ELECTRONICS and Beyond

http://www.maplin.co.uk

AUGUST 2000 NO. 152 £2.65

Mastering Audio on CD

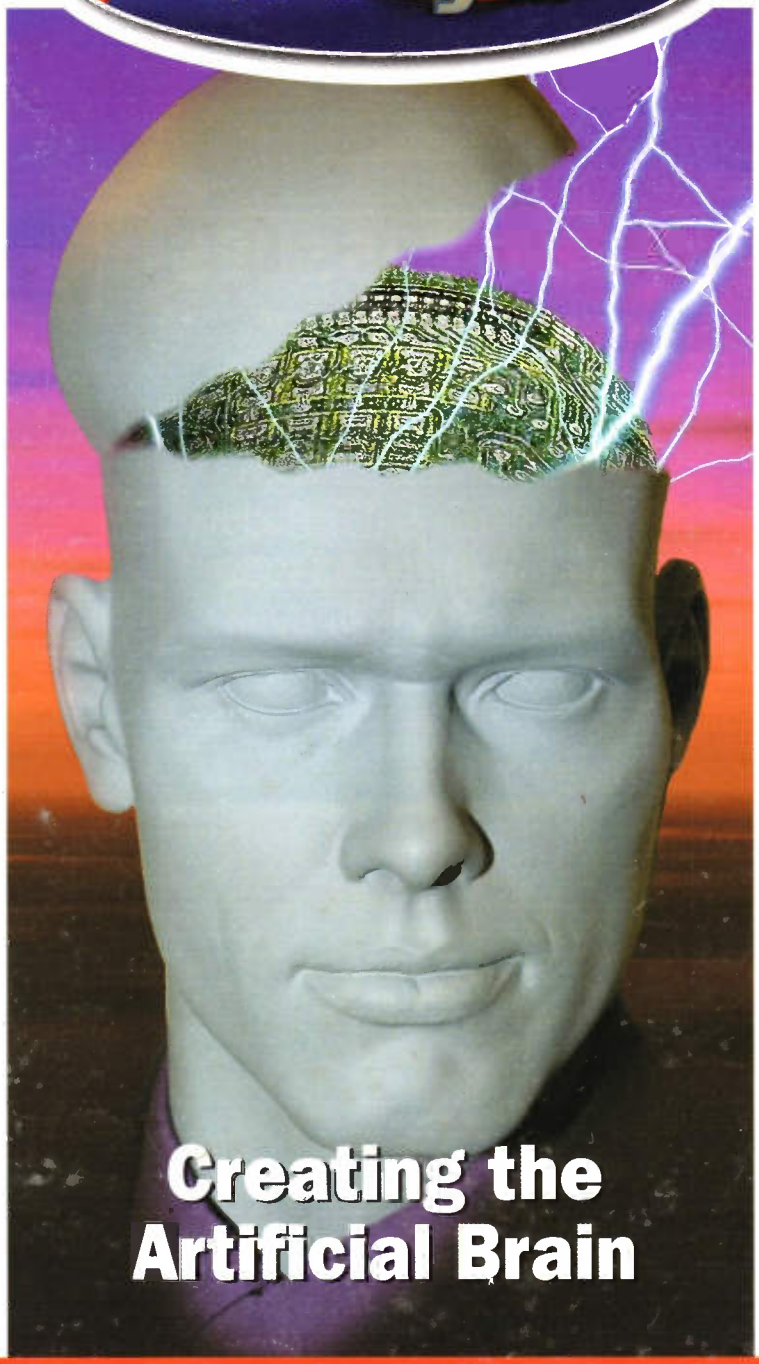
MP3 Player Update

PC-based MP3 player

Towards a Safer Future

Beyond the Silicon Chip

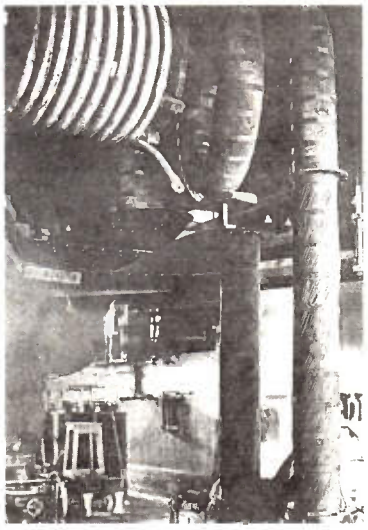
Easy Web Creation Update



Creating the Artificial Brain

21st Century Liquid Crystal Displays

VLF - High-Power Spark Transmitters



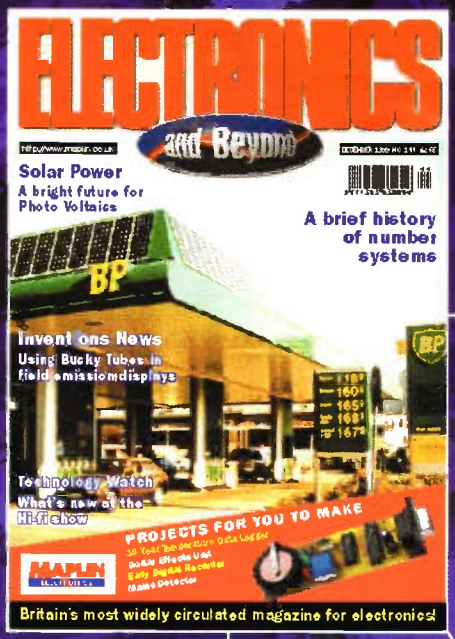
PROJECTS

Portable Alarm

Digital Panel Meter

PC Controlled Disco Lights

Britain's most widely circulated magazine for electronics!



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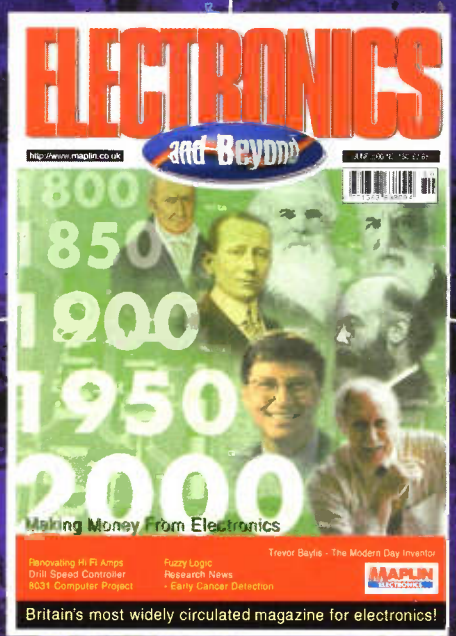

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★ Using Servos & Stepper Motors	★ Garage Protection	★ 8031 Single Board Computer	★ 8031 Single Board Computer Part 2	★ 8031 Single Board Computer Part 3
★ Hardware MP3 Player	★ Hardware MP3 Player	★ Water Alarm	★ Renovating Hi Fi Amps	**FEATURES**
FEATURES The Quantum World	**FEATURES** DVD The Next Generation	**FEATURES** Creating Artificial Retinas	**FEATURES** Fuzzy Logic	★ Liquid Crystal Displays
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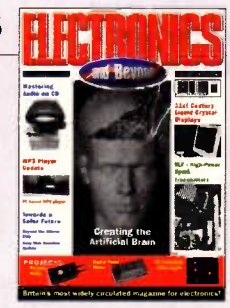
ELECTRONICS and Beyond

August 2000 Vol. 19 No. 152

Projects

Features

Regulars



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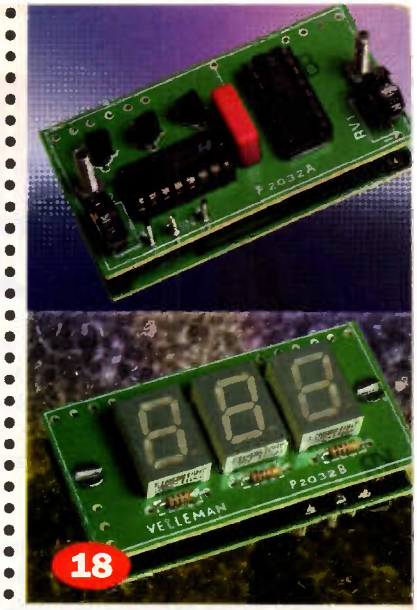


ELECTRONICS and Beyond

The theme this month is very much entertainment. Martin Pipe continues with an update to his MP3 player featured in our March and April issues, with further ideas on burning audio CDs in his other article Mastering Audio.

These two articles are very much related. And in a similar way so is the simple PC controlled disco lights system from Rob Heslop, which is yet another indication of how audio entertainment is moving to a totally digital world.

Intelligent systems, machines and robots, are now practical realities. Artificial intelligence is already widely used in software fields as diverse as disease diagnosis, financial market modelling, project planning, speech recognition etc. And for hardware applications the inputs of FPGAs can be connected to sensors and the outputs to motors, actuators etc. In his thought-provoking article, The Artificial Brain, David Clark discusses how the latest artificial intelligence systems mimic the behaviour and structure of the human brain, and looks at the principles behind the 'artificial brain'.

As the Internet age develops, it will be most interesting to observe how it changes the perception of risk in society, and more importantly perhaps how it is used to minimise the risk to the individual from all the processes that will constitute life in the 21st century. Douglas Clarkson in his article Towards a Safer Future looks at the problem of risk assessment and the ways and means of reducing the risk to our ourselves, whether it be from the food we eat to driving on our roads.

Britain's Best Magazine for the Electronics Enthusiast

NEWS REPORT

Lego Partners with Spielberg to Inspire Young Movie-Makers

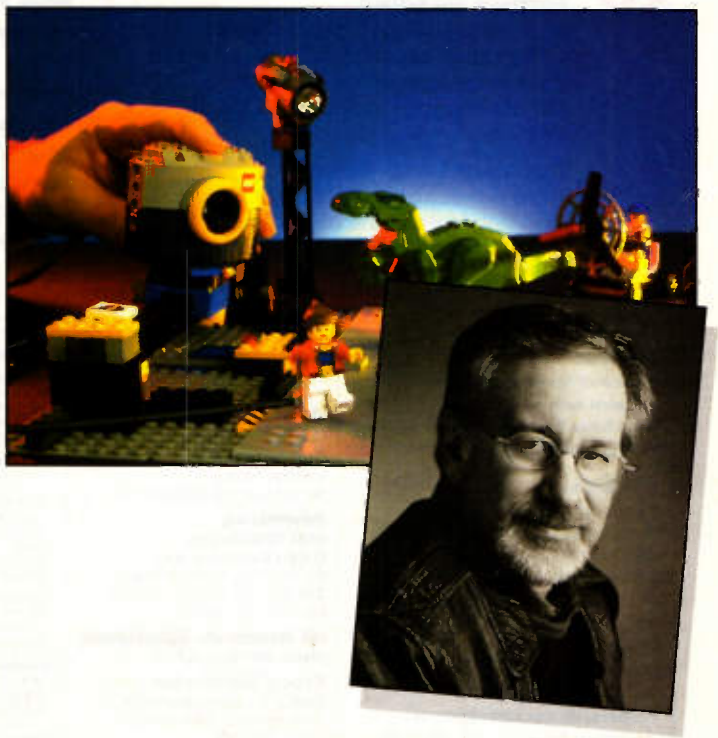
Lego has formed an alliance with filmmaker Steven Spielberg to launch Lego Studios, a new product that allows kids to create real movies.

Scheduled to be on store shelves early next year, Lego Studios enables children ages 8 to 16 to bring the imaginative adventures in their Lego worlds to life.

The set includes a PC movie camera, editing software and an assortment of Lego props and unique elements. Also included is a book of tips, tricks and challenges for making real movies.

Youngsters first build their story and capture the action on the PC movie camera. They then use the child-friendly editing software with professional functionality to edit their footage, and add music and sound effects.

For further details, check: <www.lego.com/studios>.
Contact: Lego,
Tel: (01753) 495000.



Compaq Attacks High-End Server Market

Compaq has announced an aggressive attack on the $20 billion high-end UNIX market with the worldwide launch of its new AlphaServer GS Series systems.

Targeting dot-coms as well as customers in telecommunications, high- performance technical computing, healthcare and financial services, the new AlphaServers are optimised to support the most demanding e-business applications and customer environments.

For further details, check: **<www.compaq.com>**.

Check: Compaq,
Tel: (0845) 270 4000.

WAP's Window of Opportunity Closing

WAP's window of opportunity is closing, warns analyst Ovum As the first generation of WAP-enabled mobile phones finally comes to market, the industry has been warned: you don't have long to get this right.

In a report released in May, independent research and consulting company Ovum tells players intending to jump on the WAP bandwagon that WAP isn't the only technology available.

Now that users are beginning to see what all the fuss over WAP was about, there is a significant danger of disappointment and backlash against the technology.

As Ovum's report points out, the development of WAP was never going to be easy given the widely differing interests of the players involved - what Ovum calls a collision of the mobile world with the Internet world.

This has resulted in slow progress and disappointing early releases of the technology. In fact, WAP may end up being squeezed as next-generation technologies based on XML catch up during the next three years.

In the meantime, although WAP has massive industry backing, the delays in decision-making are leading some players to hedge their bets.

Ericsson, for example, is backing a dual-mode microbrowser. Even worse, the development of WAP handsets has been out of step with coming 2G+ mobile network upgrades.

This means that the early WAP user will need to buy yet another handset to take advantage of the faster speeds.

For further details, check: **<www.ovum.com >**.

Contact: Ovum,
Tel: (020) 7551 9021.

Industry Luminary Predicts Technology Futures

In 1991 he asserted, "Microsoft is abusing its monopoly", called for greater encryption on the Internet in 1996, and recently said that Linux would fizzle against Windows.

Now, renowned computer industry renaissance man, Bob Metcalfe has combined some of his most memorable InfoWorld columns along with frank rebuttals from a who's-who of computing luminaries in his new book 'Internet Collapses And Other InfoWorld Punditry' published by IDG Books Worldwide.

Since 1992 Metcalfe, the creator of Ethernet and founder of 3Com, has inspired and challenged his readers and the world's leading technologists with his thought-provoking columns and predictions at **<www.infoworld.com>**. This collection is no exception.

Ranging from comments on renaming cyberspace to questioning the legality of Microsoft's business practices, these columns speak to the state of our technological culture. Metcalfe's columns such as "The Oh-So-Slow Internet," "Wireless Computing Will Flop... Or Will It?," "Making ISPs Accountable," "Crypto, Privacy and Censorship," "The Telco Empire Strikes back," "The Day The Internet Stock Bubble Bursts" will engage and amuse readers.

Each guest rebuttal and commentary is a no-holds-barred comment on Metcalfe's assertions and opinions. Nobel Prize winner Arno Penzias, Open Source evangelist Eric Ray, Internet Pioneer Vint Cerf and many others take aim at Metcalfe's opinions with surprising candor and intensity.

For further details, check: **<www.idgbooks.com>**.

Contact: IDG Books,
Tel: +1 800 434 3422.

NEWS BYTES

TI Notches up a Million Digital Processors

Texas Instruments (TI) has sold its one millionth digital signal processor (DSP) device after only nine months of production, making it one of the most rapidly accepted general-purpose DSPs in the industry.

DSP works by clarifying, or standardising, the levels or states of a digital signal. A DSP circuit is able to differentiate between human-made signals, which are orderly, and noise, which is inherently chaotic

Hundreds of customers and thousands of developers are currently using or have design-ins with the TI C5402 DSP product across a wide range of portable, wireless, networking, industrial and telecom applications.

For further details, check: **<www.ti.com>**.

Contact: Texas Instruments,
Tel: (1604) 663399.

Government Gives Consent for Cheshire Power Station

Energy Minister Helen Liddell has given the go ahead to ICI Chemicals & Polymers to build a 250MW gas-fired combined heat and power station at Runcorn, Cheshire.

Combined heat and power plants are designed to produce both electricity and usable heat. They have environmental benefits due to their very high levels of efficiency.

The proposed station will supply the heat and electricity needs of the ICI Chlor-Chemicals Runcorn works.

For further details, check: **<www.dti.gov.uk>**.

Contact: DTI, Tel: (020) 7215 5000.

IBM Backs Linux for Server Solution

IBM has announced Linux software and services for the S/390 enterprise server. The announcement is the latest initiative in IBM's strategy to support Linux across its portfolio of e-business servers and services.

For further details, check: **<www.s390.ibm.com>**.

Contact: IBM, Tel: (020) 8818 4000.

NEWS BYTES

Dolby and ARM Enter Patent Agreement

To cut costs, save time, and better Dolby Laboratories has entered into an agreement with ARM, allowing it to develop an optimised version of Advanced Audio Coding (AAC) technology for the ARM architecture.

The ARM-optimised AAC implementation, available now through ARM, enables hardware manufacturers to create ARM Powered™ portable music playback devices capable of decoding high-quality music delivered via the Internet.

AAC is the latest audio coder standardised by the International Organisation for Standardisation (ISO) as part of the MPEG specification.

Compared to MPEG Layer-3, popularly known as MP3, AAC provides higher quality music while requiring approximately 30% less storage and/or bandwidth.

For further details, check: **<www.arm.com>**.

Contact: ARM,
Tel: (01223) 400400.

High-Tech Industry Leaders Announce Open Internet Exchange

Twelve high-tech industry leaders have announced their intent to launch an independent company that will operate an open Internet exchange to serve the needs of the high-tech supply-chain community.

The 12 companies are: AMD, Compaq, Gateway, Hitachi, Hewlett-Packard, Infineon, NEC, Quantum, Samsung, SCI Systems, Solectron and Western Digital.

The new venture will provide services to buyers and sellers involved in computing and electronics-related industries. The exchange is expected to enable these businesses to manage their supply chains more efficiently and effectively, improve delivery of products and services to the marketplace, and increase customer satisfaction.

An estimated £370 billion in online business-to-business sales of high-tech components and parts will occur over the next few years, making this the world's largest e-marketplace opportunity.

The founding companies are some of the world's largest buyers and suppliers of computer and electronics components and products and have developed considerable expertise in efficient procurement and sales.

For further details, check: **<www.hp.com>**.

Contact: Hewlett-Packard,
Tel: (01344) 773100.

1... Limited Consortium Gains European Union Award

A multinational consortium of seven partners, led by 1... Limited the Cambridge-based digital loudspeaker company, has been awarded a total of £1.3 million, under the European Commission's Framework Five programme, to develop high performance piezoelectric array devices for digital loudspeakers and steered array antennas.

The seven partners are: 1... Limited (Cambridge, UK) which acts as Scientific and Technical Coordinator, University of Birmingham (UK) also acting as Finance & Administrative Coordinator, Haikutech Holding B.V. (Reijmerstok, The Netherlands), Marconi Caswell Limited (Caswell, UK), ESPCI Laboratoire Onde et Acoustique (Paris, France), UMIST (Manchester, UK), and University of Erlangen-Nuremberg (Germany).

The principal areas of investigation are high performance, large-excursion piezoelectric-ceramic linear transducers for acoustic and phase-shifting functions, control electronics for transducer driving, and aerogel sound absorber development.
For further details, check: **<www.uno.to>**.
Contact: 1... Limited,
Tel: (01223) 422290.

NASA Plans Next Giant Leap for Mankind

NASA's Marshall Space Flight Centre in the US is developing space sails technology to power a mission beyond our solar system.

The interstellar probe will travel over 23 billion miles - 250 astronomical units - beyond the edge of the solar system. The distance from Earth to the Sun, 93 million miles, is one astronomical unit.

For perspective, if the distance from Earth to the Sun equalled one foot, Earth would be a mere 6 inches from Mars, 38 feet from Pluto, 250 feet from the boundaries of the solar system, and a colossal 51 miles from the nearest star system, Alpha Centauri.

This first step beyond our solar system en route to the stars has an estimated trip time of 15 years. Proposed for launch in a 2010 time frame, an interstellar probe - or precursor mission, as it's often called - will be powered by the fastest spacecraft ever flown.

Zooming toward the stars at 58 miles per second, it will cover the distance from New York to Los Angeles in less than a minute.

It's more than 10 times faster than the Space Shuttle's in-orbit speed of 5 miles per second. Travelling five times faster than Voyager - a spacecraft launched in 1977 to explore our solar system's outer limits - an interstellar probe launched in 2010 would pass Voyager in 2018, going as far in eight years as Voyager will have journeyed in 41 years.

Thin, reflective sails could be propelled through space by sunlight, microwave beams or laser beams - just as the wind pushes sailboats on Earth. Rays of light from the Sun would provide tremendous momentum to the gigantic structure.
For further details, check: **<www.nasa.gov>**.
Contact: NASA,
Tel: +1 256 544 2121.

Abilitynet Widens Disabled Access

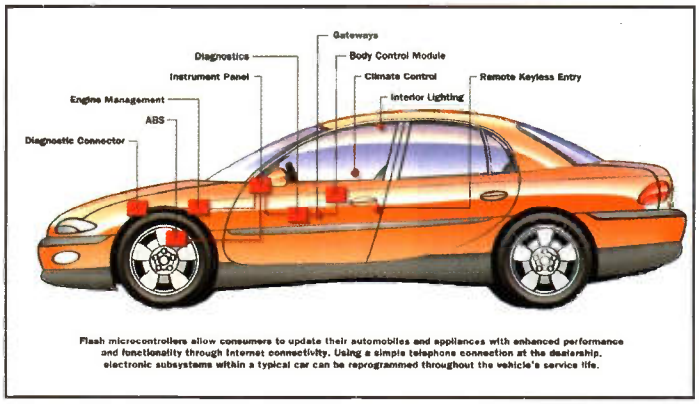
People with disabilities will be able to learn using new technologies more easily, thanks to the appointment of charity AbilityNet to provide support to the Department for Education and Employment (DEE) in the initial phase of its £252 million ICT (Information and Communication Technologies) Learning Centres initiative.

ICT Learning Centres aim to give adults who have little or no access to new technologies, the opportunity to learn computer and other ICT skills.

Around 700 ICT Learning Centres will be set up in local communities across England from September 2000, to suit local needs and current provision. A range of early projects, including 13 Pathfinder centres, are currently testing out approaches to setting up and managing ICT Learning Centres.

AbilityNet is providing staff and disabled clients of these early 'Pathfinder' learning centres with specialist hardware and software for the adaptation of PCs, plus training, advice, telephone and Web site backup. The lessons learned here will help to inform the development of provision for staff and disabled clients in ICT Learning Centres over the next two years.
For further details, check: **<www.abilitynet.co.uk>**.
Contact: AbilityNet,
Tel: (0800) 269545.

Chips with Everything



Flash microcontrollers allow consumers to update their automobiles and appliances with enhanced performance and functionality through Internet connectivity. Using a simple telephone connection at the dealership, electronic subsystems within a typical car can be reprogrammed throughout the vehicle's service life.

A new wave of electronics intelligence is bringing Internet connectivity to hundreds of household appliances thanks to exploding demand for flash-memory microcontrollers.

The average household already owns more than 150 microcontrollers, the ubiquitous low-cost chips that provide electronics intelligence to thousands of applications, such as dishwashers, garage door openers, remote controls, and motorcars.

By incorporating flash program memory on the chip, the microcontroller has the ability to reprogram itself, allowing consumers to upgrade these appliances with new features and functionality.

This can be accomplished in the home or anywhere by downloading software via the Internet through a telephone line into the appliance

In order to stay ahead of the strong demand for flash microcontrollers, Microchip Technology announces it is quadrupling its flash microcontroller portfolio.

Using the performance of flash microcontrollers, many consumer appliances can be upgraded with additional capability.

For example when a vehicle is brought in for service, the technician may be required to upgrade the body control module. Typically the body control module is removed and replaced with a newer version. This increases cost on the service.

But by utilising an under-bonnet connector and readily available tools on hand at the dealerships, the new software can be 'downloaded' through the under-bonnet connector and into the flash memory in a very controlled environment

For further details, check:
<www.microchip.com>.
Check: Microchip,
Tel: (0118) 921 5800.

Motorola Launches Interactive Communicator

The Talkabout T900 is a personal interactive communicator from Motorola, that incorporates low-cost two-way wireless messaging capabilities.

The compact, keyboard-based device enables users to send and receive text messages and Internet e-mail - as well as request up-to-date information from the Web.

For further details, check:
<www.motorola.com>.
Contact: Motorola,
Tel: (0500) 555555.

Nokia Enables Access to WAP

Nokia has announced a new feature for the Nokia WAP Server 1.1 - 'Nokia Activ', a one-button solution that enables Web sites to send WAP service settings, over-the-air, to Wireless Application Protocol (WAP)-enabled mobile phones.

The feature makes offering and using WAP services very easy for both companies and consumers. With Nokia Activ, companies and organisations can immediately offer their services and information to large numbers of mobile phone users in an easy manner.

Consumers would simply click the Nokia Activ button on a Web site and type in their mobile phone number. The settings of the service are sent over-the-air to the customer's WAP-enabled phone as a text message.

WAP is a global standard for communication between a mobile handset and the Internet or other computer application. WAP-based technology enables the design of advanced, interactive and real-time mobile services, such as mobile banking or Internet-based news services, which can be used in digital mobile phones or other mobile devices.

The WAP specification allows solutions from multiple suppliers to perform consistently and reliably for the end-user across digital networks. For more WAP information visit
<www.wapforum.org>.
For further details, check:
<www.nokia.com>.
Contact: Nokia,
Tel: (020) 7437 4380.

NEWS BYTES

Manchester Airport in Explosive Detection Deal

InVision Technologies, has received an order valued at approximately £1 million from Manchester Airport for a CTX 5500 DS explosive detection system.

InVision Technologies develops, manufactures, markets and supports explosive detection systems based on advanced computed tomography technology for civil aviation security.

For further details, check:
<www.invision-tech.com>.

Contact: InVision Technologies,
Tel: (020) 8754 9540.

Alcatel and Cambridge Silicon Radio in Bluetooth Deal

Alcatel and Cambridge Silicon Radio (CSR) have announced that Alcatel's Bluetooth-enabled OneTouch 700 and OneTouch 500 GSM phones will contain Cambridge Silicon Radio's BlueCore01 single-chip Bluetooth IC embedded into a battery pack.

Initially, Alcatel plans to use the Bluetooth functionality in the phone for cordless headsets and communication between the phone and Bluetooth-enabled handheld, notebook and desktop PCs.

For further details, check:
<www.cambridgesiliconradio.com>
Contact: Cambridge Silicon Radio,
Tel: (01223) 424167.

Intel Introduces 933 MHz Pentium III

Intel has introduced the Intel Pentium III processor at 933 MHz. This new processor delivers high performance and is available in high volumes in systems from a wide variety of personal computer manufacturers.

The Pentium III processor at 933 MHz is designed to power advanced desktop software for home and business, including entry-level workstation applications.

For further details, check:
<www.intel.com>.

Contact: Intel,
Tel: (01793) 403000.

NEWS BYTES

£4 million For New Mobile Phone Initiative - Hewitt

E-Commerce and small business minister, Patricia Hewitt has announced a £4 million research programme into the future development of mobile phone technology.

The programme will be carried out by the Mobile Virtual Centre of Excellence in Mobile and Personal Communications (Mobile VCE). The Government is contributing £1.5m. The rest is being supplied by Mobile VCE's industrial members.

For further details, check: <www.dti.gov.uk>.

Contact: DTI, Tel: (020) 7215 5000.

PC Shipments to Grow by Almost 50%

The European personal computer market shows continued strong growth over the next five years, according to the latest forecast by Dataquest.

With a five-year compound annual growth rate of 10.5% in shipments over the forecast period of 2000 to 2004, unit volumes will continue to achieve successive, new, annual records. PC shipments are forecast to surpass 45 million units in 2004.

For further details, check: <www.dataquest.com>.

Contact: Dataquest, Tel: (01784) 431611.

Microsoft to Adopt Biometric Technology

Microsoft plans to incorporate biometric technology in its Windows software that will enable users to sign on by brushing their fingertips across a scanner rather than typing in a password.

Biometric technology scans the details of a person's fingerprints, iris patterns, facial structure or other physical characteristics and compares them against a database of stored user information.

For further details, check: <www.microsoft.com>.

Contact: Microsoft, Tel: (0870) 601 0100.

Rio Digital Audio Receiver Streams Stored Music

The Rio Digital Audio Receiver from Diamond Multimedia enables consumers to stream CD-quality music from a PC to any room in the house. The receiver works with existing phone lines to distribute the digital music collections beyond the home computer.

To date, consumers have only had access to portable players as a way to hear their digital music beyond the PC. Now, consumers can play digital music selections in any room where a Rio Receiver can be placed.

With multiple receivers, various digital music selections can be sent to different locations simultaneously. Individuals can choose what music they want streamed to each Rio Receiver by scrolling and searching their stored collection via controls on the unit, or by using the receiver's remote control.

For further details, check: <www.diamondmm-europe.com>.
Contact: S3, Tel: (0118) 9444444.

Fujifilm Launches Latest Compact Digital Camera

Fuji Photo Film has announced the latest addition to its 700 series of digital cameras - the FinePix 4700 ZOOM.

The FinePix 4700 ZOOM is the first digital camera to utilise Fujifilm's new Super CCD for increased sensitivity, improved signal-to-noise ratio and wider dynamic range, attributes that result in sharp, vivid and colourful pictures.

For further details, check: <www.fujifilm.com>.
Contact: Fujifilm, Tel: (020) 7586 5900.

Why Aluminium Doesn't Rust

Did you ever wonder why aeroplanes never seem to rust, despite their constant exposure to rain, sleet and snow? The quick answer is that most aircraft are made of aluminium - a chemical element that seems to resist corrosion even when exposed to air and water.

But the fact is that pure aluminium reacts so readily with water that, according to the laws of chemistry, the aluminium shell of an aeroplane should actually dissolve in the rain.

Fortunately for the airline industry, when aluminium metal is placed in the atmosphere, a thin layer, known as aluminium oxide, forms on the metal's surface and acts like a protective, rust-resistant shield.

Scientists have long known that aluminium oxide does not corrode rapidly in water, but they have been unable to fully explain why.

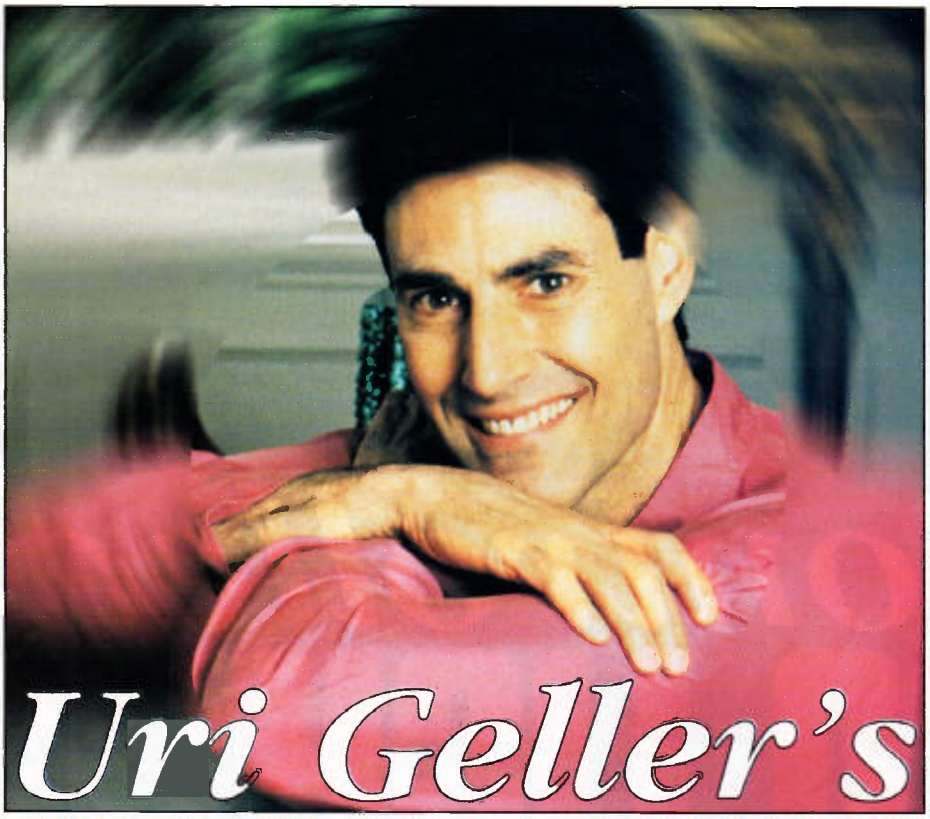
Now, for the first time, researchers have shown that liquid H_2O has a surprisingly potent effect when it comes in contact with the surface of a metal oxide, a finding that has industrial and environmental implications.

Writing in the journal Science, researchers from the University of Chicago present the first atomic-level model of what happens when water and aluminium oxide meet.

Shifting atoms Aluminium oxide consists of atoms of aluminium and oxygen bonded together. But Brown and Trainor discovered that, when water molecules come in contact with aluminium oxide, the aluminium and oxygen atoms on the surface move apart - in some cases separating by more than 50% compared to their normal molecular positions.

As a result, when the outer layer of aluminium oxide gets hydrated or wet, its structure changes just enough to become chemically inert and thus unable to react rapidly with additional water molecules or atmospheric oxygen. This change in molecular structure is why aluminium oxide metal resists corrosion.

For further details, check: <www.sciencemag.org>.
Contact: Science Magazine, Tel: +1 202 326 6417.



Uri Geller's EXTENDED REALITY

Thoughts Through Space

In April, BBC Radio 2 invited me (at rather short notice) to come into the studio for a chat with Lynn Parsons about an item that had appeared in The Independent (17 April) headed 'Arctic explorer tries to be a mind reader.' It described how Arctic explorer David Mill had just set off from somewhere in Canada in an attempt to break the record for a solo walk to the North Pole, which meant that he would have to cover 420 miles in 55 days, arriving around mid-June.

It was not to be an entirely normal expedition. Mr. Mill, who studied psychology at London University, is also interested in parapsychology (the branch of science that reaches the parts other scientists cannot reach). He planned to while away some of the time he would spend tramping over the ice and snow in a series of attempts to record images being transmitted to him - not by radio, but by telepathy - from an unnamed team somewhere in the U.K.

At the end of the experiment, Dr Caroline Watt, a research fellow at the Koestler parapsychology unit at Edinburgh University, would study the results. She would assess whether Mr. Mill's impressions matched the images beamed at him to a significant degree, or if nothing more than chance/guesswork was involved.

Dr Watt mentioned that the experiment hoped to repeat that of the famous explorer Sir Hubert Wilkins back in the 1930s, who did indeed seem able to communicate mind to mind with a friend in New York.

Now, as it happens, I met that friend briefly soon after I arrived in the U.S.A. in the seventies, and did not know much about who was who in the psychic world. His name was Harold Sherman, a successful writer who also had remarkable abilities in the area of telepathy and clairvoyance. He had just published his ESP Manual (1972), one of the best practical guides to expanding the mind I know of. One of his dozen or so other books was Thoughts Through Space (1942) in which he tells the whole story of what has to be the most remarkable series of experiments of their kind ever recorded.

It all began when Wilkins was chewing the fat with his friend and fellow club member in New York about his forthcoming plan to search for a Russian aeroplane missing on a flight from Moscow over the Arctic Ocean. He knew that communication was going to be difficult - sunspot activity in 1937 was the highest recorded for nearly seventy years, meaning that his radio link would be very unreliable. It was in fact frequently knocked out altogether. So, Sherman, suggested, why don't we see if telepathy gets through when radio doesn't?

Wilkins liked the idea. He remembered from his boyhood in Australia that the Aborigines made regular use of telepathy and precognition, so he knew it could be done. Sherman was equally convinced by his many years' experience of psi phenomena, They agreed on a routine: Wilkins would keep a diary, sending it when he could in instalments to a third party for witnessing, and Sherman would note down his impressions picked up at prearranged times. These would also be witnessed as they were made, so nobody could accuse either man of fiddling with the data after the event.

Wilkins headed north on 25 October 1937, and over the next five months Sherman was able to record a total of 68 reports containing nearly 300 specific statements.

The results were astonishing. As Wilkins himself concluded "You seem to get all the very strong thoughts and sense the vivid conditions." Not surprisingly, Sherman got a lot about ice, snow, and cold, but some of his impressions seemed quite out of place. One evening, for example, he wrote "You in company, men in military attire... evening dress, important people... You appear to be in evening dress yourself."

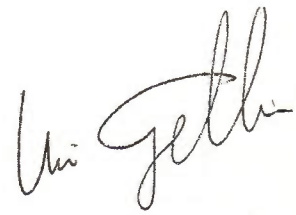
Who would imagine that an Arctic explorer would be in evening dress? However, on the evening in question Wilkins had been invited to an Armistice Ball attended by the local top brass - and yes, Wilkins was wearing a (borrowed) evening dress suit.

Soon after that direct hit, Sherman scored another. "Some kind of banquet ... seem to see it held in church... connection school, standing in front of blackboard, chalk in hand, you give short talk." At the time, Wilkins was attending a banquet in Missionaries' House, Point Barrow - about 4000 miles from New York - and that day he had given a short to talk to the local schoolchildren. Yet another 'coincidence', of course.

So it went on and on. Sherman made notes about a fire, a funeral, a ladder, and a diamond mine. Wilkins had seen both a fire and a funeral, had needed to use a ladder, and did have toothache. In fact, the only time when psi-communication seemed to go adrift was when they were doing some card-guessing. Wilkins found this tedious and clearly did not try very hard and results were close to chance.

This is just what Mr. Mill and his team is doing as I write (in May) and I would not be surprised if they got the same result, as I told Lynn Parsons in April. Wilkins succeeded because his survival was at stake and he had worked out a code for emergency signals which luckily he never had to use whereas Mr. Mill's team seem to be merely carrying out an academic exercise. And telepathy usually only works when it has to work.

Uri Geller's novelS *Dead Cold* and *Ella* are published by Headline at £5.99. *Mindmedicine* is published by Element at £20. Visit him at **www.uri-geller.com** and e-mail him at **urigeller@compuserve.com**



PC Controlled DISCO LIGHTS

Rob Heslop describes a simple to build disco light system for all budding DJs

Introduction

The following text describes an interface unit, which allows the user to switch a set of disco lights on and off, via a computer. The unit connects up to the LPT (printer) port on the back of almost any PC, and is controlled via a simple set of software commands. The two pieces of output software, detailed below, allow the lights to be manually turned on or off using the keyboard, or turned on and off automatically, in a series of predefined patterns.

PROJECT PARTS LIST

Resistors:		Miscellaneous:	
R1 - R8	680Ω	Tran1	Transformer Secondary 15V-0-15V 0-230V AC Primary
R9 - R16	390Ω 1W		Bulgin Sockets x 2
R17 - R24	330Ω 1W		25 pin D Plug
R25 - R33	39Ω 1W		Hood for Above
			9 Core Cable
			13A Mains Flex
Capacitors			13A Plug
C1 - C8	22nF 600V polypropylene		Single Core Mains Cable
C9	100μF 35V Electrolytic		Heat Shrink
C10	10μF 35V Electrolytic		Box
C11	100nF Polyester		Cable Glands
			Heat Sinks
			Strip Board
			Semiconductors
			Stand Off
IC1	2803		Hardware
IC2 - IC9	3041	FS1	500mA Fuse + Holder
TR1 - TR8	BC08A 600B	FS2	Fuse + Holder
IC10	LM7812		To suitable lamps used
D1 - D4	1N4001		

Circuit Description

The circuit is relatively simple as the LPT port outputs data on eight data lines (D0 - D7), along with read write, enable and such like. Luckily the port outputs the data constantly, unless it is instructed other wise, this means that no latches are required in the interface unit.

The LPT port connects directly into IC1 an octagonal Darlington buffer. IC1 was used because the output of a LPT port is at TTL levels, so a logic one can be less than 3V, which may not be enough to drive IC2 - IC9 the opto-isolators. The power circuit is a relatively common approach, and similar circuits have featured in several previous articles.

When current flows through the LEDs in IC2 - IC9 the triac stage starts to conduct, this is used in turn to activate TR1 - TR8, the power triacs. IC2 - IC9

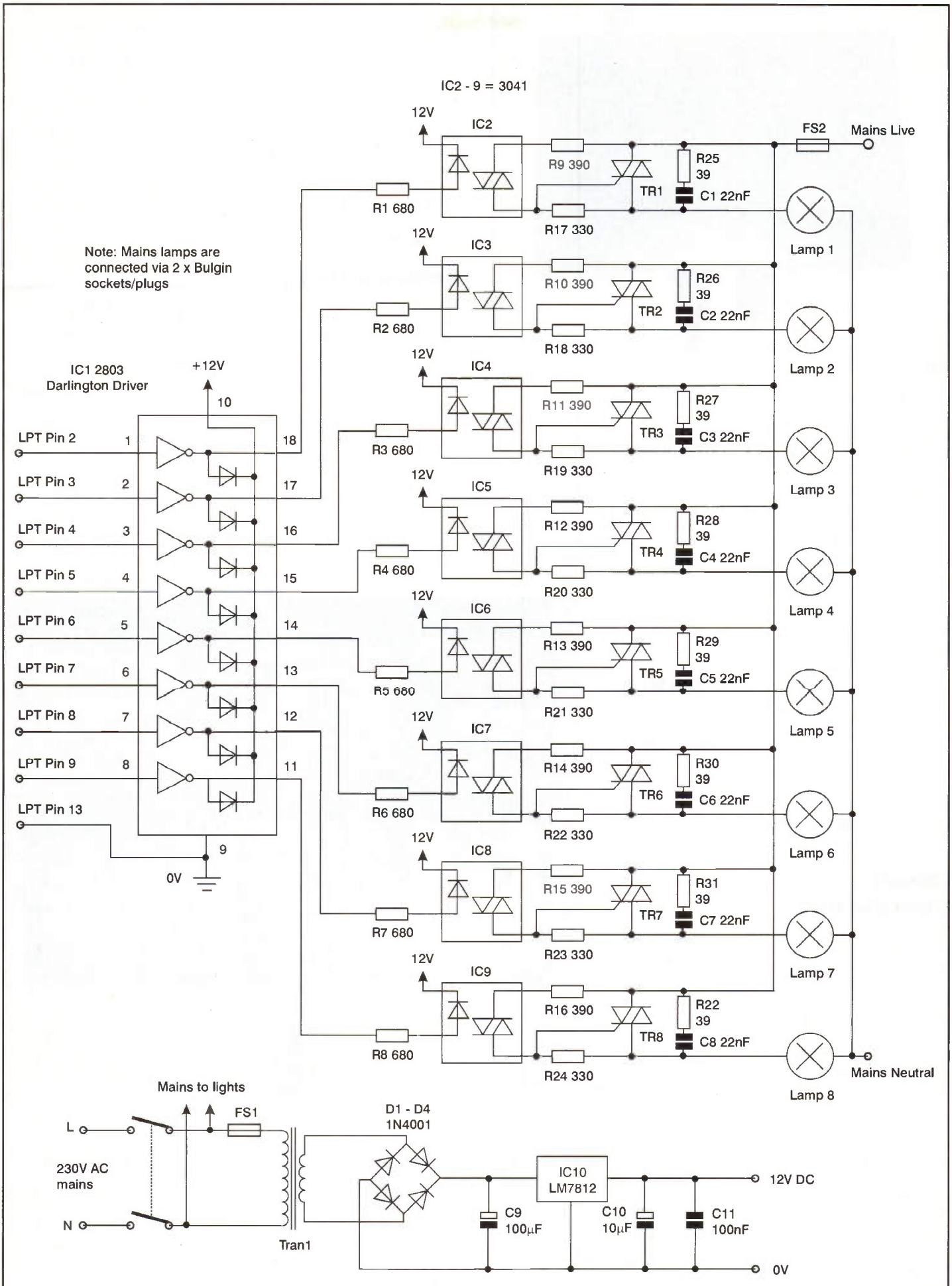


Figure 1. Complete Circuit

Box

not only electrically isolate the PC from the mains but they also eliminate the need to calculate the gate currents in TR1 - TR8. For the main triacs, BTA08 600Bs were chosen for a combination of power handling and the fact that they had isolated tabs, allowing common heat sinks to be safely used.

Resistors R9 - R24 connect the opto-isolators to the triacs, and limit the current. While resistors R26 - R32 and capacitors C1 - C8 act as traps, which remove mains spikes.

The power supply is based around IC10, an LM7812 voltage regulator, along which D1 - D4 which act as a rectifier. The resultant DC is first smoothed by C9, before being regulated by IC10, which produces a 12V output. Capacitors C10 and C11 provide high and low frequency decoupling, for the power supply.

Circuit Construction

When building the circuit great care should be taken as live mains can be fatal, and electrical safety procedures should be followed, refer to issue 83 for details on mains safety. The prototype circuit shown in the attached pictures was built on two strip boards, as PCB fabrication was not a viable option. To aid power handling the main triacs were not mounted on the boards and the current flowing on the boards was limited to a few mA. This increased the wiring greatly, but the safety aspect seemed to justify it.

Standard assembly procedure was used to build the boards, placing smaller components first; great care was taken to ensure no tracks were accidentally bridged. After the circuit boards were built, the triacs were mounted directly onto the heat sinks, and the whole circuit was connected up using single core mains cable. All mains connections were then insulated using heat shrink, to prevent risk of short circuits. The whole project was then mounted in an ABS box, with the output to the light being provided by two Bulgin connectors, one for channels 1 - 4 the other for channels 5 - 8.

Testing

After the circuit was built and checked for visual defects the whole thing was checked with a continuity tester, to make sure that there was no short circuits. Great care was taken at this stage as a short circuit could be fatal to the user or the PC. Iniitally, 5V was applied to each of the inputs in turn. The current flowing through R1 - R8 was then measured to be a couple of milliamps, which is about correct to supply the LEDs. The circuit was then connected to the mains, with load on each output (in this case a light bulb). Then 5V was applied to the appropriate input, to check weather the circuit was operating correctly. The last stage before connecting the interface up to a PC was to check for stray voltages on the 25-pin D connector, it's better to be safe than very sorry!

Software Design

The software for the interface was written in C and the two attached code listings allow the lights to either be switched on and off via the keyboard, or automatically turned on and off in a set pattern.

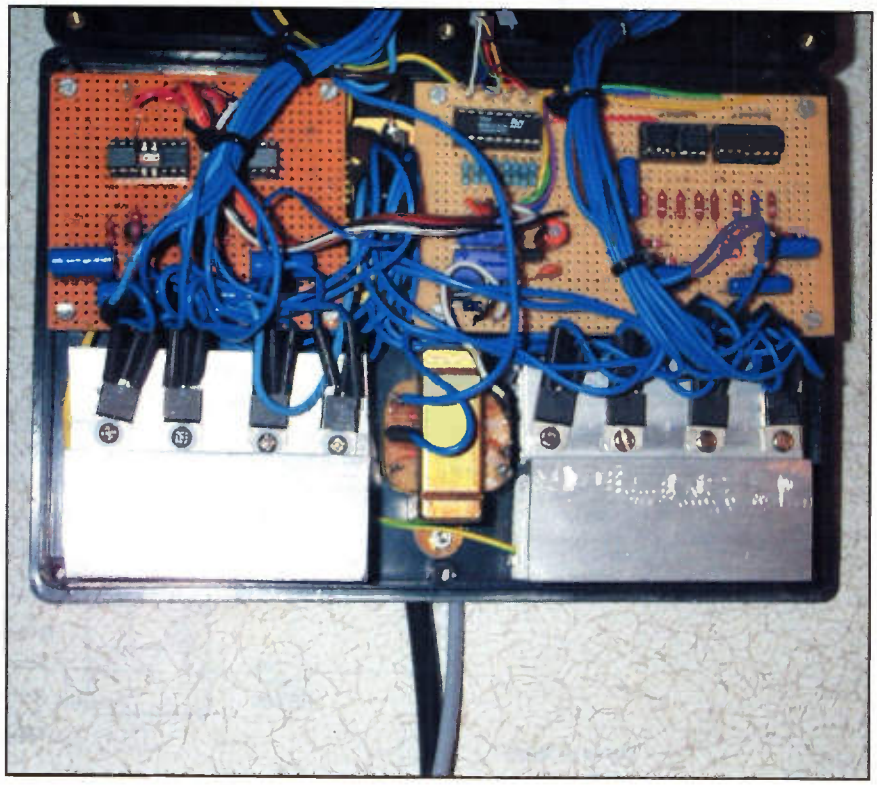
The codes are based around the instruction "outportb (0x378,'Y')". This instruction outputs the decimal value 'Y' on the LPT port in binary with data0 as the least significant bit. Based on which lights you require to turn on or off, you can output the appropriate value on the LPT port, see table 1.

Pin	Function	Pin	Function
1	E	14	R/W
2	Data 0	15	N/C
3	Data 1	16	RS
4	Data 2	17	E2
5	Data 3	18	GND
6	Data 4	19	GND
7	Data 5	20	GND
8	Data 6	21	GND
9	Data 7	22	GND
10	+5V	23	GND
11	+5V	24	GND
12	0V	25	GND
13	0V		

LPT Port Wiring

Important Safety Note

It is important to note that mains voltage is potentially lethal. Full details of mains wiring connections are shown in this article, and every possible precaution must be taken to avoid the risk of electric shock during maintenance and use of the final unit, which should never be operated with the box lid removed. Safe construction of the unit is entirely dependent on the skill of the constructor, and adherence to the instructions given in this article. If you are in any doubt as to the correct way to proceed, consult a suitably qualified engineer.



Internal details

Light No.	Light 1	Light 2	Light 3	Light 4	Light 5	Light 6	Light 7	Light 8
Decimal No.	1	2	4	8	16	32	64	128

For Example lights 3,4, & 7 on

Light No.	Light 1	Light 2	Light 3	Light 4	Light 5	Light 6	Light 7	Light 8
Decimal No.	1	2	4	8	16	32	64	128
Binary No.	0	0	1	1	0	0	1	0

= 4 + 8 + 64 = 76 decimal

Table 1

Switch Code (keyboard input)

```
#include <dos.h>            /* Contains the prototype for
outportb */

int main(void)        /* Main program */

{
int input, lite1=0, lite2=0, lite3=0, lite4=0;

/* Define the variables, ie. the lights and set them to
0 */

clrscr();  /*clears the screen */

gotoxy(25,12); printf("type 1-4 to turn lights 1-4 on or
off");
gotoxy(25,13); printf(" press Esc to exit ");

/* Print instructions in the middle of the screen */

do    /* Start of loop */

input=getch();   /* Read ASCII value from keyboard */

     {
     if (input==49)              /* Do the following
when 1 is pressed */
          if (lite1==1) lite1=0;     /* If light 1 is
turned on turn it off */
          else lite1=1;         /* Else turn it on */

     if (input==50)              /* Do the following
when 2 is pressed */
          if (lite2==2) lite2=0;
          else lite2=2;

     if (input==51)              /* Do the following
when 3 is pressed */
          if (lite3==4) lite3=0;
          else lite3=4;

     if (input==52)              /* Do the following
when 4 is pressed */
          if (lite4==8) lite4=0;
          else lite4=8;

     outportb(0x378, (lite1 + lite2 + lite3 + lite4));
/* Set the output on the LPT port based on which
lights are turned on */

     }
while(input!=27);          /* Repeat loop until Esc
is pressed */

outportb(0x378,0);    /* Set the output on the LPT
port to 0 */

return 0;             /* End program */
}
```

Run Code (automatic switching)

```
#include <dos.h>       /* Contains the prototype for
outportb */

void main(void)        /* main program */
{

do                     /* start loop */
{
outportb(0x378,1);     /* Turn light 1 on only */
delay(300);               /* Wait 300ms */
outportb(0x378,2);     /* Turn light 2 on only */
delay(300);               /* Wait 300ms */
outportb(0x378,4);     /* Turn light 3 on only */
delay(300);               /* Wait 300ms */
outportb(0x378,8);     /* Turn light 4 on only */
delay(300);               /* Wait 300ms */
}
while (!(kbhit()));    /* repeat loop until any key is
pressed */

outportb(0x378,0);     /* turn all lights off */
}
```

It is worth noting that 0x378 is the LPT port address in hex, it may differ from PC to PC although 378 is becoming standard (some PCs have 278). If you are not sure what the value can be, check in settings/control panels/ system/device manager/ports.

Either of the example codes can be compiled and run as they are, or with a bit of imagination they can be adapted to the requirements of the individual user. Also precompiled software is available to download from the Internet at **www-users.york.ac.uk/~rah110/**

MINICRAFT®

MINI REVIEW

Circular Saw Table

Ever wished you could cut your piece of modelling wood or metal in a straight line and at speed without the hassle of using a small handsaw? If the answer is yes then this 0-18VDC 100watt Circular saw bench just has to be an ideal accessory; not just for modellers but for general innovative small time use aswell. Not only will it cut balsa wood or small pieces of wood but it will cut plastics, PCB boards and metal too, all with ease. The 84 tooth saw blade provided here would cut plastics, fine wood and non-ferrous metals up to 2mm. The second saw blade will cut coarse woods and other soft materials up to 5mm. The parallel and bevel guides provided gives you the flexibility to cut at a variety of different angles. The saw runs from a 0-18V DC supply and Minicraft make two power supplies that will operate it There is a 24VA Variable Supply (Maplin Order code XP19) or 50VA variable supply (Maplin Order code BA83).

The Circular saw table is available from Maplin Electronics.

(Order code XP18U Price £53-99

High Precision Drill Kit

If you don't have a mini drill for modelling purposes then this kit is a good starter pack. For the carrying case contains a 100watt 12V hand-held drill, variable power supply and 40 useful accessories. These accessories will perform drilling, cutting, grinding, routing, shaping, polishing and sanding. The drill is particularly useful for drilling out PCB component holes, cutting and shaping PCB boards and case holes, trimming and polishing front panels and de burring holes in metal cases. A range of other accessories are available for the drill. See the Maplin catalogue for details.

This kit is available from Maplin Electronics.

(Order Code XP20W Price £84-99)

Engraving and Security Kit

For all you budding Leonardo's that fancy decorating your wineglasses or the glass fanlights over the door, this engraver is a must for the creative artist and illustrator. You can even create your favourite designs on copper sheet and then buff it up using the Minicraft polishing tool. Security marking video recorders or any other item of value is an easy task. The kit comes complete with 3 tools and an alphanumeric stencil. The kit is available from Maplin Electronics.

(Order code BA86T Price £29-99)

Software HINTS & TIPS

by Mike Bedford

Word 97 can't actually write for you but some of its facilities come close.

Here we look at the various language tools.

I guess just about everyone who uses Microsoft Word makes use of the spell checking facility - after all, it's a simple matter of clicking on the 'tick' icon on the standard toolbar. However, there is far more to Word's grammar-related features than this alone. Our subject this month is making the most of the language tools.

Checker Beware

If you are new to word processing and haven't actually made use of the spell checker yet, simply click on the following icon which you'll find at the top of the screen.

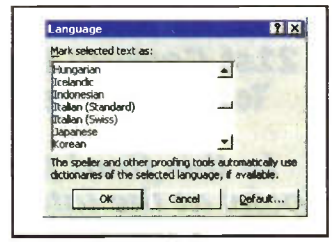
Word will then look at every word in your document (or in the selected portion if you highlighted a section of the text first), and will stop at every word which it doesn't recognise as a word of the English language. Normally it suggests some words which you might have meant and you can either pick one of these, type in your own correction, or tell it to ignore the erroneous word. You would normally use this latter option because the word in question is one you know to be correct even though it isn't in Word's dictionary. Place names are a common example of 'wrong' words you would tell it to ignore.

I guess that most Word users will be familiar with the spell checker at this level. However, there are some traps it is all too easy to fall into - the spell checker isn't a universal panacea. Some people object to spell checkers on the grounds that it conditions people to be lazy. However, I am not thinking about the effect it may have on standards of literacy. It is all too easy to accept one of Word's suggested 'corrections' without looking at it properly. In cases like this you could end up with a document which contained no wrongly spelt words but does contain some words which are not the ones you intended. It's a wise precaution, therefore, to re-read a document once you've checked it, just to make sure that you haven't got some totally wrong words in there due to an incorrect correction. Another option, which is provided when Word finds a suspect word, is to add it to the dictionary. Now, every time Word comes across the word in the future, it will no longer flag it as a potentially wrong word. However, this is another area in which care is necessary. Before pressing that Add button, do double check that you had genuinely spelt the word correctly. If you had not and you clicked on Add, Word will not recognise it as wrong if you spell the word in the same wrong way in the future.

Foreign Languages

If you write in languages other than English, then there's clearly no point in spell checking your document in the normal way since a very high proportion of words which are correctly spelt will be flagged as potentially wrong because they're not in Word's dictionary of English words. If you're a foreign user writing in a language other than English all the time then Windows will have been configured accordingly and Word will use the appropriate spell checking dictionary. However, there are ways of telling Word to spell check a document or a part of a document using a foreign language dictionary, even if you normally work in English. To do this, highlight the portion of text you want to be marked as a particular language and select Tools > Language > Set Language... Now simply select the required language from the following list that will be displayed.

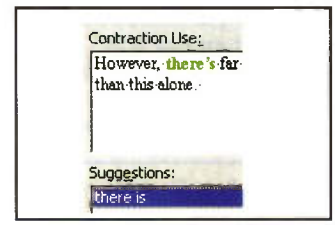
You'll notice that there are some pretty obscure languages listed. In fact it is highly unlikely that you will need to write in a language which isn't



included (except, of course, for languages which don't use Latin script and which, therefore, need a specialist word processor). However, in all probability, unless you have installed it already, the appropriate dictionary won't be on your system. To check, just try to spell check your document - if Word complains that the dictionary is missing you will have to buy it from Microsoft. Specialist dictionaries containing, for example, medical terms, are also available.

Grammar

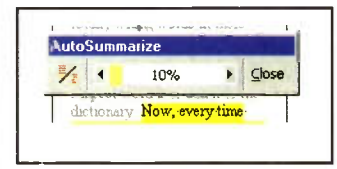
In addition to checking the spelling of a document, you can also check the grammar. Although this facility can be useful, though, be aware that grammar checking is much more difficult than spell checking so the suggestion should be treated with rather more caution. To check the grammar along with the spelling select Tools > Options... > Spelling & Grammar and then, in the lower portion of the window, check the Check Grammar with Spelling box. You can also select the style of writing from the Writing Style list box - Word will use different rules for a formal document from the ones it would use if you're aiming for a casual writing style. Now, when you do a spell check, the grammar will be checked also. To differentiate the two, suspect grammar is highlighted in green whereas suspect spelling is highlighted in red as usual. In the following example, I had selected a formal writing style and Word had objected to my use of a contraction - i.e. 'there's' instead of 'there is'.



Summarisation

Another facility you might like to experiment with is the auto-summarisation tool. Personally I've not found it to be particularly effective but you may just find a use for it. In theory it's meant to pick the key points from a document to produce a shorter summary. You tell it the size of the summary required and whether you want the summary to be highlighted, the summary to be inserted at the top of the document, the summary to be written to a new document, or all but the summary to be hidden. To try this out, select Tools > AutoSummarize... Here I've asked word to produce a 10% summary of this document but I've got to say that the sentences highlighted are not the ones I'd have chosen.

As usual, I've only managed to scratch the surface with this single page introduction to



Word's language-related features. And as usual, my suggestion is for you to delve further yourself to discover more of these facilities. I've already mentioned the Spelling & Grammar tab of the Options... window which is found on the Tools menu. This would be a good place to start your voyage of discovery. Here you can choose to check spelling and grammar on the fly, you can tell it where to store words you want to add to the dictionary, and you can even be very specific in selecting which rules you want Word to use for checking spelling and grammar.

RESEARCH NEWS

by Dr Chris Lavers

21st Century Liquid Crystal Displays Today for the Needs of Tomorrow

In this final part, Dr. Chris Lavers looks at the latest LCD technology and what we can expect in the future.

In Part A of our short look at the dramatic developments in Liquid Crystal Display (LCD) technology we looked briefly back to the origins of the different kinds of liquid crystal phases, first noted by Reinitzer in 1888: particularly the nematic, cholesteric, and the smectic phases. In this second part I want to look into the possible future of LCD applications and liquid crystal devices for sensing and communications applications.

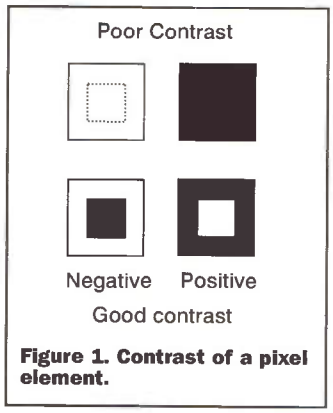


Figure 1. Contrast of a pixel element.

Passive LCD Technology

Currently the industrial electronics marketplace is the singlemost largest user of passive LCD technology. This technology includes dichroic, twisted nematic (TN), supertwist nematic (including STN, FSTN, and DSTN), some of which we shall be looking at in a little more detail. There is growing interest in Thin Film Transistor (TFT) or Active Matrix LCD's due to increases in possible switching speed and display stabilisation. Active TFT technology, as opposed to conventional passive matrix technology, also helps to 'stabilise' the pixel (display element) state until 'readdressed' with a fresh applied voltage, which combined with bistable ferroelectric liquid crystals helps to maintain the highest black/white 'contrast ' ratios possible.

Some discussion of image contrast and display segments is useful. Contrast is the ability to clearly distinguish the display element against its background in either a positive or negative format. Basically to see the pixel against its background it must be either much lighter or darker than its background. This basic principle in fact applies to any energy band and not just in the visible. A thermal or radar image is only seen if the object being viewed or detected respectively is highly distinguishable from its background. The sections of the LCDS that act as microscopic shutters turning 'on' or 'off' the display elements are known as segments. Segments are created by optical lithography and etching to produce transparent Indium Tin Oxide (ITO) electrodes patterned onto the internal LCD glass surfaces. Numbers and letters can be formed with only a 7-segment digit. A 16-segment digit can form all the numbers and letters, but a Dot Matrix (5 by 7 pixels) is often preferred as it creates a more aesthetically pleasing display script similar to conventional newspaper print (see Figure 2).

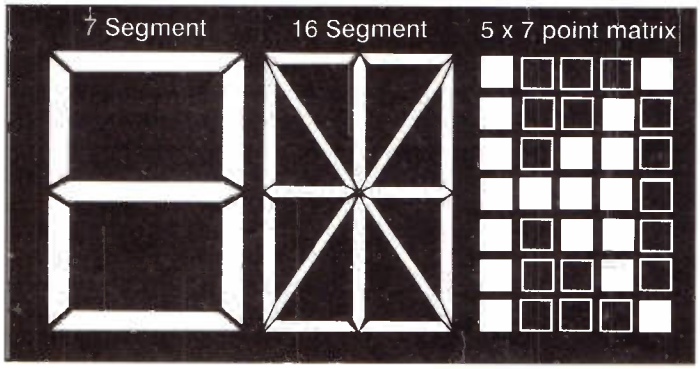


Figure 2 Pixel display types: a) 7-segment, b)16 segment,and c) Dot-Matrix segments. Courtesy Crystaloid.

A display screen made with a Thin Film Transistor (TFT) is a liquid crystal display now common in notebook and laptop computers that has an individual transistor for every pixel. Each tiny pixel element controls the illumination of your display. Having a transistor at each pixel means that the current that triggers pixel illumination can be significantly smaller and therefore can be switched on and off more quickly, and is more responsive to change. The most common example of this is when you move a mouse across the display screen, particularly a large display, a TFT display responds fast enough to match the mouse cursor movement. With a passive display, the mouse cursor momentarily disappears until the display can catch up with the change. The bigger the display the greater the delay. Displays are a vital part of industrial and personal consumer products throughout the world. They have now become major devices in the performance of computing, medical imaging and process control, and have become pseudonymous with electronic arcade entertainment and can be found in videos, kitchen appliances and portable computers, not forgetting the digital wristwatch. Recent single TFT panels have been fabricated with a diagonal a little over 28 inches. Philips TFT programme involves universities in Paris, Rome, the Einhoven University of Technology in Holland and the Dutch Polymer Institute. The first TFT was made in the USA back in 1972 using the semiconductor Cadmium Selenide.

According to a recent publication the value of worldwide shipments of electronic displays was $35.9B in 1998 and is projected to grow to $46.4B by 2001, reflecting an average annual growth rate of 9%.

The market for this astonishing growth in electronic displays is driven by the high value applications of TV and information processing. Continued growth is projected for displays as consumers increasingly invest, rightly or wrongly in what they regard as high technology products. Although heralded for at least a decade as the successor to the Cathode Ray Tube, the CRT remains robustly resistant to attacks from this relatively 'new-comer' of liquid crystal flat panel technology. A mature attitude would be to consider the relative merits of the two different class of device for the particular application in mind. The reality is that there is more than enough marketshare for both technologies to grow well into the next decade at least. To be fair penetration of the CRT market by flat panel displays has been increasing for the last couple of years. Flat panel technology is becoming less pseudonymous with liquid crystal displays, as new display technologies, such as plasma, vacuum fluorescence, light emitting diodes, electroluminescent materials and field emission displays enter the market. However liquid crystal technology still accounts for approximately 82% of existing flat panels sold globally. In 1998 flat panel displays sold valued 12.106 B$ and is projected to rise to 17.37B$ in 2001.

There are many monitor displays being developed currently by several leading

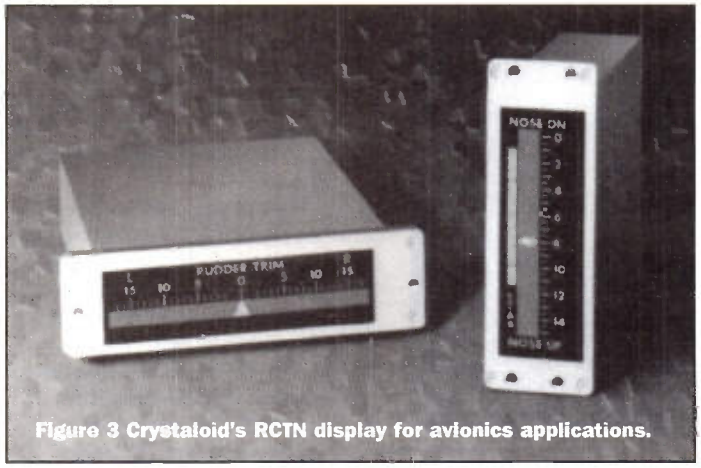


Figure 3 Crystaloid's RCTN display for avionics applications.

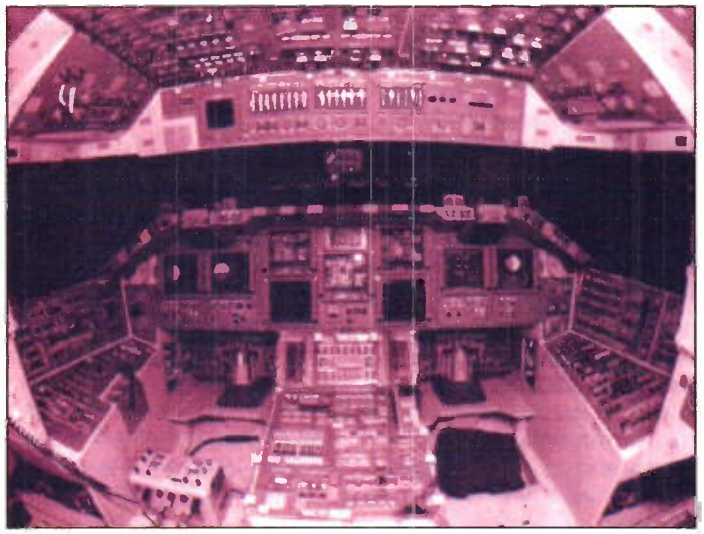


Figure 4 The glass cockpit installed in the orbiter Atlantis. The current Columbia upgrade will provide easy-to-read, graphic portrayals of key flight indicators such as attitude display and Mach speed. Courtesy NASA.

display manufacturers, including Sharp of Europe Limited in the UK, based near Oxford and Philips in Holland. Let us have a look at some areas of current and recent research by Oxford.

A Wristwatch-Type Personal Information Manager

This is basically an ultra small Personal information tool that can receive short range FM teletext broadcasts and includes a Personal Handyphone System acting as a portable phone. It will handle various types of information, and perhaps be compatible with Third Generation mobile phone technology - an area for an up and coming future Research News. In conjunction with developments of an ultra low weight, compact, high quality photographic lens LCD still-image camera with a fast half-duplex optical communications link will allow 2-way transmission and monitor applications. Screen update for this size of display is unlikely to present any technological problems. However, it must be noted that with the notable exception of video-conferencing applications, the videophone concept has not been especially well taken up by the general public who after all are the aimed end customers. Recently Motion Media has begun to offer a suitable video-conferencing phone for the higher quality end of the market and perhaps in the next few years children will grow up with this sort of technology and take it as the norm. Personally one of the few links I have seen is the not-quite real-time video-phone link between Goonhilly Earth station and Land's End in Cornwall! Sharp are also working on multimedia-compatible notebooks, using reflective full-colour LCDs, or 'industrial paper' exactly as a paper notebook, as well as being able to receive satellite broadcast communications, similar to GPS reception. This notebook has an advanced handwriting recognition feature that allows easy cut and paste editing and correction. Simple palmtop character recognition systems are now becoming quite common amongst executive types and are priced reasonably for wide availability in the next two or three years.

Several companies have developed modern versions of Twisted Nematic (TN) displays including Crystaloid in Ohio, USA. Their popular Reverse Contrast Twisted Nematic TM (RCTN TM) LCDs have extra wide viewing angles and high contrast ideal for avionic applications and have been used by aviators since 1994. Aircrew may need to glance over to displays at quite large incident angles to ascertain certain flight critical information (see Figure 3). NASA has taken this requirement a stage further for modifications on the recently refitted Space Shuttle Columbia, the oldest of the four shuttles and a veteran of 26 flights that should be completed by July 2000. The orbiter has been outfitted with a Multifunctional Electronic Display System (MEDS) or 'glass cockpit' - see Figure 4. Columbia follows the Shuttle Atlantis, which now has full-colour, flat-panel liquid crystal displays, installed on its flight deck. The new system improves crew interaction with the orbiter during flight and reduces the high cost of maintaining the outdated electro-mechanical cockpit displays currently on board. In addition a space-to-space orbiter radio and wireless video modification will increase communications capabilities for Columbia's future crewmembers and those outside working on the ISS assembly!

Cells Old to Modern

One of the first demonstrated liquid crystal devices was the voltage-dependent optical activity of a twisted nematic liquid crystal developed by Schadt and Helfrich working at Hoffmann-La-Roche Co. in Basel Switzerland in 1971. At high enough applied voltages for a liquid crystal filled cell with the surface alignments 90° apart, the applied voltage can cause the alignment in the bulk to be practically parallel to the field (see Figure 5). For 10μm thick samples transmission switched suddenly between a transmissive and a non-transmissive mode with only a mere 3V at a driving frequency of 1kHz.

Before TN displays could become commercially successful it was necessary to synthesise liquid crystals for room temperature operation. In fact early on it was established that LCD displays exported to Africa often failed because of unanticipated temperature induced phase changes! In 1972 George Gray and Ken Harrison at Hull University in the UK synthesised stable, colourless liquid crystal mixtures between -10°C to 60°C based upon so called cyanobiphenyl compounds. TN displays rapidly found niche markets in digital watches and

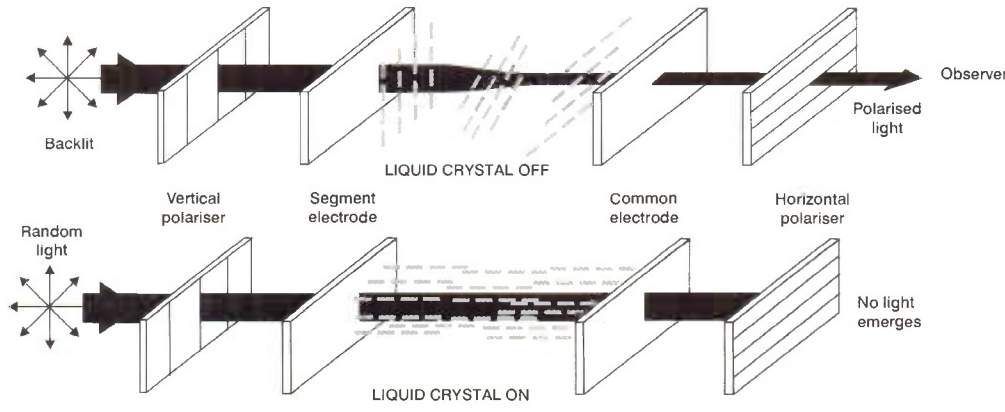


Figure 5 Twisted nematic cell without voltage and with voltage applied.

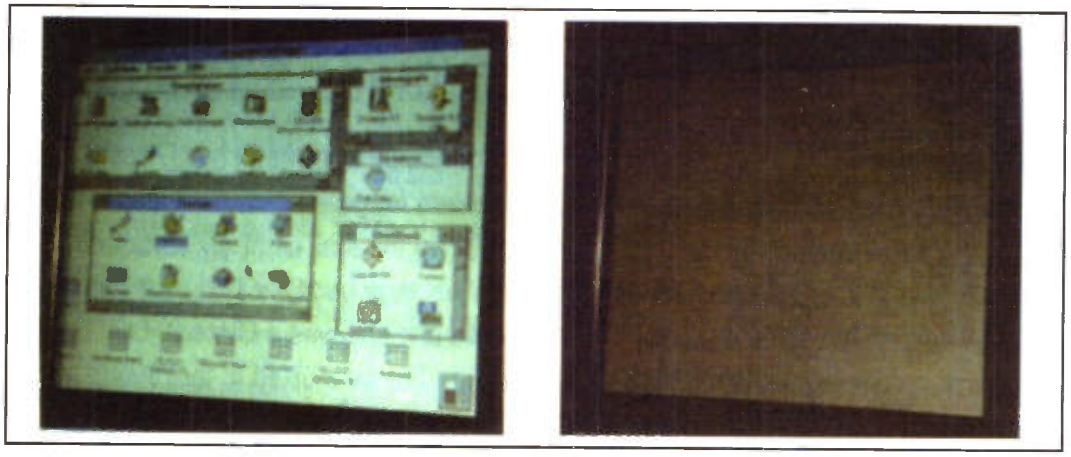


Figure 6 ATM PDLC display operated in a) wide viewing and b) narrow viewing display mode.

calculators fairly quickly. However, the number of display elements (pixels) that could be incorporated into the display was limited, and only overcome with the development of TFT active matrix displays.

At about the same time that Schadt and Helfrich were working on their nematic displays, Heilmeier in RCA Laboratories, Princeton, New Jersey had been less concerned with transmitted light but with scattering induced changes for reflective displays. However, with no electric field applied light is nonetheless transmitted. In its voltage applied or 'excited' state the liquid crystal material scatters the incident light, thus reducing the amount of transmitted light with 'on' to 'off' ratios greater than 20:1.

We reported recently in Research News a liquid crystal display providing a backlit system with variable viewing angles for Automatic Teller Machines (ATMs). The use of a Polymer Dispersed Liquid Crystal (PDLC) has a different luminance as a function of viewing angle in its scattering and transparent modes of operation (see Figure 6). In operation Dr Kalfass' display in Stuttgart is very impressive for 30 degrees viewing in wide viewing mode (scattering) and narrow restricted viewing mode (transparent). National Cash Registers has applied for a patent on the developments. The introduction of low molecular weight liquid crystals in a polymer matrix forms a new class of non-linear optical materials which have strong potentials in applications such as large-scale, low-cost, devices exhibiting high brightness without the requirement for polarisers as used in conventional cells. Polymer cells also make the cells more robust against bending and dropping! PDLCs can be switched electrically between opaque 'off' and transparent 'on' states. Liquid crystals form droplets whose size depends on the fabrication method used.

In the mid 1980's Yasayuki Okamura and his colleagues at Osaka University demonstrated that nematic liquid crystal coated flat or 'planar' waveguides could be used to demonstrate electro-optic switching with as little as 4V applied with fast switching times of only a few milliseconds, see Figure 7. Unfortunately this concept has developed little over 2 decades although the Optics Department at the Cybernetics Institute in Naples have demonstrated 'on' times of 400μs at a frequency of 100Hz. Nematic liquid crystals have also been used successfully to demonstrate an optical Spatial Light Modulator (SLM). A probe beam reflected from a surface adjacent to a nematic liquid crystal, which can be modulated with an applied voltage across the liquid crystal layer, will transfer the voltage modulation into a weak amplitude modulation of the reflectivity of the probe beam. Yeatman at Imperial College demonstrated this concept successfully in 1989. In addition in the late 1980s US workers led by Professor Noel Clark at Boulder in Colorado did start to look at ferroelectric liquid crystal coated waveguides with 'theoretical' faster switching times.

Although modelling of the liquid crystal alignment within nematic liquid crystals has been relatively well understood for some time, ferroelectric liquid crystals have not been so easy to fathom. Complicated analytical expression can be found to help describe the 'global' response of millions of nematic liquid crystal molecules in a variety of configurations. Such analytical expressions for the ferroelectric liquid crystal phase are few and far between and are mostly due to the patient and enduring work of Dr Frank Leslie at Strathclyde University in Scotland. Optical data and multilayer modelling for ferroelectric liquid crystal cells was developed by Elston and Sambles at Exeter University, UK. This enabled horizontal tilt, or so called in-plane tilt, of the molecular axis to be determined as well as the vertical (out-of-plane) tilt using a theoretical expressions similar in some respects to those used in nematic theory and then trying to fit real experimental data to various theory models!

In this way models were found that worked and more importantly models were found that began to help explain what was going on under an applied voltage. It turned out that the Vertical tilt took the form $(2/\pi)C$ arctan $(A\sin^2(z(\pi-B)/d+B)$, where $(2/\pi)C$ controls the maximum value of tilt, d is the half cell thickness, and A a function of applied rms voltage. The horizontal tilt is found in a similar way. In our own work, good comparisons of theory with data (see Figure 8) allowed values for the constants A,B,and C in the above expression to be found.

Out-of-plane tilt and in-plane tilt profiles can be obtained as a function of voltage - see Figure 9 - which shows typical tilt profiles for the ferroelectric liquid crystal MIX 783 in a 3.5μm thick cell as a function of applied voltage. Note the 'pinned' Chevron defect discussed in Part A clearly visible in the middle of the cell. Work conducted with conventional X-ray scattering shows that the defect is usually strongly pinned in the middle of the cell but some samples have been observed with a small shift to one or other side. Strange though it may seen the energy involved with a single abrupt discontinuity in the middle of the cell is less than that associated with any other likely cell defect or deformation.

Unfortunately, milliseconds switching speeds are too slow for modern communications requirements, although the use of nematic and cholesteric liquid crystals as sensing elements, usually temperature sensing are still under investigation. See part A for an encapsulated liquid crystal planar waveguide thermal sensor.

Workers at OptoSci Ltd in Glasgow and the Optoelectronics Division in the University of Strathclyde have demonstrated low voltage wavelength tuneable filters with the nematic liquid crystal E7 on a planar waveguide showing wavelength dependent transmission (see Figure 10). This may lead to a number of commercial devices for both sensors and communications applications.

In 1982 Dr Waters and Dr Peter Raynes FRS, Head of Liquid Crystal Research at DERA Malvern, developed the SuperTwist Nematic (STN). Liquid crystal molecules aligning in a cell between surfaces with a natural twist

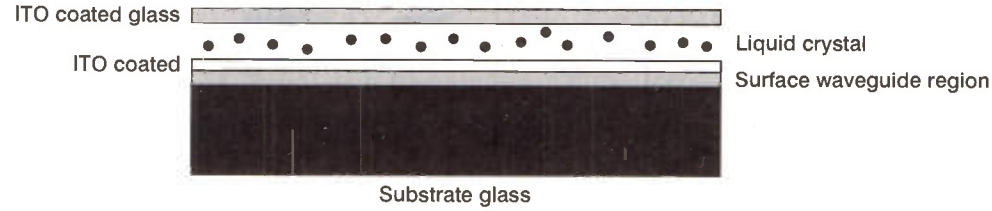


Figure 7 Electro-optic Nematic liquid crystal cell, PCH1132, incorporated into a planar waveguide.

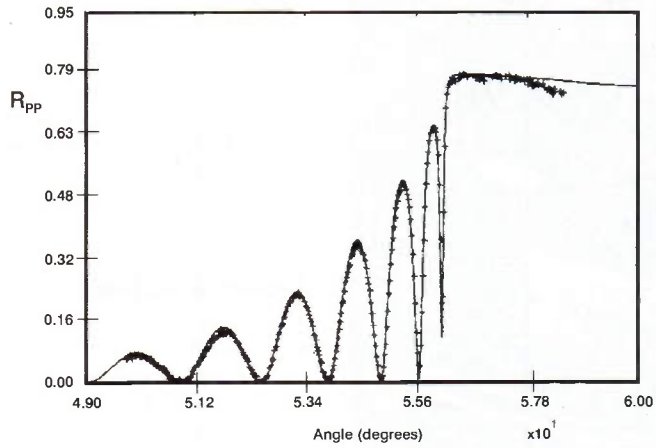


Figure 8 Reflectivity for incident TM polarised and reflected TM polarised radiation from a 3.5 micron thick ferroelectric liquid crystal cell.

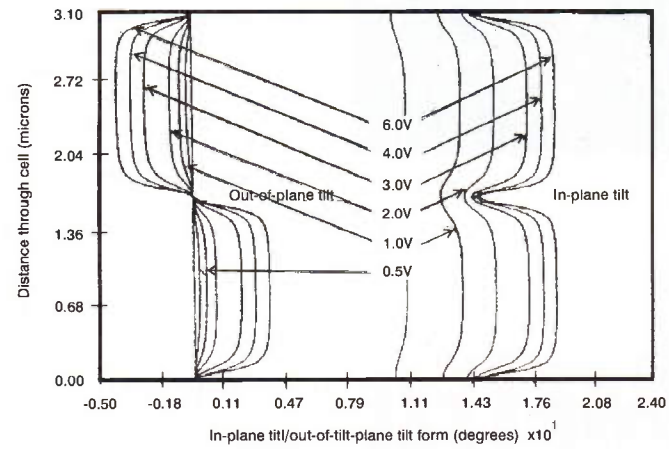


Figure 9 In-plane and out-of-plane tilt profiles as a function of applied voltage.

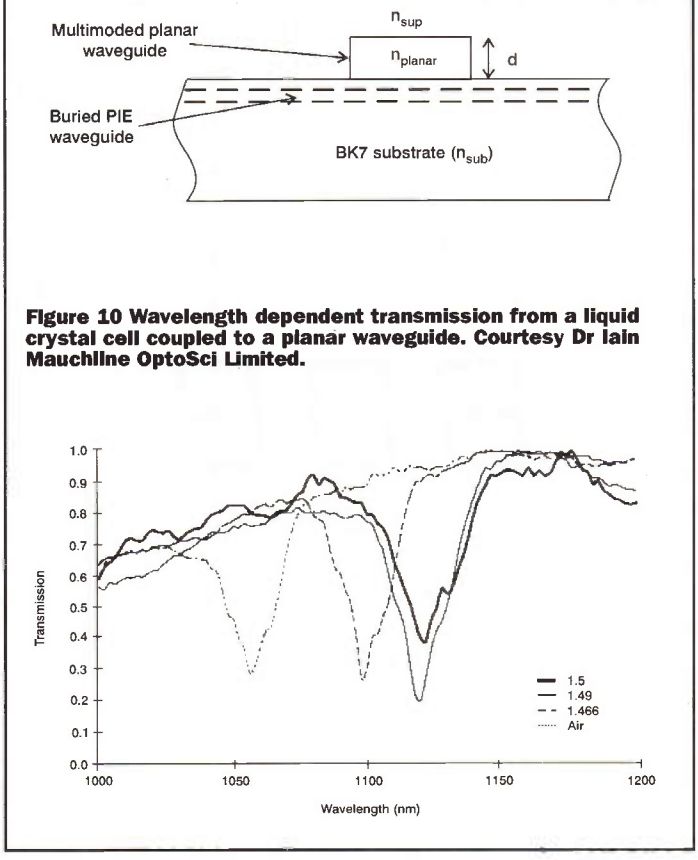


Figure 10 Wavelength dependent transmission from a liquid crystal cell coupled to a planar waveguide. Courtesy Dr Iain Mauchline OptoSci Limited.

anywhere between 240° to 270° gives better switching and makes them suitable for both notebooks and more recently mobile phones.

In terms of size LCDs can be divided into three categories - small, (less than 6in diameter) usually for telecommunications and handheld applications such as organisers; medium (6-14in) for applications such as laptop computers and large (greater than 14in) for desktops and TV sets. Small displays generally only require passive-matrix technology and must be low cost. However, the advent of 3G mobile phones and future 4G phones with their emphasis on information accessibility will probably change all this.

The Future and Beyond?

Finally a few ideas and likely possibilities for the future include windows or panels hung like paintings, which can be transformed into a backlit screen revealing beautiful pastoral images (or whatever you choose to see!) Such A3/A4 or even larger future displays could be controlled with software algorithms that could generate interesting and constantly evolving pictures. Imagine the Hay Wain by Constable going through Spring to Winter with activities taking place in the background from planting through to Harvest! Liquid crystal Heads Up Displays (HUD) will probably have widespread applications in virtual reality for fully interactive 3D virtual reality experiences. Philips have developed a multi-view 3D LCD. By adding a specially designed lens to the front of a high quality in-house designed LCD and using specially designed image processing software also developed by Philips Research, the display allows the viewer to see a 3D image without the need for special glasses (see Figure 11). Advanced computer software systems could even be combined with sound to help in teaching a variety of subjects, for example the history of an English town from the Roman period right up to modern times by giving immersion in historical scenarios.

There is certainly little doubt that LCD manufacturers are having a boom time with the explosion in demand for cellular phone displays. It is widely anticipated that production of LCDs for mobile phones will overtake notebook PCs by the end of 2000. In 2000 LCD sales for mobiles may be as high as 830M$ US compared with approximately 800 $M US for notebooks. However, notebook sales are still growing significantly year on year. One suggestion for both military and civilian displays applications is to provide head visor or 'see through' glasses displays where a variety of different types of information can be displayed more comfortably to the human operator. This information could be E-Mail, data, a high quality video-link image, and even ordnance survey map information. However, getting good viewing under a wide variety of illumination conditions and several decades of intensity is quiet a difficult challenge to achieve. Liquid Crystal Displays have truly revolutionised the portable instrument/computer/communications market in the last 2 decades and technological challenges for future applications offer a promising future for this now maturing technology.

Further information:

Motion Media videophone conferencing.
www.motion-media.com
Philips Research
www.research.philips.com/password
Dr T Kallfass University of Stuttgart, Germany.
Crystaloid Liquid Crystal Displays, 5282 Hudson Drive, Hudson, OH 44236-3769 USA.

Figure 11 Philips planned 3D LCD display. Courtesy Philips, Holland.

PROJECT

Velleman DIGITAL PANEL METER

John Mosely constructs this versatile, easy-to-build kit from Velleman

This is a very compact and easy-to-build 3-digit panel meter that can be used to replace a conventional analogue moving coil movement, or built into existing or new equipment such as power supplies, digital thermometers etc. The meter comprises of two similar size PCBs, one containing the input and driver electronics, and the other the display. The boards are held together by two long screws with spacers and connecting wire links. The screws are deliberately supplied long to allow fixing to a front panel. The meter requires a stable 5V/250mA DC supply, the accuracy of which will influence the accuracy/stability of the meter. The circuit diagram is shown in Figure 1.

FEATURES

- 5V/250mA DC max. power supply
- Range -99mV to +999mV full scale
- Null setting
- Overrange indication (positive and negative)
- 1mV resolution
- 0.1% linearity
- 100mΩ input impedance
- 20μV/°C temperature drift

Construction

Since there are minimal components, construction is very straightforward. On the component PCB a link has to be inserted near to IC2, followed by the three BC557 (or equivalent) transistors. The single capacitor in then soldered in followed by the two 16-pin IC sockets (it is important to check orientation here), followed by the supplied PCB pins for external connections to the power supply and input. Finally, the two preset resistors are mounted and soldered in.

The other PCB holds the three display modules, and again it is important to align the modules correctly. The position of the decimal point is marked on the PCB. The three resistors (Rx, value 330Ω) are not strictly necessary unless you do wish to provide a decimal point input, and adequate PCB pins are also included for connection to a source.

The boards can now be connected together, using the two screws, 10mm spacers and nuts supplied for this purpose. Ten connecting wires have to be soldered between the two boards. So before the two boards are screwed together it is necessary to ensure that the holes on the boards line up

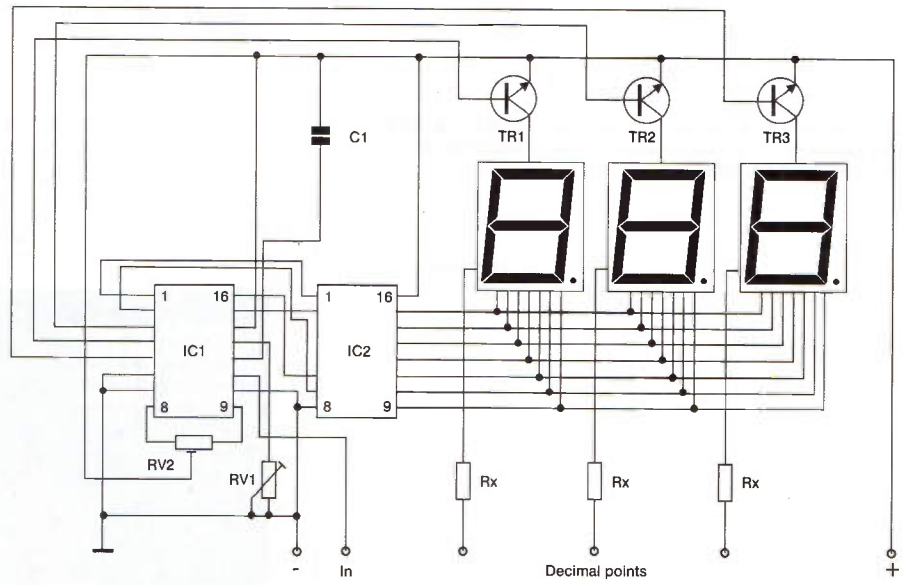
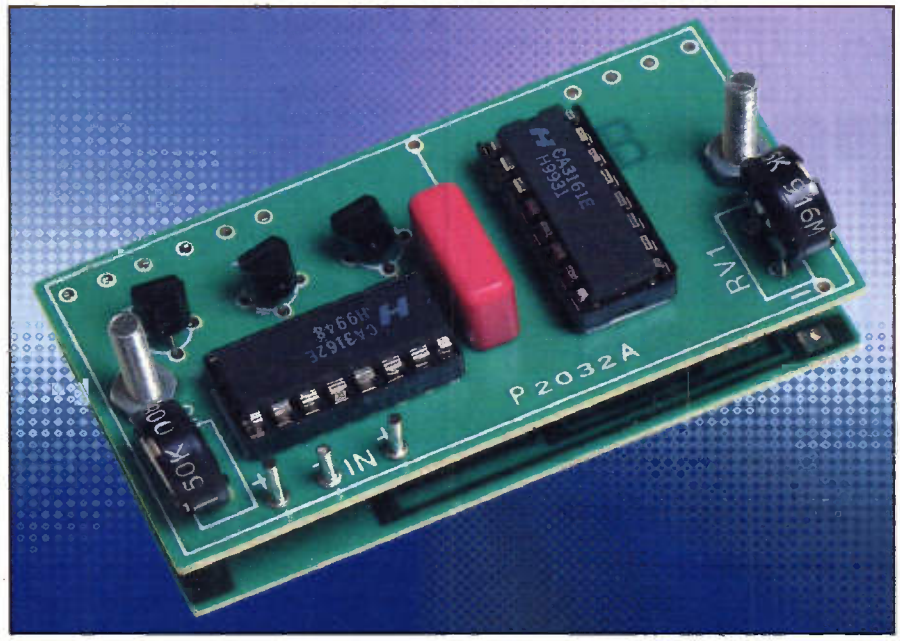


Figure 1. Panel Meter Circuit



PROJECT PARTS LIST

RESISTORS:

Rx	330Ω (optional - 3 required)
RV1	22k vertical preset
RV2	47k vertical preset

CAPACITORS

C1	220nF polyester

SEMICONDUCTORS

IC1	CA3162
IC2	CA3161
TR1,2,3	BC557 or equivalent

MISCELLANEOUS

LED 0.5mm LED display (3 reqd.)
16-pin DIL holder (2 reqd.)
PCB pins

with each other. Note that the boards are joined with the tracks facing each other. The connecting wire is supplied to provide the links, and great care has to be taken when soldering to the boards. I pushed the wires through, soldered and then trimmed both ends. When you are happy with the soldering, the two ICs can be inserted in to their respective holders. We can now test and calibrate the meter.

Set-up

With a stabilised +5V DC (250mA) applied to the board and the input terminals shorted, you should see on the display a value near to '000.' Adjust RV1 for a zero reading. Now apply a known 999mV DC supply to the input pins - I used a variable DC supply with digital readout and a digital multimeter to set this value. Now adjust RV2 so that the display reads 999mV, and that's it. I check 30 minutes later and the display was still reading correctly, and required no further adjustment.

Conclusion

Another fine kit from Velleman that can easily be incorporated into a range of test, or similar equipment.

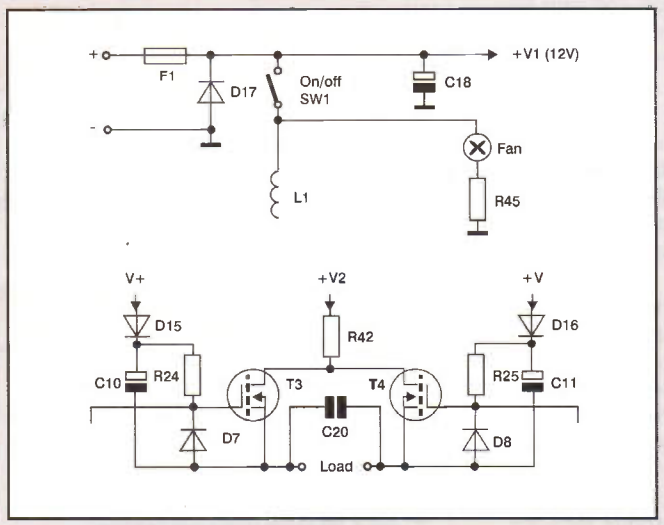
Maplin order code: VE60Q
Price £24.99

ELECTRONICS CORRIGENDA

July 2000/Issue 151
Velleman 250W 12V DC/230V AC Converter
Page 9

There were two unfortunate errors in the diagram shown on page 9 of issue 151. Diode 17 is the wrong way round and the voltage to the top end of R42 is +V2. The corrected parts of the diagram are reproduced here.

In the text it is outputs Q4 and Q5 of IC2 that are Ored together. Also it is important that suitable mains cable is used for the output, with a suitable socket. This cable should pass through the grommet and internally 'tie wrapped' with the supplied tie-wrap. The usual precautions must be followed when dealing with mains, and mains appliances. We apologise for these errors.



Easy Web Page CREATION

- Further Reading

Mike Holmes brings his recent series up to date.

Dynamic Documents - Scripts and Applets

The basic HTML specification, examples for the application of which I have attempted to illustrate in the foregoing series Easy Web-Page Creation, has, not unexpectedly, evolved a good deal in just a few short years, such that already the latest iteration has reached version 6.0.

This is because, since the very beginning, Web enthusiasts quickly concluded that the content supported by the Web's basic HTML document format was too limited. HTML extensions, such as forms and frames, and the addition of cascading style sheets that allow proper typesetting protocols to be applied to pages, only served to highlight those limitations while at the same time making it clear that no single browser could include all the features users wanted.

Yet more extensibility was desired, but without making the basic HTML code structure too unwieldy, so as a result pages acquired executable program code, in the form of scripts and/or applets, becoming dynamic documents. This has been eagerly adopted by all and sundry such that as time goes on the instances of scripted pages are fast becoming manifold. It is highly probable that of all the pages you download from the Web at the moment, 50% of them are quite likely to include some sort of dynamic script.

This has created 'pressure' on the client platform to upgrade browser software just to keep up with the latest innovations. Versions 4 of both Microsoft Internet Explorer™ and Netscape Navigator™ have already become the minimum level necessary if the user is not to miss out on all of the rapidly increasing variety of special features that are quickly becoming commonplace.

Most importantly, these browsers introduce two significant new features - in Explorer, an element called <SPAN>, and for Netscape, a device called a 'layer'. In a nutshell, each allows the author to put images or text anywhere on the page, even over the top of the normal page content, where hitherto the layout of items was restricted to side-by-side on the page.

Page Scripting

Of increasing significance, therefore, is the use of scripts. As a consequence, Web sites that don't exploit this feature are beginning to look bland by comparison.

Script is executable code, written in a programming language, and which is compiled on loading then executed by a script-aware browser. JavaScript and Visual Basic Script (VBScript) are the commonest. Unfortunately, VBScript is only supported by Microsoft Internet Explorer™ version 3.0 or greater; however, for more detailed information and a complete downloadable HTML help reference page set, go to: **http://www.microsoft.com/vbscript/**

JavaScript

This leaves JavaScript, developed by Netscape from Java (see later), and supported by Navigator version 2.0 upwards and Internet Explorer 3.0 on (at least), and which therefore has become practically universal. With a script, a Web page becomes a mini-program, able to do things like conditionally load other pages, open and close browser windows, get user input, check forms for correct content before mailing; animate images, encrypt credit card numbers, write completely new documents from scratch (as a typical example, a final 'shopping list' form made up from choices from an online catalogue), or even rewrite itself.

With no familiarity beforehand with Java-like code, the syntax of JavaScript can be quite strange, especially for anyone hitherto only used to BASIC. I was going to include a resumé about it here, but there were too many words. So instead I refer you to the equivalent document: **http://www.mc-h.demon.co.uk/maplin/aboutjava.html** for an introduction to JavaScript syntax. For more information and examples, go to Netcape's Web-site: **http://home.netscape.com.** You are also recommended to download and un-ZIP their HTML help page set: **http://developer.netscape.com/docs/manuals/communicator/jsref/jsref.zip**, a hefty tome describing all aspects of the language as used in Netscape versions 2.0 through 4.0, and which apply equally to comparable versions of Internet Explorer.

A Dynamic Menu

The List
- Latest News
- Resumé
- My Hobbies
- Biography
- Links To Other Web-Sites
- E-mail Webmaster

Figure 1. Menu of anchor links with animated arrows before styles are applied.

So what we'll do now is look at a couple of worked examples of pages that use script to animate some images, which gives an idea of how such techniques can be made to work. Note that without the script, the pages should still function as normal and so remain 'downwardly compatible' with early (non-script-aware) browsers.

Figure 1 shows a simple menu of hyperlinks to some other pages, appearing in the 'raw' style determined by the default settings of the browser. By itself it looks a bit lack-lustre aside from some arrowhead images by each option. The object of the exercise is to make each arrow change colour when the mousepointer passes over its associated anchor text.

Before that, however, we ought to improve the page's appearance and, increasingly, this is now done by applying styles, because styles allow more detailed control over appearance than conventional element attributes. Here we can group all the styles we want in a <STYLE> element added to the <HEAD> section as follows:

```
<!DOCTYPE HTML PUBLIC "-//SQ//DTD
HTML 2.0 + all extensions//EN">
<HTML>
<HEAD>
<META NAME="Description"
CONTENT="script driven image
switching">
<TITLE>Hyperlink Menu</TITLE>
<STYLE TYPE="text/css">
body {font-family:Arial, Helvetica, Univers;
font-size:11pt; text-decoration:none;
background-color:peru;}
.hltitle {font-family:Arial, Helvetica, Univers;
font-size:12pt; color:darkblue; font-
weight:bold;}
.hlitem {margin-left:14px; text-indent:-
14px;}
...
</STYLE>
```

The first forces a default sans-serif font of 11 points on all text on the page, that is, contained by the body element, except where specified otherwise. For instance, the second is a custom style, applied to a <DIV> element containing the sub-title:

```
<DIV CLASS="hltitle">The
List<BR></DIV>
```

(See also **http://www.mc-h.demon.uk/maplin/named_colours.htm** about named colour codes.) Similarly, the image/anchor pair of each hyperlink is enclosed in a division having a 'CLASS="hlitem"', to which a hanging indent is applied:

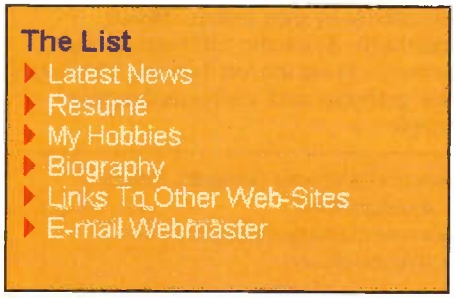


Figure 2. a: Anchor links menu with display modified by styles; b: arrow heads change when mouse pointer passes over each item.

```
<DIV CLASS="hlitem"><IMG
SRC="../images/iarrow_nr.gif"
BORDER="0" WIDTH="11"
HEIGHT="11">
<A HREF="../unavailable.html">Latest
News
</A><BR></DIV>
```

There are also other styles that affect how the anchors are displayed, and the result is shown in Figure 2a. The effected anchor that currently has the mousepointer over it is indicated by its associated arrow image 'lighting up' (turning pink), and returning to normal (dark red) when the mouse leaves, as in Figure 2b. How is this done?

Image Swapping Script

This example exists as a real page at: **http://www.mc-h.demon.co.uk/maplin/dynamic_img1.html**, which your browser can save a copy of to examine in more detail. You will find that following the <STYLE> section in the document header, there is a <SCRIPT> section, and it is this that causes the arrows to flash on and off.

I am only going to cover the essential points here - to access the complete HTML page and script, see the above URL. The script begins:

```
<SCRIPT LANGUAGE="JavaScript"><!—

and the first item is:

var imagesOK = false;
```

This is a boolean flag that will be used to determine whether the browser has loaded all the images that will be needed. Without it the situation could easily develop where an image swapping function is trying to assign a different image to an IMG element, but cannot because it is not loaded yet. This can occur where it just so happens that the mousepointer position exactly coincides with one of the anchors when the page first appears, but before it has finished loading all its images, and this is quite likely to raise a script run-time error. The idea is that while 'imagesOK' is false, the script does not try to swap an image.

The next two items will become global storages where the two alternative pictures will be held:

```
var ArrowOn = null;
var ArrowOff = null;
```

They are 'null' ('nothing') for now, but are put here in the 'root' level of the script so that they are permanently available for as long as the page persists in the browser. This is because the actual initialisation will be done by a function, but if these variables were created inside the function they would be destroyed as soon as it ends.

The function that sets up these images is called by the body onload event, as in: '<BODY ONLOAD="setupImages()">'. This is necessary to make sure that the page and all its elements have completed loading first. This done, the function will then create the two alternative image sources that will be used to change the image elements on the page:

```
function setupImages () {
  if (document.images.length) {
```

It is prudent to make sure that the page actually has pictures to swap, otherwise there is no point in going on. This is done by checking the length of the images array. Because JavaScript is an object-oriented language, it turns out that many aspects of the browser can be accessed as objects, and that furthermore some of these do themselves contain other objects, and, of course, have properties.

Therefore, as can be seen in the simple heirarchical tree of Figure 3 (there is a complete version in Netscape's JavaScript help), the document is a child of window, which is at least a child of the browser (else a frame in a frameset). Furthermore, document is a parent of several other types as shown. Because there is often more than one instance of each type, and which need not be named individually to distinguish them, it is necessary for the browser to hold them in a number of arrays; each separate item can therefore be identified by its index in the array. Hence you have an array of anchors, an array of forms, an array of applets, etc., and, of course, an array of images.

Thus, in the foregoing statement, length is a property of the images array, which is a child of document. (You could go deeper than this and write 'window.document.images.length' or 'self.document.images.length'.) If length is zero, the page has no pictures on it, and this is implied in the expression; it is false if length is zero (more properly it could have been written 'if (document.images.length > 0)').

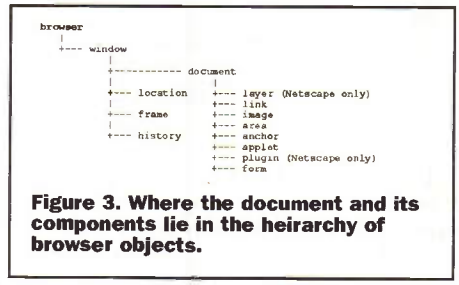


Figure 3. Where the document and its components lie in the heirarchy of browser objects.

If the page has pictures (length > 0 = true), the following statements are executed:

```
ArrowOff = new Image();
```

Without going into this in too much detail, JavaScript has a number of built-in object constructor functions that you can use to create new objects in code (there is a complete summary of this in the Netscape help). One of these is image, although of course none of them are visible on screen, they merely duplicate all the properties and methods of the equivalent visible object of that type.

One of the properties that an image, like IMG, has is SRC, the URL of the picture file. So now we can do this:

```
ArrowOff.src = "../images/iarrow_nr.gif";
ArrowOn = new Image();
ArrowOn.src = "../images/iarrow_sr.gif";
```

We now have both the pictures that we need to achieve the desired effect stored locally in new image objects. This is important because as it stands, no HTML code on the page asks for the 'active' or 'switched on' arrow picture to be downloaded, only the 'off' picture. It is no good swapping to a different image only to discover that it then needs to be downloaded from the site - apart from the possible time delay, suppose the browser went off-line before that time? This method makes sure that the browser has downloaded all the images it needs to perform the necessary actions, before they are required. This means that finally:

```
    imagesOK = true;
  } // (end of 'if')
} // (end of function)
```

we can enable the flag that informs the actual doing part of it that it can now do it.

Script And HTML

This next stage requires HTML to integrate with the script. Again taking the first item as an example, comprising an arrow picture and an anchor, we modify it as follows:

```
<DIV CLASS="hlitem"><IMG
SRC="../images/iarrow_nr.gif"
BORDER="0" WIDTH="11" HEIGHT="11"
ID="hl1" NAME="hl1">
<A HREF="../unavailable.html"
ONMOUSEOVER="GotFocus (hl1)"
ONMOUSEOUT="LostFocus (hl1)">Latest
News</A><BR></DIV>
```

All these divisions are basically the same, except that each picture now has a unique NAME, in this case, 'hl1' (hyperlink 1) for the first item. (Note that to be on the safe side, make the ID attribute the same for the benefit of Internet Explorer - often it only recognises a named object through the ID.)

The only other addition to the hitherto conventional HTML is to the anchor element - two events, ONMOUSEOVER and

ONMOUSEOUT. These call one of two functions as appropriate, 'GotFocus()' and 'LostFocus()', passing the unique name of the associated image. Note, however, that here the name is not enclosed in quotes, therefore the function's parameter actually receives a direct reference to the image as an object:

```
function GotFocus(imgname) {
  if (imagesOK) imgname.src =
ArrowOn.src;
}
```

Which means the SRC property can be applied directly to it, and which of course comes from our stored copy, 'ArrowOn'. Voila, the visible picture is changed. Not unnaturally, 'LostFocus()' is virtually the same, but does it the other way around, using 'ArrowOff' as its source. Note also that neither will do anything if 'imagesOK' is false.

Pursuing A Trend

Figure 4a illustrates a much more sophisticated extension of this theme. It is very common for commercial Web-sites, and is increasingly appearing on private ones. It is based on the idea that there are a series of images that are obviously clicked on, each with their own unique caption. Variations include buttons or image areas that change colour, or adopt a 3D beveled edge, or have text that is normally blurred or 'wind-swept', but which is sharpened (made clearer) when the mousepointer is positioned over it.

In Figure 4a, and in addition to an arbitrary image at top left representing a logo, there are a number of lozenge shaped buttons in 3D style, each with its own special caption. These have been developed in a suitable image editor, starting with a template, and something of how this was evolved is indicated in Figure 4b.

Having a series of unique images - unlike sharing common ones as was the case in the example of Figure 2 - adds some technical complexity to the process of image-swapping. The desired effect is that when the mousepointer passes over any button it should 'light up', as though there was a bulb behind it, as shown in Figure 5. This means that each button must be represented by a

Figure 4. a: A menu having a group of unique 'buttons'; b: how the basic template for each image was evolved.

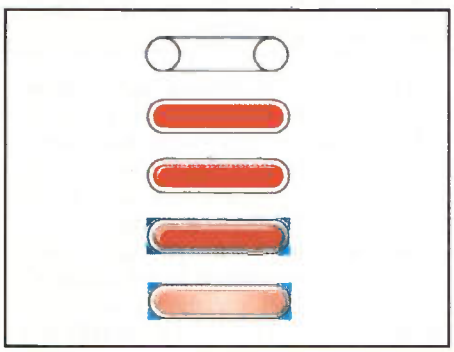


Figure 5. Each 'button' is illuminated when the mousepointer moves onto it.

pair of images with the same caption, one for 'on' (bright) and one for 'off' (dull), so actually twelve separate pictures are needed, not merely the six visible on the page.

Using Arrays

Manipulating all these images by name in code is possible but can become unwieldy and inefficient, especially if they are moved about or extra ones added, or some removed. It makes more sense, therefore, to exploit the fact that the document stores these buttons in an images array, and one of the other object types you can create in JavaScript is the array.

Again this page exists at: http://**www.mc-h.demon.co.uk/maplin/dynamic_img2.html** which you can save off and study in more detail, so only the more relevant features will be mentioned here. Primarily, this involves storing the 'on' and 'off' button image pairs in parallel arrays. This is done as follows - these are created at the script 'root' level:

```
var imagesOK = false;
var inactive = null, active = null;
```

In the 'setupImages' function, two lists of image URLs are prepared in temporary arrays, as these are easy to edit if required:

```
var inactivenames = new
Array('images/btnoff1.gif',
'images/btnoff2.gif', ... etc.);
var activenames = new
Array('images/btnon1.gif',
'images/btnon2.gif', ... etc.);
```

Once used, these will no longer be required and are discarded when the function ends. However, the next important stage is to turn the two global storage variables into arrays to hold all the images required:

```
inactive = new Array(inactivenames.length),
active = new Array(activenames.length);
```

In this variation of the assignment, the arrays are dimensioned to the number of names, as opposed to providing a set of data items. Then a for - next loop is used to physically collect the pairs of image files from the domain:

```
for (var i = 0; i < inactivenames.length;
i++) {
  inactive[i] = new Image();
  inactive[i].src = inactivenames[i];
  active[i] = new Image();
  active[i].src = activenames[i];
}
```

There are two things to note here. Firstly, a further object can be assigned to an array element (here, a new image type), and secondly, from here on the images are only identifiable by their indices. Hence, inactive[0 - 5] are the 'off' buttons, and active[0 - 5] are the 'on' buttons. This keeps the 'gotFocus' and 'lostFocus' functions simple:

```
function gotFocus (imageid, index) {
  if (imagesOK)
document.images[imageid].src =
active[index].src;
}
```

where imageid is the index of the document's own images array, and index is the number of the alternative in the named storage array. The calling code for each anchor is therefore 'ONMOUSEOVER="gotFocus(1, 0)', and so on.

Troubleshooting

Whilst Internet Explorer is probably more popular than most, this author recommends that you obtain a copy of Netscape Navigator as an aid in debugging your scripts. This is because Netscape is somewhat more fussy about script syntax and its application than is Explorer, since the latter has the ability to resolve the odd small problem by itself without you being aware that there were any!

Navigator version 4.0 is preferable as this generates proper error messages (curiously, the current beta version 4.6 does not, just a really quite useless status-bar message). It may be provided on one of the many free Internet access CD's, or you can obtain a free download from **http://www.netscape.com.**

Anomalies in the interpretation of script between the two browsers do exist - one such is Netscape's inability to recognise the 'substr' method of a string - despite being cited in Netscape's own JavaScript help! Another is a confusion that arises in rare circumstances over the length property of a string - for example, 'alert (mystring.length)' displays 'undefined' or 'NaN' (Not a Number).

One possible cause is where the string was taken from an externally accessible property of an applet; it is supposed to be a string but Netscape is not quite sure. The cure is to force it to be treated as a string type by adding empty text: 'alert (''+mystring.length), which works. On the other hand, and as you might expect, Internet Explorer has no problem with either of these occurrences.

A Brief Mention Of Java

JavaScript is, of course, based on Java. Originally called 'Oak', Java was a form of 'simplified C' designed for use in embedded consumer-electronic applications. After some years, however, it was retargeted to the Internet and renamed Java. The story behind this choice of name was that Sun were not about to call their new Internet language, based on C, 'D', but were still stuck for a suitable name. ('Oak' wasn't attractive.) Finally, at a specially convened (and, I suspect, rather desperate) 'name choosing' meeting, and because the participants were drinking coffee at the time, it was eventually named after the Java coffee bean. It's a true story, folks!

Java Support and Applets

Java is a programming environment that operates in conjunction with Java aware browsers to allow you to embed a separate program, called an applet - literally, a 'little application' - into an HTML document.

Applets are not part of the HTML 2.0 specification, and are therefore not supported by very early Web browsers. Therefore, you ought to include alternative text and applet-internal block elements defined for non-applet aware browsers.

Writing your own applets is very rewarding, when it works. Being written in Java, of course, the task is quite difficult to get your head around if you have had no experience of C. This is exacerbated by Sun System's attitude to providing suitable help texts for when it comes down to the nitty-gritty they keep referring you to books about C!

However, what information there is you can find at: **http://java.sun.com/.** There are two things to bear in mind about Java - firstly, and quite unlike JavaScript, Java is "strongly typed" (which does not mean that you press the keyboard keys especially hard!). What this means is that variables, for example, are explicitly defined as integer, float, string, char, byte, etc. types, and it is not always easy to transfer the data of one type to another.

On the other hand, you should find that many methods have been provided to do most of these things for you, so before trying to figure out how to turn a URL type, called 'u', into ordinary string form 's', for example, look to see whether a method already exists for it (in this case, 's = u.toExternalForm()'). Beginners are advised to get the hang of JavaScript before tackling pure Java.

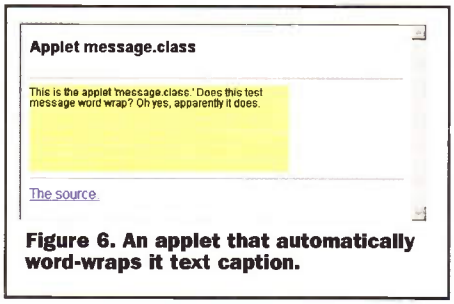


Figure 6. An applet that automatically word-wraps it text caption.

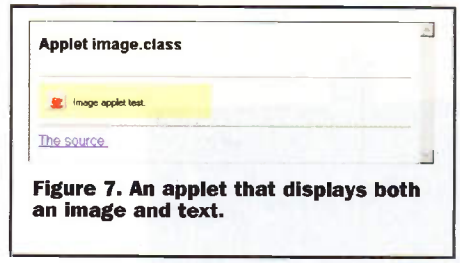


Figure 7. An applet that displays both an image and text.

Creating Your Own Applets

If you want to get into making your own applets I recommend the following two packages, both free. The first is Sun's Java Development Kit (JDK), which you can get from: **http://java.sun.com/products/jdk/1.1/.** It includes a compiler and everything else but is actually a little awkward to use, because it is, for some obscure reason, entirely DOS based.

However, it does have two redeeming features - one is a good number of finished examples, with of course source code, some of which you can use immediately as they stand to display images or play sounds (of particular note is the 'Animator' applet). The second is a complete source code library of all the applets and components that comprise the standardised Java run-time engine, the very same that every Java-aware browser is provided with by Sun.

As in the compiled product, this is organised into sections, called 'packages', spanning a number of disk directories. Interestingly the compiled version is contained in one large ZIP file incorporating the same paths; in use the browser's Java compiler extracts the relevant components directly from a ZIP just like this (or it used to be the case). Therefore, where you see a piece of applet code using a component from the engine, you can trace it right back to its source to find out what exactly what it is doing.

Especially recommended for newcomers, however, and particularly if you want to stay in the Windows environment, is Microsoft's free trial version of Visual J++, which you can get from: **http://www.microsoft.com/visualj/.** Apart from anything else it gathers Sun System's own help texts into one easily accessible source, which is also context sensitive so that you can get an instant description for all the standard Java components and functions on the screen. Better yet, it is not 'time-bombed' either (well, mine isn't).

Its best feature must be the applet wizard - this asks basic questions about what sort of applet you want, approximately based on the sort of thing you want it to do, then all the input parameters that will be supplied by the HTML <PARAM> elements. The result is a basic source code 'shell' that is then developed to form the completed applet, also a test HTML page so that you can try the thing out in your browser as you go along.

Figures 5 and 6 are applets I made with the wizard. Figure 6 is an experiment to find out how to confine a text message to the applet's background by automatic word-wrapping. It borrows directly from an example in the JDK by using the 'FontMetrics' and 'StringTokenizer' components from the Java engine to measure the width of each word and determine where to break lines. Originally called 'message', this applet was tidied up to form 'template', a basis for producing further similar applets, and a demonstation of which is at: **http://www.mc-h.demon.co.uk/maplin/template/template.html**, from which you can also get the source code.

Similarly, that of Figure 6 has the basic requirements for displaying a picture, in this case a simple icon. This demonstration can be seen at: **http://www.mc-h.demon.co.uk/maplin/image/image.html**. The source code forms the basis for other applets required to display an image, with or without text. Full descriptions of these and two other home-made applets, with demonstrations and source code, can be seen beginning with: **http://www.mc-h.demon.co.uk/maplin/tree.html.** This 'tree' page illustrates the heirarchical structure of Java, where components are invariably extensions of foregoing 'ancestors'. These pages were created by the documentation generator that is supplied in the JDK.

For more information about how to insert an applet into an HTML document, and a mention of ActiveX, see the latter part of the reference document at: **http://www.mc-h.demon.co.uk/maplin/aboutjava.html.**

Photo 'C'. Maritime discharger c1900.

The Very LONG WAVES

PART 4

In part 4, George Pickworth looks at the high power spark and arc transmitters of the early 20th Century

In this part of the study we look at spark and arc type transmitters employed by the very long wave superstations from 1906 to the early 1920's. These ingenious devices had power ratings in the order of hundreds of kW and were remarkable feats of technology.

By common usage term transmitter refers, of course, to the high frequency current generator. However, the operation of these early transmitters is still not fully understood. So I decided that it would be easier for readers to gain an insight by progressing in technical stages rather than chronologically. Indeed, both spark and arc transmitters, together with alternators, were developed concurrently. Alternators will be discussed in the following part of this study

The term spark is really a misnomer; an arc is a more appropriate term. Nonetheless the term spark has long been synonymous with wave train systems and the arc with continuous wave systems. I have continued with this tradition but only to differentiate their operating system.

For interests sake I have included Tesla's 1892 diagram that shows virtually all the possible spark and arc oscillator configurations. Readers may like to relate Tesla's diagrams to those in this study see Figure 46.

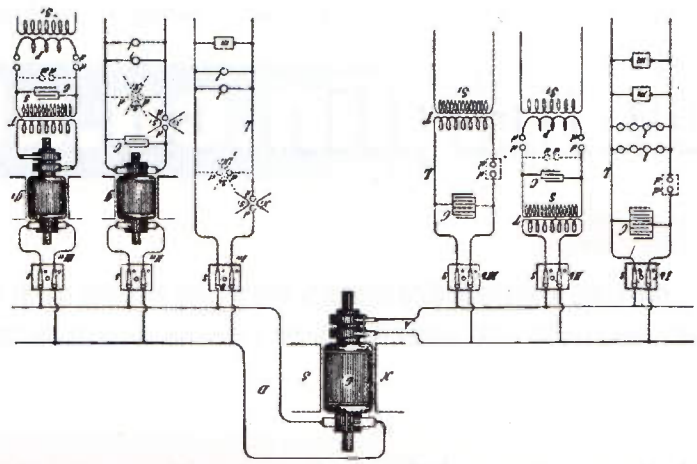


Figure 46. A 892 diagram by Tesla of spark & arc oscillators. On the left are DC powered devices whilst those on the right are AC powered. Readers may like to relate Tesla's diagram to those in this study.

The Discharger - Spark Systems

The heart of all spark systems was their spark gap assembly or discharger, so named because this device suddenly released energy stored in the capacitor.

As the capacitors were charged to a potential in the order of 25kV or more and had capacitance in the range 0.002μF to 0.02μF a large amount of energy was stored. But as capacitors have very low internal resistance, a sudden discharge involved a very heavy current.

Early maritime dischargers consisted simply of a pair of metal hemispheres 100 to 150mm diameter inside a sound deadening wooden box with a glass window that allowed the discharge to be observed but filtered out ultra violet light. The hemispheres were attached to screw threads so that gap width could be adjusted. Flanges were usually provided to assist cooling, see Photo C.

The use of hemispherical electrodes had its roots in the Righi oscillator where large spheres formed the resonant circuit. But neither spheres nor hemispheres were found necessary with inductance/capacity tuned circuits.

Rotating Discs

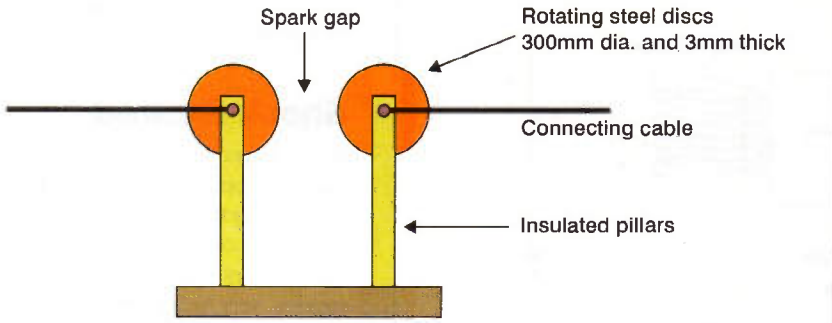
Marconi's approach to high power dischargers was to employ a pair of slowly rotating disc electrodes; discharge occurred from their edges - see Figure 47. The philosophy was that the rotating discs would be self-cooling and erosion would be greatly reduced by continually presenting a cooler surface for discharge. The Poldhu transmitter was first to use a rotating disc discharger.

The original twin disc discharger evolved into the triple disc discharger. It consisted of three steel discs. The main disc, 1.0m diameter between two smaller slowly rotating side discs - see Figure 48. Indeed, it was the development of dischargers capable of handling power in the order of several hundreds of kW that made the superstations a reality.

The triple disc discharger was capable of handling 300kW and with small modifications this versatile discharger was not only the heart of Marconi's Synchronized-Spark wave-train transmitters but remarkably the heart of his Timed-Spark and Quenched-Arc continuous wave transmitters.

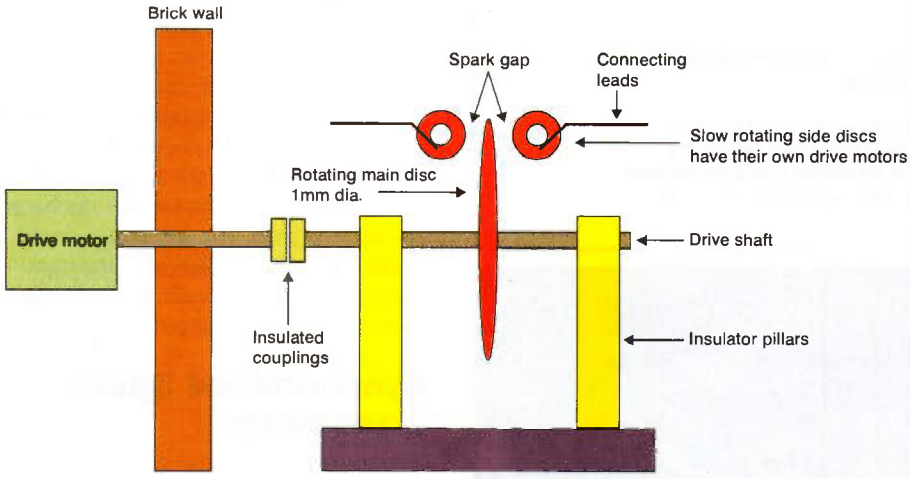
Not surprisingly, because of the high voltages involved and the loud noise they produced, the dischargers were housed on their own in a room having solid brick walls.

Other types of interrupter type dischargers include Prof. Wiens very successful 'quenched gap,' see Figure 52, and Morretti's 'hydrothermic' discharger, see Figure 53. But first let us look at capacitors.



The discs were rotated by an electric motor and worm drive via insulated couplings - compare with Photo C and Figure 48.

Figure 47. Marconi's twin rotating disc discharger used at Poldhu.



This basic design was employed with the synchronised spark, timed spark and quenched arc transmitters

Figure 48. Marconi's triple disc discharger.

Capacitors

As we have seen, energy radiated by a spark type station was first stored in a capacitor. So the dielectric had to be capable of withstanding potentials in the order of 25 - 50kV.

The capacitor of the first Poldhu transmitter consisted of glass plates coated on one side with tinfoil and immersed in oil. Earthenware troughs were used as containers. The philosophy of using oil was that if the glass was punctured by the electric charge, the oil would fill the hole and the capacitor would be self-healing.

Unfortunately because of dielectric hysteresis, the glass became very hot and mainly for this reason Marconi employed air dielectric for his Clifden transmitter. However, as the dielectric strength of air is only a fraction of glass, the plates had to be widely spaced. Moreover wider spacing reduced capacity so both the size and number of plates had to be proportionally increased. The result was a capacitor of enormous size - see Photo 'E.'

Meanwhile it was found that flint glass generated the least heat and was therefore used as the dielectric with later capacitors. Moreover, it was found that the glass plates could be reduced to strips or tubes and be used simply as separators, the oil being the principal dielectric; the oil made the capacitor self-healing.

Oil/glass types of capacitors were widely used with high power installations including the Caernarvon transmitter. However, with the Caernarvon transmitter the plates were zinc sheets and wooden boxes replaced the earthenware troughs.

Mica would have been the ideal dielectric and whilst sometimes used with small transmitters, it does not seem to have been used with superstation spark systems.

Direct

As explained in part 3, when a capacitor is suddenly discharged into an inductor it generates a train of oscillations. Remarkably, it was originally thought that energy was radiated by the actual discharge, in fact the discharger is simply a high-speed switch.

With the Poldhu transmitter, the capacitor discharged directly into the inductor that together with the capacitor formed a resonant circuit - see Figure 49. For the sake of a better name I have called this the direct discharge method.

The disadvantage of the direct discharge was that the spark gap was in series with the oscillatory circuit. So, the train of oscillations had to jump the spark gap every half cycle. Moreover, notwithstanding the resistance across the gap falling dramatically as a result of ions persisting in the spark gap, much

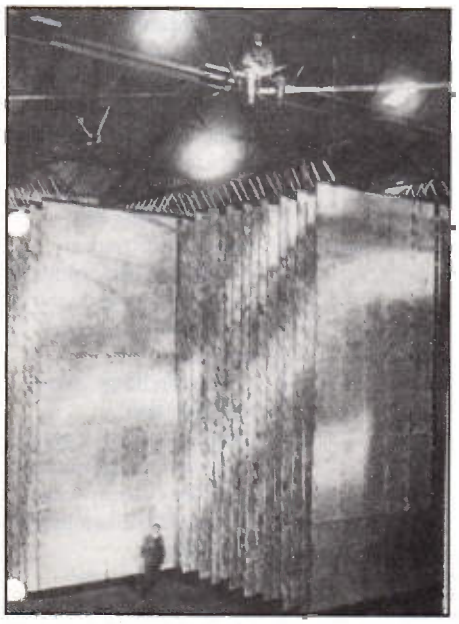
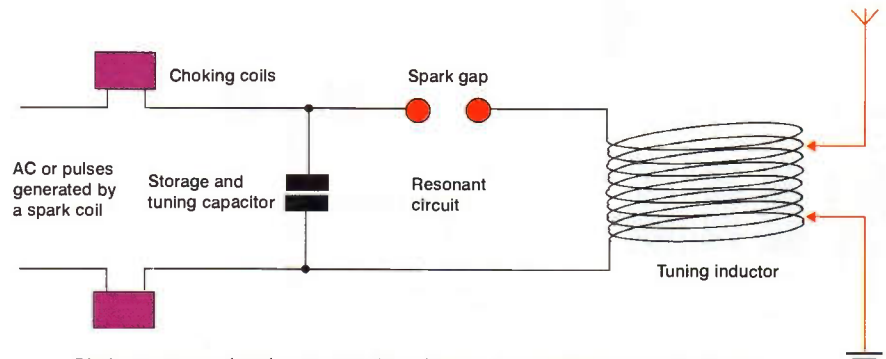


Photo 'E'. Capacitor plates at the Cliftden transmitter 1906.



Discharge occurs when the potential of the charge in the capacitor exceeds the dielectric strength of the air within the spark gap. Discharge results in a train of oscillations

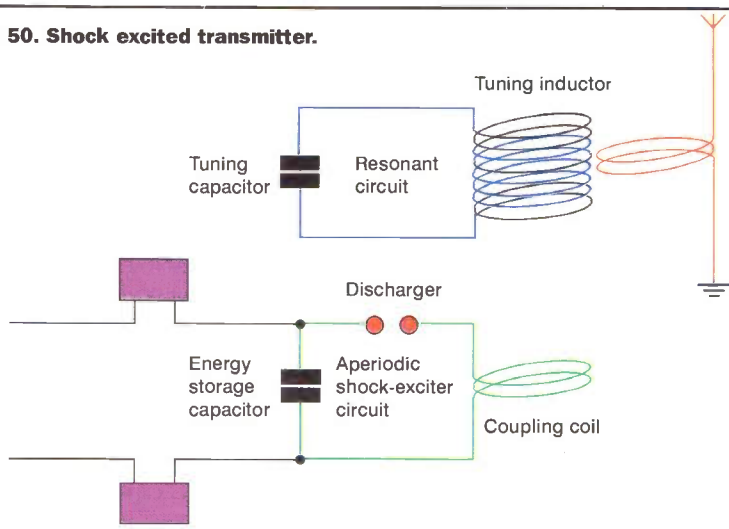
Oscillatory current jumps the spark gap every negative and positive cycle. Losses are therefore appreciable.

As the capacitor stores energy and is also the tuning capacitor, there is a limit to its value if a favourable L/C ratio is to be achieved.

The choking coils isolate the resonant circuit from the power supply.

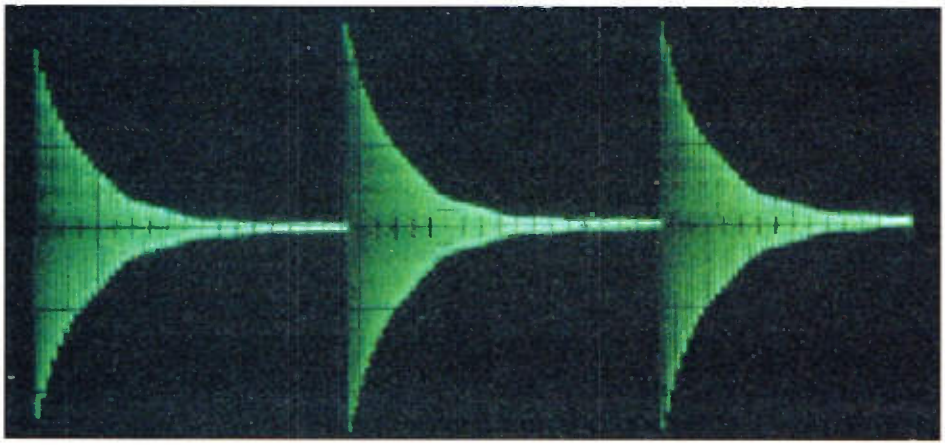
Figure 49. Spark gap in series with resonant circuit - direct system.

Figure 50. Shock excited transmitter.



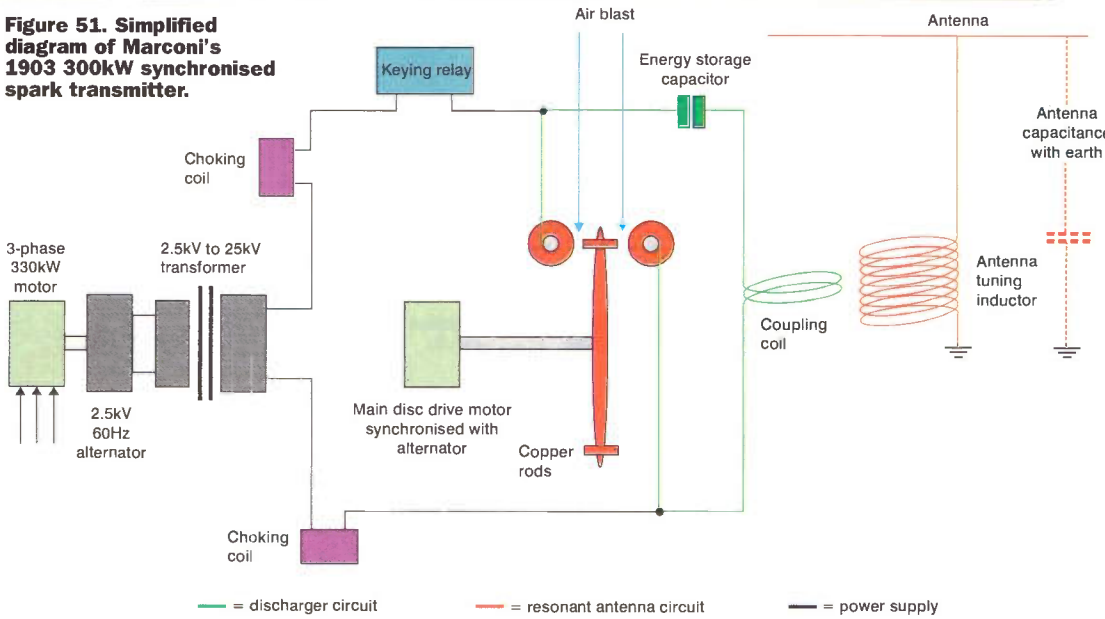
Losses are avoided by not having the spark gap in th oscillatory circuit. The resonant circuit can have the optimum L/C ratio

The storage capacitor in the shock-exciter circuit can have a large value and therefore store maximum energy. Each discharge shock excites the resonant circuit into oscillation. The discharge breaks the circuit immediately after each discharge thus preventing energy being transferred back to the exciter circuit.



Oscillogram 'D' Wave trains generated by the synchronised spark transmitter.

Figure 51. Simplified diagram of Marconi's 1903 300kW synchronised spark transmitter.



Main discharger disc drive motor is synchronised with the alternator so that a rod aligns with the side discs when the potential of each half cycle of alternator current reaches its peak. Some writers believe that the discharger circuit was resonant at antenna frequency and that the current was oscillatory and energy was transferred to antenna circuit via the coupling coil. The rotating disc, assisted by an air blast, breaks the discharge circuit immediately after discharge, thereby preventing energy being transferred back to excite circuit. The tuning inductor, together with the antenna, forms the resonant circuit. The antenna radiated wave trains with a repetition rate twice that of the alternator frequency, one train for each half cycle i.e. 120 trains/sec.

energy was converted into heat; this was not only wasteful but caused problems with overheating and erosion of the discharger electrodes.

Shock Excited

It was found that losses inherent to direct excitation could be overcome by discharging the capacitor into an aperiodic or primary circuit, inductively coupled to the resonant or secondary circuit. The sudden, very heavy current pulse shock excited the resonant circuit into oscillation - see Figure 50

We must now differentiate shock excitation and the tuned transformer system used with Tesla's magnifying transmitter where both the primary and secondary circuits were resonant and tuned to the same frequency. (See part 3)

To take advantage of shock excitation, the primary circuit must be broken immediately after discharge so that energy cannot be transferred back from the secondary circuit; this required an interrupter type discharger. The exciting pulse was therefore a single unidirectional pulse. Marconi's the triple-disc-discharger was readily adapted as an interrupter type discharger.

Synchronised Spark Transmitter

It is easier to understand the operation of the synchronised spark transmitter by first looking at its discharger. The main disc had copper rods inserted around its periphery equal in number to poles on the alternator. See Figure 51.The alternator charged the capacitor via a 25kV step-up transformer.

Rotation of the discharger's main disc was synchronised with the alternator (hence its name) so that a rod disc aligned with the two side discs, thereby narrowing the spark gap as the charge in the capacitor approached its peak potential i.e. that of the charging current.

A discharge occurred and a heavy current-pulse was sent through the low impedance primary circuit thereby shock exciting the resonant secondary circuit into oscillation; in this case the resonant circuit was the actual antenna.

The discharge short-circuited the transformer, so choking coils were employed to limit the current surge and avoid damaging the transformer.

As the main disc continued to rotate, the spark gaps widened and an air blast blew ions

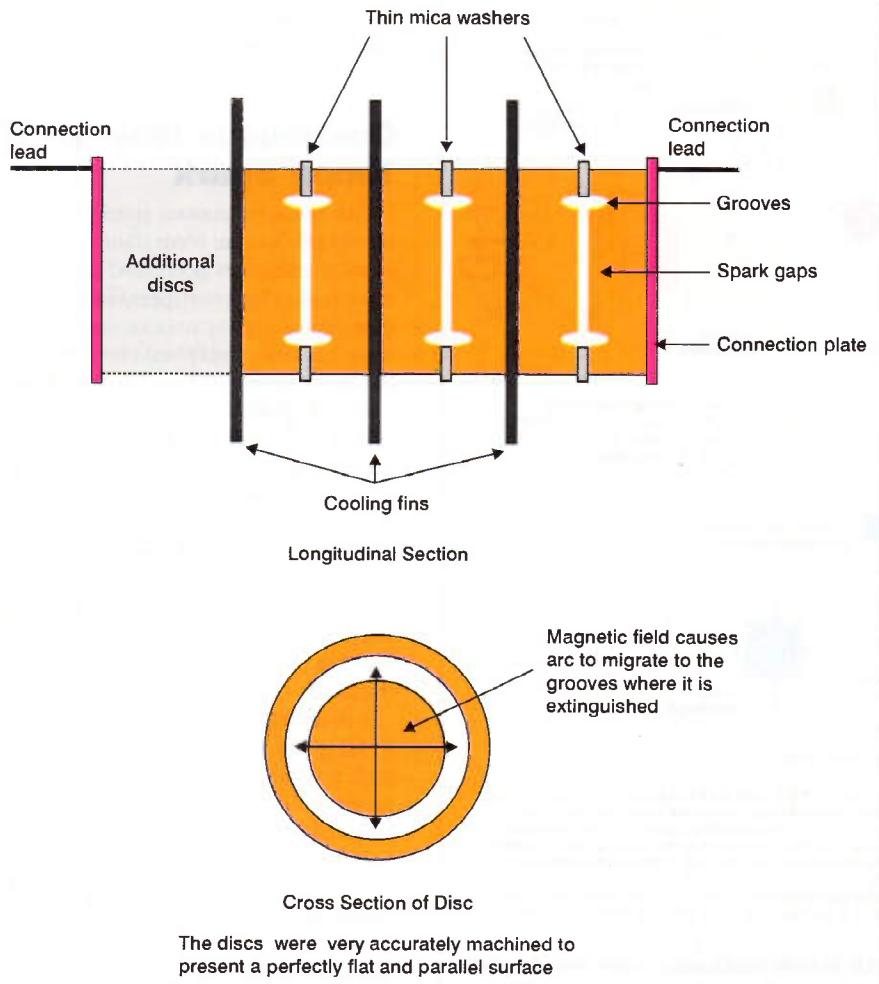


Figure 52. Wien quenched gap.

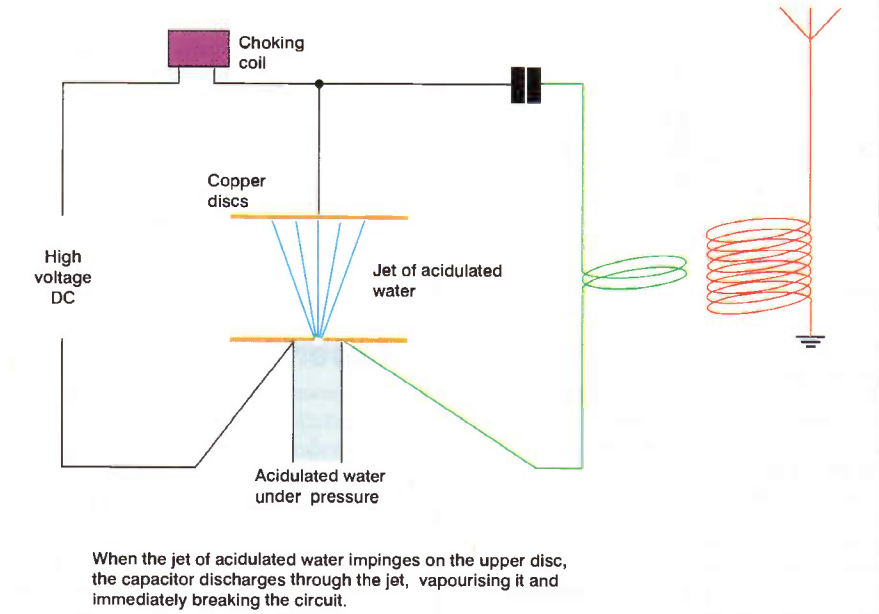


Figure 53. Morretti's hydrothermic discharger.

away from the gaps thus making the primary an open circuit and precluding re-ignition of the arc by energy transferring back from the secondary circuit. The discharge was therefore mainly current drawn for the capacitor and was essentially a unidirectional pulse.

Meanwhile the capacitor had recharged, the main disc continued to rotate and the next copper rod aligned with the side discs. So, the cycle was repeated .

Antenna Resonance

As we have seen, in part 1, very long wave antennas were a small fraction of a wavelength long, and were therefore poor radiators. The antenna was brought into resonance by its tuning inductor and capacity with earth. The tuning inductor was inductively coupled to the primary circuit. But because the antenna was a poor radiator, oscillations persisted in the antenna circuit long enough to radiate trains of exponentially declining waves.

The alternator delivered current at 150Hz so discharge and therefore wave train repetition rate was 300/second (i.e. one for each negative and positive going half cycle) so a 300Hz tone was heard with rectifier type receivers - see Oscillogram 'D' Detectors will be studied in part 5

In 1914 synchronised spark transmitters were installed at Marconi's Caernarvon, Wales and Wellfleet, Cape Cod USA stations. Both transmitters were rated at 300kW with a maximum antenna current of 220A, and a wavelength of 11,000m. Efficiency from alternator to antenna was given as 30%.

The Caernarvon transmitter was taken over by the Post Office during the First World War, principally for signalling to British navy ships in the North Atlantic (Shades of the German station at Nauen) whilst the Wellfleet station was taken over by the US authorities for security reasons!

Wien Quenched Gap

Space only allows a brief mention of the Wien quenched gap which consisted of a series of discs, each having a groove around their periphery. The magnetic field produced by the discharge caused the arc to migrate outwards to grooves where it was extinguished.

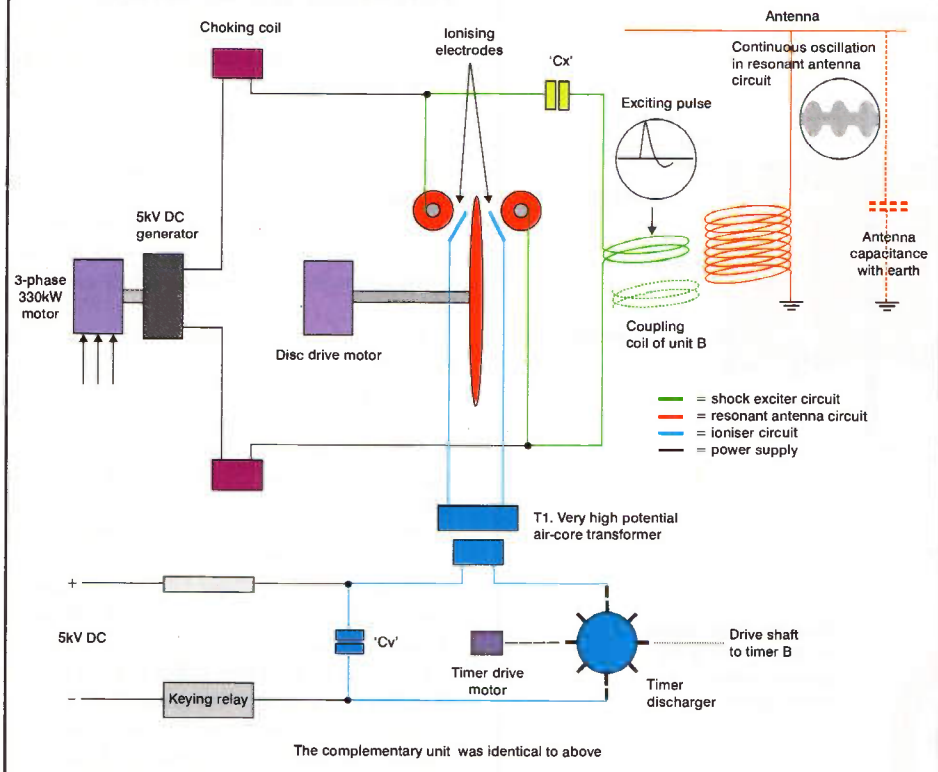
The advantage of the Wein discharger was that any number of discs could be assembled in series thereby making it suitable for use with high power installations. It was employed at the original Nauen and Eilevese superstations, but was superseded by alternator systems. See Figure 52

Morrieti Hydrothermic Discharger

This consisted of a pair of horizontal copper discs located one above the other but with a space in between. The lower disc had a small hole through its centre. Acidulated water was ejected through the hole as a jet that impinged on the underside of the upper disc. See Figure 53

The jet was immediately vaporised when it struck the upper disc, thus breaking the circuit until the jet was re-established. Then the process repeated. The advantage of Morrietti's system was that it was self-cooling and had no moving parts. Moreover, operation was rapid and current pulses were produced in quick succession.

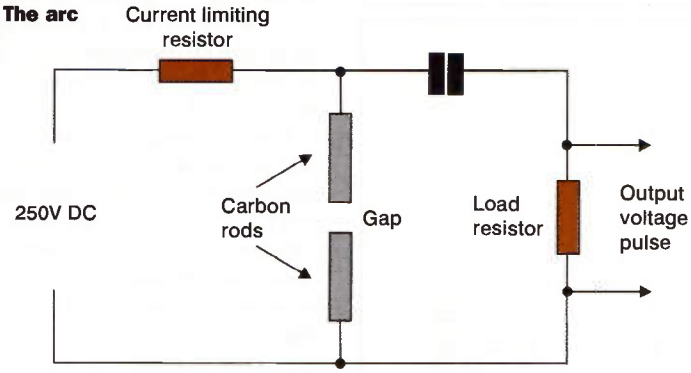
However, by adjustment of the acidulated water pressure, it was reported that the discharger could generate shock exciter pulses capable of producing trains of



The DC generator constantly charges Cx. Ordinarily, gaps between main disc and side discs are too wide for a discharge to occur. So ioniser electrodes are located near to the gaps. When the rotating timer electrodes are located near to the gaps. When the rotating timer electrodes align with fixed electrodes, 'Cy' discharges through T1. The resultant very high voltage pulse energises the ionising electrodes thereby causing 'Cx' to discharge and create pulse through the coupling coil that shock excites the resonant antenna into oscillation. The main disc rotates at high speed, dispersing ions thereby quenching the discharge after each pulse and preventing energy from being transferred back to the exciter circuit.
Oscillations persist in the resonant antenna circuit and are re-enforced by each discharge. Oscillations in the antenna circuit are therefore continuous but not of constant amplitude. Pulse period is set by timer drive motor. Each discharge short-circuits the DC generator. Choking coils limit the current.

Figure 54. Simplified diagram of Marconi's 1916 300kW continuous wave timed spark transmitter.

Figure 55. The arc as a pulse generator.



With the arc extinguished, resistance across the gap is that of the dielectric strength of air. So the current goes to charging the capacitor. Normally, the arc would only ignite when potential of the charge in the capacitor exceeds the dielectric strength of the air within the electrode gap, typically in the order of several kV. So with potentials in the order of 500V the arc is initially ignited by momentarily bringing the carbon rods together.

Resistance through the arc falls and current is drawn from the capacitor much faster than the limiting resistor allows it to be replaced. So, the capacitor discharges and the potential across the arc falls. But because of its negative resistance characteristics, the resistance across the arc also falls. So the arc is sustained even though the capacitor is discharging and the potential across the arc falling. But ultimately the arc is no longer sustained - it returns to its high resistance state and the capacitor recharges.

Ordinarily, the arc would not re-ignite without the carbon rods being brought together again. But provided the gap is narrow and the pulse is not too slow, ions persisting in the gap facilitate re-ignition. So once started, operation becomes automatic. The time taken to recharge the capacitor sets the pulse repetition rate.

oscillations in phase and thereby produce continuous oscillations. The device was apparently used with early radiotelephone transmitters.

Continuous Waves - The Timed Spark

Unlike the synchronous spark that produced discrete wave trains, the timed spark transmitters generated precisely timed wave trains that overlapped in phase and thus producing continuous oscillations. Little has been published on its operation but the following is how I believe it worked.

The discharger was essentially the same as that used with the synchronised spark but the main disc did not have the copper rods around its periphery - it was a plain disc as shown in Figure 54. A 5kVDC, 300kW generator delivering 50A charged the capacitor. Ordinarily the gaps between the main disc and the side discs would have been too wide to allow discharge, so ionising electrodes were located close by the gaps.

A discharge only occurred when the ionising electrodes were energised with very high voltage pulses. Ionising pulses were timed to occur at the precise moment for trains of oscillations in the antenna circuit to overlap in phase.

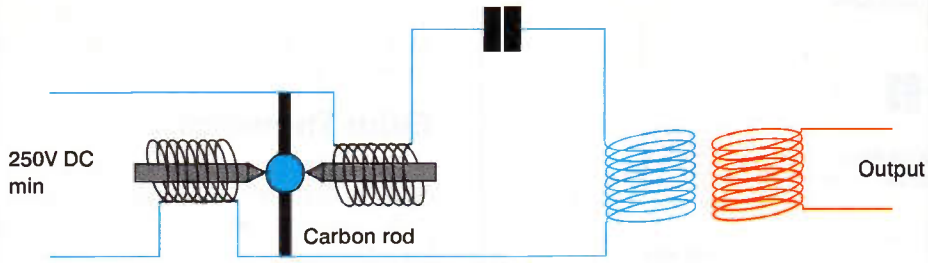
The discharge short-circuited the DC generator but here again choking coils limited the load on the generator and discharge current was drawn mainly from the capacitor. However, as the gaps were wide and ions were dispersed by the draft created by the disc rotating at high-speed, the arc was extinguished when the potential of the capacitor's charge fell to a lower level (see pulse generator - Figure 55). Oscillatory current in the primary circuit was therefore precluded.

Each discharge was a unidirection pulse that shock excited the resonant antenna into oscillation. Oscillations persisted in the antenna and progressively built up in amplitude by the reinforcements. So although the oscillations were continuous they were not of constant amplitude. See Oscillogram 'E'.

Timer

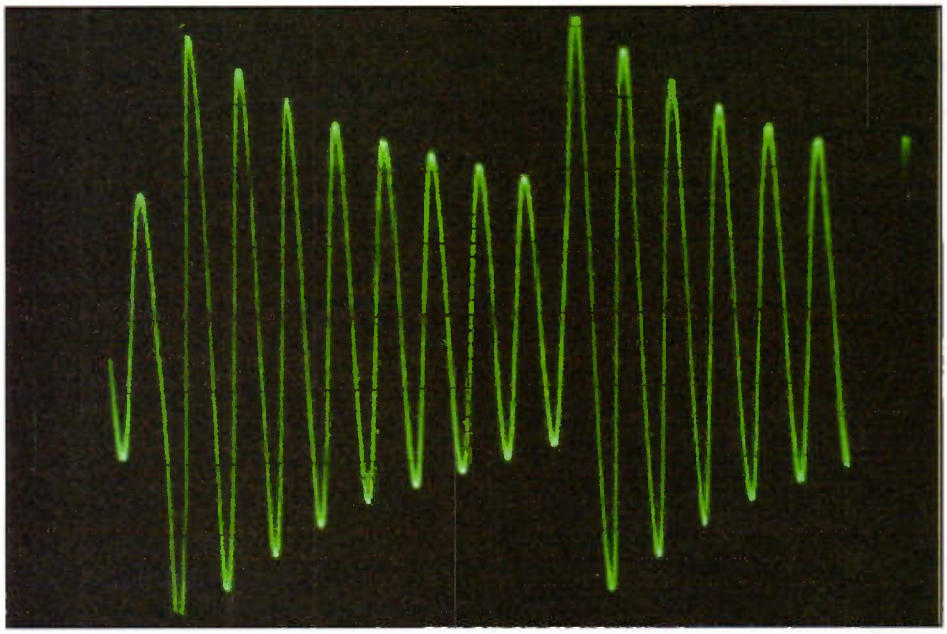
The timer had its own discharger that consisted of a disc with 16 projecting electrodes rotating between a pair of fixed electrodes - see Figure 54. When a pair of projecting electrodes aligned with a pair of fixed electrodes, the timing capacitor discharged across the gap thereby causing current pulse through the primary winding of a transformer. The result was a very high voltage pulse across the secondary winding that energised the ionising electrodes.

Current through the timing discharger was low so the electrodes had a gap width of only 1mm and a small face area. This close mechanical tolerance minimised timing errors that could be caused by changes in the dielectric strength of the air. But the drive motor actually set the timing so its speed had to be maintained within

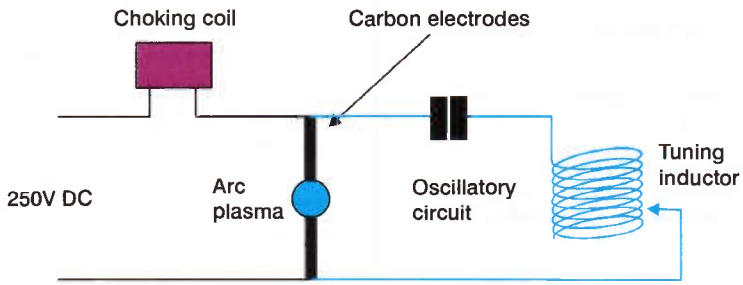


The electromagnets quench the arc when current through the arc reached maximum. Then the mmagnetic field collapsed and the arc was re-ignited thereby enabling pulses to be produced at a faster rate than with Figure 55. Because of the relatively low voltage of the supply current, initial ignition was by momentarily bringing the electrodes together. Once started, ions persisting in the gap make operation automatic.

Figure 56. Tesla's electromagnetic magnetic quenching system.



Oscillogram 'E'



The arc was in series with the resonant circuit, it was extinguished and re-ignited each half cycle. Capacitor charging now had to be synchronised with oscillations. With optimum values for the capacitor, inductor and 'arc gap' width, capacitor charging is automatically locked into synchronisation with the oscillations. Frequencies as high as 100kHz were reported, but I don not know how this frequency was measured. With a supply current of only 250V, re-ignition depended on residual ions.

Figure 57. Elihu Thomson's 1892 wave generator.

very close limits.

Overlapping seems to have occurred with every 11 cycles so in the meantime the amplitude of the oscillations declined as energy was radiated from the antenna. So to make amplitude as level as possible, two identical units worked in parallel but generated pulses timed so that the first half cycle of each successive wave train was 180° out of phase with that of the previous train. So overlapping would seem to have occurred with every 5½ cycles.

Whilst persistence of oscillations in the antenna system integrated wave trains into continuous oscillations and made the system workable it also limited the speed of signalling, which was by long and short transmission periods corresponding to the Morse code. Reception was typically by devices known as 'tikkers' that mechanically chopped radio frequency current into intermittent DC that produced an audible noise in the headphones.

Two timed spark transmitters, one of which was in reserve, were installed at Caernarvon in 1916. Both were rated at 200kW and efficiency was given as 60%, which was high by any standards. Wavelength was originally 11,000m but was increased to 14,000m. They were capable of 195 words per minute (wpm). In 1920 quenched arc transmitters replaced the timed spark transmitters.

Quenched Arc

The quenched arc transmitter evolved from an arc lamp. However, it is far from fully understood, and until I have conducted further experiments with my small-scale reproductions the best explanation I can offer is shown graphically in Figure 57. Perhaps some readers may come up with a clearer explanation.

Unlike the previous oscillators, the capacitor of the quenched arc transmitter was re-charged every cycle thereby maintaining oscillation at constant amplitude as energy was transferred to the antenna.

Negative Resistance

The quenched arc transmitter is based on the negative resistance characteristics of an electric arc. When the potential across the electrode gap is too low for an arc to strike it obviously presents an infinitely high resistance i.e. the dielectric strength of the air is the gap separating the electrodes. As the potential across the gap increases, a point is reached where the air dielectric breaks down and the arc strikes. Then resistance through the arc is then in inverse ratio to current flow.

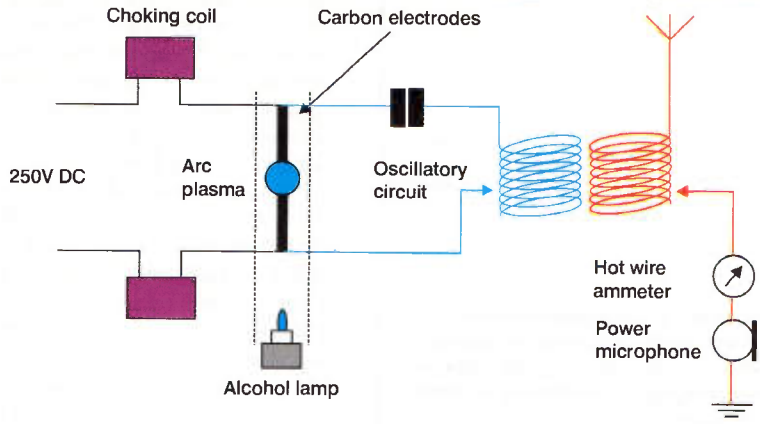
Pulse Generator

Let us first consider the electric arc as a basic pulse generator. A capacitor is connected across the arc electrodes and a variable resistor in the DC supply. See Figure 55

When the arc is extinguished the current passing through the limiting resistor goes to charging the capacitor. The arc strikes only when the potential of the capacitor's charge reaches the level greater than the dielectric strength of the air between the electrodes.

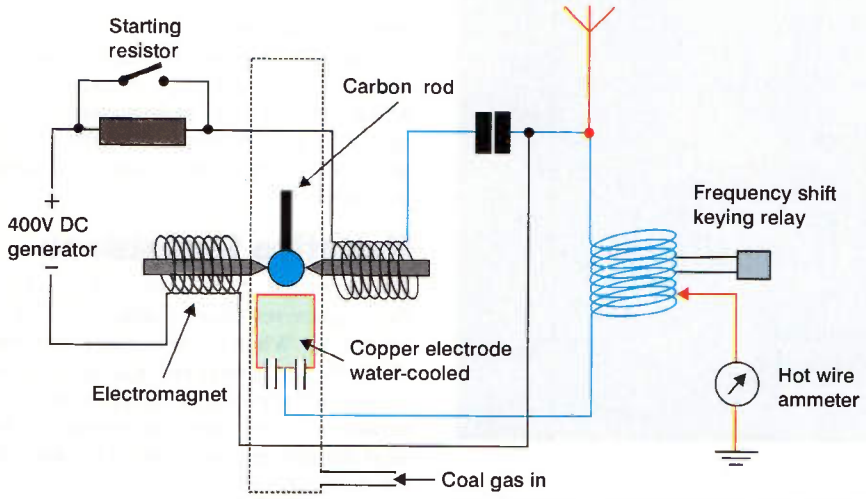
Once the arc strikes, resistance through the arc drops but because of the current limiting resistor, current for the arc is drawn from the capacitor faster than it can be replaced. The capacitor is ultimately discharged and the arc extinguished. Arc resistance returns to a high value and the capacitor recharges. The cycle is then repeated.

However, if the current limiting resistor passed sufficient current to sustain the arc, equilibrium would occur at some point in its resistance curve. Then the arc would burn



Remarkably, continuous wave transmitters were originally developed for radiotelephony. Note alcohol lamp in the arc chamber and power microphone were designed to carry a heavy current. The lamp provided additional ions and facilitated re-igtnition of the arc every half cycle.

Figure 58. DeForest's continuous wave transmitter for radio telephony.



Based on contemporaneous drawings. ═ capacitor charger and electromagnet circuit and ▬ arc or oscillatory circuit.

This combined Elihu Thomson's wave generator, Tesla's electromagnets, Lepel's water cooled electrode and the principle of Deforest's alcohol lamp.

The arc was initially ignited by momentarily bringing the electrodes together. The resistor is in the current supply to prevent overload of the DC generator. Thereafter re-ignition was automatic and the resistor was shunted. Note frequency shift keying was achieved by shorting out a few turns of the tuning inductor.

Figure 59. Pouslen quenched arc 100kW transmitter.

continuously albeit at low intensity with the capacitor partly charged. So, to ensure that the arc is extinguished, the value of the limiting resistor must be so high that direct current flow is unable to sustain the arc. However, as the capacitor is slow to charge the pulse repetition rate is slow.

To ensure the arc was quenched, Tesla inserted electromagnets in the arc circuit. When current through the arc reached maximum, the magnetic field 'blew' ions away from the gap thus periodically quenching the arc and producing pulses. Residual ions facilitated re-ignition of the arc by the reverse current - see Figure 56.

Oscillator

When an inductor is connected in series with the capacitor it becomes a resonant circuit and with careful selection of component values it can be made to behave as an oscillator. The arc is therefore ignited and quenched as the current reverses with each half cycle. So, capacitor charging must be synchronised with the oscillations. The choking coils isolate the oscillatory current from the DC source.

Operating frequency is set primarily by the value of the inductor and capacitor but with the arc itself and the current limiting resistor playing a significant role. Let us now look briefly at some of the pioneers whose work led to the development of high power quenched arc CW transmitters

Elihu Thomson

In 1892, Elihu Thomson patented an arc type CW oscillator with a frequency probably in the order of 100kHz. It became known as Elihu Thomson's 'wave generator' - see Figure 57

DeForest

Around 1906, DeForest developed Elihu Thomson's wave generator into a radio telephony transmitter. Indeed, it was radiotelephony that originally motivated development of continuous wave generators. Modulation was by means of a 'power' microphone inserted in the antenna system.

It ran on a fairly low voltage and needed to be started by momentary bring the carbon electrodes together. Thereafter, re-ignition was automatic and facilitated by ions released from an alcohol lamp burning in the arc chamber. See Figure 58

Von Lepel

Von Lepel employed water-cooled electrodes and remarkably, integrated a tone generator into the system that modulated the transmission; this enabled the telegraphy transmission to be received with rectifier type detectors. A 100 kW Lepel transmitter was installed at the Eiffel Tower radio station around 1910.

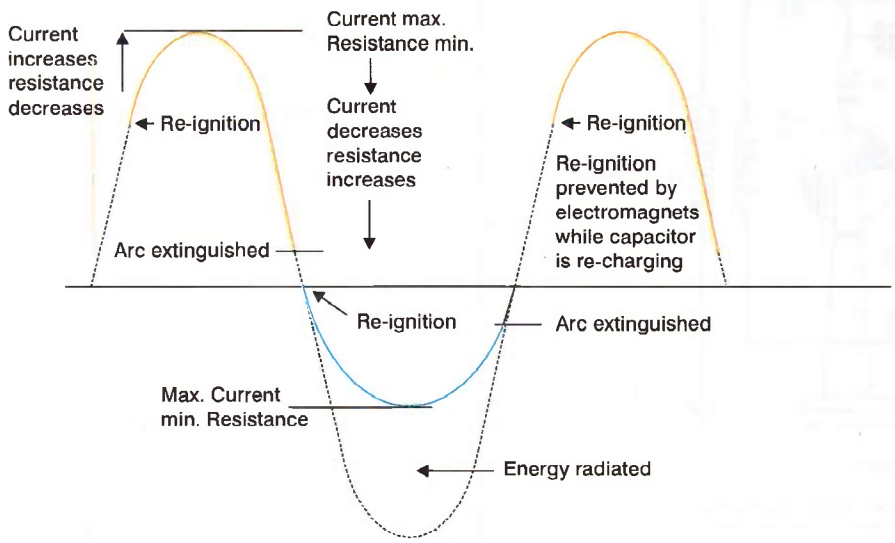
Poulsen

With his high power transoceanic telegraph transmitter, V. Poulsen combined Tesla's electromagnets with Von Lepel's water-cooled electrodes. However, his transmitter operated on a voltage of only 500V and it incorporated DeForest's method of providing ions to facilitate re-ignition but employed a stream of hydrogen rich coal gas. See Figures 59 & 60.

As with conventional arc lamps, Poulsen's transmitter incorporated a mechanism to automatically advance the carbon electrode as it burned away and thereby maintain the correct gap with the copper electrode. But to ensure that the end of the carbon electrode remained flat, it rotated against a scraper. The carbon electrodes needed frequent replacement but the water-cooled copper electrode lasted for a few months.

Stop and start keying, where the transmission consists of short and long periods to represent the Morse code, could not be applied to Poulsen's transmitter. Once started, by momentarily bring the electrodes together, it had to continue running; this was no problem with low power early versions designed for radiotelephony

For transoceanic operation, frequency shift keying was adopted and attained by shorting out a few turns of the tuning inductor. See Figure 59. As the transmission



The author's interpretation from his own experiments with a small scale reproduction.

Gaps in the waveform are 'filled' by the flywheel effect of the resonant circuit, typically the antenna. The arc is extinguished near the end of the positive-going half cycle when the capacitor has discharged to a low potential. It is re-ignited by the reverse current at the start of the negative-going half cycle.
Radiated energy reduces the magnitude of negative-going half cycle. So, the potential of the following positive-going half cycle may be insufficient to re-ignite the arc.
During oscillation, the electromagnets serve as choking coils to isolate the oscillatory circuit. When the arc is extinguished, DC passes through the electromagnets and re-charges the capacitor. Their magnetic field prevents re-ignition during the charging period. When the capacitor is charged to its full potential, current through the electro-magnets ceases. Their magnetic field collapses and ions provided by the gas facilitates re-ignition - and so the process is repeated.

Figure 60. Poulsen quenched arc - current through the arc.

was not modulated, Tikker type receivers were employed, and as already mentioned, directly convert radio frequency current into intermittent DC that produced an audible noise in headphones.

Contemporaneous diagrams show direct antenna connection; this does seem to question my explanation of its operation that would require energy to be transferred to the resonant antenna via inductive coupling. But contemporaneous diagrams are not always correct. Efficiency for 100kW machines was given as 35/40% as much energy went into and heating of the electrodes and the magnetic field.

Probably the best known Poulsen transmitters were those at the superstations that worked commercially between San Francisco and Honolulu, a distance of 3,600km - see Photo 'D'. Both were rated at 100kW. Wavelength was probably in the order of 7,000m. During WW1, a 60kW Poulsen transmitter was installed at the Eiffel Tower where it transmitted military messages.

A high power Poulsen transmitter was installed at Marconi's Caernarvon station directly after WW1 as a reserve for the timed spark transmitter. Unfortunately, it was incapable of delivering more than 170A to the antenna, compared with more than 200A with timed spark. Furthermore, it could not be worked for long periods without giving trouble.

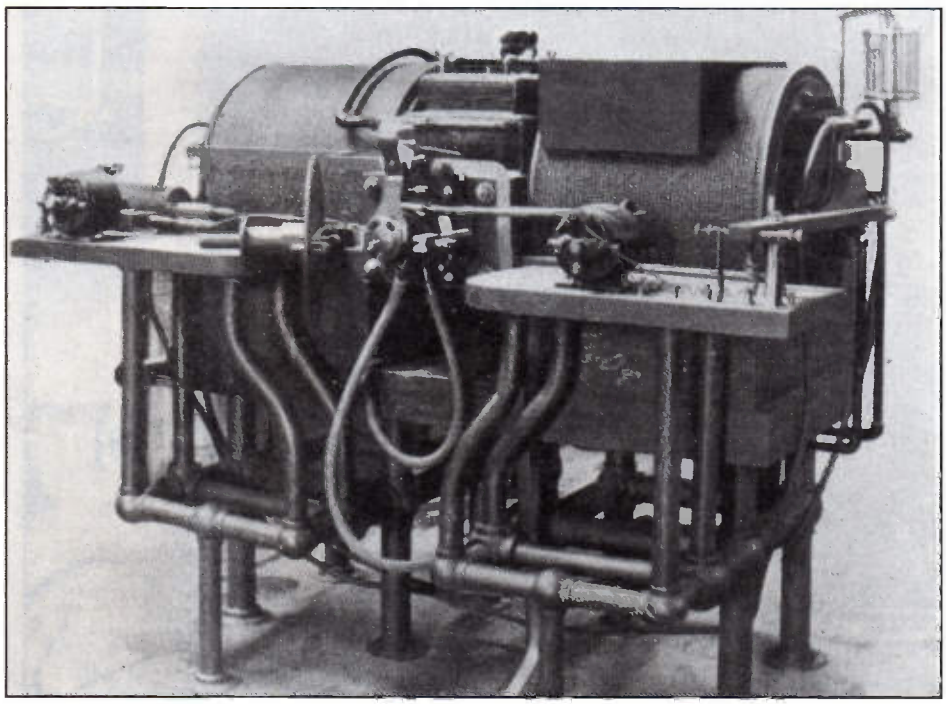


Photo 'D'. 100kW Poulsen arc generator at the San Francisco station.

Marconi's Clifden Transmitter

The Clifden transmitter was commissioned in 1906 and its sister station at Glace Bay were physically the largest transmitters ever built and both were derived from knowledge gained empirically. It must have required enormous confidence to construct such stations knowing that nothing like them had been built before. Wavelength of the Clifden station was 6,666m - see Figure 61.

Marconi described the transmitter as being a cross between a spark and an arc system. Unfortunately, I found the circuit diagram to be confusing. But, based on the fact that it produced continuous oscillations, the frequency was set entirely by its resonant circuit and since it operated on DC, I am convinced that it was a quenched arc system. So operation would have been electrically similar to Poulsen's system.

The Clifden and Glace Bay transmitters were more or less identical. Let us consider the Clifden transmitter. Remarkably, the dischargers were basically the same as those used with the later synchronised spark and timed spark transmitters.

Although the Clifden transmitter predated Poulsen's transmitter by a few years, it was far more elegant and reliable than Poulsen's device. The main disc revolved at high speed thereby dispersing ions whereas Poulsen employed electromagnets. Moreover, it was self-cooling thus avoiding the need for a water-cooled electrode. Its disadvantage was its high operating voltage, 12kV compared to 400V with Poulsen's system. Nonetheless, the high voltage facilitated arc re-ignition without the need to provide additional ions.

The capacitor had air dielectric and was therefore self-healing. It consisted of zinc plates 8m tall and 3.5m wide suspended 300mm apart from insulated beams. A large building was therefore necessary just to house this giant capacitor - see Photo 'E.' The enormous antenna tuning coil and coupling coil is shown in Photo 'F'

Power was provided by a steam engine burning peat mined nearby and transported

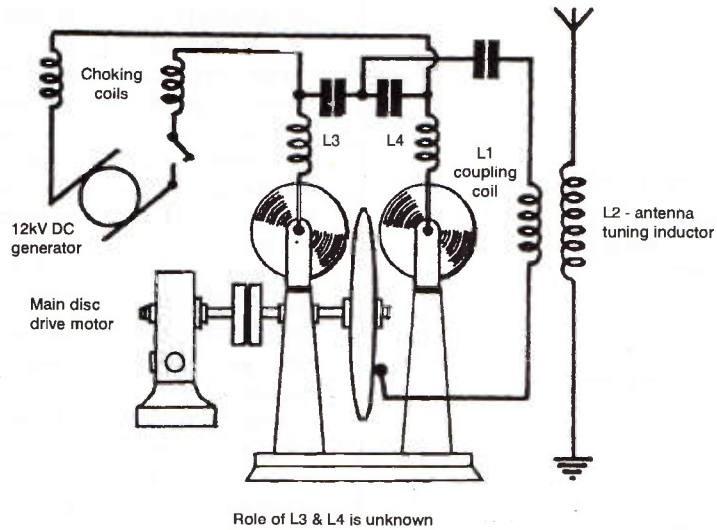


Figure 61. Contemporaneous simplified diagram of Marconi's 1907 Clifden transmitters.

directly to the boiler house by a light railway. The generator provided an output of 300kW at 20kVDC and charged 6,000 40Ah secondary cells giving a working voltage of 12kV. Another large building was required to house the batteries. Unfortunately my circuit diagram does not show how keying was accomplished.

Shortly after the station was commissioned, the carborundum rectifier type detector was developed. But as unmodulated CW could not be resolved with rectifier detectors it was decided to modulate the transmission with tone by inserting small studs around the periphery of the main disc.

The Clifden station worked Glace Bay, Newfoundland from 1906 until destroyed during Irish independence troubles during WW1; it was not rebuilt. Thereafter the Caernarvon station handled transatlantic communication. So with these notes on this remarkable transmitter I conclude this part of the study.

Next Month..

In part 5 we look at alternator systems pioneered by Tesla and ultimately dominated pre-valve very long wave transmitters. Indeed they are still used with submarine signalling systems

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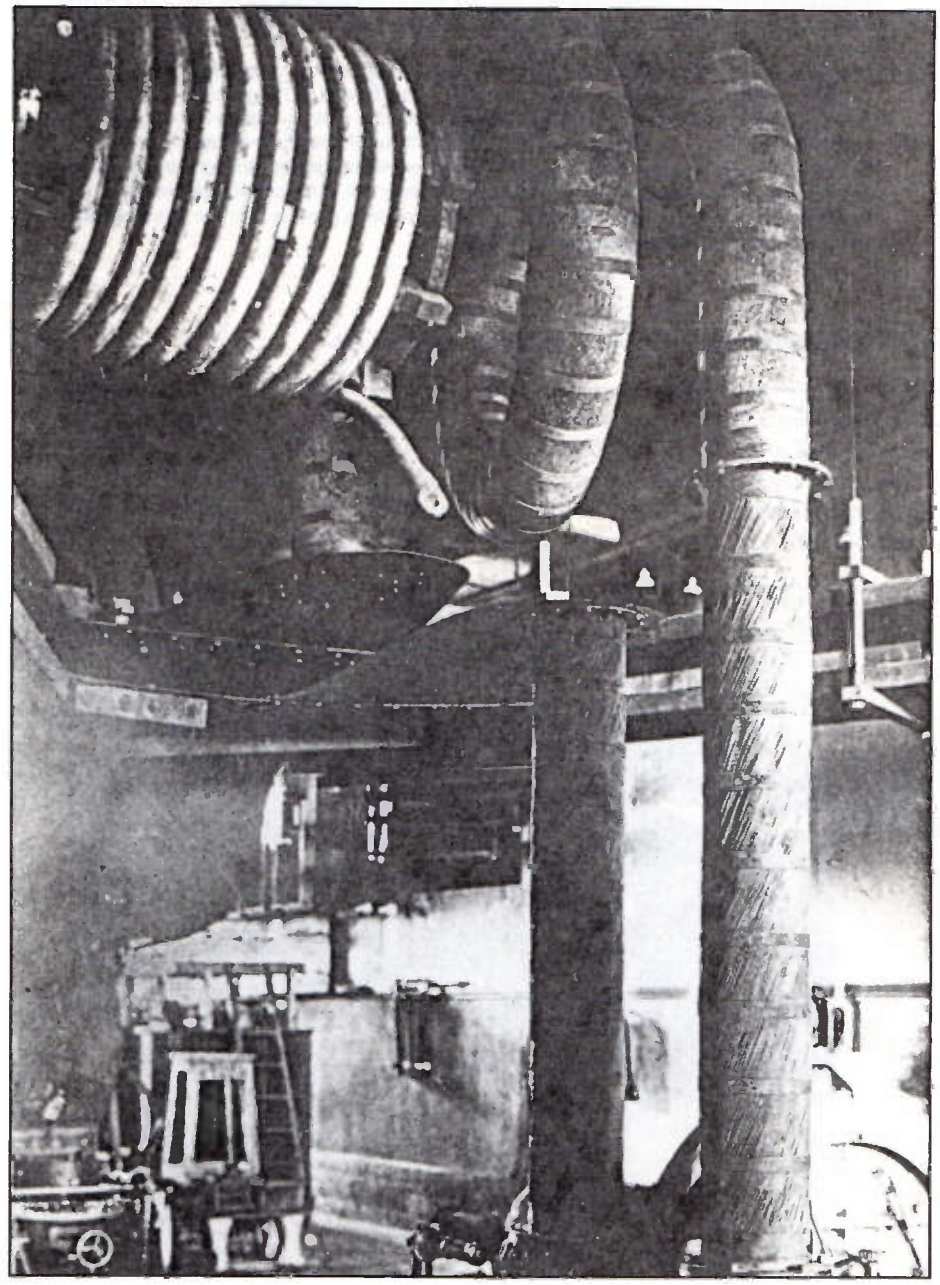

Photo 'F'. The antenna transformer Clifden c1908.

Fast, Faster, Fastest

For most readers Internet access is with a modem. However, while they have increased in speed over the past few years, modems have finally reached their effective limit. In effect, modems are as good as they can get - at 56Kbps, the telephone lines on which they rely can no longer support any further increase. So, on a fine day, with the wind behind us, we may be able to reach a usable speed with our modems of around 48Kbps and, if we're very lucky the connection might not reduce too much during the time of the call and, indeed, might even stay online at all.

Other technologies exist. Most famous is ISDN, with its digital connection and reliable speeds of 64Kbps or 128Kbps if we join the standard two channels into one.

But the most exciting new technologies are just about to burst onto the scene. Like ISDN these are based on digital technologies so offer much more reliable connections than modems, and they are both significantly faster than even ISDN.

Digital subscriber line (DSL) is the technology favoured by BT. BT's preferred method of DSL is known as asymmetrical digital subscriber line (ADSL). BT is - rather confusingly - calling its ADSL service BT Highway (which is remarkably close in name to BT existing ISDN services: BT Home Highway, and BT Business Highway). Once you've got your mind around its name, though, you'll be happy to hear that BT Highway will be an always-on service - that is, when you turn on your computer, the ADSL link becomes active. It's also a flat-rate cost - at a proposed £40 a month or so.

The cable telephone and television companies have their own system, called cable modems, but these aren't modems at all. They're digital connection boxes, just like ADSL equipment. Like ADSL, cable modems provide an always-on, flat-rate (at around £40 a month, too) service, with equivalent digital reliability.

Both systems allow download speeds of 500Kbps. With time, faster systems will be created at increased cost, for larger businesses and corporate users. Mind you, the download speed does depend on the fact that connections are contended with other users and are not dedicated (as they are on ISDN). BT Highway will have a contention ratio of 50:1 for its entry level system, so theoretically your actual download speed could be as low as 10Kbps, but that's a worst-case scenario, and BT expects that typical real speed will not be anywhere near that low. In a realistic scenario, download speeds will actually be defined more by your ISP's connection to the Internet backbone: not your digital connection to your ISP - a chain's only as strong as its weakest link, after all.

So, when can we have fast Internet connection? The short answer is - eventually. ADSL is scheduled for general release in the Autumn, while cable modems are being rolled out slowly around the country already. So apart from a few lucky people who are trialling either service, the rest of us will just have to wait!

Secure e-commerce For Users

PIPEX has joined forces with IBM to produce an easily usable solution for small to medium sized business who want to set up an online sales site. PIPEX Websell is priced from £15 a month, but is free to all existing PIPEX Dial users, which means that PIPEX is the first ISP to offer e-commerce facilities to its users as part of its standard Internet services.

PIPEX users set up their Website using the tools within Websell, such as an online catalogue builder that produces your site complete with images and descriptions of products and shopping carts. A secure payment facility is provided by a leading payment service provider (PSP) NetBanx. Payments can either be routed direct to a user's merchant bank (if the user already has credit/debit card facilities), or can be through NetBanx's own merchant scheme. Either way, NetBanx charges a processing fee for each transaction. Deliveries to customers is through ParcelForce Worldwide, and customers are able to track parcel delivery online through the user's Website.

Oftel Puts the Screw on BT

BT is being forced to let rival Internet service providers have access to its network for a low annual tariff on a wholesale, unmetered basis, in a move that looks set to bring forward the day when all Internet access over telephone lines is free. Oftel, the telecoms watchdog, reacted to a complaint by MCI Worldcom that although BT was launching its Surftime Internet access, BT was not allowing other licensed operators access to its network at competitive rates. Oftel found that this was true and, as this is obviously uncompetitive, has the power to force BT to offer the facility to all operators. This it has done, and the new pricing structure takes effect from the date (June 1) when BT Surftime was launched.

It's interesting that Oftel's general rulings on unbundling of local loops from BT to other operators has been literally years in the making (and will be a while yet coming to fruition), but an official complaint by one of BT's competitors on a single point of BT practise means that decisions can be reached almost immediately.

Bibliophile Launches Cut Price Book Site

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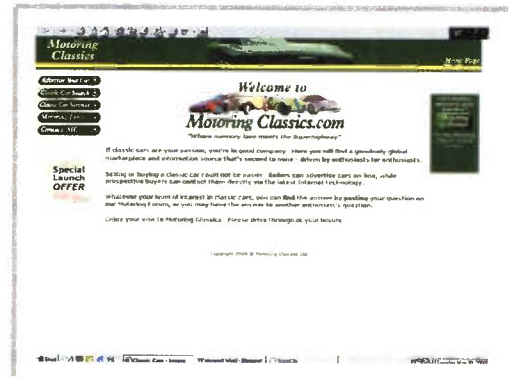
Motoring Site is a Classic



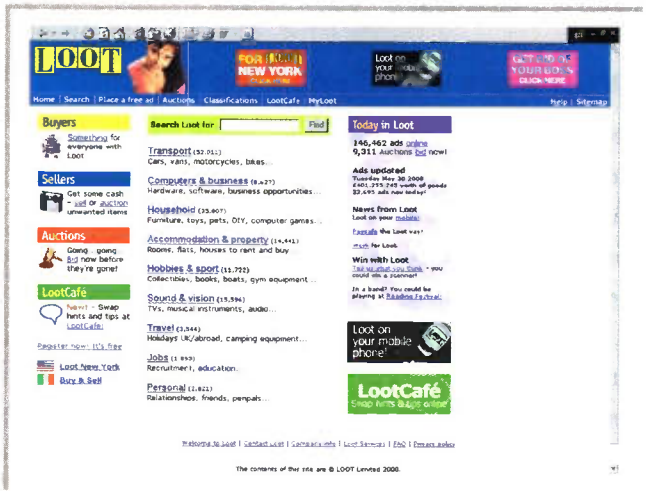
Motoringclassics.com at **<www.motoringclassics.com>** is a Web site dedicated to classic car enthusiasts, giving drivers, owners, buyers and sellers of classic and prestige cars a new home on the Internet.

Whether you're selling a Bentley or buying a Bugatti, need storage for a Saab or want insurance on a Jenson Interceptor, motoringclassics.com is the number one place on the Internet for lovers of automobiles that stand out from the crowd.

The site, which is offering three months of free advertising to the first 500 subscribers, also boasts individual discussion forums for every classic car marque, where people can swap experiences and hints and tips with fellow marque owners.

An extensive list of classic car service providers around the UK is also available, as are links to owners clubs from around the British Isles.

Sight and Sound at Loot.com



Loot.com at **<www.loot.com>** - the UK's largest consumer buying and selling Web site with over 13.8 million page impressions a month - provides the perfect online tool for consumers wishing to set up their ideal home entertainment system.

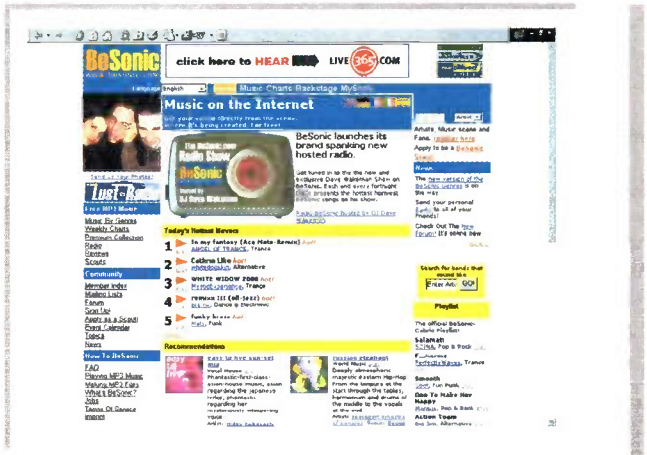
Loot.com hosts an extensive sound and vision section which is home to thousands of ads for TVs, VCRs, DVD players and hi fi equipment. On site, you can find items to your requirements, whether you're looking for a colour Sony portable for the kitchen or a Bang and Olufsen TV for the lounge at much lower than the recommended retail price.

The site utilises a powerful search engine that allows users to search through the ads in seconds. By entering simple search criteria such as brand name and geographic location, Loot.com quickly displays all relevant ads on screen in seconds with telephone or e-mail contact details.

Selection of ads from the Loot.com sound and vision section:

1. Sony 29in, brand new, in box, Nicam stereo, remote control, Argos price £450. Loot.com price £285;
2. Panasonic L50DVD player, portable LCD screen, region 2, Dolby digital, remote, rechargeable battery pack, optical & SVHS out speakers, mint condition. Loot.com price £450;
3. Toshiba DVD player, brand new, never been used, recommended retail price £300. Loot.com price £150; and,
4. Sony SLV/SE 80 smart engine, Nicam stereo, brand new, recommended retail price £330. Loot.com price £175.

BeSonic.Com Bursts onto UK Music Scene



BeSonic.com at **<www.besonic.com>**, the unsigned band community Web site and fastest growing source of legal free music over the Internet, is opening an office in London.

BeSonic.com has been expanding quickly since its launch in September 1999 and has a truly international audience.

With over 13,000 free tunes - ranging from ambient house to classical - available to download on the site, music lovers can find original, CD-quality music that they cannot experience through traditional sources.

zoom.co.uk to Launch WAP Shopping Service

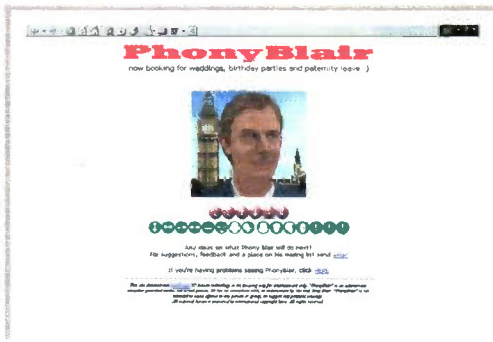
Zoom.co.uk, one of the UK's most successful shopping sites with 60% of its users making regular transactions, has launched wap.zoom at **<wap.zoom.co.uk>**.

Over a secure transactional platform, WAP users on Zoom will for the first time be able to shop, e-mail and receive news live from Zoom.co.uk.

Using WAPorizer technology, owners of WAP enabled phones will be able to read, reply and compose e-mails from their Zoom Web-based e-mail, access the latest fashion news, get up to the minute weather reports and horoscopes.

And, from early June, Zoom WAP surfers will be able to buy the latest fashion while on the move straight from their WAP phone.

phonyblair.com Shows Potential of Modeling Technique



While Tony Blair and wife Cherie recuperate from the birth of their new son, a team of UK software developers have created a 3D virtual Tony Blair stand-in, at **<www.phonyblair.com>**. PhonyBlair is the latest 3D virtual human to hit computer screens.

An interactive, photo-realistic animated caricature of Prime Minister Tony Blair, PhonyBlair showcases the latest developments in the creation of 3D 'Virtual Humans' or 'avatars'.

PhonyBlair's head can be rotated through 360 degrees and his features and facial expressions exaggerated, while he can even be made to sport a mohican-style haircut and to moo like a cow.

Developed by BioVirtual, a team of UK software developers, PhonyBlair represents a significant leap forward in the creation of a 3D 'Virtual Humans' or 'avatars'.

A number of companies have shown virtual humans on the Internet already, but have actually demonstrated semi-realistic cartoon style characters, produced with the latest computer graphics software at significant expense.

As impressive as some of these are, they do not represent true photo-realism, which is what the BioVirtual team have achieved.

The technology behind PhonyBlair has a diverse range of applications. In the first instance, it will help police produce accurate 3D composite images of criminals.

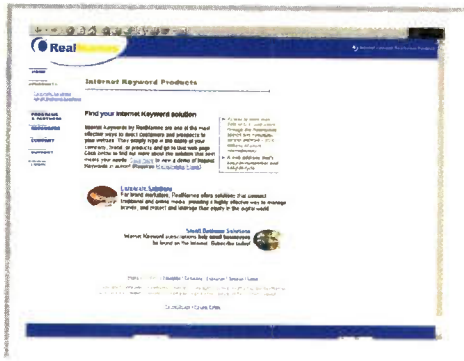
Using technology developed over a three-year period in conjunction with experts at New Scotland Yard, BioVirtual's engineers have perfected a method of applying the actual bitmap image from one or more photographs to an anatomically accurate 3D model, to produce truly photo-realistic 3D virtual humans.

BioVirtual has teamed with Aspley to supply the first commercially available 3D E-FIT product for police and security applications.

How to load the BioVirtual 3D model:

1. Load URL **<www.phonyblair.com>** in your browser;
2. Click on the Pulse logo - this will load the Pulse Entertainment site in a new instance of the browser;
3. Maximise this new window so the Pulse cube can be seen;
4. Click on 'Click here to install' (not 'Click here to continue') - message will indicate 'Verifying Pulse Player installation...';
5. Wait approximately 90 seconds on a 56k modem link - modem light are the only indication of activity, unfortunately;
6. Click 'Yes' when the 'Security warning' Window pops-up to advise of plug-in installation;
7. Click 'Agree' when 'License Agreement' Window pops-up to advise of free license terms;
8. When 3D spinning cube can be seen, close this browser window and return to **<www.phonyblair.com>**; and,
9. Click the link labelled 'click HERE...' and after approximately 15 seconds, PhonyBlair will appear.

UK Government Registers Real Names



The Prime Minister's Office has registered a number of Internet key words with Real Names at **<www.realnames.com>** to make it easy for users to go direct to its Web site.

Internet Keywords allow people to use brand names, familiar words or phrases to easily find the information they are looking for on the Web.

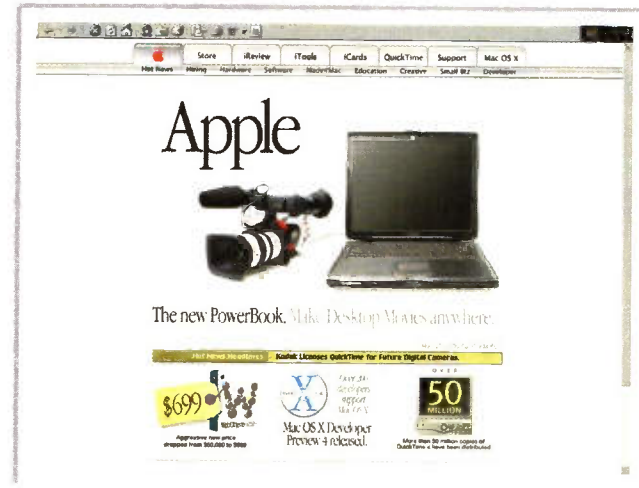
These latest Internet Keywords allow users to go straight to the Prime Minister's Web site simply by typing a number of commonly used and recognisable names into Microsoft's Internet Explorer browser and many popular search environments.

The names registered by the Government include amongst them: Number 10, Tony Blair, Downing Street and UK Government.

The Web site of the Prime Minister's Office provides a comprehensive daily news service covering all the Government's events and announcements.

It is also a gateway to the rest of the Government with all the latest information including manifesto commitments and video footage of the Prime Minister's questions from the House of Commons.

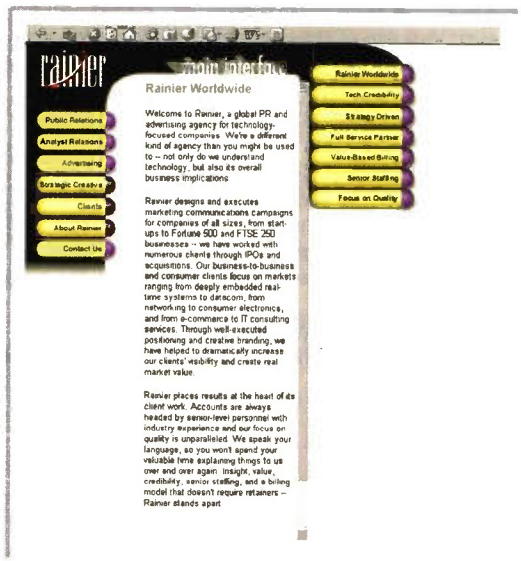
Apple.com Named Number One Movie Trailer Site



Apple has distributed more than 50 million copies of its QuickTime 4 player software and in particular has been distributed to Mac and Windows users worldwide.

In addition, Nielsen//NetRatings has named Apple's Web site, **<www.apple.com>**, the most popular destination for movie trailers on the Web.

10 Things To Do When E-mail Goes Down

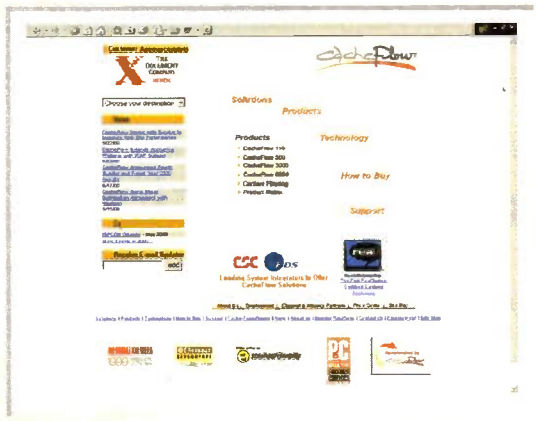


Following the worldwide problems caused by the Love Bug computer virus, marketing agency Rainier at **<www.rainierco.com>** has produced a 10-point list to help office workers get on with their jobs without e-mail.

Top 10 things to do without e-mail:

1. Talk in loud tones of your wonder at what people did before e-mail. Wonder at productivity increase;
2. Find a book on the use of English grammar and amaze yourself at your complete ignorance of how to use it;
3. Go to the pub early and discuss the merits of continued employment for those who sent or opened a freak e-mail entitled 'I Love You'. Drink to the hackers who caused you to be there;
4. Blow the dust off your phone book and ring your parents, remind them who you are and explain what e-mail is;
5. Find the life you left behind when first you logged on. Log off at the last page of the Internet at **<www.wackycreations.com/lastpage.html>**;
6. Pull out the Yellow Pages. Ring up market research companies and offer to take part in any surveys they're currently running;
7. **<www.eeggs.com>** to find out how to access hidden games and utilities in common computer operating systems and applications;
8. Re-programme databases, desktop and mobile phones and faxes to account for the recent UK phone number changes;
9. Set-up a chair racing circuit round your office and line-up the swivel chairs for a spot of office Grand Prix; and,
10. Spot the companies trying to cash-in on the Love Bug virus and admire their creative ingenuity.

Unacceptable Download Speeds Leave UK Waiting for E-Commerce



The UK is in danger of losing out on e-commerce revenues due to unacceptable download times according to the results of a study published in May by Internet caching appliance providers, CacheFlow at **<www.cacheflow.com>**.

The study provides the clearest indicator yet of the likely winners and losers in the race to create successful e-commerce businesses, with UK sites polarised between acceptable and appalling download speeds.

The CacheFlow study found Web users in the UK typically have to wait an average of 28 seconds for a Web page to download from an e-commerce site, but that waits of two or three times this figure are not untypical.

A report issued by US Internet analyst Zona Rearch in June 1999 stated that Internet shoppers are likely to leave an e-commerce site if they are unable to download Web pages in less than 8 seconds.

Travel

In the travel category, the study found that Web pages from EasyJet, the cut price airline, took an average of 10.7 seconds to download, whilst its traditional counterpart British Airways had an average download time of 33.7 seconds - three times slower.

Books

In the book category bol.com, the Internet bookstore took an average of 17.7 seconds to download, compared to high street bookstore Blackwells with an average download time almost three times slower at 47.6 seconds.

Financial Services

But in the financial services sector, Web pages at Internet bank Egg took an average of 47.6 seconds to download compared with LloydsTSB at 17.3 seconds.

Search Engines

In the search engine category, Lycos and Excite had averages of 8.3 seconds and 8.4 seconds respectively, almost five times faster than AltaVista and Yahoo which had average download times of 31.7 and 47.7 seconds respectively.

Supermarkets

In the supermarket category Tesco, which has invested heavily in the Internet as an ordering channel for customers had an average download time of 16.4 seconds per Web page, almost half that of rival Somerfields.

The study investigated the download times of 50 leading UK e-commerce Web sites across 13 business categories over a period of two weeks. The test was conducted using 56k dial-up accounts from half a dozen different Internet Service Providers. Each site was hit 10 times over the two-week period, at a variety of times throughout the day.

The most surprising finding of the survey was the lack of consistency in terms of performance between companies in the same category, and old-style retailers versus younger upstarts that are building businesses solely on the Web.

Eight of the top ten fastest Web sites are businesses that have been developed specifically on the Web such as lycos.co.uk, excite.co.uk, thetrainline.com and bol.com.

By comparison six of the top ten slowest sites are traditional businesses that have developed an e-commerce Web presence to compliment existing channels. The notable exception here is Boo.com, the online clothes stores that has suffered mixed fortunes over the last 12 months.

Forrester Research's Retail Pan-European Future published in March 2000, foresees a dramatic re-shaping of the European retail landscape as e-commerce sales grow 98% annually over the next 5 years. Starting from £1.73 billion in 1999 sales will reach £104 billion in 2005. CacheFlow believes that slow download times may well hinder this progress in the UK.

Terra to Acquire Lycos

Terra Networks at **<www.terranetworks.com>** is set to acquire Lycos at **<www.lycos.com>** in a bid to create the first truly global Internet company.

The combined company will be built on a unique platform that capitalises on the convergence of Internet services, new media, branded content, e-commerce, and next-generation communication technologies.

Terra and Lycos expect pro forma 2000 revenues of approximately $300 million and together currently have an estimated 50 million unique users and 175 million page views per day.

Terra Lycos will have operations in 37 countries, with leading positions in multiple high-growth markets in North America, Latin America, Asia and Europe.

Top 100 Bookmarked Sites Released by Hotlinks

HotLinks at **<www.hotlinks.com>** has released the top 100 list of the most popular sites bookmarked by HotLinks members for the month of May.

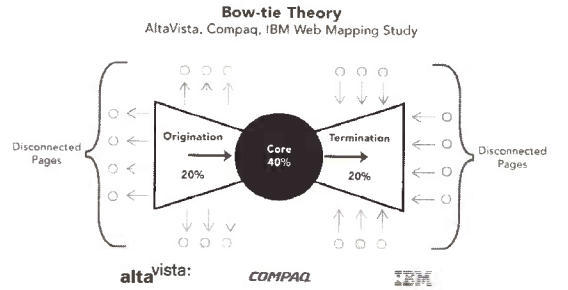
The HotLinks 100 data offers a glimpse into what Web sites Internet users like, save and utilise to navigate the Web.

Unlike several other Internet user measurement tools, which take a look at page views of Web users, the HotLinks 100 identifies the sites that people take the time to bookmark and use over and over again, the sites that people really find valuable.

Top Ten HotLinks' sites:

1. www.microsoft.com
2. www.looksmart.com
3. www.real.com
4. www.city.net
5. www.yahoo.com
6. www.miningco.com
7. www.abc.com
8. www.fedex.com
9. www.geocities.com
10. www.simplenet.com

Researchers Create Accurate Picture of the Web



Scientists from IBM Research, Compaq and AltaVista have completed the first comprehensive map of the Web, and uncovered divisive boundaries between regions of the Internet that can make navigation difficult or, in some cases, impossible.

Previous studies, based on small samplings of the Web, suggested that there was a high degree of connectivity between sites as evidenced by recent reports on the small world Web and 19 degrees of separation.

Contrary to those preliminary findings, the new study - based on analysis of more than 500 million pages - found that the World Wide Web is fundamentally divided into four large regions, each containing approximately the same number of pages.

The findings further indicate that there are massive constellations of Web sites that are inaccessible by links, the most common route of travel between sites for Web surfers.

Developing the 'Bow Tie' Theory explained the dynamic behavior of the Web, and yielded insights into the complex organisation of the Web. These discoveries will help computer scientists better understand the structure of the Internet, and lead to new technologies and design advances that will speed and simplify e-business.

Store Passwords Safely on the Web

UnLockMe!™

Unlockme.com at **<www.unlockme.com>**, a new online password retrieval site, announces the launch of a Web site that eliminates the frustration of remembering a different user ID and password for every site visited on the Web, without yielding hard drive access.

Unlockme.com offers a free virtual service that allows Internet users to safely store and retrieve IDs and passwords while browsing the Web.

Unlike other ID and password storage programs, Unlockme.com ensures complete privacy and unlimited access by eliminating the need for hard drive connection.

Sensitive data is fully encrypted and all ID and password information is protected through industry-leading SSL (Secure Socket Layer) technology to ensure user information security. In short, this site offers a 100% virtual solution to an age-old problem.

A first of its kind, Unlockme.com is completely free and private with nothing to download or install.

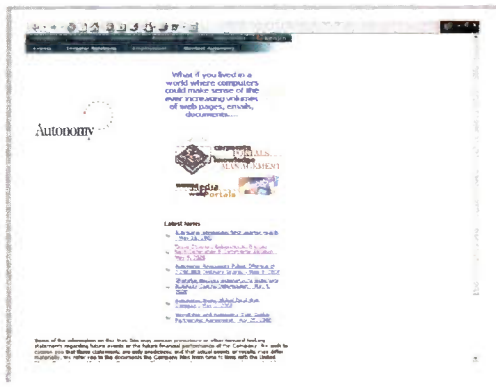
audiohighway.com Tops 8 Million

audiohighway.com at **<www.audiohighway.com>** generated more than 8 million total online visits in April 2000 up from 7 million total online visits in March 2000.

In addition, PC Data Online ranked audiohighway.com 392 among the most frequently visited Web sites on the Internet for April 2000.

audiohighway.com, has built one of the largest and most diverse libraries of free audio content for consumers on the Internet, making it one of the top choices for consumers to listen online.

Tesco Chooses Autonomy for Virtual Shopper



Autonomy at **<www.autonomy.com>** has announced that Tesco at **<www.tesco.net>**, the biggest Internet grocer in the UK, has purchased Autonomy's technology to power the next generation of its online shopping service.

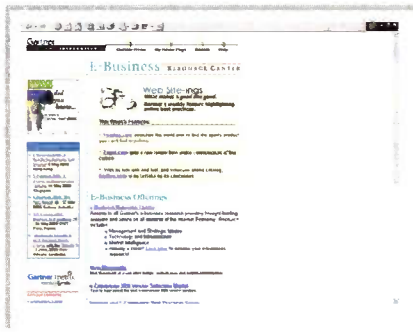
Tesco will use the technology to automatically manage products across its catalogue, as well as provide advanced personalisation, through both personal computers and mobile phones, for customers using the tesco.com site.

Tesco will use Autonomy's technology to create personal shopping assistants on the Web, as a way of suggesting products and services that are appropriate to customers' needs and interests.

The technology will understand customers' interests automatically as they interact with the content on the site, providing them with interesting and appropriate product suggestions and promotions, whenever they are online.

For example, beer connoisseurs will receive news of the latest continental lagers or real ales, chocolate addicts will be shown the latest confectionery, and vegetarians will avoid the latest meat promotions - without the need to fill in online forms specifying user interests.

Gartner.com Launches Web Site-ings



Gartner Group has launched Web Site-ings at **<www.gartner.com/ebusiness>**, a new weekly Web content feature that highlights online best practices using Gartner's proprietary Web Evaluation Tool.

Web Site-ings is designed to deliver practical advice to technology, business, and new media executives charged with the responsibility for their Web sites' effectiveness. The proprietary Web Evaluation Tool represents a detailed methodology to assess and weigh the many contributing features of good Web sites.

Specifically, the tool articulates value-generating elements in site design, site functionality, and creating customer value, and offers industry-specific criteria for more than 20 industries.

Web siteforFREE.com and freeInternet.com Combine

Web siteforFREE.com at **<www.siteforfree.com>** is to make its Web site development software available to freeInternet.com's registered users at **<www.freeInternet.com>**. FreeInternet.com is the world's leading free and anonymous Internet service provider.

The agreement enables approximately 2.2 million freeInternet.com users to take advantage of Web siteforFREE.com's e-commerce opportunities and small business services.

U sers will be able to build, access, maintain, and expand their Web sites online. Fusing it all together is Web siteforFREE.com's online education center which offers all the assistance needed to develop a Web site.

NetRadio.com Attracts Record 2.9 Million Users

NetRadio.com an Internet broadcaster at **<www.netradio.com>** claims that 2.9 million unique users accessed at least one of NetRadio.com's online offerings during March, including its Web site content, listening page, and Windows Media Player or RealPlayer content streams.

The company also announced that more than 2.5 million unique listeners accessed NetRadio.com's Internet broadcast services in March. This is a record audience figure for NetRadio.com, representing an increase of approximately 87% during the first quarter of 2000.

NetRadio.com is a leading broadcaster of originally programmed audio entertainment over the Internet. NetRadio.com's has more than 100 channels of music and information on demand, 24 hours a day, seven days a week.

The site connects with music enthusiasts through 15 interactive music communities ranging from Jazz, Modern Rock and New Age to Vintage Rock, Country and Classical.

NetMechanic Launches HTML Toolbox 2.0

NetMechanic at **<www.netmechanic.com>**, a leading independent provider of online Web site maintenance, has launched a new tool called HTML Repair. This service is a new addition to HTML Toolbox and a primary component to the new Version 2.0 of HTML Toolbox **<www.netmechanic.com/info/toolbox.htm>**.

This is the only product on the market that will both diagnose HTML code problems and, at the user's direction, repair them. The HTML Repair service will evaluate up to 400 pages of any site, alerting the user to existing and potential problems, then recommending solutions.

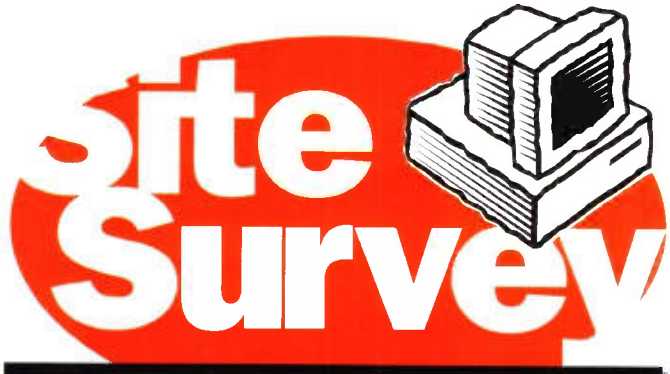
This online service is safe and allows the user to choose whether to implement the repairs. Customers continue to access the user's site while NetMechanic's tools test and repair the pages that can later be uploaded without any down time.

HTML Repair and all HTML Toolbox - Version 2.0 tools can be used on an existing site or to identify and fix errors on a new site while it's being designed.

Coupled with NetMechanic's other promotional and monitoring services; NetMechanic is a one-stop resource for all Web site maintenance needs.

A recent report by Jupiter Communications suggested 46% of users have left a preferred Web site because of a site-related problem.

With NetMechanic all Webmasters, from the novice to the expert can avoid potential visitor disasters due to site errors.



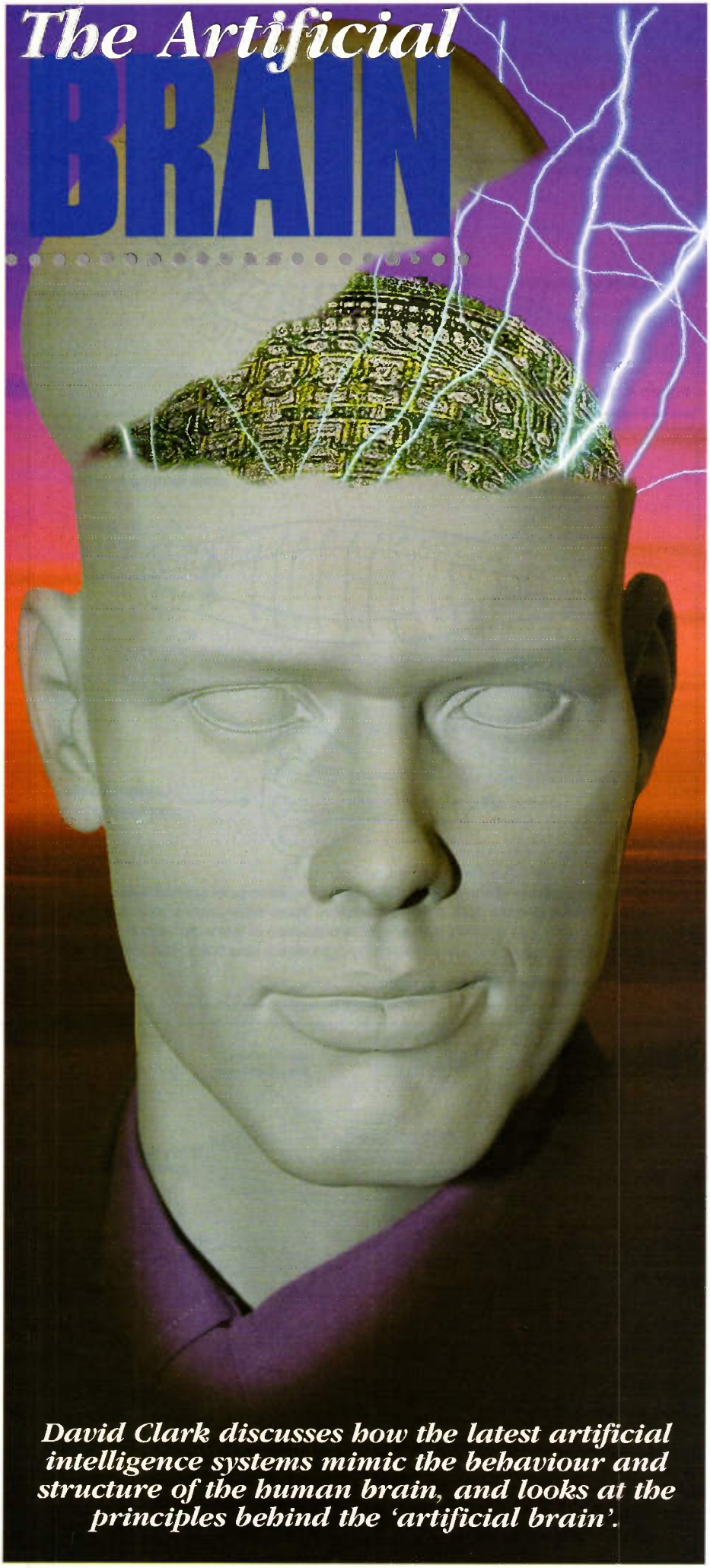
The months destinations

There are quite literally thousands of Webcams hooked up to the Internet, but finding them all is a bit of a problem. One site that aims to help is EarthCam, at **<http://www.earthcam.com>**, where all Webcams it can find are listed in a searchable format. Just type in the name of the place you want to check, and if there's a Webcam there, EarthCam will show you.

While Webcams are one thing, panorama views of places on the Internet are another. Euro VR, at: **<http://www.eurovr.com>** lists virtual reality panoramas in an easily accessible manner. Panoramas are in QuickTime VR format, which allow you to scroll around the panorama interactively. To use the site, you'll need Apple QuickTime software. If you haven't already got it, QuickTime is available free from Apple Website, at: **<http://www.apple.com/>**.

Join the mud and glory brigade online this year, from 23 to 25 June, but leave your wellies behind. This year's Glastonbury Festival is taking the Internet plunge, at **<http://www.glastonburyfestivals.co.uk>**. Surfing the virtual concerts beats plodging in the real mud anytime. Only the murky atmosphere's missing.

The Artificial BRAIN



David Clark discusses how the latest artificial intelligence systems mimic the behaviour and structure of the human brain, and looks at the principles behind the 'artificial brain'.

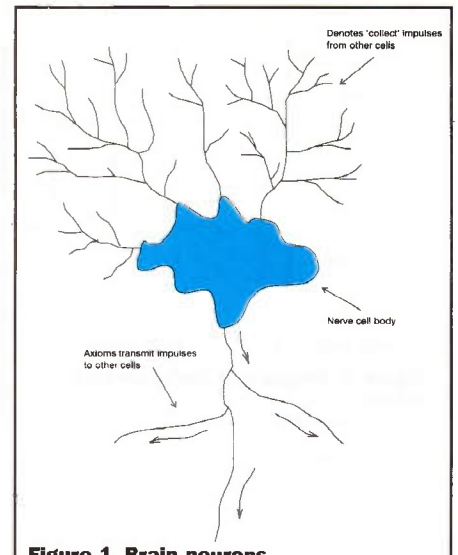


Figure 1. Brain neurons

Introduction

The human brain is a remarkable device. Consisting of around ten billion cells each of which connects to many, typically 6000, others (see Figure 1) it is a network of unimaginable complexity.

However, it is also remarkably organised, both in terms of how different regions have specific roles but also in levels of function, a hierarchy that corresponds to how the brain has evolved over many millions of years. Manipulating the brain has been a staple of science fiction for many years, from Doctor Who style aliens consisting of brains living in vats of nutrient, through Hammer Horror head transplants to the fully functioning androids virtually indistinguishable from humans of more slick sci-fi films. Perhaps part of the fascination is the fact that the human brain perhaps uniquely possesses - awareness of its own existence and its limited life span. Added to this is the poignancy of the apparent waste of the loss of knowledge and experience that disappears with each generation.

But medicine and engineering have some more immediate and perhaps more noble concerns and requirements for the study of the brain and artificial intelligence. Knowledge of the working of the brain, memory and intelligence can give help with learning, and problems with dyslexia for example. It might help in the development

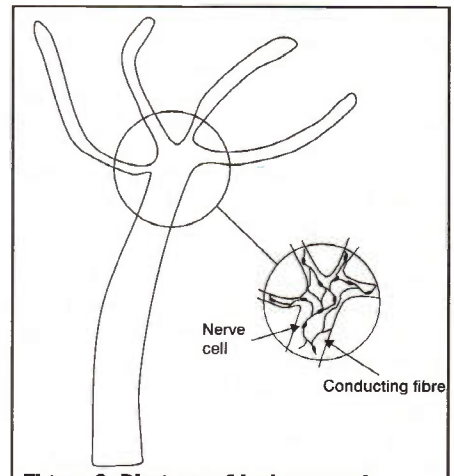


Figure 2. Diagram of hydra neural network

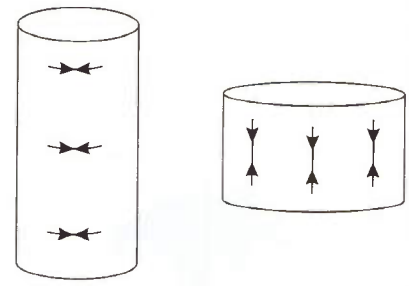


Figure 3. Diagram of hydra muscle action

of more refined and even safer anaesthetics, and in the understanding and treatment of degenerative diseases such as Alzheimer's and Parkinson's and those caused by infective agents, for instance bovine spongiform encephalopathy (BSE) and the human form Creutzfeld-Jakob disease (CJD). 'Intelligent' systems should provide more effective methods of operating equipment in hostile environments, for example, and aid more mundane everyday tasks that involve interacting with computer based applications.

Evolution

Fifty years ago the computer pioneer Alan Turing devised a test that would give a measure of how intelligent an artificial intelligence was. This was basically a measure of how long it took a human observer to tell whether it was a human or a machine that was giving responses to a set of questions asked - the test usually didn't take very long! Earliest artificial intelligence programs were more or less systems for giving a pre-determined output from a combination of inputs based on examination of the input according to a set of fixed rules, essentially a fixed logic system. This soon developed into a system that involved 'fuzzy' logic. 'Fuzzy' logic output is based on probability or likelihood and so allows the possibility of definitely true, probably true, might be true, unlikely to be true, definitely not true etc., rather than the hard output of a simple 'true' or 'false' value. The next generation of artificial intelligence is now being modelled on the best device available so far for exhibiting intelligence, the human brain.

To understand how the brain works it is useful to look at how it evolved. The most primitive organisms to evolve were single cell organisms such as the amoeba, where the single cell obviously has to perform all the functions necessary to live. This includes absorbing nutrient, and digesting and metabolising it to give energy and material to enable other processes such as movement, growth and cell division. As organisms evolved and became multi-cellular there came a need for a form of communication between the different types of cells. The hydra for example, a tube-like animal with tentacles that lives in ponds, lakes and rivers has a neural network (see Figure 2).

The organism has two types of muscle-like cells one of which acts longitudinally thus shortening the body and the other

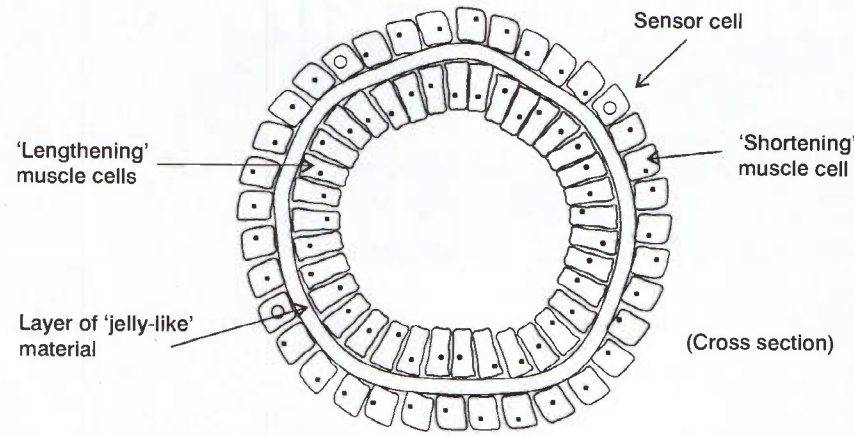
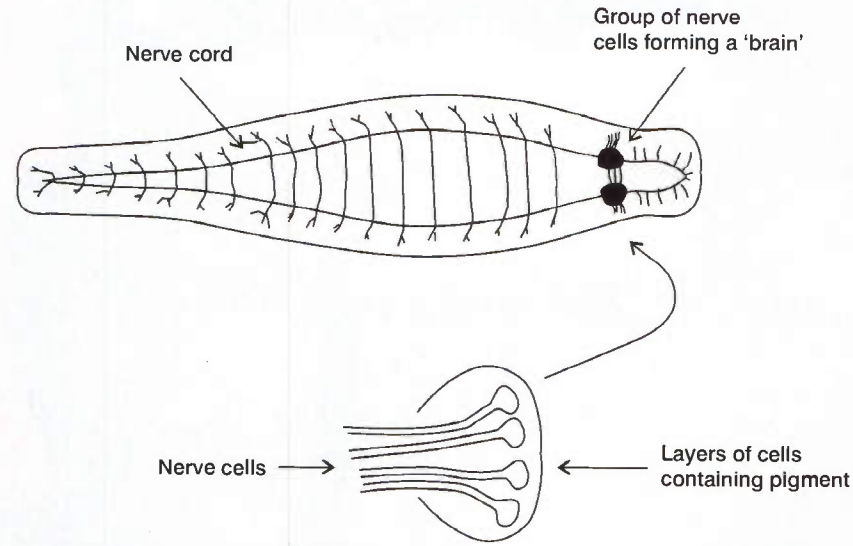


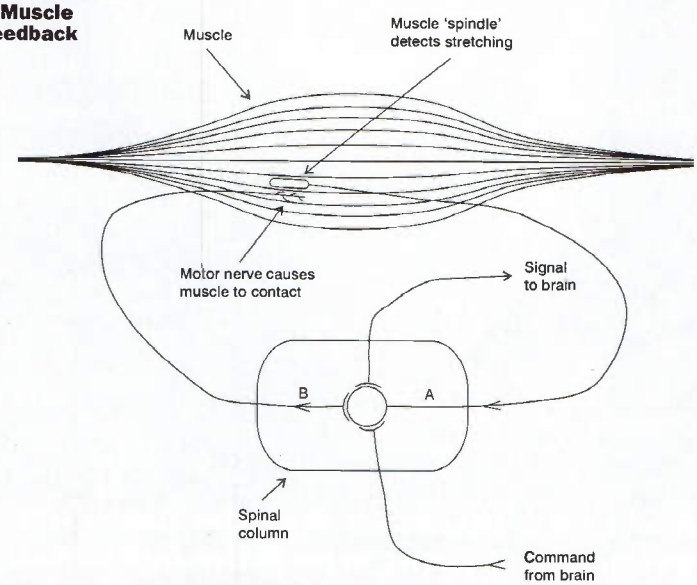
Figure 4. Diagram of structure of hydra body



The nervous system of the flatworm shows the beginnings of specialised organs. These are a nerve cord from which other nerve fibres emanante, a collection of nerve cells acting as a 'brain' and a 'eye', a collection of a few nerve cells contained with a pigment cup which are triggered by light which also link to the brain.

Figure 5. The flatworm nervous system

Figure 6. Muscle control feedback



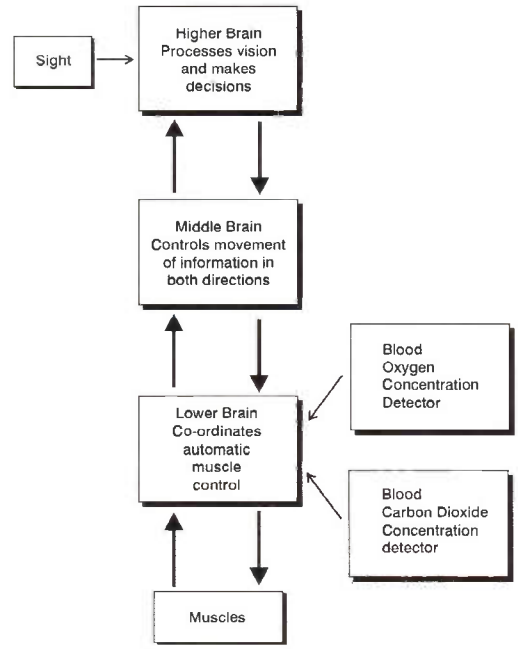
For automatic reflexes the signal travels directly from A to B with no brain involvement. Other signals 'tell' the brain what is happening, and give 'commands' for voluntary actions which 'over-rule' automatic actions.

Brain Hierarchy

Breathing is a good example of demonstrating the hierarchy of processes in the brain. Normally we are not aware of the fact that we are breathing. Detecting systems around the body 'monitor' the amount of oxygen and carbon dioxide in the blood; the lower part of the brain automatically controls the muscles of the chest wall and diaphragm and we automatically breathe in and out. The middle 'level' of the brain passes this information up to the higher part of the brain so that we are aware of breathing if we stop and think about it. The higher part of the brain processes sight and might tell us for example we are about to dive into water. This then causes a conscious decision to take a deep breath and hold it as we jump. In this case the command is passed in the opposite direction from the higher brain down to the systems that co-ordinate the movement of all the muscles involved and make them act correctly.

This outer part of the brain is a complex 'high-level' neural network, and different regions are responsible for different functions in other words the brain can be thought of as having a 'modular' structure. For example there are 'modules' associated with vision, hearing and so on. The rest of the upper brain, called the association cortex, appears to have areas responsible for less definable functions such as speech and pattern recognition, and the remainder is responsible for more abstract attributes such as thought, memory and conscious behaviour. This indicates that these attributes are not mere functions of individual modules but are due to the hugely complex 'interconnectedness' of the modules.

Figure 7. Brain Hierarchy



which acts laterally thus lengthening it (see Figure 3).

These muscle-like cells connect to the neural network. The animal additionally has sensory cells that respond to light and which are also connected to the neural network. When stimulated these sensory cells trigger the neural network, which then causes the co-ordinated contraction of the muscle-like cells and hence movement towards the light source. (Figure 4 shows the structure of the hydra body.)

More complex organisms such as the flatworm have even greater levels of organisation, possessing an 'eye', nerve cords and small collections of nerve cells acting as a 'brain'. Flatworms were in fact the first organisms in the evolutionary process to develop an identifiable 'head' region containing a sense organ and a 'brain' from which a definable nervous 'cord' connected the nervous 'system' to the rest of the body. See Figure 5.

Development and increasing complexity beyond the flatworm has ultimately led to the insects, probably the most successful class of organism in terms of numbers and adaptation to particular environments. Another route of evolution occurred however, via a creature which was similar to the flatworm but which had a different embryo stage, and this led to the evolution of creatures with a spine to carry the nerve cord and a skull to protect their larger brain. Ultimately of course, in brain development terms, this has led to humans. Interestingly, the structure and activity of the brain and spinal cord reflect the evolutionary process in its hierarchical formation. Mimicking this structure is leading to the most successful attempts so far to produce artificial intelligence.

The Reflex

At the base of the hierarchy is the most simple nervous system activity, which involves no intelligence at all. This occurs in the spinal cord part of the nervous system. For example a sensory nerve built into the muscles called a muscle spindle sends out a signal when the muscle stretches. The far end of this nerve is in the spinal column where it ends in a synapse. (The synapse is a junction between nerves. The electrical impulse of the first nerve is converted into a chemical 'message' which crosses the gap between the nerves and triggers a further electrical impulse in the second nerve. The advantage of this system over a direct electrical connection will be seen in the 'Synapses' section.) The nerve signal crosses the synapse and triggers the spinal column end of a motor nerve. The far end of the motor nerve is connected to the muscle and the signal reaching this end causes the muscle to contract. Thus this is a sensitive feedback system that enables the muscles to remain in just the right amount of tension in order to stand upright for example. This system also enables an effectively instantaneous response to pain for instance by causing an involuntary withdrawal of say the hand from a sharp object.

However the sensor - synapse - muscle signal path doesn't occur in isolation. The synapse is also connected to other nerve cells, each of which can influence the activity of the cell to which it is connected. These communicate information about this simple reflex activity to the next level up in the hierarchy, the lower brain, and also receive 'commands' from the brain, enabling conscious, or deliberate, activity. Figure 6 shows this.

The lower brain co-ordinates all the information about muscle tension and position etc. and hence regulates coherent body movement. It is the equivalent of the neural network of primitive organisms, and we are unaware of its activity. The 'next level up' in the hierarchy is the mid-brain. In primitive creatures this region processed the information from the light sensors, or primitive 'eyes', and communicated it to the rest of the nerve system. In humans the processing of sight has moved to the higher brain along with all the other senses. Nevertheless, the mid-brain still controls the communication of information between the lower brain and the part of the brain that in humans contains 90% of the total number of nerve cells in the whole of the body's nervous system. This is the upper brain, or

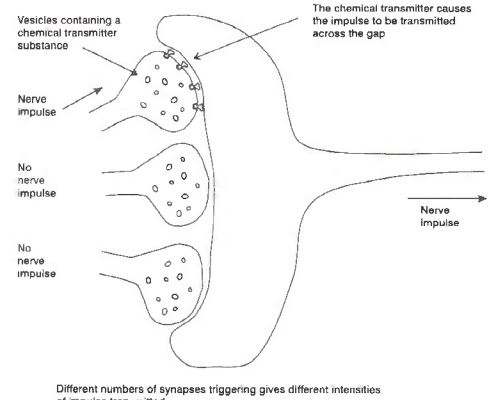


Figure 8. The synapse

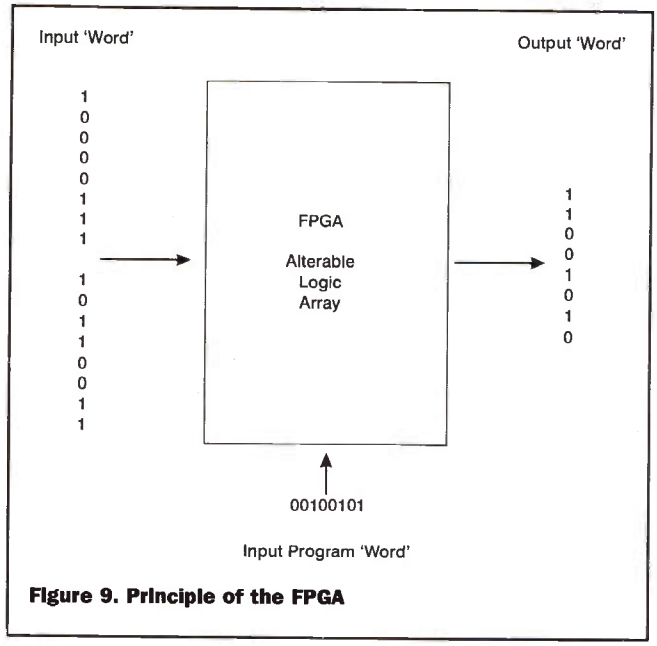


Figure 9. Principle of the FPGA

forebrain, or cerebrum. It is the part of the brain where it is believed all conscious activity occurs, thought, decision-making, memory, learning, awareness, language, imagination, 'inner visualisation', creativity, where in fact consciousness itself 'exists'. See the box text 'Brain Hierarchy' for an example of this.

Synapses

Here another aspect of the connections between brain cells, and nerve cells in general, needs to be considered. These connections are mediated by the synapses. The electrical impulses pass between the nerve cells via a chemical 'messenger' and this allows the link to be more than a simple on/off digital-like event in that it can vary in intensity and hence have a 'fuzzy logic' type response. See Figure 8.

This allows a much greater level of variability and complexity between all the many nerve interconnections. What is more there is an even greater level of complexity to be considered. The 'messenger' chemicals, or neurotransmitters, involved in the synapses act only locally at that synapse. However, there is another neurotransmitter at work in the brain. This is nitric oxide and it is such a small molecule that it can pass easily through cell membranes. When it is present it increases the amount of normal neurotransmitter released when a nerve triggers. Furthermore because of its ability to pass through cell membranes it can act on nerve cells a long way from the cell that released it. This adds another order of complexity and sophistication to the 'interconnectedness' of the cells of the brain.

So given this high level of network interconnectedness how does artificial intelligence even attempt to simulate such a complex system? Latest developments in artificial intelligence are looking more and more to mimicking not only the biological functioning and structure of the brain, but also the fundamental process by which intelligent behaviour developed, genetic evolution. And just as in a biological system the intelligence and the brain modules are inseparable parts of the whole brain.

The Artificial Brain

The basic artificial brain module corresponding to the module of the biological brain is a Field Programmable Gate Array (FPGA). See Figure 9.

This is a device that has a number of digital inputs and outputs. For example's sake assume sixteen inputs and eight outputs. The series of 1s and 0s or 'word' that appears on the output for a given 'word' on the input is determined by how the internal logic of the FPGA is configured which itself is pre-determined by a set of instructions loaded onto another 'input'. For the sake of simplicity assume this too is a single 8-bit 'word'. The ability to modify the output that appears for a given input allows each module to be built into a system that can 'learn' and modify its behaviour so that it gets better and better at the role for which it is intended. This is done by allocating a score (in a similar way to a fuzzy logic output has a probability value) as a measure of how well the module has performed its task, ie how close the actual output of the FPGA is to the desired output for a correct result. The first time it performs the task it is likely to be fairly poor at it. The score will be low. Another 'word' is then put on the programming input and the task performed again. If the score is even worse the programming input word will be discarded and the original word kept. Then another one is tried. If the score is better the new word is kept and the original one discarded. Again another one is tried, and the word giving the best score is kept each time; with each 'generation' of brain module behaviour the module will improve its performance. Furthermore if the task is changed the module will automatically start to 'learn' its new task thus giving a flexible system.

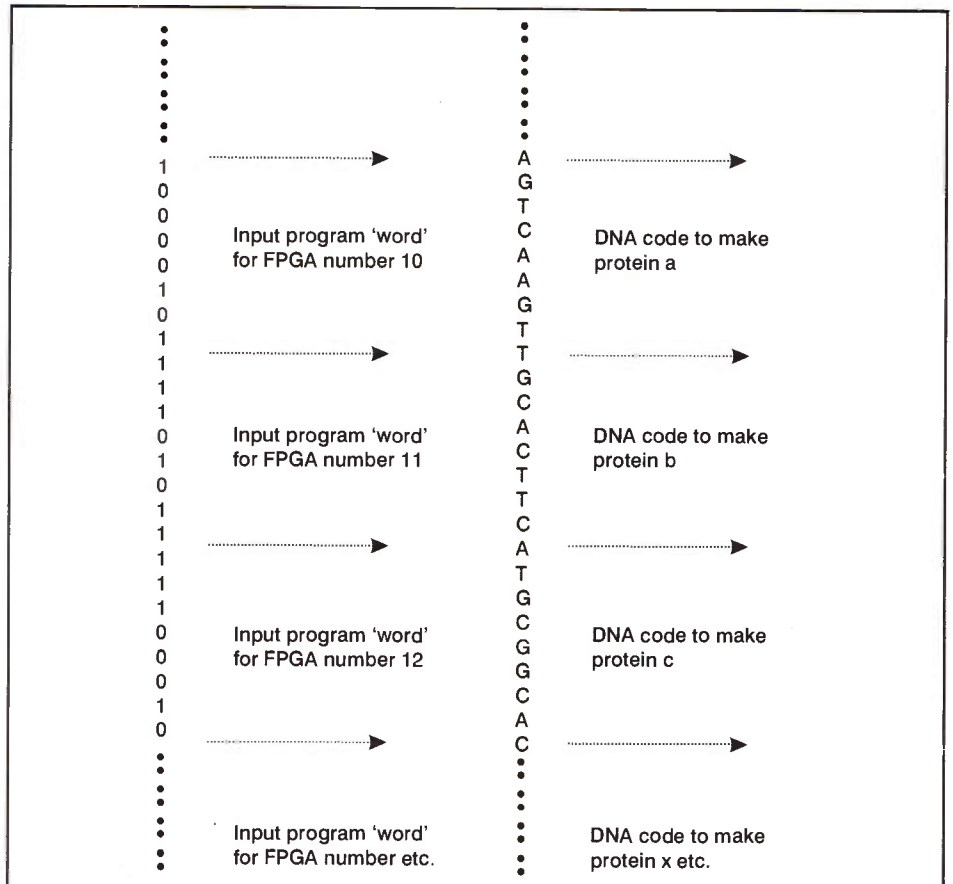
An example of one of the functions of a real brain module is pattern recognition, for example recognising faces. Simplifying this for example's sake to the recognition of a square, the set of optical sensors that form the FPGA input might give an input word value of:

0000 0110 0110 0000

corresponding to 'seeing' a square ie:

0 0 0 0
0 1 1 0
0 1 1 0
0 0 0 0

The output word from the FPGA that is desired for when 'there is definitely a square



The string of 1s and 0s that control the 'behaviour' of the FPGAs is analogous to the human chromosome that controls the cell manufacture of proteins, many of which are enzymes that control cell behaviour.

Figure 10. The electronic chromosome

exactly in the centre of the field of view' would be say 255, the maximum value of an 8-bit word. 'Seeing':

0 0 0 0
0 0 0 0
1 1 0 0
1 1 0 0

might give an output of 200 corresponding to 'there is likely to be a square in the field of view' and:

0 0 0 0
0 0 1 0
0 0 1 0
0 0 0 0

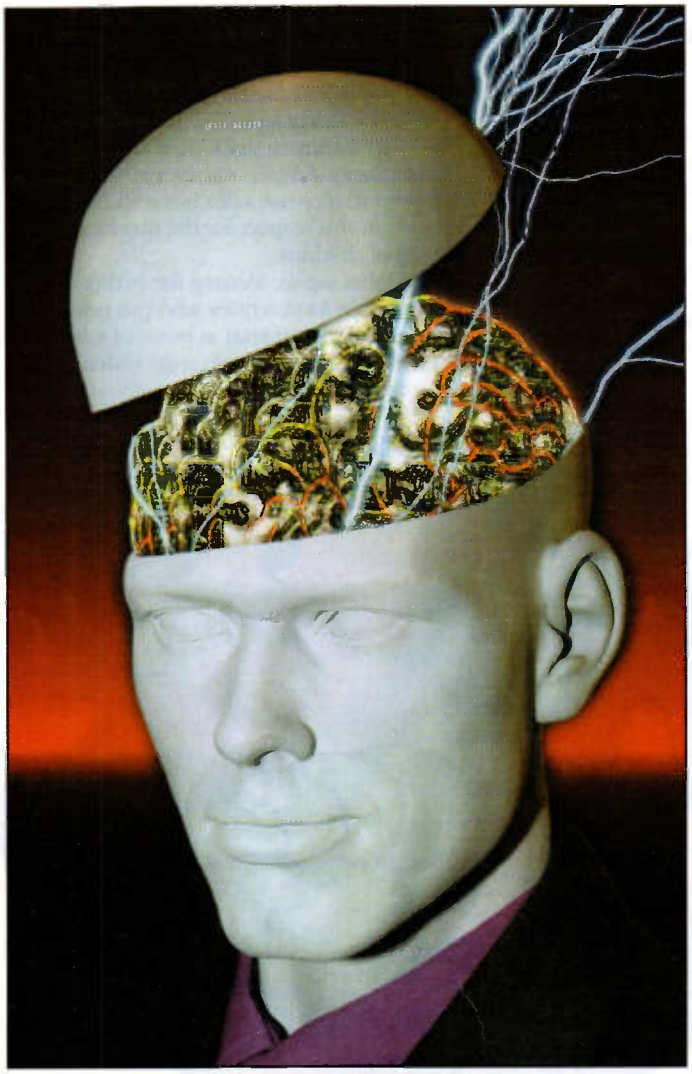
might give 10 to indicate 'there is something there but it's not a square' and:

0 0 0 0
0 0 0 0
0 0 0 0
0 0 0 0

might give 0 to indicate 'there's nothing in the field of view'. Any of the last three 'results' might for example trigger another FPGA to control output actuators to 'look' around until something comes else comes into the field of view. If the word on the program input didn't give these results, another word could be tried that see if that gave closer to the required output and if it did then that word would be kept. The artificial brain module is therefore 'learning' under the control of the word on the 'programming' input.

One 'artificial brain' already developed has several FPGAs all dedicated to individual tasks, all working in parallel and independently, ie at one level in a hierarchy. The next level in the hierarchy is to have all the FPGAs interconnected and so influencing each other's behaviour. But just as each individual FPGA's behaviour is controlled by its input programming word the interconnections between the FPGAs can also be changed by an input programming word. The artificial brain can then 'learn' to perform a complex task that needs the 'co-operation' of all the individual FPGAs in a complex system of interconnectedness in a way that matches that of a real brain. (This mimics the biological learning of activities where the connections between the neurons involved are strengthened when a good result is achieved, and disappear when it is not.) In computer simulations of artificial brains the FPGAs are replaced by software models. An additional advantage of software implementation is that the activity of the NO neurotransmitter can also be mimicked to give an even closer imitation of a biological brain. And just as in a real brain there is no 'top level' system controlling the lower levels. The artificial brain has its own activity that is independent of outside influence. In a way it has a 'life' of its own that is too complex to predict.

In reality of course there is a 'higher' influence. Someone has to decide what the task is that the 'brain' is being set to do, and to provide the yardstick by which the score for how well it is doing that task is determined. But within that limit the brain's behaviour is autonomous.



Electronic Genes

Another fascinating concept that this structure allows is that of the 'electronic gene', several of which might make up an electronic 'chromosome' (see Figure 10).

In an artificial brain of say one hundred FPGAs control of the brains activity is completely determined by the one hundred input program words. This string of 1s and 0s one hundred words long is analogous to the string of Gs, Cs, As and Ts (the guanine, cytosine, adenine and thymine nucleic acids) that make up the DNA of a chromosome that completely controls the behaviour of biological cells. Just as a particular sequence within the chromosome is a gene that controls the production of a protein or enzyme that determines a particular structure in, or activity of, a biological cell so the particular word (gene) within the string of words (chromosome) controls a particular activity of the artificial brain. The discarding or keeping of a particular word to improve the activity of the module is analogous to the process of evolution in adaptation to environment - good genes are selected and 'bad' ones are rejected ie die out.

This gives rise to two more incredible possibilities. Any particular 1 or 0 on the electronic chromosome can periodically be randomly changed (which can be outside the control of an operator) - an electronic mutation. If this random event leads to an improved performance it will be kept - the artificial brain will automatically evolve from 'generation' to 'generation'. Even more incredible is the possibility of a form of electronic breeding or cloning. A particular region of 1s and 0s on the electronic chromosome could be swapped or intermingled between two artificial brains to give an 'offspring' with some characteristics of both 'parent' brains. Or a particularly successful string of 1s and 0s could be copied to another artificial brain to give identical behaviour.

There is one thing that is still missing from this artificial intelligence however. That is an inherent goal or purpose. The system can learn from errors and change behaviour indefinitely until a correct 'result' is achieved, but the initial goal has to be given to the intelligence for it to work on. Nevertheless the possibilities are amazing (or terrifying depending on your point of view), and the future holds the prospect of devices with a form of machine 'consciousness'.

Conclusion

Artificial intelligence is already widely used in software fields as diverse as disease diagnosis, financial market modelling, project planning, speech recognition, natural language interrogation of complex databases and safety critical software development. In the hardware field of applications the inputs of the FPGAs can be connected to sensors and the outputs to motors, actuators etc. This gives intelligent systems, machines and robots, though in practice very different to the androids of science fiction. Nevertheless the humanoid-style robot is a goal of many developers and simple 'personal robots' have featured in Electronics & Beyond's News Bytes pages. So working towards the goal of an autonomous mechanical 'intelligent being' in a small series of steps will very likely provide useful devices, knowledge and techniques that will enrich 'real' life. It certainly provides plenty of food for thought for 'real' intelligence!

Towards a SAFER FUTURE

Douglas Clarkson

Introduction

As we try to map out the options for the future, we can be sure that we will have increasingly available data across a broadening range of subjects and topics. There is of course great interest in trying to use this information on as broad a range of fronts as possible. The very core of the Internet operates on the basis of efficient search engines to find specific selected categories - so this is an example of developing a mechanism to utilise a resource.

The vast effort currently in place to direct and control our spending on the net is an example of corporate skill working on the individual. What hopefully will evolve, will be information systems that operate for the single benefit of the individual - by lowering the 'life risk' of the individual through lifestyle modification. On a more general topic, our increasingly complex infrastructure needs to be optimised in its design to present a minimum of risk to those who live and work within it. The two strands can be expected to develop in parallel in the future.

As social patterns alter rapidly, prompted by technological change, there is also increasing suspicion of new processes. The fear of genetically modified products is a manifestation of fear of a future over which we feel we have less and less control. Perhaps we intuitively understand that there is a very good reason why the gene pool of the world is the way it is and it is not worth the risk to tinker with this delicate 3500 million year old mechanism.

We can expect, however, an increasing awareness of the 'risk' of doing anything and to actively look for service providers that will be able to provide answers in respect of lifestyle choice. This confirms an increase in awareness that the cost of services and goods may not be the prime concern of consumers. There is also the strand of purchasing goods and services from non- polluting sources.

As the Internet age develops, it will be most interesting to observe how it changes perception of risk in society and more importantly perhaps how it is used to minimise the risk to the individual from all the processes that will constitute life in the 21st century.

Living with Risk

We live at a time, also, where the increasing industrialisation and technological developments are changing the dynamics of risk factors in society. This is also happening in such a complex way that it is almost a full time occupation keeping track of new information let alone remembering all that has been researched previously.

There is also the perception that we have not even have caught up with implementing what we already knew to be safe living style before technology has given us yet more options to choose from and with not all of these potentially healthy. Yet in some way there is a process of 'diffusion' of information into society regarding the risk factors that are now current. The obvious reality of this process of diffusion is that while there is awareness of what the risks are, the perceived relative importance of these risks is often out of proportion to actual risks. Some mechanisms of providing information are under our very noses.

Diet: Nutritional Profiling

Diet, in its broadest context plays a significant part in determining the health of the nation. As a factor in cancer prevention, it can alter predispositions by as much as 35%. With the migration towards weekly supermarket food purchasing being a firm feature of global shopping, the 'bottom line' has come to mean the cost of the food purchased. At the same time, however, the opportunity is also there to give a basic nutritional analysis of the products thus purchased. Imagine all of the nutritional data of food items listed on the till receipt could be processed into some relevant summary. Table 1 presents an assessment of what such a basic nutritional analysis could entail based on a family of four with a basic calorie input of 2000 calories per individual per day.

Total Individuals = 4		% Weekly Value
total calories	56000	105
total fat	560	33
cholesterol	14g	76
sodium	7400mg	88
total carbohydrate	1100g	85
dietary fibre	320g	80
protein	650g	83
vitamin a		60
vitamin c		120
calcium		67
iron		83

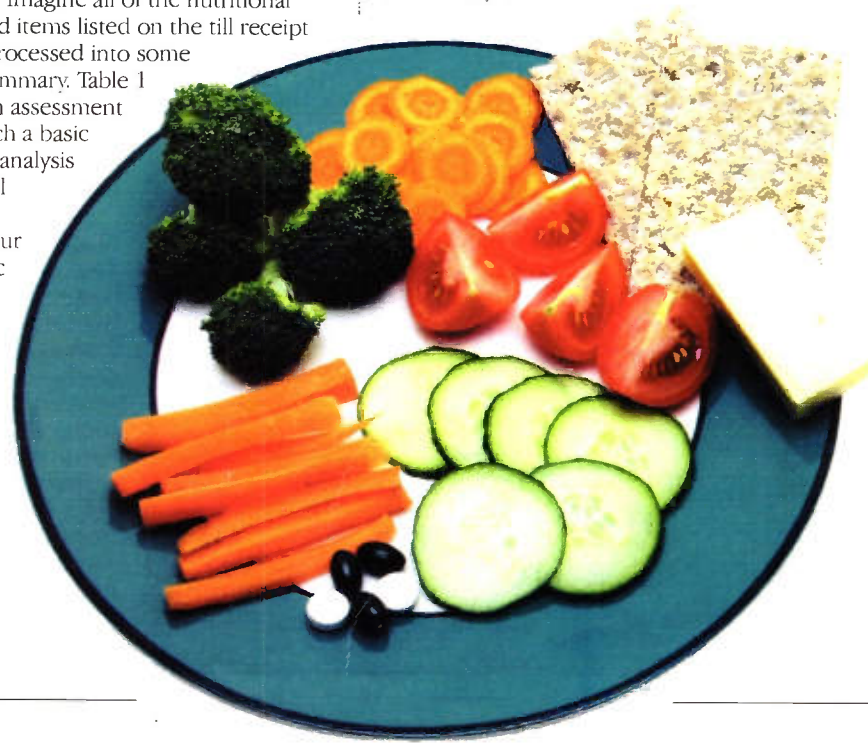
Table 1: Format of 'weekly shop' possible nutritional profile of purchasing based on FDA nutritional guidelines (see points of contact).

Based on this assessment, the calorie input is slightly high and the vitamin A input is quite low.

In terms of food labelling in the USA, there is a structured approach to label information with Table 1 modelled closely on displayed product data. The active selection of the items displayed in Table 1 are based on ' % Daily Values'. There is of course debate as regards the particular values that represent individuals and family groups. To allocate 2000 calories to every member in a family is not going to include perhaps the very young or the very old. Also, depending on the options available for processing such data, a running history, display of trends etc. is possible, and it could allow trends in food purchase to be monitored.

One of the thin veils in product merchandising is the perception of advantage of the retailer as against that of the welfare of the customer. The recent damning report on the nutritional value of children's 'foods' indicates that supermarkets are quite happy to stock their shelves with food of very dubious nutritional value in an attempt to increase sales but with no real regard in this respect for the nutritional well being of children.

So what we are looking for, is the responsible food retailer who can provide nutritional data at least at point of sale or better on a personal web page which can be more finely tuned to



giving independent nutritional advice. It is quite obvious that customers would wish to purchase a greater percentage of their 'food buy' at a facility that supported 'nutritional profiling' - so from the point of view of the food retailer, this is indeed a 'win win' situation.

There would be an opportunity to establish a 'nutritional profiling' industry based on the Internet, which could provide individuals or families with individual account access on behalf of food retailers.

However, the basis of this approach is that it takes little or no effort on behalf of the food shopper. It is the item code reader/IT of the food retailer that would be enabling the flow of information back to the customer. One option is to store the data on a 'smart card' for the customer and where the details can be processed/ reported on terminals within the food store.

It is usually the case that where one leads the others will follow. It is a fair question to ask what supermarket would indeed be willing to present an honest nutritional profile of the goods that were purchased by its customers?

Altering the Perception of Road Traffic Accidents

Each year around 5500 people are killed on the roads of the UK. A worrying trend of these statistics relates to increased casualties among children. Across the developed world, in excess of 125,000 people are killed in road traffic accidents each year. RTAs have regrettably become almost an 'acceptable' aspect of modern living.

It is, however, becoming a social custom to mark the location of fatal RTA's with bunches of flowers at both the time of the initial accident and also at anniversaries of the accident. This on the one hand meets the need of the relative to give remembrance of the individual(s) and increases the awareness of the public at large that accidents happen and that driving with care is required.

It might not be obvious, but the image of the car is constantly being re-inforced as an image of personal prestige and independent lifestyle and with little emphasis on the requirement for responsibility on behalf of vehicle drivers. Within a typical terrestrial commercial channel at peak viewing up to three minutes per hour are devoted to car advertisements - reinforcing not just the particular model of the car but the concept of the car as a legitimate extension of individual lifestyle. On a more disturbing note, many of these advertisements provide a focus on children. Is this because they present a more non-questioning, trusting manner?

Local authorities could give increased prominence to RTA's if they posted on the Internet information relating to RTAs involving serious injury or death within their boroughs. The object of such a process would seek to heighten local awareness of traffic risks and would, for example, provide a set of information for school based RTA awareness projects. If such a system were to be linked up nationally, to provide a national

resource, it would provide a great wealth of information that could be used to raise awareness of RTA prevention.

St.Cristopher.com

If we consider, another way that information is managed regarding road traffic accidents. In route navigation, the prime concerns relate typically to shortest distance/fastest route. It would be equally relevant to find the route that had the least chance of a RTA based on an available database of such information. As an individual there is little chance of having access to this core information, or even being in a position to utilise it in a sensible fashion. It would be a quantity, however, which would be in some demand. Is there an information provider - a St.Christopher.com of the Internet age, who could provide such as service.

Towards Risk Minimisation

One of the great challenges, is to model and plan for safety within our complex technological infrastructure. Taking a cue again from road transport, car drivers are aware that there are very specific locations where accidents are more likely to happen. This gives a clue that these 'dangerous' black spots have passed from the town planner's drawing board to concrete and asphalt without being identified as a hazard. What is required is a more comprehensive system of risk minimisation.

This could relate, for example, to design of a roundabout, lane change or intersection. There is thus afforded at the design stage of such structures an opportunity to simulate a given segment of road design and model aspects of traffic density, type, and driver competence in order to determine the safest solution.

In the example of the roundabout, we can simulate the traffic flow, vehicle mix, weather conditions, vehicle acceleration, - modelled very closely on observed driver behaviour and get a feeling for quality factors of closeness of approach and collision probability. The computing power of current computers is certainly up to simulating decades of use of such traffic systems. The design selected would presumably be that which could offer the safest operational factor within the set operational budget. This is therefore determining design as an integral part of risk reduction. It is an open notion, therefore, to consider which percentage of RTA's have contributing factors which relate to non optimisation of road infrastructure design.

In the design of a railway train feeding in and out of a main station, an appropriate test facility would be a software facility to simulate say 10 years of train operation. This would entail modelling all of the routine operation of the station, giving allowance for disruption of timetables, mechanical defects in trains, train breakdown, failure in signalling systems etc. and potential driver error. Closer bunching of tracks and signalling systems would, for example, be associated with greater chance of signal reading error. The advantage of such simulations systems, with appropriate probabilities of events taking place, is that

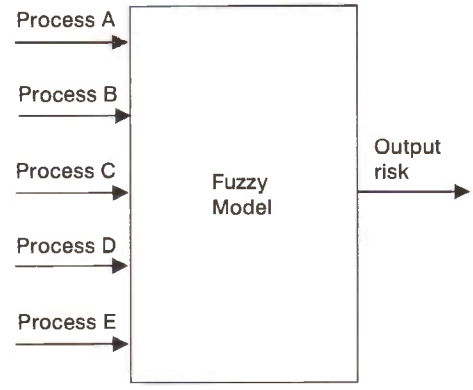


Figure 1: Model of processes that interact to create a risk factor as an output.

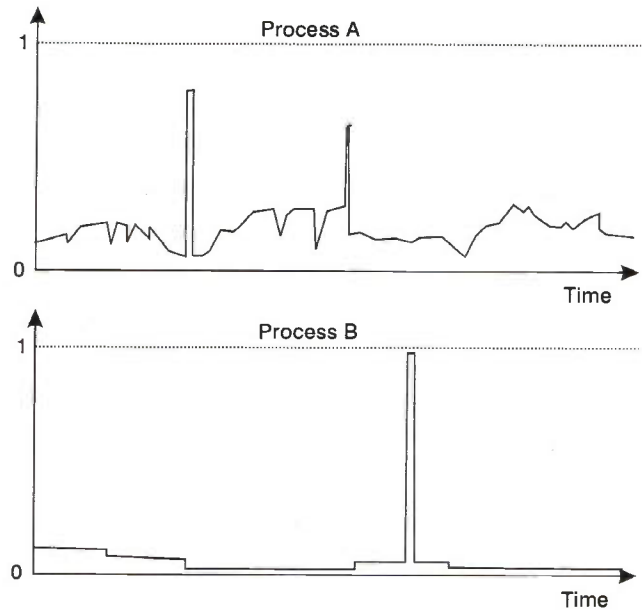


Figure 2: Representation of processes A and B with time.

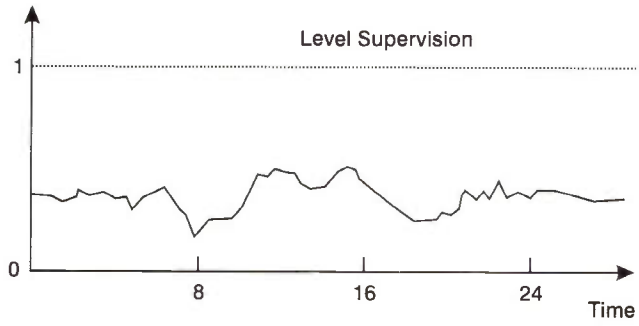


Figure 3: Making input functions 'real': Levels of relative supervision on a shift work installation.

many different configurations of design can be tested as a component of optimising the final design for lowest risk.

Risks Modelling Using Fuzzy Logic

Where risks are relatively well known, based on statistics, we can, however, develop mechanisms to model these factors, and undertake the translation of relative risk into representative probabilities. We are looking therefore for ways and means to model events taking place. One way of understanding how different processes interact is to use Fuzzy Logic. While the conventional Fuzzy Model has so called 'crisp' inputs, such as pressure, temperature etc, when we are trying to model probabilities and risk, and our input functions are themselves reflecting probabilities. They can be considered to vary on an instant by instant basis. The many complexities of modern life, however, make it increasingly difficult to take a situation and unravel the many different components of activity determining the ultimate risk outcome.

This creates the problem, in many ways, of representing a relative risk - one component among several, as a time varying function, which reflects a representative value of the given function. Then there is the task of combining these together as a series of rules to make the combined risk reflect the interaction of specific factors.

We can consider a model of various processes as indicated in Figure 1. In real time each process has a specific unique value so that as inputs we have five independent time varying functions. The next question emerges, how do we combine these independent input parameters to form a single value representing the outcome of risk? The solution is to use Fuzzy Logic and with the rule-based nature of the system description being the main key to the process.

In Table 2, the format of these rules is outlined.

IF PROCESSA is HIGH and PROCESSB is HIGH then ORISK is HIGH

IF PROCESSB is HIGH and PROCESSD is HIGH then ORISK is HIGH

Table 2: Structure of rule based framework of Fuzzy Logic.

The 'fickle' nature of risk can be seen if we take some functions that represents processes A and E as indicated in Figure 2.

The combinational nature of the risk interaction, which typically relates to two factors interacting together, means that we have modelled the risk of random interaction of the two processes.

The actual values of the risk profiles, however, should reflect relative risks based on operational conditions. In Figure 3, for example, we display the level of system supervision on a three-shift system and with better supervision during the main day shift. The Chernobyl disaster, remember, took place when the night shift were on duty.

The process of simulation of such systems requires to be conducted for extensive time periods - reflecting the processes associated with many years of operation.

It is then that some picture of the inherent safety of the system can be resolved as a reflection of some kind of 'infinite' simulation experiment as indicated in Figure 4.

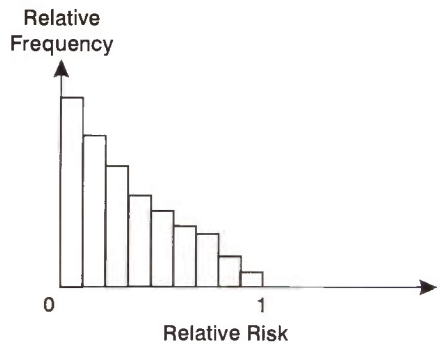


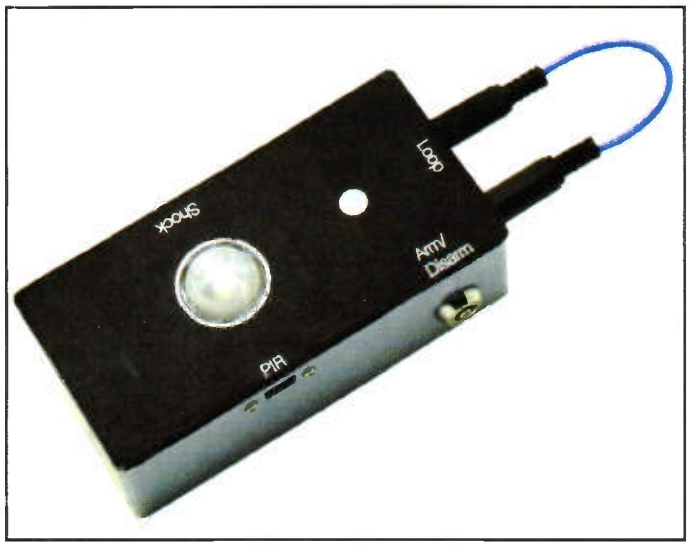
Figure 4: End point analysis: A picture of risk based on specific characteristics of input processes.

Summary

The dot.com community is only becoming aware of its potential to understand and reduce lifestyle risk. While this is in the interests of the individual, it is not in the interests of many commercial groupings. Also, we need better systems to let us understand risk and hence minimise risk in our increasingly complex infrastructure.

Points of Contact

The food pyramid-food label connection:
http://www.fda.gov/fdac/special/foodlabel/pyramid.html



General Purpose PORTABLE ALARM

Gavin Cheeseman describes a simple, low-cost, versatile alarm

Introduction

In this article we look at the construction of a simple portable alarm with a wide range of uses. The alarm operates from a 9V battery and features a relatively low quiescent current consumption allowing many hours of operation in the standby condition. The circuit can be used as a basic vibration or loop alarm or alternatively may be triggered using an integral PIR detector. The alarm features entry and exit delays when operating in the vibration and PIR modes to prevent triggering when arming and disarming the unit. When the alarm is triggered a built in siren sounds for a predetermined time. The unit may be used in a wide variety of applications such as indicating when luggage is tampered with or when a room is entered. A keyswitch is used for arming and disarming the alarm.

How it works

A simplified block diagram for the alarm is shown in Figure 1. The circuit is fundamentally based on a series of timers. There are three main inputs. Two of these are used by the PIR and vibration (shock) sensors and the third provides an external input that can be wired to other suitable sensors with dry contact outputs. The three main inputs drive a simple latch when triggered. The latch is effectively disabled during the period of the exit delay. If a trigger event occurs after the exit delay has elapsed, this operates the latch and starts the entry delay timer. The entry delay allows a short time to elapse before the alarm sounds, during which the alarm may be disabled using the key switch. If the alarm is not disarmed, the siren sounds until it times out. It is then necessary to reset the alarm, using the key-switch, before it can be re-triggered by this method.

A second method of triggering the alarm is via the security loop. If the loop is broken the unit is triggered instantaneously. There are no entry or exit delays. The alarm still times out after the preset period has elapsed.

Circuit description

Figure 2 shows the circuit diagram of the alarm unit. Sensors are not shown. It can be seen that the circuit is based around IC1 (40106 Hex Schmitt Inverter IC). As the name suggests, the IC has six sections and these are used to perform a range of switching functions in the circuit. The circuit is designed to operate from a 9V PP3 battery power supply and this is connected between terminals P1(+V) and P2(0V). D1 provides reverse polarity protection. Sensor connections are made to input terminals P4 (shock), P5 (PIR) and P6 (External input). TR1, R1, R2, D2 and C1 form part of the shock sensor circuit and help to ensure excessive voltage spikes from the piezo transducer do not appear at the input of IC1a. This is important as excessive voltage levels can easily damage the IC. The main input lines are effectively 'OR'ed via diodes D3 - D5. Resistor R3 provides a 0V reference for IC1 pin 1 when the alarm is not triggered. IC1a, IC1b and D6 are connected to form a simple latch. When the alarm is armed but has not been triggered, the output at IC1 pin 4 sits in a logic low condition. If a trigger condition (logic high) occurs at the input of IC1a, IC1 pin 4 latches at logic high until the alarm is reset. Transistor TR2, together with R5, R6 and C2 ensures that it is not possible to trigger the latch for a short period after arming the alarm (exit delay). When IC1 pin 4 switches high, capacitor C3 starts to charge via R7 (entry delay). When the voltage at IC1 pin 5 reaches the appropriate switching threshold, IC1 pin 6 switches low and IC1 pin 8 switches high. This triggers a monostable comprising IC1e, IC1f and associated components which in turn switches on TR4 applying power to the siren. The siren continues to sound until the monostable times out. The circuit is reset when the circuit is disarmed once any remaining charge in the capacitors has dissipated.

The security loop connects to the circuit on terminals P11 and P12. When the wire loop is connected, the base and emitter of TR3 are shorted and TR3 is turned off. If the loop is broken the short is removed and current flows into the base of TR3 via resistor R8. TR3 switches on, pulling IC1 pin 11 high via diode D9; this triggers the alarm. Because the loop alarm circuit is applied directly to the input of IC1e, there is no entry or exit delay and triggering using this method is instantaneous.

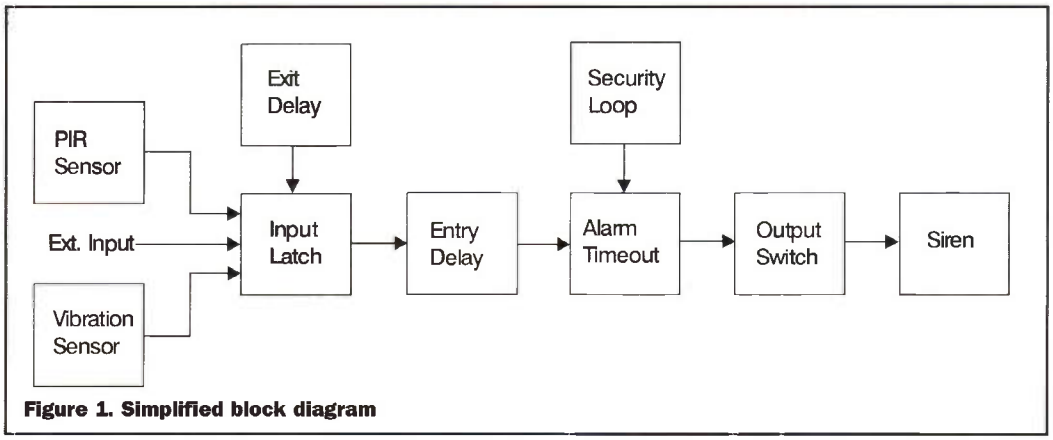
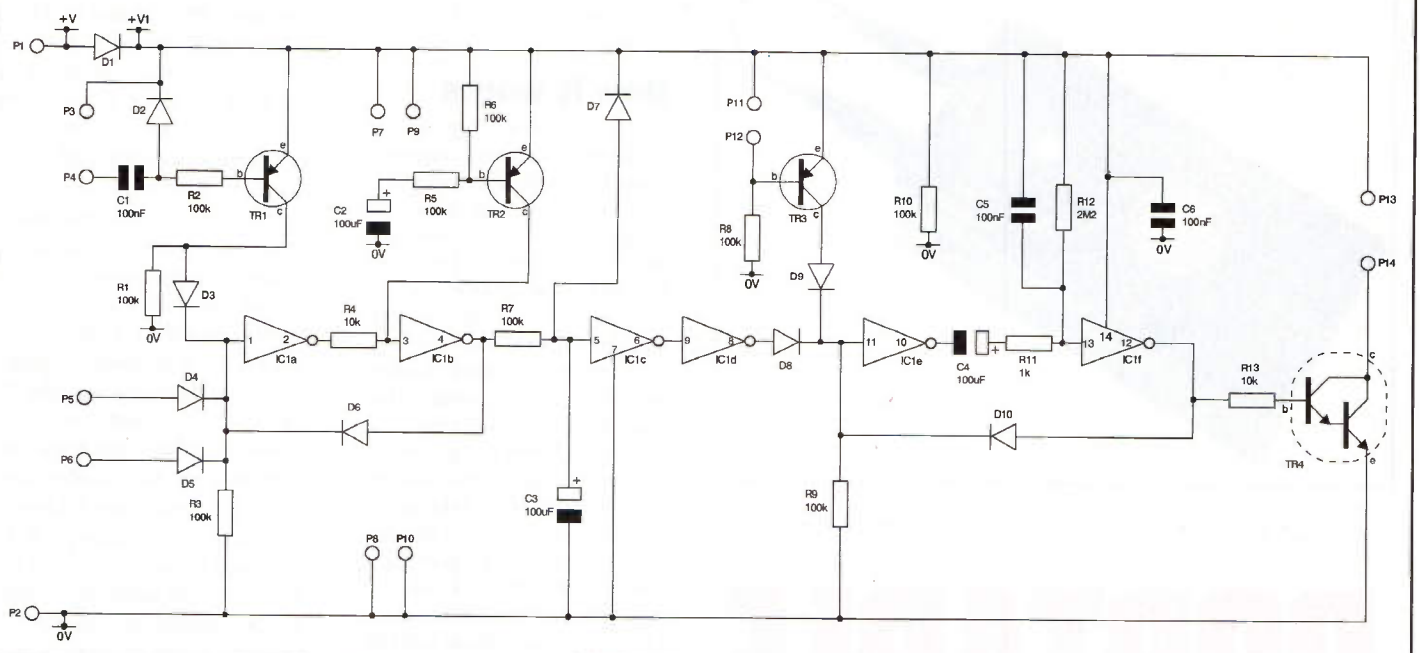


Figure 1. Simplified block diagram

Figure 2. Circuit diagram



Constructing the alarm

The alarm may be constructed using any suitable medium. Matrix board is fine. The circuit is not particularly layout critical but as with most circuits it is sensible to keep the length of the wiring as short as possible. Consider the size of the box in which the circuit board is to be mounted and try to layout the components so as to maintain efficient use of the space available. Remember that the box also has to house a number of off board components (battery, PIR module, sounder etc.) in addition to the circuit board.

Semiconductor pinout information is shown in Figure 3. The negative lead of an electrolytic capacitor is usually the shortest of the two leads. IC1 is a CMOS device and the use of a DIL socket is recommended so as to avoid the possibility of damage during soldering.

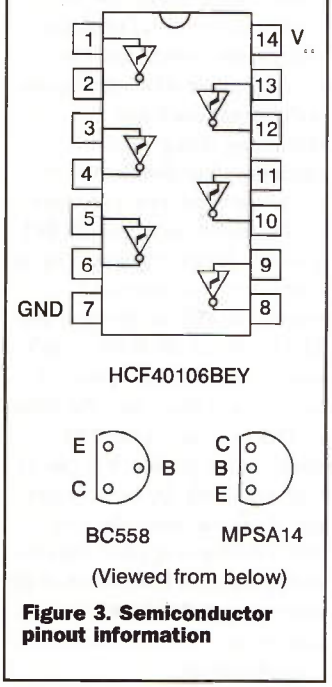


Figure 3. Semiconductor pinout information

Off board wiring

Figure 4 shows the wiring diagram for the alarm unit. It is best to decide how and where you wish to mount the off-board components in the case before completing the necessary wiring. Siren wiring is coloured red (+) and black (-). The lead designations for the PIR module are marked on the module PCB. The battery clip lead is colour-coded red and black. The red lead connects to terminal P1 of the alarm circuit. The black lead connects to terminal P2. Do not connect the battery at this stage.

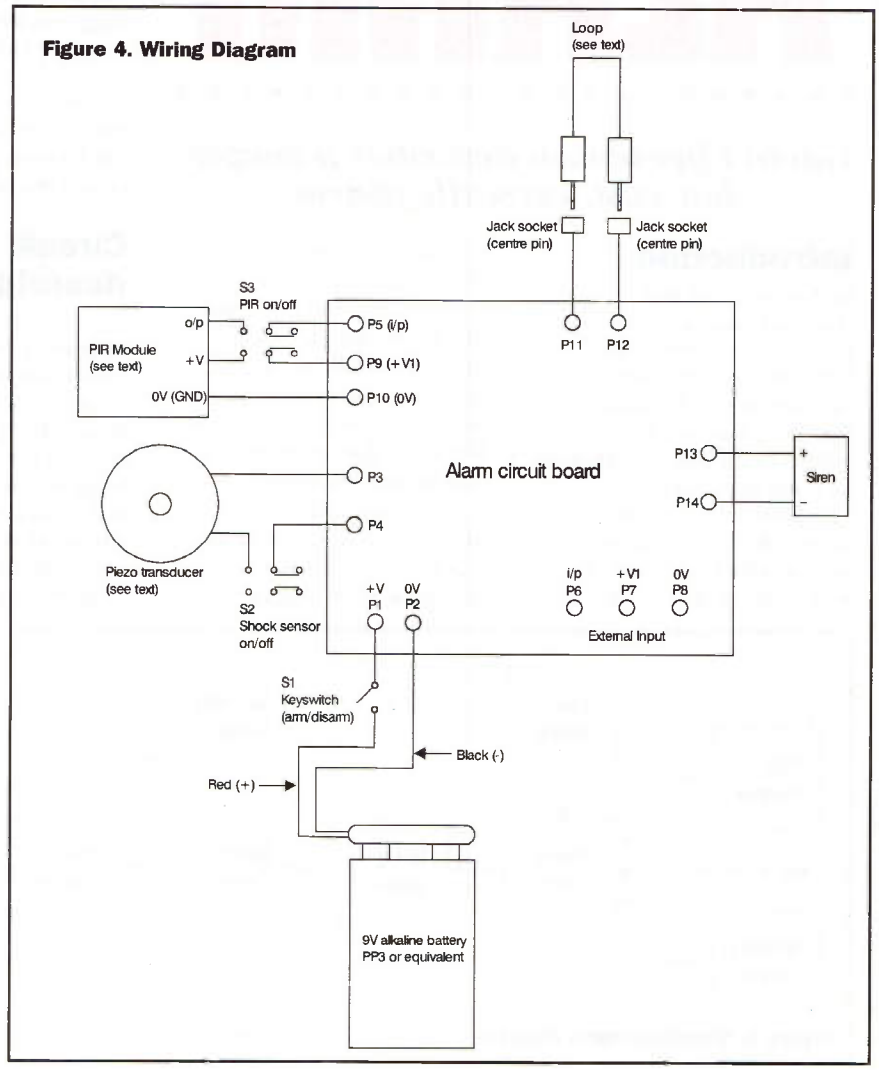
Connections for the security loop are made to the centre (tip) connection of each jack socket. The jack plugs are wired to the loop accordingly.

Testing

It is probably best to initially test the circuit before it is finally installed in the case. Before testing, check over the alarm circuit board and external wiring errors.

Set all switches to the 'off' position and connect a suitable alkaline PP3 battery to the battery clip (rechargeable batteries are not recommended). It is useful to connect a multimeter in series with the

Figure 4. Wiring Diagram



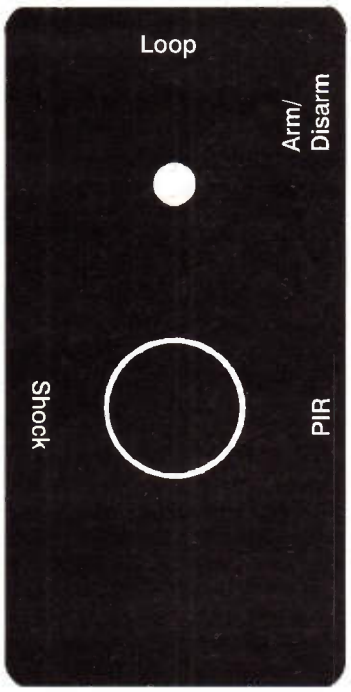


Figure 5. Example label
Picture shown at 70% of actual size

+V supply when the circuit is initially powered up as this allows the supply current to be monitored. Ensure that the security loop is connected at this stage. Set S1 to the 'armed' (on) position. The alarm should remain silent. The supply current should be considerably less than 1mA and should never exceed a few tens of mA, even when the alarm is sounding. Disconnect the security loop. This should trigger the alarm. The alarm should sound for a few minutes and then time out. Set S1 to the 'disarmed' (off) position to reset the circuit (you do not need to wait for the alarm to time out to do this). Allow a few seconds to elapse to give capacitors in the circuit time to discharge before continuing.

Set S3 to the on position. Arm the alarm and wait a few seconds for the exit delay to elapse ensuring there is no movement within the coverage area of the PIR sensor (the area viewed by the PIR lens). The alarm should remain silent. Wait around 1 minute and then move your hand in front of the PIR sensor lens. There should be a short delay of a few seconds (entry delay) after which the alarm should sound. Return S1 to the off position.

Set slide-switch S2 to the 'on' position. Arm the alarm and wait around half a minute to ensure that the exit delay is complete. Sharply tap the shock sensor (piezo transducer) a few times. There should be a few seconds delay and the alarm should sound. If everything is working correctly the circuit board may be installed into the case.

Installation

The alarm may be installed in any suitable plastic housing. An example is stock code YU53H. A typical label suitable for use with this case is shown in Figure 5. The keyswitch has two flat edges to help prevent rotation in the mounting hole. A large hole is required to allow the PIR lens to protrude. A small hole should also be drilled in the alarm case to correspond with the hole in the siren housing before the siren is mounted in position. This hole makes a considerable difference to the final volume of the siren. The circuit board may be mounted on pillars as shown in Figure 6. Depending where the jack sockets are mounted it may be necessary to remove some of the PCB guides from the inside of the case in order to allow the thread to protrude sufficiently.

Positioning of the off-board components is not particularly critical. The piezo transducer, PIR and siren need to be permanently attached to the case. Mounting holes are provided in the sensors and siren so the components can be bolted into position. Particular care is required with the PIR module. An alternative and perhaps simpler approach is to glue the sensors and siren into the case using an appropriate adhesive. The piezo transducer should be mounted facing and in physical contact with the side of the case. To save space, the PIR unit and slide switches may be mounted under the circuit board as long as the circuit board mounting pillars are long enough to allow room. Make sure that the battery is positioned such that it will not damage other parts of the circuit due to movement in normal use. Depending on the layout, it may be useful to fix the battery in position using small self-adhesive pads.

Applications

The alarm is useful for a whole host of different applications. As the circuit is based around simple concepts it cannot be expected to give the same performance as a fully featured microprocessor based alarm. However, ease of use and portability allow the unit to be set up very quickly with a minimum of fuss. Where and how the alarm is used is ultimately up to the user. The following examples give an idea of the versatility of this little alarm.

Loop Alarm

The loop alarm feature uses a loop of wire that triggers the alarm without an entry delay when the loop is broken. The wire loop is connected using jack plugs. In use the loop may be passed through an appropriate part of the equipment to be covered by the alarm or for example through handles on a cabinet door. The system should be arranged such that it is necessary to break the loop to gain access to the protected item. Breaking the loop without disarming the alarm should result in the siren sounding. Figure 7 shows a typical example of how the loop alarm may be set up. The loop may pass through a number of items. The unit could also be used as a simple bicycle alarm by placing the loop around the frame and wheel spokes. If required a number of different sized loops may be constructed to cover a range of different applications. The loop alarm may be placed in a bag and the loop fastened to the owners belt etc. If the bag is snatched the loop is broken and the alarm sounds.

It is possible for a well prepared thief to bypass the loop so this mode of operation is only recommended in applications where the user is close-by. If necessary tampering can be made more difficult by using heavily insulated wire and gluing the jack plug cover in place. Alternatively the loop may be terminated inside the case so that the case must be opened to gain access to the terminals. An additional tamper switch may be fitted as described later.

Panic Alarm

The loop alarm may also be used to deliberately trigger the unit if the user wishes to attract attention. Remember that the feature only operates when the key switch is set to the 'arm' position. To stop the alarm sounding before the timeout has elapsed it is necessary to set the key switch to 'disarm'.

Vibration Alarm (shock sensor)

In this mode the circuit is triggered when the vibration sensor detects an appropriate degree of vibration. Very small levels of vibration below the trigger threshold will not normally trigger the alarm. The alarm may be placed in baggage or on items of equipment that are not expected to be moved. However, it should be noted that the alarm must be subjected to significant mechanical shock before the shock sensor will activate the unit. Both entry and exit delays are active in this mode. The exit delay allows time for the vibration sensor to settle after the alarm is armed and the entry delay helps to prevent the alarm from sounding when you pick it up to disarm it.

PIR Alarm

The PIR alarm may be used to indicate when a person enters the area covered by the sensor. The unit may be used as a simple portable intruder alarm without any need for external wiring. When first switched on the sensor takes a short time to settle before it becomes active. This is normal for PIR sensors of this type. As with the vibration sensor both exit and

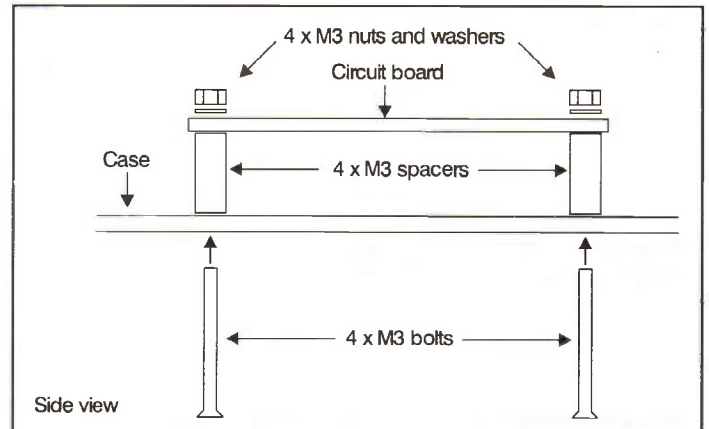


Figure 6. Mounting the circuit board

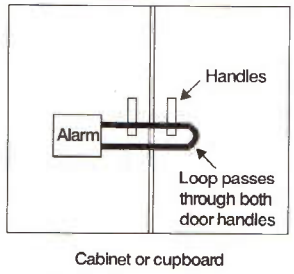


Figure 7. Loop alarm application idea

entry delays apply in the PIR mode. Make sure that the PIR covers the area you wish to guard with the alarm. If unsure, carry out a test run to check that a person entering the covered area triggers the alarm.

One point to bear in mind is that PIR sensors are designed to detect changes in the ambient infrared environment such as those produced by body heat. Unfortunately, body heat is not the only thing that can trigger a PIR detector. Other sources of rapid temperature variation are also likely to trigger the alarm and this is an important factor to consider when siting the unit. Try to avoid areas immediately under air conditioning vents or close to cooking or heating appliances. The alarm will also respond to the body heat of pets and other animals. The coverage angle of the sensor is relatively wide although this can be effectively reduced by obscuring one side of the sensor lens or by appropriate positioning close to a wall. False triggering may also be a possible problem when the alarm is used in a shed or other outbuilding where there are rapid temperature fluctuations. In this type of situation it may be preferable to use an alternative method of triggering the alarm via the external input terminals.

External Input

The external input terminals allow various types of externally wired sensor to be used with the alarm. Although the alarm is not intended for use with an extensive network of sensors, there may be some occasions where the use of an external sensor is appropriate. For example where the PIR may be prone to false triggering. The system is designed for use with sensors that have normally open (N.O.) dry contacts. Figure 8 shows how external sensors may be connected to the alarm. With a small modification normally closed (N.C.) sensors may also be used. Figure 9 shows one way of doing this. The modification results in a small increase in the quiescent current consumption of the circuit but this is not normally significant from a practical point of view. In common with the PIR and vibration modes, the external input has both an entry and an exit delay. Wiring to external sensors should be kept as short as possible. It may be necessary to connect a small decoupling capacitor across the external input terminals in some instances, to avoid false triggering by RF fields. The required value depends on a number of factors but a typical figure would be in the region of a few nF. False triggering by very strong RF fields can often be a problem and is not always simple to cure. If the signal is being picked up by external wiring the inclusion of a small choke or ferrite ring close to the alarm input can sometimes provide an effective solution.

Whichever mode is being used, the condition of the battery should be checked regularly. A simple way to do this is to arm the alarm and open the security loop. If the battery condition is poor the volume of the siren will be reduced.

Modifications

For those readers who enjoy experimenting with circuit design, there are several modifications that can be carried out to enhance the performance of the alarm. The exit and entry delays can be made user adjustable. In order to achieve this it is simply necessary to fit variable resistors in series with the existing timing resistors. For example to make the entry delay adjustable, connect a variable resistor in series with R7. Specific component values depend on the range of adjustment required. A value of 1M should provide a good starting point.

The standard alarm does not provide tamper protection for the case. A small microswitch may be fitted inside the case and connected in series with the security loop. The switch should be positioned so that it is closed when the case cover is in position. When the cover is removed the switch opens and the alarm is triggered. The security loop may also be extended to cover other external sensors.

Finally...

Although very simple in concept, this little alarm unit can be very effective. It also provides a introduction to the concepts behind larger and more complex security systems. Of course, a simple unit of this type can only provide a limited degree of security and cannot be guaranteed to afford protection in all circumstances. Nevertheless the alarm is fun to build and has a host of different uses.

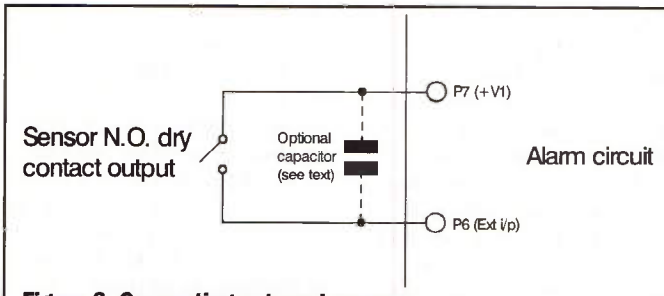


Figure 8. Connecting external sensors

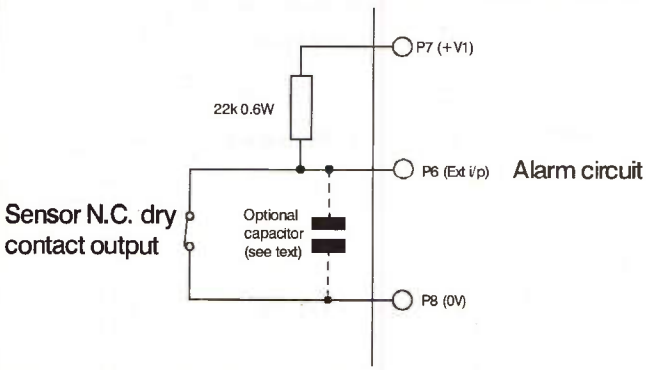


Figure 9. A method of connecting normally closed external sensors.

PROJECT PARTS LIST

RESISTORS			
R1-3, 5-10	100k	9	M100K
R4, 13	10k	2	M10K
R11	1k	1	M1K
R12	2M2	1	M2M2
CAPACITORS			
C1, 5, 6	Disc 0.1μF 50V	3	BX03D
C2-4	GenElect 100μF 16V	3	AT40T
SEMICONDUCTORS			
D1	1N4001	1	QL73Q
D2-10	1N4148	9	QL80B
TR1-3	BC558	3	QQ17T
TR4	MPSA14	1	QH60Q
IC1	HCF40106BEY	1	QW64U
MISCELLANEOUS			
	DIL Socket 14-Pin	1	BL18U
P1-14	Pin 2145	14 pins	FL24B
	PP3 Clip	1	HF28F
	PIR Sensor Module	1	YD85G
S1	Min Round Key Sw	1	CJ92A
S2, 3	Sub-Min Slide	2	FH35Q
	Jack Socket 3.5	2	HF82D
	HP Buzzer	1	FK84F
	ABX Box PX2	1	YU53H
	Plug Plas 3.5	2	HF80B
Shock Sensor	Min Piezo Sounder	1	FM59P

SCSI, IDE or USB? External or Internal? Price? Speed? CD-RW? Mac or PC? Choose the drive that's best suited to your individual needs.

Mastering AUDIO

The CD-R(W) drive is undoubtedly one of the most useful peripherals available, not least because they allow you to make your own audio CDs! Martin Pipe examines how you can get the best results and also discuss MPEG audio, along with making MP3 CD-ROMs optimised for the stand-alone player.

Hardware Requirements

Since we first delved into the wonderful world of CD audio mastering, back in 1997, a lot has happened. Most importantly, the choice of CD burners has widened considerably. Intense competition has brought prices down to everyday-consumer levels - some mail-order and computer-fair vendors are selling basic two-speed models for less than £100. Today's IDE interfaces, and the peripherals attached to them, are of a good enough performance for reliable CD mastering. The 'buffer-underrun' errors and ruined disks that were once a frequent occurrence are now a thing of the past.

That's not to say SCSI burners - which tend to be more expensive - don't have their place. If your PC only has one drive bay, a SCSI drive, mounted in an external enclosure, will allow you to make copies (sorry, ahem, backups) of discs without having to copy all of the files (or songs) to your hard disk first. External SCSI drives are also a natural choice for owners of older Macs. Practically all modern burners - regardless of interface - support digital audio extraction (DAE), or the ability to 'rip' one or more audio tracks from an audio CD and copy them to your hard disk as WAV files. A moot point if your current CD-ROM drive isn't DAE-ready. DAE is, of course, essential if you want to make 'compilation' CDs of your favourite music, culled from a selection of albums. All current CD mastering software supports DAE, although stand-alone programs capable of doing the job - such as Audiograbber and AudioCatalyst - are available via the Internet. Some of these even have MP3 converters built in, making ripping and conversion of a CD pretty much a one-click operation.

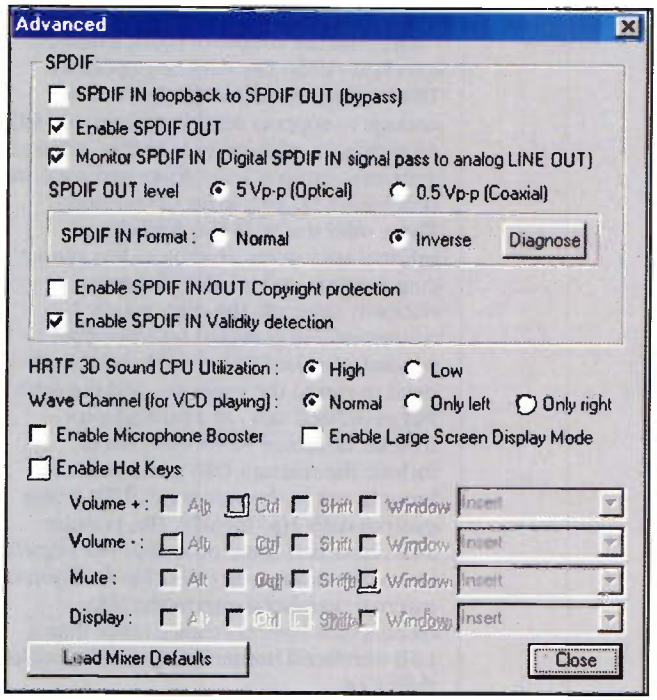
Over the last couple of years, a new PC interface - USB - has risen in popularity. This high-speed serial interface is fast enough to support reliable multi-speed CD recording. In addition to scanners, printers, webcams, external hard drives and mice we now have USB-interfaced CD burners. These offer the SCSI-like flexibility of external enclosures, leading to less power consumption and greater long-term reliability (after all, the drive is only connected and powered up when it's needed). Unlike SCSI, though, you don't need to run to the expense - and the extra PCI peripheral slot - of a host adaptor. Instead, all recent PC motherboards include the relevant USB port, which is brought out to the rear panel. USB is also exceptionally Mac-friendly. The popular iMac, launched some time after our original series of articles, only caters for this form of external peripheral interfacing. iMac owners thus have no choice other than a USB-interfaced burner if they want to make their CDs.

So what else has happened to make the lives of budding CD producers cheaper and easier? Most obviously, CD-R prices have fallen considerably. Back in 1997, a 74 minute 'branded' blank would have set you back around £4 - today, the same disc only costs £1 or so. And of course, much has happened to the computer hardware since then. Hard disks are now much more capacious, and it's now possible to buy a 20GB drive for less than £150. WAV editing programs tend to eat up a lot of space with temporary files - the size of today's drives means that you're much less likely to see 'disk full' error messages.

The upshot? CD audio mastering is now very affordable, and so why not give it a try? The same drives, media and mastering software does a lot more into the bargain - you can backup your hard disk (quite relevant in these days of well-publicised e-mail viruses and widespread Internet use) and archive files. In the remainder of this article, though, we'll be concentrating on audio applications - of which there are many.

Soundcards

Your soundcard - which must be a 16-bit type - is the ultimate arbiter of sonic quality. After all, it's the device that's used to source audio from an external source. Cheap (£20 or less) soundcards generally have rather poor analogue stages. Although the effects here won't be noticeable through a typical PC's multimedia speakers, they will be when you master a CD from an analogue source and play it on a reasonable hi-fi system. Obvious shortcomings include a lack of fine detail, top end 'sparkle' and bass. Some cheap cards can be heard to distort quite badly, too! There is, however, one inexpensive card that's well worth considering - particularly if you have a MiniDisc or DAT recorder with SP/DIF output. The £10 Audio Excel AV511 - based around CMedia's 'single chip' CM8738 solution - does have a fairly lacklustre analogue performance, but more than makes up for this with SP/DIF input and



output. You can thus make digital transfers from SP/DIF-connected sources - with no loss of quality whatsoever!, as digital audio effectively passes directly to the PCI bus. It has to be enabled first, using the 'advanced mixer' controls

Some MiniDisc and DAT decks, notably Sony models, will act as analogue-to-digital converters if 'record' is selected with no media present - under these circumstances, the front-panel display will indicate 'AD-DA'. In the same mode, the machine is also capable of acting as a high-quality DAC if the AV511's S/PDIF output is hooked up to one of the digital outputs (switch the input selector to the input in question, and the display will show '-DA'. Couple one of these digital recorders with an AV511, and you'll end up with a sound quality that's better than what's offered by any consumer-level soundcard. Keeping the sensitive analogue electronics away from the PC's noisy innards is a distinct advantage, as is the 'audiophile' quality circuitry specified by most hi-fi grade digital recorders. In order to work properly with external digital sources, the AV511 requires some external interfacing, which is described elsewhere in this issue - the AV511 formed the basis of our audio PC. The card is supplied with a mixer software application. You'll need to enable the SP/DIF input for digital recordings - we also recommend disabling the unwanted inputs (mike, line, CD audio and so on) to reduce the possibility of unwanted noise. Although digital audio from the S/PDIF input is passed 'as-is' to the bus, so too is the converted analogue output. Note that a previous Audio Excel card, the AV511, is capable of similar results. This card's CMedia CM8338 chipset is very similar to the CM8738, but doesn't support 48kHz sampling rates (whether from analogue sources, or from S/PDIF ones like DAT). What's more, the CM8338 doesn't have the modem interface of the CM8738 - not that it's relevant here!

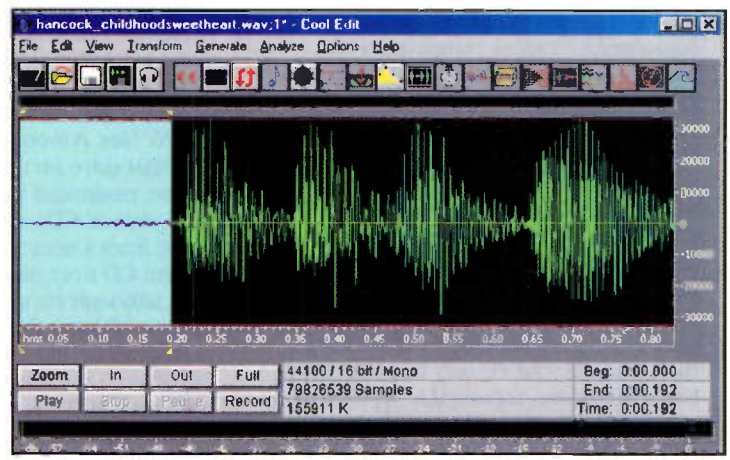
If you don't yet have a digital source, but want to author from analogue sources, you could always consider Creative Lab's Soundblaster Live! If our experience is anything to go by, this card is capable of making very good captures from analogue sources. In its most expensive 'Platinum' guise, the Live! is supplied with a connector panel - known as the LiveDrive - that sits in a spare 5.25in. drive bay. The LiveDrive provides accessible connections for analogue stereo phono in, microphone jack, standard 5-pin DIN MIDI in/out, headphones and optical/coaxial S/PDIF input/output. Unfortunately, you'll still need to root around the back of your PC for a line-level analogue output. Note that a similar connector bay can be constructed for the AV511, and indeed other soundcards, from an old PC front-panel blanking plate. The Live Platinum is supplied with an excellent software bundle that includes games, an audio effects manager, 'virtual turntables' mixing software and Steinberg's Cubase VST music production package. Indeed, the Live is an excellent choice for budding musicians, not least because it can be turned into an effective sampler merely by substiting the supplied wavetable sounds with your own. There are some criticisms, though. First of all, the digital output has a fixed sample rate of 48kHz, regardless of what you're listening too.

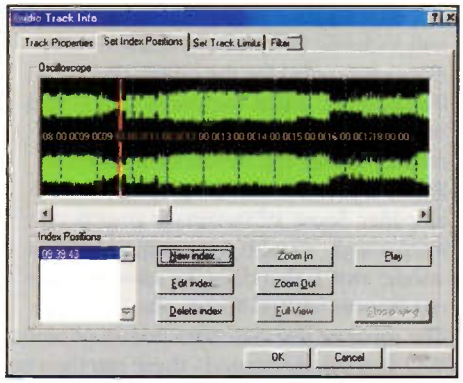
Although MiniDisc recorders have in-built sample rate converters, I can't imagine that upconverting thé sample rate from 44.1 to 48kHz at the Soundblaster end, followed by a down-conversion to 44.1kHz at the Minidisc end, is going to have a particularly positive effect on sound quality. Still, this is irrelevant as far as CD audio mastering is concerned. - the issues only apply if, for example, you want to transfer MP3s or WAV files onto Minidisc. The Live! doesn't, however, integrate particularly well with Iomega's superb RecordIt program. That's not to say it doesn't work, but you need to be careful or you'll record only silence. Our final option as far as soundcards is concerned extends to the original Soundblaster 16 (SB16). Turn to my article MP3 Update in this issue, and you'll discover how to make your hardware sound much better by replacing its analogue input stage. The same comments apply to the AWE32 and AWE64, both of which are based around the same AK4501/CT1703 codec IC used by the SB16. If you don't have one of these cards, it may be worth finding out more about its chipset. Look around on the 'Net for datasheets, and you might be able to find a way of modifying your card for better sound quality.

Soundcards are happy with line-level sources, such as cassette decks, tuners, reel-to-reel recorders and hi-fi VCRs (the latter is a formidable but little-exploited option, with up to 10 hours of audio recording on a E300). Just connect them directly to the soundcard using a dual phono-to-3.5mm stereo jack cable. The 'Deluxe' version of Adaptec's Easy CD Creator is supplied with such a cable. As an alternative, you could make your own - or purchase a ready-made 1.2m cable (KQ12N). One of the most useful applications of a CD audio recording system, however, is getting those old vinyl records onto user-friendlier CDs. A soundcard cannot be fed directly with the low-level outputs of a magnetic cartridge. They need to be amplified, and corrected according to the RIAA equalisation curve. The required circuitry is, however, found in hi-fi amplifiers and DJ-type mixers - in both cases, simply connect the 'tape out' phono sockets to the soundcard's line input using the cable just described, and select the equipment's 'phono' input. If you don't have a mixer or amp with a phono input, you could always build your own preamplifier.

Recording and editing

OK, so you've wired up your equipment. How do you make the best possible recordings? Well, you'll need an audio editing program. One of the most popular is Syntrillium's Cool '96, a PC Windows 9x shareware program which can be downloaded from a variety of sites. Unfortunately, you won't find it on Syntrillium's web site, because they've since replaced it with an updated (but time-limited) program known as Cool Edit 2000. The original Cool '96 - and its replacement - allow you to record, modify and save audio captures in a number of audio file formats - including the 16-bit stereo 44.1kHz one needed for Red Book-standard audio CDs. The program also features sample rate conversion, so that you can transfer 48kHz DATs onto CD. Cool '96 - and its time-limited successor Cool Edit 2000 - are well-served with plug-ins for MP2/MP3 conversion, digital noise reduction and so





on. We'll concentrate on using Cool '96 for the purposes of this article, but other programs of this type are equipped with similar features. If you have more than one soundcard in your system - as with the audio PC featured elsewhere in these pages - you'll need to select the soundcard before you can begin. You'll find the menu you need, 'select wave device', under the 'options' menu. Very flexible and useful, in other words. Another handy feature of Cool '96 is its pair of peak-reading input meters, which can be used to calibrate input levels before capture begins. These can be adjusted with conventional rotary controls (if you're using a MiniDisc/DAT deck as an ADC, or the audio PC featured elsewhere in this magazine), your source equipment's playback level control or the 'line input' fader of the Windows 'virtual' mixer panel (which can be accessed by clicking on the speaker symbol that should be visible on the taskbar). Peaks should register at 0dB - the highest point of the meter - if the best dynamic range is to be achieved. 0dB correlates to a sample in which all 16 bits are fired up as ones; put another way, you can't go any higher! When the input signal level meets or exceeds the resolution of the ADC, Cool Edit flags up a red 'clipping' indicator for the relevant channel.

Which brings us neatly to a handy little gadget that you can knock up fairly quickly. The swtchbox depicted in Figure 1 is particularly valid for those of you who want to transfer analogue tape or cassette recordings onto CD-R. The device, which sits between the cassette/tape deck and the soundcard's line inputs, would normally be used in the monitoring phase prior to capture. The rotary switch will determine whether the left, right, mono (left and right) or normal stereo audio signals are passed to the soundcard. It's thus easy to fully check programme quality prior to capture. The mono position is particularly interesting, since it allows you to check the replay azimuth alignment. If the head is out of alignment relative to the tape, then the treble will sound rather wishy-washy. This is because azimuth misalignment introduces phase distortion. The effects of azimuth adjustment are particularly obvious when you're playing a mono recording on a stereo machine. A slight physical delay between the left and right playback heads will, if the machine's stereo outputs are combined into one by our switch, cause the shorter-wavelength higher-frequency signals to cancel each other out. The azimuth setting on your replay machine - normally a grubscrew - can be adjusted until optimal treble output is attained. When the best compromise has been reached, the switch can be changed to its normal 'stereo' position. When transferring mono material, you might find that one of the stereo channels might deliver the best results - simply select the appropriate channel prior to capture.

After calibrating your level controls and setting up your replay equipment, you can start capturing audio to your hard disk - Cool '96 is equipped with tape-recorder type controls for this purpose. The peak level meters are still displayed for monitoring purposes, although they're not refreshed as often because processing power is being diverted elsewhere! 'Record' invokes capture, while 'stop' does the opposite. When 'stop' is pressed, the audio captured until that point is displayed in a pictorial form akin to that of an oscilloscope screen. Keep captures as short as possible, in order to reduce processing and saving times. This, of course, isn't always possible - especially if you're capturing an entire hour-long concert off the radio in one go. Now it's time to edit, but before you do so save your work in case you make any mistakes! Cool '96 enables you to 'zoom in' on the waveform, and - in conjunction with regular playback - accurately identify parts of the capture (such as announcements) that you don't want on your CD! You can highlight the areas in question with your mouse, and delete them (select 'delete selection' from the 'edit' menu).

If you want to produce a concert CD from a radio broadcast, but want to split the tracks up instead of producing the entire disc as one track, then Cool '96 can help you. Identify, through playback and waveform monitoring, the gaps (normally applause) between the tracks. Cut the track that precedes it, and paste it into a new instance of Cool '96. You can then save the track separately. Repeat until all of the tracks have been processed in this way. When making the final CD, remember to select the 'disc-at-once' option - which eliminates the two-second gap between tracks. Note that at least one recent CD authoring package - Ahead's powerful Nero - has a less cumbersome track-split function. The 'Set Index Positions' option within Nero's 'Audio Track Info' menu gives you the opportunity to define 'index' points that determine when one track ends and the next begins. Once again, you must remember to select the 'disc-at-once' burn option.

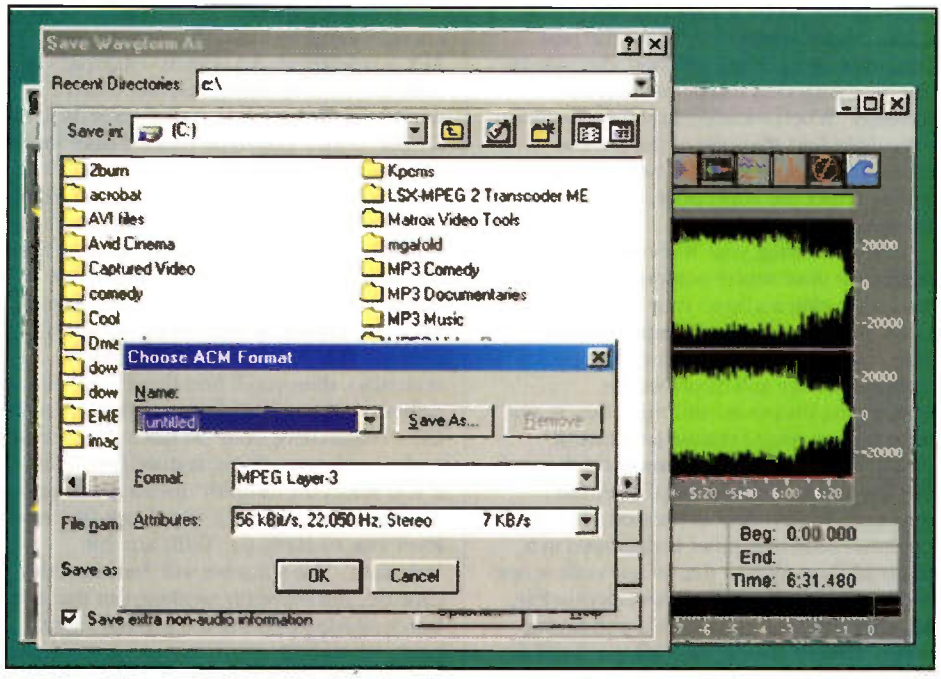
Sometimes, though, there might not be enough signal to make the most of the ADC's resolution. An obvious example - at least for the time being - occurs when you're trying to make a digital recording, via S/PDIF, from a DAB-type tuner. I have found that the broadcasts of BBC and commercial stations alike seem to peak at around -8dB. In other words, those DAB broadcasters don't appear to be making the most of the dynamic range afforded by DAB's 16-bit resolution! If you're making a recording of, say, a live broadcast and decide to put it onto a CD-R (for your own enjoyment, naturally), then you'll find that it sounds rather quiet compared to your normal audio CDs. Fortunately, Cool '96 has a very useful audio level normalising feature. You'll find it if you select the 'amplify' menu (look under 'transform/amplitude'). Simply set the 'peak level' box to 100% (i.e. 0dB) and hit 'calculate'. The software will then scan the capture, automatically working out the gain factor needed to bring the highest signal peaks up to 0dB.

Remember to normalise audio levels before splitting up a concert audio recording! If your machine is relatively low-powered and you want to avoid long waits, seek out the loudest passage and note the optimum gain setting found by the software. This figure can then be applied individually to all of the tracks. The 'normalise' feature is also very useful when bringing together tracks sourced from a selection of CDs, for the purposes of a compilation album. You'll usually find that volume levels vary widely, indicating that digital mastering hasn't always been done properly! Sometimes, though, the dynamic range has been deliberately compressed - as a 'full' view of the waveform will suggest. Nevertheless, Cool '96's 'normalise' feature does help you to make audio levels consistent across your entire CD. You'll also find highly-configurable 'fade in' and 'fade out' options in the 'amplify' menu, which are useful for live recordings and tracks that you want to shorten. I recommend the 'linear' option.

MPEG Audio

Most modern audio editing packages, such as Cool Edit 2000 and the latest incarnation of Goldwave, make some kind of provision for MP3 output - here, the WAV file is compressed into MP3 format. Sometimes, as in the case of Cool '96, a MP3 plug-in is available as share- or freeware from various sites. But what if yours doesn't? You could always process the files with a standalone conversion program, many examples of which can be found on the Internet. There's even a DOS freeware one (l3enc.exe) available from many web sites. Good

Creative Lab's high-end Soundblaster Live! Platinum soundcard. The 'Platinum' suffix means you get the convenient Live!Drive plugbay, which is clearly visible to the right of the picture.



starting points for such programs are the MP3-specific sites (such as www.mp3.com) as well as the more-generalised shareware search engines (www.shareware.com). The programs available change on an almost-daily basis, owing to MP3's current status as a 'hot' technology. Most Windows packages, including Cool '96, have an ACM (Audio Compression Manager) export facility that allows the file to be saved using a third-party Windows codec. You may well find that some other application has already installed a MP3 codec. In Cool '96, simply select 'ACM' from the 'save as type' options. Click on 'options' - MP3, if present, will be found in a pull-down menu that's accessed by clicking on 'format'. 'Attributes', meanwhile, allows you to specify the sampling rate, bitrate (the level of compression applied) and whether the output should be in stereo or downmixed to mono.

Some more advanced programs and codecs support the more efficient joint stereo (in a similar manner to the pilot-tone analogue FM stereo system, this transmits the lower-bandwidth difference between stereo channels on second channel) and variable bit-rate - VBR - encoding (the bandwidth of the compressed file varies dynamically according to the complexity of the musical passage). VBR works very well, and it's not uncommon to end up with a smaller-than-expected file with higher-than-expected sound quality. If you're producing MP3s for the player project, stick to a sampling rate of 44.1kHz otherwise the player's S/PDIF output won't work properly - although the analogue outputs should be fine. In my experience of stereo 44.1kHz 16-bit conversions, 96Kbps is fine for most speech radio programmes - at the other end of the broadcast spectrum, 128Kbps should suffice for live concerts sourced from a digital radio source. CD material benefits from rates between 128Kbps and 192Kbps. There's an often-perceptible difference in the sound quality between MP3 compression programs. Generally speaking, the quicker the conversion the poorer the sound quality. Most MP3 compression utilities have a 'quality' slider that allows you to trade off sound quality against processing time. A badly-compressed 128Kbps or 192Kbps track can often sound worse than a well-compressed 96Kbps one!

Double the Quantity

There is, would you believe it, a way of doubling the amount of material you can fit onto a CD. No compression is involved, and the result is compatible with any CD player. There is, as you would expect, a catch! First of all, the system only applies to mono material. Secondly, it's doubtful whether it adheres to the Red Book standard - but who cares, along as it works? The idea was conceived out of the need to archive a series of mono comedy programmes, each being half an hour in length, on the minimum number of CDs. Mono CDs apply the same signal to both stereo channels, which is wasteful. Why not apply a different mono track to each channel - thus doubling the potential storage capacity? In other words, a single CD will accommodate four, rather than two, half-hour programmes. Playback will involve turning your hi-fi amplifier's balance control fully anticlockwise (left) for one track, or fully clockwise (right) for the other. The disadvantage is that the sound only comes out of one speaker! An alternative is, of course, to wire the switchbox detailed in Figure 1 between the CD player and amplifier. Some 1970s-vintage amplifiers, interestingly enough, are equipped with a 'mode' switch that does the same job. My old Pioneer SA9500 Mk2 is one such amp. The separate text describes how dual-mono WAV files can be created - these can then be burnt onto CD using any authoring package (including the one supplied with your burner).

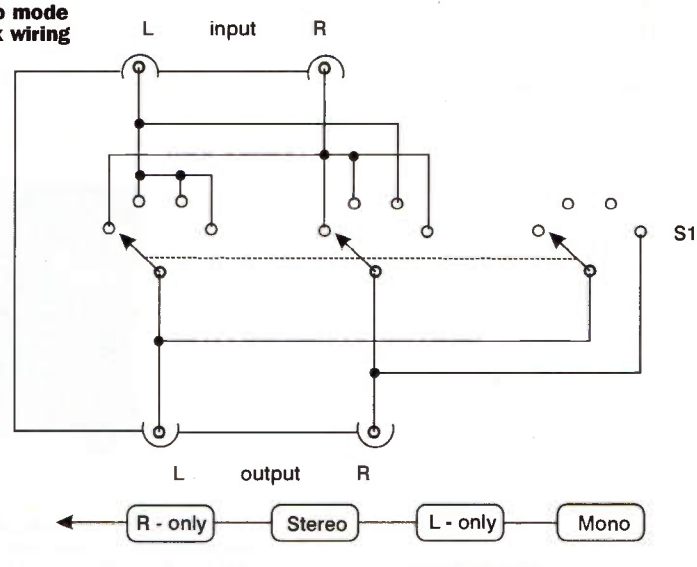
Conclusion

Mastering your own audio CDs is a fun and worthwhile experience that would have seemed impossible a few years back. Do the job properly, and you can achieve worthwhile results. Although stand-alone CD audio recorders are available, they are not as flexible and require special 'audio-only' blank discs that sell for four times the price of the more common audio variety. Today, both the computer-based and stand-alone varieties are capable of writing to rewritable (CD-RW) discs. Be careful here - owing to a lower recording-surface reflectivity, audio CD-RW discs can only be played on a limited number of recent CD players.

Copyright Warning

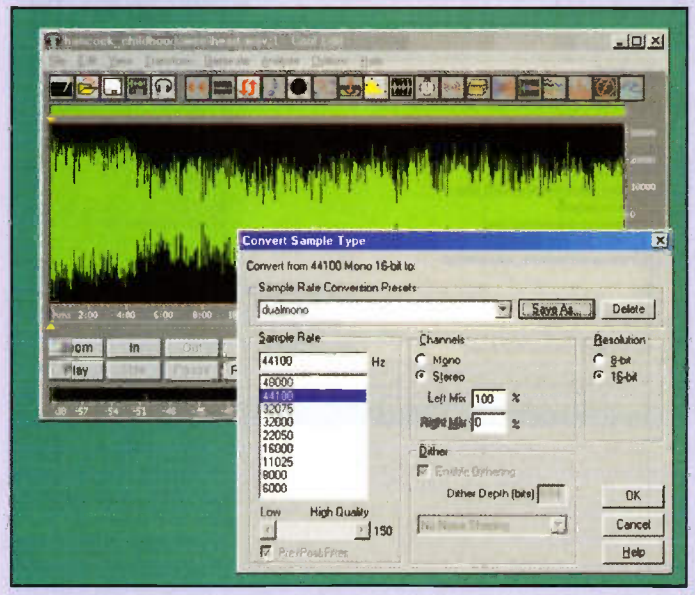
With the equipment and procedures outlined in this article, it is possible to make recordings of copyrighted works. If this is the case, such recordings must be made solely for your own use, and then only if you have the original recordings. If you do not own the copyright, or have permission to copy from the copyright owner, you may be violating copyright law and could be subject to payment of damages and other remedies. If you are in any doubt, please contact your legal advisor.

Figure 1. Stereo mode audio switchbox wiring diagram.



Creating dual-mono WAV files, using Cool '96

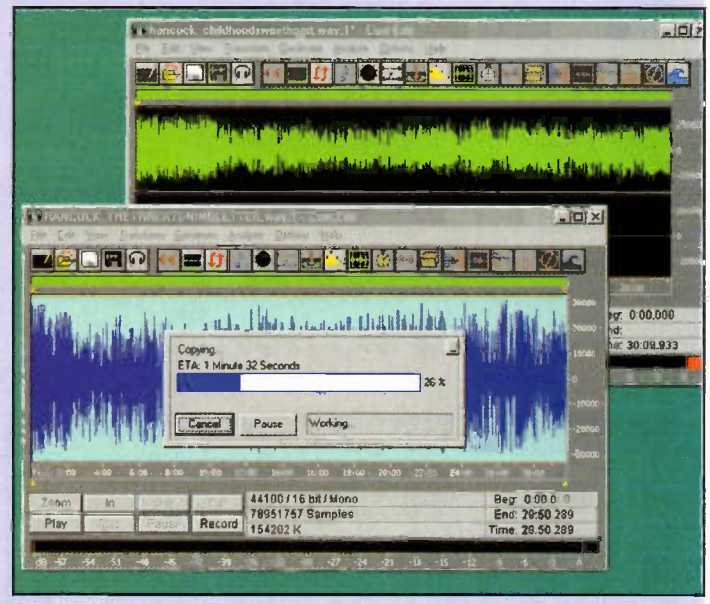
1. Capture your mono material as a 16-bit mono WAV file. Normalise volume levels for each capture, as described in the main text.
2. Note down the lengths of each capture, listing them from shortest to longest. You will be sequentially pairing of files of similar length, starting from shortest to longest, to form 'stereo' WAV files.
3. Convert the longer of the two captures into a stereo file, by selecting 'convert sample type' from the edit window. Go to the 'channels' option, and choose 'stereo'. Enter '100%' in the 'left mix' box, and 0% in the 'right mix' box. You should see



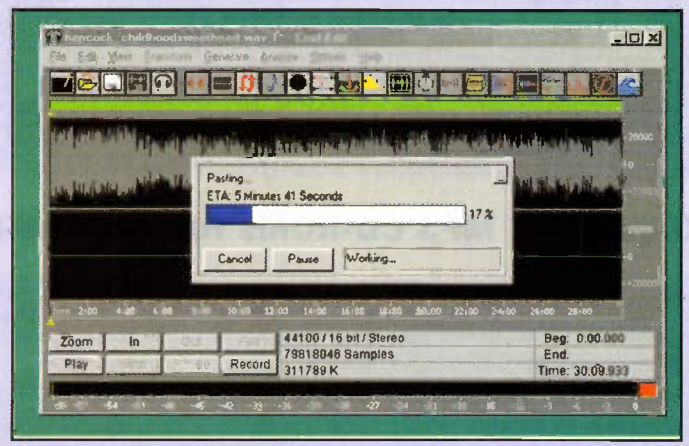
you original mono capture on top (this will be the left channel), and 'silence' at the bottom - it's into the latter (right channel) that the second clip will be pasted.

4. From the 'view' menu, select 'right channel' only.

5. Open up the second, shorter capture of the pair in another instance of Cool '96. Select 'entire wave' from the 'Edit' menu, and then copy.



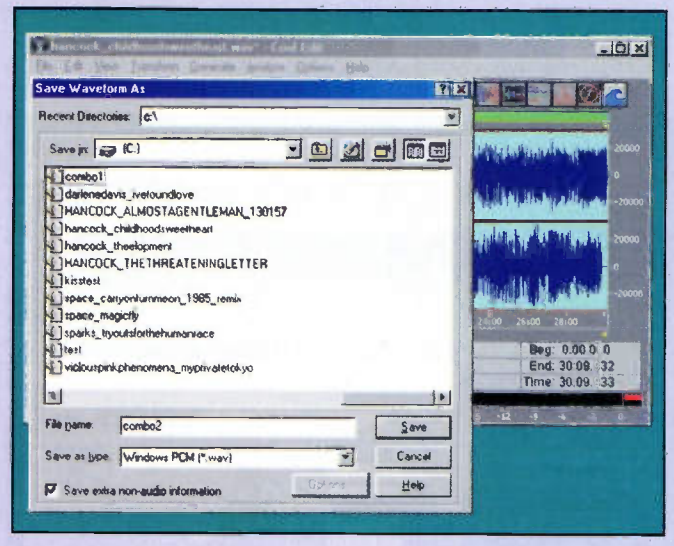
6. Go to original instance of Cool '96, and paste into right channel. You should now see two independent audio tracks



on the timeline. Go to 'view' menu and re-enable the left channel. If you select play, a different track will heard from each speaker!

7. Select the entire file and save your dual- mono file under a different filename - such as comboxx.wav.

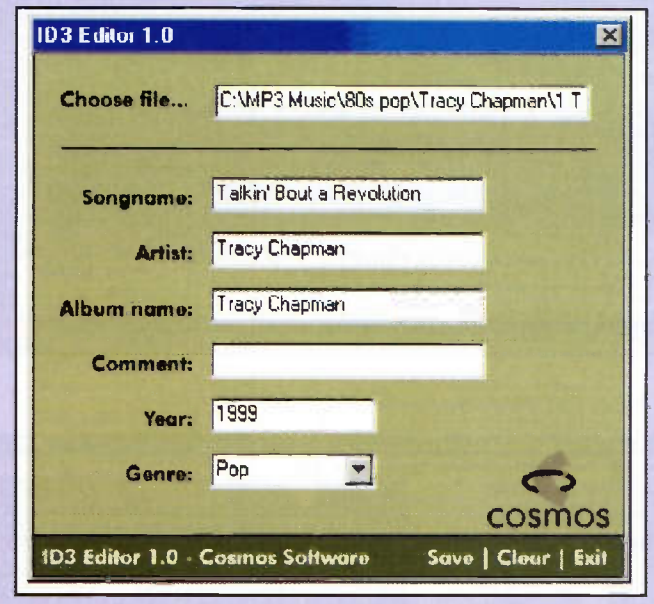
8. Repeat steps 3 to 7 with the next pair of files, until you have enough material to fill a CD (i.e. up to 74 minutes of dual-mono material). The dual-mono files can then be committed to CD-R in the normal way, using your mastering software.



Organising MP3 CD-ROMs for the DOS-based MP3 CD player

Here, the information on each song (or other audio clip) is contained within an ID3 tag, rather than the filename. DOS filenames, unlike those of Windows 9x, are restricted to 8 characters (the extension must always be .MP2, or .MP3, according to whether Layer 2 or Layer 3 MPEG compression is used).

1. Create MP3 files, and store them in an album-specific directory.
2. Edit the ID3 tags - track/artist and other text information than can be 'buried' in MP2/3 audio files - using a stand-alone third-party application (such as Cosmos' freeware ID3 Editor, available from `www.neutralzone/org/cosmos/`) or the ID3 editor within Winamp (you'll find this within the inappropriately-named 'view file info' menu).
3. Rename the files in each directory to meet the DOS 8.3 convention along the lines of albxxx01.mp3. The first characters of the filename are specific to the album, and should be followed by numbers that indicate the track number. If the album contains more than 9 tracks, tracks 1 to 9 must be numbered 01 to 09 - otherwise they'll be played in the wrong order.
4. Move all tracks to a common directory, and burn them so that they appear within your CD-ROM's root directory. Don't forget to 'close' your disc! A full CD-ROM will contain up to 650MB - which equates to a fair number of tracks!



5. Reboot your machine in DOS playback mode. You'll find that albums are played in alphabetical order - with all tracks in the correct sequence. DAMP (the MP3 playback application) decodes the ID3 information of each track, and passes the artist and songname to the LCD screen. Tracks can be selected using the front panel buttons (refer to the July issue of 'Electronics and Beyond'.

COMMENT

by Keith Brindley

There's no such thing as a free lunch! It's an old adage, and one that everyone should remember in all walks of life. It was one of the first things I learned when I trained as a journalist. If someone offers you a freebie whether it's lunch, software, hardware, gadgets or money for nothing, then the first thing you should ask yourself is 'What's the catch?'

Nothing's free, of course, ever - and the term 'free' is usually just a euphemism for something else. That's why - as a journalist writing about Internet matters - I'm wary when Internet service providers tell me their Internet service is free. It may be free in the sense that use of access is not charged for, or that use of access and telephone calls are free, but then you have to ask yourself 'Well, if it is free, why am I being offered it for nothing?' In effect, 'What's the catch?'

There is a small but rapidly increasing number of Internet service providers that offer free Internet access and telephone connection. I've been playing around with a couple over the last month or so, and I've found that not all is at it seems. Not that any of these free Internet service providers are doing anything wrong. Indeed, anything that can reduce the cost of Internet access for the general public in the UK is a great thing!

No, instead, the problem is generally that any truly free Internet access service is inevitably popular. So popular that in some cases the Internet service provider might not be able to cope with demand. And that means that - particularly at certain times of day - the system is so busy that users often have trouble gaining access. For example, it's not unusual to find access unavailable (indicated by busy dial tones) around 6pm - the time when most users will have returned home from work, and want to connect to the Internet. At other times of day, access is more usually available at the first or second dial-up attempt.

This is all to do with Internet service providers' access lines of course - and in particular the number of modems they have to allow user access. Paid-for Internet service providers can afford to put in more modems, so their dial-up lines will be less busy. To put this in perspective, paid-for Internet service providers usually have a ratio of modems-to-users that allows access to most users at most times. There's always the odd occasion that more users than usual try to dial-up at the same time, because it's not economically feasible to provide a modem for every user but, overall, such Internet service providers find that busy dial tones don't often occur. The free access Internet service providers have an inherent problem installing the numbers of modems that they need to provide access at all times because users naturally tend to use the system a lot more because it's free. Indeed, it's not uncommon for users to dial-up to a free access provider and hang on the line indefinitely - even if it's not being used - simply because it is free. This is because they know that if they log off they might not be able to get back online as easily next time. On the other hand, users of paid-for Internet access providers tend to get off the line when they're not actually using the Internet, as they know the clock's ticking and they will be charged.

Of course, a lot of current problems are teething problems that will sort themselves out over time. As users become more familiar with free access, and become aware that the Internet can be accessed freely at any time, say, their use of the Internet will probably fall not rise.

So how do these pioneering free Internet services exist, if they don't charge for Internet access? In the main, their income is generated by charging users for non-Internet telephone calls, which have been bought at a discounted rate from BT. The idea is that if users make sufficient conventional telephone calls through their service, the income generated will pay for the free Internet usage, leaving a profit. To do this, users usually require a small converter box (usually called a Smart Dialler), with plugs into the BT master telephone socket. The box merely prefixes any outgoing telephone call with a few digits. The digits identify the call to the BT telephone exchange as a call to be charged to the free Internet service provider's account. It's really all quite simple, yet extremely effective.

There's a couple of alternatives to this method - the cable telephone and television companies. Theses of course have their own networks, so can provide customers with whatever priced Internet access they wish. For example, ntl has recently introduced its ntlworld system, which is a totally free Internet access service. As not all the country has yet been cabled, this would appear to be of benefit only to ntl's existing customers. However, ntlworld is interesting in that existing BT telephone users can take advantage of ntlworld, with an ntl Smart Dialler in the same manner as already described. As you might expect, the demand for ntlworld has been huge, and ntl is having problems getting all interested users online. For example, even though I'm an ntl customer, and although the service officially started on 12 April, as I write this in early June I haven't yet received my connection pack from ntl.

Whatever the teething problems though, free Internet access for all looks to be on the very near horizon, and getting closer daily. And, even though teething problems exist, being free is better than being charged. Despite its apparent high technology, the Internet itself is really just a technology in its infancy, and it has a significant way to go before it realises its potential. Part of realising its potential is free access to it. Summing up, while North America has a rocket powered Internet - due to free access - the UK (and most other countries) languishes with its steam-driven, paid-for, access. The pioneering free access service providers are all part of the move towards allowing the UK to compete in Internet technology. If we don't have free access, we'll simply never compete, and inevitably fall further behind.

The whole situation though, begs one simple question: if pioneering free Internet access providers (and ntl) can do it, why can't BT?

The prototype in 'stand-alone' MP3 playback mode. Sirocco speakers courtesy of Videologic.

MP3 Player UPDATE

PART 2

Martin Pipe completes the revision of his PC-based MP3 player project

In last month's issue, we described how the industry-standard Creative Labs Soundblaster 16 (SB16) - which forms the audio output device of the MP3 player project - could be improved. We detailed a replacement analogue output stage, and explained how an operating system-independent S/PDIF output could be added. The latter comes into its own if you want to copy MP3 songs onto DAT or Minidisc digitally, or simply want to listen to music through an audiophile-quality DAC. That said, the re-engineered analogue stage was found to significantly improve sound quality, and should suffice for all but the most critical applications. Subjectively speaking, the resulting soundcard is capable of better replay sonics than just about any consumer-level model. It even stands up pretty well against semi-professional types like Terratec's EWS64XL (which, by the way, isn't fully SB16-compliant in DOS mode). Combine these modifications, the software changes covered in the last issue and the original articles (March and April 2000), and you should have a stand-alone MP3 player of excellent quality.

All of that computing power 'under the bonnet' makes the system capable of doing a lot more than some of the stand-alone MP3-compatible players that are now becoming available. For example, you should be able to make your own MP3s from CDs or other sources. The config.sys and autoexec.bat files have been designed in such a way that Windows '98 can be loaded from a boot-up menu. In this mode, the unit will run the huge range of compatible audio editing, MP3 conversion and CD mastering tools. Indeed, the prototype now has a Creative 'CD-Studio' rewriter instead of the originally-specified CD-ROM drive. With appropriate software, the Creative drive gives the system an ability to produce regular audio CDs, as well as MP3 CDs, on cheap CD-R media. Not only does this bring it ahead of ordinary MP3 players, but it also makes it considerably more flexible than stand-alone audio CD recorders. Such devices won't edit tracks prior to burning or record/play MP3 discs - what's more, they require a special variety media that is more expensive than those sold for computer use.

The software provides much of this flexibility, and we'll be discussing how in this article - and a companion one on CD audio mastering in this issue. It has to be said that the average audio CD recorder is better-connected (in audio terms, certainly) than the average PC. The same comment thus applies to this system, which is - after all - a very specialised PC. Your typical stand-alone recorder will have SP/DIF and/or TOSlink digital inputs and outputs, as well as analogue line ones. Digital audio inputs are useful if you want to master from DATs, Minidiscs or DCCs. If you merely want to copy (tracks from) CDs, then the digital input isn't necessary with our computer-based approach - with CD audio recorders, it is of course a different story! Most modern CD-ROM drives and 'burners' support DAE (digital audio extraction), and are thus capable of 'ripping' CD audio tracks to the hard disk as WAV files. We'll discuss how digital inputs can be added very cheaply later.

Modifying the SB16

As it stands, our project has only the standard SB16 line inputs. What's more, a careful listener through a good hi-fi amp and speakers will reveal that they're of mediocre quality. The line-level audio signal is routed through a considerable amount of superfluous circuitry, including dozens of small-value electrolytic capacitors, 741-grade op-amps and, within the specialised CT1745 mixer chip, a series of VCAs and analogue switches. No wonder that detail is masked, noise levels high and bass depth restricted. We decided to re-engineer the analogue input along similar 'minimalist' lines to those described last month. The SB16's analogue-to-digital converter is contained within the same AK4501 device as the DAC, as shown last month. The datasheet for this device (which, on some Creative cards, is known as the CT1703) also mentions that anti-aliasing filters are built-in. These filters won't reject noise at 3.072MHz (and multiples thereof), but that won't be a problem with audio signals!

Replacing the SB16's analogue input circuitry is thus a fairly simple matter, and the circuitry required can be built up from standard op-amps (in this case, TL072s). As Figure 1 last month shows, the required input format for each stereo channel is differential. Pins 7 (-) and 6 (+) accept the left channel, while the right channel is fed into pins 5 (-) and 4 (+). The differential signals can be produced from the normal single-ended line input using the circuit described in Figure 1. Note that one of these circuits is required for each stereo channel. IC1, which has a voltage gain of just under 5, inverts the signal and feeds it to the chip's '-' input. The gain is sufficient to cope with a wide variety of signal levels. The inverted output is also fed to the inverting unity-gain buffer of IC2, which restores the signal to its original non-inverted state - it is then fed to the chip's '+' input. A 2.5V bias signal, required by the AK4501, is derived from 5V regulator IC2 and associated components. Note that the SB16 PCB tracks currently connected to pins 4 to 7 will need to be cut. The AK4501 is a surface-mounted device and the board layout rather dense - so be careful!

Level Monitoring

Some means of setting the input levels - and indeed monitoring them - would be a sensible idea when recording from the line inputs with programs like Syntrillium's Cool Edit (record, edit, replay, convert and save to a variety of file formats - including, with the appropriate plug-in, MP3) or Iomega's RecordIt (record and replay MPEG-1 Layer 2 audio). Although CoolEdit has a valuable software-implemented meter, the same isn't true of RecordIt. Remember that the maximum signal level during recording should correspond to 0dB - full-scale, or in

this case a ADC hex output value of 7FFF - if the best possible dynamic range is to be achieved. We used 47k potentiometers, wired up as shown in Figure 2. This pair of pots are mounted on the front panel. Figure 2 also details output and meter switching. We'll discuss the output switching shortly, but for now let's talk about those meters and the associated circuitry. We specified a pair of Velleman 10-LED VU meters (VF91Y) - one for each channel. To save on metalwork and internal 'real-estate', they were configured in a novel way. The LEDs supplied in the kit were discarded in favour of a pair of 10-LED 'bars'. These were fitted behind the front-panel window provided for the LCD screen - refer to Figure 3. The devices were epoxied into position so that the tips of the individual LEDs were just visible from the top (left channel) and bottom (right channel) of the window. Another photo shows how the Velleman boards were mounted vertically on the side of the case - connections to the LED bars were made via 11-way ribbon cables.

The boards - shown in Figures 4 and 5 - were made as per Velleman's instructions, except that Minicon connectors were soldered into position instead of the LEDs. Another change is that the 220k preset (RV1, which sets the gain of IC1) is replaced with a 470k type to increase sensitivity - the reason why will follow shortly. I based my display around scrap LED bars from an old Ferguson TV control panel - here, the cathode and anode connections for each device are isolated. A common-anode connection was made in both cases. The isolated connections allowed the LED bars to be wired in such a way that both bars read from left to right, despite the fact that they are 'upside down' relative to each other. Unfortunately, this won't be possible with the obvious choice of LED bar sold by Maplin (YH76H), because this employs a fixed common-anode connection. Mount it without fouling the LCD module, and you'll find that the indicator bars move in opposite directions! Two of the other devices available from Maplin are suitable, although they may require extra work. The red DIL bargraph (BY65V) could be mounted to read vertically, but its 25mm height requires additional metalwork. A practical alternative is to horizontally 'stack' together several of multi-LED arrays - two red dual-arrays (YH77J) and two red tri-arrays (YH78K) arranged side-by-side should suffice.

Back to the signal routing circuitry, detailed in Figure 2. A monitor selector switch (shown as S2 in Figure 2) determines whether the unprocessed input, or the output from the modified SB16, is fed to the line output and meters. The feeds for the SB16's modified line input and S2 are both taken from the wipers of the input level controls (shown as RV1 - left channel - and RV2 - right channel). S2, a 4-pole 3-way rotary type (FF76H), is analogous to the 'record/play' switch fitted to the earliest tape recorders. Two of its poles are used to switch the left and right audio signals between input and output, while the remaining pair determine which signals are fed to the meters. A series of 47k presets

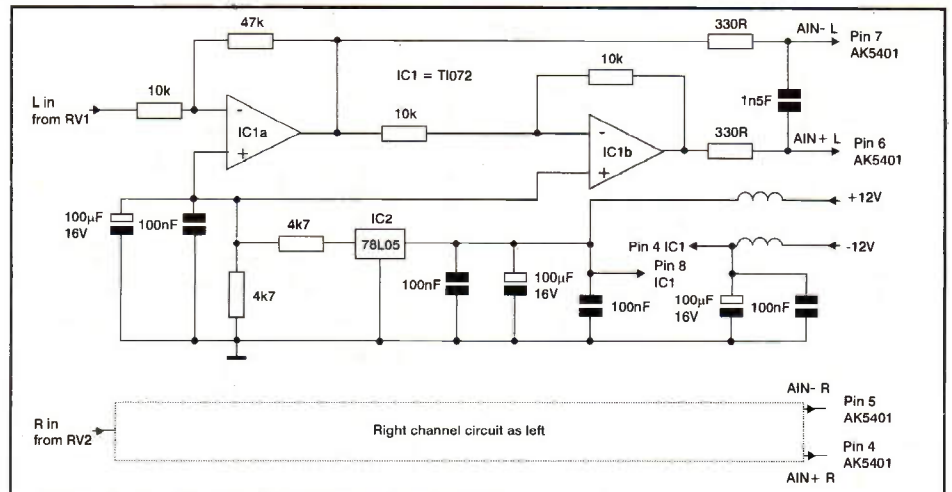


Figure 1. Modified SB16 analogue input stage

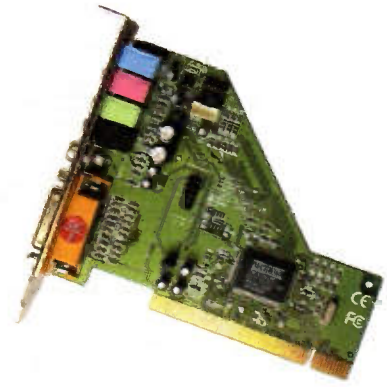
(RV2 to RV6, mounted on a piece of matrix board) are used to match the record and replay signal levels so that the meter levels tally with each other when switching from record to replay. These presets, plus those on the meter drive boards, were calibrated using the meter built into Cool '96 (available as shareware from several sites, including www.shareware.com). On the subject of meters, note that the S2's third position switches them out of circuit altogether - you might not want those LEDs blinking away distractingly when the system is, for example, playing MP3 files in its DOS mode.

Digital Inputs

OK, that's the analogue inputs dealt with. But what about the digital ones? You might want to transfer recordings from DATs onto CD or MP3, but avoid any quality penalties incurred by having to go from digital to analogue and back again. The same considerations will apply if you want to make lossless digital recordings directly from a DAB tuner - or the modified DVB satellite receiver described in the February 2000 issue of 'Electronics'. All of these items of equipment are equipped with S/PDIF (coaxial) or TOSlink output terminals. Most of the cards with compatible inputs are very expensive - Creative's Soundblaster Live Platinum, for example, retails for around £200. There is, however, a cheap alternative - and its basis is a cheap soundcard known as the Audio Excel AV511. Look around computer fairs, and you should be able to pick up one of these cards, which is based around CMedia's CM8738 chipset, for £10 or so. OK, its analogue circuitry delivers fairly grotty results - but who cares? In the modified SB16, we have a card that's more than capable of handling the analogue side of the operation. The AV511's claim to fame is that it offers S/PDIF input and output, and what's more they're bit-perfect! As with other PCI cards, the AV511 only works under Windows 9x. No problem - in this application, the AV511 will be employed solely for digital audio mastering applications, nearly all of which require Windows anyway. To this end, the card is supplied with Windows '95/98 drivers, and a series of applications.

Mixer Software

Most important of these is the 'mixer', which replaces the one associated with Windows. From here, you'll be able to kill the unwanted (analogue) inputs to eliminate unwanted noise. In the mixer's 'advanced' menu - accessed via a button on the bottom-left - you'll be able to switch the S/PDIF input and outputs on or off, and select the S/PDIF signal output level (TTL or 1V). Other options, such as the S/PDIF invert and input signal level, don't work properly because the hardware doesn't support them. Inversion of the signal may be required for compatibility with some devices, but this can be achieved easily with hardware - we'll discuss the importance of this shortly. Another disadvantage is that you can't adjust the volume of the SP/DIF input, as you can with the Soundblaster Live. Some digital radio channels are frequently rather low in level (a pity, because they're not making the use of the full dynamic range). If you're making recordings, you could always boost levels using software. We'll explain how Cool Edit can be applied to the task in the CD authoring article in this issue. The AV511 was installed alongside the modified SB16, which is retained for working with analogue sources and DOS MP3 playback. The soundcard required is selected via the 'Multimedia' control panel within Windows.



The bargain-basement Audio Excel AV511 PCI soundcard, which forms a bargain digital audio I/O device. Although we've specified this card for our project, it can be used to add S/PDIF input and output to any device - the circuits of Figure 7 and 10 are still relevant.

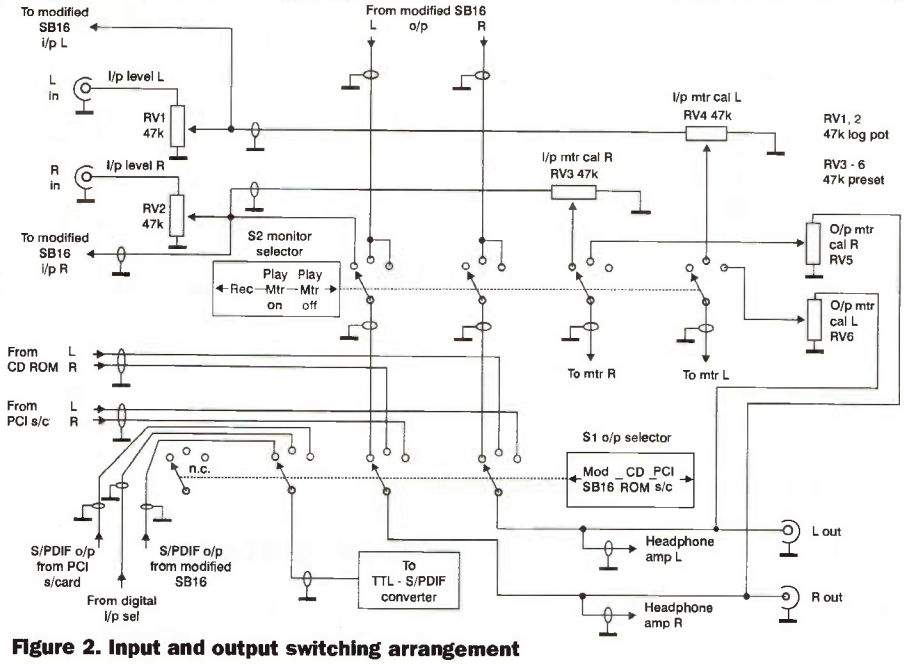


Figure 2. Input and output switching arrangement

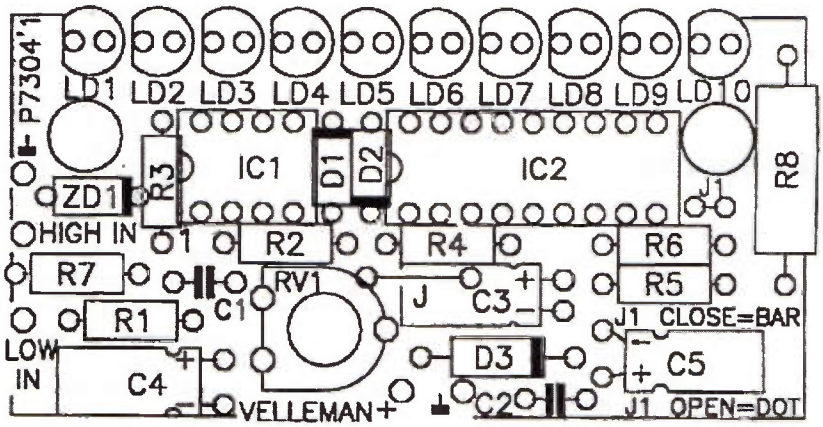


Figure 4. Velleman 10-LED VU meter PCB

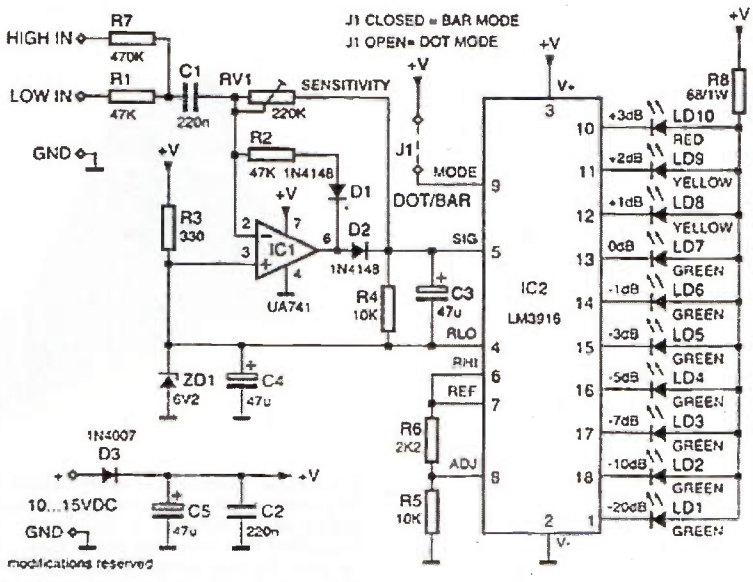


Figure 5. Velleman 10-LED VU meter circuit diagram

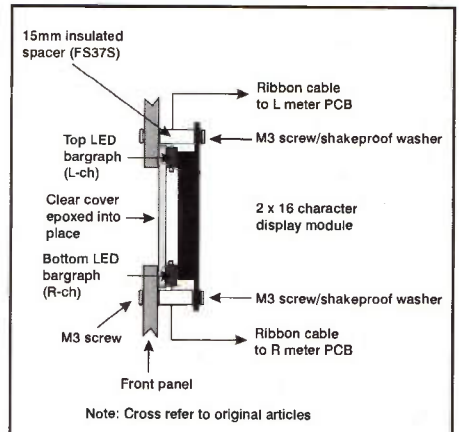


Figure 3. Fitting LED bargraphs to front panel

CoolEdit

Interestingly, Cool Edit's various incarnations (and other editing programs, no doubt) permit you to specify the desired peripheral directly, without having to mess around with Windows. Look for a menu that says 'select wave device', or something similar. From here, you should be able to tell the software which card should be playing back, and which should be recording. The AV511's S/PDIF input and output are compatible with 44.1 and 48kHz sampling rates - good news for DAT devotees! Note that if you want to make audio CDs from 48kHz DATs, you'll need to convert the sampling rate to 44.1kHz. The same may also apply if you plan to convert those audio captures into MP3 files. Note that the CS8402A is only compatible with 44.1kHz sampling rates. In other words, if you try to play a 48kHz MP3 file in DOS mode, you'll get audio through the SB16's analogue outputs - but nothing from the S/PDIF output. Convert to 44.1kHz before compressing to MP3, if full compatibility with the player mode is required.

Card Connections

A 10-way header connector on the AV511, reproduced in Figure 6, contains the (TTL-level) S/PDIF inputs and outputs. Pin 4 is the output, Pin 5 the input, and Pin 6 a convenient ground. To integrate the card into the system, some extra hardware is required. The first is a circuit - shown in Figure 7 - that converts the low-level 1V coaxial S/PDIF signal to a TTL-level one compatible with the AV511. The ingenious circuit, developed by Heiko Purnhagen, was found to work exceptionally well. The active circuitry consists of two hex inverters (part of 74HCU04, IC1). Note that a TOSlink receiver module delivers a TTL-level signal, and will feed the AV511 directly. This device - shown in Figures 8 and 9 - is required if your source equipment is equipped with an optical output. We have specified the Sharp GP1F32R, because availability is good - albeit not from Maplin stores. Guess which company used to sell TOSlink modules, but does no longer? Note that many Sony MD and DAT decks are only equipped with an optical output, giving you no choice but to adopt the TOSlink input method unless you're prepared to make modifications to

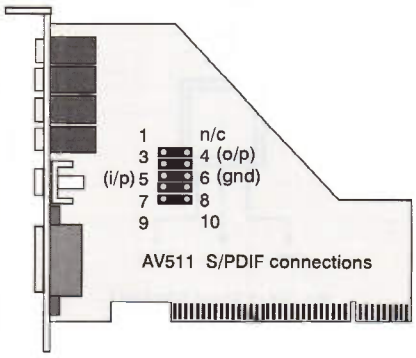
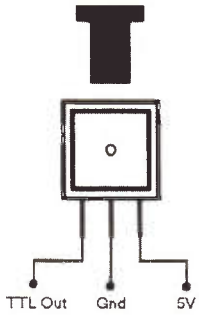


Figure 6. Pin-out details of AV511 header plug, which contains S/PDIF input and output signals.



Pin-out of Sharp GP1F32R
TOSlink receiver module
(Viewed from REAR of device!)

Figure 8. Pin-out details for the Sharp GP1F32R TOSlink optical receiver module.

your decks! Figure 7 also shows the prototype's digital input switching arrangements. Here, S3 - a 4-pole 3-way rotary type (FF76H) - selects between the coaxial input, optical input and the rear-panel TTL-level S/PDIF output fitted to many modern CD-ROM and CD-R(W) drives. Two of the spare gates of IC1, and a changeover switch, provide a S/PDIF input inverter. In my experience, the AV511 is very fussy about what's presented to it. If the polarity of the signal isn't what the card expects, you'll get horribly distorted audio. Flicking the 'invert' switch should fix the problem, which seems to vary from one digital source to another.

Output Arrangements

Which brings us neatly to the output arrangements. The AV511 has a coaxial S/PDIF output on its mounting bracket, and the voltage level can be set - by the mixer's 'advanced' menu - to the required 1V. If you're using the 19in. rack-mounted case originally specified for the project, you'll have to drill a hole on its rear to provide access to this socket. I wouldn't bother. Metalwork hassle notwithstanding, the coaxial output is not isolated as per the S/PDIF specifications. This could create problems with earth loops. Interestingly the S/PDIF output is duplicated on the header. Using the mixer, set the card to produce a TTL-level output. The circuit given in Figure 10 will convert this to an isolated output of the required level. The transformer (T1) was salvaged from a scrap CD player, but one can be made from a 12.7mm diameter

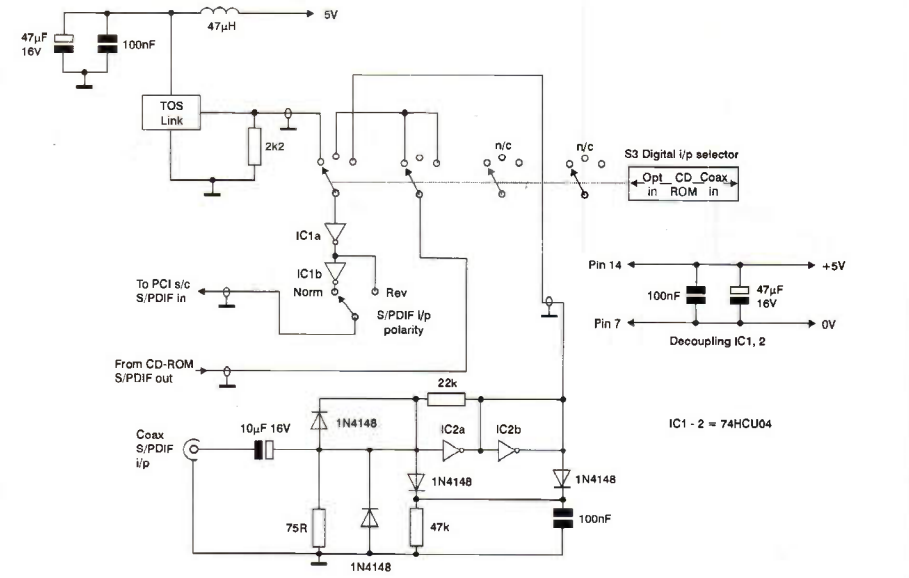


Figure 7. Digital input switching, and coax-to-TTL converter circuit

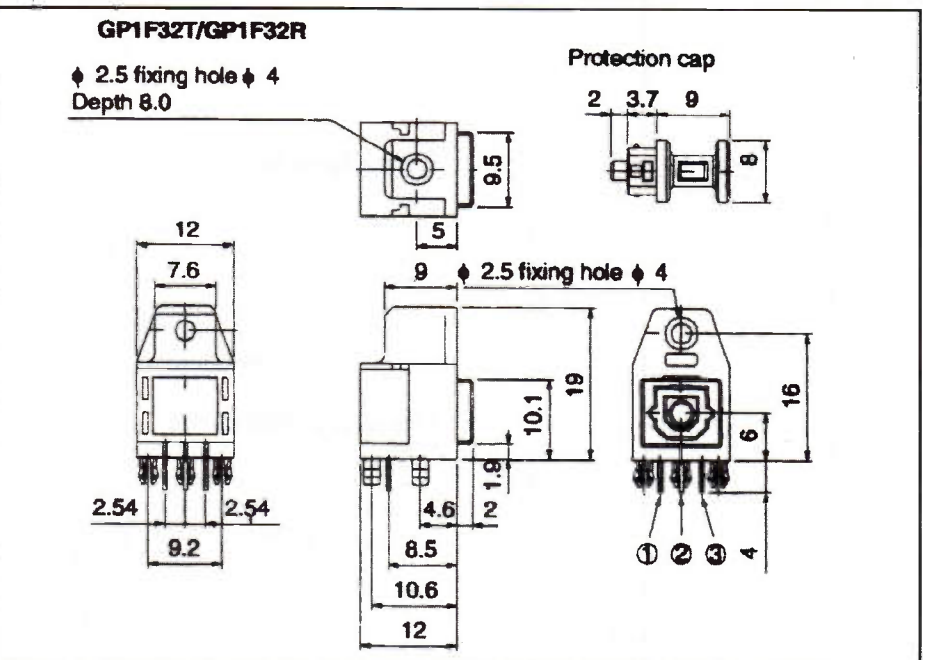


Figure 9. Mounting details for the Sharp TOSlink optical receiver and transmitter modules

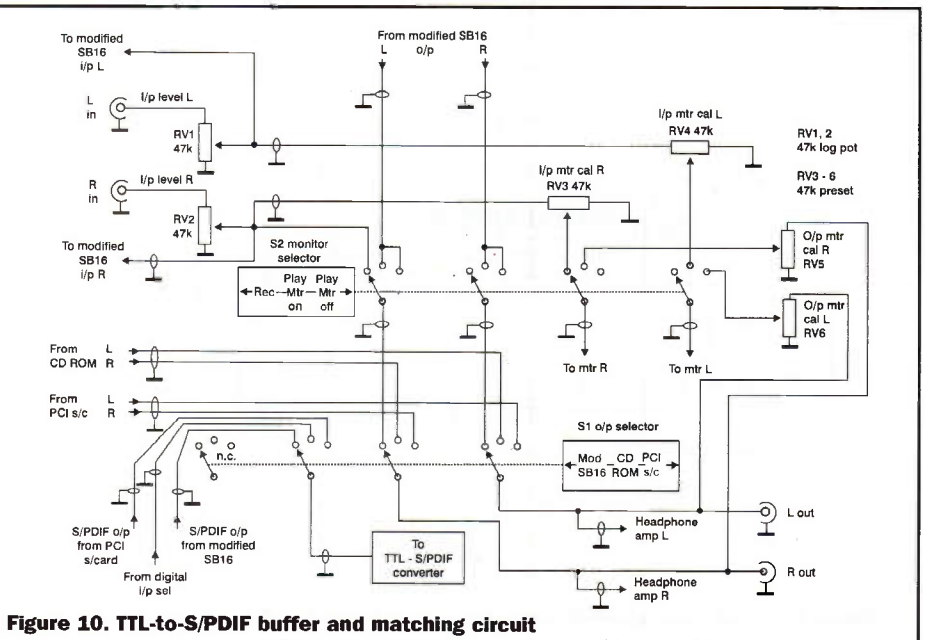


Figure 10. TTL-to-S/PDIF buffer and matching circuit

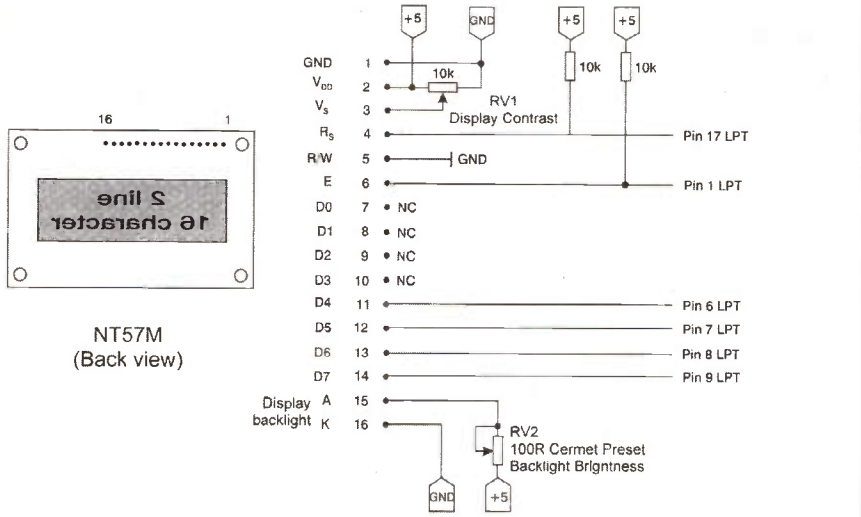


Figure 12. Wiring details for replacement 16 x 2 display module

ferrite core. 20 turns are required on the primary side, and 4 on the secondary. Until very recently, Maplin sold a suitable ferrite (AN74R), but - as with many other useful items - the company has helpfully decided to discontinue them. If you don't want to take your CD player apart, you might be able to find one on a junkbox Ethernet card. Note that the Figure 10 circuit could also be used to add a coaxial output to TOSlink-only digital audio equipment. The required TTL-level S/PDIF, 5V and ground signals will all be found on the TOSlink connector.

If you have no luck finding a suitable transformer, the AV511's TTL S/PDIF output signal could be used to drive a TOSlink transmitter (refer to Figures 9 and 11) directly. Your player can then be connected to external equipment via an optical fibre cable. An advantage of the optical approach is that complete isolation is afforded. The CS8402A chip and CD-ROM S/PDIF outputs are also at TTL level. The output selector (S1) shown in Figure 2 will determine whether the S/PDIF output from the modified SB16, CD-ROM drive or AV511 is fed to the TOSlink module and/or coax circuit of Figure 10. The switch is yet another 4-pole 3-way rotary type (FF76H). As you can see from Figure 2, two of the switch's other poles simultaneously switch in the relevant analogue stereo outputs. Note from Figure 7 that the CD-ROM drive's S/PDIF output is not available when the digital input selector is set to deliver this signal to the AV511.

Conclusion

Implement all these changes, and you'll end up with a highly flexible and expandable piece of audio gear. We wish you many hours of happy recording and listening! Any future changes to this project will be detailed on the Web. I urge you to visit **www.digitalmods.com** regularly...

Display Module

The backlit LCD module (RB36P) detailed in the original March and April issues is, alas, no longer available from Maplin. However, the company continues to stock a suitable module (NT57M) which is compatible with the existing LCD driver. The wiring diagram for the new module is given in Figure 12. Although the device is pin-compatible, we include the drawing because some information was missing from the original! Note that the mounting arrangements are completely different to those of RB36P - as can be seen from the front and side-view drawings reproduced in Figures 13 and 14. This information, plus the original drawings, should allow you to provide a suitable front-panel cut-out and mounting holes.

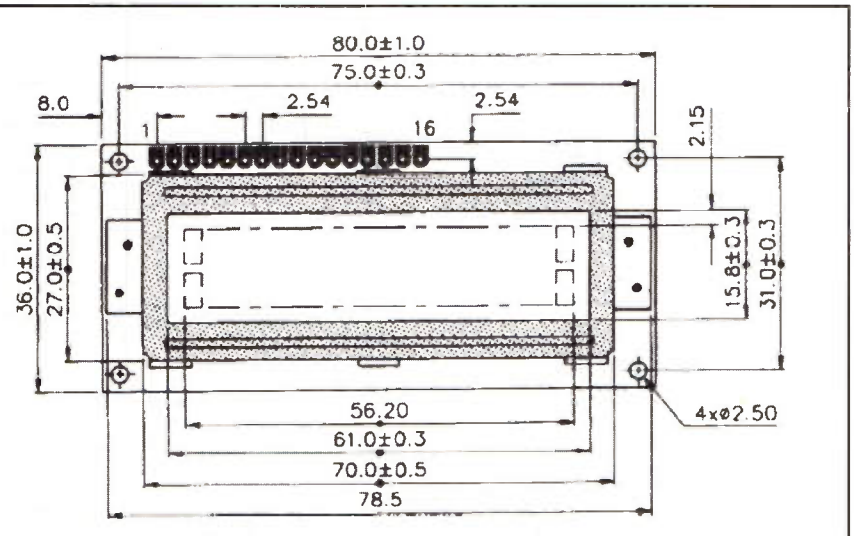
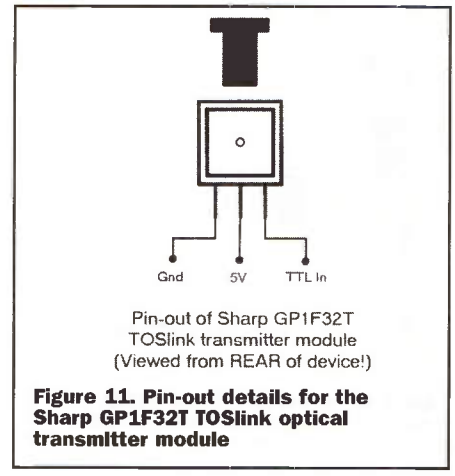


Figure 13. Front dimensions of replacement 16x2 LCD module (NT57M)



Pin-out of Sharp GP1F32T TOSlink transmitter module (Viewed from REAR of device!)

Figure 11. Pin-out details for the Sharp GP1F32T TOSlink optical transmitter module

Note

The Sharp GP1F32T TOSlink transmitter and GP1F32R receiver are available from Hero Electronics Ltd, which can be contacted on (01525) 405015. The company can also be contacted by writing to them at Hero Electronics, Dunstable Street, Ampthill, Beds MK45 2JS. As an alternative, you could e-mail hero@heroelec.co.uk. The cost of each device, inclusive of VAT and post/packing, is less than £10.

I have seen AV511 cards at various computer fairs - mine was acquired for £10 at the Picketts Lock radio rally a few months back. Central London-based computer dealer Morgan Computers was selling a Zoltrix version of the card for £20. Another company worth trying is Pivot Systems, which has been known to sell Audio Excel products. The company's telephone number is 020 8850 3939. Its Web site resides at **www.pivotcomputers.co.uk.** If you have no luck with conventional retailers, try a search on the Internet.

Neither Maplin Electronics nor the author can be held responsible if your soundcard or PC blows up - so be careful! The information in this article is provided on an 'as-is' basis.

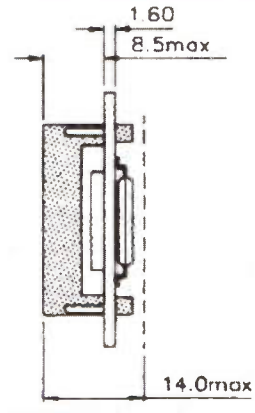


Figure 14. Side dimensions of replacement 16x2 LCD module (NT57M)

Beyond the SILICON MICROPROCESSOR

Mike Bedford concludes his look at the future replacement for silicon in the electronics industry

In last Month's article on Moore's Law, and the obstacles which lie ahead for semiconductor manufacturers, I made a rather disturbing assertion. If the experts are correct, it may not be possible to shrink the feature size of chips much beyond the year 2015 and beyond this time, further processor performance increases will be modest, at the best. What makes this so disturbing, of course, is that it's at odds with our expectation of a doubling in performance every two years. But although this seems so contrary to our experience, there are so many potential roadblocks ahead - some concerned with technology, some with economics, some with the fundamental laws of physics - that we really do have to take the possibility seriously. And for a number of researchers this involves investigating alternatives to silicon integrated circuits. After all, computers haven't always been based on silicon chips - earlier generations of computers used valves and then discrete transistors - so why should we expect that microprocessors will remain dominant forever? Some of this research is evolutionary, in much the same way that valve computers evolved into transistor computers which, in turn evolved into computers using small scale integrated circuits and eventually microprocessors. However, other strands of research are concerned with revolutionary technologies, as different from today's computers as today's computers are from the slide rule or the mechanical adding machine.

Evolution

Evolutionary changes to the basic silicon semiconductor are, in fact, already taking place in an attempt to overcome some of the problems associated with the ever decreasing feature size. As we saw last month, one such change is the gradual changeover from conventional aluminium to copper interconnects. This change, which has already been introduced on the PowerPC and will be introduced by Intel for the 0.13 micron process, is to overcome the resistivity of the increasingly narrow tracks of the interconnection layers. But this is really just fine-tuning - much more radical changes are going to be needed if that roadblock is to be averted.

Another possible evolutionary change, albeit one which is more fundamental than a move to copper interconnects, would be the pensioning off of silicon in favour of another semiconductor material such as Gallium Arsenide, GaAs. My reason for describing this as evolutionary is that we're still talking of semiconductors built into an integrated circuit but there are some possible benefits to be had from such a change. As someone with an interest in electronics, you've probably read about GaAs, indeed this is a technology which could be applied across the board, not just for processor or memory manufacture. Because GaAs is, therefore, a reasonably familiar technology, I won't dwell on this to any length but no feature on future trends in computer hardware could be complete without a brief mention. And although we haven't seen GaAs in mainstream processors yet, the supercomputer industry has already embraced the technology and has reaped benefits in so doing. If you do already know something about GAs semiconductors you'll know that they offer the possibility of higher speed operation than an equivalent silicon device. Needless to say it's not all plain sailing for GaAs and one of the major drawbacks is that the thermal conductivity is much lower than that of silicon and this would make heat dissipation more difficult. We saw last month that getting rid of the waste heat is one of the potential show stoppers for further miniaturisation of silicon semiconductors so the benefits to be gained from GaAs would have to be pretty impressive in order to compensate for this drawback.

Really that's all I have to say about evolutionary new technologies. Not because there's nothing more to be said - far from it - but because the revolutionary new technologies make a much more interesting story. The likelihood of any of these revolutionary technologies making the big time and shaping the future of computing is remote. Indeed the evolutionary technologies are more far likely to come to fruition. However, the evolutionary technologies are likely to be just stop-gap measures affecting the short to medium terms and providing a modest boost in performance. Some of the radical new technologies, on the other hand, hold out the promise of dramatic gains in performance and, should they come to into being, could affect the future of computing for decades if not for centuries.

Diodes from Spinach

It's got to be said that we owe a lot to plants. Without the photosynthesis that takes place inside them, this world would be devoid of carbohydrates and without carbohydrates it would be devoid of life. Photosynthesis, of course, is the chemical reaction that takes place in all green plants converting carbon dioxide and water into carbohydrates using sunlight as the energy source. However, according to Elias Greenbaum of the Oak Ridge National Laboratory in Tennessee, the powerhouse of life may soon become the driving force behind a new generation of computers.

Biologists talk about tiny chlorophyll-containing reaction centres deep in the cell structure of green plants. It is here that the sun's energy is converted into the chemical energy that is stored in carbohydrates, a process that takes place through the transition of electrons. Furthermore the reaction is structured in such a way that the reaction is non-reversible and this means that the electrons can pass in one direction only, just like a semiconductor diode. Not only this but these are diodes which are just 7nm long - that's twenty times smaller than the smallest conventional diodes - and the passage of an electron is measured in pico seconds. As one of the most fundamental building blocks of digital circuitry, the reaction centre diode might just, one day, lead to photochemical OR-gates and AND-gates, and ultimately to complete computers.

Greenbaum and his colleagues are still some way from this goal. Currently, the team has managed to isolate these reaction centres from spinach and has proved that they do, indeed, behave like diodes. They have also managed to deposit the diodes onto a gold wafer and align them all in a single direction, a first step toward assembling them into a working circuit. One of the biggest challenges, though, is to find a way of connecting the reaction centres together into a circuit - something that Greenbaum believes may be possible using carbon nano-tubes. This, of course, would be a radically different approach from today's method of manufacturing

integrated circuits. Rather than the top-down approach of carving the circuit out of a slab of silicon, the circuit would be built, bottom up, from tiny components.

The Optical Alternative

Strange as building up processors from tiny reaction centres isolated from spinach may seem, though, it has to be admitted that we're still not talking of something radically different from silicon chips. Certainly the raw material is very different as is the manufacturing method but this would still be a processor built out of electronic logic gates which would be similar in its operation to a Pentium III. So let's now start out tour of technologies, which are very different indeed.

When discussion turns to super-computers of the future, the semi-technically-literate man in the street will generally think in terms of an optical computer. This is strange since there really isn't too much research going on into this subject today. There has been lots of research in the past but today the concept of an optical computer is largely discredited. Or to be more accurate, the idea of a general-purpose optical processor, the equivalent of today's electronic microprocessor, is all but forgotten about. Research into optical computing continues but mainly for niche applications, frequently connected with image processing, rather than in the aim of producing something which will power the next generation of PCs. The difficulty in producing an optical computer lies in the difficulty of devising an optical switch, the optical equivalent of a transistor. Certainly it's possible, indeed it's trivial, to come up with an electro-optical switch in which an electrical signals switches an optical beam. And whereas logic devices have been built this way, most researchers would argue that this offers few, if any, benefits over a fully electronic circuit. Scientists have also discovered crystals that exhibit non-linear properties and thereby allow one light beam to switch another light beam. The difficulty with this approach, though, is that the switching beam has to be generated by a high power laser. This is not energy efficient and heat dissipation is a major problem.

Let me now introduce you to the CyberDyne Computer Corporation of St. George, Utah and their photonic transistor, the rights to which had been acquired from the Rocky Mountain Research Center. In the next paragraph I'll say something about how the photonic transistor is supposed to work and what it could offer the world of computing. Before I do that, though, I really need to sound a note of caution concerning this. Personally, I can't quite make out CyberDyne. I first came across their Web site, and that of the Rocky Mountain Research Center, over two years ago. The claims are impressive, patents applications have been filed, and there's talk of developing a fully operational photonic computer in the near future. Yet as of today, the Web sites are still there, but the information is little changed, despite the photonic transistor dating back to 1989, and the photonic computer is no closer. Furthermore, I can find no other respected authority on optical computing who even makes mention of the concept. So are these guys mad or are they brilliant? And if they're brilliant, why has nobody else taken notice? I'll leave that for you to ponder as we take a look at the photonic transistor, a concept which, I have to admit, begs the question "if it's so simple why did nobody do it before and why are we not all using it in our PCs?".

First of all the rhetoric. Photonic transistors are capable of switching a beam of light in 30 femtoseconds, that's 30 millionths of a nano-second compared to a one nano-second switching of a 1GHz processor. The company believes that a one femtosecond switching speed would, ultimately, be achievable. To quote CyberDyne "The light used to turn these transistors on and off is produced by tiny lasers that operate at very low energy levels, producing considerably less heat than electronic transistors. Furthermore the transistors are made from glass or plastic holograms so, compared to non-linear crystals, they are cheap to manufacture. These transistors can be arrayed to mimic electronic functions to produce data processors, memories, video displays, telephone fibre optic switches or any other electronic-like product."

But how does a photonic transistor actually work? It's all to do with interference

Figure 1.

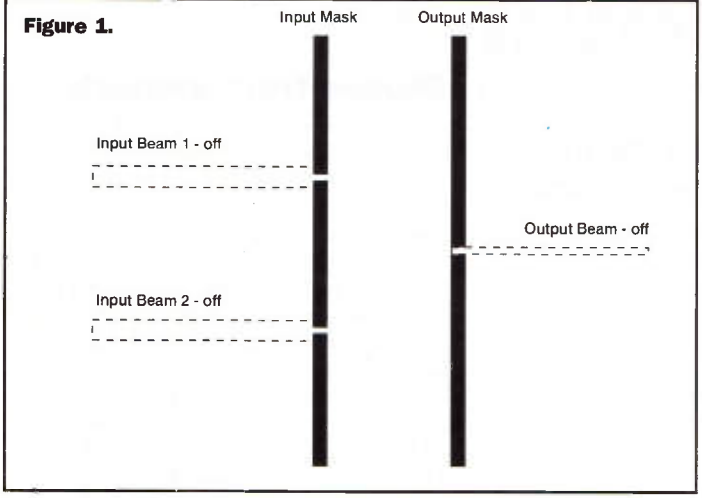


Figure 2.

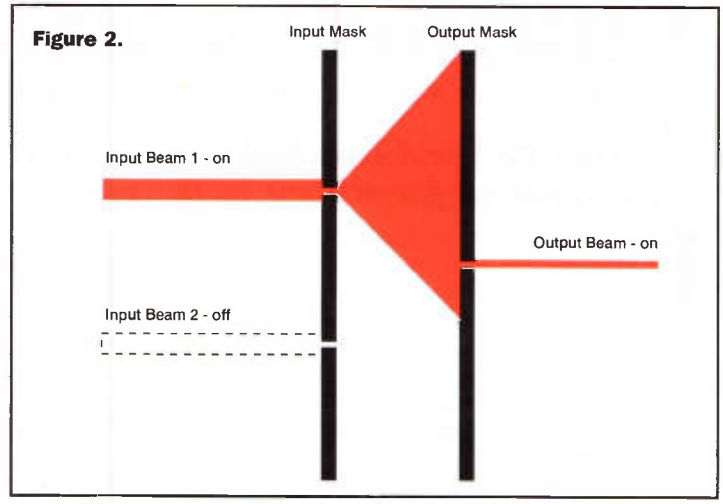


Figure 3.

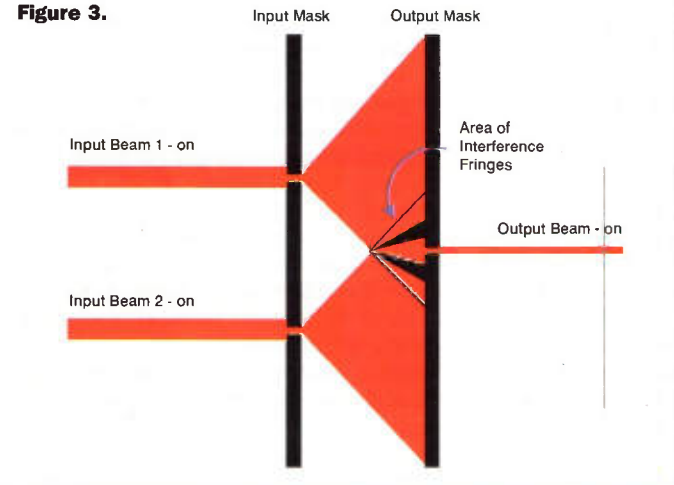
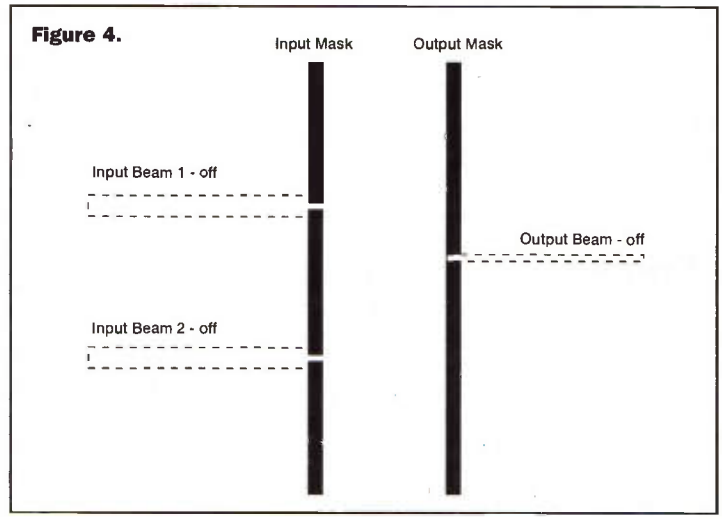
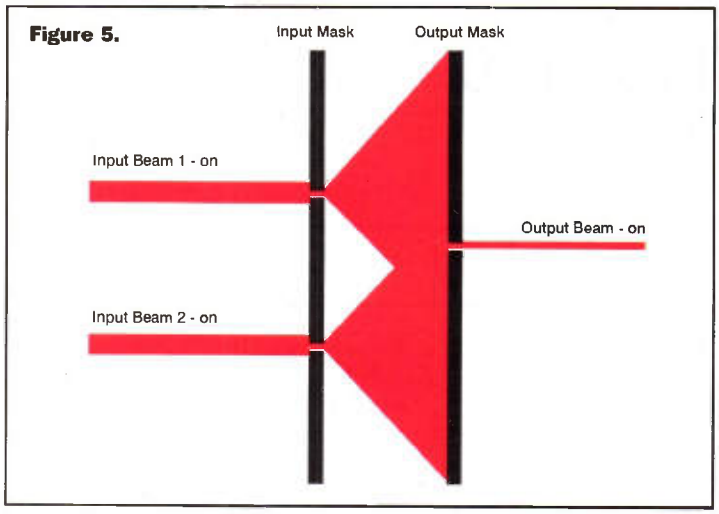
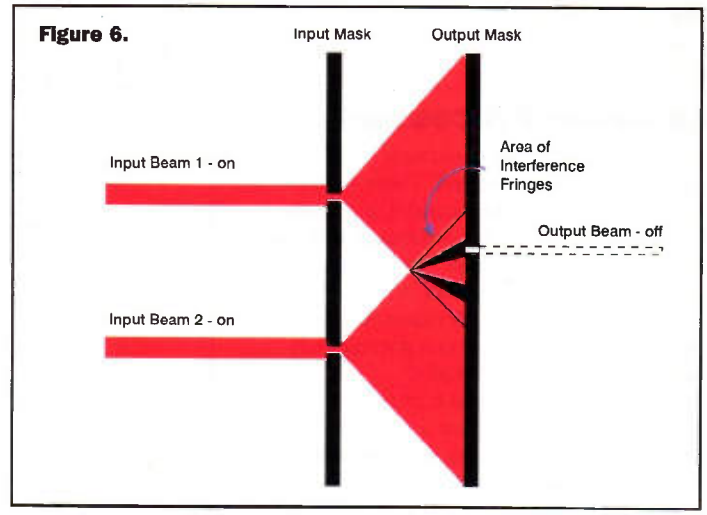


Figure 4.







fringes like the ones we had demonstrated in school physics lessons by the well-known Young's Fringes experiment. If you shine two beams of monochromatic light, derived from the same source using a pair of slits, onto a flat surface, the two beams will interfere to produce alternating light and dark fringes. The light bands are produced by constructive interference (i.e. where the two beams are in phase) and the dark bands by destructive interference (i.e. where they are out of phase). With that bit of background behind us, let's take a look at Figures 1, 2 and 3 which are of a photonic transistor which mimics an OR gate. Note that the phrase "photonic transistor" is really something of a misnomer. Rather than this being just a transistor it's actually a logic gate and other variants of the photonic transistor exhibit different logic functions as we'll see.

In Figure 1, we see what happens when neither of the input laser beams is on. The output mask receives no illumination so no output emerges from the back of the mask. In Figure 2 just one of the input beams is on. The output mask is illuminated uniformly and so light passes through the slit to produce an output beam. Clearly if we were to arrange for the other input beam to be the only one which was on then we would still get an output. In Figure 3 both input beams are on and, as with Young's experiment, the output mask is illuminated with alternate light and dark interference fringes. However, the slit in the output mask corresponds to an area of constructive interference so light passes through and we have an output beam. To summarise, therefore, we get an output if either or both of the input beams are on but not when both are off. This is the operation of an OR-gate. It doesn't require a large change to turn this OR gate into an XOR-gate, that is an exclusive OR gate. In fact, the only change is to the position of the slit in the output mask. Figures 4, 5 and 6 show the photonic XOR-gate with no inputs, one input beam on and two input beams on respectively. The operation with no input beams and one input beams is the same as that of the OR-gate. However, since the slit in the output mask is now in an area of destructive interference, no output is produced when both input beams are on. The end result is that we get an output if one but not both of the input beams is on - this is the exclusive OR function. Using exactly the same configuration but having one of the input beams turned permanently on, we end up with a single input device which, in fact, operates as an inverter. XOR-gates alone are sufficient to build any logic function so this clearly lays the foundation of a universal computing device.

The Travelling Salesman

In an age when we're told that computers can do just about anything if we can make them fast enough, it's a sobering thought that some problems are officially non-computable. Examples of traditionally non-computable problems are "Does God exist?" and "Will lightning ever strike at National Grid Reference SD0125497537?" And it's not only problems like this, which common sense tells us can't be answered by computer, that are problematic. For example, Alan Turning, one of the fathers of computing, proved that it's impossible to write a computer program to determine whether another computer program will ever terminate with a given set of input data. But there's another class of problem which, despite the fact that we can easily devise an algorithm to solve it, in the general case it's not a practical proposition to do so. A classic example is the travelling salesman problem - let's take a look.

The travelling salesman problem asks the following question. "Which is the shortest route between a number of named cities?". In some cases, and with comparatively few cities, for example London, Glasgow, Aberdeen, Manchester, then the answer is obvious - London - Manchester - Glasgow - Aberdeen. In the general case, though, it isn't. Take a look at Figure 7 and I think you'll agree that it's not immediately obvious which sequence you should visit these cities to achieve the shortest round trip. Nobody has managed to come up with a solution other than the obvious one of adding up the total distance for each of the permutations and taking the lowest total. The snag, though, is that the number of permutations can be quite large and that it increases rapidly as the number of cities increases. For the example given in Figure 7 there are no less than 362,8800 possible routes and if we increase the number of cities to, say, 15, the number of possible routes is a touch over 87 billion. Now let's assume that we can evaluate one million routes per second. It would take 24 hours to come up with the answer. OK, that's a long time but if it saves a day every time your army of salespeople go on a sales trip I guess it's worthwhile so let's say that it's feasible to computer an answer to the problem. However, let's now assume that it becomes necessary to visit one more city, the number of permutations, and hence the computing time needed, increases by a factor of 15 to a couple of weeks and adding yet another city would increase it to 32 weeks. If we add another city we'd be talking of 11 years. Clearly processors will continue to get faster but, even if we don't encounter that brick wall we talked about last month, they're only doubling in speed every two years. In other words, the increase in processor speed will never allow us to cope with more than, say, 20 cities at the most. We know how to solve the problem but, in the general case, it's not feasible to do so. To stand a chance of solving problems like this, therefore, we

Figure. 7

need a completely new type of computer. One such computer is based on the principle of quantum processing.

Quantum Processors

OK, let's start off with a warning - this stuff is weird, very weird indeed. There's a good chance you won't understand it, in fact to be honest I don't really understand it. We're in good company, though. Nobel prize winning physicist Niels Bhor once commented, "anyone who can contemplate quantum mechanics without getting dizzy hasn't properly understood it". Nevertheless, understand it or not, hopefully I'll communicate something of this fascinating, albeit incomprehensible, field and give you a feel for the phenomenally powerful computers which could utilise quantum mechanics.

We've already mentioned Young's fringes as part of our discussion of the photonic transistor. Another famous experiment used much the same set-up except that the light source emitted just a single photon at a time. Viewing this classically we'd have to assume that each photon goes through one slit or the other and, accordingly, that interference fringes would not occur. The strange fact is, though, that Young's fringes still do occur which would seem to suggest that each photon actually passes through both slits and is therefore in two places at once. This strange property of being in two places at once or in two different states at the same time is the quantum mechanical property known as superposition. And whereas superposition is totally counter-intuitive, basically because it doesn't occur with a significant probability for large objects, is perfectly natural if we concern ourselves only with fundamental particles such as single photons or electrons.

Now let's assume, for the moment, that we can build a computer which operates on particles which can be superimposed. In one state this particle will represent a zero, in its other state a one, and when it's in a superposition it represents both zero and one together. These quantum mechanical bits are referred to as qubits. Now if a single qubit can store two different values at once, then a qubyte can store 256 values at once (see figure 8.)and a register of 16 qubits can store 65,536 values at the same time. Not only that but if it can store 65,536 values at once then it may be feasible for it to perform some calculation on all 65,536 values in the time it would normally take to carry out a calculation on a single value. This phenomenon is referred to a quantum parallelism and is demonstrably more powerful than conventional parallelism. Because the degree of parallelism increases exponentially with the size of the quantum computer rather than linearly, problems which increase in complexity exponentially, like the travelling salesman problem, suddenly become computationally feasible after all. Sounds amazing, and so it is. Unfortunately, a practical quantum computer is a long way from reality as there are some very significant hurdles to be overcome.

The first difficulty is the one of obtaining the result of a massively parallel quantum

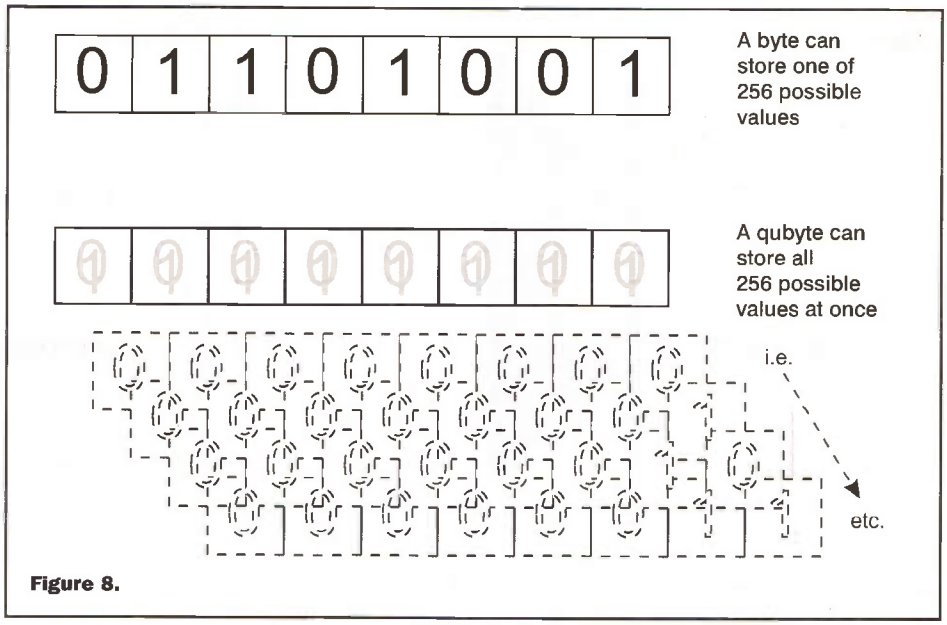


Figure 8.

computation. The result of reading something that is superimposed causes the superposition to be destroyed. So although a quantum computer might actually carry out a huge number of calculations at once, as soon as you try to read out a result the superposition will collapse that is all the superimposed qubits will become either ones or zeros, not both. So you'll only actually end up with s single result. But not only will the result collapse to a single value, if you then try to read the value in the input register you'll find that this has also collapsed to a single value - the value corresponding to the result read out - so it will appear that the computation has only been carried out on a single value. This is due to as bizarre sounding effect called entanglement. I won't even attempt to describe how this problem is overcome - suffice it to say that it requires a very convoluted way of thinking to devise algorithms for quantum computers. And the second problem is the physical one of how to build a quantum computer - a problem that becomes increasingly difficult as the number of qubits increases. The snag is, apparently, that just as deliberately reading the data in a register of qubits destroys the superposition, unintentional interaction with the outside world can also produce decoherence as it's called. Qubits can all too easily give up their information so destroying the superposition. Furthermore, the likelihood of this happening increase with the complexity of the computer and with the number of operations carried out. So far about 100 logic operations have been carried out on two qubits and ten operations on seven qubits. Estimates are that a computer which could do useful computations on ten qubits is ten years away and one which can operate on one hundred qubits (carrying out more operations in an instant than there are atoms in the known universe) is 100 years away.

DNA Computing

The reason that a quantum computer is so powerful is that the number of computations it can do in a given time rises exponentially rather than linearly with the size of the hardware. With all conventional computers the power increases linearly with the amount of hardware which is why the traditional approach will never keep up with

Figure 9.

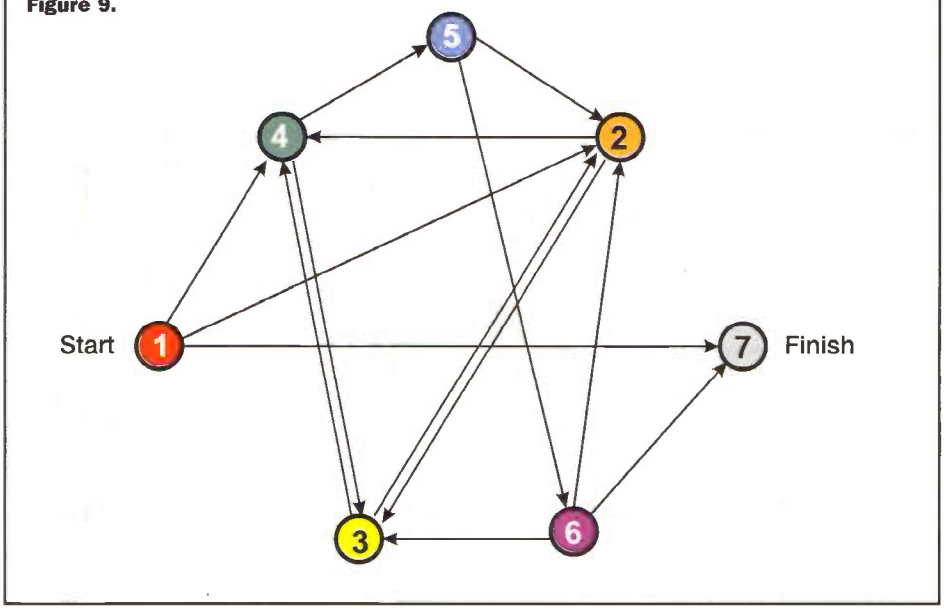


Figure 9.

problems like the travelling salesman which require an amount of number crunching which rises exponentially with the size of the problem. Our final possible model for future computing is a massively parallel one but one for which, unlike the quantum computer, the power is directly proportional to the amount of hardware. However, since it's so easy with this technique to have a vast number of processing elements, a vast amount of work can be done at once. Even this approach will eventually run out of steam on computationally unfeasible problems like the travelling salesman but the point at which this happens will be far beyond the point at which a standard electronic computer runs out of steam. What I'm talking about is a DNA computer, one that operates by carrying out chemical reactions.

The first problem to have been solved in the test tube is the Hamiltonian Path problem, one which, like the travelling salesman problem, has an exponential relationship between the size of the problem and the number of computations need to get an answer. This problem is to determine a route, if one exists, between a number of cities, visiting each one of them once and only once. The problem specifies the starting and finishing cities and what paths - together with the permissible direction of travel - existing between the various cities. The version of the Hamiltonian Path problem chosen by Leonard Adleman of the University of Southern California, who first demonstrated the technique of DNA computing, had seven cities and 13 paths. It is shown in Figure 9.

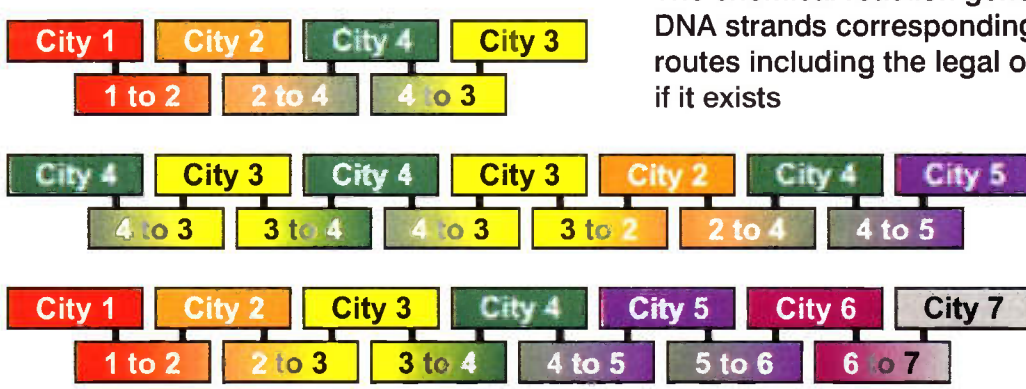
Adleman's experiment made use of DNA molecules. DNA is a very large molecule which is, in fact, a string of basic building block called bases. There are, in fact, just four different bases - adenine (A), thymine (T), guanine (G) and cytosine (C) - but because DNAs contain so many of them, the number of possible permutations is huge.

The other thing we need to know is that strands on DNA link up to form the familiar double helix if, and only if, the sequences of bases allows it. Specifically A will link with T (the complimentary base to A) and G with C (the complimentary base to G). So, for example, the DNA strand defined by the sequence CAGT will link with GTCA but with no other strand. So, back to the Hamiltonian Path problem - each city was represented by a strand of DNA 20 bases long. The sequences were chosen pretty much at random, in fact, so long as they're unique and they won't link up with each other, it really doesn't matter what sequences are used. Paths between the cities were also represented by DNA strands. The strands were also 20 bases long but, unlike the cities, they were not random. Instead these 20 bases correspond to the complements of the two cities joined by the path in question up to the half-way point. If this verbal description is confusing, Figure 9 should help. The experimental procedure involved allowing a few grams of the DNA strands corresponding to each of the seven cities to react with a few grams of the DNA strands corresponding to the 13 paths. Since even a few grams contains millions of molecules, the result will be a mixture of DNA sequences corresponding to all possible routes as shown in Figure 10.

This reaction occurs in a matter of a second or so - a long time in computing terms but not when we consider how many routes have been tried out. Clearly not all the routes which have been tried out, and hence for which DNA sequences have been produced, will be valid answers. Some will start or end at the wrong city, some will miss out some of the cities, and some will visit cities more than once. So the next stage of the process is to sift out the legal ones. This is carried out by performing further chemical reactions. So, for example, the first reaction might be to extract all those DNAs which start and end with the correct cities. The next might be to extract from those that remained, all those which pass through seven cities. And the final step may be to extract from those DNA sequences the ones which have no duplicated cities. If anything is left at the end of the sifting process, it's the DNA sequence corresponding to the answer. So finally, the order of the bases, and hence of the cities, is determined by the usual methods of chemical analysis. Ironically, in view of the fact that the actual calculation took only a second, Adleman took about a week to perform the subsequent sifting out and analysis of the final DNA sequence to obtain the correct answer. That result is, in fact, the order in which I numbered the cities in the illustration of the problem. This is early days, admittedly, but clearly DNA computers have shown their potential.

Optical, Quantum or Molecular?

So we've seen three possible methods of computing, all very different from electronic computing and all with vast potential. But which of these technologies is likely to give us the computer of 2050? At the moment I'd have to say it's anyone's guess. In fact, despite the potential roadblocks to the further development of silicon chips, I don't believe we can rule out electronic computers either. Perhaps the spinach computer might come to the rescue here. Also I'd have to say that optical, quantum and molecular technologies probably aren't the only options which might be dreamed up before silicon comes to the end of the line. So in marked contrast to the rather downbeat way in which we concluded last month's article on the future of Moore's Law, I believe we have every reason to conclude this article on an upbeat note. Perhaps your dreams of even faster computers beyond 2015 may not be over-optimistic after all.



The chemical reaction generates DNA strands corresponding to all routes including the legal one if it exists

Figure 10.

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.

August 2000

28 Aug. Computer Fair, Boumemouth International Centre, Boumemouth. Tel: (01342) 718 699.

September 2000

3 to 5 Sept. European Computer Trade Show (ECTS), Olympia, London. Tel: (0208) 742 2828.

10 to 13 Sept. PLASA - Light & Sound Trade Show, Earls Court, London. Tel: (0207) 244 6433.

13 to 14 Sept. OnBoard - Electronics Assembly Exhibition, Olympia, London. Tel: (01799) 528 292.

13 to 14 Sept. ECIF - Electronic Components Industries Fair, Olympia, London. Tel: (01799) 528 292.

17 Sept. National Vintage Communications Fair, NEC, Birmingham. Tel: (01392) 411 565.

19 to 20 Sept. Call Centre Expo, NEC, Birmingham, Miller Freeman. Tel: (0208) 742 2828.

21 to 24 Sept. Live - Consumer Electronics Show, Earls Court, London. Tel: (0208) 742 2828.

22 to 23 Sept. Leicester Amateur Radio Show, Donington Exhibition Centre, Derby. Tel: (01455) 823 344.

26 to 27 Sept. Business Systems Show G-MEX Centre, Manchester. Tel: (07000) 464 336.

26 to 28 Sept. GIS - Geographic Information Systems Exhibition, Earls Court, London. Tel: (0208) 742 2828.

27 to 28 Sept. Communications for Business, Barbican Centre, London. Tel: 01923 676 867.

October 2000

3 to 5 Oct. Coil Winding 2000, NEC, Birmingham. Tel: (0207) 417 7400.

4 to 5 Oct. Softworld Accounting & Finance, NEC, Birmingham. Tel: (0208) 541 5040.

9 to 11 Oct. TMA33 - Telecommunications Managers Association Exhibition, Stakis, Metropole, Brighton. Tel: (01372) 361 000.

11 to 12 Oct. SIT - Small Business IT Show, Boumemouth International Centre. Tel: (01934) 420 365.

11 to 12 Oct. TEST - Electronic Testing Exhibition, NEC, Birmingham. Tel: (02476) 230 333.

11 to 12 Oct. Webmaster - Web & Internet Show Olympia, London. Tel: (01256) 384 000.

11 to 12 Oct. JAVA - Computer Software Trade Exhibition & Conference, Olympia, London. Tel: (01256) 384 000.

17 to 18 Oct. Property Computer Show, Barbican Centre, London. 01273 836 800.

18 to 19 Oct. PHOTONEX/FIBRE EXHIBITION, NAC, Stoneleigh, Coventry. 01932 866 766.

25 to 26 Oct. Accounting IT, Business Design Centre, London. Tel: (0207) 221 1155.

24 to 25 Oct. OSPMA FieldComms - Industrial Networking Show, Telford International Centre. Tel: (0207) 417 7400.

31 Oct to 2 Nov. Voice Europe Olympia, London. Tel: (01244) 378 888.

Please send details of events for inclusion in 'Diary Dates' to: News Editor, *Electronics and Beyond*, P.O. Box 777, Rayleigh, Essex SS6 8LU or e-mail to swaddington@cix.compulink.co.uk.

What's On?

Internet Insiders Give 'Thumbs Down' to Government's Commitment to UK.com

According to a survey undertaken by Internet World UK 2000, 93% of e-movers and shakers don't think the Government is communicating effectively with British business on e-commerce.

Leading dot.coms have given a resounding 'thumbs down' to the British Government's recent record on UK.com at Internet World, Earls Court, London in May.

Tony Blair pledged last year to make the UK "the best place to trade electronically by 2002", but according to industry leaders in the new economy, only 7% of respondents think that the e-commerce minister, Patricia Hewitt, is doing an effective job.

The survey results make uncomfortable reading for anyone involved in the development of a potentially world-beating UK.com. Only 15% of respondents think that the UK government is helping the country to keep pace with the dynamic world of e-commerce.

Given the swiftness of the digital economy, any delay means that the UK is falling further and further behind the US and other 'e-savvy' nations each day. The concern of these business leaders is not that the Internet economy won't take off - it will - but that UK companies will be left behind and may never recover.

35% of respondents said that they thought Richard Branson would make a better e-envoy than the incumbent, Alex Allen. In fact, only one fifth of those surveyed knew who the e-envoy was, which is a worrying statistic given that Allen's primary role is to encourage British businesses to get online.

For further details, check: <www.internetworld.co.uk>.

Contact: Internet World, Tel: (0870) 7511 472.

Apple Previews QuickTime and Mac OS X at Developers Conference

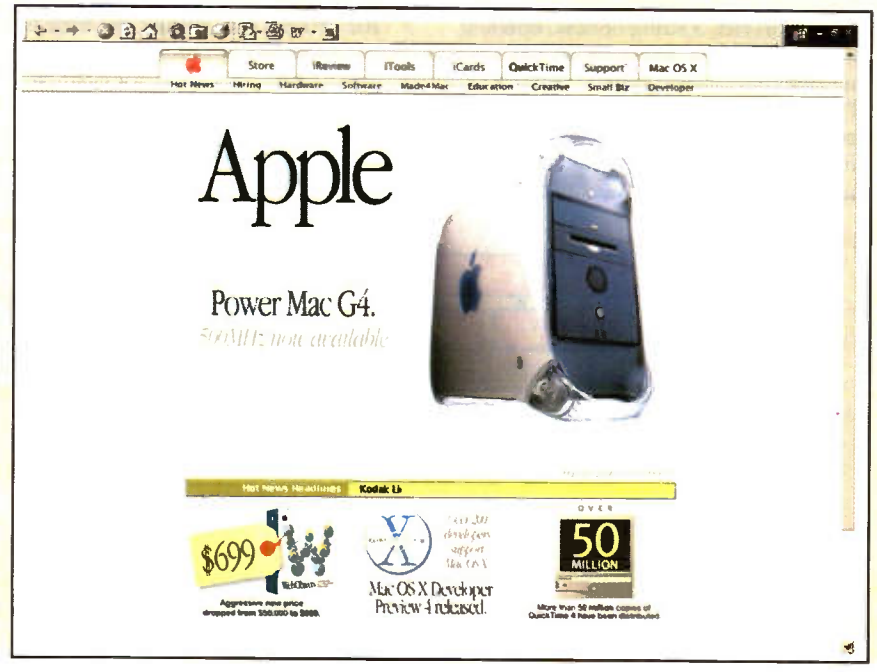
Apple gave developers at the Apple Worldwide Developers Conference in May a sneak preview of its next version of QuickTime.

Apple also released its fourth developer preview of Mac OS X to the 4,000 developers attending its annual Worldwide Developer Conference.

This preview version of Apple's next generation operating system includes the final API specifications required by developers to complete upgrades of their applications to take full advantage of Mac OS X's new capabilities. Mac OS X Developer Preview 4 also includes a version of Microsoft's Internet Explorer 5 specifically for Mac OS X, and support for the Java 2 Platform.

The new version of QuickTime, which will be available this summer and includes cross-platform support for MPEG-1 and MPEG-2, Flash 4 for Web animation, and an enhanced QuickTime VR playback function providing unlimited spherical views of virtual-reality scenes.

The new version of QuickTime will also feature QDesign software that has been optimised to take



advantage of the Power Mac G4's Velocity Engine to encode music up to three times faster.

Apple's QuickTime 4 player for Macintosh and Windows users is available as a free download from **<www.apple.com/quicktime>**.

Mac OS X supports the Java 2 Platform, Standard Edition (J2SE) featuring the HotSpot client virtual machine. Mac OS X, a completely new implementation of the Macintosh operating system, will be the only high-volume personal computer operating system with out-of-the-box Java 2 integration. Java applications running on Mac OS X will realise the benefits of the Aqua user interface, a major advancement in personal computer user interfaces.

A public beta of Mac OS X will be available this summer enabling customers to experience Apple's next generation operating system firsthand. The final version 1.0 of Mac OS X will be available in January 2001. Mac OS X is designed to run on all Macintosh computers using PowerPC G3 and G4 processor chips, and requires a minimum of 64MB of memory.

For further details, check: **<www.apple.com>**.

Contact: Apple, Tel: (020) 8218 1000.

SPACE.com Chairman Keynotes at 37th Space Congress

SPACE.com Chairman and CEO Lou Dobbs delivered the keynote address at the 37th Space Congress on in May at Cape Canaveral, Florida.

"Space is the biggest story of our age and one of the largest emerging markets of our time, offering unlimited commercial opportunities, from satellite technology to space tourism," said Dobbs.

"SPACE.com's primary mission is to popularise space, we are proud to support the aerospace business community and I'm delighted to have the opportunity to open the 37th Space Congress," added Dobbs.

SPACE.com at **<www.space.com>** is the definitive space site on the Web, offering the richest and most compelling content, featuring news, information, education, entertainment, science fiction and games.

For further details, check: **<www.space.com>**.

Contact: SPACE.com, Tel: +1 212 703 5800.

Electronic Communications Bill Receives Royal Assent

The Government's commitment to making the UK the best place in the world for e-commerce hobbled forward last month, when the Electronic Communications Bill received Royal Assent.

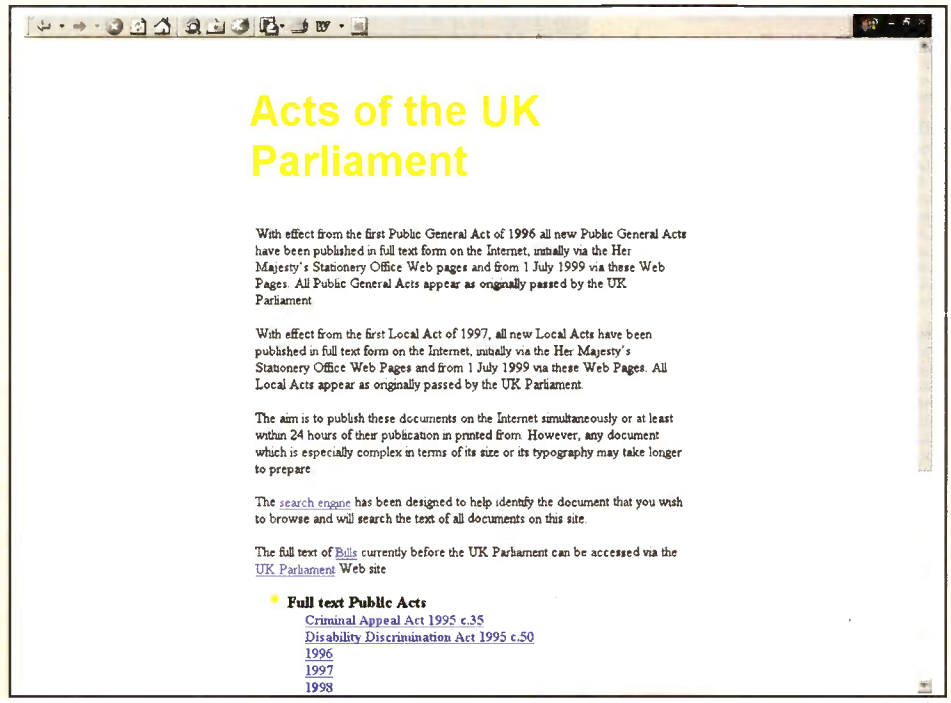
E-Minister, Patricia Hewitt said, "This Government is determined to make the UK the best place in the world for e-commerce. To realise this vision, we need a modern, flexible market framework, confident consumers and businesses, and a government that leads the way. The Electronic Communications Act is a significant step towards achieving all of these.

"This new legislation will create confidence in doing business electronically, giving legal certainty to electronic signatures and encouraging the development of secure and trusted e-commerce services. The Act gives us powers to sweep away obstacles in existing laws, which insist on the use of pen and paper, giving people the electronic option wherever possible. This will lead to major changes in the way Government delivers its services to citizens and businesses," added Hewitt.

Cabinet Office Minister, Ian McCartney said, "The Electronic Communications Act is a fundamental element of the Modernising Government programme. We have already launched initiatives to make the UK a world leader in e-commerce and to make information technology available to all. This Act is an important instrument for progress towards the target of making all Government's services available electronically by 2005, ensuring that we play a full part in the digital revolution."

For further details, check: **<www.uklegislation.hmso.gov.uk/acts.htm>** or **<www.dit.gov.uk>**.

Contact: DTI, Tel: (020) 7215 5000.



Project Ratings

Projects presented in this issue are rated on a 1 to 5 for ease or difficulty of construction to help you decide whether it is within your construction capabilities before you undertake the project. The ratings are as follows:

Simple to build and understand and suitable for absolute beginners. Basic of tools required (e.g., soldering, side cutters, pliers, wire strippers, and screwdriver). Test gear not required and no setting-up needed.

Easy to build, but not suitable for absolute beginners. Some test gear (e.g. multimeter) may be required, and may also need setting-up or testing.

Average. Some skill in construction or more extensive setting-up required.

Advanced. Fairly high level of skill in construction, specialised test gear or setting-up may be required.

Complex. High level of skill in construction, specialised test gear may be required. Construction may involve complex wiring. Recommended for skilled constructors only.

Ordering Information

Kits, components and products stocked at Maplin can be easily obtained in a number of ways:

● Visit your local Maplin store, where you will find a wide range of electronic products. If you do not know where your nearest store is, telephone (01702) 554002. To avoid disappointment when intending to purchase products from a Maplin store, customers are advised to check availability before travelling any distance; ● Write your order on the form printed in this issue and send it to Maplin Electronics PLC, P.O. Box 777, Rayleigh, Essex, SS6 8LU. Payment can be made using Cheque, Postal Order, or Credit Card; ● Telephone your order. call the Maplin Electronics Credit Card Hotline on (01702) 554000; ● If you have a personal computer equipped with a MODEM, dial up Maplin's 24-hour on-line database and ordering service, CashTel. CashTel supports 300-, 1200- and 2400-baud MODEMs using CCITT tones. The format is 8 data bits, 1 stop bit, no parity, full duplex with Xon/Xoff handshaking. All existing customers with a Maplin customer number can access the system by simply dialling (01702) 552941. If you do not have a customer number, telephone (01702) 554002 and we will happily issue you with one. Payment can be made by credit card; ● If you have a tone dial (DTMF) telephone or a pocket tone dialler, you can access our computer system and place your orders directly onto the Maplin computer 24 hours a day by simply dialling (01702) 556751. You will need a Maplin customer number and a personal identification number (PIN) to access the system; ● Overseas customers can place orders through Maplin Export, P.O. Box 777, Rayleigh, Essex SS6 8LU, England; telephone +44 1702 554000 Ext. 376, 327 or 351; Fax +44 1702 554001. Full details of all the methods of ordering from Maplin can be found in the current Maplin Catalogue.

Internet

You can contact Maplin Electronics via e-mail at **<recipient>@maplin.co.uk** or visit the Maplin web site at **http://www.maplin.co.uk**.

Prices

Prices of products and services available from Maplin shown in this issue, include VAT at 17·5% (except items marked NV which are rated at 0%). Prices are valid until 4th August 2000 (errors and omissions excluded). Prices shown do not include mail order postage and handling charges. Please add £2.95 to all UK orders under £30.00. Orders over £30.00 and MPS Account Holding customers are exempt from carriage charges.

Technical Enquires

If you have a technical enquiry relating to Maplin projects, components and products featured in *Electronics and Beyond*, the Technical Service Dept. may be able to help. You can obtain help in several ways, ● Over the phone, telephone 0906 550 1353 between 9.00am and 5.30pm Monday to Saturday, except public holidays (calls charged at £1/min BT rates); ● By sending a facsimile, Fax (01702) 554001; ● Or by writing to Technical Services, Maplin Electronics PLC., P.O. Box 777, Rayleigh, Essex, SS6 8LU. Don't forget to include a stamped self-addressed envelope if you want a written reply! Technical Services are unable to answer enquires relating to third-party products or components which are not stocked by Maplin.

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A kit building service is on offer for any of our kits. Please contact our customer service department for any pricing details.

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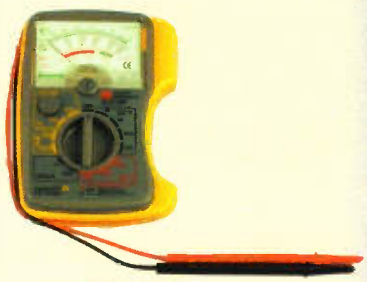

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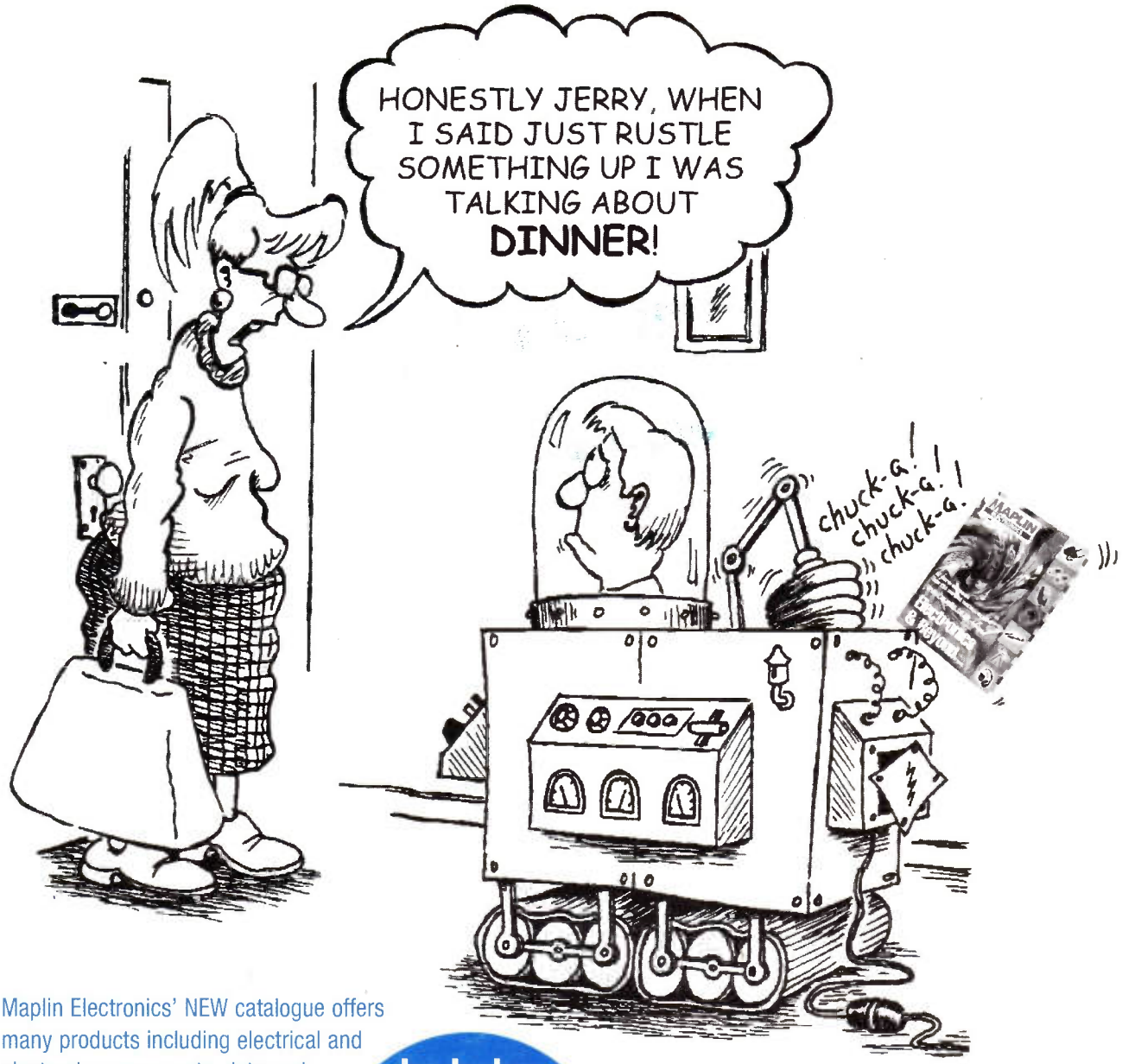

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