter and a sampling and hold circuit. The analogue voltage is then written into non-volatile flash analogue RAMs.

During sound replaying, the IC's control circuit reads analogue data from flash RAMs. The signal then passes through a low-pass filter, a power amplifier and output to an 8 to 16 Ohm speaker.

There are different sound recording and replaying modes (see Table 2). These modes are selected using MSEL1 (Pin 24), MSEL2 (Pin 25) and -M8 (Pin 9). -M1 to -M7 keys have different functions in different modes.

#### Experimental circuit

The circuit diagram of the module is shown in Figure 3. It is built on a single-sided PCB board. Figure 4 and 5 give the PCB artwork and component layout.

The module consists of an APR9600 chip, an electret microphone, support components, a mode selection switch (-RE, MSEL1, MSEL2 and -M8) and 9 keys (-M1 to -M8 and CE). The oscillation resistor is chosen so that the total recording period is 60 seconds with a sampling rate of 4.2kHz. Users can change the value of the ROSC to obtain other sampling frequencies. It should be noted that if the sampling rate is increased, the length of recording time is decreased. Table 3 gives

-M1/MESSAGE	1	28	VCCD
-M2/NEXT	2	27	-RE
-M3	3	26	EXT CLK
-M4	4	25	MSEL2
-M5	5	24	MSEL1
-M6	6	23	CE
OSCR	7	22	-STROBE
-M7/END	8	21	ANA OUT
-M8/OPTION	9	20	ANA IN
-BUSY	10	19	AGC
BE	11	18	MIC REF
VSSD	12	17	MIC IN
VSSA	13	16	VCCA
SP+	14	15	SP-

Figure 1.

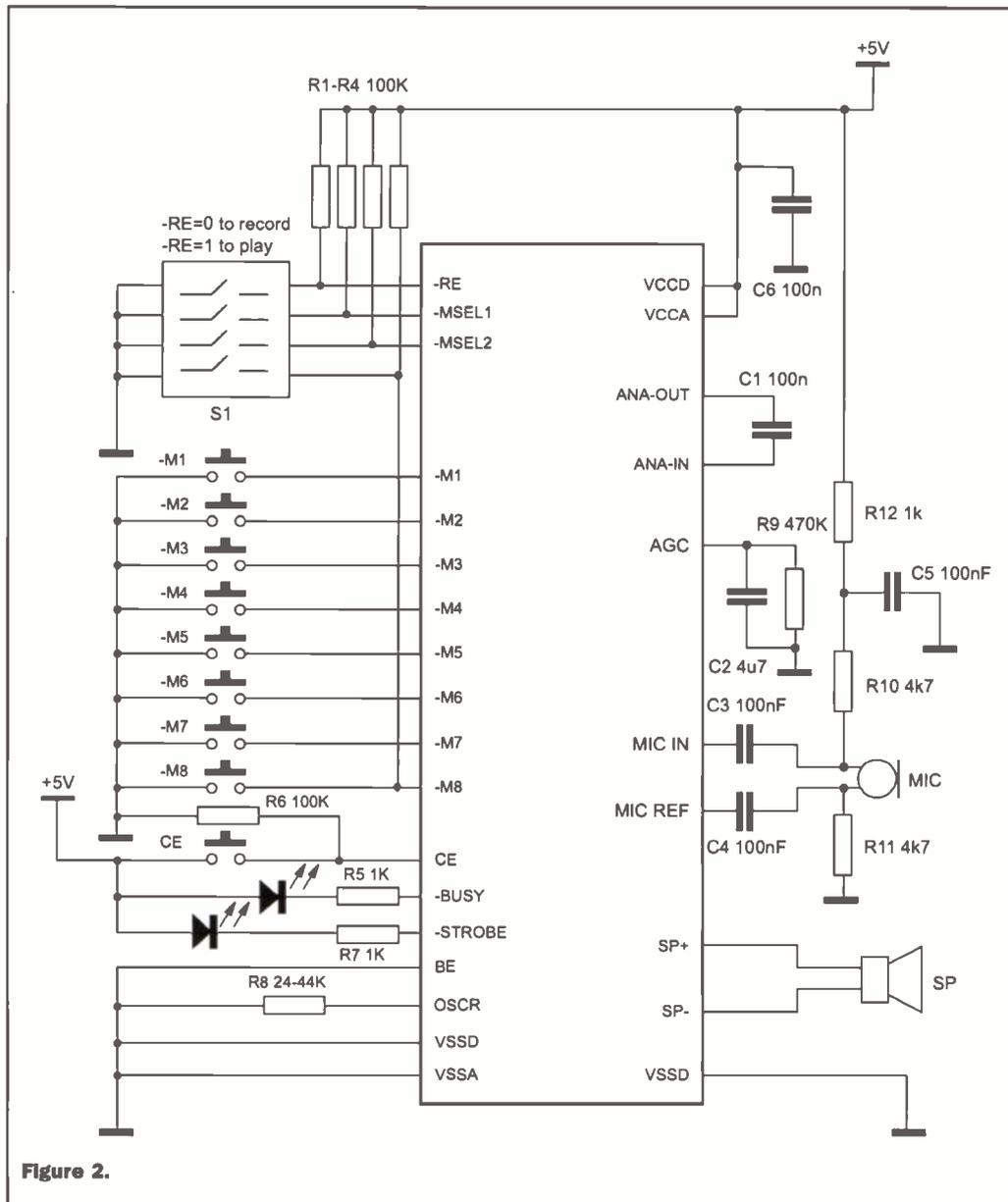


Figure 2.

the details.

An 8-16 Ohm speaker is used with the module. Users can select different modes using the mode selection switch.

### Parallel mode recording and replaying: Record sound tracks

The mode switch should have the following pattern: MSEL1=1 (switched to left-hand side of the mode selection switch), MSEL2=1 (left-hand side). -M8=1 (left-hand side). RE=0 (right-hand side). The maximum length of the 8 tracks is 7.5 seconds. Press -M1 continuously and you will see BUZY LED illuminates. You can now speak to the microphone. Recording will terminate if -M1 is released or if the recording time exceeds 7.5 seconds. Similarly, press -M2 to -M8 to record other sound tracks.

### Replay sound tracks

Now make RE=1 (switched to Left-hand side of the mode selection switch) while keep other switches at the same location.

Toggle -M1 to -M8 (press key and release) causes a particular sound track to replay once. While the sound is playing, press the same key again or pressing the CE key will terminate the current sound track. Press the

other key while a sound is being played causes a new sound track to be played.

If a key from -M1 to -M8 is pressed continuously, the particular sound track will be played continuously. Press CE to stop playing the sound track.

### Serial mode recording and replaying: Record sound tracks sequentially

The mode switch should have the following pattern:

MSEL1=0 (switched to right-hand side of the mode selection switch), MSEL2=0 (right-hand side). -M8=1 (left-hand side). RE=0 (right-hand side). Press CE first to reset the sound track counter to zero. Press and hold -M1 down and you will see BUZY LED illuminates. You can now speak to the microphone. Recording will terminate if -M1 is released or if the recording time exceeds 60 seconds (in this case you will run out the memory for your next sound track). Press -M1 again and again to record 2nd, 3rd, 4th and other consecutive sound tracks. Each sound track may have different lengths, but the accumulated length of all sound tracks will not exceed 60 seconds.

### Replay sound tracks sequentially

Now make RE=1 (switched to Left-hand side of the mode selection switch) while keep other switches at the same location. Toggle -M1 (press key and release) causes the 1st sound track to be played once. Toggle -M1 again and again

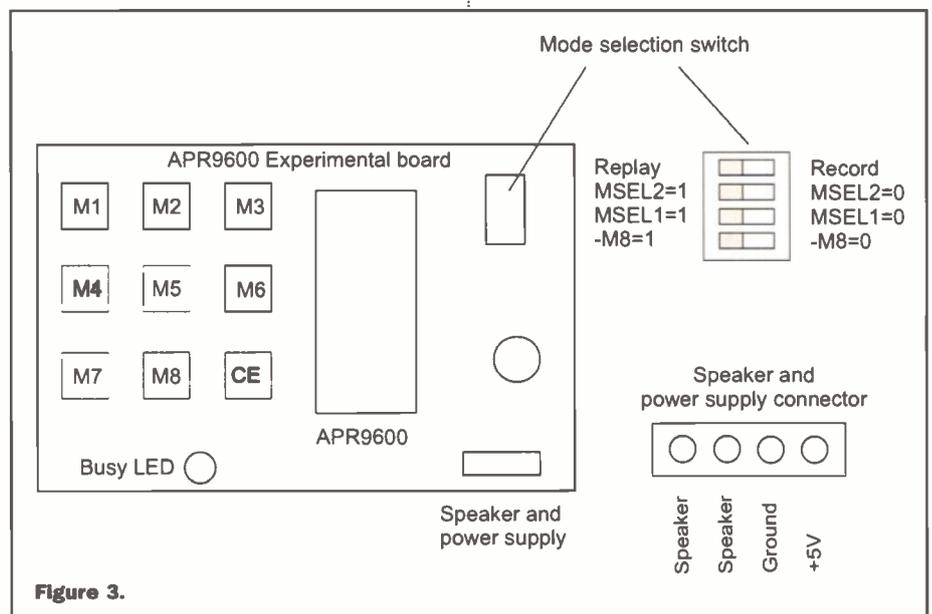


Figure 3.

Pin	Name	Functions	Pin	Name	Functions
1	-M1	Select 1st section of sound or serial mode recording and replaying control (low active)	15	SP-	Speaker, negative end
2	-M2	Select 2nd section or fast forward control in serial mode (low active)	16	VCCA	Analogue circuit power supply
3	-M3	Select 3rd section (electret type microphone)	17	MICIN	Microphone input of sound
4	-M4	Select 4th section of sound	18	MICREF	Microphone reference input
5	-M5	Select 5th section of sound	19	AGC	AGC control
6	-M6	Select 6th section sound	20	ANA-IN	Audio input (accept a of signal of 100mV p-to-p)
7	OSCR	Resistor to set clock frequency. See Table 3 for details	21	ANA-OUT	Audio output from the microphone amplifier
8	-M7	Select 7th section of sound or IC overflow indication	22	STROBE	During recording and replaying, it produces a strobe signal
9	-M8	Select 8th section of sound or select mode (see Table 2)	23	CE	Reset sound track counter to zero/ Stop or Start / Stop
10	-BUSY	Busy (low active)	24	MSEL1	Mode selection 1 (see Table 2)
11	BE	=1, beep when a key is pressed =0, do not beep	25	MSEL2	Mode selection 2 (see Table 2)
12	VSSD	Digital circuit ground	26	EXTCLK	External clock input
13	VSSA	Analogue circuit ground	27	-RE	=0 to record, =1 to replay
14	SP+	Speaker, positive end	28	VCCD	Digital circuit power supply

**Table 1. Pin-functions of the APR9600**

will play the 2nd, 3rd, 4th and other consecutive sound tracks. Press CE to reset the sound track counter to zero.

### Record sound tracks with forward control

The mode switch should have the following pattern: MSEL1=0 (switched to right-hand side of the mode selection switch), MSEL2=0 (right-hand side). -M8=0 (right-hand side). RE=0 (right-hand side). Press CE first to reset the sound track counter to zero. This mode is rather similar to the above sequential sound recording. The only difference is that after -M1 is pressed and released, the sound track counter does not increment itself to the next sound track location. To move to the next sound track, -M2 should be toggled. So if -M1 is not toggled again and again without toggling -M2, sound will be recorded at the same sound track location.

### Replay sound tracks with forward control

Now make RE=1 (switched to Left-hand side of the mode selection switch) while keep other switches at the same location. Toggle -M1 (press key and release) causes

the 1st sound track to be played once. Toggle -M1 again and again will still play the 1st sound track. Once -M2 is toggled, the sound track counter is incremented and the next sound can be played. Press CE to reset the sound track counter to zero.

### Sampling rates

The sampling rate is determined by the value of the OSC resistor (R8 in the circuit diagram). It can be adjusted by users to suit their specific requirements. The relationships amongst the resistance, sampling rate, bandwidth and recording period are shown in Table 3.

### Technical support

The APR9600 IC and its experimental board are available from the author. Please forward your enquires to Pei An at:

<pan@intec-group.co.uk>

Telephone/fax/answer:

44(0)1614779583.

OSCR resistance [kOhm]	Sampling rate [kHz]	Bandwidth [kHz]	Recording time [Second]
44	4.2	2.1	60
38	6.4	3.2	40
24	8.0	4.0	32

**Table 3. OSC resistor selection guide**

MSEL1	MSEL2	-M8	Function Keys	Functions
0	1	0 or 1	-M1, -M2 to select 1st and 2nd sound tracks. CE to stop	Parallel mode, 2 sections, 30 seconds for each
1	0	0 or 1	-M1 to -M4 to select a sound track, CE to stop	Parallel mode, 4 sections, 15 seconds for each
1	1	1	-M1 to -M8 to select sound track, CE to stop	Parallel mode, 8 sections, 7.5 a seconds for each Pressing and hold down a key from -M1 to M8 to play the selected sound track repeatedly
0	0	1	-M1 and CE	Serial mode, allow up to 256 sound tracks to be recorded and played. Sound tracks are played from 1st to N in order after -M1 is toggled. Press CE to play from the 1st sound track.
0	0	0	-M1,-M2 and CE	Serial mode, Press -M1 to replay one sound track. Toggle -M2 once to move to the next sound track. Press CE to play sound from the 1st sound track

#### Notes:

RE=0 to record sound. RE=1 to replay sound

Press -M1 to -M8 once to replay a sound track. Press the key again to stop replaying the track

Press and hold -M1 to -M8 continuously, the corresponding track will be replayed repeatedly

During recording, -M1 to M8 should be pressed while the sound is being recorded.

Releasing the key terminates recording.

**Table 2. Operation modes**

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# Delivering sunlight READABILITY WITH TFTs

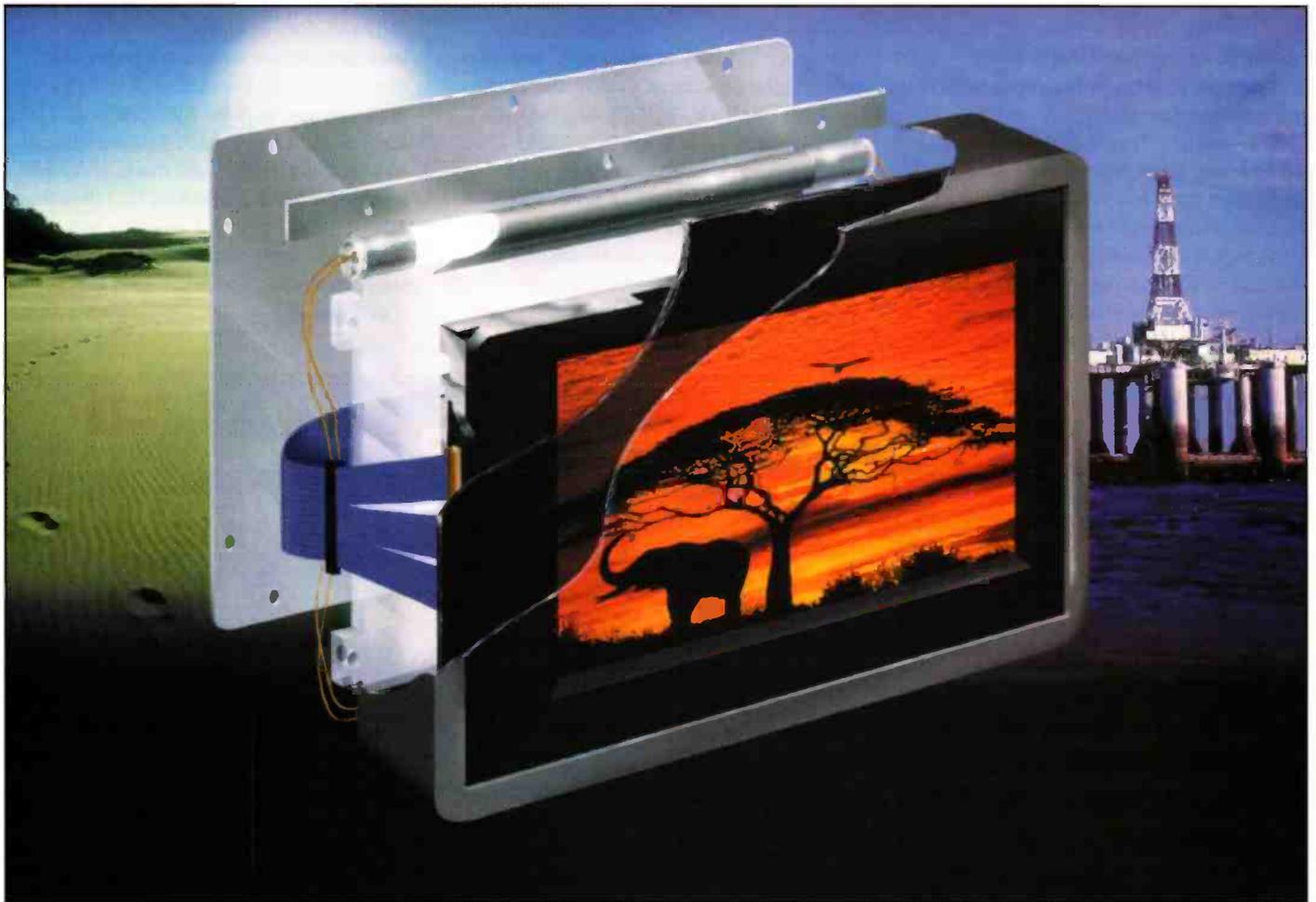
*Hugh Coghill-Smith, Anders Electronics*

Over the past few years, the use of TFT displays has grown enormously - mainly because of their excellent performance characteristics in terms of colour, resolution, viewing angle, etc. Today, however, there is one rapidly emerging need - sunlight readability - which system designers have found it

fundamentally subjective concept. However, most people will readily accept that it is more to do with contrast, than straightforward brightness; it is perfectly possible to have an extremely bright, but unreadable, display. In fact, although precise estimates vary, a definition of readability can be said to be, for practical

One approach is the "brute force" method: simply beef up the backlighting. Actually, this is - to date - the most common technique, and it's effective enough for many applications. For these Anders has a standard range of backlight enhanced product based on the LG.Philips range. Displays from 10.4" VGA to 15.1" XGA are available off the shelf with brightness of up to 1000units.

But a display based solely on backlight enhancement can also have major drawbacks for the more demanding application. Take, for example, the power problem. As a result of adding backlights, you add - significantly - to the power requirement of the application. But it's worse than this, because turning electricity into light is an inherently inefficient process - most input energy is lost as heat. So



hard to satisfy, even with TFTs. It can be done, but at a price - a big price. Now, though, a technique is available which changes all this. In this article, we will explain this technique, and why it makes sunlight readability a commercially viable option.

But before we discuss this, we need to go back a step or two and start from the beginning. The definition of readability is as good a place to start as any.

You won't be surprised to learn that there is no single, universally agreed definition of readability. After all, it's a

purpose, a contrast ratio of 60:1 for black text on a white background in the prevailing lighting conditions. Today, LCD manufacturers can easily achieve this level of CR - a typical TFT panel might be specified as offering a CR of 100:1, measured at 1m in lighting conditions of 500 lux.

The problem is, not all ambient lighting is 500 lux (a typical office). And when the display is transported to another environment - outside, say, which can be up to 100K lux - the CR is insufficient to maintain readability. How can this effect be countered?

adding backlights produces the need for a heat management system of some kind (normally fans). For which you need still more power. Not exactly an ideal solution for a low-power design!

And it gets even worse. Most LCDs are performance limited to 50°C, at which temperature - the clearing temperature - the liquid crystal becomes unstable, and cannot change orientation as the applied voltage (across the cell) changes. The LCD then turns black! As backlights are added, this temperature is quickly reached, even in cold environments. In warmer conditions,

matters are worse, and solar loading exacerbates things still further.

As if all this weren't enough, backlights also add cost and physical thickness. As a result there is often a need for more control circuitry. This is because, in an application which has to operate in different lighting conditions, it is necessary to be able to set the backlighting to match current conditions. An overbright display can be bad news, too!

So what's the solution? In fact, until recently, there has been two principal alternatives to extra backlighting, both offering limited performance benefits at best. These are to increase the efficiency of the backlights (as opposed to adding more) using a special coating (Dual Brightness Enhancement Film), or to treat the TFT surface with a standard anti-reflect film. The latter will cut reflections slightly (and therefore increase contrast), but are not a true optical match for the TFT surface. The gains from both approaches are less than dramatic.

Now, though, there is another approach. Superficially, it is similar to the use of an anti-reflect film - but a film perfectly "tuned", in an optical sense, to the TFT surface. It is a process known as optical enhancement, and makes use of one of the basic laws of optics: that whenever light passes from one medium to another there

is always (assuming the media concerned have different refractive indices) some reflection at the interface between the media. The amount of reflection depends on a number of parameters, such as - obviously - the amount of incident light, the difference between the refractive indices, and the viewing angle, but these reflections can easily dominate the light transmitted from the image. Think of looking out of, say, the plate glass of a supermarket window at night. At some angles, the reflections from inside the store completely dominate the "image" - the view of outside. Such reflections can cause a similar problem when viewing an LCD.

If, however, the surface of the LCD can be "index matched" with the ambient conditions (air, usually), reflections will be reduced dramatically. The question then becomes: how can this be achieved? Well, until recently, it couldn't, outside of the aerospace industry. Now though, Anders is offering the process as a viable alternative to other methods - and offering massive performance advantages. In fact, the approach can reduce the reflection of incident light by a factor of up to 1500%, producing extremely high contrast displays without the need for extra backlights. We offer a full range of standard optically enhanced TFTs, as well as a custom service for enhancing 3rd party products. We offer

optical enhancement as a custom service for enhancing 3rd party TFT products.

Also, a number of variations on the optical enhancement theme are available. Contrast Enhancement Filters (CEF), for example can be used when the LCD does not have a vandal shield or touch panel. The etched, anti-reflection coated glass separates the (small amount of) reflected light into two components - specular and diffuse. The result is a more finger-print friendly glass surface. Alternatively, if a vandal shield or touch panel is present, a plain anti-reflection filter can be used. Or, if the LCD is to be used in very low temperatures, bonded-glass heaters can be used. These are constructed of 20 ohms/m<sup>2</sup> ITO (Indium Tin Oxide) on 0.04" glass with a buss bar on two opposite sides and leads for power-in. The heater assembly is epoxy bonded directly to the inside surface of the LCD and does not interfere with the backlight. Yet another filter option is an electromagnetic interference/ electromagnetic pulse EMI/EMP coating. Ideal when some level of EMI shielding is required, these filters are made of double index of refraction-matched ITO (less than 10 ohms/m<sup>2</sup>) on glass for greatly reduced reflections, these filters can be made to supply shielding compliant with FCC specifications.

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# THE INTERNET: *a history*

## PART 1

### Cracking the distance thing – by Gregg Grant

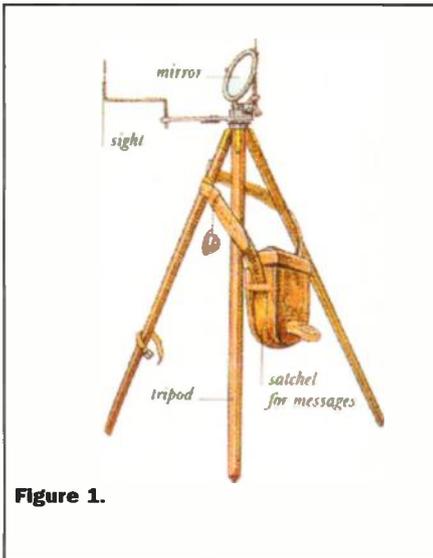


Figure 1.

The dream of communicating and garnering information instantly over great distances has a long history, part of which is legendary, part apocryphal and part crudely experimental. The earliest attempts to communicate over long distances took place in classical Greek times, a system known as heliography, in which sunlight was reflected in flashes from a movable mirror. Although this technique had its limitations - cloud cover being but one of them - it was still used by the British army in the South African war, at the beginning of the 20th century! In fact the equipment illustrated in Figure 1 differed hardly at all from the Greek original.

As early as the closing years of the 16th century, rumour had it that a device existed which enabled people to communicate across great distances. This 'instrument' was - allegedly - based on what was termed magic needles that appeared to influence each other over considerable distances.

None of this was true of course but this irritating fact didn't stop the largely credulous population of Europe believing in such a device. In fact the Italian savant Famianus Strada wrote a book on this supposed 'instrument' in 1617!

Yet the hope of a far more immediate method of communication than a swift horse, a packet boat or even a Church bell

would not go away and in 1746, a distinguished French natural philosopher, the Abbé Jean-Antoine Nollet made an attempt to discover just how swiftly electricity could 'signal,' as well as how far this - apparently natural - phenomenon could travel along a wire.

His experimental technique was nothing if not original, as befitted the man who would discover the semi-permeable membrane, be elected a Fellow of the Royal Society in 1734 and construct one of the first electrometers. He asked some 200 monks to arrange themselves in a long line, each being connected to the other by an iron wire, some 25 feet in length. Without giving any prior indication of his intentions, the Abbé connected a primitive battery - probably a version of the English physicist Francis Hauksbee's static electricity generator of 1706 - to the line of monks.

The reaction was immediate: they all experienced a sharp shock.

From this, Nollet deduced that electricity could not only cover a great distance but appeared to do so virtually instantaneously. It seemed therefore that the phenomenon could well be the medium around which a speedy, effective communications system could be built.

#### The First Telegraph

The first successful telegraph system - although French - relied not on electricity but black and white wooden panels, a telescope and a single codebook. Its inventor, Claude Chappe, thought of calling his creation the Tachygraphe, from the Greek expression

for Fast writer, but was persuaded by a friend that another Greek expression - Telegraphe, or Far writer - would be more appropriate.

Chappe later came up with another design, a radical departure from his first model. His new idea - shown in Figure 2 - had a long rotating bar termed the Regulator, at the ends of which were two smaller rotating arms, termed indicators.

These indicators were rotated into one of seven indicatory positions in 45° increments. The system provided some 98 coding combinations, of which four were control functions, and came with its own 94-page code book of each page listing 94 numbered meanings. This gave some 8,836 - i.e. 942 - words or combinations of words.

Signals were represented by sending two codes in succession, the first of which gave the codebook page number, the second the word - or combination of words - on the page. The control mechanism had been designed by Abraham-Louis Bréguet, the leading clockmaker in France, indeed the world, at this time.

Bréguet had hundreds of inventions behind him, including the Overcoil, an improvement on the Balance Spring and the Tourbillon, a further improvement in the Lever Escapement, making it immune to errors due to the changing position of the watch when being carried. His mechanism for the telegraph was equally as accurate and a line of three of Chappe's telegraph stations was built, the system

covering a distance of some 20 miles.

On its opening trial, the three-station system took 11 minutes to send a two-sentence message in one direction. The reply to this signal took 9 minutes to make the return journey. The new republican government was impressed and decided to install a national telegraph system, based on Chappe's invention. With assistance of his two brothers, Chappe built 15 relay stations in a year.

The first leg of the new system - the 130-mile Paris to Lille

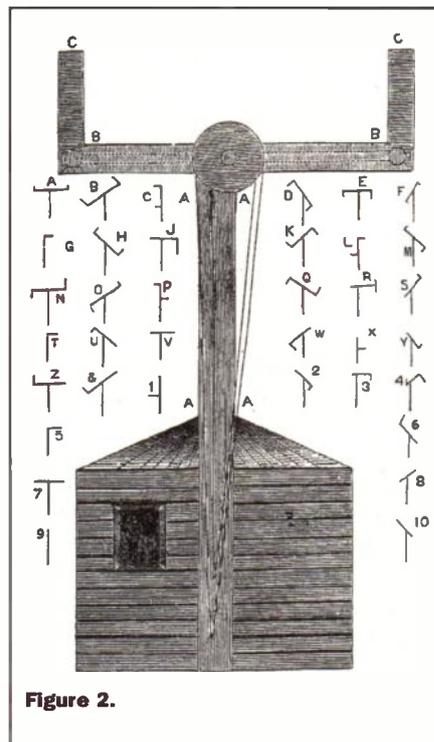


Figure 2.

line - began operating in May 1794 and three months later reported the recapture of Quesnoy by the French army from the Prussians and Austrians, less than an hour

after the victory. There could have been no better demonstration of the system and in 1798 a second line - stretching from Paris to Strasbourg - was up and running. Furthermore, the Paris-Lille line had been extended to Dunkirk, on the Channel coast.

Shortly, telegraph towers were being erected throughout Europe, the result of national governments recognising what Napoleon had already noted: the telegraph was a technology that was here to stay. Chappe however did not enjoy the rewards due to him.

He committed suicide at the telegraph workshops in 1805, driven to it by money worries and - a familiar situation this, as we shall see - attempts to contest the priority of his invention.

And this, at a time when completely formalised patents had been introduced into French law 14 years before. In the United Kingdom, (UK), the Admiralty constructed a line of telegraph towers from London to the Channels ports.

The system was - in true British fashion - designed by a scientific amateur, a clergyman called George Murray. His system - shown in Figure 3 - was based on six wooden shutters, every one of which could be opened (horizontal) or closed (vertical) - an early digital arrangement - to provide 64 possible signalling combinations.

### How About Electricity?

If you were to ask a chemist who first discovered that most useful of substances sulphuric acid, he - or maybe she - would say to you that they hadn't a clue. This is because the alchemist who first discovered  $H_2SO_4$  around 1300 used the name Geber.

By doing so, he was hoping to gain Brownie points by associating himself with the greatest of all the Islamic alchemists, the 8th century Jabir ibn Hayyan, whose name had been mispronounced as Geber for centuries in the West. Consequently the discoverer of sulphuric acid is known as False Geber. The suggestion that electricity might be used as a communicative medium has an identical air of mystery about it.

On February 17th 1753, The Scots Magazine published a letter outlining 'An expeditious method of conveying intelligence,' in which the correspondent proposed a system of wires, one for each

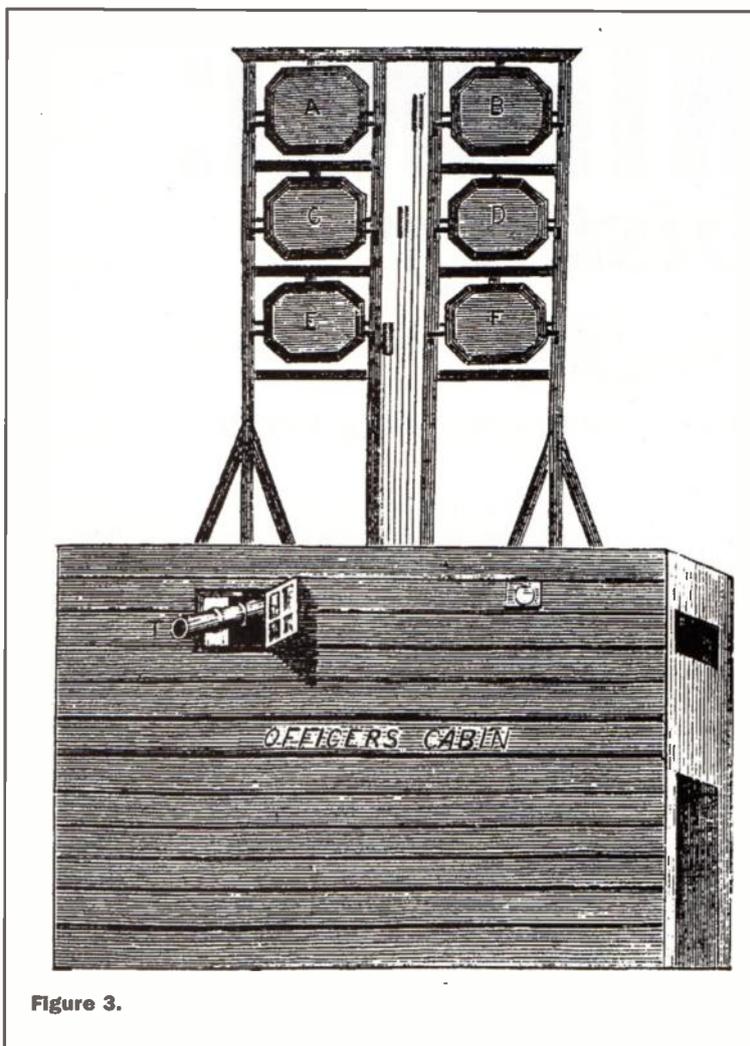


Figure 3.

letter of the alphabet, along which an electrostatic generator could send bursts of electricity, rather as Abbé Nollet had done, seven years previously. The originator of this idea had signed the letter simply as 'CM.' To this day, the identity of the originator of this idea is as mysterious as that of false Geber.

Electricity it seemed was not so much a practical solution, more a tantalisingly ephemeral one. As the 19th century opened however, the possibility of an electric telegraph seemed that little bit closer with Alessandro Volta's invention of the Voltaic Pile, a far more reliable way of delivering electrical power than the brief burst of energy given off by an electrostatic generator.

The problem that still needed cracking however was how to detect the flow of electricity in a wire. Without such an aid,

neither location in a telegraph system would have any idea what the incoming signal meant, or even if there was an incoming signal at all!

The solution to this glitch appeared some 20 years after Volta made electricity portable. The Danish physicist Hans Ørsted noticed that an electric current, in the course of flowing through a wire, produced something else besides an electric shock: a magnetic field.

This phenomenon can be detected via the effect it has on another piece of metal, for example an iron bar, another wire placed close to it or - as Ørsted demonstrated - a compass needle. At last electricity could be detected and monitored by means other than a suddenly excited human being.

Later that year the French physicist André-Marie Ampère demonstrated that wires in which a current flowed clearly showed magnetic properties.

They attracted and/or repelled one another, depending on whether the currents were in the same, or

opposite, directions. More to the point, by bending a wire into a helix, or solenoid - from the Greek word meaning 'pipelike' - Ampère found that the magnetic effect was strengthened, the helix behaving like a bar magnet, having north and south poles.

Shortly after Ampère's experiments, the German physicist Johann Schweigger learned of Ørsted's discovery.

He used the Dane's work as the basis for the first galvanometer, shown in Figure 4, the earliest piece of equipment for measuring both the direction and intensity of an electric current.

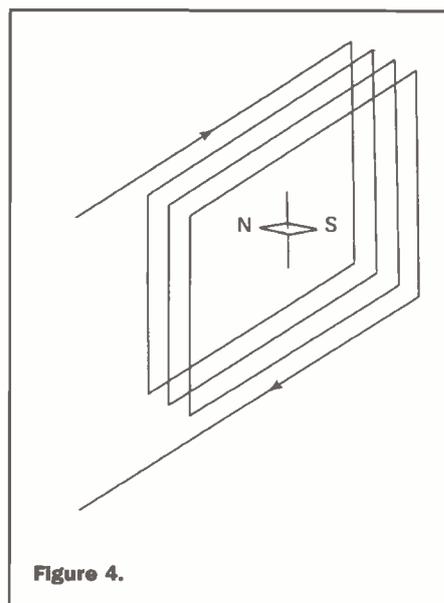


Figure 4.

Three years later the British physicist William Sturgeon placed an iron rod inside a solenoid and found that the iron appeared to concentrate the magnetic field.

Next using another rod which he'd bent into a horseshoe shape and wrapping a

solenoid around it, he succeeded in lifting a load of nine pounds - 20 times the weight of his experimental device - whilst the current was flowing. Sturgeon found that when he switched the current off, the magnetic effect ceased. The Electromagnet was born.

Thus the basic pieces of equipment needed to build a telegraph system were now in place. Given this, why was it 1839 before the first, commercial, telegraph system was in operation? Largely because the scientific community in general regarded long distance telegraphy as an impossible dream.

The British physicist Peter Barlow had carried out carefully controlled experiments to establish whether the current decreased as the length of the wire carrying it increased. He reached the conclusion that it did. A self-educated optician and mathematician Barlow - at the early age of 25 - had authored *New Mathematical Tables*, a compilation of factors and functions of all numbers from 1 to 10,000 that was

considered so accurate that they've been regularly printed ever since.

The inventor also of the Barlow Lenses - achromatic, or non-colour distorting - lenses which increased the eyepiece power

of optical instruments, Barlow was thoroughly competent and much respected in the scientific community of the day. Consequently, his view of long distance telegraphy was widely regarded as an accurate one, on both sides of the Atlantic.

Two years later Georg Simon Ohm published the law called after him, who linked the fundamental properties of current, voltage and resistance in an electrical circuit, although it would be 1842 or thereabouts

before the law became established, let alone understood, in Britain.

In Germany meanwhile, a Russian diplomat called Schilling had built a telegraph system in Heidelberg, which was noted by a British visitor, Dr. William Cooke. The idea so impressed him that, on his return to Britain, he began to

experiment by building his own equipment. Eventually he had to get help because - as Barlow had discovered - he was having problems with distance.

Cooke was introduced to a Professor Charles Wheatstone, of King's College London, who was also interested in telegraphy.

The pair went into partnership and the world's earliest patent for electrical communication was drawn up in June 1837. Two years later, the world's earliest commercial telegraph system - covering the 13 miles between London's Paddington railway station and West Drayton - was open for business.

Using the Cooke-Wheatstone telegraph - shown in Figure 5 - along with five, hemp-covered wires wrapped into what was termed a 'telegraph rope' and encased in iron piping, the system proved a resounding success. The dream of centuries past had been realised, at least for 13 miles of the British countryside!

One feature of electrical technology would soon become apparent: the rapidity with which improvements would be made to the equipment in use. Shortly, what had been done for a very small area of Britain would be extended to most of the world. Our small planet was about to get surprisingly smaller, thanks to the first Internet.

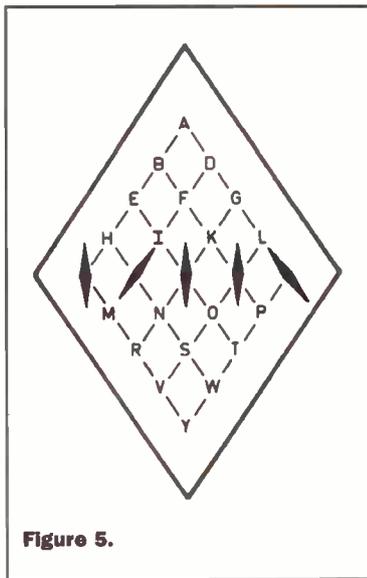


Figure 5.

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O	S	R	O	T	I	E	R	H	L	R	I
M	R	K	T	A	S	E	J	L	D	P	R
E	R	L	T	M	I	A	O	E	M	A	O
N	V	R	O	R	K	O	C	R	F	Y	Y
N	I	R	R	L	N	R	O	N	I	L	A
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# UNIVERSAL MID RANGE PIC Programmer

*A review of the Brunning Software PIC programmer by Martin Edwards.*



**P**rior to being asked to write this review I had never used a microcontroller. I have built numerous electronic circuits using transistors, MOSFETs and 74HS logic circuits but the idea of using a microcontroller was a daunting prospect that I had chosen to avoid. Looking back I can understand why that happened. I always create my own circuits so to use a microcontroller I needed to be able to programme the device right from the very first time of using it, which is indeed a daunting prospect.

If you are a regular reader of *Electronics and Beyond* you may remember that I have already reviewed the first two books by Peter Brunning. The first teaches PC assembly language and the second teaches C and C++. But hang on this is not a book review is it? Well, yes it is! There is no point having PIC programming hardware if you cannot write PIC programmes. Brunning Software's Universal Mid Range PIC

Programmer comes with the book *Experimenting with the PIC16F877* and if you are a beginner like myself you will also need their book *Experimenting with PIC Microcontrollers*.

The day after I agreed to write this the parcel arrived. My first impressions are very favourable. The programmer printed circuit board is quite tightly packed with a neat layout, holding two zero insertion force sockets, a 2 line by 16 character alphanumeric liquid crystal display, keypad, audio socket and centronics connector. The PCB is mounted on a base with a large plugboard mounted at the front. I have also been sent both books which means I have 518 pages to read through.

But no! I have been given my instructions "get some practical experience of programming before reading about programming techniques". I must not begin by reading the books. I am to install the software (appendix B) and then start at the

beginning of *Experimenting with PIC Microcontrollers*.

The first chapter, the introduction, answers the question at last that has been bugging me over the years. Which microcontroller should I learn to program? Peter Brunning explains his own thought process by which he made his decision to write about PICs and in particular the PIC16F84 and PIC16C711. In a nut shell PICs are easy to use, very popular, and Microchip, the manufacturer, are committed to huge investments in ongoing development, so this is never going to be a dead end learning pattern.

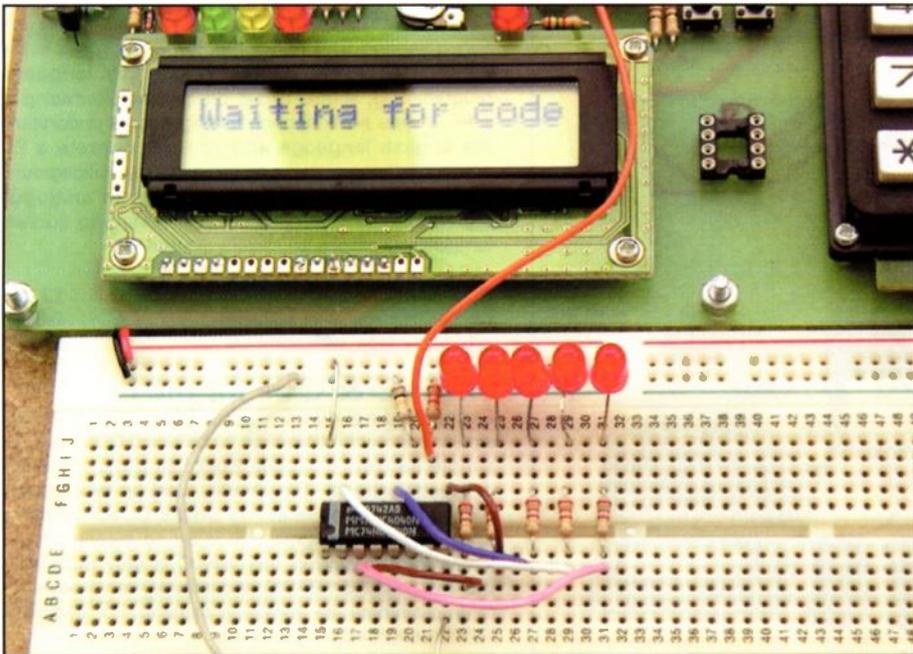
Chapter 2 gives a brief overview of PICs, introduces us to the internal arrangement of the PIC's memory and summarises the 35 instructions that we are to use to write PIC programmes. I often use PC assembler and in comparison these PIC mnemonics look particularly unusual.

So, I have reached Chapter 3 still knowing virtually nothing about PIC programming, but I am familiar with Peter Brunning's technique. His idea is that we learn most easily if we copy nature's own system where we never ever study theory before we understand the actual process.

The first experiment where we use the test PIC simply to turn on one light emitting diode is explained with ten and a half pages of text and diagrams. A circuit diagram showing only the connections to the PIC that are needed for this experiment, a flow diagram detailing the outline requirements of the program, and step by step instructions of how to type in the text, how to single step using the simulator and how to write the code into the real live PIC using the programmer module plugged onto the end of my printer lead.

Three more simple experiments explained in less detail complete Chapter 3. Then we examine the three MOVE instructions to understand the underlying philosophy behind the PIC instruction set. From here on progress is much faster. We use the built in 8 bit timer, write text messages to the alphanumeric liquid crystal display, create a real time clock, experiment with the watchdog timer, save power using the sleep mode, generate beeps and then onto something of great interest to me, we use the PIC to play simple tunes. The first PIC book completes with two projects, building a sinewave generator and building an AC power meter.

The second book *Experimenting with the PIC16F877* begins with the same four experiments to illustrate the differences between the PIC16F877 family and the PIC16F84. Then some of the special features of the PIC16F877 are examined in detail: we use the 16 bit timer, drive the LCD with three different types of lookup tables using FLASH and EEPROM memory,



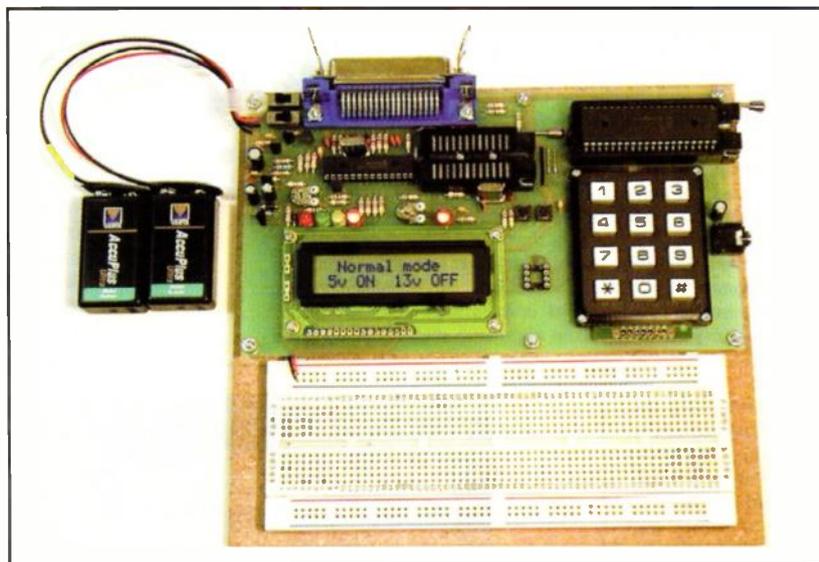
The authors own circuit wired onto the plug board so it can be driven by the onboard PIC 16F877

create a simple frequency counter, and use the 10 bit A/D converter to measure voltages.

The two books between them amount to a most impressive introduction to PIC programming. Even readers without a soldering iron and with no background in programming or electronics will be able to work through the experiments in *Experimenting with PIC Microcontrollers*. The first project requires a degree of soldering ability while the second project must not be attempted by anyone without experience of handling mains voltages. Each of the experimental chapters ends with a set of questions mostly having answers at the back of the book. I found these very helpful as each one seems designed to bring home a particular point that might be overlooked.

The software supplied with the programmer module (BWPICA) has a very similar feel to the Brunning Software PC programming software which is not surprising as that is where it originated. It is a DOS based program which has been streamlined for use under Windows 98. I ran the program directly from Windows 98 and it performed continuously without a hitch. When I asked Peter why he is still sticking to DOS his reply was straight to the point "Windows is for people who want to avoid learning about hardware, surely a PIC is hardware". "Yes", he conceded, "you can have a prettier screen layout using Windows but my time is better spent perfecting the inner workings of the program".

The software suite has a number of features that are unique. For example when



using a PIC16F84 to store information such as a text message the data can only be stored as `retlw` statements. The usual way to do this is:-

```
Message:    addwf pcl,f
            retlw 'M'
            retlw 'a'
            retlw 'r'
            retlw 't'
            retlw 'i'
            retlw 'n'
            retlw 0
```

But when using BWPICA this can be typed as:-

```
Message:    addwf pcl,f
            db 'Martin',0
```

An even more impressive system is available for use with the PIC16F877 family where the text can be stored as twin 7 bit ASCII characters in the 14 bit flash memory:-

```
Message:    dw 'Martin Edwards',0
```

This text is stored with two characters in each memory location so it is twice as efficient as the `retlw` system. Note that in this case the label will often have a numerical value above 255 so there are special instructions which split a label address into its lowest 8 bits and highest 6 bits so that the number can be handled using the working register `W` which like all the other PIC registers is only 8 bits wide.

The BWPICA text editor has a number of special features. For example each line is tested as it is typed to ensure that the line will produce valid PIC code, and with a couple of key presses the cursor can be moved along the program flow following `CALL` and `GOTO` instructions, and then

reversed back along the same path. Another unusual feature is the ability to save the text files in an encrypted format. This works particularly well because all operations work directly from the text in the editor, so unencrypted data is never saved to disc.

Finally I now get to looking at the performance of the hardware. This uses a 28 pin microcontroller to buffer all the input and output lines coming from and going to the PC, and

to handle the timing requirements of the test PIC when it is being programmed and verified. The on board LCD is used for system messages such as 5v OFF test PIC can be changed and can also be driven by the programmes that are written into the test PIC. All I can say is that the hardware complements the software perfectly and performed faultlessly.

## Summary

As always when writing reviews I have been through this far too quickly. Even so I am totally converted. How I lasted so long without using microcontrollers I will never be able to justify. Let it suffice to say that I will now be using PICs everywhere!

## Prices and contact

Universal Mid Range PIC Programmer with software and 212 page 170 x 240mm wirebound book £129.50. Beginners also need *Experimenting with PIC Microcontrollers* at £23.99. Total postage and packing £7.50. Contact Brunning Software 01255 862308.

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The assembler understands PIC16F84 and PIC16C711 terminology so it is not necessary to start programmes with a list of definitions. The programming is performed and verified at 5 volts, then verified with 0.10% applied to ensure that the device is programmed with a good margin and not poised on the edge of failure. The module is supplied with a test PIC fitted, and requires two PP3 batteries which are not supplied.

Book *Experimenting with PIC Micros* ..... £23.99  
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# Op-Amp COOKBOOK

PART 3

Ray Marston looks at practical op-amp oscillators and switching circuits in the third episode of this 4-part survey of op-amp principles and applications.

The opening episode of this 4-part 'op-amp' series described the basic operating principles of conventional voltage-differencing op-amps (typified by the 741 type) and showed some basic circuit configurations in which they can be used. The present episode looks at practical ways of using such op-amps in various oscillator and switching applications.

When reading this episode, note that most practical circuits are shown designed around a standard 741 or 3140-type op-amp and operated from dual 9V supplies, but that these circuits will usually work (without modification) with most voltage-differencing op-amps, and from any DC supply within that op-amp's operating range.

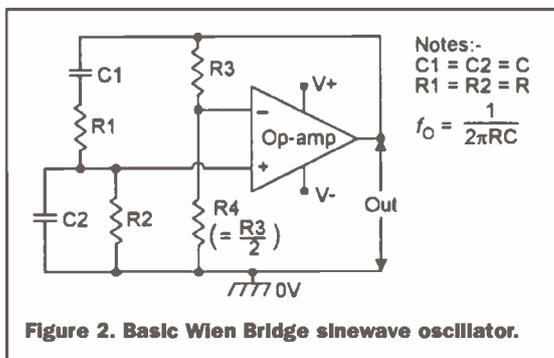


Figure 2. Basic Wien Bridge sinewave oscillator.

## Sinewave Oscillators

An op-amp can be made to act as a sinewave oscillator by connecting it as a linear amplifier in the basic configuration shown in Figure 1, in which the amplifier output is fed back to the input via a

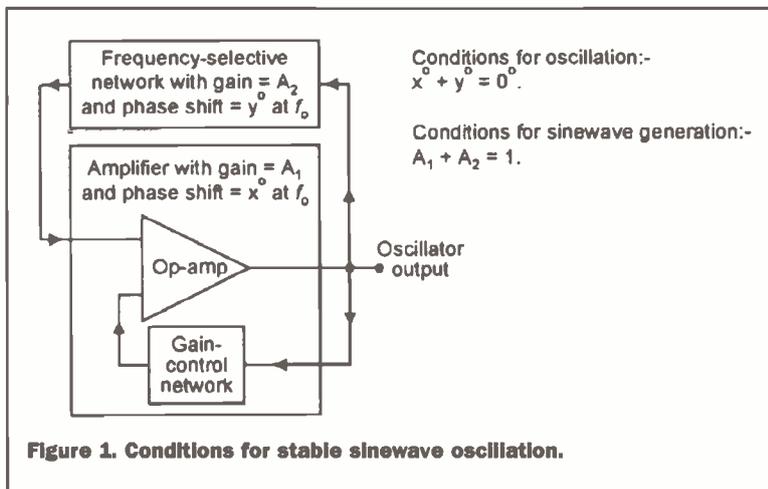


Figure 1. Conditions for stable sinewave oscillation.

frequency-selective network, and the overall gain of the amplifier is controlled via a level-sensing system. For optimum sinewave generation, the feedback network must provide an overall phase shift of zero degrees and a gain of unity at the desired frequency.

If the overall gain is less than unity the circuit will not oscillate, and if it is greater than unity the output waveform will be distorted.

One way of implementing the above principle is to connect a Wien Bridge network and an op-amp in the basic configuration shown in Figure 2. Here, the frequency-sensitive Wien Bridge network is constructed from R1-C1 and R2-C2.

Normally, the network is symmetrical, so that  $C1 = C2 = C$ , and  $R1 = R2 = R$ . The main feature of the Wien network is that the phase relationship of its output-to-input signals varies from  $-90^\circ$  to  $+90^\circ$ , and is precisely  $0^\circ$  at a centre frequency ( $f_o$ ) of

$\frac{1}{2\pi CR}$ . At this centre frequency the symmetrical network has a voltage gain of 0.33.

Thus, in Figure 2, the Wien network is connected between the output and the non-inverting input of the op-amp, so that the circuit gives zero overall phase shift at  $f_o$ , and the actual amplifier is given a voltage gain of x3 via feedback network R3-R4, to give the total system an overall gain of unity. The circuit thus provides the basic requirements of sinewave oscillation. In practice, however, the ratios of R3-R4 must be carefully adjusted to give overall voltage gain of precisely unity that is necessary for low-distortion sinewave generation.

The basic Figure 2 circuit can easily be modified to give automatic gain adjustment and amplitude stability by replacing the passive R3-R4 gain-determining network with an active gain-control network that is sensitive to the amplitude of the output

signal, so that gain decreases as the mean output amplitude increases, and vice versa. Figures 3 to 7 show some practical versions of Wien Bridge oscillators with automatic amplitude stabilisation.

## Thermistor-Stabilized Circuits

Figure 3 shows the basic circuit of a 1kHz thermistor-stabilized Wien bridge oscillator of the type that has been popular in the UK and

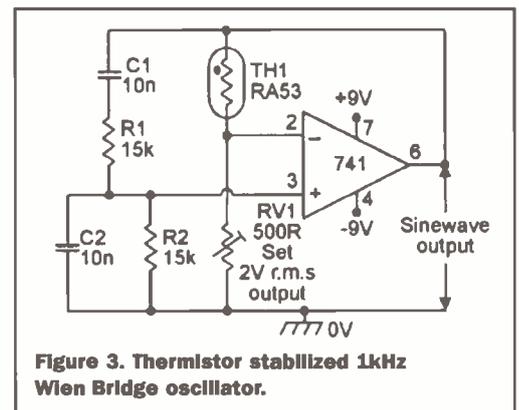
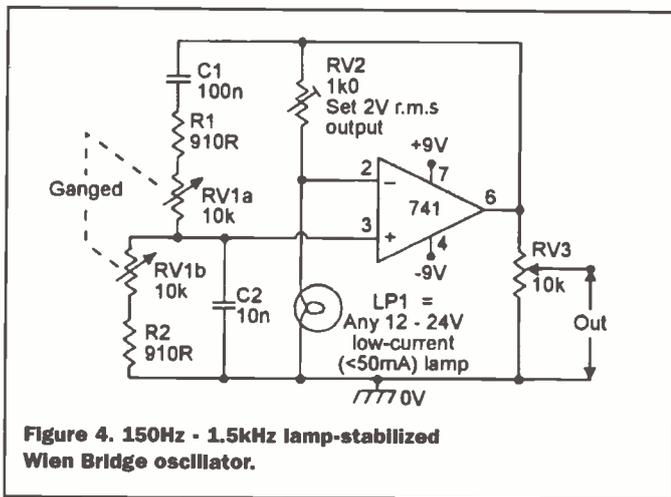
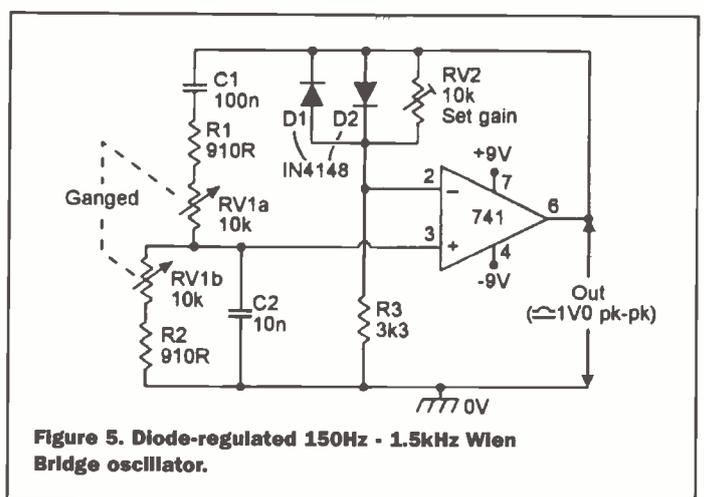


Figure 3. Thermistor stabilized 1kHz Wien Bridge oscillator.

other European countries for many years. The thermistor used here is a rather expensive and delicate RA53 (or similar) negative-temperature-coefficient (ntc) type. The thermistor (TH1) and RV1 form a gain-determining network. The thermistor is heated by the mean output power of the op-amp, and at the desired output signal level has a resistance value double that of RV1, thus giving the op-amp a gain of x3 and the overall circuit a gain of unity. If the oscillator output starts to rise, TH1 heats up



**Figure 4. 150Hz - 1.5kHz lamp-stabilized Wien Bridge oscillator.**



**Figure 5. Diode-regulated 150Hz - 1.5kHz Wien Bridge oscillator.**

and reduces its resistance, thereby automatically reducing the circuit's gain and stabilizing the amplitude of the output signal.

An alternative method of thermistor stabilization is shown in Figure 4; this circuit variant is very popular in the U.S.A. In this circuit a low-current filament lamp is used as a positive-temperature-coefficient (ptc) thermistor, and is placed in the lower part of the gain-determining feedback network. Thus, if the output amplitude increases, the lamp heats up and increases its resistance, thereby reducing the circuit gain and providing automatic amplitude stabilization. This circuit also shows how the Wien network can be modified by using a twin-gang pot to make the oscillator frequency variable over the range 150Hz to 1.5kHz, and how the sinewave output amplitude can be made variable via RV3.

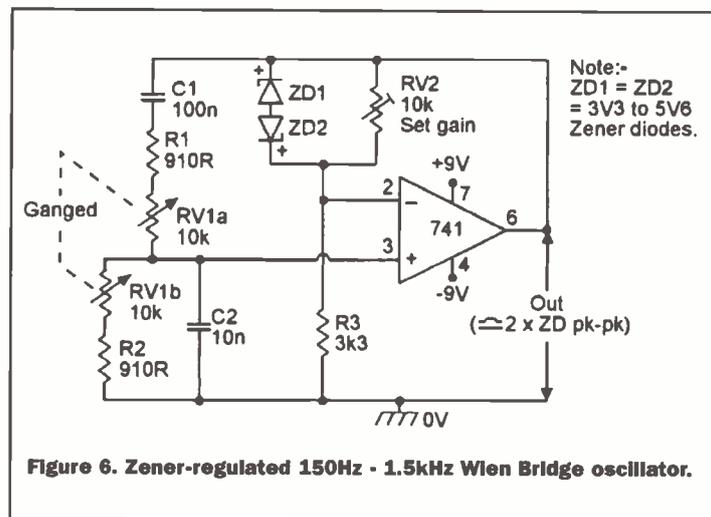
Note in the Figure 3 and 4 circuits that the pre-set pot should be adjusted to set the maximum mean output signal level to about 2V r.m.s. and that under this condition the sinewave has a typical total harmonic distortion (THD) level of about 0.1%. If the circuit's thermistor is a low resistance type, it may be necessary to interpose a bi-directional current-booster stage between the op-amp output and the input of the amplitude control network, to give it adequate drive. Finally, a slightly annoying feature of thermistor-stabilized circuits is that, in

variable-frequency applications, the sinewave's output amplitude tends to judder or 'bounce' as the frequency control pot is swept up and down its range.

diode or zener conduction for automatic gain control. In essence, RV2 is set so that the circuit gain is slightly greater than unity when the output is close to zero, causing

the circuit to oscillate, but as each half-cycle nears the desired peak value one or other of the diodes starts to conduct and thus reduces the circuit gain, automatically stabilizing the peak amplitude of the output signal. This 'limiting' technique typically results in the generation of 1% to 2% THD on the sinewave output when RV2 is set so that oscillation is maintained over the whole frequency band. The maximum peak-to-peak output of each circuit is roughly double the breakdown voltage of its diode regulator element. In the Figure 5 circuit, the diodes start to

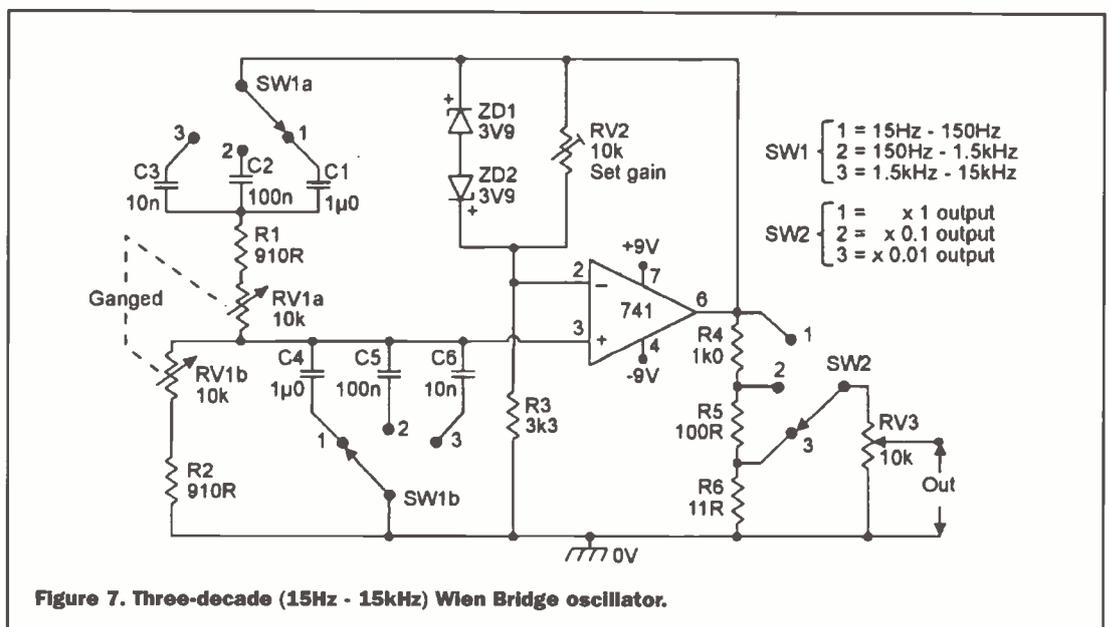
conduct at 500mV, so the circuit gives a peak-to-peak output of about 1V0; in the Figure 6 circuit the zener diodes are connected back-to-back and may have values as high as 5V6, giving a pk-to-pk



**Figure 6. Zener-regulated 150Hz - 1.5kHz Wien Bridge oscillator.**

### Diode-Stabilisation Circuits.

The amplitude 'bounce' problem of variable-frequency circuits can be minimised by using the basic circuits of Figures 5 or 6, which rely on the onset of



**Figure 7. Three-decade (15Hz - 15kHz) Wien Bridge oscillator.**

output of about 12V.

The frequency ranges of the above circuits can be altered by changing the C1 and C2 values; increasing the values by a decade reduces the frequency by a decade. Figure 7 shows the circuit of a variable-frequency Wien oscillator that covers the range 15Hz to 15kHz in three switched decade ranges. The circuit uses zener diode amplitude stabilization; its output amplitude is variable via both switched and fully-variable attenuators. Note that the maximum useful operating frequency of this type of circuit is restricted by the slew-rate limitations of the op-amp. The limit is about 25kHz with a 741 op-amp, or about 70kHz with a CA3140.

### A Twin-T Oscillator

Another way of making a sinewave oscillator is to wire a Twin-T network between the output and input of an inverting op-amp, as shown in the diode-regulated 1kHz oscillator circuit of Figure 8. The Twin-T network comprises R1-R2-R3-RV1 and C1-C2-C3, and in a 'balanced' circuit these components are in the ratios  $R1 = R2 = 2(R3 + RV1)$ , and  $C1 = C2 = C3/2$ . When the network is perfectly balanced it acts as a frequency-dependent attenuator that gives zero output at a centre frequency ( $f_0$ ) of  $\frac{1}{2\pi C_1 R_1}$ , and a finite output at all other frequencies. When the network is

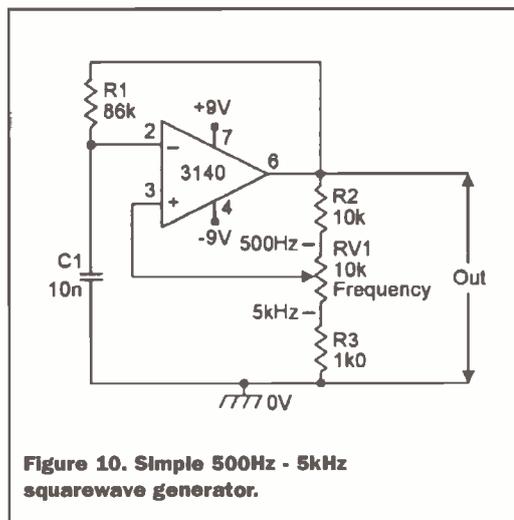


Figure 10. Simple 500Hz - 5kHz squarewave generator.

imperfectly balanced, it gives a minimal but finite output at  $f_0$ , and the phase of this output depends on the direction of the imbalance: if the imbalance is caused by  $(R3 + RV1)$  being too low in value, the output phase is inverted relative to the input.

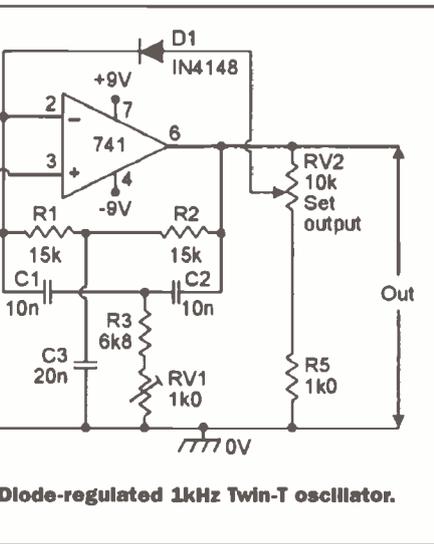


Figure 8. Diode-regulated 1kHz Twin-T oscillator.

In Figure 8 the 1kHz Twin-T network is wired between the output and the inverting input of the op-amp, and RV1 is

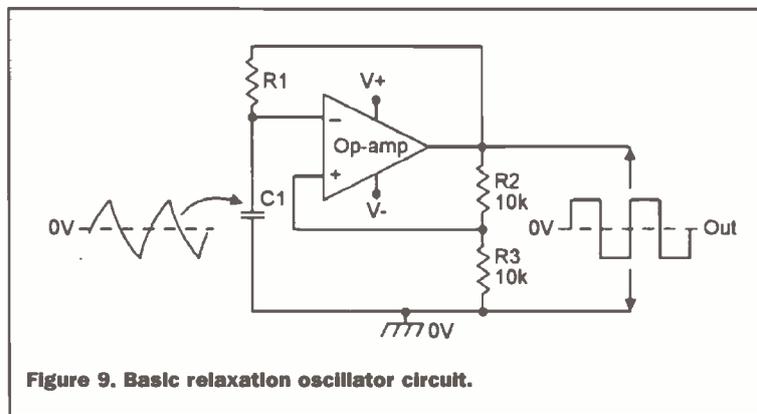


Figure 9. Basic relaxation oscillator circuit.

critically adjusted so that the Twin-T gives a small inverted output at  $f_0$ ; under this condition zero overall phase inversion

occurs around the feedback loop, and the circuit oscillates at the 1kHz centre frequency. In practice, RV1 is adjusted so that oscillation is barely sustained, and under this condition the sinewave output distortion is less than 1% THD. Automatic amplitude control is provided via D1, which provides a feedback signal via RV2; this diode progressively conducts and reduces the circuit gain when the diode forward voltage exceeds 500mV.

To set up the Figure 8 circuit, first set RV2 slider to the op-amp output and adjust RV1 so that oscillation is just sustained; under this condition the output signal has an amplitude of about 500mV pk-to-pk. RV2 then enables the output signal to be

varied between 170mV and 3V0 r.m.s. Note that Twin-T circuits make good fixed-frequency sinewave oscillators but are not suitable for variable-frequency use, due to the difficulties of varying three or four network components simultaneously.

### Squarewave Generators

Figure 9 shows a basic op-amp relaxation oscillator or squarewave generator using dual (split) power supplies. Its circuit action is such that C1 alternately charges and discharges (via R1) towards an 'aiming' or reference voltage set by R2-R3, and each time C1 reaches this aiming voltage a regenerative comparator action occurs and makes the op-amp output switch state (to positive or negative saturation); this action produces a symmetrical squarewave at the op-amp's output and a non-linear triangle wave across C1. The operating frequency

can be varied by altering either the R1 or C1 values or the R2-R3 ratios; this circuit is thus quite versatile. A fast op-amp such as the CA3140 should be used if good output rise and fall times are needed from the squarewave.

Figure 10 shows the basic circuit adapted to make a practical 500Hz to 5kHz squarewave generator, with frequency

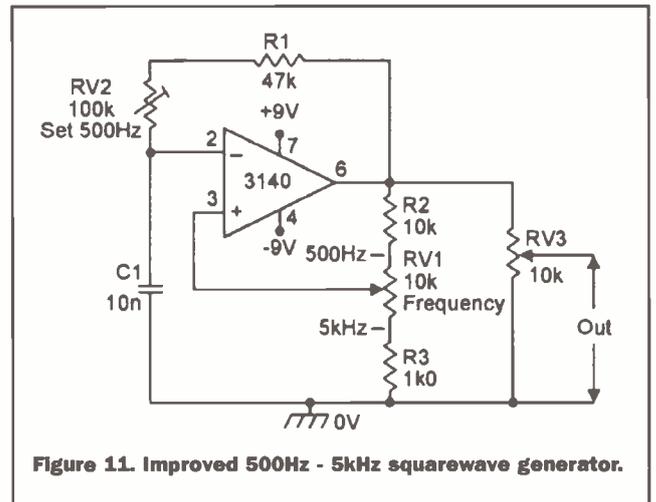
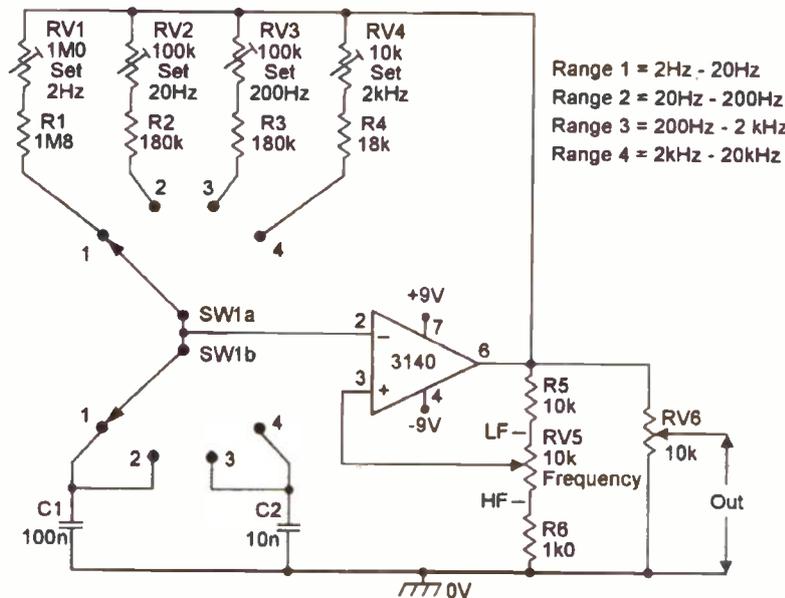


Figure 11. Improved 500Hz - 5kHz squarewave generator.

variation obtained by altering the R2-RV1-R3 attenuator ratio. Figure 11 shows the circuit improved by using RV2 to pre-set the range of the RV1 frequency control, and by using RV3 as an output amplitude control.

Figure 12 shows how the above circuit can be modified to make a general-purpose squarewave generator that covers the 2Hz to 20kHz range in four switched decade ranges. Pre-set pots RV1 to RV4 are used to precisely set the minimum frequency of the



Range 1 = 2Hz - 20Hz  
 Range 2 = 20Hz - 200Hz  
 Range 3 = 200Hz - 2 kHz  
 Range 4 = 2kHz - 20kHz

Figure 12. 4-decade, 2Hz - 20kHz, squarewave generator.

2Hz to 20Hz, 20Hz to 200Hz, 20Hz to 2kHz, and 2kHz to 20kHz ranges respectively.

### Variable Symmetry

In the basic Figure 9 circuit C1 alternately charges and discharges via R1, and the circuit generates a symmetrical squarewave output. The circuit can easily be modified to give a variable-symmetry output by providing C1 with alternate charge and discharge paths, as shown in Figures 13 and 14.

In the Figure 13 circuit the mark/space (M/S) ratio of the output waveform is fully variable from 11:1 to 1:11 via RV1, and the frequency is variable from 650Hz to 6.5kHz via RV2. The circuit action is such that C1 alternately charges up via R1-D1 and the left-hand side of RV1, and discharges via R1-D2 and the right-hand side of RV1, to provide a variable-symmetry output. In practice, variation of RV1 has negligible effect on the operating frequency of the

circuit.

In the Figure 14 circuit, the mark period is determined by C1-D1-R1, and the space period by C1-D2-R2; these periods differ by a factor of one hundred, so the circuit generates a narrow pulse waveform. The pulse frequency is variable from 300Hz to 3kHz via RV1.

### Triangle-Square Generation

Figure 15 shows the basic circuit of a function generator that simultaneously generates a linear triangle and a square waveform, using two op-amps. IC1 is wired as an integrator, driven from the output of IC2, and IC2 is wired as a differential voltage comparator, driven from the output of IC1 via potential divider R2-R3, which is connected between the outputs of IC1 and IC2. The squarewave output of IC2 switches alternately between positive and negative saturation. The circuit functions as follows.

Suppose initially that the output of IC1 is positive and the output of IC2

has just switched to positive saturation. The inverting input of IC1 is a virtual earth point, so a current ( $i$ ) of  $+V_{sat}/R1$  flows into R1, causing the output of IC1 to start to swing down linearly at a rate of  $i/C1$  volts per second. This output is fed, via the R2-R3 divider, to the non-inverting input of IC2, which has its inverting terminal referenced directly to ground.

Consequently, the output of IC1 swings linearly to a negative value until the R2-R3 junction voltage falls to zero, at which point IC2 enters a regenerative switching phase, in which its output abruptly switches to negative saturation. This reverses the inputs of IC1 and IC2, so IC1 output starts to rise linearly, until it reaches a positive value at which the R2-R3 junction voltage reaches the zero volts reference value, initiating another switching action. The

whole process then repeats ad infinitum.

Important points to note about the Figure 15 circuit are that the pk-to-pk amplitude of the linear triangle waveform is controlled by the R2-R3 ratio, and that the circuit's operating frequency can be altered by changing either the ratios of R2-R3, the values of R1 or C1,

or by feeding R1 from a potential divider connected to the output of IC2 (rather than directly from IC2 output). Figure 16 shows the practical circuit of a variable-frequency triangle/square generator that uses the latter technique.

In Figure 16, the input current of C1 (obtained from RV2-R2) can be varied over a 10:1 range via RV1, enabling the frequency to be varied from 100Hz to 1kHz; RV2 enables the full-scale frequency to be set to precisely 1kHz. The amplitude

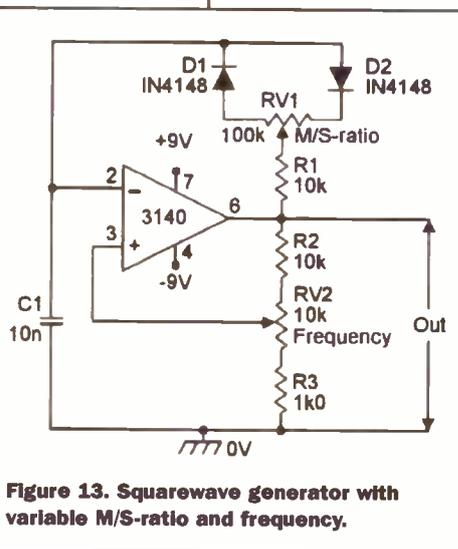


Figure 13. Squarewave generator with variable M/S-ratio and frequency.

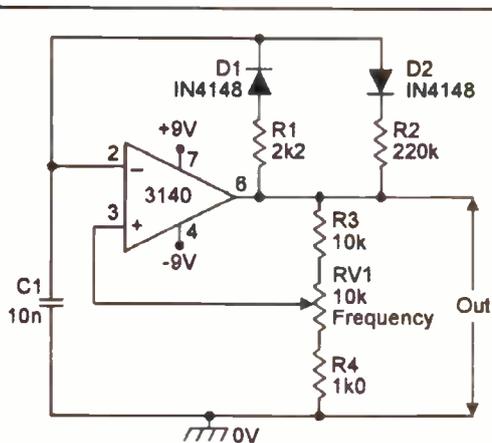


Figure 14. Variable-frequency narrow-pulse generator.

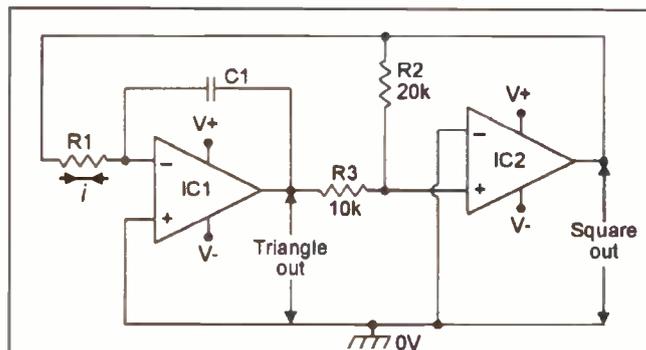


Figure 15. Basic triangle/square function generator.

of the linear triangle output waveform is fully variable via RV3, and of the squarewave via RV4.

The Figure 16 circuit generates symmetrical output waveforms, since C1 alternately charges and discharges at equal current values (determined by RV2-R2, etc.). Figure 17 shows how the circuit can be modified to make a variable-symmetry ramp/rectangle generator, in which the slope is variable via RV2. C1 alternately charges via R2-D1 and the upper half of RV2, and discharges via R2-D2 and the lower half of RV2.

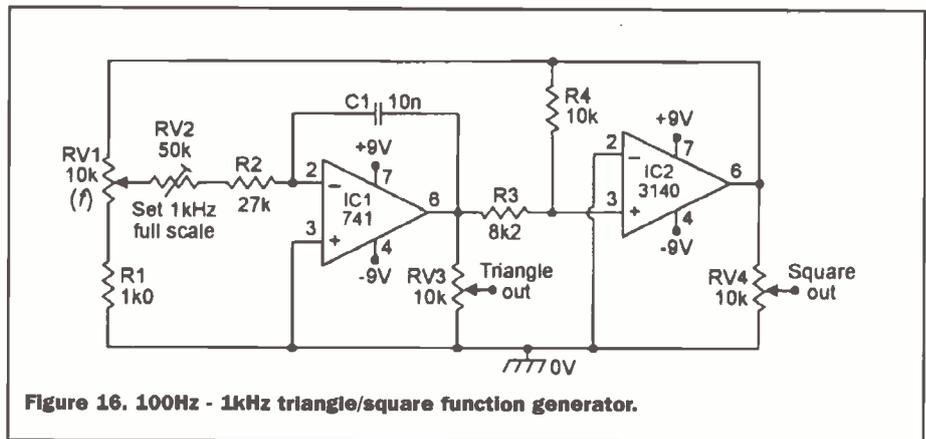


Figure 16. 100Hz - 1kHz triangle/square function generator.

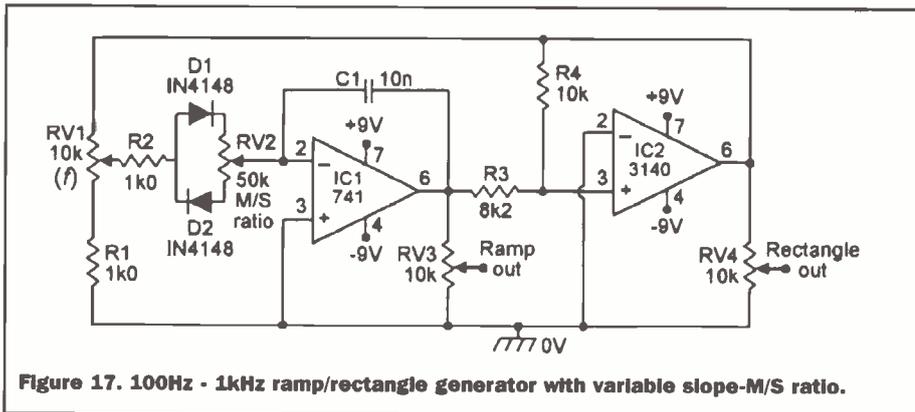


Figure 17. 100Hz - 1kHz ramp/rectangle generator with variable slope-M/S ratio.

into a squarewave output. The circuit operates as follows. Suppose initially that the op-amp output is at a positive saturation value of 8V0. Under this condition the R1-R2 divider feeds a positive reference voltage of  $8V \times (R1 + R2)/R2$  (= about 80mV in this case) to the op-amp's non-inverting pin. Consequently, the output remains in this state until the input rises to a value equal to this voltage, at which point the op-amp output switches regeneratively to a negative saturation level of -8V0, feeding a reference voltage of -

80mV to the non-inverting input. The output remains in this state until the input signal falls to -80mV, at which point the op-amp output switches regeneratively back to the positive

### Switching Circuits

To conclude this month's edition of the 'Op-Amp Cookbook', Figures 18 to 20 show three ways of using op-amps as simple regenerative switches. Figure 18 shows the connections for making a simple manually-triggered bistable circuit. Note here that the inverting terminal of the op-amp is tied to ground via R1, and the non-inverting terminal is tied directly to the output. The circuit operates as follows.

Normally, SW1 and SW2 are open. If SW1

is briefly closed, at which point the op-amp output switches to positive saturation, and locks into this state until SW1 is again operated. The circuit thus gives a bistable form of operation.

Figure 19 shows how the circuit can be modified from a single-ended power supply; in this case the op-amp's inverting terminal is biased to half-supply volts via R1 and the R2-R3 potential divider.

Finally, Figure 20 shows how to connect an op-amp as a Schmitt trigger, which can (for example) be used to convert a sinewave input

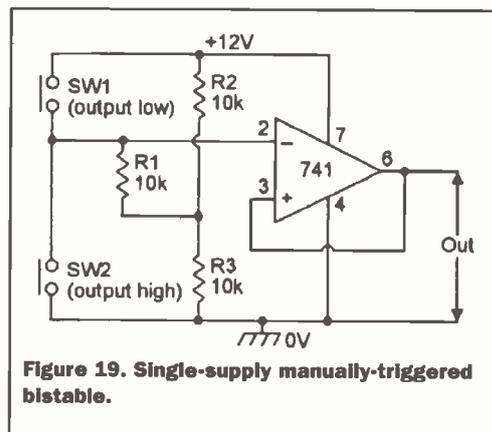


Figure 19. Single-supply manually-triggered bistable.

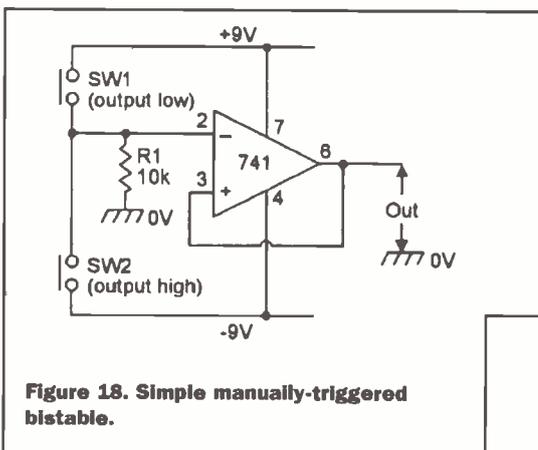


Figure 18. Simple manually-triggered bistable.

is briefly closed, the op-amp inverting terminal is momentarily pulled high and the output is driven to negative saturation; consequently, when SW1 is released again, the inverting terminal returns to zero volts but the output and the non-inverting terminals remain in negative saturation. The output remains in this state until SW2

saturation level. The process then repeats ad infinitum. The actual switching levels can be altered by changing the R1 value.

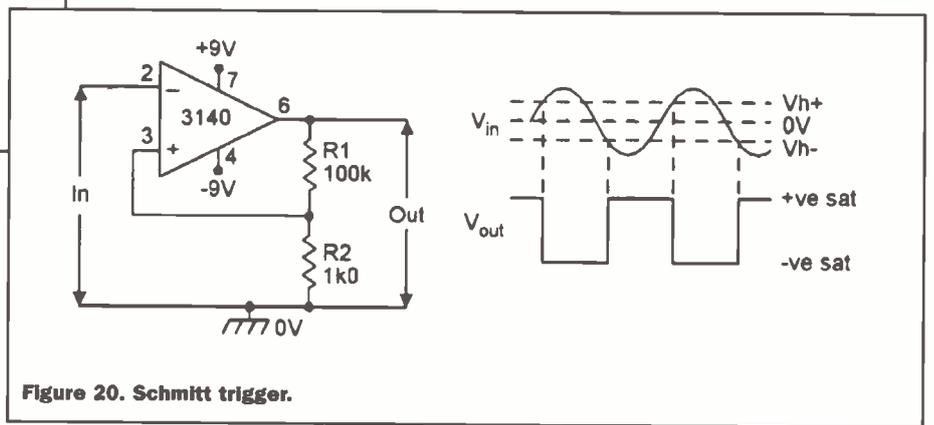


Figure 20. Schmitt trigger.

# Excursions INTO EXCEL

PART 7

by Mike Bedford

Elsewhere in this issue is an article which considers the issues of computability and non-computability. One reason that some systems defy computation is because they are chaotic – that is they show super-sensitivity to the initial conditions. The article gives some introductory material on chaos theory and presents various graphs. It's the creation of these graphs, and especially the bifurcation diagram, which I've chosen for this month's example in this column. Please refer to that other article for the necessary background information on chaos theory and the bifurcation diagram.

The model that is usually used to illustrate chaos theory is a simplified one of population growth. Despite its apparent simplicity, though, it has been shown to be remarkably accurate for some species – a population of fruit flies, for example. The model consists of the following equation and we're interested in the variation of the population size,  $x$ , with time ( $n$  is the generation number) for various values of the growth constant  $a$ .

$$x_{n+1} = x_n + ax_n(1 - x_n)$$

This, in itself, is trivial. However, the fact that I also wanted to generate the bifurcation diagram means that I did this rather differently from how I'd otherwise have tackled the problem. Accordingly, here's a brief description of how I produced the trend graphs. An obvious way to do the job would be to start with an initial population size (I used 0.1) at the top of a column and then generate the population size of successive generations in the cells

a sensible approach. However, the other chaos-related graph I reproduced in the computability article was the bifurcation diagram and for this I need figures relating to a number of different values of  $a$ . My first step, therefore, was to generate a matrix with the value of  $a$ , in steps of 0.01 from 1.9 to 3.0 running across the worksheet, and the generation number running down. Although I only needed to plot the population trends over 50 generations, I actually extended the matrix down to around row 400 since we'll need significantly more data for the bifurcation diagram. The workbook so far is shown as Figure 1 and you'll notice that I've created graphs for the first 50 generations for  $a=2.3$  and  $a=2.7$ , the latter being in the chaotic region.

You'll recall that the bifurcation diagram shows the "final" population on the y-axis against the value of  $a$  on the x-axis. Of course the word "final" suggests that the population always settles down to a single value although, except for values of  $a$  less than 2, this is not the case. For values of  $a$  greater than 2 the "final" population either oscillates between two or more values or appears to fluctuate randomly between many possible values. This being the case, we're obviously not talking of a line graph. Instead, the bifurcation diagram must be generated as an XY plot, otherwise known as a scattergram.

So the data we need to plot is the values of  $a$  and the final populations. To ensure that we only end up with the final populations, and miss out the initial fluctuations, we'll only use population values from generation 150 (actually in row 159) onwards. So we select D8:DJ8 (the values of  $a$ ) and

D159:DJ408 (the "final populations" for generations 150-399 for all values of  $a$ ). If you've not done this before – you can select more than one range by hold down the Ctrl key while selecting the second range. Now we use the Chart Wizard to create an XY plot but to get the correct result you'll have to select "Series in Rows" as opposed to "Series in Columns" in the Data Range tab of Step 2 of the

Chart Wizard. The result you'll get is shown in Figure 2. You'll recognise it as the bifurcation diagram but it's very confused and gaudy due to the large numbers of symbols and colours that Excel uses by default. Although, conceptually, all our data is a single entity, Excel has plotted each

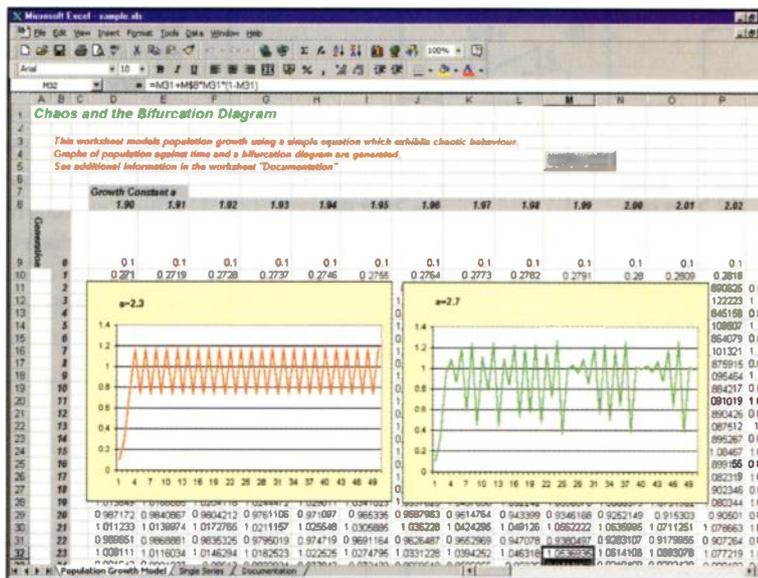


Figure 1.

below it. You might also expect that the growth constant,  $a$ , would appear in a cell somewhere and that it would be picked up as an absolute reference in the formulae in the cells which show the population trend.

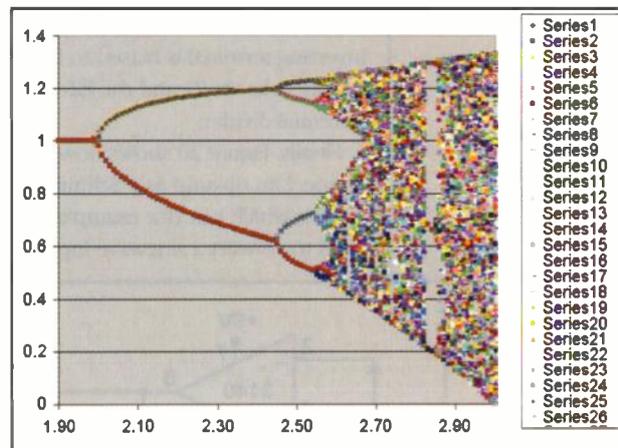


Figure 2.

This way, of course, we could generate a single line graph of population size against the generation number and see this change as the value of  $a$  is altered. If all we wanted were these trend graphs then this would be



# TECHNOLOGY WATCH



With Martin Pipe

This month, I thought I would take a look at a pair of affordable DAB (Digital Audio Broadcasting) radio receivers. Both priced at £299, they're the cheapest such units available at the time of writing. Until recently, one could expect to pay £500 or more! We have to say that in the UK, digital radio is available for considerably less - thanks to Sky Digital. Hook up your Digibox to your hi-fi system via its phono outputs and tune to (for example) BBC Radio 1 (EPG channel 911) and you'll experience a sound quality that's far superior to the FM one. This is primarily because the satellite-delivered service isn't spoiled by heavy Optimod audio compression. There is some compression, but it's achieved digitally and is far less intrusive. DAB offers more 'free' radio services, doesn't need a dish and won't impinge on your TV viewing! Still, the sound quality on offer through digital satellite is very close to what DAB can deliver - we detailed how to make the most of it in an earlier Technology Watch. DAB and the audio component of Sky's DVB (Digital Video Broadcasting) service both specify a 48kHz sample rate, a variant of MPEG-1 Layer 2 compression (Musicam) and a bitrate of 192Kbps.

Indeed, there's a good chance that the BBC's DAB and satellite services are both fed from the same encoder. DAB also supports 256Kbps, but nobody uses it in the UK (not even Radio 3, which is a pity!).

So let's talk more about DAB. In the UK, there are two national operators - the BBC, and a commercial outfit known as DigitalOne. The BBC simulcasts Radios 1 to 5, plus Radio 4 LW and the World Service. It hopes to bring the Asian Network (currently available only through Sky

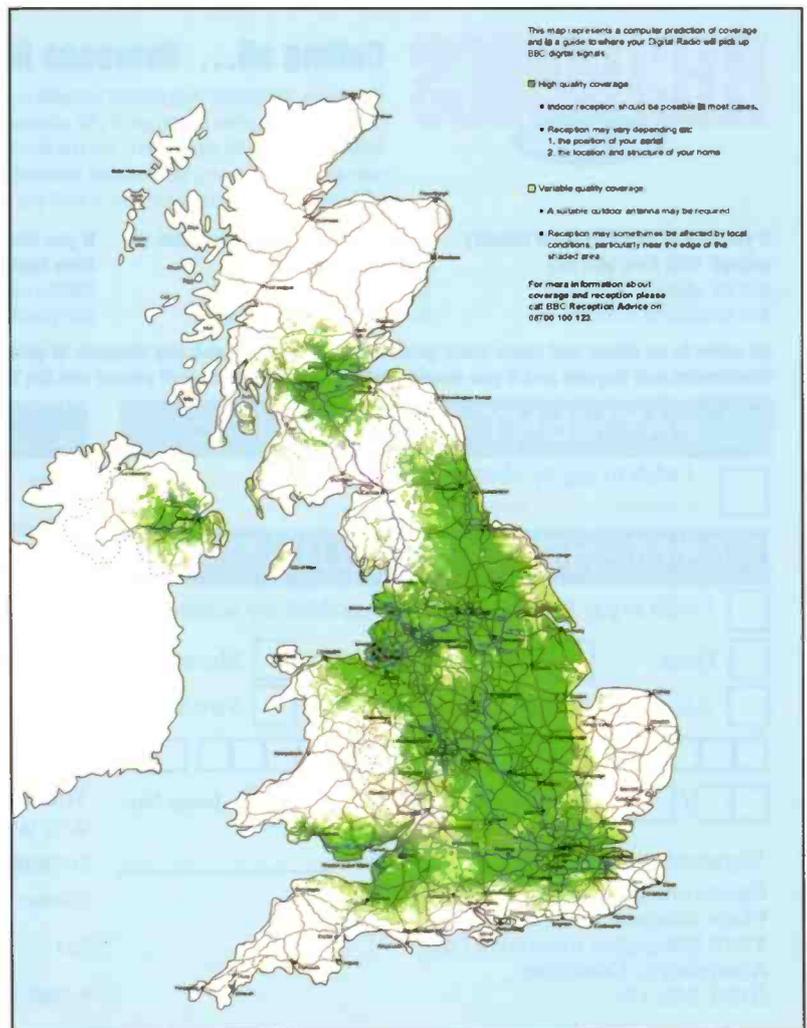
Digital), plus several new services on board soon. Some BBC local radio stations are on air - typically the ones that serve large populations, like London's GLR and Manchester's GMR - but others will follow in time. The BBC's regional services - Radio Scotland, Radio Cymru, Radio nan Gaidheal and Radio Ulster - already have a DAB presence in their catchment areas. DigitalOne, which received its 12-year operating licence from the Radio Authority in 1998, is responsible for ensuring that the existing national services - Classic FM and Virgin - can be received nationally through DAB. Digital One offers some additional DAB-only stations. These are talkSPORT (speech), Planet Rock (classic rock), Core (club and chart hits), Life (adult contemporary), Oneworld



**Top: BBC Family concept DAB radio.**

**Above: BBC shower concept DAB radio.**

**Right: BBC coverage map for DAB.**



(plays, books, comedy and reviews), Primetime Radio (music and features for older listeners), Bloomberg talkMONEY (business, finance and money), ITN News (rolling news service).

The Radio Authority has also awarded a total of 23 local DAB licences so far, the most recent one being North-West England (which went to MXR in March). These local DAB multiplexes will include the ILR station, plus additional digital-only services. London benefits from two local DAB operators (the Capital Radio/EMAP-controlled CE Digital and Switch Digital). Between them, they offer old favourites like Jazz FM, Capital FM, Capital Gold, Kiss, Xfm and LBC. New services include Magic ('soft and melodic'), News Direct ('rolling news'), Ministry of Sound (dance) and Saga (easy listening). Further licences for the remaining areas

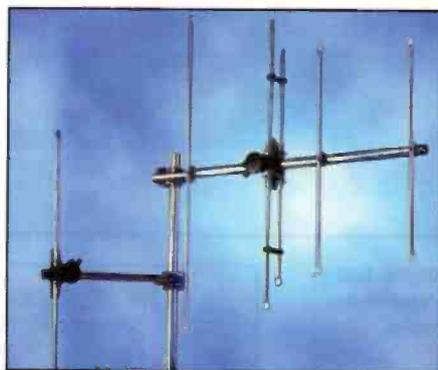
of the UK will be issued in due course. DAB isn't just about audio, though; in addition to mono and stereo

broadcasts of different bitrates, each multiplex can carry data (text, such as show/presenter/song information, and images). The BBC plans to introduce a traffic information service known as TPEG (Transport Protocol Experts Group), which will allow localised

traffic information to be displayed or 'spoken' by compatible car radios.

In the UK, Band III (the old TV frequencies) is used for DAB - in other areas of the world, part of the L-band (1452 to 1492MHz) is specified. The Band III frequencies specified are between 174MHz and 240MHz. Band III is divided into 41 channels labeled from 5A to 13F. In the UK, only channels 11B to 12D have been allocated for DAB reception to avoid 'clashes' with other services, such as PMR (note that elsewhere in Europe, Band III is still employed for analogue TV broadcasting!). In the UK, transmitting (and thus also reception!) aerials are vertically-polarised. In either case, the modulation scheme is COFDM (Coded Orthogonal Frequency Division Multiplex). Here, the MPEG bitstream is split across 1,536

different carrier frequencies, and also across time. This provides a high degree of resilience, even if some of the carrier frequencies are affected by interference. It also ensures that 'multipath' - multiple reception paths, direct and reflected, which can cause distortion in FM/VHF systems



**Top: Antiference DAB aerials.**  
**Above: Videologic drx601es - New version.**  
**Below left: Videologic drx-601e.**  
**Below right: Wavefinder.**

when they are received simultaneously - is less problematic. All national DAB multiplexes employ the same

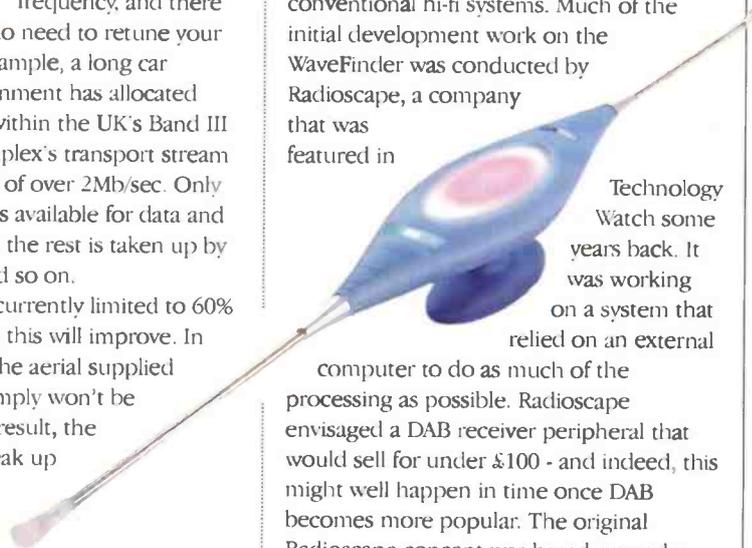
frequency, and there will hence be no need to retune your radio during, for example, a long car journey. The Government has allocated seven multiplexes within the UK's Band III services. Each multiplex's transport stream has a total data rate of over 2Mb/sec. Only around half of this is available for data and audio broadcasting; the rest is taken up by error protection and so on.

DAB coverage is currently limited to 60% of the UK, although this will improve. In some fringe areas, the aerial supplied with the receiver simply won't be good enough. As a result, the audio signal will break up or even disappear altogether. If you are getting intermittent reception, an external aerial mounted outside the building (the higher the better!) would definitely help. Antiference have recently introduced two DAB aerials - a dipole for areas of relatively good signal

strength, and a 4-element Yagi with 4dB gain for fringe areas. They're not widely available yet, although there's a good chance that Maplin - an Antiference dealer - will stock them at some point. The aerial and receiver can be linked together with normal 75-ohm TV coax; because the frequencies are a good deal lower than those associated with UHF TV broadcasting, losses through attenuation are lower! DAB aerials are not exactly commonplace at the moment, and so there's no reason why a DIY approach couldn't be tried. Maplin sell the £14.99 'Radio Rod' (XP09K), a simple quarter-wave dipole aerial. You could buy one of these, and 'trim' it for quarter-wave operation at a frequency halfway between 174MHz and 230MHz (i.e. 202MHz). Here, each dipole element would be cut down to approximately 37cm in length. Another option would be an old Band III TV aerial, many examples are still corroding away on rooftops! These aerials, which are usually directional Yagi designs, were optimised to work over the old TV band, rather than the portion assigned to the digital-age DAB. The aerial would need to be re-pointed towards the nearest DAB transmitter, which might be rather difficult considering the state of that bracketry after several decades! The cable would probably need to be replaced too. Still, it's worth a shot if nothing else is available.

So let's move on to our two receivers. Although both of those £299 units do the same job - facilitating the reception of digital radio stations - they go about it in completely different ways. Psion InfoMedia's WaveFinder is designed for use with a PC, while the VideoLogic DRX-601E is a 'stand-alone' tuner for use with conventional hi-fi systems. Much of the initial development work on the WaveFinder was conducted by Radioscape, a company that was featured in

Technology Watch some years back. It was working on a system that relied on an external computer to do as much of the processing as possible. Radioscape envisaged a DAB receiver peripheral that would sell for under £100 - and indeed, this might well happen in time once DAB becomes more popular. The original Radioscape concept was based around a tuner card that fitted inside your PC. Psion has deviated from it slightly, and we're not just talking about the selling price! For starters, the minimum PC spec has gone from a P133MMX to a PII/333MHz! Your money buys a CD-ROM containing some



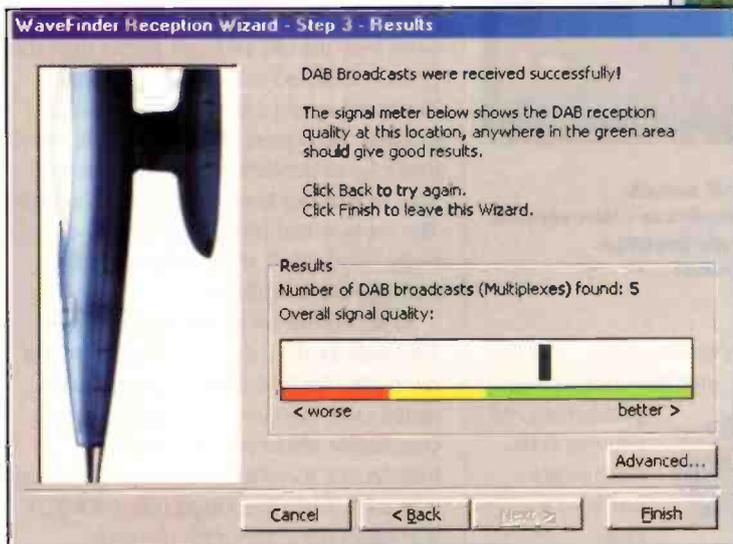
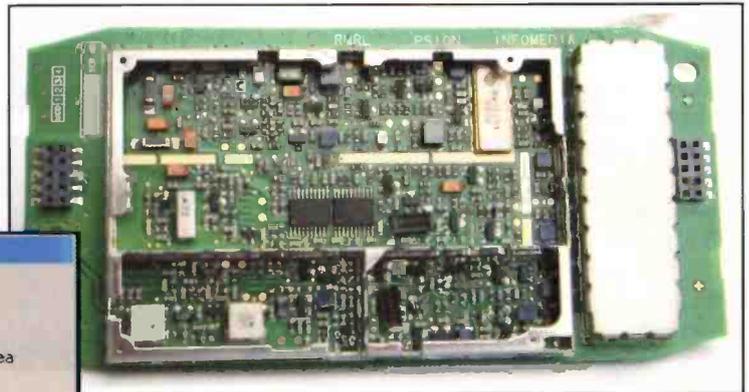
software, plus a dipole aerial that plugs into your PC's USB port. It's more than just an aerial, though – a central oval 'bulge' contains all of the RF electronics, plus a series of LEDs that radiate pretty coloured patterns. Unlike the DRX-601E, the WaveFinder will cope with both Band III and L-band transmissions. Handy, I suppose, if you take it travelling! The WaveFinder aerial can be mounted on a wall and, trailing cable apart, happens to look quite good. Styling complements that of the Apple iMac, which is ironic because WaveFinder is currently Windows-only! Internally, construction is good - everything's screened to prevent



**Videologic  
drx-601e interior.**

**Right: Inside  
Wavefinder  
tuner.**

**Below:  
Wavefinder  
signal strength.**



interference.

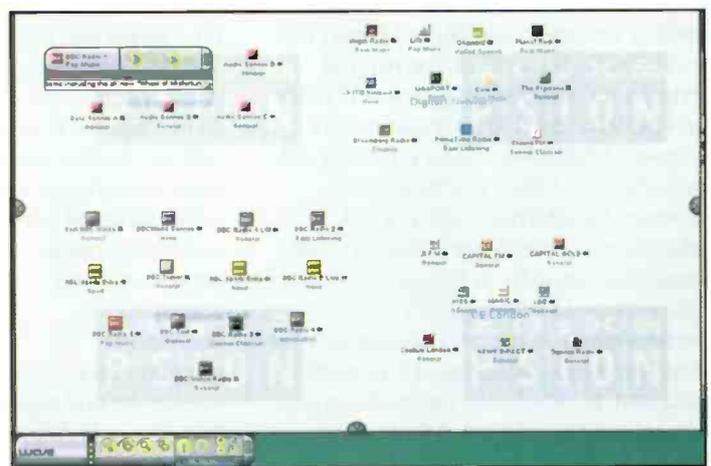
The DAB COFDM baseband signal retrieved by the aerial unit is passed down the USB cable to your PC, which decodes the audio via software so that it can be heard through via the soundcard and speakers. As all users of Winamp know, the average PC is capable of decoding MPEG audio streams as a 'background activity'. This fact is harnessed by WaveFinder – provided your PC meets the minimum specification, you'll be able to run other programs while listening to the radio. Running the Java-based WaveFinder software conducts a search of all available stations, and displays them as icons on a 'map'. Clicking on an icon brings up a station window, and moments later the audio pours out of your speakers. Text info is displayed, together with any Web links. Building the device around the PC has one main disadvantage – the computer needs to be switched on every time you want to listen to the radio! Offset against this,

however, are several advantages. For a start, access to information services is possible in a way that simply isn't with self-contained DAB radios. Videologic's tuner has a

rear-panel data port, but as far as PCs are concerned it's non-standard. The WaveFinder, in contrast, will let you 'jump' to relevant websites - such as the BBC's 'Vision Radio' and 'The Digizone', both of which have their own icons. Another unique feature that the WaveFinder derives from its PC-based nature is its ability to record programmes. Effectively, the software writes the station's DAB MPEG datstream directly to your hard disk. Recordings are as good as the original source, because they are the original source! This is a real advantage over the VideoLogic - for a

start, the only limit on recording times is the size of your hard disk. In terms of quality, the WaveFinder's ability to directly record the bitstream is a better approach than using a conventional DAB tuner with a stand-alone digital audio recorder via SP/DIF. This is because you've avoiding any potential timing and jitter problems that may occur through the link. Two-box (DAC and transport) CD players disappeared largely for this very reason! But then again, you're very unlikely to notice any problems with DAB; after all, it is a compressed format! Note that MPEG-1 Layer 2 captures are incompatible with many personal MP3 players.

Mind you - with a data rate of 192kbps from the higher-quality stereo services, it's just as well considering the limited storage capacities that tend to be on offer.



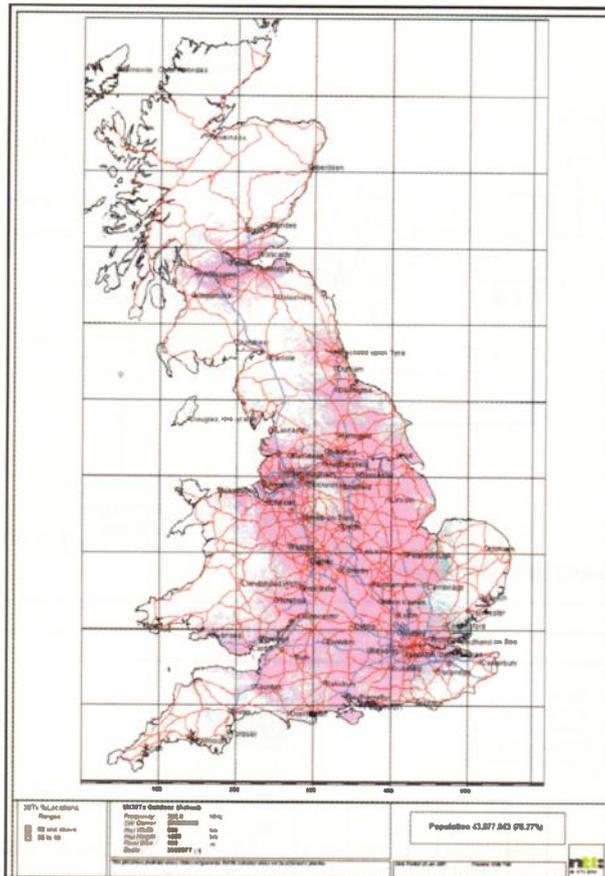
**Wavefinder map.**

Fortunately, the WaveFinder has an 128kbps MP3 option too. If you want to put favourite programmes to audio CD-Rs, we would recommend saving them in the original MP2 format, importing the files into a compatible audio editor and exporting them as 44.1kHz WAV files. Don't forget to choose the 'Musicam' import option where provided, and note that the sample rate will need to be down-converted from DAB's 48kHz if you want to put DAB-sourced music onto standard audio CDs. A good choice of program here is the venerable Cool '96 editor (search for c96setup.exe on the Net) and MP2 input filter (coolmp32.exe). Quite simply, this one feature of the WaveFinder answers the prayers of serious recordists (and, come to think of it, serious bootleggers!). MP2s can be played by Winamp, although Psion InfoMedia supplies RealAudio Jukebox for this very reason.

Another advantage of the WaveFinder is that you can record and listen to different programs - provided they're on the same multiplex! But it isn't perfect. Why isn't there a timer for unattended recording? Furthermore, the WaveFinder's 'map' approach can be rather tiresome. Psion InfoMedia should provide an alternative, in the form of a simple 'pull-down' menu. If our experience is anything to go by, the WaveFinder isn't as sensitive as the DRX-601E. With some stations, audio 'broke up' on occasions - a surefire indication that insufficient signal is being received. Yet the VideoLogic, which was only being fed by the bundled 'wire' aerial, suffered no such problems in the same location. But then again, the DRX-601E is a hard act to follow in this respect. VideoLogic reckon that independent tests conducted by the BBC reveal the DRX-601E to be the second most sensitive receiver they've tested to date (they didn't name the unit that beat it, but chances are it's considerably more expensive!). Fortunately, the WaveFinder hardware does have an external aerial socket for users who live in 'fringe' reception areas (note that DAB coverage is restricted at present).

The connector in question is a miniature one that's rather similar to the external aerial sockets of mobile phones. It will be difficult to buy compatible plugs; thankfully, Psion InfoMedia sell an external aerial designed for the WaveFinder. Another disadvantage is that an external power unit is required. Portable operation with a notebook PC is thus out of the question, unless a mains socket is to hand. This is a shame, seeing that most USB ports are capable of supplying 5V (at currents of up to 500mA) to peripherals. We can't imagine

that those bright flashing LEDs do much for power consumption; would things have been any different if they weren't incorporated? It is possible - any varicap tuning voltages (which tend to be greater than the USB's 5V) can be derived using a DC-to-DC converter. In any case, Canon produces nothing less than a scanner that is powered entirely by the USB port! Interestingly, Windows recognises the device even if the power unit isn't plugged in; I guess what it's actually seeing is the



**Left: DAB coverage map**

USB interface, which is normally powered by the host computer's port.

The British-made VideoLogic DRX-601E is of the more conventional hi-fi tuner design, with stereo analogue and optical/coaxial S/PDIF digital outputs. A nice touch is the analogue input, to which your existing analogue tuner can be connected. These are connected to the 'normally-closed' inputs of a changeover relay; when the Videologic is turned off, they're automatically switched to the relay's 'common' terminals, which are in turn routed to the phono audio outputs. A simple touch, but an effective one that's free of the audio distortions introduced by semiconductor analogue switches. Also round the back is an optical RDI (Receiver Data Interface), which contains the raw multiplex bitstream. The RDI interface is provided for upgrade purposes, and is a standard feature of most DAB tuners. In

time, we'll be able to buy units that decode the information associated with present and future data services. VideoLogic reckons that such devices would take the form of a LCD panel, a unit that uses your TV as a display or an interface for your PC. Also round the back of the DRX-601 is the aerial socket, which is of the 'F' type normally seen on satellite and cable set-top boxes. VideoLogic supply a simple quarter-wave wire dipole for room use, but this will only suffice in areas where the DAB

coverage is fairly good. That said, the DRX-601E appears to be sensitive as we've already observed.

A backlit 2-line 16-character LCD panel dominates the DRX-601E's front panel. There's also a tuning knob, which is rotated until the desired station name appears on the lower line of the screen - pressing it selects the station. The currently-tuned station is displayed on the top line of the display. Four buttons select display brightness (four levels), manual autotune, display mode (programme-specific information, programme genre, multiplex name or frequency) and 'information' (bitrate or signal strength). Several additional functions are available through the tiny infra-red remote control unit supplied. You can select from up to nine preset favourite stations, invoke DRC (dynamic range compression) where supported by the broadcaster, mute the audio and toggle between 'primary' and 'secondary' (split) services. Secondary DAB services are rather thin on the ground - about the only examples are BBC Radio Five, which occasionally broadcasts a Sports Extra secondary service. These mono services have

bitrates of 96 and 80Kbps - the combined total is close to the 192Kbps of the UK's main primary-only services, and so clearly the bandwidth is split. The LW and FM services of Radio 4 - the original split-wavelength broadcaster - are thus both 'primaries', to ensure that the full 192kbps - and the potential sound quality - is available for the 'FM' service's plays and comedies. A front panel red LED glows if a secondary service is available. In the case of the WaveFinder, secondary services are treated like the rest, with their own icons on the 'map' (Psion InfoMedia has placed emphasis on ease of use, and as an aside doesn't bore the user with 'superfluous' information like bitrate and frequency).

Other front-panel LEDs indicate stereo services and confirm that data is being received from the remote. Oh yes, and there's a cool blue 'power' LED! Turning on the DRX-601E invokes autotuning - which searches out all available channels on the multiplexes within range. I found the process

to be a good dealer faster than it is with the Psion, all stations being found within a few seconds. Construction is of a high standard, both externally and internally. The power supply is a good old-fashioned 'linear' one, based around a toroidal transformer. These are far better than switch-mode ones as far as audio work is concerned; although they're not as efficient, they are considerably 'quieter'. Dominating the PCB is the screened tuner 'front end', which plucks the COFDM baseband signal out of the ether. It was developed by Enigma Technologies, a sister company of VideoLogic. The Band III-only tuner acts as a frequency-changer, its IF being fed into a specialist DAB chip from Panasonic.

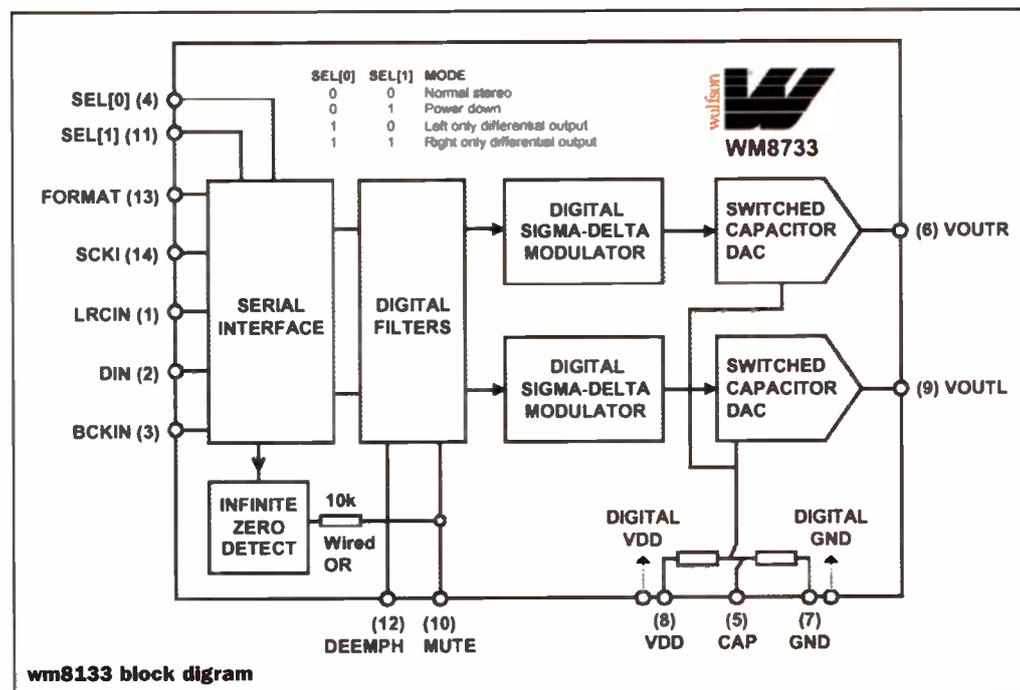
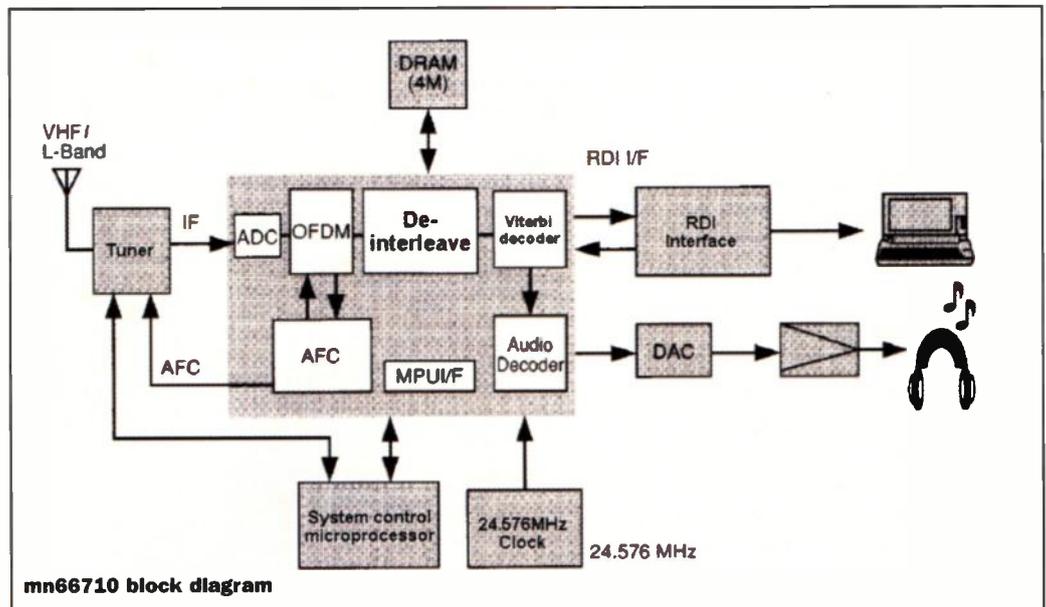
The LSI IC in question, the MN66710, demodulates the COFDM signal amongst other things. It can also be found in other DAB tuners of considerably higher price - including, one can presume, the products sold by Panasonic's sister company Technics. Note that the MN66710 is 'hard-wired' and cannot be software-upgraded to support any changes to the DAB standard (your only upgrade options are via the RDI socket). Because most of the WaveFinder is implemented as PC software, it doesn't have this

ensures that user data (presets, etc.) are retained for a month or so.

The sound quality of the WaveFinder is, of course, restricted by the capabilities of your PC's soundcard and speakers - any comparison with the DRX-601E is therefore pretty meaningless. We can say, however, that auditioning the WaveFinder with a Soundblaster Live Platinum and VideoLogic Sirocco speaker system proved to be a worthwhile experience. Connecting the DRX-601E to our Naim amp and Acoustic Energy

for example - the tuner also acquires itself well. Sometimes, an exceptionally low-level 'chatter' can be heard if you listen very carefully; this is an artifact of the MPEG audio compression. But then again, it's below the noise floor of even the best analogue tuners.

Stations at lower bitrates fare less well, with audible 'warbling' and roughness. VideoLogic recognise this, and the latest version of its DAB tuner (the £350 DRX-601ES) applies some clever trickery (in both analogue and digital domains) to smooth things out.



problem. The MN66710's audio decoder is coupled to a Wolfson WM8733. This sigma-delta stereo DAC is capable of working at 24-bit/96kHz, and is thus possibly over-specified as far as DAB is concerned. There are two WM8733s, the second one being concerned with providing fine-tuning voltages to the front end. Controlling the whole show is a 16-bit microprocessor, which is also sourced from Panasonic. A rechargeable battery

floor-standing speakers yielded a revelatory sound quality when compared to olde-world FM - with 192Kbps radio stations, certainly. Radio 1 is considerably cleaner than its FM counterpart, owing to the lack of Optimod compression. With more revealing material - Radio 3,

Unfortunately, the technique was still being patented at the time of writing, and so VideoLogic was not prepared to talk about how it worked. So which tuner would I buy? Personally, I would plump for the VideoLogic - but that's because I wouldn't want to turn on my PC every time I wanted to listen to the radio! The user interface of the DRX-601E is a good deal more responsive than the WaveFinder's. If, however, you've got a CD writer inside your PC and want to make the best possible recordings off-the-air, the WaveFinder would be the best choice. Thanks to its PC 'connection' and L-band tuner, Psion InfoMedia's product also happens to be the more future-proofed of the two.

Martin Pipe welcomes comments and ideas. E-mail him at:

[martin@webshop.demon.co.uk](mailto:martin@webshop.demon.co.uk)

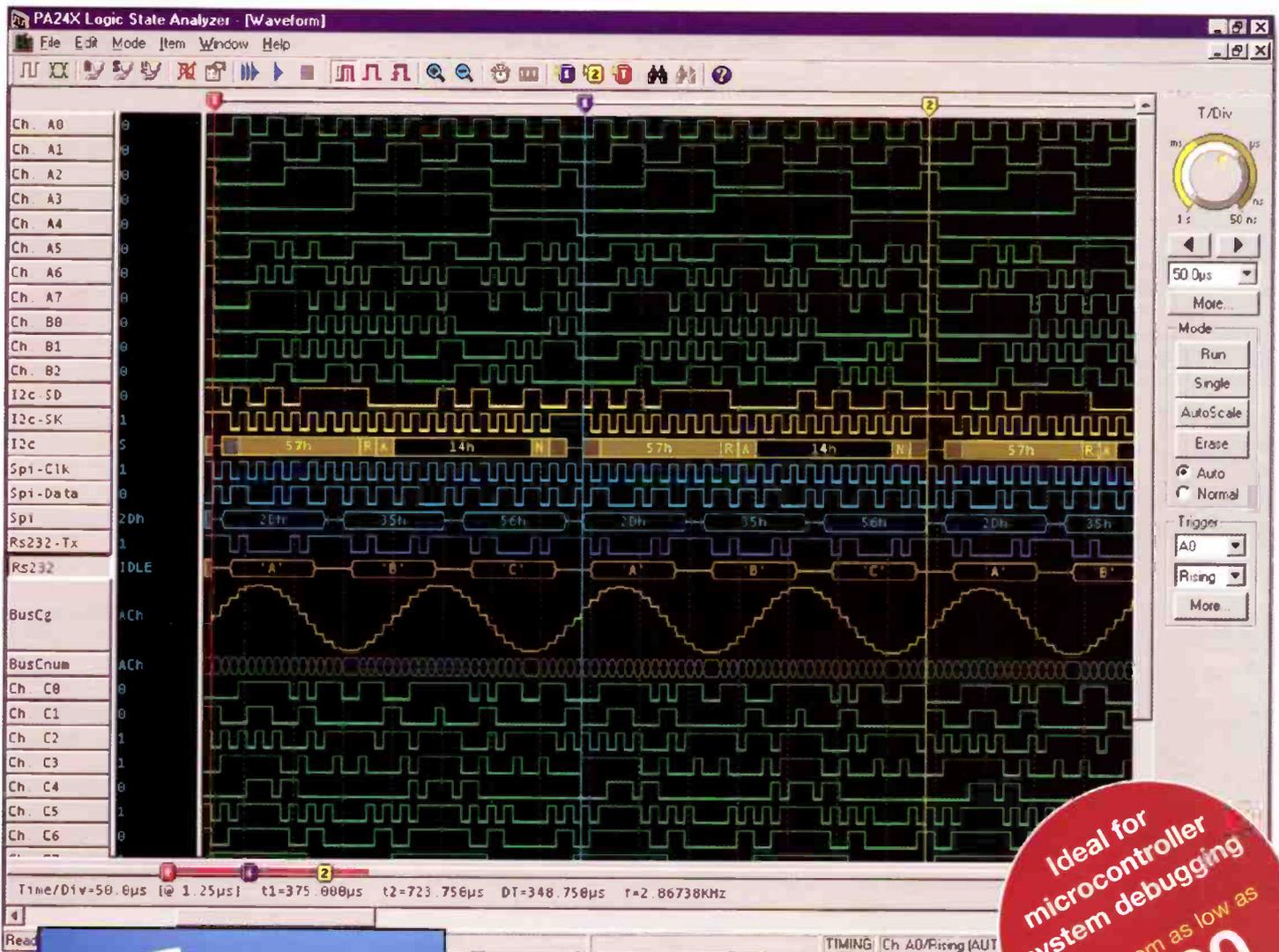
Or look out for him online! His ICQ ID is: 15482544.



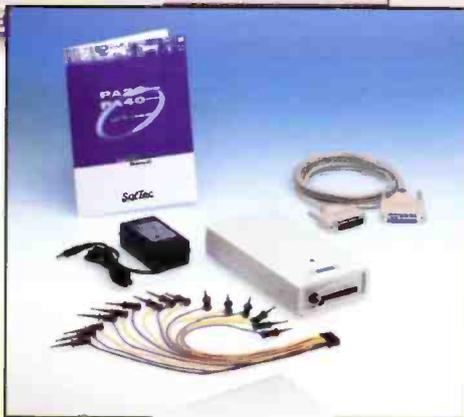
### Points of Contact

VideoLogic; (01923) 277488. [www.videologic.co.uk](http://www.videologic.co.uk)

Psion InfoMedia; (0207) 317 4100. [www.wavefinder.com](http://www.wavefinder.com)



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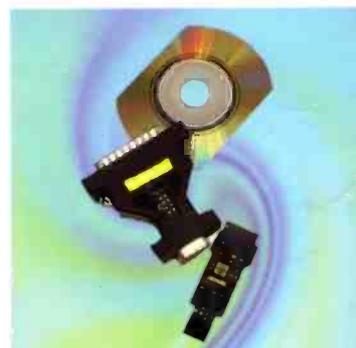
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