ELECTRONICS and Beyond

http://www.maplin.co.uk

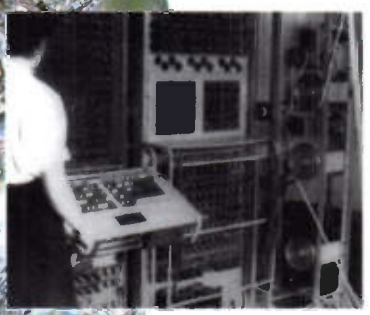
NOVEMBER 1999 NO. 143 £2.65

9 771363 638094 43

MAPLIN ELECTRONICS

Internet Fraud
How big is the problem?

Code Making & Code Breaking
The history unfolds



On the Move with Video Telephony

MPEG Standards
The full Story

Art & Technology
Aesthetics meets the Functional

PROJECTS FOR YOU TO MAKE

- Simple Valve Line Amplifier
- 8-Channel Logic Analyser
- Music Controlled Running Light
- Guitar Effects Unit

Britain's most widely circulated magazine for electronics!

By subscribing to Electronics and Beyond

ye shall

*Receive your first 2 issues free**

** on a 12 month subscription*

Save 10% on the normal cover price

Participate in monthly offers open only to subscribers!

Call the Subscription Hotline now on

01702 554000

6 MONTHS - £14.10
UK SUBSCRIPTION
ELECTRONICS and Beyond
12 MONTHS - £28.20

The Maplin Magazine

THE MAPLIN MAGAZINE

ELECTRONICS and Beyond

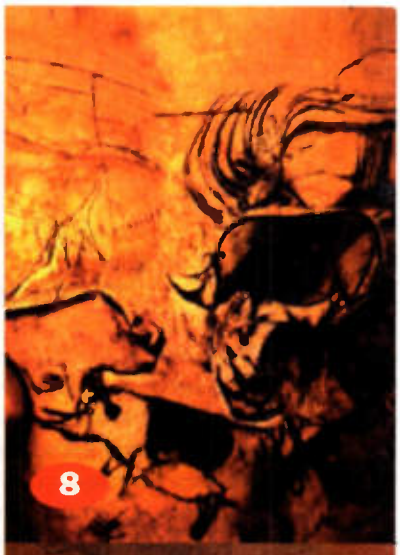
November 1999 Vol. 18 No. 143

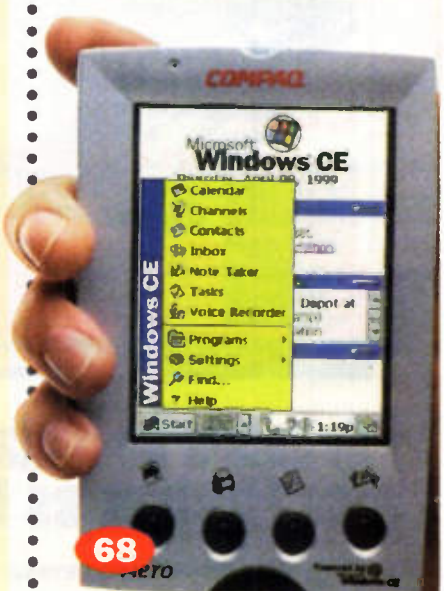
Projects

Features

Regulars

Cover pictures: ©Copyright 1999 Maplin Electronics PLC. All rights reserved. Main cover picture courtesy NASA STSCI.





Editorial
Editor Paul Freeman-Sear BSc (Hons)
Technical Author John Mosely
Editorial Assistant Lynda Hardy
News Editor Stephen Waddington BEng (Hons)
Technical Illustration Set Square Designs

Production
Design Layout Artists Karen Harris, Jason Hyatt
Published by Maplin Electronics plc.,
P.O. Box 777, Rayleigh, Essex, SS6 8LU.
Tel: (01702) 554155.
Fax: (01702) 554001.
Lithographic Reproduction by Planagraphic Studios,
18 Sirdar Road, Brook Road Ind. Estate, Rayleigh, Essex SS6 7UY.
Printed by St Ives (Gillingham) Ltd.,
Grant Close, Gillingham, Kent. ME8 0QB.

Management
Manager
Paul Freeman-Sear BSc (Hons)
Marketing Services Manager
Steve Drake

Subscriptions
Maureen Harvey
Tel: (01702) 554155 Ext. 311.

Advertising and Circulation
Maplin Electronics plc.,
P.O. Box 777, Rayleigh, Essex, SS6 8LU. Tel: (01702) 554155.
Fax: (01702) 554001.

UK Newstrade Distribution
Maplin Electronics PLC.

Export Distribution
Comag Magazine Marketing
Tavistock Road, West Drayton, Middx, UB7 7QE

ELECTRONICS and Beyond

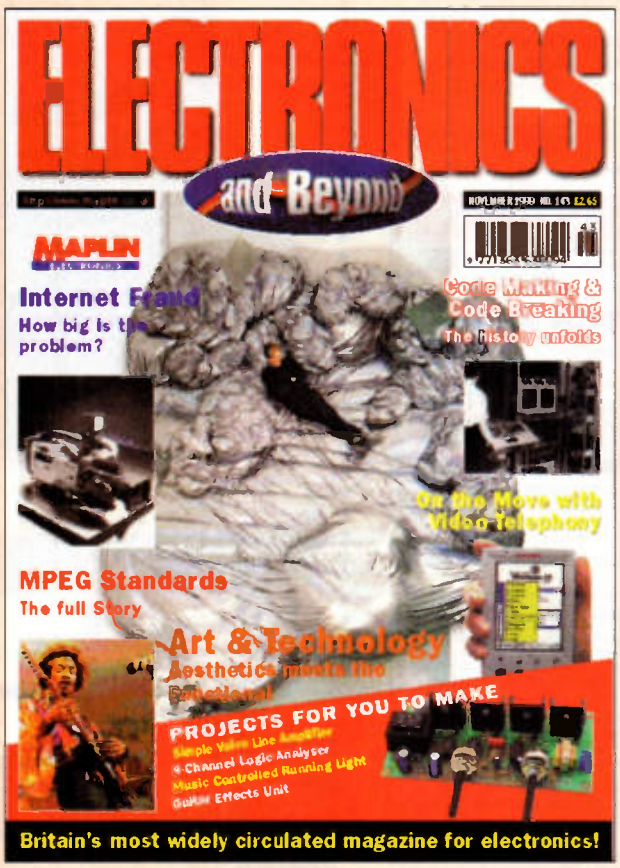
As the use of the Internet for purchasing goods and services increases, so too does the amount of Internet fraud. Crimes on the Internet range from homepage vandalism to online bank robbery. Electronic theft, such as breaking into bank accounts and generating fake credit card numbers, is cited as by far the most widespread type of cybercrime. Michelle Grieg looks at the extent of Internet and computer fraud and discusses ways to tackle this rapidly increasing problem.

Regular users of the Internet (and computer users in general) will be familiar with the terms MPEG and JPEG, but may not have a true understanding of how these compression systems work. Reg Miles describes the various MPEG standards in great detail in his article which starts this month.

Apologies..

Due to unforeseen circumstances we have had to hold over the second part of Car Audio Capers until next month. Sorry!

P. S. The Maplin Store at Aberdeen is now open.



Britain's Best Magazine for the Electronics Enthusiast

NEWS REPORT

Apple Invests £60 Million in Samsung

Apple has invested $60 million in Samsung to further expand Samsung's TFT-LCD flat-panel display production capacity. The investment is part of Apple's strategy to insure an adequate supply of TFT-LCD displays to meet the growing demand for Apple products.

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

Contact: Apple, Tel: (0870) 600 6010.

Dando Bullet Leaves Digital Clue

Digital evidence matching systems are helping police solve the murder of TV presenter Jill Dando. The key computer systems known as Drugfire and Integrated Ballistics Information System (IBIS) digitally record ballistics evidence collate the results and automatically match projectiles.

Examination of the case of the cartridge found at the Dando crime scene shows it to have markings on it which are unique. The cartridge has six tiny indentations, which are fairly regularly spaced around the top edge. The indentations have been made with a single tool and are hand made. They have the effect of crimping - holding the bullet head in place within the cartridge.

The Metropolitan Police believe that the bullet was not handmade, but had been tampered with. He said that a single tool had been used to make the markings at the top of the brass cartridge case. The killer's intention may have been to reduce the gun powder charge, cutting the noise of the attack.

For further details, check: <www.met.police.uk>.

Contact: Metopolitian Police, Tel: (0181) 246 0732.

Intel Ships Fastest Pentium III, Celeron Processors

Intel has introduced two new processors, the Pentium III processor 600MHz for powerful Internet and mainstream computing, and the Intel Celeron processor 500MHz for sub-£600 PCs.

The Pentium III processor 600MHz is designed to power an Internet experience filled with rich audio, video, animations and 3D graphics that makes information come alive. Whether on or off the Internet, the Pentium III processor's high performance and Internet Streaming SIMD Extensions also provide Intel's most advanced computing experience for business users as e-commerce, data visualisation, streaming audio, video and speech recognition applications become more pervasive.

With the Intel Celeron processor line, Intel continues to use its manufacturing and system design expertise to optimise the cost and capabilities of value PCs. As a result, Intel Celeron processors offer consumers leading value PC performance and a great way to get on the Internet for £600 and below.

For further details, check: <www.intel.com>.
Contact: Intel, Tel: (01793) 403000.

3D Glasses For Computing Masses

Graphics card maker ELSA, which launched its REVELATOR 3D glasses earlier this year, has now adapted them to work on any graphics card based on the latest chip sets from NVIDIA. Now, the immersive experience of playing PC games with a near iMax 3D quality is open to everyone using RIVA TNT, TNT2 or TNT2 Ultra based graphics cards.

The ELSA 3D REVELATOR use LCD shutter technology to create an entirely new spatial display in games and other 3D applications. These active 3D glasses feature control technology to enable normal PC monitors to display three-dimensional images with a holographic like quality.

For further details, check: <www.elsa.com>.
Contact: ELSA,
Tel: (0118) 965 7755.

NEWS BYTES

NoiseBuster Headset Is Number One For Speech

The NoiseBuster Multimedia Headset ranked number one amongst 15 products for speech recognition accuracy in testing conducted by Byte.com Magazine. The NoiseBuster outperformed every other product in the test including headsets from Emkay, Plantronics, Andrea Electronics, Shure, Telex, VXI, and Philips.

For further details, check: <www.nct-active.com>.
Contact: NCT,
Tel: (01954) 205502.

Palm Licenses Phone.Com's Micro-Browser

Palm Pilot is set to incorporate Phone.com's Wireless Application Protocol (WAP) micro Web browser in its next generation of Palm Pilots following a licensing deal struck between the two companies earlier this month.

For further details, check: <www.3com.com>.
Contact: 3Com,
Tel: (0118) 927 8200.

Orange Launches Virtual Personal Assistant

Orange has launched a new service called Wildfire, claimed to be the UK's first intelligent voice-activated mobile phone service. The new service can take messages, place calls and store contact details – all this by responding to voice commands.

For further details, check: <www.uk.orange.net>.
Contact: Orange,
Tel: (01246) 454339.

Removable Disk Drive Market Explodes

The computer industry's rapid growth and diversity of applications has stimulated the development of numerous types of disk drives which enable users to remove data from systems so that it can be organised by individual projects, stored in a safe place, or exchanged with others.

1999 worldwide sales revenues will top £6 billion for all types of disk drives which offer removability, with shipments of more than 260 million drives, according to the new Disk/Trend report on optical and removable disk drives.

For further details, check: <www.disktrend.com>.
Contact: Disk/Trend,
Tel: +1 650 961 6209.

NEWS BYTES

Mouse With No Wires

A cordless mouse from Logitech use radio waves to provide PC users with wireless mouse navigation. The Cordless MouseMan Wheel priced at around £100 removes the frustration with cords that catch on the edge of the desk, tangle around things while in use, and limit movement.

For further details, check: <www.logitech.com/uk>.
Contact: Logitech, (01306) 734300.

Future Of Work

A report published by the DTI's Future Unit ,'Work in the Knowledge-Driven Economy', takes a look at what work might be like in 15 years' time and concludes that for many in this generation, the world of work will be very different to that of their parents. It warns we must all prepare for change and will need new skills in the work place of the future.

For further details, check: <www.dti.gov.uk\future-unit>.
Contact: DTI, Tel: (0171) 215 5000.

Radiocommunications Agency On The Move

The Radiocommunications Agency has moved back to London Docklands. The Docklands building has undergone major renovation after it was extensively damaged in the IRA bomb blast in February 1996. The new address is: Wyndham House, 189 Marsh Wall, London E14 9SX.

For further details, check: <www.rsgb.org.uk>.
Contact: RSGB, Tel: (01707) 659015.

Sony and NASA Research High Definition for Use in Space

The Space Shuttle Columbia has touched down with its payload of high definition mission footage, taken with Sony's versatile HDCAM HDW-700A, the world's first high definition camcorder.

NASA and Sony will research this high-resolution footage of shuttle mission STS-93, including the deployment of the Chandra X-ray Observatory.

This agreement between NASA and Sony is designed to demonstrate high definition technology developed by Sony with the purpose of accomplishing a number of objectives.

These include, producing side-by-side simultaneous comparisons of HDTV and NTSC formats during Shuttle missions from which NASA can make post mission color and clarity assessments, and to provide NASA with HDTV source material for broadcast distribution which meets FCC HDTV standards.

For further details, check: <www.sonny.com/professional>.
Contact: Sony, Tel: (0990) 111999.

NEC Launches Consumer PC

Computer manufacturers have recognised that consumers don't care how fast a PC runs, they're more interested in what is looks like. Apple under the leadership of Steve Job was the first company to realise this, but now manufacturers are queuing up to bring their consumer PCs to market.

The latest comes from NEC and is called the Z1. The PC's innovative design incorporates numerous ease-of-use and ease of set-up features, which has helped it earn acclaim from the industry.

And guess what, the Z1 requires only two connections - power and telephone - to be fully operational in less than 10 minutes. Haven't we heard this kind of marketing before?

For further details, check: <www.nec-z1.com>.
Contact: NEC, Tel: (0181) 993 8111.

Wearable Air Conditioner' is Summer's Hottest Item

US scientists have created what must be the ultimate in personal comfort. The Personal Cooling System 2.0 is a lightweight aluminium collar that houses a patented, miniature evaporative-cooling system. When the weather's hot and there's no air conditioner, the invention makes the entire body feel cooler - up to 20 degrees cooler than the surrounding temperature even on the hottest days.

The Personal Cooling System, which sells in for £30 from the company's Web site and is very lightweight and easy to wear. A user can simply fill the device's two chambers with a few ounces of water, rest it comfortably and securely around her or his neck, and switch it on.

Once the Personal Cooling System is switched on the quiet motor drives a tiny fan that creates immediate evaporative cooling and a gentle breeze.

For further details, check: <www.sharpimage.com>.
Contact: Sharper Image, Tel: + 41 1 211 0147.

New Semiconductor Giant Emerges

ON Semiconductor, the new name and corporate identity of a former division of Motorola, which was acquired by Venture Capitalist Texas Pacific Group.

A focused strategy coupled with global joint ventures and a manufacturing restructuring process has positioned ON Semiconductor to maximise its success in leading the world in supplying high volume power and interface components.

ON Semiconductor has developed focused joint ventures with Leshan, China, focusing on small signal products; Roznov in the Czech Republic, focusing on supplying both raw silicon wafers and low cost analogue technologies; and Piestany, Slovakia, focusing on power TMOS and metal gate logic families.

These joint ventures complement ON Semiconductor's diverse global organisation and enhance its ability to provide faster cycle times and speed development of new products in battery management, portable and networking applications.

For further details, check: <www.onsemi.com>.
Contact: On Semiconductor, Tel: (01296) 395252.

Musical Robotics

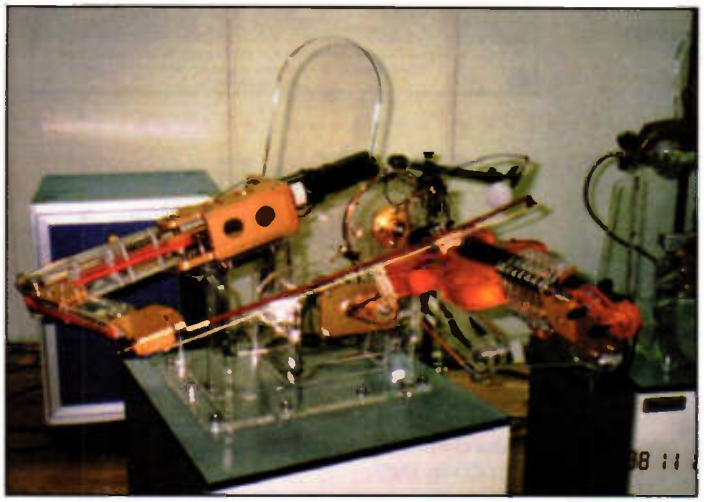
It has taken more than 20 years of hardware and software development, but scientists at the University of Electro-Communications in Tokyo, Japan have developed a group of robots that can play musical instruments. Under the leadership of Professor Makoto Kajitani, the team have developed musical robots, or MUBOTs for short that are able to play a recorder, violin or cello automatically.

The MUBOTs have performed regularly as a trio or quintet and approach an almost human-like performance. They play more than 30 pieces from the Beetles to Beethoven. Check out the University's Web site to listen to a recent performance.

But the project's real value lies in the expertise and understanding in the syncronisation of complex multi-jointed robots that Professor Kajitani's group have developed.

For further details, check: <www.kajitani.mce.uec.ac.jp/index_e.html>.

Contact: Tokyo University of Electro-Communications, Tel: + 4 24 43 5209.



IBM Announces Three Hard Drive World Records

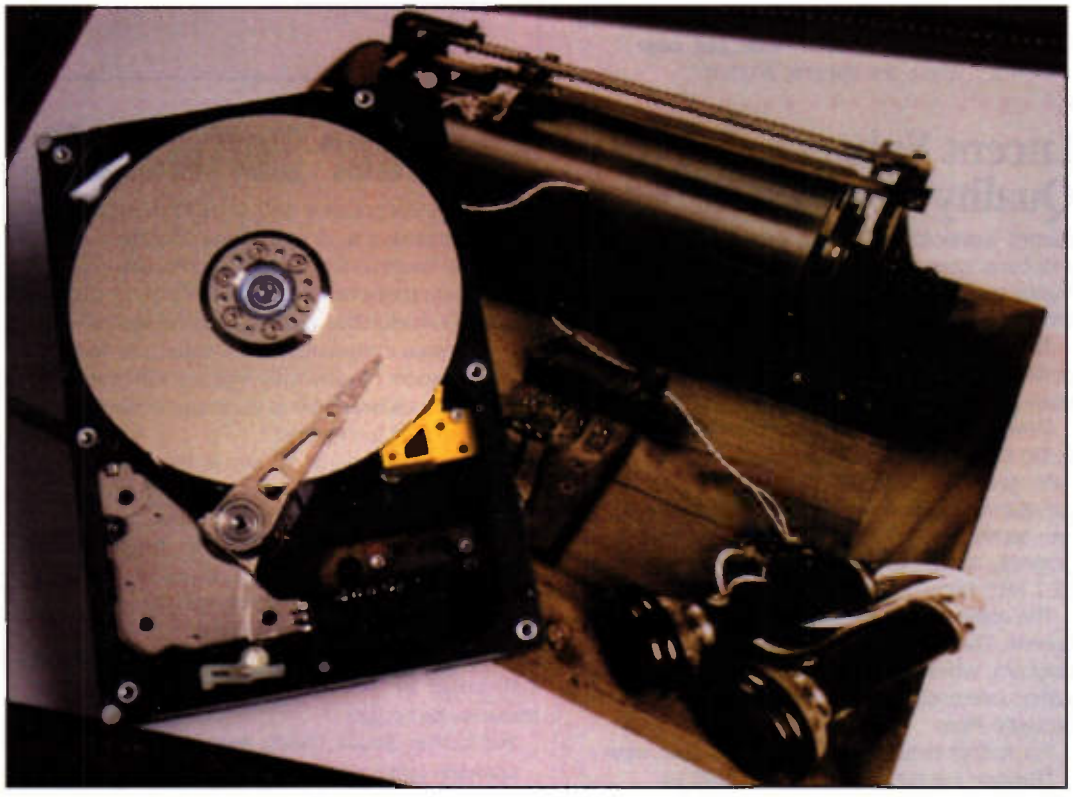
IBM has entered the record books again this month with three hard drive world records: the world's highest capacity notebook PC hard drive entitled the Travelstar 25GS; the new 12GB Travelstar 12GN for ultra-portables and an 18GB drive for mainstream notebook users.

Travelstar 25GS is designed for premium notebook PCs and holds four times as much data as the average notebook hard drive. The drive holds 25 gigabytes (GB), the equivalent of either 20 TV-quality movies, 792 feet of shelved books or seven million pages of text.

At 5,400 revolutions per minute, the new Travelstar 25GS drive has the highest rpm of any notebook PC hard drive, contributing to significantly higher performance.

For further details, check: <ww.ibm.com>.

Contact: IBM, Tel: (0990) 426426.



NEWS BYTES

European PC Industry Posts 20% Growth

Driven by strong sales in the United Kingdom and France, personal computer shipments in Europe reached 6.3 million units in the second quarter of 1999, an increase of 20% over the second quarter last year, according to Dataquest.

PC shipments in the UK grew 31% over the second quarter last year, while shipments in France were up 37% over the same period last year. The professional segment led the region as shipments reached 4.9 million units, an increase of 20.6%.

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

Contact: Dataquest, Tel: (01784) 431611.

Broadcom Delivers Single Chip Voice, Video and Data Switch

Broadcom has developed a breakthrough, wire-speed, multi-layer switch that combines switching, routing and traffic classification functionality into a single monolithic integrated circuit (IC).

The StrataSwitch chip performs the work currently required by as many as 10 separate chips, and is capable of receiving, prioritising and forwarding packets of voice, video and data at full speed over existing corporate networks.

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

Contact: Broadcom, Tel: (01709) 579770.

Broadcom Goes Custom For 3Com's NIC

Broadcom has announced that 3Com's next-generation, high-volume EtherLink XL 10/100 PCI Network Interface Card uses an advanced, custom-integrated controller from Broadcom. This device is the latest solution to be co-developed by the two companies for the Ethernet NIC and LAN-on-Motherboard (LOM) markets.

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

Contact: Broadcom, Tel: (01709) 579770.

S3 Ships Fastest 3D Accelerator for Value PC

Raising the performance level of its popular Savage4 family of products, S3 has announced its Savage4 Xtreme accelerator. Featuring significantly increased 166MHz memory and engine clock speeds, as well as higher performing OpenGL software drivers, S3's Savage4 Xtreme 166 is the fastest 3D accelerator available for the £60 to £80 retail PC graphics market.

For further details, check: <www.s3.com>.

Contact: S3, Tel: (01256) 332800.

NEWS BYTES

Intel Leads in Home Networking

Intel has emerged as the leading retail provider of home networking solutions, according to market research firm PC Data.

In addition to strong retail sales, four PC manufacturers have announced plans to ship consumer PCs enabled with the AnyPoint Home Network solution in 1999.

AnyPoint Home Network products use existing phone lines to allow multi-PC households to share Internet access, printers, files and play multi-player games.

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

Contact: Intel, Tel: (01793) 403000.

ARM Introduces Synthesisable ARM9E Family

ARM has unveiled two new members of the ARM9E Thumb processor family: the ARM946E and ARM966E processor cores. These new cores, which will initially be available as synthesisable implementations, feature flexible memory systems as well as the AMBA Hi-Speed Bus (AHB) interface, making them particularly well suited for leading-edge, system-on-chip (SOC) designs.

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

Contact: ARM, Tel: (01223) 400400.

IDT and Intel Sign Cross-Licensing Agreement

IDT and Intel have entered into a cross-license agreement that enables each company to utilise the intellectual property (IP) covered by the other's patents.

Under the terms of the agreement, both companies will license each other's technologies with certain exceptions. Additionally, Intel will pay IDT £12 million for the licenses granted under this agreement.

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

Contact: Intel, Tel: (01793) 403000.

Shrink Files to Fit

Sending large files over the Internet can be a real pain. Anything over a 1.5MB will struggle and can often be seriously delayed en route. But TurboZip Express has a solution. The applications chops files into smaller chunks that are easy to transmit over the Internet, and then reassembles them back together at the other end. TurboZip costs 20 and is compatible with other Zip programmes such as PK Zip and Winzip.

For further details, check: <www.soft-shop.com>.

Contact: Atlantic Software, Tel: (01297) 552222.

NASA Research Uses Computer Generated Code

NASA is using a computer code generator from ISI to automatically generate code for the F-15 ACTIVE flight control software, a safety critical application. The F-15 ACTIVE is a manned aircraft and is presently undergoing rigorous flight tests at NASA's Dryden Flight Research Centre in California.

F-15 ACTIVE Control LAWS (CLAWS) are sophisticated safety critical software programs that control the aircraft during flight and prevent it from exceeding the flight envelope. Because they contain thousands of lines of computer code, CLAWS have traditionally been very time consuming and costly to produce.

For further details, check: <www.isi.com>.
Contact: ISI, Tel: (01462) 687300.

Toshiba Has First CD-RW/DVD-ROM Drive

Toshiba has introduced the first CD-RW drive with DVD-ROM readability. The SD-R1002 drive provides the rewritability of a CD-RW drive with the high-capacity storage of DVD-ROM. Because of its backward compatibility and low cost media, the SD-R1002 drive also provides customers with a sound investment and an effortless transition from CD to DVD.

For further details, check: <www.toshiba.co.uk>.
Contact: Microtronica (Toshiba distributor), Tel: (0118) 963370.

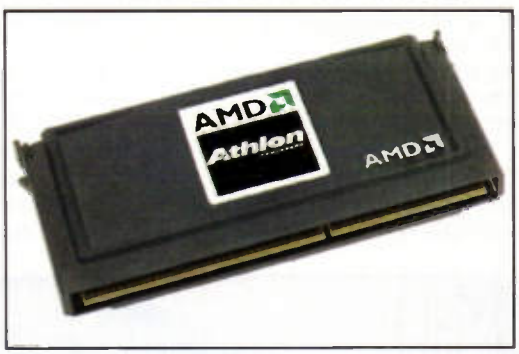
AMD Introduces The 650MHz Athlon Processor

AMD has introduced the 650MHz Athlon processor, the world's fastest and highest-performance microprocessor for x86 computer systems.

The Athlon family is designed to deliver unprecedented performance for cutting-edge commercial and consumer software applications running on high-end desktop systems, workstations, and servers.

The AMD Athlon processor is available in speed grades of 650, 600, 550, and 500 MHz. At 650MHz, the AMD Athlon is the world's fastest x86 processor.

For further details, check: <www.amd.com>.
Contact: AMD, Tel: (01276) 803100.



Lucent Enhances Sound Quality Over the Internet

Lucent Technologies has announced a family of wideband speech coders that offer significantly higher sound quality at transmission rates three times lower than the current industry standard.

The coders are designed to enhance sound quality over the Internet, voice, video and wireless networks.

Developed by Bell Labs, the ClearPresence Audio Coder is a new class of coders that deliver fuller sound at lower bit rates, putting the capabilities of wideband (7kHz) speech quality into technologies and applications that were originally limited to using only simple narrowband (3.7 kHz) frequencies.

The coders are now available for licensing from Lucent. The first manufacturer to use the coder is Polycom, which incorporated it into its ViewStation videoconferencing systems under the name Acoustic Plus.

For further details, check: <www.lucent.com>.
Contact: Lucent, Tel: (01793) 883333.

Feel Your Software?

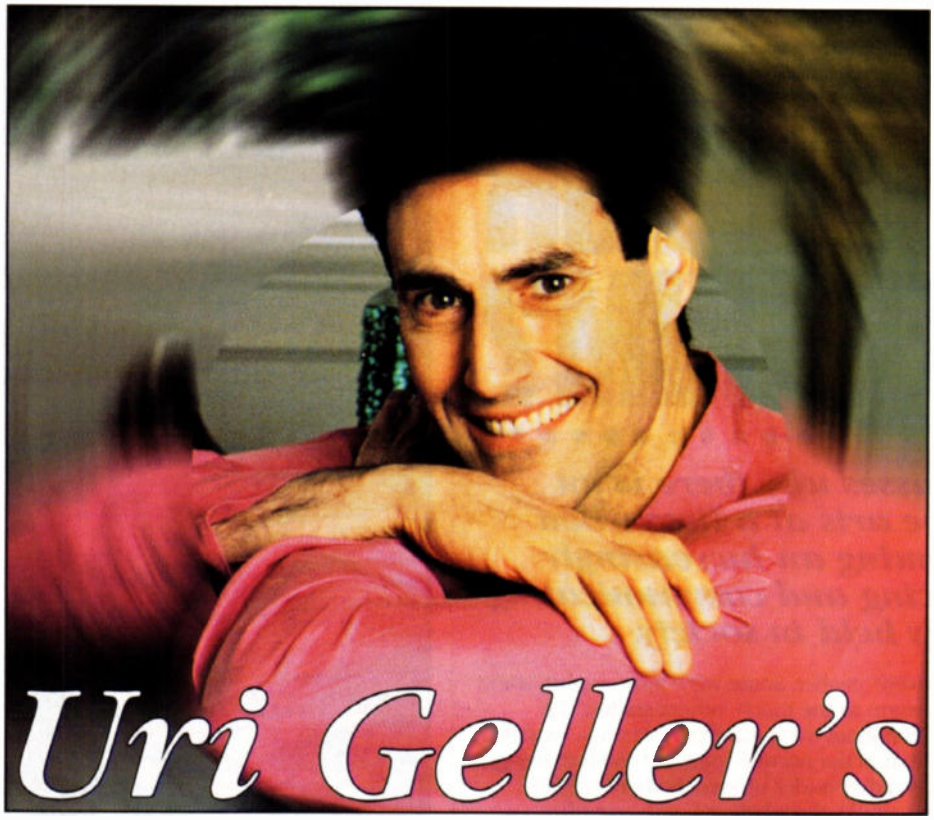
Immersion Corporation and Logitech have been working together to develop force feedback mice that allow users to feel their onscreen actions.

Based on Immersion's FEELit technology and Logitech's world-class pointing device expertise and industrial design, these innovative products will allow users to physically interact with anything the cursor touches, adding the sense of feel to all aspects of user interaction.

The first product, the Wingman Force Feedback Mouse from Logitech, is expected to be available this Christmas for approximately £100.

From surfing the Web, to graphic design, to gaming, to business - the implications of adding feel to software applications are vast. Imagine drawing a 2D image and feeling the cursor interact with points, lines, and curves or Imagine exploring a 3D image and feeling contours, surfaces, textures, and edges.

For further details, check: <www.logitech.com/uk>.
Contact: Logitech, (01306) 734300.



Uri Geller's EXTENDED REALITY

The Sunspot Mystery

Eleven has always been my lucky number, and at exactly eleven seconds past 11.11 a.m. on August 11, I had the experience of a lifetime along with millions of other people who were lucky enough to be on the line stretching from somewhere in Asia to the middle of the Atlantic the line followed by the total eclipse of the Sun.

I had never really thought much about the Sun before that unforgettable moment when day became night in a few minutes. It was just a huge blob that rose in the morning and set in the evening (or seemed to), kept us all warm and helped my garden grow. I did remember reading about a power failure in Canada that had been caused by a solar flare back in 1989, and I had heard of the sunspot cycle without knowing exactly what it was and not suspecting that it could have anything to do with life on Earth.

Since August 11, I have been thinking about the Sun a good deal and finding out all I can about it, and especially its rash of spots. These are dark blobs - dark because they are relatively cool by solar standards - thought to be caused by internal magnetic processes. They are studied and counted every day by observatories all over the world, so if it's cloudy in Britain the chances are that somebody in Hawaii or Brazil will be able to see them.

Some days there are no spots at all. On other days there can be hundreds of them, and for the past century and a half it has been known that they come and go in cycles of about 11 years (that number again!) in length on average, though they can last anywhere from seven to fourteen years. There doesn't seem to be any known reason why this happens, nor why the spots increase in number much more quickly than they decrease, so that solar 'maximum' (when there are more spots visible) comes just three or four years after minimum, whereas it is seven or more years before we get back to minimum and the start of another cycle.

This all may sound rather academic and irrelevant to our daily lives, but it might be more important than we think, because a sunspot means an extra burst of solar energy that does all kinds of things as well as cause the Northern Lights and (in extreme cases) knock out power systems. It has a direct effect on the Earth's magnetic field, which in turn has a direct effect on us. It has been proved to affect human blood and even chemical reactions, as shown fifty years ago by researchers Maki Takata in Japan and Giorgio Piccardi in Italy. In the former Soviet Union, 'heliobiology' the study of the effects of the sun's radiation on biological systems has long been recognised as a scientific field in its own right.

The man today's Russian researchers regard as the father of heliobiology was an extraordinary man named Alexander L. Chizhevsky (1897 - 1964). He was not only a scientist with a whole string of degrees in nearly all the physical sciences, but he was also a painter, a musician, a poet and a historian - a real allrounder of the kind we don't seem to have in this age of super-specialisation. He was only eighteen when he presented a paper to the Moscow Archaeological Institute entitled 'The periodical influence of the Sun in the earth's biosphere,' and he followed this with a series of papers and articles with titles like 'Solar radiation and life' and 'The astrology of our times'. He claimed to have found correlation between the sunspot cycle and all kinds of things, from epidemics, diseases and weather patterns to no less then the whole course of human history!

Crazy as this may sound, there is a disturbing amount of evidence for this. Chizhevsky divided the solar cycle into four periods: in the first, the masses are generally at peace, but are also lacking in unity and purpose. In the second, new ideas and new leaders emerge and new alliances are made. In the third, things come to head and nations are spurred to both their greatest achievements and their greatest outbursts of aggression. This is when we have wars, revolutions, persecutions and mass emigrations.

It is a fact that many major historical events took place right on cue, from the French revolutions of 1789, 1830 and 1848 and the commune of 1870 to both Russian revolutions (1905 and 1917), both world wars, the communist takeovers of the late 1940s and the Soviet invasions of Hungary, Czechoslovakia and Afghanistan.

Now, a scientific theory that has no predictive value is no use to anybody. Yet in 1926 Chizhevsky did predict "..man activity of the highest importance which will change the political map of the world.." for the period 1927 to 1929. And what did happen? A rightwing coup in Portugal inaugurated the longestlasting dictatorship of this century. The Italians elected a fascist parliament, paving the way for Mussolini. Chang KaiShek invaded Peking. The Baldwin government in Britain collapsed. Stalin expelled the last of his potential rivals, Trotsky, from the communist party (1927) and then exiled him (1929). Quite a period of upheaval. And, oh yes, I nearly forgot, it also included the Wall Street crash of 1929. It's all beginning to look like rather more than coincidence to me.

Chizhevsky never claimed that the sunspots made us do anything specific, only that they made us do something and become more active, whether in a positive or a negative way. It is up to us to channel these peaks of collective energy in the direction of peace and progress rather than war.

We never know exactly when the solar cycle reaches maximum until it has peaked and started to decline, but we can make a good guess that it will be three to five years after the last minimum. So we must be close to a maximum right now. I think it's time for some enterprising university to appoint a professor of heliobiology in this country..

Uri Geller's novel Dead Cold is published by Headline Feature at £9.99, Ella at £5.99, and Jonathon Margolis' Uri Geller Magician or Mystic? by Orion Books at £6,99.

Visit him at **www.tcom.co.uk/hpnet/** and e-mail him at **urigeller@compuserve.com**

Art & Technology: A MARRIAGE FOR THE MILLENNIUM?

PART 1

Douglas Clarkson discusses why there is an increasing interest in the arts at a time when technology itself is becoming an increasingly powerful means of reinforcing and communicating the values currently held in society.

Introduction

The twentieth century has predominantly been about the advance of science and technology and the raising of our 'standard of living' as the things society as a whole can objectively measure and be sure about. The identification of more nebulous concepts such as art and social values remains outside this clear focus of material certainty.

Signs of an increasing interest in the arts comes at a time when technology itself is becoming an increasingly powerful means of reinforcing and communicating the values currently held in society - whatever they may be. Also, technology is providing new methods of creating a range of art forms and in general making them easier to create and for individuals to produce and access.

There is a growing awareness that the more advanced technology becomes, the greater the need to understand the social impact on society of all these developments and, if possible, direct endeavours for the benefit of all.

A Wake Up Call

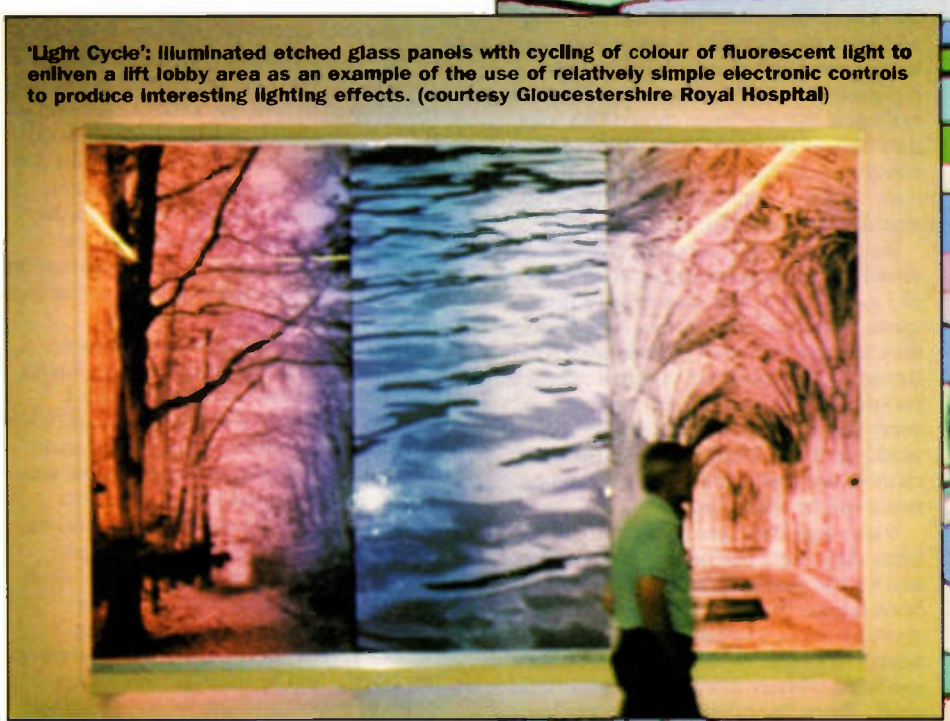
The problem is that there is a very sharp distinction between what we can measure and observe in the physical world by way of physical science and the separate world of human perception and thought. The opportunity to visit the Tobias School of Art in East Grinstead, near Gatwick Airport, on its open day was really some sort of wake up call to the reality of the perception of what could be termed as 'artistic concepts.'

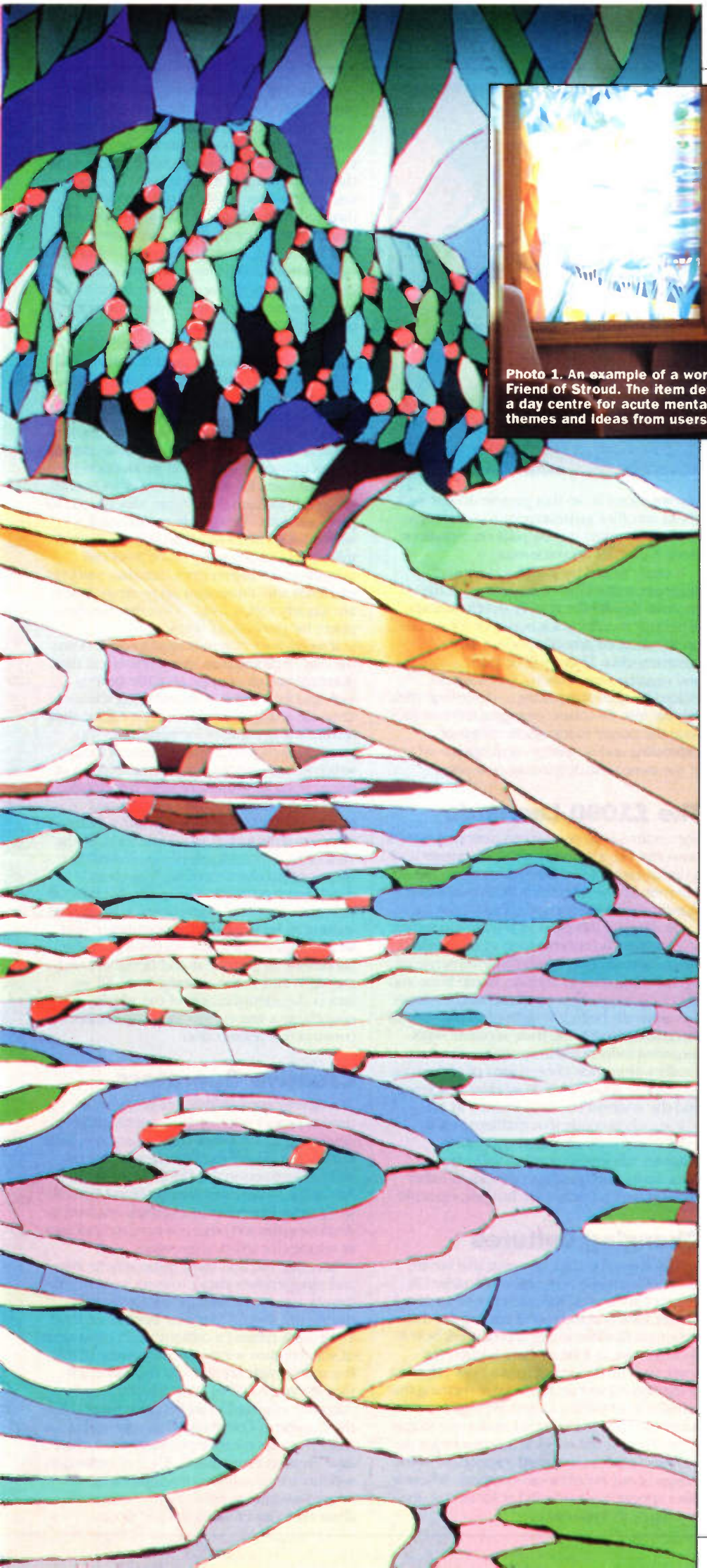
The school teaches a range of art courses drawing significantly on the colour theory of the German Philosopher Rudolf Steiner and who in turn was an interpreter of the German philosopher Goethe. Goethe is really a philosopher that the English speaking world has not really studied to any great depth.

Taking part in a demonstration sculpture session, about twenty of us had the opportunity to take a handful of clay and make a round ball. So after about ten minutes or so we had in front of each of us our own artefact. On holding it, it seemed very much our own creation. Then proceeding with a game of pass the object, we experienced the tactile feedback from handling the items produced by all the others in the group. Some were of course larger while some were smaller. Some were more round, some warm to the touch, others colder. The important thing was that here was a sensation that in the normal course of modern living, is rather under utilised. So here was an example of a whole sub universe of expression of thought, of state of mind, of concept with the shape, colour and surface texture of a physical object. The sculptor, however, lives most of his creative time in a tactile environment, developing surfaces that have visual and tactile overtones.

Later we would break for tea, to be followed by a talk on the subtleties of colour and its use. Straightaway I felt a great abyss of my own ignorance opening up in front of me. And quite rightly so, for had not Goethe himself regarded his treatises on colour above all else that he had accomplished. There was the perception that now we spend much more time indoors, missing sun rises, evading sunsets, and as a consequence our appreciation of colour is generally being steadily diminished, to say nothing of our general dislocation from the natural world.

'Light Cycle': Illuminated etched glass panels with cycling of colour of fluorescent light to enliven a lift lobby area as an example of the use of relatively simple electronic controls to produce interesting lighting effects. (courtesy Gloucestershire Royal Hospital)





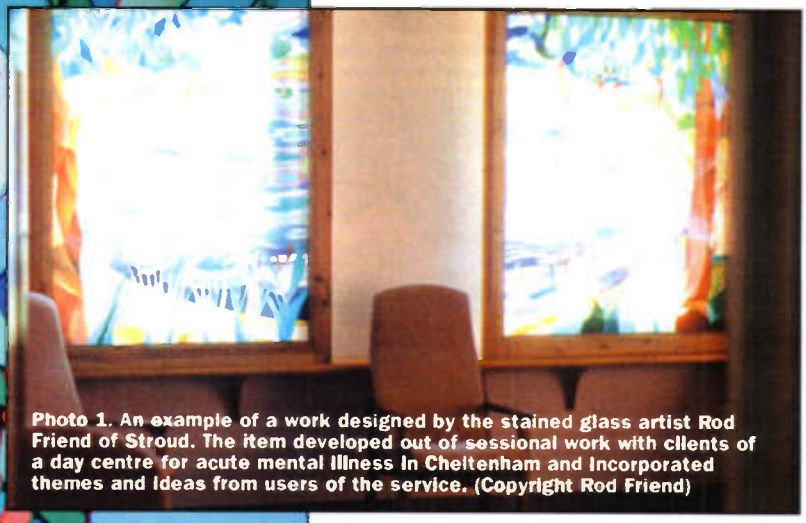


Photo 1. An example of a work designed by the stained glass artist Rod Friend of Stroud. The item developed out of sessional work with clients of a day centre for acute mental illness in Cheltenham and incorporated themes and ideas from users of the service. (Copyright Rod Friend)

E-Dislocation

I was quite struck also, in the way in which the lecturer spoke to us, for about 25 minutes - with only as a visual prop two water colour paintings and a vase of fresh flowers. She was communicating solely on the impact of her voice, being in tune with her perceptions, she was quite able to talk to us and impart her subtle interpretation of colour - if not so much to make us complacent but rather to acknowledge our poor appreciation of colour and certainly awakening a deep curiosity on the whole subject.

I began to realise, in quite a subtle way, that despite our fax machines, our e-mails, our voice mails, our smart Powerpoint presentations, that the power of communication in relation to imparting what are our more deeply felt perceptions has probably declined also. The paradox is, moreover, that we would all say that we have become better individual communicators because we have more technology at our fingertips.

And so, there was the perception, of the growing dislocation between what people may be feeling, for whatever reason, and their ability to express these feelings in an appropriate way. There was also the perception of the importance of being able to release feelings, through the mechanism of creative expression - which is art.

If we look closely at the situation, technology is neither wholly positive or wholly negative in the way in which it can be used in society. Even the most enthusiastic historian would not wish to live at the height of the Roman Empire, or witness the glories of Classical Greece - life was just too unpredictable, brief or painful. We do not wish to revert to a year zero of technological achievement. We would not wish to do without our medical technology, global transport infrastructure or the convenience of our local supermarket.

Healthy Art

There is a bewildering array of spheres for artistic expression so that it is difficult to gain a perspective on their relevance and effectiveness within our increasingly technological society. An interesting sector, however, for the examination of the therapeutic use of art is to be found in the HealthCare sector, where the problems of physical, emotional and mental well being are placed under especially sharp scrutiny. It is very likely that the focus of the use of art in HealthCare can provide a focus for the constructive application of art throughout the whole of society.

Photo 3. The 'cutting edge' of automotive technology used in cutting and trimming automotive components using a Nd:YAG laser using fibre optic beam delivery with robot control. (Courtesy GSI Lumonics)

It appears that if art can allow the artist to convey a feeling, an expression, a quality of relevance, this is in turn a point of communication for the individual observing the art. So the outward art manifested by the artist is received in turn by those who encounter it. The quality of the expression thus resonates in the individual who observes it. Within hospitals, you do not wish to debilitate the patient any further, so you find the levels of artistic expression are generally well accepted, in particular where the staff and patients have an active part to play in selecting the art and even developing it with the artist. Other platforms of artistic expression are apparently much less in tune with broad public acceptance. This application of art into this specific functional area is providing some powerful clues and guidelines for the constructive use of art throughout society at large.

Photo 1 shows an example of a work in a 'quiet room' designed and implemented by the stained glass artist Rod Friend of Stroud. The item developed out of sessional work with clients of a day centre for acute mental illness in Cheltenham and incorporated themes and ideas from users of the service. Photo 2 shows details from one of the windows.

The actual work is based around the need for a calming and relaxing area and so in the first place there has to be the perception that this aim can be achieved and is worth achieving.

The Big Experiment

So while technology may provide masterful advances, there have been some negative aspects in terms of the connectedness of individuals to themselves and to other people. Is it actually that progressive for children to lock themselves away in their rooms to play computer games? Is learning through a computer providing the same resonance on numerous levels as person oriented contact and interaction? These are questions which seem never to have been raised because it seemed rather foolish and pointless to ask them in the first place. What group in our present society is monitoring its emotional well being? It would seem that we are all part of a 'Big Experiment'.

It may be my perception, however, that those who deal most with computers or IT tend to demonstrate generally poor person-to-person communication skills. Greater relevance is placed on the use of the attribute of computers to undertake the day-to-day communication, so that people do not walk about an office environment to see people any longer - they merely pass on e-mails or leave messages on voice mail.

It really would be useful if we could engineer some kind of evaluation of the more in depth effects of IT developments, especially its effects for better or for worse on interactions among modern office environments. There will be both positive and negative ramifications, and it would indeed be quite interesting to determine their relative mix. Of course emerging technologies have the power to transform means of expressing and accessing conventional art and at the same time developing new ones.

The £1000 Leonardo

For under £1000 people can now purchase a powerful PC, a scanner, a colour printer and a digital camera and be connected to the Internet. Those who don't think that this is a significant artistic cocktail should think again.

Dwelling on this point, it is quite interesting to consider the contribution of Leonardo da Vinci - whose contribution was immense to so many branches of science, to medicine and of course to art. This excellent 'all roundness' has generally been lost sight of as the various disciplines have gone their separate ways - requiring individuals to specialise almost totally within their chosen area of endeavour so that the artist has little interest in science and the scientist has little interest in art.

It is only recently that mathematics in association with advanced computer graphics has investigated visually the complexity and qualities of exotic number sets - of which fractals are but one example.

Changing Cultures

It is probably the case, however, that we are overlooking some very major difficulties - in terms of addressing the relevance of art in our society, for it is at the end of the day, not that important how the image is produced, how it is composed, as long as there is given the space to exist. According to our post industrial revolution society, art has been something that remains in a building locked overnight and for which we have to pay an admission fee to gain entry. There is still no wide acceptance for the inclusion of art as a normal component of the design of our everyday environment. Where it does appear, it is marvelled at for its cost, its bearing or its irrelevance.

As costs of manufacturing of products tend to fall, due to use of more efficient, more automated products, the element of design becomes more critical. Computer controlled laser cutting technology can cut the most intricate of shapes into materials of unparalleled ranges - and these have directed their products with the consumer marketplace. Design fibres can now be cut by lasers using relative low power industrial type carbon dioxide lasers operating at 250W or below. Surface pattern finish of all types can be engineered by laser processing using Nd:YAG systems.

Photo 3 shows the 'cutting edge' of automotive technology used in cutting and trimming automotive components using a Nd:YAG laser using fibre optic beam delivery with robot control.

Photo 4 shows how the low inherent heat input and synchronised beam pulse control allows ultimate flexibility in production of intricate parts for a wide range of industries.

Already industrial lasers are widely used to produce signs - being able to cut plastics with a cut width of less than 0.5mm. Typically mild steel can be cut by more powerful systems up to 20mm thick, stainless steel up to 12mm and aluminium up to 6mm. Lasers are already widely used to cut the massive plates for the hulls of ships.

If technology is merely used to drive down the cost of production, then there is lost the potential benefit of improving the general look and feel of our work and living spaces. Thus the shape of products, their colour, their texture will become of increased relevance which again is focusing on aspects of design which in turn springs from the perception of things possible within a creative framework.

So technology can provide a means of producing products with a positive design element. This was in many the forte of the Victorians, who relentlessly exploited the means of production of work such as magnificent wrought iron work. We have all the same potential ingredients, a landscape waiting to be improved, a population that would appreciate it, the technology to be harnessed to provide it and designers with the skills and vision to imagine it. All we lack is the identification of the whole country as a vast canvas awaiting a splash of constructive reinvention.

Creative Operators

The development of the data projector as used to project video or PC images is also being developed as a mean of communication to the public. The duo of Joan Beadle and Joanne Vickers, lecturers in the Department of the Arts at the Manchester Metropolitan University as 'Creative Operators', are actively involved in developing this and other emerging technologies as vehicles for artistic expression.

Recently the duo used three synchronised and independent data projector systems to display a work in Manchester Cathedral during the 'Digital Summer Festival' of 1998. Their work created a contemporary equivalent of stained glass windows using three of the five metre high windows in the cathedral (see Photos 5 and 6). The creative duo is currently engaged in an initiative funded by the European Commission to regenerate cities through creative practice - the Urban Pilot Projects Programme. Their contribution will involve projection of a wide range of images using data projection to create an illusionary city of windows and doors.

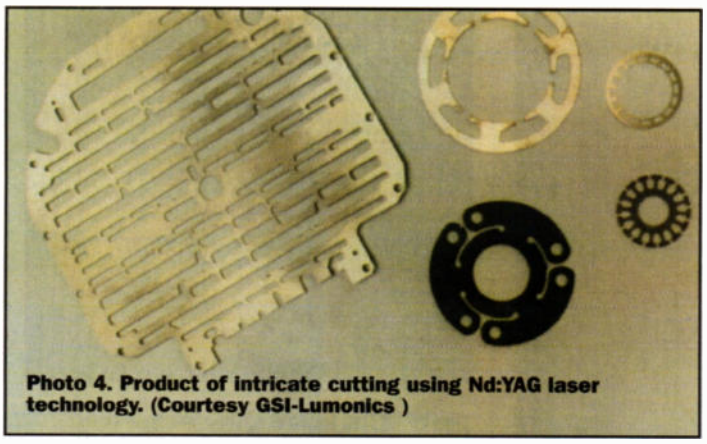


Photo 4. Product of intricate cutting using Nd:YAG laser technology. (Courtesy GSI-Lumonics)

Photo 5. Extract from the presentation by 'Creative Operators' in Manchester Cathedral during the 'Digital Summer Festival' of 1998 using three independent, sychronised data projectors. (Courtesy Creative Operators)

Changing the Rules of Publishing

The key to art is perhaps the level of connectedness it provides to the people who engage in it and the identification with aspects of the work by those who perceive it. This interaction is a fundamental reality. Artists have as it were a more dominant need to communicate their feelings and perceptions. They are as it were driven by a compulsion to express their thoughts and emotions. A writer who has not written for some time will typically experience a sense of mounting frustration.

If one looks at the influence of technology in this area, the introduction of the Internet has provided a rapid change in the access of the individual to the arts in general, and in particular of the visual art - reference the image archives of the world's range of art galleries now being put on line.

Perhaps there is one major component of this that has been somewhat overlooked. The figure for the number of manuscripts accepted for publication to those submitted to publishers must be really quite small - something certainly less than 0.5%.

What we now could witness is the virtual publishing of manuscripts on the net - which could be downloaded and printed by the individual browser or hosted by a manuscript publishing company that could print even individual copies of books using modern printing techniques. It is possibly the case that this has already happened. This has therefore fundamentally changed the nature of book publishing. A flat ASCII file of a text novel will contain only around one Mbyte of data though texts with images and figures would contain considerably in excess of this. The concept of going to a book store and accessing titles that were either in the particular store or in print in the publisher's warehouse will have to be expanded to include having a specific work downloaded by a virtual publishing house, printed on their premises and then sent on by post. No one really wants to read 250 pages of A4 text on a PC monitor. This could render the term 'not in print' obsolete. This will create new industries and companies and challenge the power of the major publishing houses.

There are of course potential drawbacks to the scheme such as loss of copyright, plagiarism, unsavoury material etc, though this may usher in a future wave of literary abundance in years to come. There is no doubt, that one useful use of Lottery funding would be to 'rescue' in this way the 1000 'lost' books of the Millennium - those titles which have gathered dust in the publisher's in tray, and been reconciled to the attic or the bank vault.

One World: Two Cultures

It is challenging in the extreme to convey some carefully focused thoughts on the role of art and technology. Each world is in itself vast, and each is evolving rapidly. To examine the contents of a technology publication such as Maplin's Electronics and Beyond and the prestigious 'Craft' magazine is to observe two diverse viewpoints of priorities - one about collecting, transmitting and processing information about the physical world and one the translation of human concepts and perceptions via the human senses using a range of artistic media.

While our understanding of physical science has vastly expanded, there has been no matching exponential marker for the breadth of artistic expression within our culture.

The process of art in its active mode is the materialisation of creative effort by the artist and in its passive mode is the appreciation of such creations through sensory perceptions. The actual process which causes one person to be actively creative while another not so remains a mystery and likewise the appreciation of art is again another mystery.

So on the one hand you have very rapid progress with the science and technology of physical phenomenon and not very much progress at all in the understanding of more abstract thought level processes.

While the scientific method may not be able to resolve as yet the processes that relate to artistic expression and appreciation, it must surely be able to come to some conclusion about the benefit of each. It is the widely held view that the arts are beneficial to individuals and society as a whole. Without music, without opera, without dance, without literature, without art galleries, our society would be immeasurably the poorer. The impact on the individual, however, as

Jane Mulfinger: The Drunkard, Forewarned & Swearer Cautioned: Photo Credit Richard Valencia courtesy of the Mayor Gallery, London. Fabricated in silver plate, steel wire, television, video, compresor, inflatable, wadding, foam, pillows and silver fabric - dimensions variable. The subject presents an example of the wide open nature of modern artisic representstions using modern materials and technological trappings.

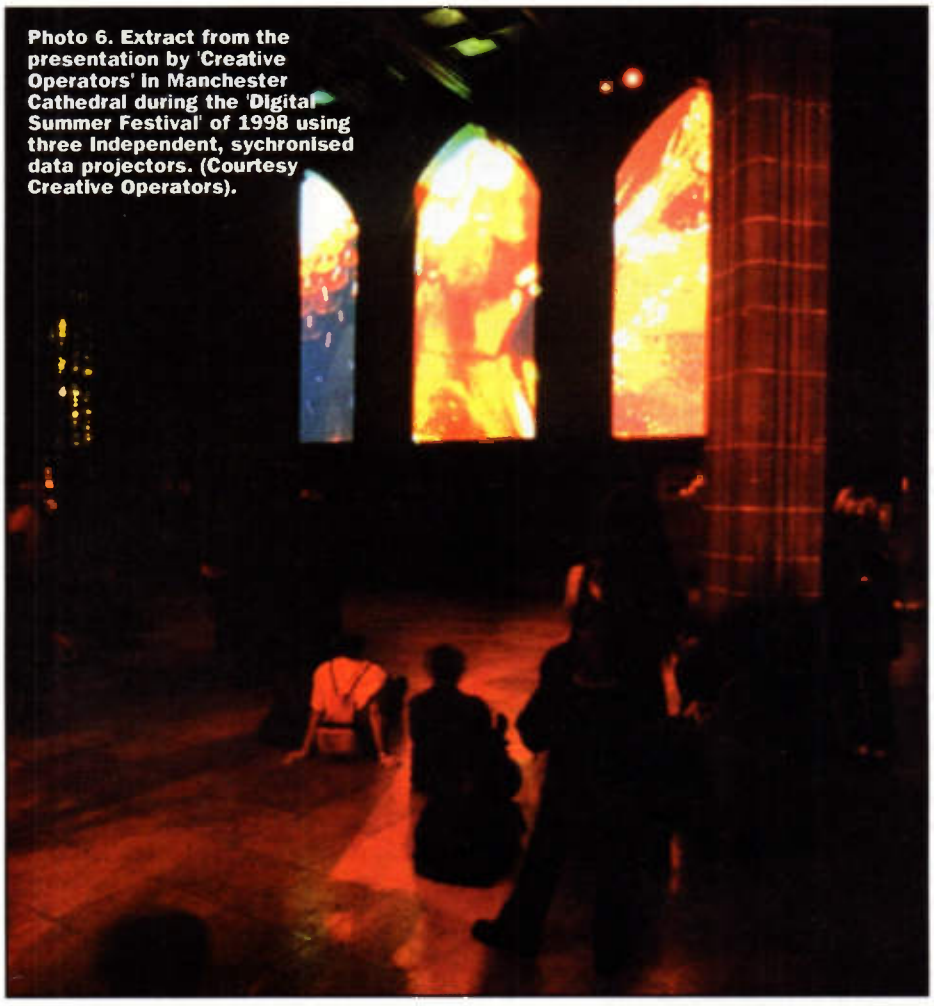


Photo 6. Extract from the presentation by 'Creative Operators' In Manchester Cathedral during the 'Digital Summer Festival' of 1998 using three independent, sychronised data projectors. (Courtesy Creative Operators).

the producer of creative material is less well documented. Some of the most highly acclaimed works of artistic endeavour have been created out of the most abject human misery and tragedy in relation to personal circumstances, but generally artistic expression is regarded very much as a healthy means of self expression. The expression of art in society, is very much a factor in the Health of the Nation.

It is here, however, that the role of the art therapist is receiving increasing interest. If Freud had encouraged his patients to paint instead of look for associations of guilt, perhaps we would look upon art more favourably. So while we may not understand it, in the way that we appreciate how a Pentium II processor operates, it is important to appreciate the useful role that it can occupy. This is where the benefits of modern methods of social research come to the fore - to identify what are the positive, creative inputs into society.

We also should also remind ourselves in our age of technological wizardry that we have also to constantly rediscover the past. One novel way to focus on this is to be aware of the art of cave painting - an example of which is indicated in Figure 1.

Far Side of Art

In as much as art remains a mystery, as to how cerebral processes are activated by engaging in art or appreciating art, modern branches of technology such as functional MRI scanning and PET and magnetic field mapping using SQUIDS, may provide some pieces of the jig saw. Quite likely, artistic expression is likely to manifest itself in broad waves of cerebral processes that give either really little indication to the onlooker as to the complex patterns triggered internally.

Thus while science can catalogue and document responses of individuals at the question and answer level of study and evaluation, it can also probe at a much more absolute level to help map the specific cerebral responses.

Summary

So as a candle in the sun of Millennium predictions, there is this dawning perception that the future can be more creative - if we so choose. Technology will keep on developing but at the same time the needs of human expression to externalise its deep seated feelings will remain. What may be a theme for the next millennium is to finally separate clearly technological achievements from creative implementations and the degree of vision for human culture.

And the greater scope that modern technology has provided to alter the visual appearance and general environment of living and work spaces should be applied to this goal. So if there is a thought for the millennium, it is for the creative element to tunnel through at the individual and the collective level in a constructive and supportive way and in so doing help to produce a more balanced society.

Points of Contact

Points of Contact: GSI - Lumonics, Hull. (supplier of Laser cutting systems) Tel: 01482 831154

Laser Expertise Ltd, Unit H, Acorn Park Industrial Estate, Hartmans Lane, Dunkirk, Nottingham, NG7 2TR. Tel: 0115 9851273 **:www.laserexp.co.uk** (provider of laser cutting/processing service)

Rod Friend, Dove Cottage, 40 Summer Street, Stroud, Glos., GL5 1NY. Tel: 01453 750919

Joan Beadle and Jane Vickers (Creative Operators) Tel: 07931 321966 or 07957 158315

Further Reading

Our Prehistoric Past: Art And Civilisation, Denis Vialou, Thames and Hudson, 1996

Rudolf Steiner: His Life And Work, Gilbert Childs. Floris Books, 1995.

Figure 1. French 20,000 year old cave painting (Courtesy Le ministere de la Culture et de la Communication)

PROJECT

Guitar Practice AMPLIFIER WITH EFFECTS

PART 1

In part one, Gavin Cheeseman discusses the requirements and techniques involved.

Introduction

There are many guitar practice amplifiers on the market with levels of performance ranging from very basic to professional quality. Basic units often consist of an amplifier, perhaps with tone controls and some form of distortion or overdrive effect. If you require additional effects you can always invest in the appropriate effects pedals to connect between the guitar and the input to the amplifier. Sometimes, however, you can end up with a large selection of pedals connected in series. Unless left permanently installed these can be a considerable nuisance to connect and disconnect for what may be just a short home practice session. In this article we look at a series of concepts and circuits that can be used in combination to construct a customised practice amp with built in effects tailored to the needs of the individual. The system is aimed at hobbyists who enjoy experimenting with various effects in the home environment.

Before looking at specific circuits, it is useful to gain a general understanding of the type of techniques used to produce the more common effects. Here we provide a basic overview of some of the fundamental considerations that apply when constructing a guitar amplifier. The circuits and diagrams shown are intended to illustrate the general principles discussed and are not for end use. The component values shown are typical and may vary for different applications. Practical constructional information and circuit details of the amplifier will be covered next month.

It is not suggested that all of the effects discussed should be included in one amplifier cabinet but it is ultimately for the user to decide which combination of effects are required. Complex circuits using digital processing are only touched on briefly as the technologies are widely varied and to provide full details would not be possible in the space available.

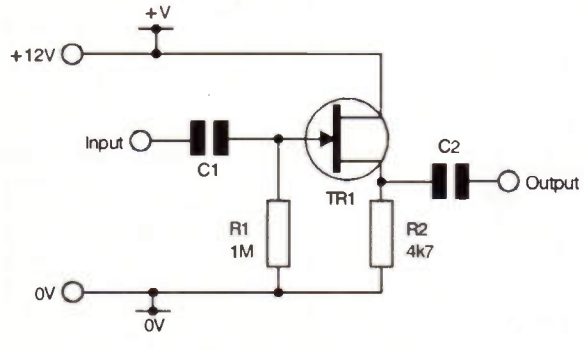


Figure 1. Typical configuration of a FET input buffer.

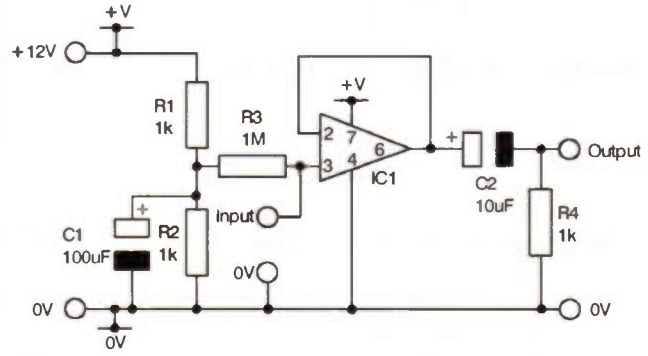


Figure 2. An input buffer using an operational amplifier.

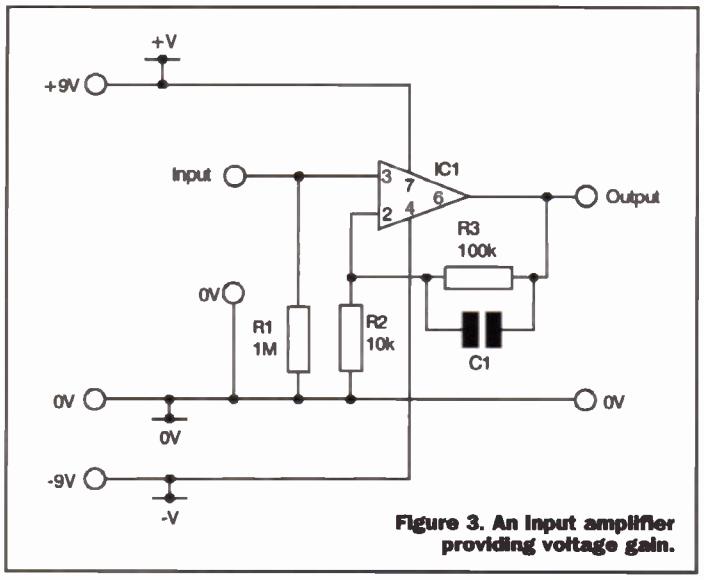


Figure 3. An input amplifier providing voltage gain.

Input Stages

Before connecting a guitar to any kind of amplifier or effects circuit, it is important to provide a suitable impedance for the guitar to drive into. If the impedance is too low the guitar pickup will be heavily loaded. This will result in a reduction in signal amplitude and possibly modified frequency response. To avoid these problems it is usual to include some form of input buffer to act as an interface between the guitar and amplifier electronics. These can take various forms.

One example, using a Field Effect Transistor (FET) is shown in Figure 1. The circuit makes use of the fact that FETs have an extremely high input resistance. In practice the input resistance of the circuit is determined by R1. Other factors, such as the capacitance between the gate and source of TR1 also play a part in determining impedance but with most small signal FETs this does not generally create a serious problem at audio frequencies. Capacitors C1 and C2 are used to block DC and the values are determined by the required input and output characteristics. In some cases C1 may not be required.

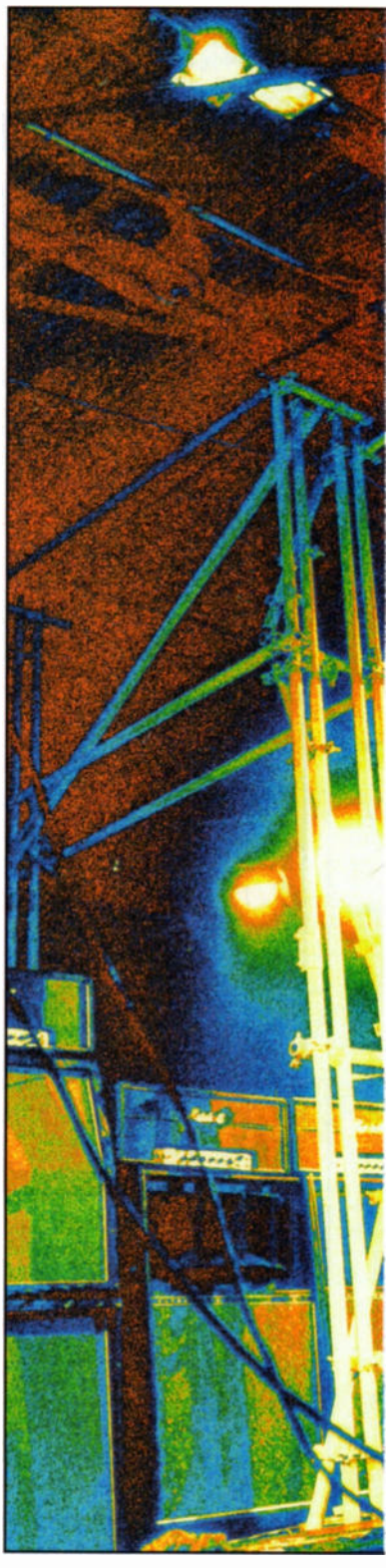
Operational amplifier ICs may also be used for buffering, and the FET input types are particularly useful. Figure 2 shows a typical circuit. The pin numbering shown is based on the LF351 IC but similar circuits may be constructed using most standard op-amps. The circuit shown is designed to operate from a single rail power supply but may be modified for split supply operation if needed. Resistor R3 effectively determines the input resistance of the circuit. R1 and R2 are used to provide a half supply reference voltage which is filtered by capacitor C1. DC blocking capacitor C2 is included as the output of IC1 is centred at approximately half supply. R4 acts as an output load ensuring that C2 charges quickly and may not be required depending on the input resistance of the next stage.

The circuit shown in Figure 2 purely serves to convert the high impedance at the input to a lower impedance suitable to drive the next circuit. It has no voltage gain. Sometimes, however, it is useful to configure the input stage to provide some voltage gain, for example, to help overcome noise or attenuation in a later stage. Figure 3 shows an example of an input stage that exhibits both a high input impedance and gain. This time the circuit shown is intended to operate from a split supply. It is not generally necessary to use input and output coupling capacitors unless there is a difference in DC levels. However, it may be required to trim any offset produced at the output of the op-amp and many devices provide the facility to do this (see manufacturers data sheets). The gain of the circuit is determined by the values of R2 and R3 and may be set to suit particular requirements. Capacitor C1 is included to limit the frequency response of the amplifier. This capacitor is not essential but helps to reduce noise and RF pickup. The value is selected to provide the required high frequency roll off and is typically a few pF.

The operating voltages shown for these circuits are arbitrary may be varied as long as the IC specifications are not exceeded. The working voltages of the capacitors must also be appropriate for the supply voltage. From an operational point of view, care should be taken to provide sufficient head room for the signal to avoid distortion. A low supply voltage will result in clipping at a smaller signal level.

Tone Controls

Adjusting the tone of a guitar amplifier has a drastic effect on the kind of sound produced at the output. When you adjust the tone controls you are effectively altering the frequency response of the amplifier. Many guitar amps use standard passive tone control circuits based on resistors and capacitors and although the configurations are often relatively basic, they are well tried and tested and produce a response that guitarists have come to expect over the years. Figures 4a and 4b show two very simple resistor/capacitor circuit configurations for controlling bass and treble response respectively. In both cases the frequency characteristics are determined by the values of R and C together with variable resistor VR which provides the adjustable element. These circuits form basic building blocks and are not usually used singly, most practical tone controls using various combinations of capacitors and resistors to create the desired effects. It is normal to have bass and treble



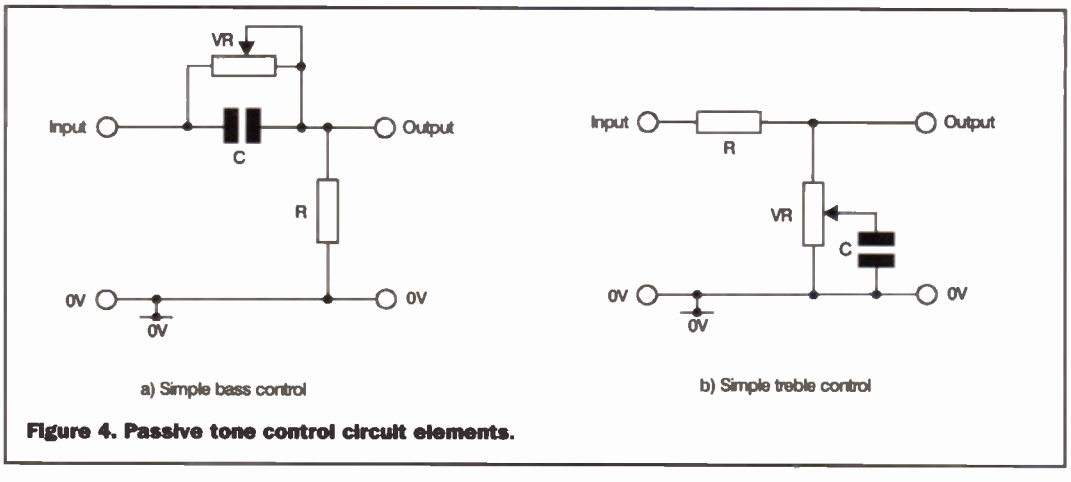


Figure 4. Passive tone control circuit elements.

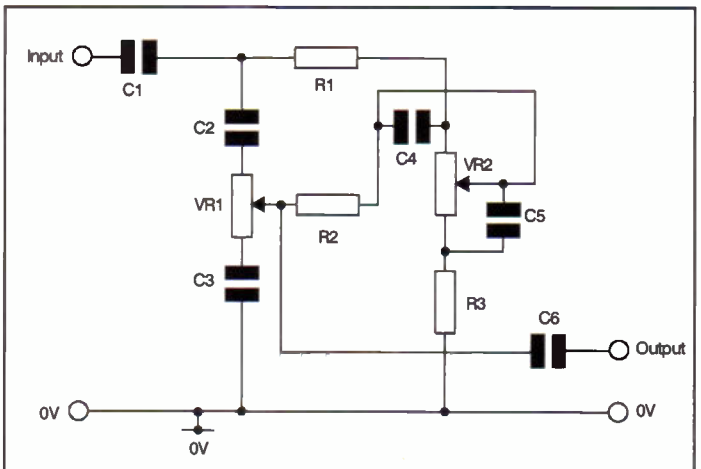


Figure 5. An example of a combined bass and treble control circuit.

controls but sometimes a mid control is also included. Figure 5 shows an example of a typical combination bass and treble control circuit. In this circuit VR1 adjusts the treble response and VR2 controls the bass. Although some controls may provide effective bass and treble boost and others feature boost and cut, all passive tone controls actually operate by attenuating the input signal to varying degrees depending on the signal frequency. The circuits only provide effective boost when coupled to an amplifier providing sufficient gain to overcome the losses.

Choice of the correct centre frequency for the bass and treble controls is considerably important and has a pronounced effect on the final sound produced. The waveform produced by a guitar is not a pure sine wave of one frequency but is in fact a complex waveform high in harmonic content. Therefore depending on the chosen centre frequencies the controls may operate mostly on the fundamental frequency or on a specific range of harmonics. In practice the response can be tailored to suit individual tastes.

Of course, in addition to the effect of electronic tone controls and other circuit characteristics, the dimensions and construction of the amplifier cabinet also affect the final sound. Obtaining adequate bass response from a small cabinet can be a problem. This can be partially overcome by tailoring the response of the tone controls to suit the response of the cabinet.

Distortion Overdrive and Fuzz

A linear amplifier will faithfully reproduce the output waveform of the guitar without the introduction of additional harmonics. This is fine if you want to create an 'acoustic' sound but the electric guitar sound that we have all become accustomed to is only created by introducing varying degrees of distortion. The type of distortion required depends on the effect you wish to create. A 'fuzz' effect can be produced by simply overdriving the input stage to a semiconductor amplifier. The resultant waveform is virtually a square wave and contains a large proportion of harmonics but the sound is harsh and very unsubtle. Another method of producing a fuzz effect is to 'soft clip' the input waveform using diodes. An example of this type of circuit is shown in Figure 6. VR1 adjusts the gain of the amplifier and hence the proportion of the input signal that is affected by the clipping circuit. Variations on this type of circuit are often used in low to medium cost practice amps with varying degrees of success. The result is softer and generally more acceptable than hard clipping allowing a larger degree of control. Figure 7 shows a graphical comparison of the type of waveforms produced by hard and soft clipping.

There have been many attempts to emulate the classic 'valve amp' sound of the 1960's using semiconductors. The original 'tube overdrive' effect was usually produced by overdriving a valve amplifier ('tube' is simply an American name for the thermionic valve). The way in which the output current of an amplifying device changes with input voltage or current is known as its transfer characteristic. The transfer characteristics of valves are considerably different to those of bipolar transistor, similarly, the harmonic response is considerably different with each technology producing a characteristic sound. Whether anyone has ever quite managed to emulate the valve sound using semiconductors is a highly emotive subject for many guitarists and it is really for the individual to make up his or her own mind. Whatever the case, different semiconductor circuit configurations can be used to produce a variety of effects.

Some circuits make use of Field Effect Transistors as these have a transfer characteristic closer to that of a thermionic valve than a bipolar transistor. They also offer the advantage of providing a high input impedance which is useful when driving the circuit directly from a guitar pickup. Other circuits make use of a number of diodes or other non-linear components to produce unsymmetrical clipping.

In all cases it is important that the preamplifier stage provides enough gain to allow the necessary level of distortion to be introduced. The use of high gain amplifiers with a high input impedance inevitably results in high noise levels or even instability if steps are not taken to minimise these effects. Correct circuit layout is an important factor in this respect and the use of long wiring runs should be avoided where possible. In some cases it may

be necessary to limit the frequency response of the amplifier to prevent high frequency instability, particularly where the active device used has a wide bandwidth.

Compression and Sustain

Compression may be used to control the level of the input signal so that, as far as possible, the output of the amplifier remains at a preset level. To achieve this it is necessary to vary the gain of the amplifier dependant on the signal level. At high input levels the gain of the amplifier is reduced and at low levels the gain is increased. As a result the dynamic range of the amplifier is effectively compressed. Compression is useful to ensure that an overdrive stage is consistently driven at the correct level to maintain the required level of distortion or to produce a sustain effect. Also different effects can be obtained by varying the attack and decay characteristics of the compressor circuit.

Wah Wah

The classic Wah Wah effect is produced by sweeping a narrow bandpass filter or a lowpass filter with a peaked response across a band of frequencies. The sound varies as a different set of harmonics falls within the filter pass band. Traditionally the effect is controlled using a pedal but automatic control may also be used. The effect may be implemented in a number of different ways.

One form of automatic control uses the amplitude of the guitar output waveform to determine the centre frequency of the filter. As the guitar is played the filter frequency changes depending on the loudness of the guitar output. The block diagram shown in Figure 8 illustrates a typical configuration for this type of circuit. The output from the guitar is buffered as necessary and fed to the input of a voltage controlled filter (VCF) with a bandpass characteristic. Circuits of this type are often based around transconductance operational amplifiers or switched capacitor filters such as the popular MF10 IC.

In addition the signal from the guitar is amplified and rectified to produce a varying DC level. The envelope shape produced is directly determined by the amplitude of the signal from the guitar and is fed to the control input of the VCF. It should be pointed out that correct filtering of the rectified control signal is essential. The envelope produced should follow amplitude variations in the input signal as closely as possible so it is important that the circuit used to filter the rectified signal has a fast response. At the same time the circuit must be designed so as to avoid significant amounts of audio frequency signal reaching the VCF control input as this can produce unwanted effects. It is normal to provide some form of sensitivity control to allow the depth of the Wah Wah effect to be varied. The overall range of the sweep may also be made adjustable to allow a variety of effects to be selected.

Another method of producing an automatic Wah Wah effect involves applying the output of a low frequency oscillator to the control input of the VCF as shown in Figure 9. This produces a predetermined sweep rate independent of how the guitar is played. The frequency of the sweep oscillator can be adjusted to speed up or slow down the sweep rate as required. This control can be via a pedal or a panel mounted potentiometer.

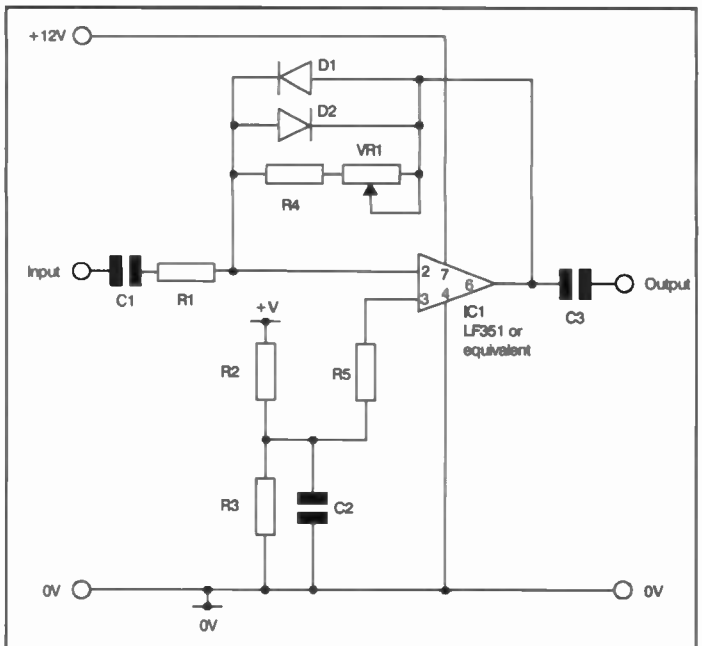


Figure 6. A simple 'fuzz' effect circuit using diode clipping.

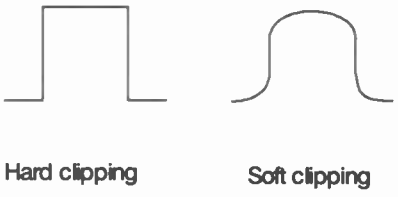


Figure 7. Comparison of the waveforms produced by hard and soft clipping.

Reverb and Echo

Reverb and echo effects are produced by introducing a time delay in the path of the signal. The traditional method of implementing this effect is to use a springline reverb unit. This makes use of acoustic effects produced in a spring to create the reverb effect. These systems are commonly used in low to medium range amplifiers and can provide a relatively simple way of creating a reverb effect. The units are not without their disadvantages however; the delay time is usually fixed and springline units tend to be microphonic and prone to acoustic feedback.

Another method of introducing reverb uses Bucket Brigade Delay (BBD) devices. These work by storing analogue voltage levels and provide predetermined delay times. The delay may be increased by cascading the devices. This allows different delay times to be selected and may be used to create a variety of reverb and echo effects but often a large number of devices are needed if significant delays are required.

The introduction of digital techniques has provided various methods of producing delay effects with a high degree of precision and control. The idea is to convert the guitar's output signal into digital codes using an Analogue-to-Digital Converter (ADC) so that digital processing can take place. In a typical example the code is saved to memory and clocked out after the desired delay time has elapsed. The code is converted back to an analogue signal using a Digital-to-Analogue Converter (DAC), filtered as necessary and fed to the input of the guitar amplifier. Some of the signal is fed back to the input to create a loop effect. The above description of this system (illustrated in Figure 10) is somewhat simplified but serves to illustrate the general principle. Many modern systems use computer software enabling the characteristics of the audio waveform to be manipulated on screen. Once the signal is changed to a digital code, the possibilities are virtually endless. These systems are outside the scope of many home constructors but simple digital delays can be produced relatively easily and cheaply and are capable of good performance when correctly designed.

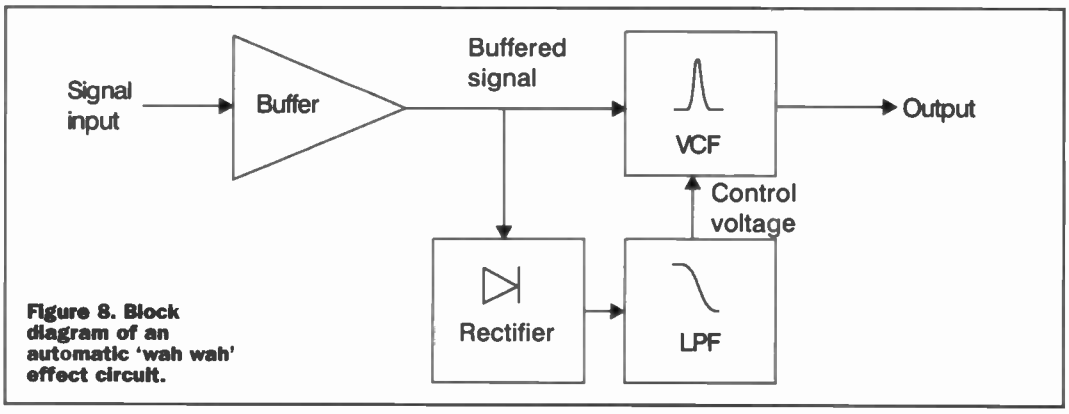


Figure 8. Block diagram of an automatic 'wah wah' effect circuit.

Digital techniques are being continuously updated and it is not possible to cover all of the possible configurations here. Those interested are referred to the relevant text books on the subject. A number of these may be found in the books section of the Maplin Catalogue.

Flanging and Chorus

Similar methods to those used for producing digital delay effects can also be used to produce flanging and chorus effects. Flanging is produced by creating a cyclically variable short duration delay. Different effects can be created by changing the rate at which the delay is varied and the amount of delay time variation (depth). A similar method can be used to create a chorus effect but longer delay times are required.

Dealing with Unwanted Noise

When several high gain circuits are connected together a considerable amount of unwanted noise can be introduced onto the signal. With each successive stage of amplification the noise is amplified further. When the amplifier is being driven at high input levels, the effect of the noise is usually negligible but when there is no input the hiss and hum can be extremely irritating. It is best to deal with the noise at source, for example by ensuring input leads are reliably screened, circuit layouts are correct and frequency response is not excessive. The use of balanced lines can also be useful as these tend to cancel common mode noise.

When high levels of amplification are used, sometimes even the best circuit design does not reduce the noise level sufficiently. Various active noise reduction techniques have been developed over the years. One method that is relatively simple to implement is the noise gate. This is a circuit which mutes the amplifier during quiet breaks in the music. Although the actual noise level is not reduced when the amplifier is active, the noise becomes less noticeable because the power amplifier input is effectively disconnected when no signal is present. The threshold of the noise gate must be chosen so that it does not cut the output when the guitar is being played even during quiet passages. A threshold level control may be provided to enable the user to set the most appropriate cut off point.

Choice of Power Amplifier

There are many factors to be considered when constructing a power amplifier for guitar use. Power output, frequency response, power supply requirements and dynamic range are all factors that must be considered. One factor of foremost importance is safety. It is essential that inputs and other parts of the circuit that are accessible to the user are correctly isolated from the mains supply and other lethal voltages and that adequate protection is afforded against the risk of electric shock. These points are of particular concern with valve amplifiers due to the high voltages present, but it should be remembered that semiconductor amplifiers can also involve high voltage supply rails and often are mains powered. Correct fusing is also important. Even amplifiers with comparatively low power supply voltages can develop high current levels with associated thermal considerations. For this reason, high power amplifiers are generally not a good starting point for beginners.

For home practice use, the power levels required are generally in the order of just a few watts and the hazards can be considerably reduced by the use of IC power amplifiers operating from low voltage power supply rails. The use of this technology may be considered inappropriate by some guitarists but these devices allow effective power amplifiers to be built by those relatively inexperienced in amplifier construction. Many different types are available with widely varying characteristics. Some stereo types allow the outputs to be bridged to provide a lower output impedance. This allows the output power to be increased without increasing the supply voltage.

The main points to look out for with these ICs are adequate heatsinking, correct fusing of the supply rails and prevention of RF instability. To this end, correct component layout is essential. For amplifiers operating at just a few watts involvement with the mains supply can be almost entirely eliminated by powering the unit from a commercial DC power supply.

Next month

Next time we will look at the construction of a practical home practice amplifier with a range of optional effects using some of the ideas we have covered in this article.

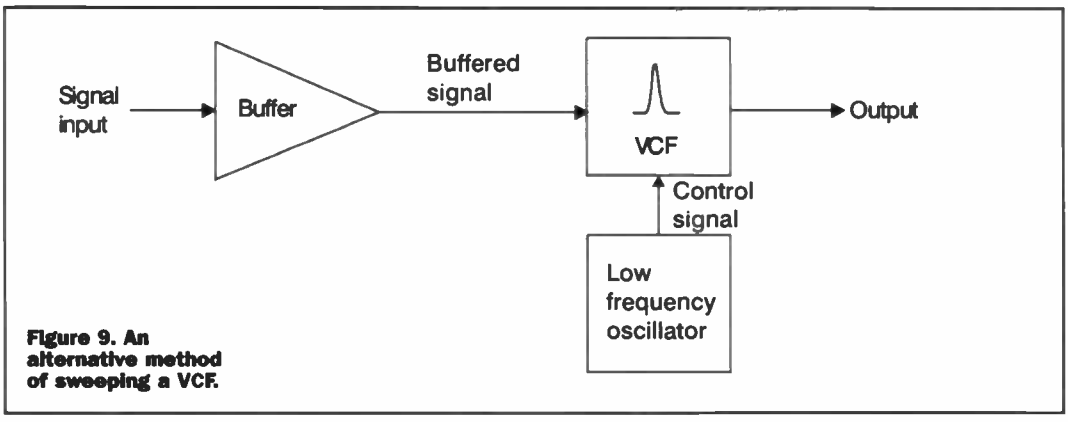


Figure 9. An alternative method of sweeping a VCF.

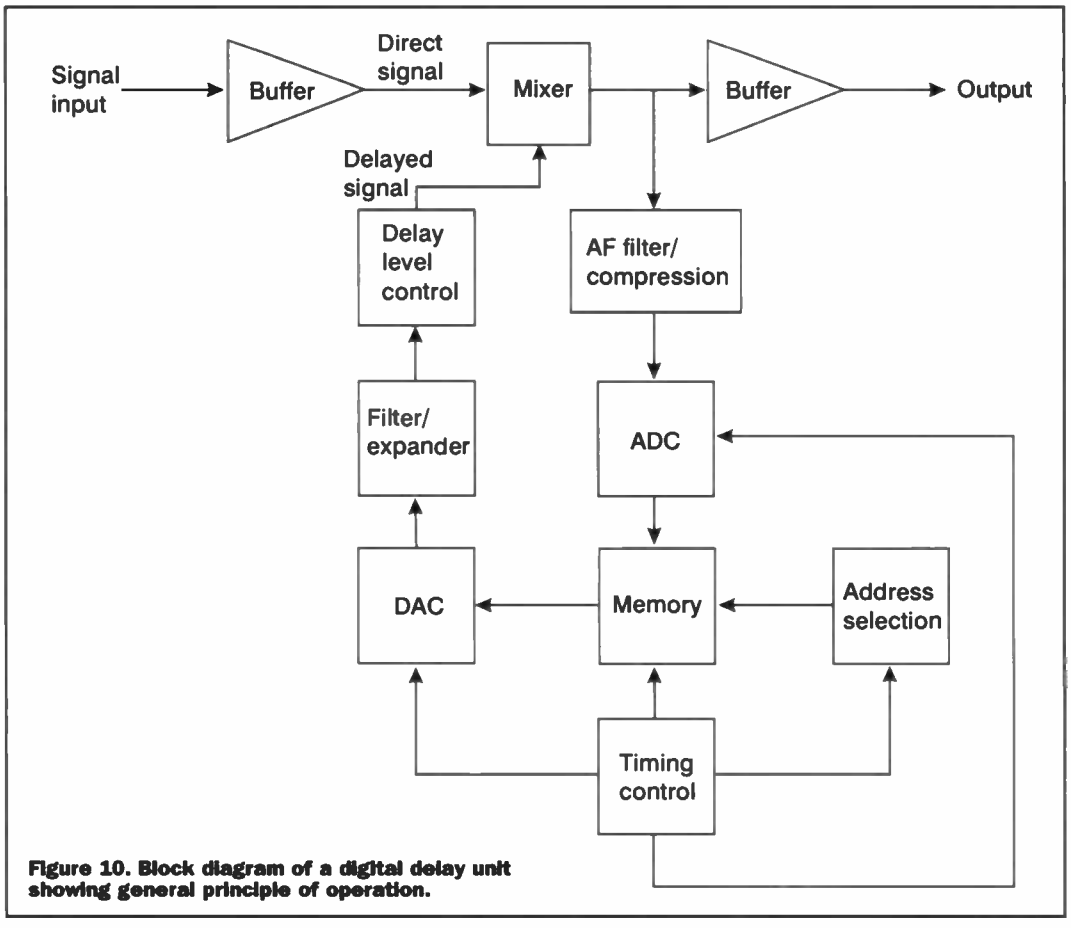


Figure 10. Block diagram of a digital delay unit showing general principle of operation.

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.

October 1999

1 to 2 Oct. TheatreWorld - Theatre Productions & Management, Wembley Exhibition Centre, London. Tel: (01895) 811 986.

5 to 6 Oct. FieldComms - Industrial Networking Show, Telford Exhibition Centre, Telford. Tel: (0171) 417 7400.

6 to 7 Oct. Softworld in Accounting & Finance, National Exhibition Centre, Birmingham. Tel: (0181) 541 5040.

6 to 7 Oct. TEST - Electronic Testing Exhibition, National Exhibition Centre, Birmingham. Tel: (01203) 230 333.

12 to 14 Oct. Cards UK - Plastic Card Technology, National Exhibition Centre, Birmingham. Tel: (0121) 767 2665.

19 to 20 Oct. Property Computer Show 99, Barbican Centre, London. Tel: (01273) 836 800.

20 to 21 Oct. Accounting IT, Business Design Centre, London. Tel: (0171) 221 1155.

26 to 28 Oct. City Information Show, Barbican Centre, London. Tel: (01865) 204 947.

26 to 28 Oct. Computers & Networks in Manufacturing, National Exhibition Centre, Birmingham. Tel: (0181) 232 1600.

26 to 28 Oct. Mobile Data Communications Trade Exhibition, Olympia, London. Tel: (0181) 910 7910.

26 to 28 Oct. Windows NT - Computer Trade Exhibition, Olympia, London. Tel: (01256) 384 000.

November 1999

2 to 4 Nov. e-business expo 2, Olympia, London. Tel: (0181) 910 7910.

8 Nov. PC@Home+Internet4All, G-MEX Centre, Manchester. Tel: (01895) 630 288.

10 to 11 Nov. Data Warehousing, Olympia, London. Tel: (0181) 879 3366.

16 to 18 Nov. Digital Media World, Wembley Exhibition Centre, London. Tel: (01244) 378888.

16 to 18 Nov. Electronic Information Display, Sandown Exhibition Centre, Sandown. Tel: (01822) 614 671.

17 to 18 Nov. JAVA - Computer Software Trade Exhibition & Conference, Olympia, London. Tel: (01256) 384 000.

17 to 18 Nov. Softworld in Sales & Marketing, National Exhibition Centre, Birmingham. Tel: (0181) 541 5040.

December 1999

7 to 8 Dec. Digital Signal Processing & Data Acquisition, Sandown Exhibition Centre, Sandown. Tel: (0181) 547 3947.

7 to 9 Dec. Online Information, Olympia, London. Tel: (01865) 388 000.

February 2000

8 to 9 Feb. Accounting IT, G-MEX Centre, Birmingham. Tel: (0171) 221 1155.

9 to 10 Feb. Softworld in Human Resources & Payroll, Wembley Exhibition Centre, London. Tel: (0181) 541 5040.

March 2000

6 to 9 March. Electrex 2000, National Exhibition Centre, Birmingham. Tel: (01483) 222 888.

9 to 10 March. Softworld in Accounting & Finance, Olympia, London. Tel: (0181) 541 5040.

April 2000

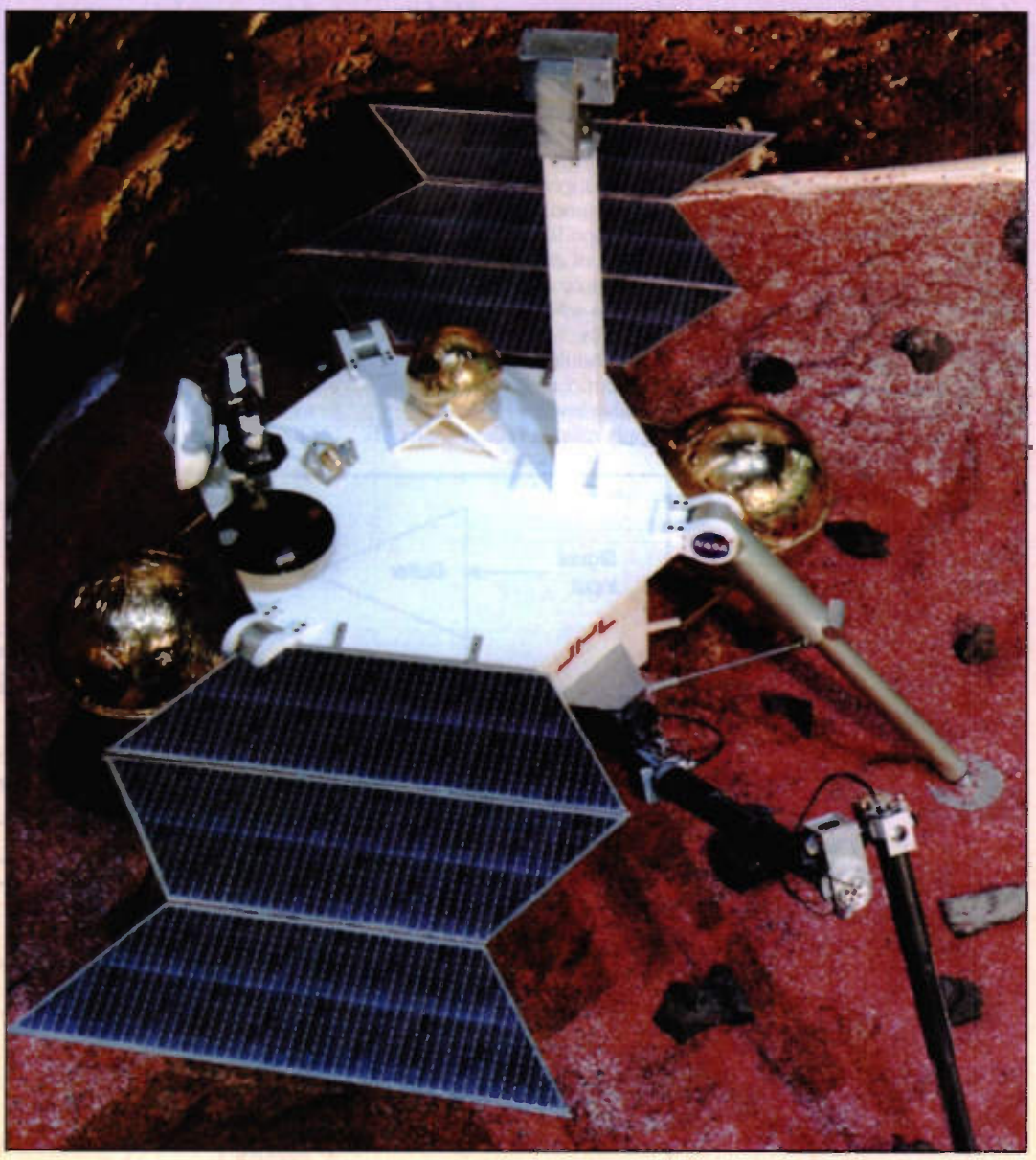
10 to 13 April. Automation & Robotics, National Exhibition Centre, Birminham. Tel: (01737) 768 611.

10 to 14 April. Engineering Lasers, National Exhibition Centre, Birmingham. Tel: (01737) 768 611.

28 to 30 April. PC@Home & Internet 4, Earls Court, London. Tel: (01895) 630 288.

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?



New Space Strategy Brings £19.5 Million Boost For UK

Science Minister, Lord Sainsbury has announced a £19.5m package of new investment in space science, engineering and technology.

"Commercial markets for satellite communications and navigation are estimated to reach $150bn per year by 2010", said Lord Sainsbury, speaking at the Science Museum where he announced the UK Space Strategy 1999 to 2001.

"The challenge for UK industry is to continue to capture more than its fair share of those markets, supplying both hardware and software to meet the needs of tomorrow's customers and tomorrow's society."

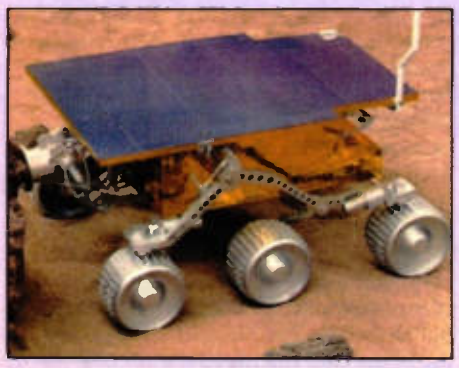
To help achieve this goal Lord Sainsbury announced a three year £10.5m investment in the European Space Agency's programme of telecommunications technologies accompanied by a £4m national programme of advanced spacecraft technologies.

Lord Sainsbury also introduced the UK Space Strategy 1999 to 2001 which maps out the actions to be pursued by the British National Space Centre in positioning industry to maintain and expand its share of the rapidly growing commercial markets for telecommunications, multi-media and global navigation. It also sets challenging objectives in the space and environmental sciences, where UK researchers have an established reputation for excellence.

The Strategy confirms the outcome of the Comprehensive Spending Review which earlier this year led to an allocation within the DTI's budget of £90m for space for each of the next three years. On the basis of commitments made and already foreseen, total UK civil space expenditure is expected to amount to a minimum of £180m per year in this period.

In addition to support for pre-commercial technology development, Lord Sainsbury also committed £5m to developing the Mars Lander, Beagle 2.

"The Beagle 2 Mars Lander is an exciting scientific mission which will be a superb demonstration of the skill and creativity of British science and engineering.



"By examining the composition of the atmosphere on Mars, of what lies below its surface and inside Martian rocks, Beagle 2 will be able to determine what processes take place on Mars, including its geology and climate. It is a ground-breaking mission which will give us a great insight into this intriguing planet."

Beagle 2 is due to be launched in 2003 on the European Space Agency's Mars Express mission. It will reach the planet in late December that year.

The Space Strategy is the result of an open consultation process with the British National Space Centre (BNSC), involving a wide range of representatives from the space industries, the space science community and the Earth observation science community.

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

Contact: British National Space Centre, Tel: (0171) 215 0806.

UK Space Programme Goals

- help industry maximise profitable business opportunities in the development and exploitation of space systems;
- foster development of innovative technology, its commercial application and its application in research;
- pursue the highest quality astronomy and space science;
- improve the understanding of the Earth's environment and natural resources;
- communicate the results and their significance to a broad audience.

Design A 6m Transceiver Costing Less Than £50

A radio project initiative has been proposed by 1997 Young Amateur of the Year Emma Constantine, 2E1BVJ. Called 'Emma's Challenge', the project involves building a 6m, 3W FM portable transceiver for less than £50. Entrants have until the end of 1999 to submit their entries.

The RSGB has agreed to give the competition maximum publicity. The Radio Communication Agency has also pledged its support and has donated £1,000 worth of sponsorship, and Emma is keen to attract other sponsors.

Those wishing to submit a project must comply with the following requirements: all practical designs must have been submitted for print in RadCom, (Ham) Radio Today, Practical Wireless or Sprat by the 31 December 1999.

A component list, with sources and costs for new components must be included, together with a PCB layout design. At least one unit must have been built and be available, if required, for evaluation by one of the participating magazines or the judges.

For further details, check: <www.rsgb.org.uk>.

Contact: RSGB, Tel: (01707) 659015.

Martlesham Engineer Wins First IEE

Premium Award Andrew Rimell, a Research Engineer at BT Laboratories, Martlesham, has received the first Associates Premium Award to be presented by the IEE, Europe's largest professional engineering society. Dr Rimell, 31, won the Award for the best original published article written by an Associate member of the Institution over the age of 30.

As well as a cheque for £500 Andrew also received a Certificate which was presented to him by Professor Peter Cochrane OBE, chief technologist at BT and himself a Fellow of the IEE.

Rimell has worked at the BT Laboratories since 1997 in the Multi-Model Perception Group. His research interests include spatial audio, perceptual modelling and signal processing.

For further details, check: <www.iee.org.uk>.

Contact: IEE, Tel: (0171) 240 1871. ELECTRONICS

WAS EINSTEIN RIGHT?

PART 2

In this last part, Graham Marett puts Relativity to the test.

As mentioned last month, Newton had already formulated the view that the laws of physics should remain invariant for all observers. Einstein recognised that this idea was fundamental, and he adopted it as a 'metaprinciple' which should underpin all other theories. His crucial insight was to see that this 'Principle of Relativity' must apply to Maxwell's electromagnetic theory as well as to the dynamics of moving bodies described by Newton's laws of motion. He saw that this would immediately provide a solution to the puzzle of the Michelson-Morley experiment, and would also resolve his 'gedanken' experiment. It would also have dramatic and far-reaching implications for the rest of physics.

Einstein's Two Postulates

Einstein made two postulates which were central to relativity theory. Firstly he stated quite simply that the ether could not be detected. He did not deny its existence, but noted that experimental detection of the ether would give one particular frame of reference a 'special' status denied to all others: namely, the frame of reference which was at rest relative to the all-pervading ether. If all frames of reference were to be considered equal in the eyes of the laws of physics, then the ether must in principle be undetectable, so that we need not waste our time performing experiments designed to measure its properties.

Secondly, and more controversially, Einstein stated that the velocity of light 'c' should be the same for all observers, regardless of their relative states of motion (note that Einstein is referring here to the velocity of light in vacuo, since it was well known that light travelled at slower speeds in dense media such as water or glass). This seemingly harmless statement had dramatic implications which would quite literally shake the world.

The constancy of the speed of light was a necessary consequence of applying the Principle of Relativity to Maxwell's equations, which specified the value of 'c' independently of any particular frame of reference. It immediately resolved both of the problems described above: the Michelson Morley experiment would never detect a difference in the speed of light in two different directions, because according to relativity theory there could never be any difference! And Einstein's 'gedanken' experiment would not lead to a problem with electromagnetic theory, because it would never be possible to travel alongside a light beam at the same speed: however fast the observer tries to travel, the light beam will always be passing him at precisely the same relative velocity c.

The fact that all observers of a specific light beam will obtain a velocity relative to their measuring equipment of 'c', whatever their velocities relative to each other, clearly contravenes our common sense ideas about space, time and velocity. In the Newtonian world velocities are additive: if you are travelling on a train and you walk towards the front at two miles per hour, and the train is moving at sixty miles per hour, then your own speed relative to the ground will be sixty two miles per hour. For a light beam, however, things are different: its velocity relative to both the train and the ground are precisely 'c', regardless of the speed of the train!

Einstein saw that this was not something peculiar about the light beam itself, but reflected a bizarre and highly non-intuitive property of space and time which would affect the way observers in different frames of reference viewed one another. The strange effects would become more noticeable as the relative velocities of the frames of reference approached the ultimately unattainable speed of light itself.

The two postulates of relativity formed the heart of Einstein's 'special' theory of relativity. The word *special* in this case means that the theory is restricted to a special case: that when the frames of reference in question are 'inertial' frames, which means that they are moving relative to one other with uniform motion, at constant velocities and in straight lines. Extending the theory to the general case of non-uniform motion would tax even Einstein's abilities to the full, and take him a further ten years of study.

Theory Put to the Test

The underlying laws of physics which govern our universe should not depend on who is observing them. This simple fact may seem patently obvious, but Einstein showed that a rigorous logical application of this 'metaprinciple' revealed a subtle and previously hidden structure to the universe.

Last month I described how careful thinking about the interplay between electromagnetic theory and Newtonian physics had led Einstein to his remarkable conclusion that the velocity of light was constant for all observers. This is not a property of light itself but reflects the peculiar nature of space and time, which do not simply form the passive 'backdrop' to the universe.

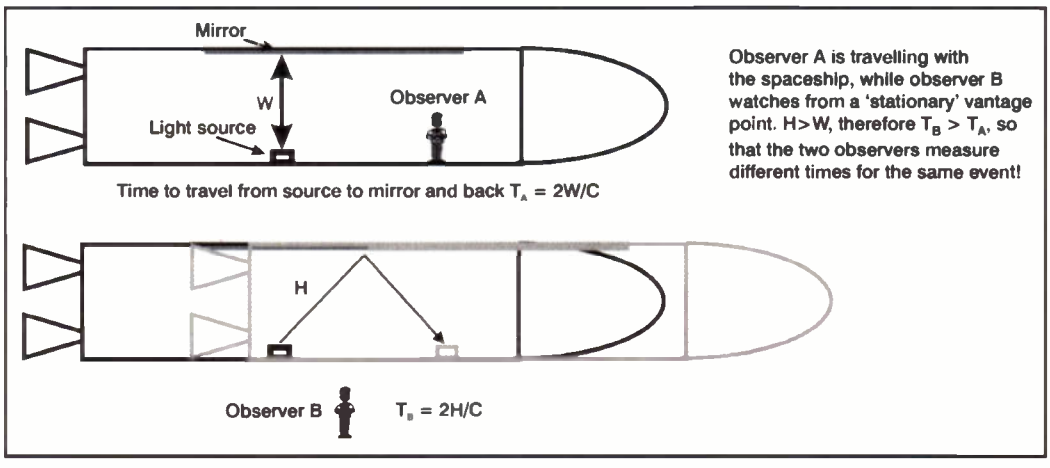
So let us look at some of the bizarre consequences of relativity, and discuss some of the ways in which the theory has been put to the test. For Einstein this was only the beginning, and his long-term goal was to incorporate the mystery of gravity within his Principle of Relativity. The resultant general theory of relativity was one of the most aesthetically beautiful constructions in the history of physics, and its power and scope form the intellectual heart of modern physics and cosmology.

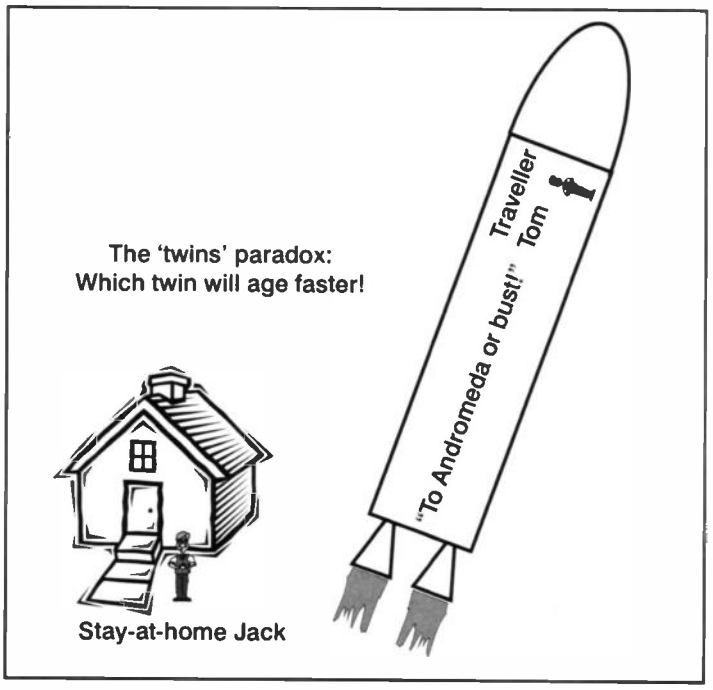
The Consequences of Special Relativity

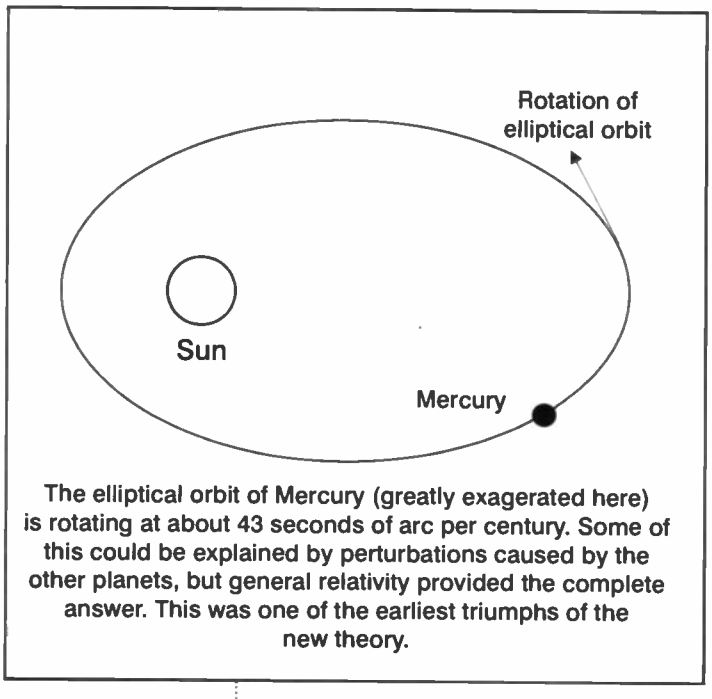
Using little more than the Pythagorean equation for a right-angled triangle and some elementary concepts from physics (such as momentum and kinetic energy), it can be shown that Einstein's statement about the constancy of the speed of light has some remarkable implications which seem to defy common sense. However the predictions of the theory have been put to the test in many ways, and verified to a high degree of accuracy.

Firstly, time in one frame of reference appears to flow at a different 'rate' to time in another frame of reference when the relative velocity between the two frames is large. We are forced to abandon any fond ideas we may have about a uniform time applying throughout the universe, or our ability to accurately synchronise two clocks, or even our intuitive idea about what it means for two events to occur 'simultaneously'. Ultimately this can lead to a reappraisal of the concept of cause and effect (especially when linked to the even more bizarre implications of quantum theory), with profound philosophical implications.

The difference in the 'rate' at which time flows in different frames of reference has been verified by careful observation of cosmic rays and atomic collisions occurring in particle accelerators, where velocities can be very close to the speed of light. The high-energy particles produced in such circumstances are observed to decay at a slower rate than their low energy counterparts, exactly in







The elliptical orbit of Mercury (greatly exagerated here) is rotating at about 43 seconds of arc per century. Some of this could be explained by perturbations caused by the other planets, but general relativity provided the complete answer. This was one of the earliest triumphs of the new theory.

accordance with Einstein's prediction.

An even more convincing demonstration of this phenomenon was carried out in 1971, when researchers in the United States borrowed four atomic clocks from the US Naval Observatory and flew them around the world on commercial airliners in both easterly and westerly directions. After the experiment, the times indicated by the clocks were found to differ by precisely the amounts predicted by Einstein's equations (this experiment involves taking into account the force of gravity as well, of which more later). We are not talking large differences here. The discrepancies were of the order of a few tens of nanoseconds (1 nanosecond = 10^{-9} seconds) - undetectable by traditional time-keeping devices, but well within the range which can be accurately measured by modern atomic clocks.

This time dilation effect, as it is called, becomes extreme as the relative velocities approach the speed of light. The ultimate time dilation is achieved in a light beam itself. In our time frame it may take millions or even billions of years for a light beam to cross the vast expanse of the universe, but as far as the light beam itself is concerned the journey is completed in a mere instant.

Another peculiar consequence of relativity theory is that both the mass of an object and its physical dimensions change as the velocity increases, with mass approaching infinity and dimensions approaching zero as the velocity approaches the speed of light (of course the velocities and the effects are as seen by a 'stationary' external observer: an observer travelling *with* the object at the same speed will detect no such effects). These bizarre phenomena have also been verified experimentally, and it is the relativistic mass increase of highly accelerated particles that is the key to the enormous collision energies achieved in atom-smashing machines.

Perhaps the most dramatic and far reaching prediction of Einstein's theory was his famous mass-energy equivalence equation, $E = mc^2$. Compare this equation with the familiar equation for kinetic energy, $KE = \frac{1}{2}mv^2$. Einstein's equation can be derived from the kinetic energy and some other concepts of basic physics using just a few lines of mathematics, involving the Pythagorean equation $x^2 + y^2 = z^2$ and the constancy of the speed of light.

The equivalence was first demonstrated experimentally by Cockcroft and Walton in 1932, when they were able to show that mass lost in atomic collisions was exactly balanced by the energy of the resulting collision products, in full accordance with Einstein's equation. The most awe inspiring demonstration of mass-energy equivalence was the explosion of the first atomic bomb in the New Mexico desert in 1945, closely followed by the devastating use of this new weapon at Hiroshima and Nagasaki.

The power of such devices, and the enormous energy released in atomic reactors (and the similar processes operating within our own sun and other stars), derives from the factor c^2 in Einstein's equation - the speed of light squared is a huge number, so that just a tiny loss of mass can result in the generation of vast amounts of energy.

Proving Einstein Wrong

Many attempts have been made to disprove relativity theory, by showing that its conclusions are fallacious or self-contradictory. An important intellectual difficulty with the theory is that it makes predictions which seem to defy common sense, so that 'common sense' arguments can sometimes appear to contradict relativity theory.

Einstein was well aware of this difficulty, which he countered by pointing out that it was in fact common sense itself which was suspect. 'Common sense', he said, 'is just that layer of prejudice which is laid down in the mind before the age of eighteen'.

One serious attempt to disprove relativity theory is a 'thought experiment' of the kind which Einstein himself enjoyed. The famous 'twins paradox' considers the question of extreme time dilation, and imagines that two twins start off in different frames of reference, with one of them (call him Tom) travelling on an extended journey at time-warping velocities before returning home to his brother Jack.

On Tom's return, special relativity predicts that he will have aged at a slower rate than Jack, who will consequently appear to be considerably older. But there is a perfect symmetry in the universe and no frame of reference can be considered to have 'special' status. We can therefore consider the experiment from Tom's point of view, and decide that it was his frame of reference which remained in place while Jack's frame whizzed off to the far side of the galaxy and back. In this case the situation would be reversed, and special relativity would make Jack the twin who had aged the least.

Since either point of view should be valid, there is evidently a problem: how can both twins have aged faster than the other? This paradox seemingly shows that the ideas of relativity are flawed, since the two contradictory viewpoints cannot both be true.

As usual Einstein was ahead of the game. He was well aware of the twins paradox, but he pointed out that the experiment was not quite as symmetrical as we might imagine. Firstly, the entire experiment violates the conditions under which the logic of special relativity applies. Special relativity is concerned with *inertial* frames of reference: that is, frames of reference which are in a state of uniform motion with respect to one other. The twins experiment requires one twin to travel a large distance at a very high velocity and then return. This involves correspondingly large accelerations and decelerations, during which uniform motion cannot be maintained. Thus the symmetry between the two interpretations is broken, and no paradox occurs.

Einstein also knew that this apparent loop-hole in the theory had to be closed: the Principle of Relativity claimed that the laws of physics should remain invariant for *all* observers, and this should not exclude observers in an *accelerating* frame of reference. Acceleration and force are intimately linked (via Newton's second law), but how does a gravitational force field extend its reach through empty space, and what exactly do we mean by *acceleration* in empty space?

Einstein grappled with these problems for more than ten years after publishing his special theory, and at last solved the puzzle to produce his magnificent general theory of relativity, often referred to as Einstein's theory of gravity.

General Relativity

Whereas the mathematics of special relativity was elementary, requiring little more than a mastery of Pythagoras and high school physics, Einstein soon realised that extending the scope of relativity to accelerating frames of reference would prove immensely difficult. He also knew that this vital step had to be accomplished - inertial frames of reference were all very well for abstract thought experiments, but in the real world they do not exist. Every object in the universe is under the influence of gravitational forces, so that all frames of reference are undergoing some form of acceleration.

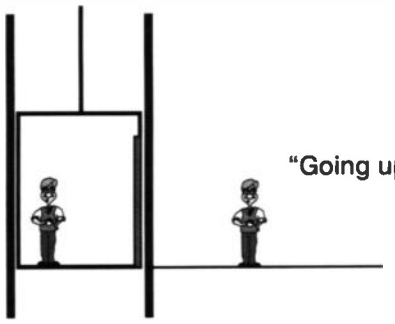
It is important to remember here that planets in orbit around the sun are also accelerating, even though their motion may seem uniform. In the case of an orbiting planet the acceleration is in the form of a constantly changing *direction* of motion, as Newton realised when he formulated his new mathematics of the infinitesimal calculus to explain the link between orbital acceleration and gravitational force via his second law of motion.

Einstein started pondering the question of gravity and acceleration in 1907, shortly after publication of his special theory. A key insight was his sudden realisation that a person falling freely under the force of gravity no longer feels his own weight: a seemingly obvious fact, but one which Einstein described as 'the happiest thought of my life'. He saw that the link between acceleration and gravity was subtle and profound, and he formulated his Principle of Equivalence - observations carried out while undergoing acceleration are indistinguishable from observations carried out in a gravitational force field.

We are all familiar with the links between gravity and acceleration. We refer to test pilots and astronauts experiencing 'g' forces when their crafts are undergoing large acceleration, and when we shake the mercury down in a clinical thermometer we are inducing an artificially large gravitational pull by the process of acceleration. The 'artificial' gravity induced by rotation in the fairground 'wall of death' ride (and in Arthur C. Clarke's space ship in 2001) are other familiar examples. But Einstein went further. His principle of equivalence states that gravity and acceleration are more than just equivalent, they are different aspects of *one and the same thing*.

In the late nineteenth century the great American astronomer Simon Newcomb had made painstaking planetary and lunar studies, and the results of his work became the standard for positional astronomy in the twentieth century. His tables of planetary positions were in regular use well into the second half of our century, and his tables of the sun are still referred to today.

In particular Newcomb had made an exhaustive treatment of Mercury, the innermost planet of the solar system, and had noted a slight orbital anomaly called the precession of the perihelion. This anomaly had already been spotted earlier in the nineteenth century, and the French astronomer Leverrier had proposed that an undiscovered planet (which he named Vulcan) was responsible for the perturbations. This was a reasonable conclusion, since Leverrier had already been involved in the discovery of Neptune as a result of its effects on the planet Uranus, and astronomers hunted in vain for the missing planet.



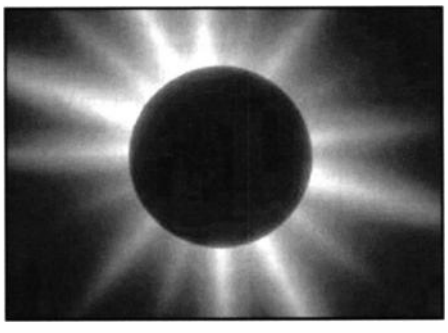
If you are inside a lift, how could you tell the difference between lift acceleration and an increase in the earth's gravity? According to Einstein's Principle of Equivalence there *is* no difference

Newcomb suspected that Mercury's anomaly defied explanation by Newton's law of universal gravitation, and Einstein was convinced that general relativity would provide the answer. He had already suspected himself that Newton's law of gravitation violated special relativity, since it assumed that the distances between objects and their masses were absolute and independent of the frame of reference used for their measurement.

Einstein struggled for years with the problem, finding that he needed to immerse himself in a fiendishly difficult branch of modern mathematics known as differential geometry (or tensor analysis, or absolute differential calculus as it is variously known). He was helped in this endeavour by an old classmate Marcel Grossman, now a professor of mathematics. (Einstein was primarily interested in the problems of physics, and although he was a thoroughly competent mathematician this was not where his primary genius lay, contrary to the popular view.)

In the autumn of 1915 Einstein finally solved the problem, and as he had anticipated he found that his new theory precisely accounted for the observed anomaly in the orbit of Mercury.

As usual Einstein's genius was his ability to push ideas to their logical conclusion, and he realised that the application of the principle of equivalence and general relativity to electromagnetic phenomena had profound (and ultimately testable) implications. An early test of the theory was provided shortly after its publication, by the occurrence of a total eclipse of the sun in 1919.



The general theory had predicted that electromagnetic radiation, and light in particular, would appear to bend around a massive gravitational object. A total eclipse is the perfect opportunity to verify such an effect. The apparent position of a star lying very close to the sun in the sky can be measured, and compared with its position when the sun is in a different part of the sky.

The experiment was performed by the astronomer A.C.D. Commelin at Sobral in Brazil, and the deflection due to the sun's gravity was observed to precisely match Einstein's prediction. Notice that we commonly refer to this phenomenon of general relativity as the 'bending of light', but this is not actually what general relativity says is happening. Our vocabulary is simply not up to adequately describing what is actually happening - the curvature of space itself. The light beam is still travelling in a 'straight' line, in fact, the path of a light beam is the very best we can manage for a definition of what we mean by a straight line, curved space or not. The lines are still 'straight' in the vicinity of a massive object, but the space-time continuum itself has become warped.

These earlier successes of the theory were just the start. Since then the general theory has been tested in countless experiments, and has passed every test with flying colours. It is one of the most remarkable achievements in the history of physics, and has probably undergone more rigorous and searching verification than any other theory.

Today general relativity is the cornerstone of modern cosmology, and lies at the heart of modern ideas concerning such exotic objects as white dwarfs, neutron stars and that ultimate mystery of the universe, the black hole. The 'cutting edge' of cosmological physics is seen by many as the search for an understanding of the nature of the inaccessible interior of a black hole.

The American physicist Kip Thorne has spoken of 'domains of validity' for physical theories. We can think of Newtonian mechanics as being perfectly valid and acceptable in the familiar domain of our everyday lives, where speeds and gravitational forces are relatively modest. As velocities approach the speed of light, however, Newtonian mechanics does not cut the mustard, and it is necessary to resort to special relativity for a proper understanding of the universe.

Further up the scale, where gravitational forces become overwhelming in the vicinity of neutron stars and black holes, general relativity rules the day. Time and space as we know them become so warped in the vicinity of a black hole that 'normal' physics no longer applies, and at the so-called 'event horizon' of the black hole time and space simply cease to exist.

What about the interior of the black hole? Here perhaps we are in a domain which could properly be described as 'outside' of our own universe, and the conditions may resemble the infinite void which predated (if that is the right term!) the existence of our universe. Physicists and cosmologists today grapple with the complexities of a new branch of physics known as 'quantum gravity' in an attempt to understand this new domain of validity, but that is another story!

Software HINTS & TIPS

by Mike Bedford

Finding a needle in a haystack – that's what finding a file on your disk can be like. This month – some tips on finding files.

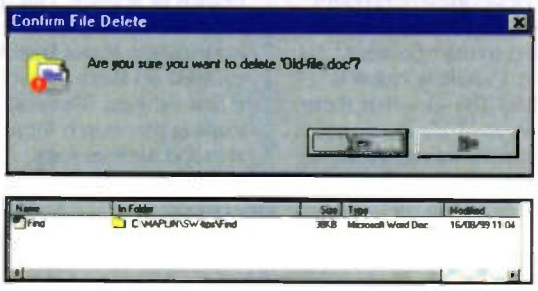
I'm sure I'm not the only PC user who has difficulty in remembering where I stored a file or even what I called it. The snag is that hard disks are just so large. The file containing the text and screen dumps for this article is just a touch smaller than 40k. I could cram over 150,000 files this size on my 6Gbyte disk – no wonder it can be a real headache finding files. This month I present some hints and tips on finding files. Many of my tips will be pure common sense. However, if you feel that some of the suggestions are blatantly obvious, as indeed they will be to some readers, I trust you'll stick with us. What's obvious to one person isn't always obvious to another and you'll know how easy is to overlook the obvious.

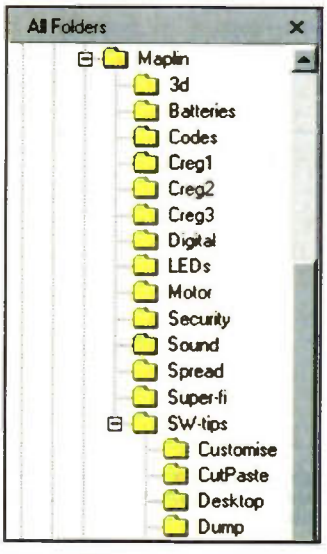
Housekeeping

Common sense tip number one is to carry out housekeeping on your hard disk on a regular basis. I'm sure I don't have to introduce you to the Widows explorer and the Delete key and together these provide a means of ensuring that your disk doesn't get cluttered up with rubbish. At one time disks were small and PC users were forced to clear out old files in order to free up some space. Today this usually doesn't apply and so the squirrel instinct comes to the fore. But although you might not have to delete old files to make space on the disk, it's far easier to find a file among 50 Word documents than to have to search through a few hundred. So be ruthless with your old files. Certainly don't delete stuff you may want in the future but most people end up keeping files which they know they'll never need to refer to again. And if you really can't bring yourself to delete those old files, how about archiving them to a Zip disk?

Directory Structure

A hierarchical directory structure has been a feature of all serious operating systems for many years but, many people still don't make the best use of this feature. Such a directory structure, of course, is one which allows you to create directories, sub-directories, sub-sub-directories and so forth, ad infinitum. Official Windows terminology is now folder and sub-folders but directories is a more general term which applies to any operating system. Sensible use of a hierarchical directory structure is one of the most reliable ways of being able to find files. I write articles for a number of magazines so have a directory for each – the directory I use for Electronics & Beyond articles is called Maplin. Immediately, this makes it far easier to find an article I've written for this publication than if I'd stored all my articles for all magazine in the root directory. But even so, finding one article among the many I've written for this magazine wouldn't be easy if I didn't also use sub-directories. So I have a SW-tips sub-directory for this column and this file is actually in a sub-sub-directory called Find. So the full path for the directory containing the text and screen shots of this particular article is C:\Maplin\Sw-tips\Find.





Perhaps you haven't made best use of the Windows hierarchical directory structure but it's not too late to start now. So long as you're au fait with the Windows Explorer – and we looked at this in some details a few months ago – you can start creating a sensible directory structure and moving files around accordingly. Then, next time you want to find a file, it should be rather easier than it has been in the past.

Also, on a closely related topic, don't overlook the naming of files. Use sensible names which give a clue to the file's contents. Don't use names like Fred (unless it actually is a letter to Fred) or File3 as these give no clues whatsoever as to what the file contains.

Searching

OK, that's the common sense measures out of the way. But despite all your good intentions on regular housekeeping, and despite having a logical directory structure, you're still going to get into the situation, on occasions, in which you just can't remember where you saved a particular file. Fortunately, the Windows Explorer comes to the rescue with a search facility. Let's assume that you know there's a file called Find.doc (this file) somewhere on the disk but you can't remember which folder you stored it in. In fact, we've already seem where this file is stored and because the directory structure is logical it should be easy to remember. Nevertheless, let's now see how the Windows Explorer could be used to find it. In the Windows Explorer select the root directory (C:\) then select Tools > Find > Files or Folders. Enter the name 'Find.doc' in the 'Named' text box, ensure that the 'Include subfolders' checkbox is checked, and press the 'Find now' button. After a few seconds, a list of all files with the name specified will be listed. An example of a search on my disk is shown here and you'll see that there was only one file called Find.doc and that it was, as expected, in the folder C:\Maplin\SW-tips\Find.

Of course, finding a file this way is only useful if you can remember what you called it. But even if you can't remember what name you gave to a particular file, the Find facility in the Windows Explorer can still be very useful. I'm not going to provide you with exact details of how to perform the various types of search, after all it should be easy for you to figure this out yourself, but I will hint at the sorts of facilities offered. Do play around with this useful utility so that you'll know how to use it when you need to do so. One useful facility for files containing text, is to search for files including a specified word or phrase. As you'll know from Web searching, this can easily throw up too many files to be useful so you'll have to learn to specify a text string which is truly unique to the file you're looking for. This type of search is also likely to take a long time so be sure to cut down the number of files searched by also specifying a file type (e.g. *.doc") under "Named". You can also cut down the search by specifying only files created or last modified between certain dates or within the last so many months. You can even restrict your search to files larger than or smaller than a specified size. Also, in addition to the Windows Explorer find facility, MS Word contains an even more fully featured utility for finding Word files. Take a look under File > Open > Advanced.

ASTROBIOLOGY

PART 1

The new science of Astrobiology is dedicated to the search for life on planets other than the Earth. In the first part - A Basis For Life - of a three part series, David Clark goes back to the beginning.

Introduction

More than three billion miles from Earth, and five hours away by radio communication, the Voyager spacecraft is continuing its cold, silent, solitary journey towards interstellar space. As it headed away from Triton, Neptune's moon, its original purpose, the flyby of all of the giant gas planets; Jupiter, Saturn, Uranus and Neptune and their satellites was complete, a journey made possible by an alignment of the planets that only occurs once every two centuries. Its power systems will enable it to send back ever fainter signals until around 2015 when it will be 12 billion miles away, and then, starved of energy, its systems will fade and shut down, and it will passively pursue its potentially endless journey, helplessly pulled and pushed by the gravity of as yet unknown planets circling unnamed stars, a lifeless shell. We will no more know the ultimate fate of our age's technical achievement than the builders of Stonehenge could know the fate of their work. Is it possible that below the watery surface of one of the planets that Voyager flies past, strange creatures are swimming, or are about to crawl from that water onto a land that would be recognisable to the first organisms that left the sea on Earth more than 300 million years ago? Or even more fantastic, could it be retrieved by a race of beings with the capability of deducing what it was and its purpose, and would they look up at their own night sky and be amazed by the realisation that there is a star in another galaxy somewhere with a planet circling it like their own, and that they are not alone in the universe after all?

This is the stuff of science fiction of course. Why should any other form of life in the universe be at the same stage of evolution as ourselves, standing upright at around six feet tall, with two legs, two arms, and one head at the top containing a brain capable of designing space craft, creating music and paintings, and looking at the stars and wondering 'is there anyone out there' and 'does God exist?', after 4600 million years of development brought about by chance mutation and adaptation to environment. Perhaps it's unlikely, but is it impossible? The idea that there is some form of life elsewhere, not necessarily beings currently 'out there' but any form of life, perhaps micro-organisms that are alive now or once were alive, now has sufficient credibility to justify a new branch of science. Discovering such life would provide information about how life evolved on Earth or even where it first evolved. The science leading the search for such life is called Astrobiology.

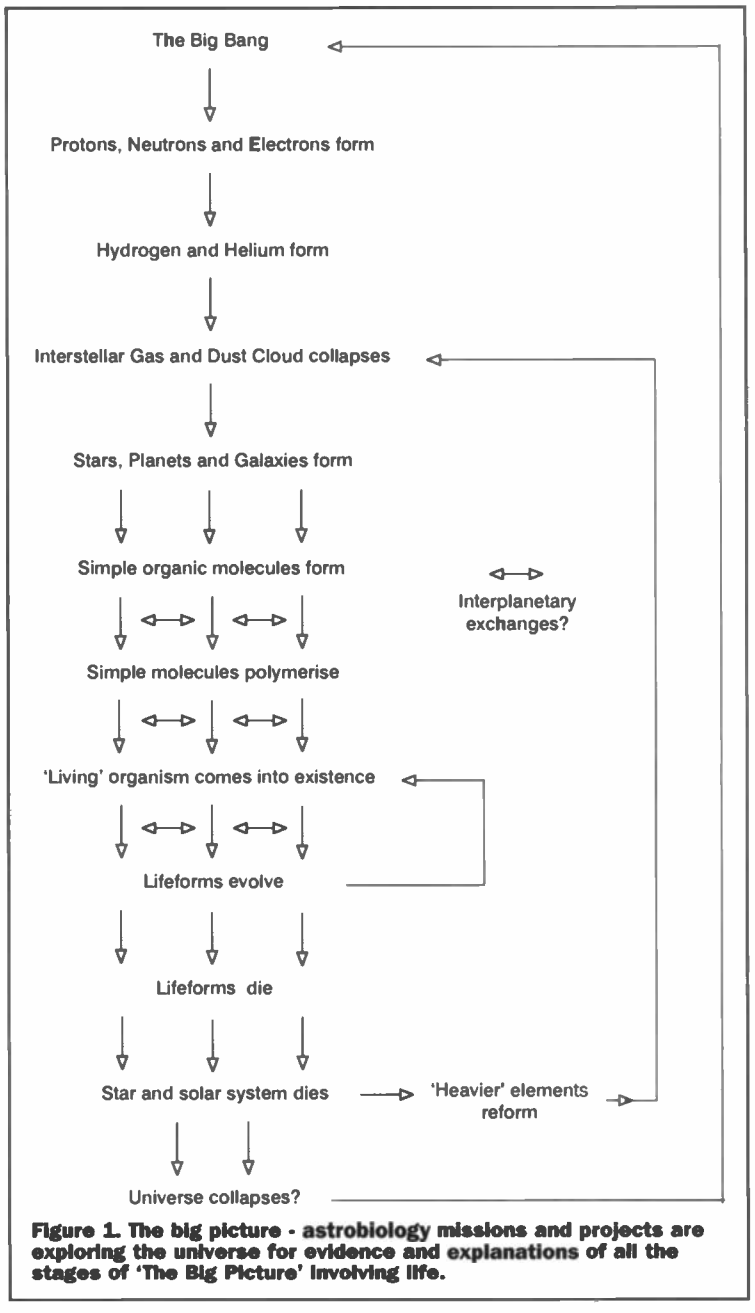


Figure 1. The big picture - astrobiology missions and projects are exploring the universe for evidence and explanations of all the stages of 'The Big Picture' involving life.

Astrobiology

Astrobiology, sometimes referred to as exobiology or xenobiology, is the science of life anywhere in the universe other than on Earth. Such a broad definition involves most branches of science and engineering both on and off Earth, and even brings in questions of philosophy and religion; this makes this fascinating subject literally of universal interest. The questions it seeks to answer address issues that have been debated across all cultures throughout history, namely why are we here?, how did we get here? and how is it all going to end?, but the current state of science, technology and knowledge gives us the ability to search for real answers to these questions whereas previous generations could only wonder.

The Very Beginning

Current thinking says that the universe began at a single point, called a singularity, where literally everything that has come into existence since then, all matter, energy and space and time itself was compressed into this single point. At such a point, the laws of physics don't apply and so there is no way of determining what occurred prior to that point; for example had a previously existing universe collapsed back on itself to re-form that singularity? Since time itself came into existence at that point the concept of 'before' the universe came into existence is meaningless, and so some might argue that believing in such a thing is as much a matter of faith as believing that life and the universe were created by some divine being. However, theoretical physics and practical experiments into the nature of materials, fundamental particles and forces has established that the universe began with this 'Big Bang'. From that moment, according to some beliefs, it was inevitable that life on Earth evolved. But some of the big questions are, throughout the vastness of the universe, is life on Earth really unique? Are the conditions that led to life on Earth unique? Might different conditions lead to different forms of life? Could there be similar forms of life but at different stages of development? And might some forms of life have already run their course, extinguished as water and atmospheric gases boiled away, leaving nothing but ghostly traces perhaps billions of years old, possibly to be found by robotic interplanetary explorers, maybe already returned to space dust as their sun died, collapsed

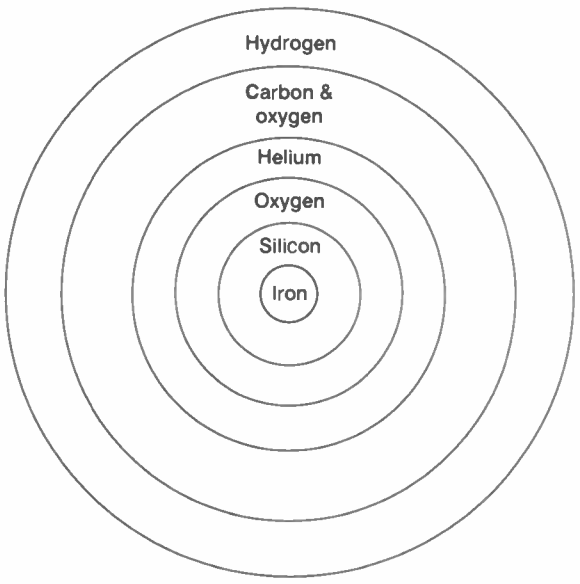


Figure 2. Dying stars - unlike dying small stars where the helium atoms fuse to produce carbon, larger stars collapse into 'layers' of nuclear fusion which produces 'heavier' (greater atomic mass) elements up to iron. In the largest stars the iron then disintegrates releasing neutrons which fuse with these elements to form all other elements. All these are then blown into interstellar space.

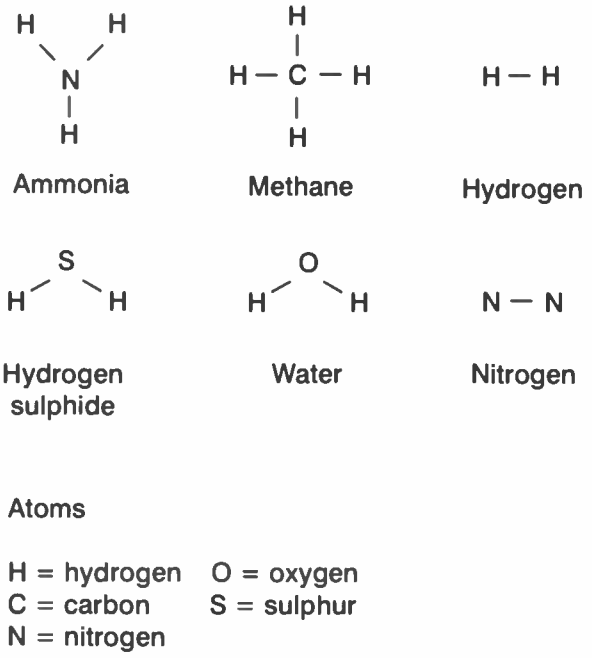


Figure 3 Basic gas molecules present in primitive atmospheres - the basic molecules present after planets form can be seen to have simple structures.

and exploded? Astrobiology seeks to answer some of these questions using science and technology to uncover clues, and human imagination to solve the mysteries.

Common sense, some might say, declares that simply due to chance there must be many places where similar or even identical conditions exist, and so we are unlikely to be alone in the universe. Science is now beginning to prove that there are planets like our own, circling suns like our own, and not that far away in astronomic terms. It could be just a matter of time before we find evidence of some form of life similar to that of Earth at some stage of development behind or even ahead of us, or even a different form of life that has a very different biochemical basis.

The Formation Of the Universe

Immediately following the 'Big Bang' the four fundamental forces of nature and all fundamental particles existed as an unimaginable concentration of energy in the form of a single force sometimes called 'supergravity'. As the universe expanded and cooled the individual forces and particles separated leading eventually to the existence of protons, neutrons and electrons (which compose all materials under normal conditions), and electrical forces (which hold these materials together). Initially these protons, neutrons and electrons were separate entities but as things cooled further and the energy keeping them separate decreased, they could combine and form the stable elements hydrogen (one proton and associated electron), deuterium (one proton, one neutron and associated electrons) and helium (two protons, two neutrons and associated electrons) plus tiny amounts of lithium (three protons, four neutrons and associated electrons) and beryllium (four protons, five neutrons and associated electrons).

Galaxies, Stars and Solar Systems

The next stage was the formation of stars and galaxies, a process which is part of a continuing cycle of formation and destruction as stars are born, live and die along with their associated planetary systems. The vast clouds of primarily hydrogen begin to collapse under their own gravity, becoming more and more dense and getting hotter and hotter as potential energy is converted to kinetic energy, until each is small enough and hot enough to form a core, which causes a flow of material away from itself that removes the surrounding gas. The core then collapses further until it is hot and dense enough to start nuclear fusion which converts the hydrogen to helium giving off huge amounts of energy; this is the state our own Sun is in at the moment. At the same time as the core is forming, the rest of the gas and dust around the core starts to collect into a disc of material. This material begins to clump together forming bigger and bigger particles until they are planet-sized and have their own significant gravity; this attracts other lumps of material large enough to hit the planets with sufficient force to cause craters, or even to cause planets to split into a planet and moon. The gravity can cause planets to capture the moons of other planets, or even capture planets which then become the satellite of the capturing planet. Jupiter is so large, nearly large enough in fact to have become a star in its own right, that its satellites effectively form a solar system within a solar system, the inner moons being rocky like the Earth and the outer ones being cold and icy like the solar system's icy planets. Eventually the disc is completely converted into a system of planets, moons, planetary rings, asteroids, comets and meteors.

A recognisably distinct grouping of stars is of course a galaxy; our star and solar system is a tiny part of the galaxy called the Milky Way. In the beginning the force of the impacts on a rocky mass heats it sufficiently to cause dense molten material to sink and form a core, which becomes surrounded by a less dense mantle and above that a surface crust; this provides the basis for volcano formation and a physically and chemically active planet or moon.

Dying Stars

Eventually all the hydrogen of a star is converted to helium and the star begins to die; the core collapses even more; and then a further nuclear fusion process occurs, with helium nuclei combining to form beryllium and then carbon. In different types of stars as they die different types of fusion take place, forming oxygen and neon, and so on, and in fact all the elements are produced this way. Small stars like the Sun become red giants, then possibly planetary nebulae (the term planetary is historical and refers to its appearance - it has nothing to do with actual planets). The core becomes a white dwarf, eventually fading into an invisible black dwarf. Larger stars can die through different routes, some becoming supernovae, some leaving a neutron star, pulsar or even a black hole. Whichever way the star dies, whatever the elements created as it dies, everything is blasted into surrounding space when the star self-destructs, releasing the material that composes the dust that forms the next generation of stars and planets. It is true to say that all things, including living things, begin as a star.

Back To Earth

When the Earth formed 4600 million years ago the denser material, mostly iron and nickel, became the molten core, above which 'floated' a less dense mantle of iron and magnesium silicates, and above that a relatively light outer crust of silicates, forming the sea floor and the land masses. The gases in the interior, hydrogen, water

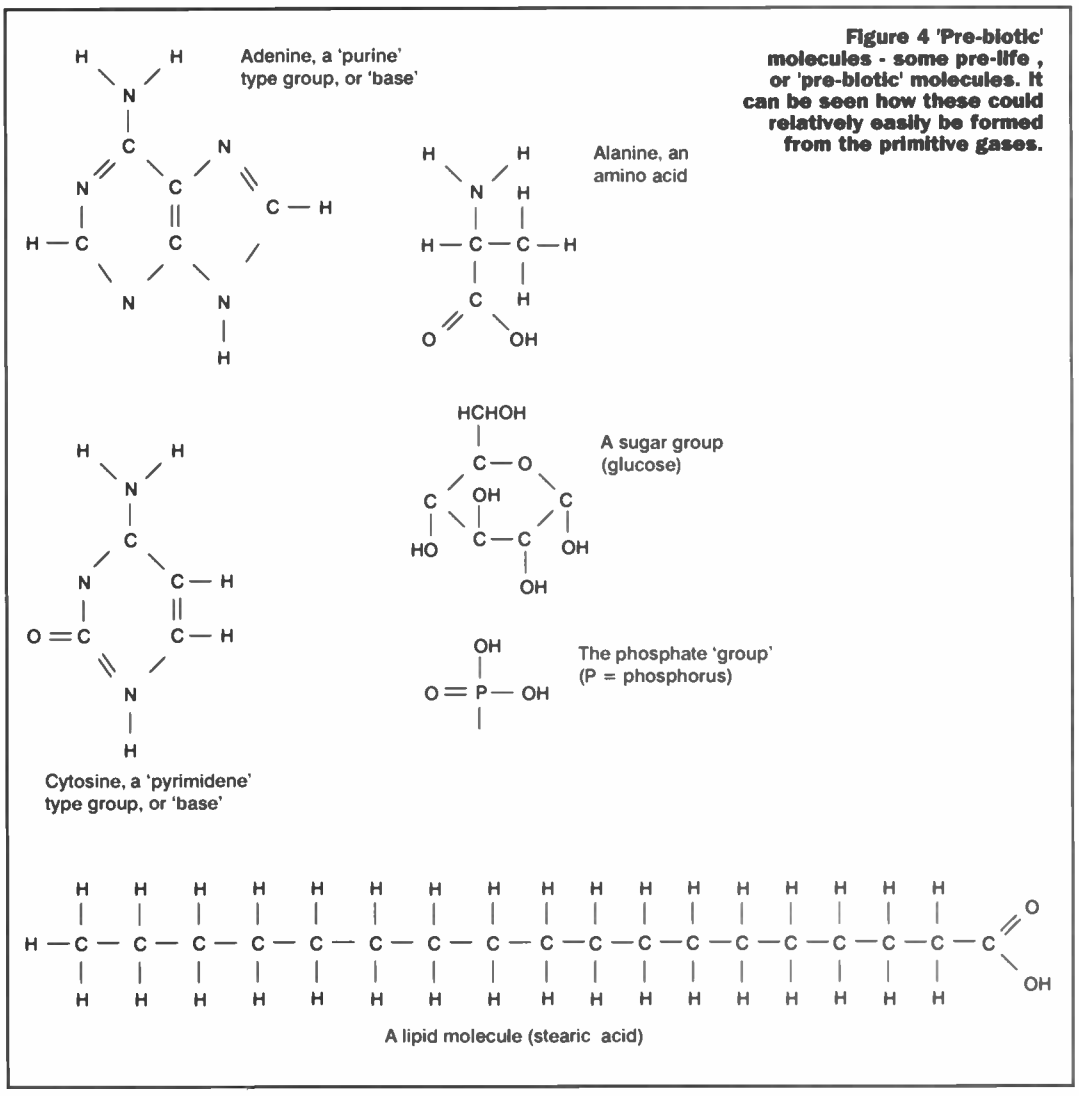


Figure 4 'Pre-biotic' molecules - some pre-life , or 'pre-biotic' molecules. It can be seen how these could relatively easily be formed from the primitive gases.

vapour, methane, ammonia, nitrogen and hydrogen sulphide escaped through volcanoes and formed the atmosphere and the oceans. All these gases contain the elements hydrogen, carbon, nitrogen, oxygen and sulphur, which along with phosphorus are all the major 'light' elements ('light' meaning having a relatively small atomic number) that compose living material, and the conditions were right for the formation of simple molecules and compounds that were in a form that was just waiting for a 'kick-start' for life on Earth to begin.

Chemistry of Life

There are three main categories of chemicals necessary to support the existence of a living thing of even the simplest structure, and most people will recognise these as the components of all the food we must consume in order to stay alive (indicating another link between the most simple and the most complex living things). These are proteins, carbohydrates and fats, also known as lipids. Carbohydrates are composed of carbon, hydrogen and oxygen, and their purpose in all life is to supply energy; in plants they also act as a structural material. Proteins have a range of functions; in non-plants they form fibrous material which has as a structural function, and they also make up enzymes, which are the biological catalysts that speed up many of the normal reactions in a living cell and which also play an important role in controlling the genetic instructions that make living things uniquely able to reproduce. Lipids are a major component of membranes, which make up the cell walls that isolate a living cell from its environment, but also allow it to interact with it by allowing the movement of certain substances through it. How are these seemingly complex molecules that are so necessary for life connected with the simple non-living organic molecules that might arise by chance in the right conditions? The answer is surprisingly simple.

Links, Chains and Polymers

Carbohydrates are simply sugar molecules linked together in chains, often branched chains. Sugars, or saccharides, themselves are simple molecules of three, five or six carbon atoms and their associated hydrogen atoms linked as a chain or ring. As more and more of these rings and chains join together, or polymerise, a wide range of varieties with differing properties become available to provide the energy production and structural properties necessary for the wide variety of forms of life that exist.

Proteins and Lipids

All proteins are made up of subunits of amino acids linked together in chains. Amino acids are composed of relatively small numbers (single figures) of carbon, oxygen and nitrogen atoms (and sulphur in two cases), and associated hydrogen atoms. Only twenty different amino acids are needed to make up the wide range of proteins that occur in all living things.

Lipids are even simpler. These are chains of carbon atoms and associated hydrogen atoms (typically 17 carbon atoms) with relatively few oxygen atoms; they can exist on their own, or link with others to form different fats, or importantly for cell membranes, with a simple phosphate group consisting of one phosphorus and three oxygen molecules, to form a phospholipid.

DNA

The fourth group of chemicals necessary for life, and the ones that enable reproduction, mutation and adaptation, are the nucleic acids, which are a part of DNA and RNA molecules. DNA and RNA completely control the activity of living cells. Nucleic acids are long chains of nucleotides, which are themselves composed of three simpler units, two of which have already been met; the phosphate molecule, and the 5-carbon sugar ring. The third vital part is called an 'organic base', of which there are only five. Two are a type of molecule called purines, namely adenine and guanine, the remaining three are a type of molecule called pyrimidenes; these are thymine, cytosine and uracil. All five are simple molecules again made up of carbon, nitrogen, oxygen and hydrogen atoms - the purines are a double ring of total ten atoms, the pyrimidenes are even simpler single rings of six atoms. The names give a false impression of complexity - the organic bases are normally indicated by their initials A, T, G, C and U. The first four A, T, G, C might be recognised as the four letters used to signify the four types of base making up DNA (RNA uses A, G, C, U bases) - these simple molecules elegantly code the structure, activity and life cycle of all living things.

Water

The final crucial component of life systems is the simplest of all - water. This most basic of molecules mediates life's chemistry by virtue of its electronic structure. An oxygen atom has a strongly positively charged nucleus which draws negatively charged electrons towards it. In the water molecule therefore the hydrogen atoms tend to be slightly positively charged and the oxygen atom slightly negatively charged. All of life's molecules contain hydrogen and oxygen atoms; all of these molecules in an aqueous environment therefore interact with water molecules as well as with each other, and this acts in a way that determines the very shape of the molecules and the way they react with each other. The simplest molecule is perhaps the most vital for the most complex system that exists - a living organism.

Life-giving Chemicals

Shortly after the planet's formation an ocean, which ironically would be poisonous to modern life forms, covered

large parts of its surface, exposed to radiation from space, ultra-violet (UV) radiation from its nearest star, and blasted by bolts of electrical lightning, a maelstrom of chemicals and energy. There must have been a first moment when an atom of carbon fused with one of oxygen, or sulphur, or nitrogen and hydrogen; was this the moment when the path to life began? It is believed that under these conditions, and this has been shown to occur in laboratory experiments, basic organic compounds such as glycine and alanine, which are amino acids, and lactic acid and urea, two other compounds which are basic parts of fundamental metabolic processes, were formed, along with sugars such as ribose and de-oxyribose (parts of RNA and DNA), purines, pyrimidines, and nucleotides. The purine base adenine combines with ribose and phosphate compounds under the influence of UV light to form adenosine tri-phosphate (ATP), which is an important chemical involved in the energy processes of living things. These simple chemicals needed one more step to be in place to form the basic chemicals of life - carbohydrates, proteins, lipids and polynucleotides.

Polymerisation

In living cells enzymes are the biological catalysts that speed up the reactions that convert simple molecules into more complex ones, using energy from other chemicals as they do so. Before any life existed, no enzymes existed. However, very many chemical reactions are catalysed by inorganic materials. A common example is platinum, which when in a form that has a large surface area speeds up chemical reactions between compounds that come into contact with it. It is used in cars in catalytic converters where it converts nitrogen oxide, carbon monoxide and hydrocarbons to their oxidised forms, including carbon dioxide and water. To give a large surface area the platinum is deposited on a support material such as magnesium aluminosilicate, a ceramic composed of elements common in rock. A catalyst does not take part in a reaction, it simply causes it to occur more efficiently and rapidly; on the primitive planet surface this role is believed to have been performed by the surface of clay particles in shallow rock pools which would have been subject to the energy of the sun's heat and UV rays. As a result, the simple molecules of amino acids, sugars and nucleotides would polymerise to give the first proteins, carbohydrates and polynucleotides.

Primordial Soup

A 'primordial soup' of organic molecules now washed over large parts of the planet's surface, which over time, by simple chemical reactions, came to consist of more and more complex molecules along with the simple basic ones. This would include chains of similar molecules, and polymers such as chains of amino acids, polysaccharides and nucleotides. Some of these interact to form droplets which again in laboratory experiments have been shown to form membrane-like structures which are capable of absorbing other chemicals. One important chemical which has been shown to be capable of being absorbed by such droplets and be chemically active within them under the influence of light is chlorophyll. This is the chemical that in modern plants uses the energy of sunlight to convert carbon dioxide and water into carbohydrate molecules; this is the lower end of the food chain, and at the top of it is humankind. All the processes described so far are 'lifeless', occurring without any 'controlled' organisation, but it can easily be seen how the basic elements were in place for a jump to a 'living' form, a living form being loosely defined as an organism which can sustain and reproduce itself. That jump probably occurred when such a droplet came to contain the polynucleotide RNA. RNA is capable of 'organising' amino acids into proteins, and proteins are the basic structure for the manufacture of enzymes and structural proteins, so the droplets would be capable of carrying out some of the processes of a living organism, using the chemical ATP as an energy source. From that point on it was a matter of organisms evolving in complexity and variety and adapting in response to a changing environment. As these organisms used up the poisonous materials in the atmosphere and converted them to oxygen and carbon dioxide, thus blocking off most radiation, the conditions seemingly necessary for the formation of new life forms disappeared and the existing organisms had the planet to themselves. But are we talking about planet Earth alone? So far this is one explanation which fits existing knowledge about life on Earth. Conventional scientific theories say that the evolutionary processes that led to the creation of every living thing that has ever existed began in the primordial soup and poisonous atmosphere of primitive Earth. But different theories might also fit in with existing facts. Other bodies in our solar system billions of years ago had similar structures and atmospheres, and some still do today. And what of the billions of other stars and their potential planets?

Other Possibilities

In the next part of this series I'll be examining some different theories - some of which propose an alternative method for the development of life on Earth, and some which propose that life on Earth actually began elsewhere in the universe.

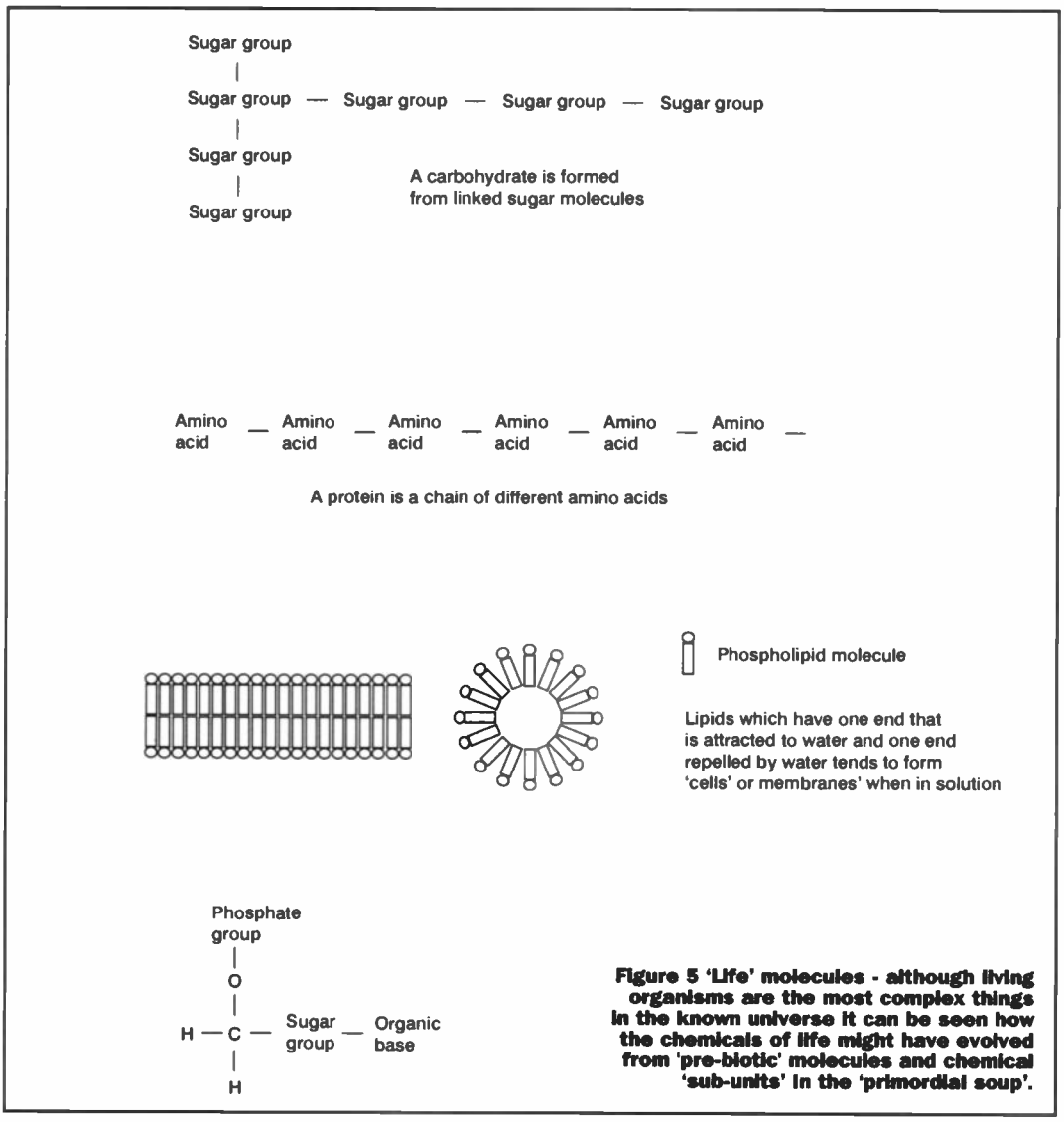
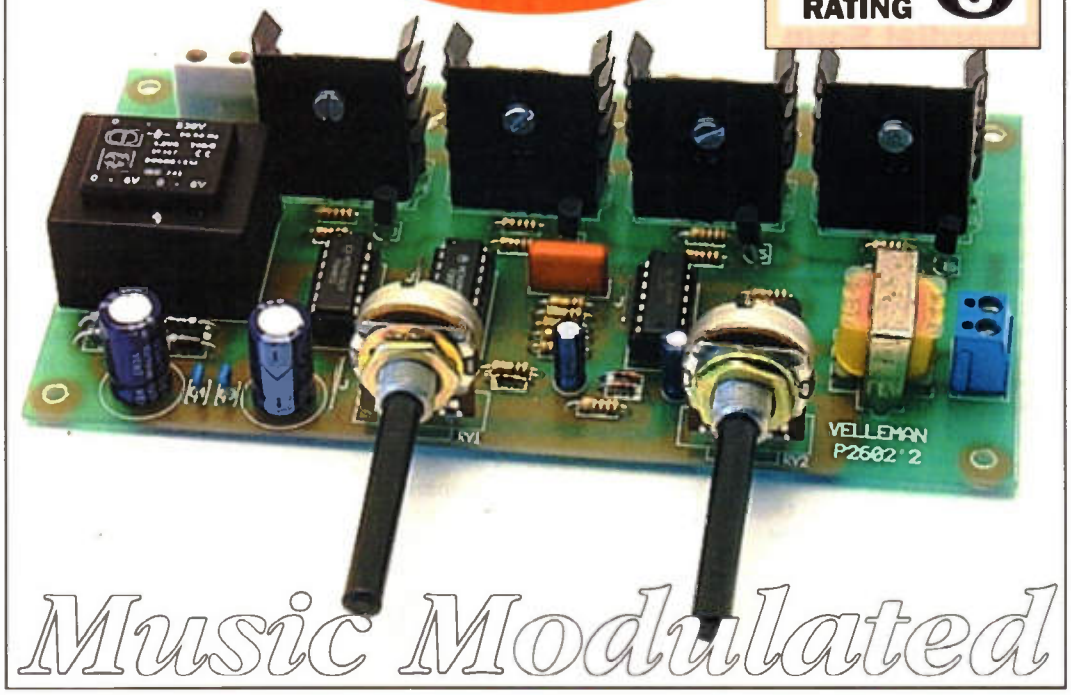


Figure 5 'Life' molecules - although living organisms are the most complex things in the known universe it can be seen how the chemicals of life might have evolved from 'pre-biotic' molecules and chemical 'sub-units' in the 'primordial soup'.

PROJECT

PROJECT RATING 3



Music Modulated RUNNING LIGHT KIT

John Mosely looks at this recently introduced kit from Velleman, that will be of great interest to budding and established DJs and to use for all those parties at Xmas and the New Year!

The Velleman Kit K2602 is a variation on the classic running light show with the speed determined by the applied audio signal. The input is fully isolated via a transformer, and can be connected to any audio source capable of delivering 100mV minimum. The four outputs are triac controlled and can each handle 2A, which should be enough to light the largest of rooms or small hall.

Construction

Unfortunately, the layout shown in the instructions (and in the photograph on the box) supplied with the kit did not resemble the PCB board, the PCB has obviously been updated - I suspect the board is now smaller. The two main differences being that the mains connectors, all five of them, are now all grouped together along one side, and the triacs now mounted vertically and not horizontally. This will improve heat dissipation from the triacs, but does require the centre lug on the four triac heatsinks to be removed. Also, the audio input connector is situated very close to the audio isolating transformer, and there are now seven wire links and not three as mentioned in the text. Hopefully as new kits are supplied the instructions will be updated by Velleman.

Since this a mains powered kit, then we would only recommended a reasonable competent electronics enthusiast assembles this kit. The changes noted above should not pose any problems to such a constructor.

As usual, start with the small components first i.e. the resistors and the seven links - if you are using the Velleman PCB. Then comes the capacitors and the dual-in-line IC sockets, followed by the rectifying diodes 1N4001 and the small signal diodes 1N4148/1N914. Please make sure you insert the diodes the correct way round. This last comment also applies to the electrolytic capacitors. Note the two smoothing capacitors, C1 and C2 are now radial types and are therefore mounted vertically, and not axial types as shown in the diagram supplied with the kit.

The secondary of the audio isolation transformer has a centre-tap connection that is not used in this application and needs to be trimmed back so that the transformer sits flush on the board.

When mounting the mains and audio connector, ensure that the lead entry side is facing away from the board. In the kit supplied the mains connectors were colour coded grey and had recessed screws. The audio connector was colour coded blue.

Note that T1 and T2 are both npn type and can be BC547/8/9 and that T3 to T6 are pnp type and can be BC557/8/9. All three ICs are carried in sockets, so make sure that you observe orientation, which is clearly marked on the board. Note here that the supplied text was wrong, all the ICs and their sockets are orientated with their respective notch facing the triac heatsinks.

For the sake of safety, the board must be mounted in a suitable enclosure and adequately

SPECIFICATION

Outputs:	4, each rated at 2A (400W at 230V, 200W at 110V)
Input sensitivity:	100mV to 5V approx.
Input impedance:	20kΩ approx.
Speed (no input):	adjustable from 0.25Hz to 3Hz approx.
Max. speed:	30Hz approx.

PROJECT PARTS LIST

RESISTORS

R1, 2, 12, 13, 14, 19, 20, 21, 22	10k Min Res
R3	68R
R4, 6	3k3
R5, 7, 8, 9, 10	100k
R11	470k
R15, 16, 17, 18	100R
RV1	1M Linear Pot
RV2	1k Linear Pot

CAPACITORS

C1, 2	1000μF 16V Elect
C3, 4	100nF
C5, 7	4.7μF 16V Elect
C6	330nF

SEMICONDUCTORS

D1-4	1N4001
D5, 6, 7	1N4148
T1, 2	BC547/48/49
T3-6	BC557/58/59
TRI1-4	TIC226D
IC1	LM3234
IC2	CD4094
IC3	CD4023

MISCELLANEOUS

TR1	Mains 6V-0-6V AC
TR2	Impedance Transformer LT44
Heatsinks	4 reqd.
14-pin DIL Sockets	2 reqd.
16-pin DIL Socket	
PCB	
Box	
Stand-offs	4 reqd.
Mains Connectors	5 reqd.
Audio Connector	
Fuseholder and Fuse	
Mains Outlets	4 reqd.
Light Bulbs	as reqd.

Kit Order Code VE54J £34.99 inc. VAT

fused - if you use a metal case then ensure that it is adequately earthed. Much of the board is connected to the neutral side of the mains. Support holes are provided at each corner, and the board should be secured to the box with insulated stand-offs. You will need to drill two holes to line-up with the two pot spindles, and further holes for the fuseholder and cables. How you connect the unit to the lights is a matter of choice, but exercise extreme care - remember you are almost certainly going to use this kit where there is likely to be many people around, including possibly children. You may wish to mount mains outlets to the back of the chosen case.

Testing

When you have finished, and thoroughly checked the board, then testing is very easy. You can use the tape output of your amplifier, or the output from a personal CD player or cassette. When using music as your source then adjust RV1 (sensitivity) and RV2 (speed) for the desired effects.

I also used a battery powered signal generator switched to square wave output, and produced a more 'uniform' effect - I could make the lights 'run' fast, and produce a dazzling effect. Beware that some people can be affected by such lighting effects.

Naturally, the resulting effects will be more impressive if coloured lights are used. You may wish to mount the lights in a reflective case for ease of setting up and protection - you could have a different coloured assembly at each corner of a room or hall. Alternatively, you might choose to construct one large unit that stands in front of the disco equipment.

Whatever method you adopt, then this kit will certainly enhance any Christmas and Millennium bash that you may be considering. The kit can easily be built in an evening and works extremely well. ELECTRONICS

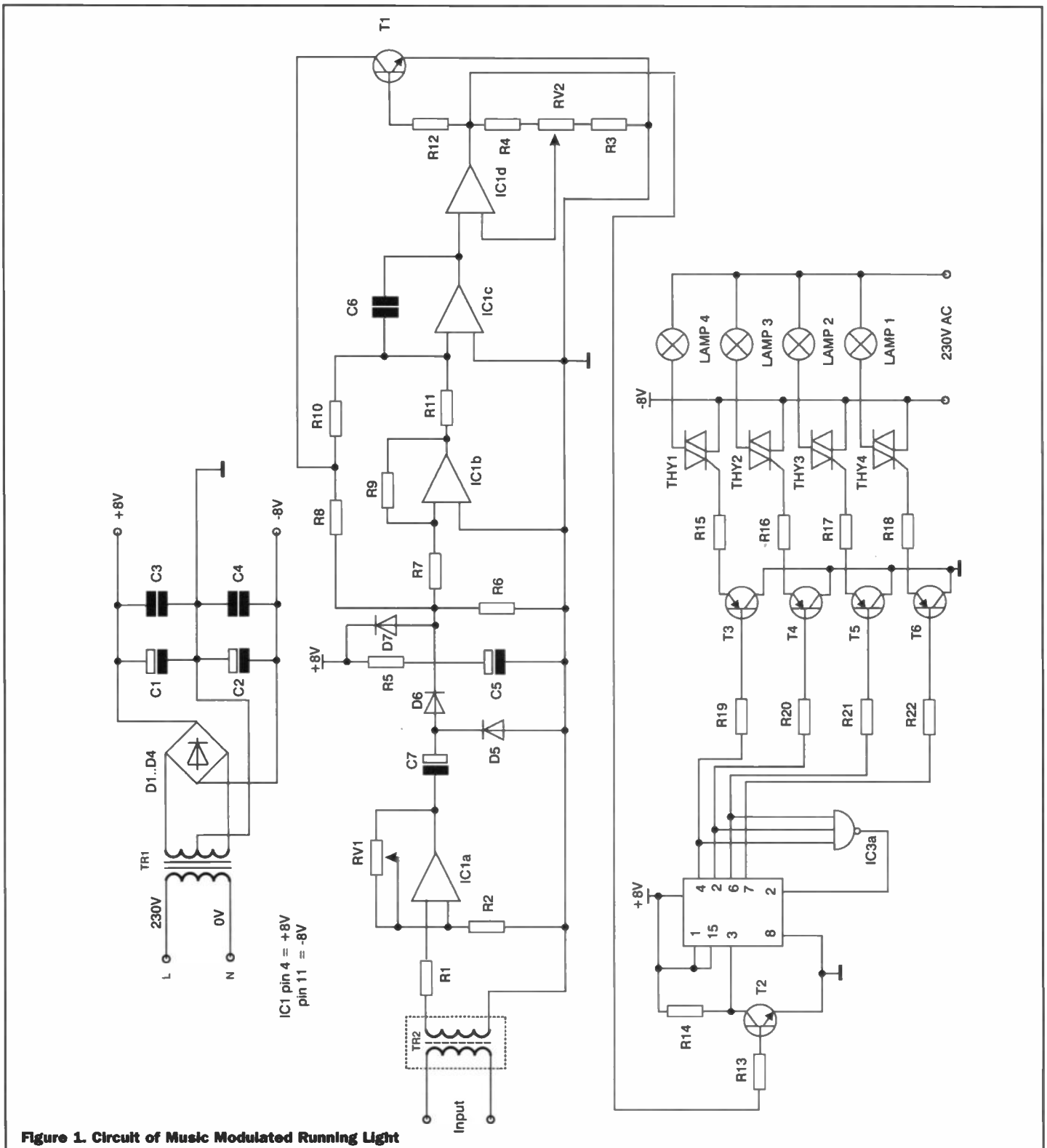


Figure 1. Circuit of Music Modulated Running Light

Easy Web Page CREATION

PART 3

In part 4, Mike Holmes expands on things to do with pictures - backgrounds, image maps and special fonts.

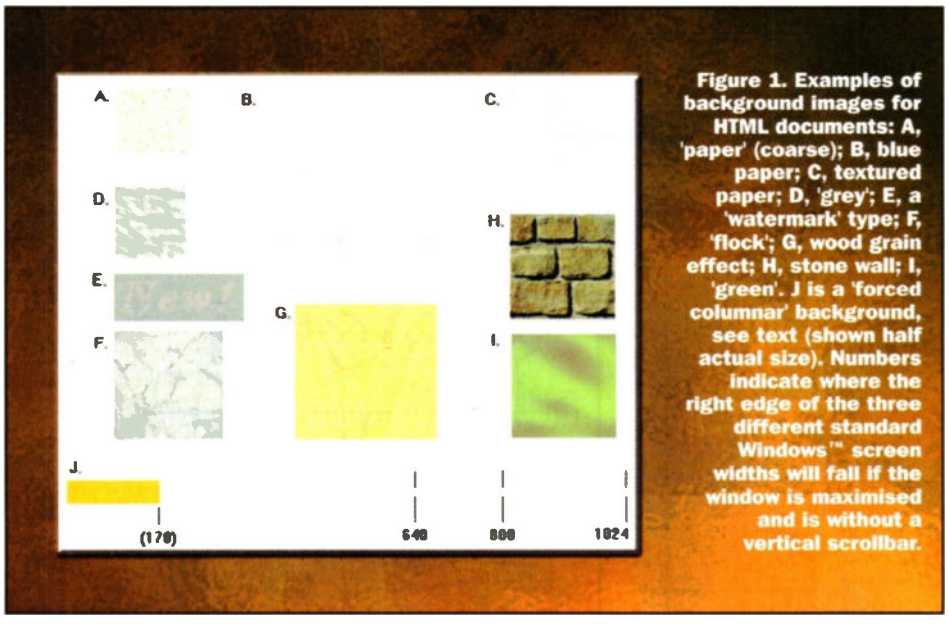


Figure 1. Examples of background images for HTML documents: A, 'paper' (coarse); B, blue paper; C, textured paper; D, 'grey'; E, a 'watermark' type; F, 'flock'; G, wood grain effect; H, stone wall; I, 'green'. J is a 'forced columnar' background, see text (shown half actual size). Numbers indicate where the right edge of the three different standard Windows™ screen widths will fall if the window is maximised and is without a vertical scrollbar.

Background Images For Documents

Continuing the subject of images, not yet mentioned is the fact that an HTML page can not only have a specific background colour - as defined by the BGCOLOR attribute of the <BODY> element - but also a *background image*.

This is provided by the BACKGROUND attribute of the <BODY> element. Its purpose is to specify a URL pointing to an image file that is to be used as a background for the document. In many recent browsers, this background image is used to tile the full background of the document-viewing area. Thus, by specifying:

```
<BODY BACKGROUND="URL or path/filename.gif">
Document here
</BODY>
```

would cause whatever text, images, etc. that appear in that document to be *placed over* a background texture or other effect consisting of the *filename.gif* graphics file. The image is *tiled* to cover the viewing area, in the same way that a small bitmap is multiplied by step and repeat to create a 'wallpaper' that covers the Windows desktop.

Figure 1 shows a small selection of various examples used for making tiled backgrounds for HTML documents. In the examples A to I, the chosen image is tiled both horizontally and vertically to fill the entire visible area.

The exception is J, which I call a 'forced columnar' type of background filler image. Its purpose is to divide a page vertically into a coloured left margin - 170 pixels wide in this case - and a textured white 'paper' remainder. The actual displayed text contents will be confined to corresponding left or right portions of the page through the use of one or more table elements that control page layout (more about which in Part 5, to follow).

The one significant aspect about example J is that it is a full 1024 pixels wide. This is because it must only tile vertically; if it was say designed for a screen width of 640 pixels only, the image will try (and probably succeed!) to tile horizontally as well in wider screen resolutions of 800 or 1024 pixels. This would completely destroy the desired effect, viz, a single coloured left column or margin.

Planning For Different Screen Resolutions

This raises yet another issue to do with what is good or bad HTML page authoring - somehow you need to arrange, to the best of your ability, that your page will at least look fairly natural in *any* screen resolution, for there is no way you would know what the viewer's screen size is going to be.

Currently, for instance, several examples on the Web are showing an emerging trend for pages to require a minimum of 800 pixels screen width, on the assumption that nowadays everyone has long since opted for 800 X 600 pixel screen sizes. But not everyone has. Consequently, for the user still using a 640 X 480 size, the page bleeds off one side or the other, and albeit the browser provides a horizontal scrollbar in this event, it is nevertheless irritating!

On the other hand, a page layout designed to fit at least 640 pixels width as a minimum must not then 'go all to pieces' and look ridiculous on a 1024 pixels wide screen!

It is worth mentioning that pages with separate left columns, with which a background image such as Figure 1J is also used to help distinguish the two parts, have become quite common. Here, the left margin is typically reserved for a hyperlink index or similar menu type of list; the actual 'page' part being confined to the right portion, so that the two portions appear to be quite separate entities with different functions, but are actually combined in the same document. The method is often preferred to the alternative of generating separate documents displayed in frames (a discussion about frames to follow in a later part).

'Watermarked' Backgrounds

Moreover, the image in Figure 1E may be typical of a type used to produce a 'watermark' effect in the background.

The ability to *watermark* HTML documents, by *fixing* the tiled background image so that it *does not scroll* with the foreground as a normally tiled background image would do, has been added to Microsoft's Internet Explorer from version 2.0 onward. To give a

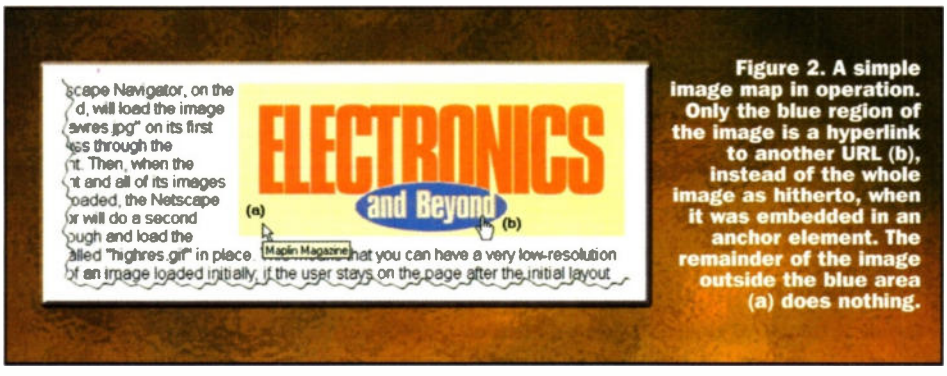


Figure 2. A simple image map in operation. Only the blue region of the image is a hyperlink to another URL (b), instead of the whole image as hitherto, when it was embedded in an anchor element. The remainder of the image outside the blue area (a) does nothing.

page a watermark background, you add BGPROPERTIES=FIXED to the BODY element as follows:

```
<BODY BACKGROUND="filename.gif" BGPROPERTIES="FIXED">
```

The background pattern or texture provided by the tiled image *remains stationary* while the page is scrolled. Note that originally this attribute is specific to Microsoft Internet Explorer only (although it may now be recognised by others).

Coloured Backgrounds

It can be seen then that there is plenty of scope for experimentation in the subject of tiled background images alone, even without the simpler option of being able to set the background to any one of an enormous variety of different colours. To see a range of hex enumerated colours - also suitable for *any* HTML element supporting the COLOR attribute - refer to: **http://www.mc-h.demon.co.uk/maplin/colours.htm.**

Furthermore, the basic Internet Explorer allows any one of the 16 base Windows colours to be defined by name, while Netscape Navigator accepts 140 discretely named colours, as do also latter versions of Internet Explorer. These names are often much easier to remember, for example "red" as opposed to "#FF0000". To see these, refer to: **http://www.mc-h.demon.co.uk/maplin/named_colours.htm.**

Images With 'Hot Spots'

Quite often you will see an image on an HTML page that has several 'hot spots' that you can click on, that is, individual regions of the same picture, each of which causes a different URL to be accessed when clicked on. There are two ways to accomplish this - by server-side or client-side *image mapping*.

Because server-side image maps use the server to accomplish the image map setup, they are being used by more browsers; however, *client-side* image maps are faster and less complicated to set up, because the browser does the work, not the server, and are gaining in popularity, and especially where the author is unable to use the first kind.

Server-Side Image Mapping

The reason is as follows. The **ISMAP** (is map) attribute of the **<IMG>** element identifies the image as an *image map*. *Note*, however, that to be able to employ image maps in HTML documents by ISMAP, the HTTP server that will be controlling document access *must* have the correct cgi-bin software (an image map handling script) installed to control image map behaviour.

However, operating on the basis that your Web site is not a fully commercial one, you will most likely not be able to use server-side image mapping since you are not allowed to have server-side scripts or any other unauthorised software installed and running on 'free' Web-space - other than those supplied as 'freebies' by your ISP. So ISMAP can be safely ignored.

Instead later browsers, such as Microsoft's Internet Explorer, allows the simpler option of using *client-side image maps*.

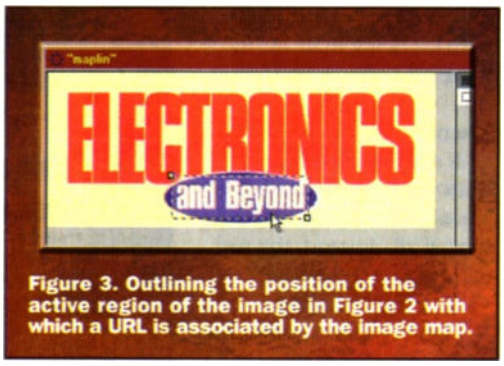


Figure 3. Outlining the position of the active region of the image in Figure 2 with which a URL is associated by the image map.

Client Side Image Maps

Both kinds of image mapping, either server-side or client-side, involve a listing of the co-ordinates that define the mapped regions of the image and which URLs they are associated with. While server-side image maps comprise a separate map file which is linked to the image by a program running on a Web server, client-side image maps use a map file that is embedded in, and forms a part of, the HTML document itself. This is contained in an element called <MAP>. This map is linked to the image by the Web browser.

While most Web browsers support the use of server-side image maps, client-side image maps are becoming increasingly common, mainly for the reason just described, but also because they are much easier to implement (requires no separate files and script).

The feature should be used with caution, noting that good HTML style includes giving users who *do not* have access to map features an *alternate way* of accessing different Web pages, such as a text-only list of hyperlink anchors.

How Client-Side Image Maps Work

Figure 2 shows a modification to the example that had been developed to that of Part 3, Figure 6. At that point it had become a right aligned, floating image of the Maplin Magazine logo embedded in text that flows around.

However, in Figure 2, placing the mousepointer over the image at point '(a)' does not cause it to change to the pointing hand style as before, as there is no longer a hyperlink here. In fact, it will not do so anywhere on the image *except* when over the blue section, at '(b)'.

How is this possible? Because the hyperlink is now *mapped* to the blue portion of the image only. This and any other links for a client-side image map are specified within the same HTML document.

In Figure 2, the foregoing anchor element that contained the image is completely removed, leaving just the HTML image element embedded in the text as:

```
<IMG SRC="images/maplin1.gif" ALT="Maplin
Magazine" WIDTH="375" HEIGHT="150" BORDER=0
ALIGN="right" VSPACE=3 HSPACE=3>
```

The hyperlink is then added by defining it with a portion of the image in an associated <MAP> element.

Figure 4. Samples texts written in non-standard fonts, alternatively created in an image editor to be displayed as GIF images. Transparent backgrounds ensure that the texts blend naturally into the document.

Associating An IMG With A MAP

In order for the browser to know which MAP to use for a particular image, a USEMAP attribute for the IMG element must be added, pointing to that MAP.

The value of this attribute must be a URL that refers to the MAP element for this image map. In this case - and in every case of client-side image mapping - the MAP element must be in the current document.

The URL will start with the hash ('#') character, followed immediately (no spaces) by the name of the MAP element (that is, the value of the MAP's Name attribute):

```
<IMG SRC="images/maplin1.gif" ALT="Maplin
Magazine" WIDTH="375" HEIGHT="150" BORDER=0
ALIGN="right" VSPACE=3 HSPACE=3 NAME="maplin"
USEMAP="#maplin">
```

As an aside, it is possible to create and reference MAP elements that exist in other documents; in this case, the '#' and the name of the map would be immediately preceded by the other document's URL. This is only useful if a single instance of a map can be applied to a series of very similar images, meaning that they share in common identically positioned hyperlink 'hot-spots'.

Otherwise, and for convenience, the MAP element is often placed adjacent to its associated IMG element (in this example, immediately before), but if you want to be tidy you could collect all maps near the beginning or end of the BODY element. The MAP element is not displayed in the browser window.

The MAP Element

MAP has one attribute, NAME. It is a string of characters that is used to identify the MAP, so that an IMG element can refer to it. So we now have:

```
<P><MAP NAME="maplin">
</MAP>
<IMG SRC="maplin1.gif" ALT="Maplin Magazine"
WIDTH="375" HEIGHT="150" BORDER=0
ALIGN="right" VSPACE=3 HSPACE=3 NAME="maplin"
USEMAP="#maplin">The Netscape Navigator, on
the other hand... (text)
```

The MAP element then contains one or more AREA elements, each of which defines a *region* of the image as the 'hot-spot'. AREA is not a 'wrapper' for anything else; all of the required information is contained in its attributes. The example then becomes:

```
<MAP NAME="maplin">
<AREA HREF="http://www.maplin.co.uk/"
SHAPE="RECT" COORDS="120,100,252,141">
</MAP>

<IMG SRC="maplin1.gif" ALT="Maplin Magazine"
WIDTH="375" HEIGHT="150" BORDER=0
ALIGN="right" VSPACE=3 HSPACE=3 NAME="maplin"
USEMAP="#maplin"> ...
```

resulting in the behaviour of Figure 2.

The co-ordinates (COORDS) in pixels can be found arithmetically or by experiment, or you could use one of the proprietary image mapping tools. Figure 3 is a detail from MindWorks' ImageMapper program, which, given an existing HTML document, allows you to choose one of its images to map, draw the 'hot-spot' regions on it, assign the URLs, then insert the finished map element into the document in one operation. Figure 3 also illustrates where the exact boundaries are in this example (shaded area).

Creating New Mapping Regions

The types of regions you can create are rectangles, circles, polygons, and points. At present most browser versions are able to accept rectangles, the others being extensions, so while rectangles are reliable, the others may not work.

Making Fancy Fonts With GIFs

One particular area where GIF images with *transparent backgrounds* are very useful is in producing Windows like icons and non-standard fonts. It was mentioned in Part 1 that you cannot assume that the client machine has the same fonts that yours has. Therefore, when originating HTML documents, you are restricted to a limited, standard range of fonts for all texts, that you know ought to be installed on any PC by default. (Unless the user has removed them of course, but that is beyond your control.)

You cannot force a client machine to download a non-standard font that you desire your text to be displayed in, because this is a violation of the browser's built-in security that cannot be overridden (it is meant to prevent unsolicited or dangerous files such as viruses being maliciously or otherwise distributed over the Net completely without clients' control).

If a non-standard or 'fancy' font is required, the usual resort is not to use text at all - instead, the text in question, set in the desired font, is a *picture*.

Figure 4 shows some examples of non-standard fonts that are unlikely to be possessed by all clients. Moreover the last four have been manipulated with special effects added.

It is not practical (though not impossible!) to present large chunks of text set in a special font in this way, so most commonly the technique is reserved for creating headings and sub-titles, hyperlink menus and so on.

The procedure requires a suitably capable image editor able to save GIF files. In this editor, the words are typed in the required font and size, colour etc. on a plain background. You can apply various effects as required. In these examples, the words were set in a 24-bit image with a white background initially. Then the number of colours was reduced to 16, then the palette was edited to change the background colour to yellow (or some other unused, neutral colour like cyan), in case some white detail needs to be preserved.

Then the image is saved as a GIF with the *transparent colour* selected to be that of this background colour. The GIF is included in the HTML page by the <IMG> element just like any other:

```
<DIV><IMG SRC="images/making.gif" ALT="Making
Fancy Fonts With GIFs"><BR><BR><BR></DIV>
```

In the browser this GIF's background colour becomes invisible, leaving the words to appear as though 'printed' directly onto the background of the viewed page, as in Figure 4.

Whole series of sub-titles for conventional text can be made in this way, each one a separate GIF image with a transparent background. One final thing to remember is to set the ALT attribute equal to the words that are supposed to be displayed so that, in case for any reason the image does not show, as in Figure 5 (top), it at least makes sense.

Single text lines done as images like this can also be placed in anchors to make hyperlink jumps that appear almost like simpler text links. Further to this, another frequently used technique is to create a list of hyperlink labels all in one image, then use image mapping to distinguish between the various options and specify their URLs. It is simpler to manage as it requires only one picture.

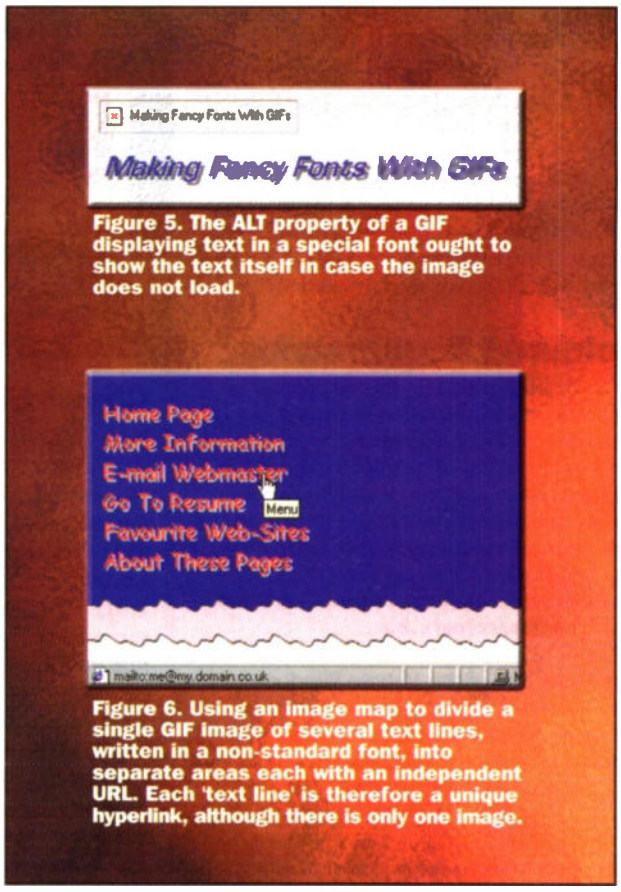


Figure 5. The ALT property of a GIF displaying text in a special font ought to show the text itself in case the image does not load.

Figure 6. Using an image map to divide a single GIF image of several text lines, written in a non-standard font, into separate areas each with an independent URL. Each 'text line' is therefore a unique hyperlink, although there is only one image.

Figure 6 illustrates a links menu made in this form; the URL of each item when under the pointing hand icon is shown in the browser's status bar (bottom). The HTML code that produced this is shown below:

```
<div>
<table bgcolor="darkblue" width=100%><tr><td>
<BR>
<MAP NAME="menu">
<AREA HREF="index.html" SHAPE="RECT"
COORDS="7,4,108,29">
<AREA HREF="info.html" SHAPE="RECT"
COORDS="7,30,171,52">
<AREA HREF="mailto:me@my.domain.co.uk"
SHAPE="RECT" COORDS="6,55,174,80">
<AREA HREF="resume.html" SHAPE="RECT"
COORDS="6,82,137,104">
<AREA HREF="links.html" SHAPE="RECT"
COORDS="6,108,194,130">
<AREA HREF="about.html" SHAPE="RECT"
COORDS="8,133,179,160">
</MAP>
<img src="menu.gif" border=0 NAME="menu"
WIDTH="204" HEIGHT="167" USEMAP="#menu"
ALT="Menu">
<BR><BR></td></tr></table></div>
```

Next Month

Introducing animations, how to achieve tighter control of page layout through the use of tables, and the correct way to display multiple pages simultaneously in frames. Don't forget, for a detailed summary of all the HTML elements and their usage, see the glossary page at: **http://www.mc-h.demon.co.uk/maplin/glossary.htm.**

@Internet Special

8-page pull-out

Get Stuffed

Stuffing is a common expression for the process of compressing computer files prior to sending them over the Internet, in emails for example, or for downloading from Websites. Compressed - or stuffed - files are smaller, and can often be encoded in the same process to prevent possibility of data loss when being transmitted over the Internet. In general, therefore, stuffing is of benefit to anyone who sends files to anyone else via Internet-based means. One of the problems of stuffing, however, is that whoever receives or downloads the files has to be able to decompress or expand the files on receipt. There are, unfortunately, several means of stuffing files in the first place, so there are the same number of methods of expanding them once received. It's also usually necessary to know the means files were stuffed, so the correct expansion tools can be used at the other end.

However, DropStuff is a shareware tool from Aladdin, that stuffs files in any of the main compression formats. Along with DropStuff comes Aladdin Expander, that's able to decompress files in any of the standard compression and encoding formats used on the Internet (for example, Zip, Stuffit, binhex, Base64, and others). DropStuff and Expander are cross-platform tools, which means that Windows or Mac users can send and receive files to each other, safe in the knowledge that files can be handled at the other end.

The latest version of DropStuff (v.5) is a free update to registered users of previous versions, and features up to 20% better compression than Zip formats, which means greater transfer speeds over the Internet and smaller archive space. It works by drag-and-drop (that is, to stuff a file or folder just drag it onto the DropStuff icon: to decompress it drag it onto the Expander icon), so is simplicity itself to use. Download it and try it out free for 30 days, from:

<http://www.aladdinsys.com/dropstuff/winindex.html>.

Free For All

It doesn't seem so long ago that free Internet service providers were just a dream, but there's now well over a hundred ways of accessing the Internet for free. So many, in fact, that it's difficult keeping a track of what's available. One way to help, and the ideal way to find out what services are around that you can sign up to, is Gordon Sharpe's free UK Internet service provider listings, at: http://www.12free.co.uk. You'll find IP details, names, URLs, and loads more information on the site. It's regularly updated with new service provider details as they come on line, so is a convenient stopping off point before you choose your next service provider.

The Best You Can Get

The next generation of Apple Mac personal computers has officially been announced by Apple Computer's interim CEO. Steve Jobs (who's been in the post for two years now, so it's hardly interim!) has unveiled Apple's latest top-end range of machines - the G4 Power Macs. Apple's Power Mac ranges of personal computers is based on PowerPC central processors, unlike Windows-based personal computers which run on Intel's Pentium central processors.

The top-end 500MHz G4 will be able to deliver sustained performance of over one gigaflop (one billion floating-point operations per second), and peak performance of over four gigaflops. This officially puts the personal computer into the supercomputer category of computers - the first time ever a personal computer has achieved this status. While this is a public relations coup in its own right, being officially classed as a supercomputer has its drawbacks. Apple - for the time being - won't be allowed, for security reasons, to export the computer for sale in certain countries because of it. In effect, by US government rules, the new G4 is a weapon, and Apple isn't allowed to sell it in certain areas of the world. Apple is petitioning the US government to have the supercomputer specification raised, but meanwhile soaks up the heat of the advantages of making what is simply the fastest personal computer ever made.

Based on the Signal Processing Library Performance spec published on Intel's own Website, the 500MHz Mac will run up to 2.94 times faster than the fastest 600MHz Intel Pentium III-based personal computer. This serves to point out the difference between the two competing central processors used in Windows-based and Mac-based computers, and underlines the fact that strict processor speed is not necessarily the only factor to consider in a computer's specification. Computer buyers should be aware - it's not quantity, but quality that really counts. You can see the new G4 on Apple Website at: http://www.appple.com.

MP3 Speed Buster

Thomson Multimedia at **<www.scmmicro.com>** is set to bundle SCM's multi-format digital media reader/writer with its new personal digital audio player. The partnership will enable users to reach new levels of speed when transferring music files from a PC or the Internet.

The reader/writer from SCM will be used with Thomson's RCA LYRA, a portable player which decodes and plays MP3 and G2 audio compression formats. It will enable the music files to be written and read up to four times faster than other MP3 players, which attach directly to the PC.

The CompactFlash reader/writer from SCM Microsystems attaches to a PC's parallel port and provides a pass-through printer interface. The device can write data on both CompactFlash I and CompactFlash II memory cards at up to 25MB per minute, and can read at up to 40MB per minute.

Pan And Tilt Webcam

The latest version of Webcam32 captures an image from a networked camera or a capture card connected to a PC and makes that image available on the Internet. The image can be refreshed every few seconds to every few hours, or displayed as full-motion video.

When paired with Surveyor's Transit Robotic Camera Mount (RCM), Webcam32 also provides users with pan and tilt Webcam position control through the Internet.

A live demonstration of Surveyor's interactive Webcam fitted with Webcam32 software can be found on the Live Demos Web page at **<www.surveyorcorp.com>.**

A fully-functional, one-hour demonstration of Webcam32 software is available free for download from Surveyor's Website at **<www.surveyorcorp.com>**, or from the Webcam32 Website at **<www.kolban.com>.**

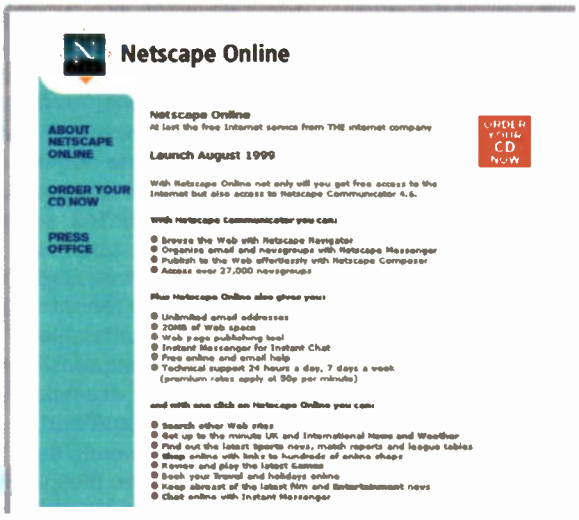
AOL's Launches Pre-registration Site For Free ISP Service

In response t thusiastic demand for its soon-to-be-launched subscription-free Netscape Online Internet service, AOL has established a pre-registration Web site and a free pre-registration phone number for the service. Pre-registrants will receive priority response to requests for Netscape Online software when the service launches in September.

The pre-registration site, accessible at **<www.netscapeonline.co.uk>**, is open to all UK Internet users interested in the new service. It includes highlights of planned products and features, a registration page for interested subscribers and press information.

The site will be continually updated with the latest information regarding the roll-out of the Netscape Online service. Pre-registration is also possible through a new free phone customer service number, Tel: (0800) 923 0009.

AOL Europe announced its plans in July to launch a subscription-free service complementing the AOL UK and CompuServe UK subscription-based brands. Aimed at the emerging budget segment of Internet users, the service will be the best in its class, offering unrivalled community, content and features including the Netscape Navigator browser and AOL Instant Messenger 2.0.



PCs Are Better Than Sex

One in six of the Internet generation prefers to stay in their rooms surfing the Web or playing computer games than spending time with their boyfriend or girlfriend.

These are the findings of research by lifestyle ISP Madasafish at **<www.madasafish.com>**, an exclusive Internet club for savvy Net surfers, aged between 16 and 30.

This group may spend more time on the Internet than going out, but many use it to find out about the latest gigs, films, bands and clubs, making sure their nights out are always events to remember.

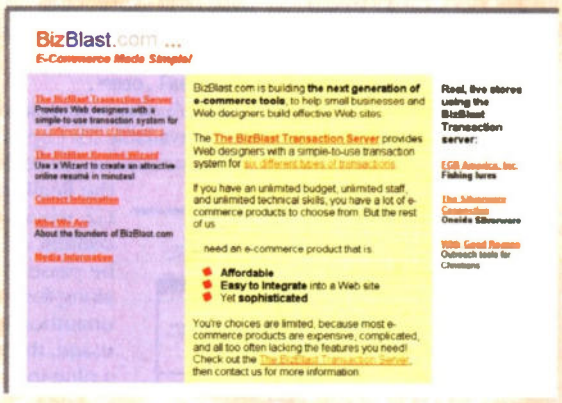
Excite Voice Chat Breaks Record Numbers

In the first month of service, Excite Voice Chat has achieved over 400,000 downloads of the Voice Chat/ Lipstream client.

Lipstream provides live Internet voice service for Excite Voice Chat - a communities and chat area for Excite users. Consumers use Excite Voice Chat to conduct live, one-to-one and one-to-many conversations over the Web, enjoying telephone-quality communication, free of charge. The Lipstream voice service is available on Excite at **<voicechat.excite.com>.**

In order to participate in Excite Voice Chat, consumers simply need a PC, microphone, and speakers or a headset to have live voice conversations with other Excite chatters.

BizBlast.com Uses Java To Simplify Online Web-Store Creation



BizBlast.com at **<www.bizblast.com>** has launched a new system that makes it very easy for Web designers to integrate Web stores into their Web sites.

Unlike most shopping-cart systems, the BizBlast Transaction Server can handle six different types of Web transactions which include:-

Tangible Purchase Transactions - sell a product and ship it.

Electronic Purchase Transactions - sell a product, transmit it over the Internet, and provide a way for the buyer to unlock the product.

Member Transactions - sell memberships or Web-site access.

Billing or Payment Transactions - no product changes hands, but a bill is paid or donation made.

Dynamic Transactions - a transaction such as an auction or some kind of bidding process.

Information Transactions - with information of some kind flowing to and from a database on the server

BizBlast Transaction Servers's developers claims that integrating the product into a Web site is a matter of learning a few special tags, and embedding them into the Web pages.

The BizBlast Transaction Server does the rest, placing the appropriate components - product information, drop-down list boxes, shopping-carts, and so on - into position. This removes the need for programming scripts, thereby reducing costs and improving delivery time.

The e-commerce system designed by BizBlast uses Java servlets and Sun Microsystems' recently released Java HotSpot Performance Engine to ensure fast, reliable operation.

The Epoch Of E-pop

CountdownArcade at **<www.countdownarcade.com>** an online shopping centre and free ISP, surveyed over 100 people to investigate the potential of Web-based music distribution.

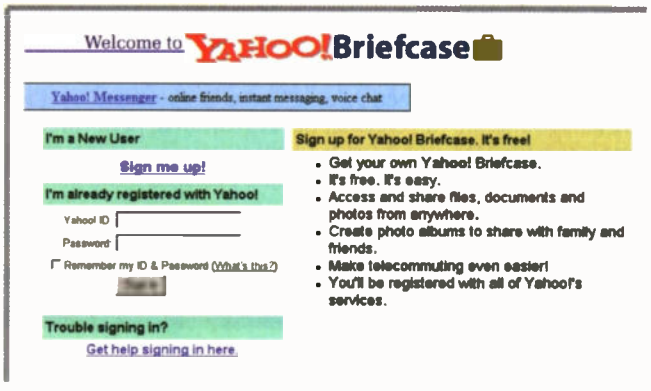
The majority of respondents had never made an online music purchase. A large proportion, however, expected to buy exclusively on the Net in the future, providing it remained cheaper to do so. Current obstacles to purchasing music online include lengthy delivery times and concerns about reliability or security.

On the positive side, respondents welcomed music search engines as a method of finding obscure or rare artists.

The Countdown Music Arcade offers the top 500 best-selling CDs of all time. The site also has a comprehensive back catalogue of titles, ranging from 80's pop to Jazz and Blues.

Anyone can shop on the CountdownArcade site with Countdown cardholders benefiting from up to 25% discount on travel, services and a wide range of products including electrical goods, bikes, golf equipment and wine. The cards can also be used in over 150,000 retail stores world-wide and new online members get a £25 rebate to spend in the Internet store.

Keep Briefcase Online With Yahoo!



What would it be like to have electronically-stored business files you could access from just about anywhere? A portable personal hard drive you don't have to carry.

Yahoo! Briefcase at **<briefcase.yahoo.com>** is a new file-storage and photo-album product that allows Internet users to store and share documents, photos and other computer files in one central location on the Internet.

Yahoo! Briefcase enables Yahoo! registered users to access their files from any computer with an Internet connection, and gives them the ability to share photos and files online with friends and family.

Wireless Instant Messaging Is A 'Killer App'.

Mobile Insights (MI) at **<www.mobileinsights.com>**, a leading information source for the mobile computing and data communications markets, today announced that the worldwide market for instant messaging will grow to 175 million users by 2002.

Instant messaging, sometimes referred to as online buddy lists, is used by over 50 million PC-based users and is now becoming available to users of handheld computers and mobile phones.

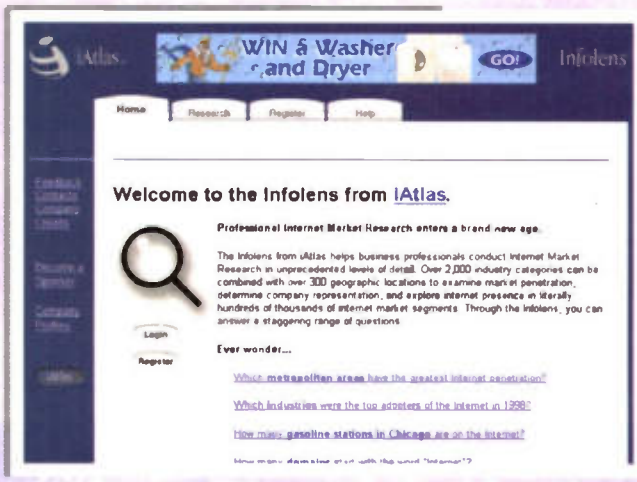
This technology allows users to view a listing of people with whom they frequently communicate, determine if these people are currently available, and send/receive messages instantly. Instant messaging created somewhat of a cult following of savvy Internet users when it was launched two and a half years ago.

It is now a mainstream Internet application with a variety of PC-based versions such as America Online's (AOL) Instant Messenger; Mirabilis' ICQ (I Seek You), recently acquired by AOL; and a host of others from the likes of Yahoo!, Microsoft and Excite.

Instant messaging is growing at a phenomenal rate. Mirabilis, pioneer in this field, grew its user base to 12 million users in less than two years and now has over 38 million users. This user community has grown primarily by word-of-mouth, and according to America Online, its Instant Messenger application and Mirabilis' ICQ have a combined user base of 63 million users sending over 750 million messages a day.

Versions of ICQ have been available for the Palm Pilot and Windows CE-based handheld PCs, but have not been widely used because integrated wireless communications - the critical missing link for this technology - has been slow to take hold. The Palm VII is the first of many mainstream handheld devices that will incorporate wireless data communications.

Order Revealed In Chaos Of The Internet



Infolens Web Site at **<www.infolens.com>** is a powerful data visualisation tool that its creators iAtlas, claim provides a clear focus of the business opportunities on the Web. The service was designed to help everyone understand the business composition of the Internet.

Visitors to the site can conduct market research, perform competitive analysis, and develop Internet strategies using empirical data from the nearly 1.5 million businesses categorised in the iAtlas Registry Database.

Audible Signs Content with RealNetworks

Audible has struck a deal with RealNetworks, to provide users of the RealPlayer G2 with instant desktop access to Audible's 17,000 hours of Internet-delivered premium spoken audio for playback on personal computers.

As part of the agreement, exclusive content packages from Audible's content library can be purchased at RealNetworks' online marketplace, **<www.realstore.com>**. In addition, Audible will become a featured advertiser at **<www.real.com>**.

All of Audible's programming will be available for copyright-secure streaming playback on the RealPlayer G2, where the content cannot be passed along for unauthorised usage, through a plug-in developed by Audible and freely available from RealNetworks.

WebOutfitter Service Brings New Features to Pentium

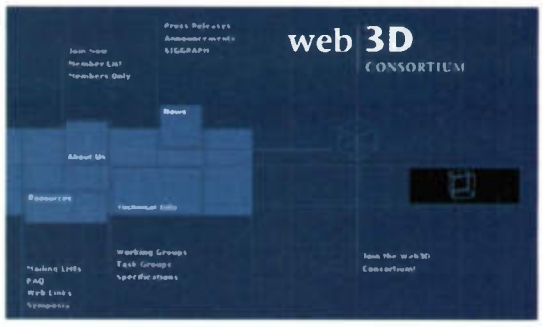
Intel WebOutfitter Service at **<www.intelweboutfitter.com>**, has brought together a collection of key players in digital photography to offer one location for members to access new technologies and services exclusively for Pentium III processor-based PCs.

First introduced in March 1999, the Intel WebOutfitter service offers the latest tips, applications and tools based on specific themes to help owners of Pentium III processor-based PCs get the most from their performance PCs.

With its Digital Photography theme, the Intel WebOutfitter Service enables members to easily capture, create and communicate with digital images - both on and off the Net - while learning about and experiencing digital photography through tutorials, interactive demos, hands-on activities and special offers.

Intel WebOutfitter Service members will have exclusive early access to Adobe's new ActiveShare software, an application that makes it intuitive and easy to import, resize, rotate and improve photos as well as post photos to the Internet.

Web3D Consortium Joins the W3C



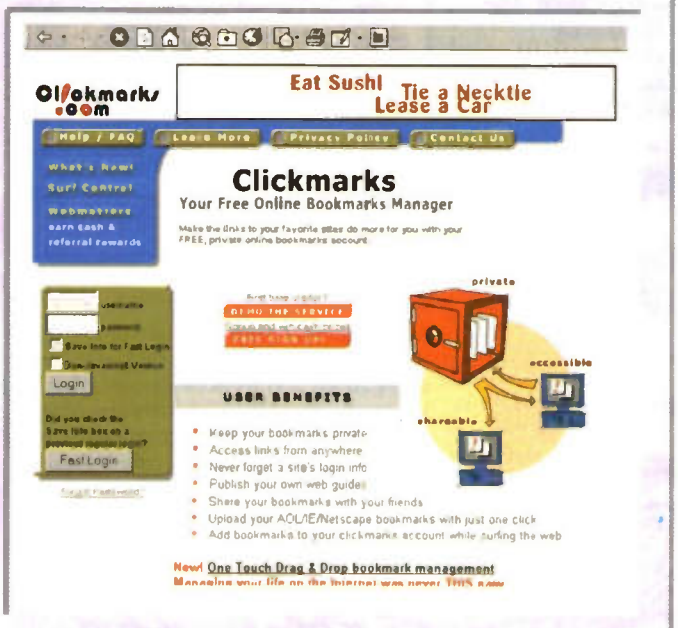
The Web3D Consortium at <www.web3d.org> has announced that it has joined the World Wide Web Consortium (W3C) at <www.w3.org>. By joining and integrating W3C specifications into its current work, the Web3D Consortium ensures that the next generation of multimedia standards for the Web include seamlessly integrated 3D graphics.

The Web3D Consortium's ongoing X3D project is developing new technology that will ensure interoperability of 3D with Web standards such as XHTML, XML, SVG, DOM and SMIL.

The X3D technology being developed by the Web3D Consortium will enable new opportunities for 3D graphics, including small, lightweight Web clients with advanced 3D capabilities, and the integration of high-performance 3D into broadcast and embedded devices.

X3D satisfies these demanding applications by adopting an advanced componentised architecture that enables highly compact 3D clients. These clients can be extended with plug-in components to create standardised profiles with the functionality to meet the demands of sophisticated vertical applications.

Clickmarks.com Introduces Drag and Drop Feature



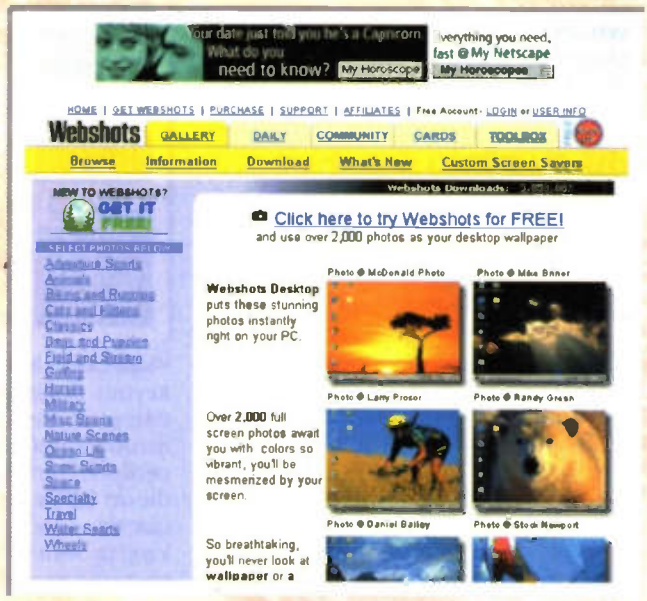
Clickmarks.com at <www.clickmarks.com> has announced the addition of drag and drop functionality to its already user-friendly online bookmark service. With drag and drop, the Clickmarks bookmark manager is as easy and intuitive as users' everyday computer desktop.

Users simply click on their mouse and drag bookmarks to add, move or delete them within their universally accessible, secure Web-based bookmark accounts.

Webshots Debuts Community Photo Sharing Feature

Webshots at <www.webshots.com>, one of the Internet's largest and fastest-growing photo communities has announced the Webshots Community. Webshots users can now share their personal photographs to use as desktop wallpaper or electronic post cards.

Users now have the ability to create their own home page with photo albums to share with family, friends and other visitors. All Webshots services can be distributed via the community, including desktop wallpaper, screensavers and e-post cards.



Mortgage Advice from FTQuicken.co.uk

FTQuicken.co.uk, the Financial Times personal finance Web site at <www.ftquicken.co.uk>, has launched a new step-by-step mortgage guide to help homebuyers progress smoothly along the path to buying a property.

Written by the expert personal finance team at the FT and designed to be as practical as possible, the easy to use, step-by-step guide offers users a comprehensive, jargon-free source of information on all aspects of home buying and re-mortgaging.

A simple introduction to the guide provides an overview of the different types of mortgages available and a helpful sequence of events, detailing the process which house buyers can expect when applying for a mortgage.

Within the mortgage guide itself is a wealth of information from getting started, through to details on conveyancing, what fees to expect, choosing a solicitor and dealing with estate agents. The information is supported by a helpful glossary covering the various terminology used by the many professionals involved in the process of buying a house.

Leading Linux Sites

Last month we took the leading Apple Web sites. This month, it's the turn of Linux. Here we take a look at the best places for Linux discussions and downloads on the Web.

<www.atipa.com>

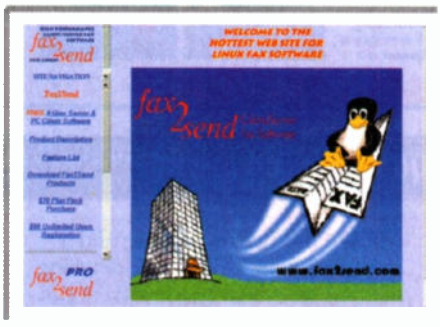
Atipa provides Linux consulting, hardware, software, and support solutions. Atipa Linux Solutions' expert staff of engineers builds and supports reliable pre-configured servers, clusters, and workstations. Atipa's systems are so robust they are found in many of the world's top universities and research labs.

<www.beasys.com>

BEA provides backbone e-commerce solutions for the world's largest enterprises, including Amazon.com, E-Trade, FedEx, Lucent, and United Airlines. BEA products include BEA TUXEDO, for distributed transaction management software; BEA WebLogic, a leading application server family, and BEA eLink, a solution for integrating enterprise applications.

<www.fax2send.com>

Fax2Send is fax-server software for Linux packaged with a browser client interface and PC and UNIX client software. Fax2Send is free to use up to 4-users. £6 registration fee provides a Plus Pack, which offers an email technical query service and other benefits. Unlimited users are supported for only £60.



<www.cobalnet.com>

Cobalt's award winning product lines-the Cobalt Qube, Cobalt Cache, Cobalt RaQ, and Cobalt NASRaQ -are widely used as Internet and Web hosting server appliances at businesses, educational institutions and Internet Service Providers (ISPs). Cobalt's solutions are delivered through a global network of distributors, value-added resellers and ISPs.

<www.cyclades.com >

Cyclades Corporation designs, manufactures and markets connectivity products. The product line includes multiport serial cards, routers, and remote access servers. Cyclades provides drivers for Windows, Linux, FreeBSD, and Unix.

<www.kde.org>

The KDE project is an international group of volunteer developers working on an Open Source desktop (GUI) for Linux. The K Desktop Environment has quickly become the de facto standard graphical user interface for Linux due to its robustness, power, stability, and ease of use.

<www.keylabs.com>

KeyLabs is the world's largest, independent testing lab, dedicated to analysing hardware and software products in a networked environment. With its state-of-the-art facility, KeyLabs delivers results quickly and accurately, allowing you to keep up with technology while lowering costs and improving productivity.

<www.linuxcentral.com>

Linux Central was created and is maintained for Linux users by Linux users. The Web site is here to act a central resource for Linux products, and Linux information.

<www.linuxmall.com >

LinuxMall.com is the online Linux Superstore. One of the 200 busiest Web sites in the world, LinuxMall.com is committed to the Linux Community and Open Source Commerce.

<www.lokigames.com>

Loki Entertainment Software works with leading game publishers to port their best-selling Windows and Macintosh titles to the Linux platform. Loki meets a demand amongst the Linux community by providing fully-supported, shrink-wrapped games through traditional retail channels.

<www.magic-sw.com>

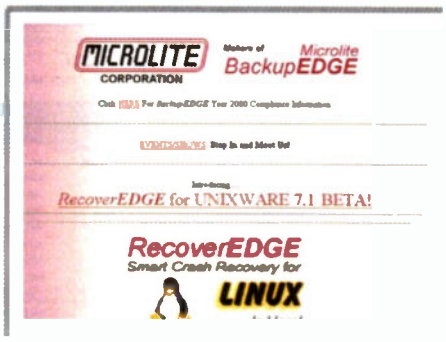
Magic Software provides state-of-the-art development, technology, customisable applications and services for cost-effectively solving business problems. Its free Magic for Linux development technology enables powerful e-commerce and other business solutions to be built ahead of the competition and at competitive cost.

<www.metrowerks.com>

Metrowerks develops, markets and supports CodeWarrior software development tools for a number of operating systems targeting the most popular microprocessors. Metrowerks' primary market segments include the desktop market, the embedded proprietary operating systems market, the real-time operating systems market, the Java technology market and the Linux operating system market.

<www.microlite.com>

Microlite has introduced the first fully integrated backup, restore, and crash recovery solution available for Linux operating systems. BackupEDGE is an award winning, dependable backup system

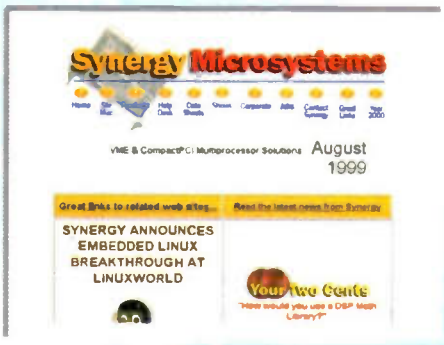


that is both easy to use and inexpensive. Its major new features include graphical, point and click Fast File Restore, complete tape auto changer/library support, and local or remote backup capability.

<www.redhat.com>
RedHat is a leader in the development of open source operating system solutions. Red Hat's newest version of the Linux operating system, Red Hat Linux 6.0, offers more stability, power and control than any other operating system. In addition to Red Hat Linux 6.0, Red Hat also offers Red Hat Linux Extra, Powertools, and it's newest product, the Red Hat Linux E-Commerce Server.

<www.stalker.com>
Stalker Software, specialises in Internet mail servers. CommuniGate Pro is a high-end, industry strength Internet Mail server. Key features include anti-spam protection, cluster support, WebAdmin, extensive multi-domain support, dial-up, unique IMAP multi-mailbox features, IMAP4rev1, ESMTP, POP3, WebEmail, MailList, LDAP, ACAP, CLI, SSL, HTTP, SASL, SNMP and Personal Web Pages with automated publishing.

<www.stormix.comn>
Stormix Technologies provides Linux tools and applications for the server and the desktop markets. Storm Linux, its flagship product, features an easy, quick install and configuration. Stormix has also created the Simple Interface Language (SIL), a general interface tool that can be used with almost any programming language to create graphical and text interfaces for other programs.



<www.synergymicro.com>
Synergy Microsystems manufactures VMEbus and CompactPCI single board computers based on the PowerPC CPU. These rugged boards are used to meet the hard real time computing requirements of critical military, industrial and commercial applications. Synergy specialises in multiprocessing, with single, dual and quad processor boards, as well as advanced connection technology supporting clusters of boards for massively parallel processing.

Video Retailer Blackstar Secures £3.8 million Investment

The UK's largest Internet video and DVD retailer, BlackStar at **<www.blackstar.co.uk>** today announced that it has secured second round funding of £3.8 million from Atlas Venture and a group of Texas investors.

BlackStar will use the new investment to fund infrastructure and marketing initiatives to propel itself onto the world e-commerce stage and prepare for future competition from established High Street and online retailers.

As an early stage Internet firm, BlackStar is in the unusual position of generating actual revenue and profit based on its business model of offering greater choice to the consumer, total customer satisfaction, sophisticated customer marketing and low overheads.

BlackStar offers more than 50,000 videos and DVDs in its online store at **<www.blackstar.co.uk>.** This compares with the 2,500 typically stocked by a high street retailer. The video and DVD retail market in the UK is currently valued at around £1 billion per year by the International Video Federation.

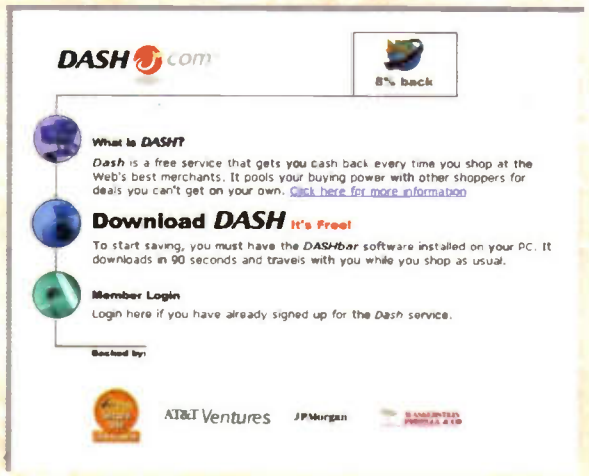
Dash.com Begins Beta Test of Mobile Shopping Portal

Dash.com at **<www.dash.com>** has opened up its shopping service to Beta testers. Dash acts as a consumer advocate to bring shoppers discounts and cash rebates at the Web's leading merchants.

Dash gives every consumer a personalised, virtual shopping assistant that collects savings while the consumer surfs and shops as usual. The beta version of the DashBar application takes less than 90 seconds to download from the Dash.com Web site.

While online rewards programs have proliferated in recent months, Dash sets a new standard for one-stop, one-click convenience. Rather than burden its members with unsolicited banner ads, rebate forms, surveys, or confusing cyber-points, Dash streamlines the shopping experience.

The DashBar integrates into the users' browsers and travels with them as they surf and shop - pooling collective buying power to provide consumers with exclusive discounts, rebates and promotions. Dash keeps track of shoppers' savings in convenient, secure cash accounts.



AOL Introduces Instant Messenger 2.0

AOL at **<www.aol.co.uk>** has announced the availability of the latest version of the AOL Instant Messenger service, version 2.0. The AOL Instant Messenger service is an Internet version of AOL's popular Buddy List service, which lets millions of home and business Internet users know when their friends come online and allows them to send and respond to private, personalised electronic text messages instantly.

AOL pioneered and popularised the development and integration of its real-time communications technology into AOL's software for accessing the AOL subscription service in 1989. In 1996, AOL launched the Buddy List feature, a collection of messaging related features including a member-created community of friends, family, and colleagues, which fundamentally changed communications on the Internet.

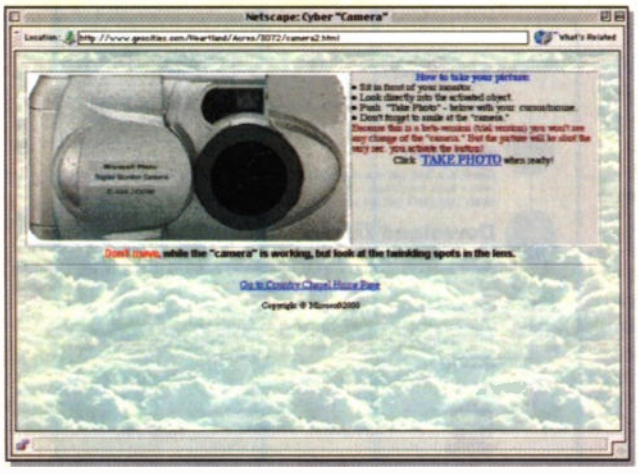
EMI Distributes Music over the Internet with encoding.com

encoding.com at **<www.encoding.com>** has announced two additional audio partners - Audio Explosion and EMI Music. These organisations chose to work with encoding.com for its expertise in creating and managing high-volume digital archives of music, and its ability to provide reliable database development and support for maintaining those archives.

Site Survey

The months destinations

It's absolutely amazing what Internet technology is able to do. Not only can you log onto Websites with remote cameras (called Webcams) to see what's happening at a distance anywhere around the world, but finally, you can use one of these Webcams to take your own picture. Checkout Cyber Camera, at: **<http://www.geocities.com/Heartland/Acres/3072/camera2.html>**, to see your true self. Be warned, this is only a beta version, but it seems to work very well, producing highly lifelike images - don't forgot to say 'cheese' though!



Barbie's reaching a new generation these days - a generation of Internet-surfing kids, who Mattel (Barbie's manufacturer) sees as needing interactive stimulus. Hence its new Generation Girl Website, at: **<http://www.generationgirl.com>**. It's worth a look-see, if only to try to figure out what modern-day toy manufacturers perceive as their customers. Big kids have their toys and games too, but these tend to be clubs where they can interact with others who have similar interests such as golf, cricket, football, and so on. There are several Internet-based clubs around, that attempt to exploit this gregariousness many adults feel. Several Internet service providers such as AOL and CompuServe have been doing it for years, of course, but others on the Internet are new. One such new club-site is theglobe.com, at: **<www.theglobe.com>**.

By all accounts, theglobe.com is a rapidly growing site, which aims to facilitate communications between its members, and is the sort of place where like-minded people all around the world can keep in touch. Sounds too good to be true, doesn't it?

Defence of THE REALM

BATTLE OF BRITAIN RADAR

To mark the 60th anniversary of the first significant air battle of the Second World War, Gregg Grant discusses the importance that Radar played.

The Air Council Member for Research and Development, Air Marshal Sir Hugh Dowding, was firm: no more money without a demonstration. Simple as that. And so, in February 1935, a now-famous experiment took place involving the Post Office's 10kW, CW transmitter at Daventry, a receiver belonging to the National Physical Laboratory, (NPL), set up at Weedon and a Royal Air Force, (RAF), Heyford bomber.

The aircraft flew towards Daventry at a distance of around eight miles and duly reflected the 6MHz signal from the transmitter, which was picked up without difficulty at Weedon.

This piece of research, involving as it did three important state bodies, extracted the sum of £12,300 from a fourth state institution - a reluctant Treasury - which enabled a small team of scientists to begin work on a system for detecting and locating aircraft. The place chosen for this work was Orfordness, on the Suffolk coast.

The Experimental Stage

The leader of the scientific team was a small, forthright Scot with granny glasses, called Robert Watson-Watt. He had - from the late 1920s onwards - been engaged in the detection of electrical storms, with his colleagues at the Radio Research Station at Slough.

He had also given evidence to a government committee of enquiry, the Tizard Committee, who had been looking into the possibility of creating a 'death ray.' Watson-Watt had explained that the concept was impossible for the power required would, quite simply, be astronomical. He added however that he thought it possible to detect aircraft in flight using radio waves. Hence the Air Ministry's interest, Dowding's insistence on a demonstration and - subsequently - Watson-Watt's new appointment.

A month after the team's arrival on the Suffolk coast in May 1935, they demonstrated a system ' . . which measured the range of an aircraft by using pulse lengths between 10 and 50μs long, with a pulse recurrence frequency of 50 pulses per second, at a radio frequency of 6MHz.' [1] By the end of July, the team were detecting aircraft at 40 miles and their experiments were unquestionably progressing.

Consequently, Watson-Watt put forward the idea of a chain of radio direction-finding, or RDF, stations - some 20 miles apart - around the British coast. Towards the end of 1935, the Air Staff agreed to the building of such a chain between Newcastle and Southampton, they stipulated that seven such units should be up and running by August of the following year. The Chain, Home or CH network was born.

The Coastal Radar Chain

Radar physicists and engineers at this period had a problem, the choice of ' . . smaller aerials with more precise radiation patterns that could result from shorter wavelengths . . . or should they use, both for transmission and reception, the more established and powerful technology of lower frequencies and accept the necessarily larger aerial arrays and less well-defined radar beams?' [2]

On the continent, the Germans chose the former course, whilst the British opted for the latter. Consequently the CH system was totally unlike any other, or subsequent, radar system design, allied or axis. The German Wurzburg system for example with its parabolic antenna for both transmission and reception, looked surprisingly modern, whereas the British CH system looked like nothing so much as a high-powered broadcasting station.

There were two types of CH station, East Coast stations and West Coast stations, the performance of each of which is shown in Tables 1 & 2.

By contrast, the German radars operated on 2.4m and 50cm. The CH system's static antenna, low PRF and 12m wavelength were - in reality - a ' . . hereditary link [with] the techniques of radio direction-finding' [3] already established in Watson-Watt's earlier research.

The typical output of a CH radar transmitter is shown in Figure 1. The solid lines indicate the main lobes generated by the principal antenna array at an

Transmitters	Type T3026	Type T3026A
Operating Frequencies	4 pre-determined ones in the 20 to 60MHz range	2 pre-determined ones in the same range
Peak Power Output	450kW	700kW
Pulse Width	Adjustable between 5 and 45μs	Remotely controlled from the receiver
Pulse Recurrence Frequency (PRF)	12.5, 25 or 50 pulses/sec	12.5, 25 or 50 pulses/sec
Mast-Antenna System	3 x 360ft high self-supporting masts with a 6-antenna array	3 x 360ft high self-supporting masts with a 6-antenna array

Table 1: East Coast Chain Home Equipment

Transmitters	Type T3026	Type T3026A
Operating Frequencies	2 wavebands covering the 20-60MHz range.	2 wavebands covering the 20-60MHz range.
Peak Power Output	300kW Depending on frequency and tuning.	300kW Depending on frequency and tuning
Pulse Width	Adjustable between 6 - 9 and 12 -17μs	Selectable from the receiver
Mast-Antenna System	325-foot guyed steel masts supporting the antenna array	325-foot guyed steel masts supporting the antenna array

Table 2: West Coast Chain Home Equipment

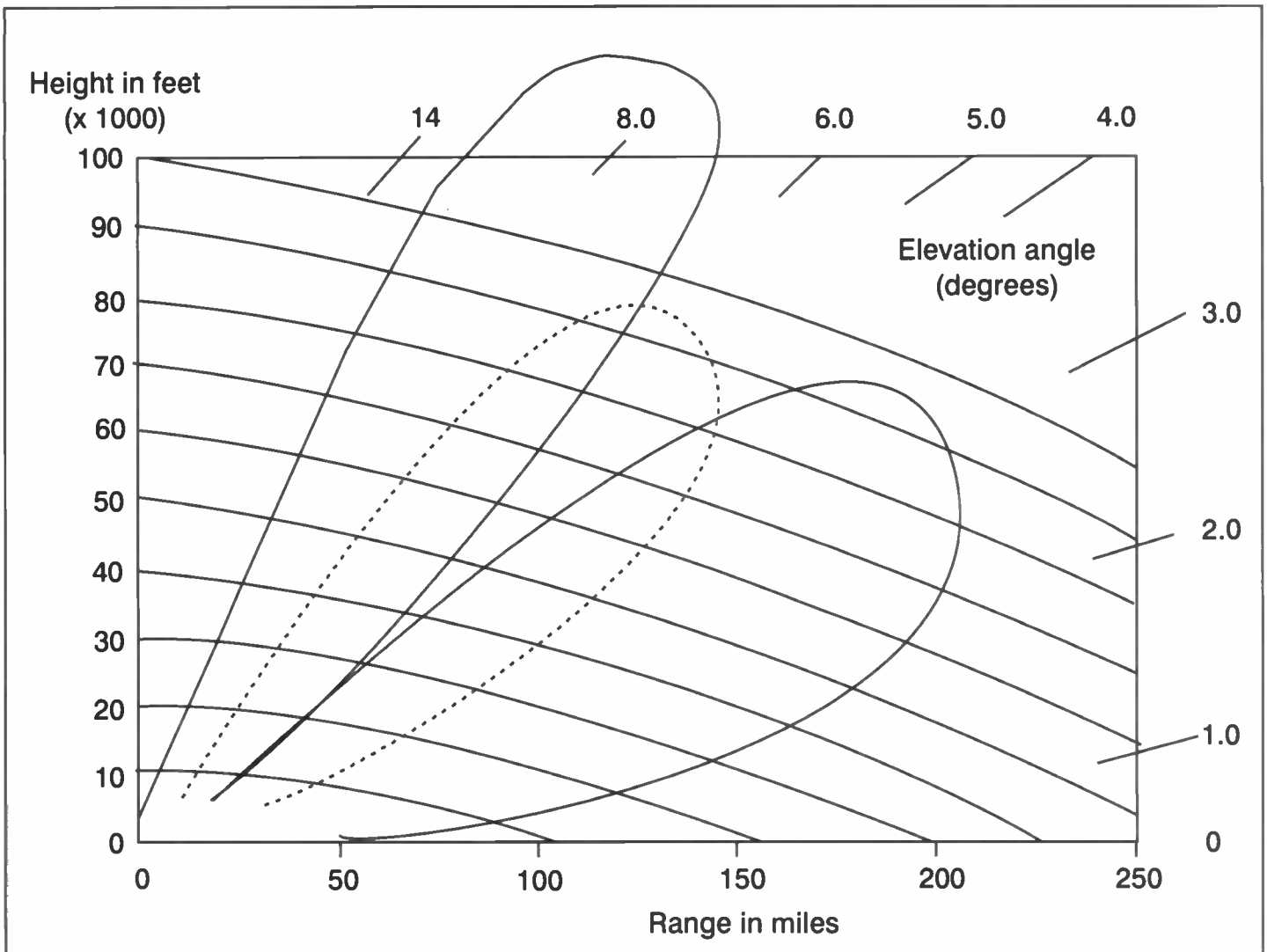


Figure 1 Typical signal output of a CH radar transmitter.

approximate height of 215ft. The null at 5° elevation was subsequently rectified by an array, placed at 95ft., transmitting the broken line lobe, which could be switched into service as required.

The CH system's receivers, specified and designed by Sidney Jefferson of Electrical and Musical Industries, (EMI), were built by Cossor Ltd. They consisted of three push-pull stages; push-pull mixers; five, single-ended Intermediate Frequency (IF) stages - at 2MHz - and a full-wave detector.

Finally, a push-pull output supplied the Y-plates of the oscilloscope display, termed a Range Tube and illustrated in Figure 2, is a typical example of an early radar display arrangement.

The operator could achieve optimum performance by selecting one of three, pre-set, bandwidths at 50, 200 or 500kHz. The design also incorporated anti-jamming precautions, which minimised continuous wave - or CW - interference, pulsed interference and frequency modulation, or FM, interference.

The Dummy Run

In 1938, during the RAF's annual home defence exercise, it was shown ' . . that while they [the CH stations] worked well under routine pressure they were easily swamped by massed attacks and their information was then rendered almost

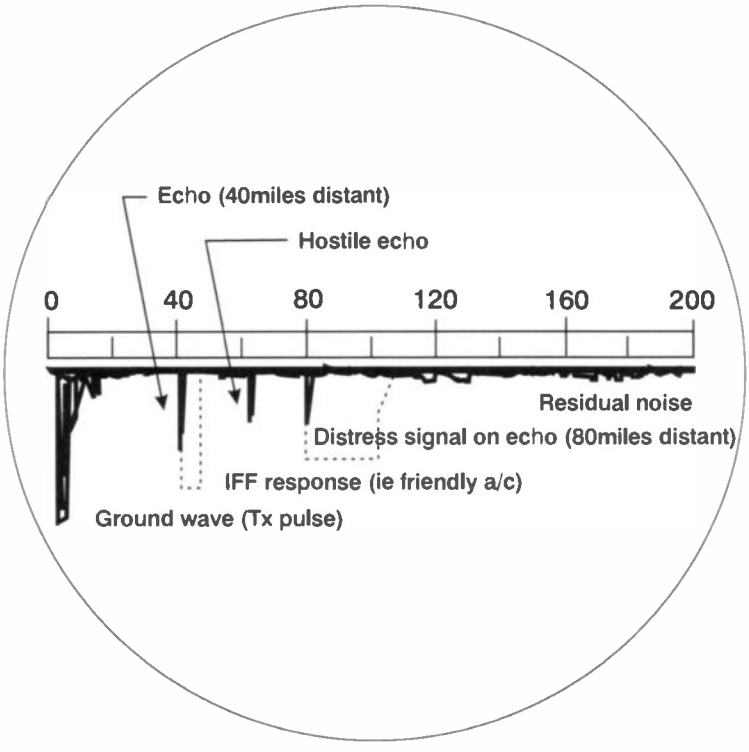


Figure 2. An early radar display. The range tube.

useless.' [4]

Easily the most difficult problem was actually identifying friend from enemy, until Watson-Watt put forward the idea of the RAF picking up the CH transmissions and then re-transmitting them either as longer, or larger, signals. Thus the concept of Identification Friend or Foe, (IFF), was born.

Another problem revealed by the August exercise was the poor cover below 2° above the horizon, an area in which low-flying aircraft could therefore remain undetected. However, this was less of a problem than originally thought for a solution to it already existed, and one developed by the navy.

The War Office had a small team of their own scientists at Bawdsey, who were developing gun-laying radar for controlling and directing anti-aircraft artillery. They were also - in co-operation with Admiralty scientists - working on Coastal Defence, or CD, radar for controlling coastal batteries. The radar sets developed for this work had already demonstrated that they could detect low-flying aircraft equally as well as surface shipping. This equipment ' . . used a higher frequency of 180 to 210MHz with a broadside, 32-dipole aerial to form a narrow beam in azimuth and elevation.' [5]

By the end of July 1939, this equipment was detecting aircraft flying at 50ft up to 25 miles distant with considerable accuracy. In the following month the Air Ministry ordered 24 CD radar sets from their manufacturer, Pye of Cambridge. One of these sets was located at each CH radar site, they becoming known as CHL, or Chain Home Low-cover units.

The CH units ' . . termed for security's sake Air Ministry Experimental Stations, (AMES), could detect aircraft up to 100 miles away, and could give the bearing and an approximate indication of the height and number of an approaching formation,' [6] and did so in a unique way.

The CH Calculator and Filter Room.

At the base of the two sets of towers there was a 'receiver hut.' Here the operators, often women, watched the cathode ray tubes.' [7] These displays gave the bearing, range and angle of elevation of aircraft, relative to the station's own position. This information could be used at the radar site to plot the bearings and ranges on a map, overlaid with the National Grid, enabling the compiler to read off the co-ordinates.

Equally, the height could be found using height conversion charts, based on the station transmitter's lobe patterns, aided and abetted by the results of the last periodic calibration of the radar equipment. This type of work however was difficult enough to carry out in a normal situation with complete and continuous accuracy. In hectic situations the task would become even more fraught with inaccuracy, the likelihood of which was foreseen in the equipment development stage.

The solution was an Electrical Calculator conceived by G.A. Roberts, a civil service scientist, and designed and built by the General Post Office's (GPO's) Circuit Laboratory. It was this very basic electro-mechanical computer that calculated the target heights from a combination of angle of elevation and range information. It also established the National Grid reference points from the bearings and ranges taken at the radar sites.

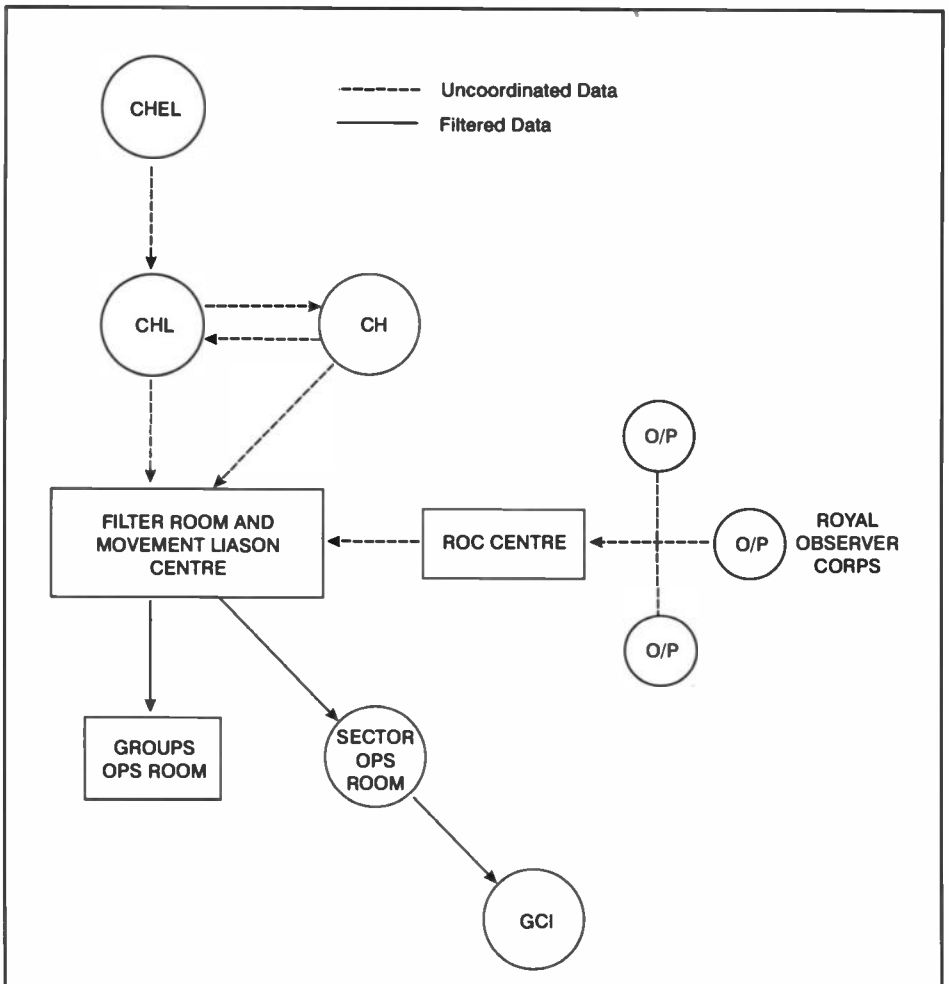


Figure 3. The British radar reporting system.

Naturally, with such a closely-spaced chain of radar stations, many aircraft tracks were plotted by more than one unit. This led to the concept of the Filter, or Plotting, Room. Here the staff - by range cuts and the combining and filtering of the plots supplied by a number of CH stations - were able to considerably increase the accuracy of the data prior to its onward transmission to Fighter Command Sector Operations.

The Filter Room staff - who put the updated information on the Plotting Table - were in direct telephone contact with the CH radar station tellers. Consequently the information placed on the table was as up to date as it could be.

Thus by the outbreak of war, the British had created a complete air defence system, one which could feed continuous track and positional information into an assessment centre which was linked to operational fighter airfields. This arrangement, shown in full in Figure 3, represented a major national organisational and engineering achievement, as yet unknown anywhere else.

The Flight of LZ130

On the third of August 1939, the CH units on the Suffolk and Essex coasts detected an enormous radar echo approaching from the east. Thirty miles from landfall this target turned north, flying parallel with the coast.

The British radar system plotted this object throughout its flight and passed the plots to Fighter Command Headquarters at Stanmore, in Middlesex. By 2.30pm, the echo was close to the Bell Rock lighthouse and half an hour later it changed course once more, flying northeast, parallel with the Aberdeenshire coast. What was it?

It was in fact an airship, indeed the sister-ship of the Graf Zeppelin, that had been dispatched by General Wolfgang Martini, the head of German Air Force Signals, to investigate the British radar arrangements. In this, LZ130 failed, and did so principally for the reasons outlined earlier.

To begin with, the British CH system operated on wavelengths of about 12m. Therefore the antennas were large and so did not produce narrow lighthouse beams which could be directed at different areas of airspace. Rather the CH system was a floodlight one, making all aircraft within its range potential targets. German radar - as already noted - worked on the lighthouse principle.

Since the coverage of each station within the British chain overlapped the next unit in the system, the Zeppelin's foray up Britain's east coast could only be described as a continuous radar drenching. Moreover, the 25pps pulse rate of the CH units - derived from the 50Hz mains supply - left the German technicians on board the LZ130 with the impression that the radiation was a form of interference rather than a radar signal.

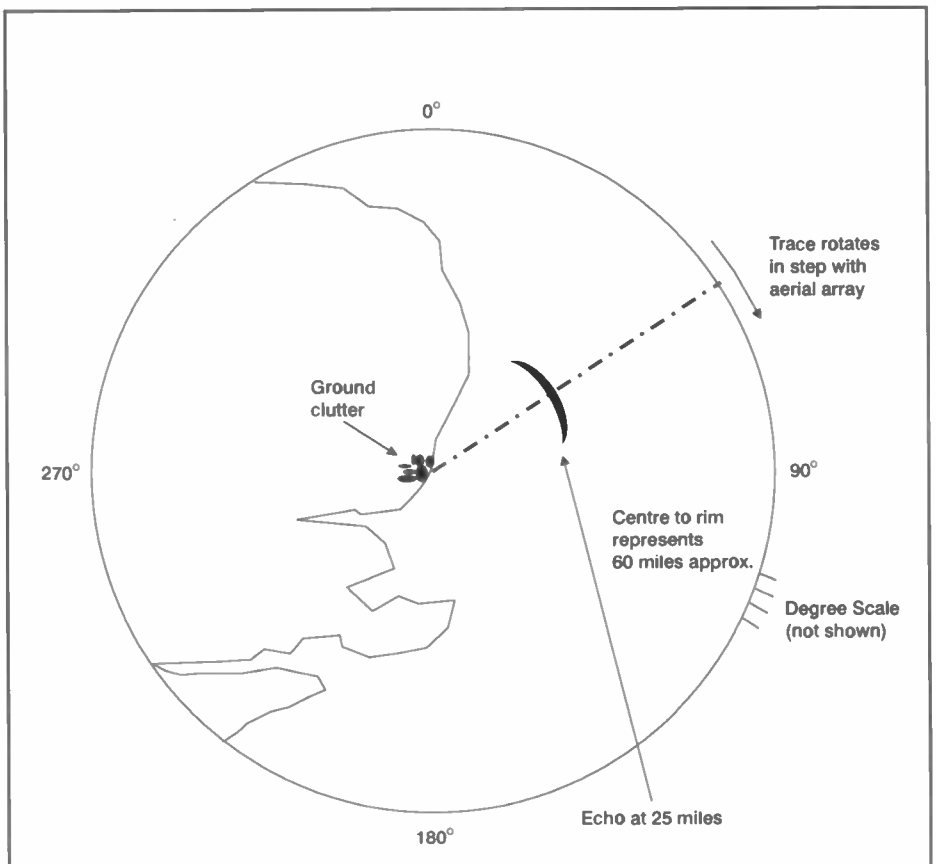


Figure 4. The plan position indicator (PPI) radar display tube.

This need surprise no-one for the airship was flying close to the CH stations, which would have resulted in the input circuits of the on-board monitoring receivers being overloaded. Furthermore, the British transmitters had no harmonic suppression, which made their transmissions 'band splashy' indeed! So the transmissions would breakthrough in any case, no matter how deftly the airship's technicians re-adjusted their receivers.

Another factor in this failed spy flight was the sheer size of the airship's structure, which distorted the British transmissions. Taken in the round, it was simply not the Germans' day, for the on-board technicians suspected that the source of the transmissions was arcing on the British national electrical grid and - or - its distribution system.

The Air Battle

At the start of what has come to be known as the Battle of Britain 57 radar stations were up and running in the United Kingdom, 32 of which were CH units, many of which had a CHL facility. A further nine CH and 22 CHL units were installed and commissioned whilst the battle was in progress. Three CH units had also been installed and commissioned overseas.

In June 1940 four members of the Bawdsey research team E.G. Bowen, W.B. Lewis, G.W.A. Dummer and E. Franklin developed the Plan Position Indicator, or PPI radar display tube, shown in Figure 4.

This was the first ever two-dimensional display, showing bearing and slant range. The earlier single dimensional display had shown only slant range to the target as a deflection on a timebase across the tube. The PPI however had a timebase as a radius on the tube, pointing in the same direction as the antenna.

Used for CHL receiver displays initially, this indicator was usually set for a range of 50 to 60 miles. It was later further developed and adapted for use in airborne radar such as the Airborne Interception, or AI equipment, the H2S navigation radar, developed by Bernard Lovell and Philip Dee, and the maritime Anti-Surface Vessel, or ASV, radar.

By early August 1940, the failure of LZ130 to detect a British radar network was having telling effects. The massive towers, which the Germans had long correctly identified as radar installations of some kind, were proving very effective indeed. Nevertheless ' . . it was still not appreciated how efficient were not only the CH and CHL radar, but equally important within the defence structure, the communications and co-ordination of the early-warning system.' [8]

One man at least remained convinced of their importance: General Wolfgang Martini. He persuaded his superiors that an attack should be made against the south coast radar units. This - a short, one-day affair which was all his superiors would allow - took place on August 12th and although some stations were damaged, the assault failed in its objective of blasting a hole in the British radar coverage. In the following month, the Germans resorted to radio jamming both the CH and CHL radars, a ploy that had already been anticipated. Consequently, the anti-jamming devices already touched on made this last attempt at disruption ineffective. By the end of September 1940, the German air assault on Britain had been broken. The world's first air defence system had proved its worth.

The Aftermath

The air battle over southern Britain between June and October 1940, established the role of radar as not only an effective defence against air attack, but also the way ahead in aerial navigation, positional identification and aerial safety.

The scientists, engineers and technicians at Bawdsey, Worth Maltravers and elsewhere had already provided the future civil aviation industry with two of their most important aids: IFF - which would later evolve into Secondary Surveillance Radar or SSR - and the PPI Display, now commonplace in the world's air traffic control rooms for providing both primary and secondary radar information.

Further developments would include centimetric radar which, in turn, would lead to weather radar, cloud avoidance radar and a number of other electronics-based safety aids for civil aviation. In fact, by the end of World War II radar would be a separate discipline within the electronics profession.

And this had all come about because one man thought that it could be done, whilst another would not part with a penny before the idea had at least been demonstrated!

References

1: Gough, Jack (1993): Watching the Skies: The History of Ground Radar in the Air Defence of the United Kingdom. HMSO Publishing Centre, London. Ch 1, Page 3.

2: Latham, Colin & Stobbs, Anne (1996): Radar: A Wartime Miracle. Sutton Publishing Ltd., Stroud, Gloucestershire. Page 221.

3: Ibid [2], Page 16.

4: Ibid [1], Ch 1, Page 6.

5 Op. Cit. [1], Ch 1, Page 7.

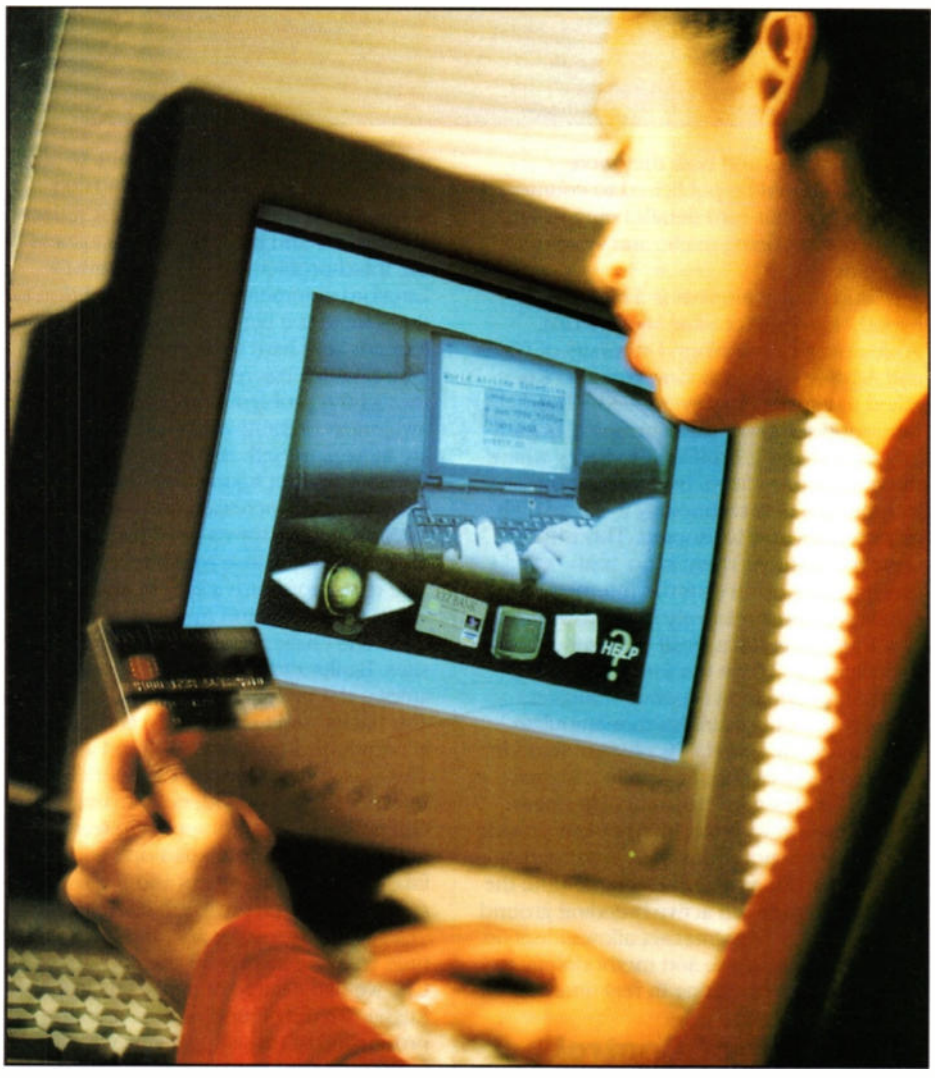
6: Hough, Richard & Richards, Dennis (1989): The Battle of Britain: The Jubilee History. Hodder & Stoughton, London. Ch 3, Page 51.

7: Deighton, Len (1993): Fighter: The True Story of the Battle of Britain. Pluriform Publishing Company BV. Page 90.

8: Ibid [6], Page 142.

Computer FRAUD

Michelle Grieg looks at the extent of Internet and computer fraud and discusses ways to tackle the rapidly increasing problem.



The traditional image of the financial fraudster is of a white collared insider. But technology and the Internet are changing this stereotype. The Internet has encouraged a new breed of criminal – faceless, remote and opportunistic – committing old fashioned crime in ultra-modern ways. Many imagine a computer criminal as a spotty 14 year old nerd in his bedroom.. But as pointed out at a recent international fraud conference, that teenager is likely to be financed by organised crime. As law enforcement agencies around the world know only too well, the advent of the Information Age has rendered traditional rules and practice of law enforcement redundant. While we are waiting for the new procedures to be agreed, the fraudster is getting on with his job.

To divulge financial secrets to a faceless stranger, without seeing their credentials or inviting that stranger into your home would be judged a foolish move. However, this is exactly what businesses and individuals are doing on the Internet. Eagerness to embrace the medium and lack of information of the potential pitfalls has meant the growth of the Internet has opened another powerful medium to the fraudster.

Where there is uncertainty, there is the potential for fraud and where there is change there is opportunity. The Internet represents both uncertainty and change. As a result, reports of Internet fraud are on the increase. According to Internet Fraud Watch, a US group operated by the National Consumers League, registered complaints have increased 600% since 1997. "More people are online, and more people are getting scammed," said Susan Grant, director of the Internet Fraud Watch. "Consumers need to remember that con artists are everywhere - even in cyberspace."

NCIS, the National Criminal Intelligence Agency service of the UK launched Project Trawler in July 1996. The Project was designed to be a comprehensive study of crime on the Information Highways. In the report, the lack of authoritative figures was cited as one reason computer crime is difficult to measure. The remit concentrates on Internet dissemination of paedophilia information, computer misuse (hacking and viruses), telecommunications fraud, piracy and cyber-stalking. Computer crime defies simple categorisation into crime types and cybecrimes remain a mixed bag of traditional offenses. Crimes on the Internet range from homepage vandalism to online bank robbery. Electronic theft, such as breaking into bank accounts and generating fake credit card numbers, is cited as by far the most widespread type of cybercrime. Online auction complaints were the number one fraud complaint in 1998, increasing from 26 per cent of the total frauds reported, to 68 percent in 1998. The top ten scams are: auctions, general merchandise sales, computer equipment/software, Internet services, work-at-home, business opportunities/franchises, multilevel marketing/pyramids, credit card offers, advance free loans, and employment offers.

Yet opinions vary as to the extent and seriousness of electronic fraud, two positions currently exist: either levels are over-hyped and misunderstood, or fraud truly has spiralled out of control.Statistics are bantered daily and do, in general, show computer crimes rising (see Table 1). However, as the UK National Criminal Intelligence Agency claims, "statistics do not provide a full picture of the level of Internet and 'computer crime' but only provide a partial snapshot."

	1997	1998
Computer security breaches	55%	64%
Computer crime losses ($millions)	$100*	$136*

* 12 month losses reported by 241 of the 550 companies and universities in poll. Most could not estimate amounts of fraud losses.

Table 1. Sampling of 550 institutions shows activity by cyberthugs is on the rise. Source - American Computer Security Institute.

Fraud Over-Exaggerated

Many of those who believe Internet fraud is over-hyped also feel the alarm has affected the confidence of e-commerce. Recent UK research carried out by Consumers International in June, found that while there were problems regarding credit card security, delivery and complaint procedures, consumer unease, real or imagined, was at an all time high. Merchants, too, have been faced with bills following Internet transactions made with fraudulent cards. For many, the cost of fraud obliterates their margin of profit and makes them unwilling to repeat the exercise.

This is backed by research conducted by the UK Consumers Association, which found over three-quarters of Internet users were reluctant to use their credit cards over the Internet to purchase goods. Fear was the main deterrent. Over half those polled were convinced the Internet is boosting fraud, and 68% would not give their credit card details on the Internet, but would gladly give their card details over the phone.

Hacking, cracking, scams, mass mailing of emails, corporate invasion and violation of intelligence rights all feature regularly within media headlines. It is these headlines that are nurturing the irrational fears of consumers. TheEcademy – an e-commerce education forum argued misinformation is the real problem in electronic commerce, not security.

Frederick Wilson of Lloyds TSB bank agreed: "There is no security problem. Consumers and small merchants often don't understand that e-commerce is no more insecure than any other type of business." Peter Bell, Microsoft UK e-commerce business manager cited Visa as the biggest proponent of the scare stories. He argued its widely reported claim that 45% of its fraud was Internet fraud had damaged the confidence of consumers worldwide. The Visa figures were received with scepticism. Visa claimed in April this year, 47% of card disputes in the European Union were Internet-related while the Internet only accounts for 1% of Visa EU turnover. In the US, where Internet transaction amounts are considerably higher, Visa USA claims online fraud is equal to or less than 0.1% its overall US card volume. This compares with 0.08% in the physical world. In contradiction, a recent study by the US National Consumers League (NCL) concluded that while six million consumers have been victims of Internet credit card-related fraud it should not be considered widespread.

The NCL has acted as a complaints clearing house for consumers with its Internet Fraud Watch project since 1996. The number of complaints it recorded grew twenty-fold between 1996 and 1998. However, the NCL found only one case of details being compromised between a consumer and reputable merchant. So if a consumer or business sticks to reputable sites there should not be a fraud problem. "Online businesses like Expedia sold US$1 million-worth of travel tickets last year without a single security incident. This type of story is not unique, and should be told with the scare statistics," TheEcademy chairman, Thomas Power argues. He added:

Virtual payment reality made by Giesecke & Devrient
The smart card terminal keyboard for secure home banking and payment transactions over the internet

"Success stories and how they were achieved should be publicised to counteract the fear of credit card details being stolen, payments not being made, and systems falling over."

"Fraud on the Internet is a bit over-hyped," agreed Professor Michael Levi, Professor of Criminology, University of Wales and Advisor to the UK Government. When asked to explain, Mr Levi replied, "The Internet does lower the start up costs for a lot of fraud and it is difficult to know where the fraud comes from. But because the Internet is a new technology it shows high growth rates as it is adopted. This is the same for fraud. As there is no real precedent or history for the Internet, all frauds will show relatively high growth rates. The Internet is still a small per cent of overall fraud." While the Internet does provide insider and corporate fraudsters with greater opportunities to manipulate companies, Mr Levi claims physical fraud in financial services should remain a higher priority for those investigating. He claims preoccupation with the Internet can provide an easy distraction from what is happening right under our noses. At the same time the Internet provides an active breeding ground for fraudsters. "The Internet allows ideas on how to commit crime and methodology to be transmitted operating in real time."

Fraud Out of Control

Dr Audri Langford and her husband started an Internet website called 'ScamBusters' four years ago in the US. The free site contains mainly US information and comments to help consumers protect themselves against Internet fraud. The information is in the form of common sense codes of conduct and what to avoid. The site also has a message board where consumers can share their experiences, providing a useful barometer to the view of the industry outsiders Internet fraud.

Dr Langford said: "We started the site when we saw friends and colleagues getting ripped off by people and companies on the Net for absurd amounts of money. We decided to do it as a public service. The scambusters site now has around 50,000 unique visitors per month and 40,000 subscribers." So does this interest reflect consumers' and business consciousness of the fraud problem on the Internet? Dr Langford commented: "In the US I don't think fraud is a big interest area. We've found it very hard to make businesses aware, which has really surprised us. Apathy toward the problem is apparent everywhere. Awareness of fraud varies, yet fraud losses are increasing with the growth of the Internet. Recent figures here in the US show Internet fraud increased 600% in 1998."

Ultra-security waves a red flag in the face of the hacker, whose sole intent is to be able to compromise a system and a cracker wants to destroy and manipulate them for gain. The challenge is breaking into secure sites. Banks and financial institutions are among the most targeted sites.The fraudster also hacks credit card details and card generation programmes to fund activity. This was apparent in the experience of Internet service providers in Russia. America Online, (aol), and CompuServe were forced to shut down their Russian operations after fake credit card numbers and the use of stolen passwords escalated dramatically.

A spokesperson for aol said: "Around the time we were setting up our service in the CIS we had a surge of applicants from Russia. We duly found out that a high proportion of those applicants were using fraudulent card details. aol decided to close its operations and we do not have plans to re-enter the Russian domestic market in the foreseeable future. Until security improves, we will not be looking at the Russian Internet market." Global access was quietly suspended. The company still offers access to the international traveller in Russia using secure accounts, but does not offer its services to the Russian domestic market.

Computer Crime

Rainer-Diethardt Buhrer of Interpol economic crime branch claims that the lack of an International definition makes statistical comparison, and measuring the enormity of the problem difficult. He claims the

potential problem will be the tendency to describe old crimes on a new medium, without new definitions or statute of the new crimes, such as introducing viruses and changing data. Mr Buhrer claims the Internet has only brought about one real change - it's universal nature means anyone can access anything, anywhere. It is easy to hide identity and difficult to track communications. There are also obvious jurisdictional problems. Mr Buhrer argues, "Who deals with it? How do you prove it? There is no regulation at this stage."

DS Nigel Jones of the Kent constabulary and Secretary of Computer Crime Committee agrees definition and current interpretation of law is the biggest problem faced in the UK where there is no requirement for the police to record crime by the way it was committed. He explained : "Most Internet crime is recorded as terrestrial crime. For example, for goods ordered on the Internet, using a false credit card, the crime is fraud, not that of Internet card fraud. Therefore the crimes are still defined in terrestrial terms. In this respect there is no method to capture or analyse the information."

There are 43 police forces in the UK and Wales. The extent of their computer crimes department is dependent on the region. At the moment, over one-third of these forces has a computer crimes division. Two years ago, Kent was one of only two provincial divisions to have such a team. The workload of police involvement has also grown dramatically as the computer becomes an internal tool to everyday life and a storage and communications tool. DS Jones claims the Kent workload has doubled on average each year. He claims this could be because the police are now aware of the crime and seizing more computers from existing crime, or because actual crime rates are on the increase.

Corporate Computer Break-ins

In the US, 4,398 corporate computer break-in's by outsiders have been recorded this year according the Pittsburgh-based Computer Emergency Response Team. The Team expect the total number of incidents to double this year. The computer is an indispensable tool for crime. It is used in facilitating hacking, storage of illicitly obtained information and money laundering. However, computers often contain the evidence that can lead to the fraudsters' conviction.

Given that most companies store financial records on computers and that computer networks are at the heart of funds transfer around the global financial system, it is little wonder that computers are such a popular target for fraudsters. But what fraudsters often forget is that the tool of their crime is also a prime source of evidence, and in many cases, ultimately their downfall.

Stolen databases, illicitly obtained banking and employee salary files and forged certificates of incorporation are typical of the files found on the fraudster's computer. The use of computer evidence in fraud investigations is increasingly common, assuming it's place along side more


DS Nigel Jones
Kent Constabulary

traditional methods such as finger-printing, and electronic surveillance.

"You can find real gems on computers", explains Ed Wilding, associate director of the forensic science division at Network International. "Computers tell the story so much easier than struggling with loads of descriptive text - they are a reflection of their users."

"Computer evidence will be used where computers are central to business or if the case is particularly major, such as in the Maxwell fraud" said Gordon Stevenson, managing director of Vogon International, the data recovery and computing forensic specialist. "Occasionally, computer evidence is the only evidence available."

More often, examination of computer systems, software and data will unearth evidence to corroborate existing perceptions of suspicious behaviour, but, it can also kick-start an investigation that was in danger of collapsing." Clearly, knowing what information is important, and its location is the key to success. "I don't want our people walking out with microwave ovens thinking they are relevant," said Wilding. Examination of computers for evidence is typically arranged via a police search warrant or, for civil recovery, via an Anton Piller Order, which allows access to premises for the search of documents, including data stored electronically, that would reveal the identity of a fraudster.

Gathering Computer Evidence

The way in which computer evidence is gathered, analysed and presented - known as computer forensics - is key in determining its admissibility in a court of law. Most forensic efforts will be concealed on the computer's 'non-volatile' or stable memory, although set-up information, including date and time settings are also relevant.

Action against computer crimes became an international objective following the G8 Action Plan, a result of a 1997 G8 Meeting. The plan outlined the importance of adequate training and co-operation between industry, government, and telecommunications in police investigations, and how best to meet the needs of law enforcement.

DS Nigel Jones argues intra-industry co-operation and training will be the main weapon in the fight against fraud. He claims Internet Service Providers (ISPs), the police and the financial services are now co-operating. However, the role of the ISPs is crucial, and their involvement often forms the foundation of an Internet case. It is the ISP that holds the information on the Internet user. The problem is that different companies have different regulations and they keep their account information for different periods.

Communications

DS Jones claims communication between the police and ISP is vital: "We are hoping to let the ISPs know what it is that we want and make it easier for them to provide it. Many ISPs were unaware of data protection laws, and were unsure whether it was lawful to disclose customer information. The police responded by putting together a new reporting procedure tailored to the ISPs, clearly defining their role. ISPs have also complained contact with local police is difficult, as there is no-one available who understands their technology, or problems. This is where the unit and police training is vital." The police face tough challenges in terms of educating and training to keep up with the growing sophistication of criminals, eager to exploit the open frontier of computer communication. Policemen face dedicated, computer literate and multi-skilled individuals. Recruiting such individuals for the service is difficult as candidates are often lured by the vast money offered by organisations in the private sector, or are enticed by organised crime. This is a problem strongly felt in police forces in Eastern Europe. The police force salary is meagre in comparison, and 'battling on the side of good versus evil' can be a weak incentive. DS Jones states the police face two main barriers: one is the misconception among colleagues as to what the job entails, the other concerns a whole generation of police officers that requires extensive and continual training. The job is made more difficult as the continual speed and dynamic nature of the Internet means once a fraud is detected, the police threat is common knowledge in an instant and the 'elusive' criminals can change tactic and hide their tracks.

One area which would be invaluable to police is the ongoing collection and monitoring of data on the Internet. This would allow police to target and record the movements of suspected criminals involved in a suspected serious crime, or those that access specific sites such as child pornography sites. DS Jones claims at the moment police are unable to get data from ISPs, a problem that is made more complex due to the differing policies of different ISPs. For example, America Online, makes web access anonymous. This means it does not keep information on what subscribers are accessing. DS Jones claimed this is an area of law needing urgent redress, explaining: " At the moment, if I want information about a serious crime that is occurring on the Internet, or being

communicated via the Internet, I can go to court to get an order to enforce the ISP to provide me with the information it may hold. This is often in the form of traffic data or email content data. However, the problem is data retention. By the time I have got the proper order through the court to attain the information, the ISP will, in most cases, no longer hold the relevant information, as they have a deletion policy. The subject of data retention needs to be addressed through the correct judicial and law enforcement channels. If I can then go to court to say a serious crime is being perpetrated on the Internet, and get an order to enforce the ISP to preserve data I need, I can use this to monitor the case and collate information. At the moment there is no such mechanism. The law is not about spying. The order would only be granted in a serious case, as under the European convention on Human rights. All police monitoring activity must be proportionate to the offence. For example, it would be a violation to monitor all email and web access of a tomato seller believed to have stolen one crate of tomatoes from his supplier, as the action is disproportionate to the crime. There is little opposition to this law from Civil Liberties groups as long as the correct safeguards are in place. The police are in effect "dealing with people who were frightened to turn on a machine to the most complex technical and crime issues."

Another point DS Jones noted was that the safety of the Internet is often not acknowledged. In effect, the Internet invites strangers into your own home, and entices you to enter their world. One common complaint to police is the bombardment of emails with pornography and offensive material. DS Jones understands the concerns of citizens, but urges education about the Internet. He argued: "People won't go to bed at night with their windows and doors open, but they will let their 10 year old son sit in front of the computer, unsupervised."

Fears Over-hyped?

But is the fear over-hyped in the UK ? DS Jones claims "There are no firm statistics to rely on. If the burglaries in the UK were thought to be increasing a person could check with the Home Office to ensure this was a fact. There are no such figures, for the Internet so anyone can interpret them any way they like."

In the public eye, virus and email targets are the most commonly felt, and they are a violation and the closest contact most people have with computer and Internet crime. These instances are only a small part of the police remit, therefore much of their other work is unfelt or unknown by the public. In the politics of crime and budgets, the Home Office dictates which crimes are given prominence determined by public opinion. DS Jones claims that as a result, high tech crimes suffer in preference to public crimes such as murder and car theft. However, he claimed, " I am quite convinced it will become a more prominent feature of policing targets as the opportunities for the criminals grow."

At the moment, the computer crime unit is mainly used as an important component of ongoing cases. As a result, the success rate is difficult to evaluate. DS Jones claims: "The success rate is 100%. If it is there, then we find it, if not, we don't." However, what if they don't know where to look? NCIS believe the future of computer crimes will be politically and financially led with the continuation of work rage and mischief making. Internet fraud will continue to demonstrate vast growth as the world and companies adjust to the learning curve of the Net.

NCIS does not buy into the hype, but warns current measures must be taken to prevent future problems. Otherwise criminals will make even more use of Internet communications to organise their illegal activities. This has the potential to undermine the ability of the police to catch and fight serious and organised crime.

NCIS warns : "In the Information age, significant opportunities exist for gain for those who are best able to utilise both technology and information. Who will do the better job, the criminal or those seeking to detect and prevent crime?" Only time will tell.

Insulting Car Audio Capers

Dear Sirs,

I have read, with interest, your article entitled 'Car Audio Capers' and have a few views I would like to air.

Point 1 - I refer to your first paragraph, where you state 'What genius thought that putting the door-mounted front speakers at slightly above foot height was a good idea?' Kickwell builds systems which have the speaker down by the foot area, pointing up to the opposite head, actually give the best imaging, because the path length is most equal. Therefore, the sound reaches the ears with less phase shift. This would, of course, be best with the tweeter and mid-bass mounted together.

Point 2 - Regarding your point on rear speakers - these should not be necessary at all. If a system is set up correctly, the right ambience will be created by a good set-up up front.

Point 3 - I agree that a metal enclosure is far from ideal, but applying Dynamat is very good at reducing ringing and making the car acoustically more dead.

Point 4 - Regarding your view on having tweeters on the dash to improve stereo imaging. The mid-bass and tweeters should be mounted together to create a point source, so as not to spread the frequency range. Also see Point 1.

Point 5 - Anechoic chambers - these are most likely for testing the RF interface, not for testing audio.

Point 6 - Your point regarding a subwoofer made to fit a car - any car hi-fi dealer worth his money should be able to design a subwoofer enclosure to suit any taste in music, whether it's SPL or Sound Quality.

Point 7 - Your view on Sound Off's and I quote 'They're often from the boy-racer 'sound-off' school of thought - in other words, if it's loud it's good! Subtlety, detail and accuracy? - out of the window, mate!' I have to say that you are incredibly mis-informed about Sound Off's and being a competitor in these competitions, I feel quite insulted at your views. There are different categories within Sound Off competitions - SPL, which is DB Drag, for your average boom boy. Then there is SQ, which stands for sound quality - this tests for quality of installation, staging, imaging, tonal accuracy, linearity, etc. I am sure you get my point.

Point 8 - Your point regarding 'Graphic Liquidiser' - many manufacturers make equalisers that take speaker level inputs and contain amplifiers as well. Better ones are 1/3 octave and 2/3 octave - as with many things, you get what you pay for. It is also much better to use the original CD, rather than always burning one specifically for the car.

I very much look forward to receiving your comments regarding the above.

Darryl Perks

Unfortunately, Martin Pipe is sunning himself in the US at the moment, and cannot answer your comments before the deadline for this issue, but we will print his reply next month. However, I venture my own comments for what they are worth. Perhaps I come from an old school of thought, that believes hi-fi (or reproducing music) was all about trying to accurately recreate the original performance. This may be of-the-mark with modern popular (Ibiza?) music which is mostly 'electronically' produced, but the basics still in general apply. Perhaps the most important being that you place your speakers at about 6 - 8ft apart and at face height - hence the general need for stands. I believe this is the point Martin was eluding too (your point 1). Also, to produce bass notes accurately requires rooms that are long enough to match the wavelength of the note, and this is just not possible in a car. Hence the need for very high powered amplifiers and large speakers to produce 'bass' in a car. I believe you are probably quite right in your point 2, but even so, Martin's criticism of parcel shelf speakers is still valid. I would certainly agree with your point 4, but it is car manufacturers who insist on this practice. I must admit to being somewhat puzzled by your point 6. "Any car hi-fi dealer worth....a subwoofer to suit any taste in music whether its SPL or Sound Quality." I listen to music, whether in the car or at home, for the enjoyment of the music - be it R&B, jazz, classical, funk etc. You imply that the taste is about whether it is sound quality or boy-racer sound! All we can hope to do in a car is to produce a reasonable sound, and I for one do not believe you can produce hi-fi in the car - sure, it can sound good, but not as good as in the living room. This I feel is what Martin is trying to suggest in his series. You have to ask yourself whether in-car 'hi-fi' is all about enjoying listening to the music, regardless of taste, or is it about generating a lot of noise - albeit good quality noise!

Fringe Science

Dear Sir

I think you have missed the point of Mr. Lee's letter. I don't think he is suggesting that those who strive for a more "scientific view" of the origins of things are "fringe" types, rather that the paranormal and philosophical views expressed in your pages recently are on the fringes of both science and religion. I would agree with him that if you are going to publish "fringe" religious views of science in the magazine you should also include more orthodox religious views on the same issues. However I suspect that even if you wished to do this the results might take up too much space, maybe you should leave the "fringes" alone, and stick to the science after all.

It seems to me that this excellent magazine has always been devoted to engineering rather than science. However, good engineering depends on an understanding of underlying scientific principles, and so it is reasonable that scientific letters and articles also find their place. I see science as a tool we use to understand the universe so that we may do better engineering. Trying to use science to trace the ultimate Why of creation is foolish, because then we are trying to turn science into a religion. Even if we were able to do this what could we hope to engineer from it, our own salvation perhaps? Science may well tell us lots about how the universe started, but not why. This is because only God knows why. Better to know God by faith, trust Him for salvation and only trust science to support our engineering!

I look forward with interest to reading how far "Beyond" Electronics you are prepared to go. Mind you I also hope to see more practical designs and circuits as well.

David Lewis

I am afraid I will have to be controversial here, since I do not feel we have brought religion in to any of our recent articles. We have endeavoured to tread a scientific path at all times. Even Uri Geller's column has only ever reported 'factual' events, he has never implied any religious interpretations. We may have strayed into 'fringe' sciences, but I would certainly disagree with your statement that "trying to use science to trace the ultimate Why of creation is foolish, because then we are trying to turn science into a religion." Surely this has to be the ultimate goal of science to discover how it all began, so how can it be foolish? Frankly, I can not help but feel that what concerns 'religious' people most is that when, and if, science does discover how it all started it may also prove once and for all whether 'God' exists, and in what form. Is it just a belief that there has to be more than being born, living and then dying, and that 'heaven' (and hell) exists somewhere.

Code Making & CODE BREAKING

PART 2

In part 2, Mike Bedford discusses the Enigma and Vigenère ciphers, and the early Greek Scytale cipher.

In the first part of this series on code making and code breaking – more accurately cryptography and cryptanalysis – we looked at some simple ciphers and saw how easy they are to crack. Admittedly, there are a vast number of possible combinations of the 26 letters of the alphabet, so cracking a monoalphabetic cipher by the sledge hammer approach of trying out all the combinations is impossible, even with a computer. Nevertheless, so long as one letter in the plain text message always becomes the same letter in the cipher text message – and this is the definition of a monoalphabetic cipher – knowledge of the frequency of occurrence of letters, letter pairs and letter triplets in the English language provides a means of cracking the cipher. Because of this weakness in monoalphabetic ciphers, all serious ciphers are polyalphabetic and here, the same letter in the plain text message will become different cipher text letters depending on where they appear in the message. The first publicised polyalphabetic cipher is the 16th century Vigenère cipher which we introduced last month. For full details we'll have to refer you back to last month's article but for now, all you need to know is that a keyword is used to determine which of 26 monoalphabetic substitution ciphers to use for each letter in the message. So, if your keyword is six letters long (as was the keyword 'MAPLIN' which we used in our example last month) the monoalphabetic cipher represented by the letter M is used for the 1st, 7th, 13th and 19th letter etc. the monoalphabetic cipher represented by the letter A is used for the 2nd, 8th, 14th and 20th letter and so forth. In the case of the Vigenère cipher, each of the monoalphabetic ciphers selected by the letters in the keyword is simply a shifted version of the alphabet but, in general, we could devise a scheme in which each of those 26 ciphers was a totally random mapping of plain text onto cipher text. So, with that slight recap out of the way, we'll come back to the question we posed at the end of last month's article – 'how do you crack the Vigenère cipher?'.

Cracking Vigenère

An important concept in cryptanalysis is the index of coincidence. Let's take a look at this important statistical measure. Take a message – plain text or cipher text – and write a version of that same message, shifted a random number of places and wrapping round at the end, immediately below it. Now mark all the positions at which a letter in the original message coincides with the same letter in the shifted version. Count the number of coincidences and divide that number by the total number of letters in the message to get the index of coincidence. In Figure 6 we see this process being carried out on the letters in the first sentence of this paragraph. You'll notice that we have six coincidences and a total of 68 letters so the index of coincidence is 6/68 = 0.88. This is a statistical measure so the exact index will vary, especially with short messages like, but the average for English language text is 0.66. And amazingly, it doesn't matter how much you shift one version of the message relative to the other. However, the index of coincidence has some more surprises. In Figure 7, we carry out the same process with 68 letters of cipher text. Specifically we're using the first 68 letters of the monoalphabetic cipher text message which

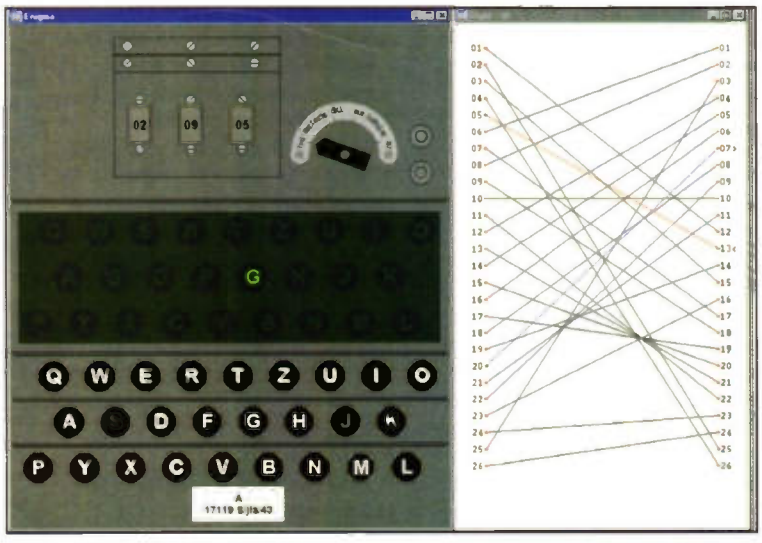


Photo 2. This Enigma simulator for Windows allows you to get some hands-on experience of one of the most famous codes ever invented.

```
A N I M P O R T A N T C O N C E P T I N C R A C K I N G T H E V I G E N E R E C I P H E R I S T H E I N D E X O F C O I N C I D E N C E
I N C I D E N C E L E T S T A K A N I M P O R T A N T C O N C E P T I N C R A C K I N G T H E V I G E N E R E C I P H E R I S T H E I N
```

Figure 6. Determining the index of coincidence for plain text. This will be 0.066 for English language text so long as the sample is long enough.

```
S F X H L X M A I S B O L Z G K X A M S B U S X M H K G Q A M A G F S B A F O L Z M Z F M Z O L S O A O A M G F B X S L X H Q O L X M A
O L X M A S F X H L X M A I S B O L Z G K X A M S B U S X M H K G Q A M A G F S B A F O L Z M Z F M Z O L S O A O A M G F B X S L X H Q
```

Figure 7. The index of coincidence of cipher text encrypted using a monoalphabetic substitution will be the same as that as plain English text. Random letters or, in the general case, polyalphabetic cipher text will give a value of 0.038.

we used last month as an example of how to crack monoalphabetic ciphers. And once again, we get an index of coincidence of 6/68 = 0.88. In fact, so long as they're sufficiently long, all monoalphabetic cipher text messages will have the same index of coincidence as the English language. A message composed entirely of random letters, however, or a polyalphabetic cipher text message (in most instances) will have a much lower index of coincidence – around 0.38. This gives us a means of determining, therefore, whether a cipher text message has been encrypted using a monoalphabetic or a polyalphabetic cipher. This is only the tip of the iceberg, though, we can also use the index of coincidence to crack the Vigenère cipher.

We've already seen how the Vigenère cipher is really a number of monoalphabetic ciphers used in rotation. And the number of these monoalphabetic ciphers is defined by the length of the key. So, if we calculate the index of coincidence of some Vigenère cipher text, the amount by which we shift one copy of the message relative to the other dictates whether we end up with a figure around 0.38 or the English language value of 0.66. If we pick a multiple of the key length then all the letters will end up alongside letters from the same monoalphabetic cipher and so the index of coincidence will be around 0.66. For any other shifts, the value will be 0.38, the same as random text. So, to determine the length of the key used to encrypt a Vigenère message, calculate the index of coincidence for various shifts starting at one and working up. So long as the message is sufficiently long for the results to be statistically meaningful, as soon as you get to the key length, the value will jump from around 0.38 to 0.66. Once we know the key length, it's possible to crack each of the monoalphabetic ciphers using frequency analysis. Admittedly this isn't as easy as the example we saw last month but it is, nevertheless, possible, especially with a true Vigenère cipher since here each of the columns in the Vigenère table is just a simple rotation of the alphabet. If you want to play around with the Vigenère cipher, take a look at **http://cw.oaktree.co.uk/crypt/index** from where you can download a simple DOS program and take a look at the source code. The program allows you to encrypt and decrypt messages using the Vigenère cipher and it will also attempt cryptanalysis.

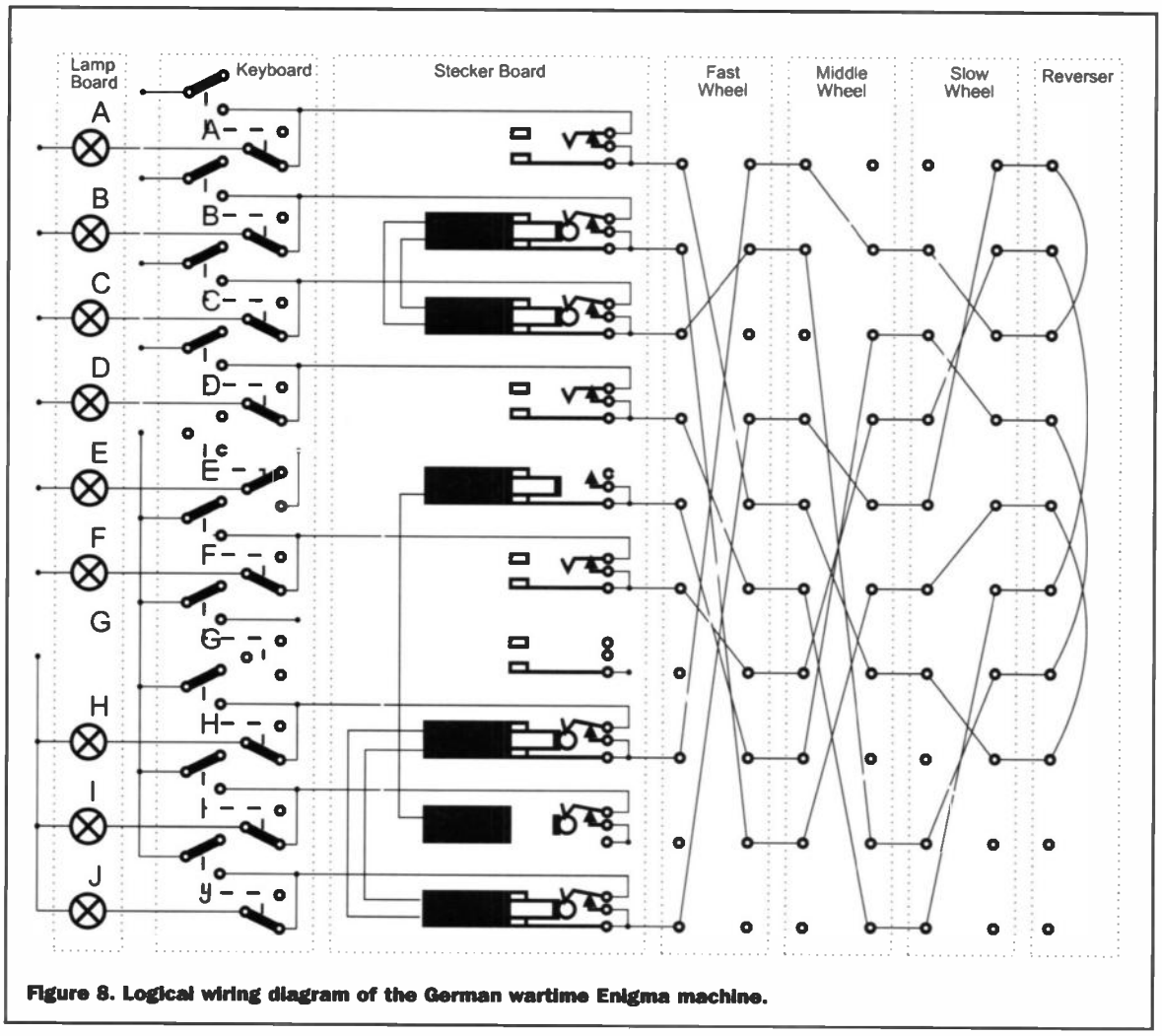


Figure 8. Logical wiring diagram of the German wartime Enigma machine.

Enigma

OK, that's enough on simple substitution ciphers. Let's now turn our attention to one of the most famous ciphers of all time, the Enigma cipher which was used by the German military during the Second World War. In common with all sophisticated ciphers, the complexity was such that encryption and decryption had to be carried out mechanically. In particular, it involved the use of the electro-mechanical Enigma Machine which, as you'll see from the photograph, looks rather like a typewriter with an array of illuminated letters above the keyboard. As you follow through the following text which describes its operation, I suggest that you refer to the logical wiring diagram of the Enigma Machine which appears as Figure 8. In fact, to keep the diagram to a reasonable size, the illustration shows a simplified version of the Enigma machine with only ten keys and ten lamps. As such, this particular Enigma would only be able to handle messages containing the letters A-J. The real Enigma machine, of course, could handle all 26 letters. You can also gain some additional insight into Enigma using the Enigma Simulator, which runs under Windows, and which you can download from **http://home.cern.ch/f/frode/www/crypto/CSG/3srs002.zip.**

The convention used in Figure 8 is that the red path is the one along which a current flows so we can see that the 'E' key has been pressed. Accordingly, a positive voltage is presented to the Stecker board. You'll notice that pressing this key has opened the other gang of the switch thereby preventing the 'E' lamp from illuminating. The Stecker board is named after the German word for plug - Stecker. By plugging patch leads into the Stecker board pairs of letters can be swapped whereas any letters which are not steckered are passed through unaltered. Typically, ten leads would be used leaving six letters self-steckered - the actual arrangement being part of the daily set-up of the machine. The output of the Steckerboard connects to the so-called fast wheel. This has some arbitrary mapping of input to output and, since it rotates after each key depression, the mapping constantly changes, repeating after 26 letters. The output of the fast wheel connects to a similar, but differently wired, wheel called the middle wheel which rotates one position every time the fast wheel has done a complete rotation. This wheel connects, in turn, to the slow wheel which has yet another mapping and rotates one position for every complete rotation of the middle wheel. The output of the slow wheel now passes to the reverser which routes the signal, via another mapping, back to the slow wheel. From here it passes back - on a different path - through the slow, medium and fast wheels and the Steckerboard to the lamp board where a single lamp is illuminated - in this case the 'G' lamp. As with the Steckerboard, the choice of wheels from a set of five which occupy the fast, medium and slow positions and the settings of these individual wheels are part of the daily set-up. Clearly, therefore, there is a huge number of ways in which the Enigma machine can be set up and this setting was changed at least daily. Not only this but, as a result of the rotation of the three wheels,

Figure 9. The Scytale transposition cipher.

the mapping through the machine will only repeat - even with the same set-up - every 26 x 26 x 26 letters. Needless to say, this is by no means a trivial cipher to crack. With today's computer technology you might reasonably expect it would be difficult, in the pre-computer days of the Second World War it would surely have been impossible. However, history proves otherwise.

The Enigma machine was used for encrypting messages prior to being sent, using Morse Code, via radio. It was used for the vast majority of German military intelligence and, needless to say, cracking the cipher was essential to the Allied forces. How this was done - by the scientists and mathematicians of the Government Code and Cypher School at Bletchley Park - is much too long a story to go into here. However, a few snippets will make interesting reading. So far, in our examples of cryptanalysis, we started out with no idea whatsoever of what plain text may be hidden in the cipher text. And if this had been the case with intercepted Enigma traffic, it's probably fair to say that the cipher would never have been cracked. In many instances, though, a good guess can be made at part of a message. The concept of known plain text (or at least guessed plain text) is often vital in cryptanalysis. At Bletchley Park, snippets of known plain text were referred to as cribs. One of the most reliable cribs, apparently, was ABSTIMMSPRUCHYYRESTXOHNEXSINN, a common early morning message which means 'tuning message, remainder meaningless'. If you're a German speaker you may be puzzled by the X and the YY which appear in the middle of apparently otherwise correct German. These and other combinations of letters which aren't used in German represent various punctuations but are prone to vary at the whim of the operator, thereby making the crib less reliable. But even if you're sure that the intercepted message contains the above string, it's not easy to figure out exactly where it occurs in the message. Even in the case of an easy crib like this – easy because you could be sure at appears virtually at the start of the message – a random number of padding letters, added to make the job of the cryptanalyst more difficult, would precede it. But a quirk of the Enigma machine, the fact that a letter can never be encrypted to itself (as you'll see if you study Figure 8), was exploited. The plain text crib would be shifted relative to the cipher text to find positions in which no letters matched – all other positions could be discounted. Now, if and only if the middle wheel didn't rotate a position in the middle of the crib – something which became increasingly unlikely as the length of the crib increased – it was possible to figure out which of the 17,576 wheel positions were possible. This was carried out using a specially-design electro-mechanical computer called a Bombe which would work for hours on end. Of course, just figuring out the possible wheel combinations alone isn't sufficient – even if you know which of the possibles is the actual one there's still the Steckers to consider – but at least it gave the cryptanalysts a head start. Winston Churchill later described the work at Bletchley Park as "the secret weapon that won the war."

Transposition Ciphers

All the ciphers we've seen so far have been substitution ciphers in which each letter in the plain text message is changed into a different cipher text letter. The substitution could be fixed, as in a monoalphabetic cipher, or variable, as in polyalphabetic ciphers like Vigenère, the one-time pad and Enigma. In the other main class of cipher, the transposition cipher, each of the plain text letters remains unaltered but the letters are jumbled up in some pre-arranged sequence. Decryption involves re-ordering the letters by undoing the scrambling process. So far in this series, each cipher we've seen has built on the principles we've seen in a previous cipher. So we saw that the Caesar Cipher, the general monoalphabetic substitution cipher, the Vigenère Cipher and Enigma represent a sequence in which each cipher is more sophisticated and hence harder to crack than the previous one. As we come to look at transposition ciphers this trend won't continue. This is a totally different technique and, as such, we'll start back at the beginning.

Figure 10. A column transposition cipher.

E	N	I	G	M	A
A	S	E	T	O	F
L	E	T	T	E	R
S	O	R	S	Y	M
B	O	L	S	R	E
P	R	E	S	E	N
T	I	N	G	O	T
H	E	R	S	U	S
E	D	T	O	C	O
N	C	E	A	L	T
H	E	M	E	A	N
I	N	G	O	F	A
M	E	S	S	A	G
E	X	Q	O	F	L

One of the first transposition ciphers, the early Greek Scytale cipher, is shown in Figure 9. A strip of paper was wound round a rod and the message written along rod in rows. When the paper was removed the strip of paper contained an apparently random arrangement of letters. To read the message, the strip of paper was simply wound around a rod of the correct diameter. Needless to say, like the Caesar cipher we saw last month, the Scytale cipher would only be secure in an age in which the whole concept of ciphers was unknown to the majority of people.

Column Transposition Ciphers

Excluding the Scytale and other trivially simple transposition ciphers such as writing the message backwards, about the simplest imaginable transposition ciphers is the column transposition cipher. An example is shown in Figure 10. Here we're encrypting the message 'A set of letters or symbols representing others, used to conceal the meaning of a message' which is, of course, the dictionary definition of the word cipher. As with many simple ciphers, the key takes the form of a word. This is an aid to memory but does make the cipher less secure compared to a truly random selection of letters. So the first job is to write down the keyword, missing out the second and subsequent occurrences of any repeated letters – in our example we're using the keyword 'enigma.' Now, we write the plain text message in rows immediately below the keyword filling the end of the last row with gibberish if the actual message doesn't fill it. The rows are the same length as the keyword and a new row is started as each row is filled. Finally, the cipher text is read out, down the columns, ordering the columns according to where each letter in the keyword comes in the alphabet. In our example, the alphabetic order of the letters in the word 'enigma' is a e g i m n so the columns are read out in the order 6th, 1st, 4th, 3rd, 5th, 2nd. This gives the cipher text FRMEN TSOTN AGLAL SBPTH ENHIM ETTSS SGSOA EOSOE TRLEN RTEMG SQOEY REOUC LAFAF SEOOR IEDCE NEX. Decryption of a row transposition cipher involves writing the cipher text in columns below the keyword, ordering the columns in the order dictated by the alphabetic position of the letters in the keyword and reading out the plain text in rows. The length of the columns is determined by dividing the length of the cipher text by the length of the keyword. To a cryptanalyst, the fact that he's dealing with a transposition cipher is evident from the fact that the frequency of occurrence of the letters in the cipher text is the same as in the English language. If the cryptanalyst has reason to believe that the cipher is of the row transposition variety the general approach is to guess the length of the key and then try re-arranging the columns. If this doesn't yield anything sensible, try a different length of keyword. In fact, using this method on our cipher text would have revealed the text relatively easily. Six letters is a common word length in the English language so this could well have been one of the first to be tried. Furthermore, there are only 720 ways of ordering six columns so the sledge hammer approach would have been

	A	D	F	G	V	X
A	K	Z	W	R	1	F
D	9	B	6	C	L	5
F	Q	7	J	P	G	X
G	E	V	Y	3	A	N
V	8	O	D	H	0	2
X	U	4	I	S	T	M

Figure 11. The first step in encryption using the ADFGVX cipher is a substitution.

possible, especially with some computer assistance. This approach becomes rapidly less feasible as the length of the keyword increases (for seven letters there are 5,040 possible sequences, for eight letters there are 40,320 and for nine letters there are 362,880 – a good reason for picking a long keyword) but a more systematic approach is still viable. For example, a good method is to attempt to order the columns so as to maximise the frequency of occurrence of common digrams (e.g. TH) and trigrams (e.g. THE). A column transposition cipher can be protected against this line of attack and thereby be made much more secure by repeating the process either with the same or a different key. This is called a double column transposition cipher.

Product Ciphers

We've just seen how the column transposition cipher become much more secure by simply repeating the process. Nevertheless, one transposition followed by another is really just a more complicated transposition. Similarly, one substitution followed by another is just a more complicated substitution. However, by combining a substitution and a transposition in a so-called product cipher, a very much more secure encryption is achieved. We'll conclude this article with a single example of a product cipher – the First World War ADFGVX cipher, so called because it only used the six letters A, D, F, G, V and X. Since the first part of the encryption process involves the use of a fixed look-up table, this is by no means a secure cipher but it does hint at the level of security which could be achieved using a more sophisticated combination of substitution and transposition.

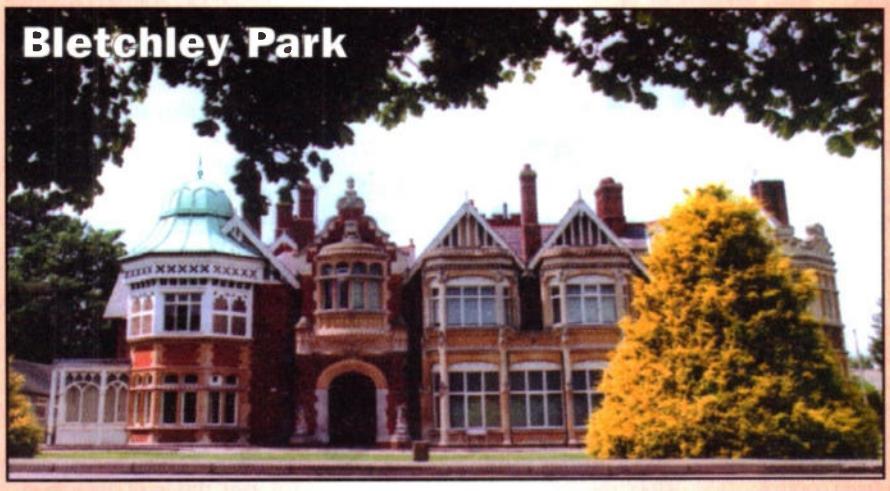
P	R	O	D	U	C	T
X	V	V	D	F	G	X
G	G	A	D	G	A	G
G	A	X	V	D	G	V
D	X	X	X	X	X	A
G	X	X	F	D	G	G
V	X	V	X	F	V	F
G	X	F	A	X	D	X

Figure 12. The second step in encryption using the ADFGVX cipher is a Transposition.

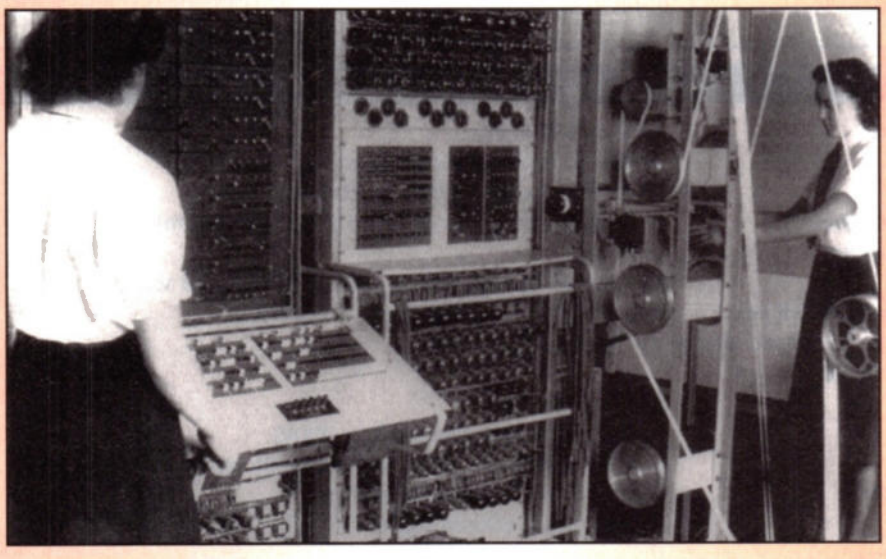
A picture is worth a thousand words, supposedly, so rather than try to describe the ADFGVX cipher, we'll simply provide an example of its use. Please refer to Figures 11 and 12 as you work through the example. The message we're going to encrypt is 'Top Secret Communication'. The first stage is to use the substitution matrix in Figure 11 to convert each letter in the plain text message into a pair of letters, basically the row and column address. This gives the following intermediate text: 'XV VD FG XG GA DG AG GA XV DG VD XX XX XA GX XF DG GV XV XF VF GX'. You'll notice that, unlike all the other ciphers we've seen, this one also allows the figures 0-9 to be encrypted. The second stage of the encryption involves a column transposition of the type we've already looked at. This is illustrated in Figure 12 using the keyword PRODUCT. Our intermediate text is written in rows below the keyword and then read out by columns in the order dictated by the letters in the keyword – i.e. 6th (C), 4th (D), 3rd (O), 1st (P), 2nd (R), 5th (U). The final cipher text is, therefore, GAGXG VDDDV XFXAV AXXXV FXGGD GVGVG AXXXX XGVAG FXFGD XDFX. As I've already pointed out, this is not a particularly secure cipher – primarily because the substitution phase is based on a fixed mapping. In fact, I suspect that the purpose of that first stage had more to do with allowing the system to be used by non-experienced telegraphy operators (the six letters used do have very different and characteristic Morse symbols) than security. Nevertheless, had a keyword also been used in the first stage, this product cipher would have been much more secure and the British Army might have taken rather longer to crack it.

Next Month

With the single exception of the one-time pad which we looked at last month all the ciphers we've seen so far can be cracked, given sufficient ingenuity, especially with the aid of a computer. In fact, the availability of vast amounts of processing muscle has caused ciphers to become much more sophisticated during the era of the computer. Next month, we'll come right up to date by investigating the ciphers of the computer age. These are ciphers which are virtually resistant to a brute force attack by computer, have no obvious loopholes such as the one exploited in cracking Enigma, and are now an important part of the growing world of e-commerce.



Elsewhere in this article we saw how the scientists at Bletchley Park managed to crack the German Enigma cipher, aided and abetted by a mechanical computer called a Bombe. The other major wartime cryptanalytical achievement at Bletchley Park was the work on Fish – a cipher used for teleprinter traffic. And a key tool here was Collosus – the world's first electronic computer – albeit one built for one specific job as opposed to the general purpose computers which would follow it. Bletchley Park now houses the UK's Museum of Cryptology and Computing and future plans involve the creation of an integrated heritage park with the overall theme, 'the science of communications'. The museum, near Milton Keynes, is open alternate weekends from 10:30 to 5:00 (last admissions at 3:30). Admission is £4.50, concessions are £3.50, and accompanied children under 8 are free. For more information, phone 01908 640404 or take a look at the Web site at www.bletchleypark.org.uk.



PROJECT

This stereo valve pre-amplifier incorporates the line amplifier described here. It can be switched out as described in the text, leaving only the cathode follower in circuit, by a front panel control (not shown).

Simple Valve LINE AMPLIFIER

Mike Holmes describes a general purpose small-signal audio amplifier that uses traditional constructional techniques.

In answer to requests for a non-specialised, simple valve preamplifier design, combining a useful (though not excessive) degree of signal gain with a flat frequency response for audio applications, this project is presented here. Either a single circuit may be made for mono, or a stereo pair may be made, as required. Such a combination would match extremely well the KT88 valve amplifiers described in issue 141.

If the amplifier is to be incorporated into existing equipment, HT and heater supplies may be tapped from the PSU of the 'host', provided it has sufficient energy reserves for this (and with the added proviso that HT should be within the range of 250 - 350V DC and with a heater voltage of either 6.3 or 12.6V).

Alternatively, the amplifier (whether mono or stereo) may be constructed as a 'stand-alone' in its own chassis, which then needs to include a power supply. In this event a suitable supply circuit is also suggested.

Circuit Description

The circuit of a complete monophonic amplifier is shown in Figure 1. It utilises a single ECC82 double-triode performing two functions. The ECC82 was chosen because firstly, as a common-cathode voltage amplifier, the low μ ('mu') of this device restricts signal gain to somewhat more than 20dB (x 10), which is sufficient for most general purpose applications, and secondly, the high current capability of this particular valve makes for a very effective low-impedance line driver, or output 'buffer'. The latter becomes significant where long signal leads are involved or where the 'target' happens to have a low input impedance (e.g., much less than 100kΩ).

Voltage Amplifier Stage

The first half of the ECC82, V1a, is the common-cathode voltage amplifier. Independent supply line isolation is provided by the combination of C1, C2 & R1. As shown here, a gain control, VR1, is placed at the input. In this position it enables a broad range of input levels to be tolerated, as applied to C5, thus ensuring that V1a is not overloaded and/or that too much distortion may result.

If, however, it is known that inputs will not exceed much more than 1V, or less on average, then an alternative arrangement may be considered - a 10kΩ potentiometer is placed across the output replacing R12, and a 1MΩ grid-bias resistor replacing VR1. The advantage of this method is that circuit noise will remain proportional to the output level as set by this gain control.

This is not meant to imply that the amplifier is especially noisy because it isn't; the option is only worth considering if input levels are consistently quite low, in the order of 100mV or less. Otherwise a gain control in the position shown in Figure 1 is sufficient. VR1 may be a linear or logarithmic type as desired, and for convenience, it doubles as the 'grid leak' (grid-bias) for V1a.

R5, colloquially referred to as a 'grid-stopper', is present to suppress any tendencies to HF instability or parasitic oscillation (rare). Voltage gain for V1a is in the order of 23dB (see also Table 1), and with a largish anode load resistor of 220kΩ (R4), the DC anode level is quite low at approximately 70V, even though the valve operates at a low current of slightly less than 1mA. This is set by cathode bias resistor R6 - value as per application data - the cathode being AC coupled to ground with C10.

It should be pointed out that this component (C10) is not to be omitted in an attempt to reduce gain - it will merely result in an increased level of 'shot noise*' in the valve, plus an unwanted susceptibility to hum pick-up from the AC heater. If for some reason you especially require a gain of much less that 20dB, you will be much better off dividing the anode load resistor in two and tapping the junction. Even lowering its value to say 100kΩ (the recommended minimum in this configuration) will not have very much effect either, and lowering it any more will make distortion worse. Similarly, increasing its value will not result in significant extra gain.

Line Driver Stage

The recommended load for V1a is 680kΩ, provided by R7. As it happens, because of the way in which V1b is set up, V1b grid could be DC coupled directly the V1a anode as the voltages are much the same. However, I opted to configure it as shown because it also allows the line driver stage to be usefully employed on its own, by feeding an input signal directly to C7.

This could be done for example by interposing a change-over switch between C7 and the junction of C6/R7 - the 'normal' position connecting these together, the alternative position routing C7 to somewhere else. This might, for instance, be the input side of C5, hence providing a straight-through or 'flat gain' mode of operation.

V1b is operated in common-anode or 'cathode-follower' mode, and as such provides current gain, but with close to unity voltage gain, to form an impedance changer. In practice, signal losses that are always incurred by this configuration result in a small reduction in output voltage (see Table 1). This is usually minimised by maintaining a comparatively high cathode potential across a

TABLE 1: SPECIFICATION

Maximum gain:	23dB (x 14) approx.
Noise:	1mV max. approx. (as measured with Fluke 83, input grounded via 100kΩ)
Signal to noise ratio:	> 73dB (based on above, i/p = 0 dB, o/p » 9V rms)
Max. usable output:	» 30V rms
Distortion:	proportional to output level, max. = 4.8% @ 28 Vrms
Efficiency of cathode follower:	86% (-0.5dB) unloaded ('load' = 100kΩ)
Output load range for cathode follower:	>= 1kΩ (min. = 1kΩ)
Power requirements -	
HT:	250V - 350V DC
HT current:	7mA mono, 14mA stereo (HT = 300V)
Heater:	6.3V AC (3.15 - 0 - 3.15, earthed centre tap)
Heater current:	600mA mono, 1.2A stereo (6.3V); 300mA mono, 600mA stereo (12.6V)

resistor chain (R10 & R11), the top-most one tenth of which (typically) providing the actual cathode bias. This tap is communicated to the grid by R9.

A coincidental effect of this is that of an impedance multiplier for the input; it is not 680kΩ (the value of R9). Because nine tenths (approximately) of the signal voltage appears across R11, only the remaining tenth is dropped across R9. The upshot is that the perceived input impedance between C7 and ground is much more like 60MΩ. This is useful to know if you have something that specifically requires a very high input impedance.

Again, R8 functions as a 'grid-stopper', particularly important here as, what with an appreciably increased anode current compared with V1a, the RF amplifying capability of V1b is much improved. R12 provides the same function for C8/C9 as does R7 for C6, that is, maintaining the output side at 0V DC. Hence, upon connecting the output of the powered-up amplifier to whatever should follow, you don't initially present to the input of the latter a massive 70V pulse as C9 charges!

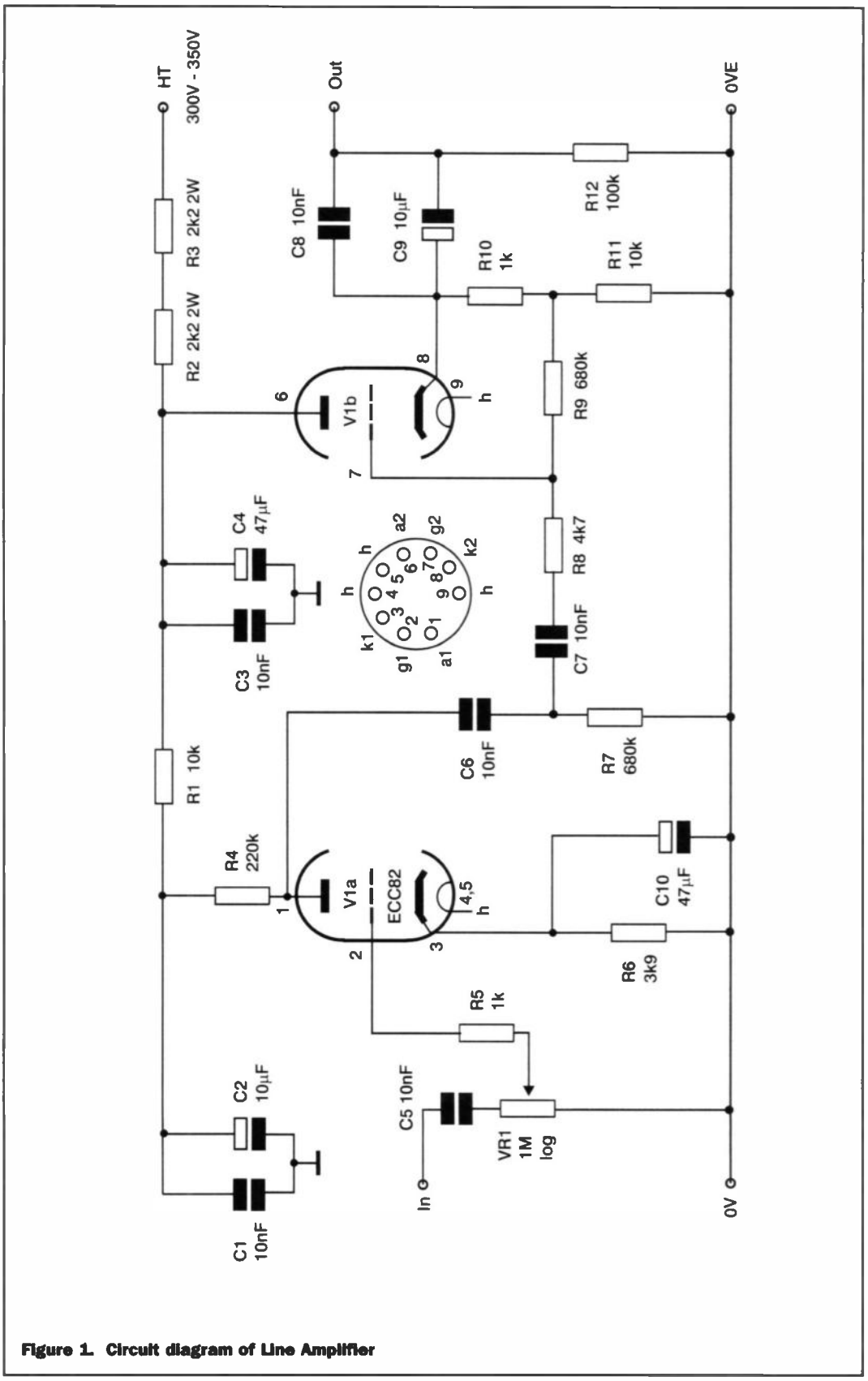


Figure 1. Circuit diagram of Line Amplifier

The value of C9 is sufficient to maintain a flat frequency response down to 20Hz into loads of less than 10kΩ. C8 is added to ensure good HF response.

The supply line for V1b is also decoupled to ground by C4, with C3 (as C1) minimising any HF noise. R2/R3 provide supply ripple filtering with C4, with a reduction of the order of -20dB approximately at 100Hz.

If you intend constructing a stereo pair of these amplifiers, it is not necessary to duplicate C3/C4 and R2/R3, these are common to both channels. Tap the supply at the R1 & C3/C4 junction to power the second V1a stage, duplicating R1, etc. only. The anode (pin 6) of the second duplicate V1b is to be connected as the first to the same junction at C4/R2.

Substituting V1a For More Gain

If more signal gain is required then V1a can be substituted for one half of an ECC83 (keeping the ECC82 for V1b). This will give a voltage gain of approximately 34dB (x 50). In addition R6 will need to be changed to 2.7kΩ if an ECC83 is used. This option is obviously best suited to a stereo pair of amplifiers where two valve envelopes would be needed anyway - if both V1a's were paired in the same envelope (and therefore both V1b's in the other) then most easily the V1a pair could be either type.

Construction

Having decided the mechanical aspects of where the valve holder(s) etc. are to be placed on a chassis top panel, the simplest wiring technique for this circuit is the point-to-point method, that is, connecting components directly between the various solder tags, but which can include for convenience a 36-way tag board. A recommended layout is shown in Figure 2 for a single amplifier.

Tag boards were the 'traditional' way of mounting components before PCBs were invented! The board can be oriented alongside the valve holder VB1 approximately as shown on a pair of threaded spacers. The layout as illustrated is fairly straightforward, but the following comments are noteworthy:

Heater wiring is not shown in Figure 2, it is assumed that this is the first thing that is done. Connection of the heaters to the power supply is always made via a twisted pair of insulated wires, the heater secondary of the PSU

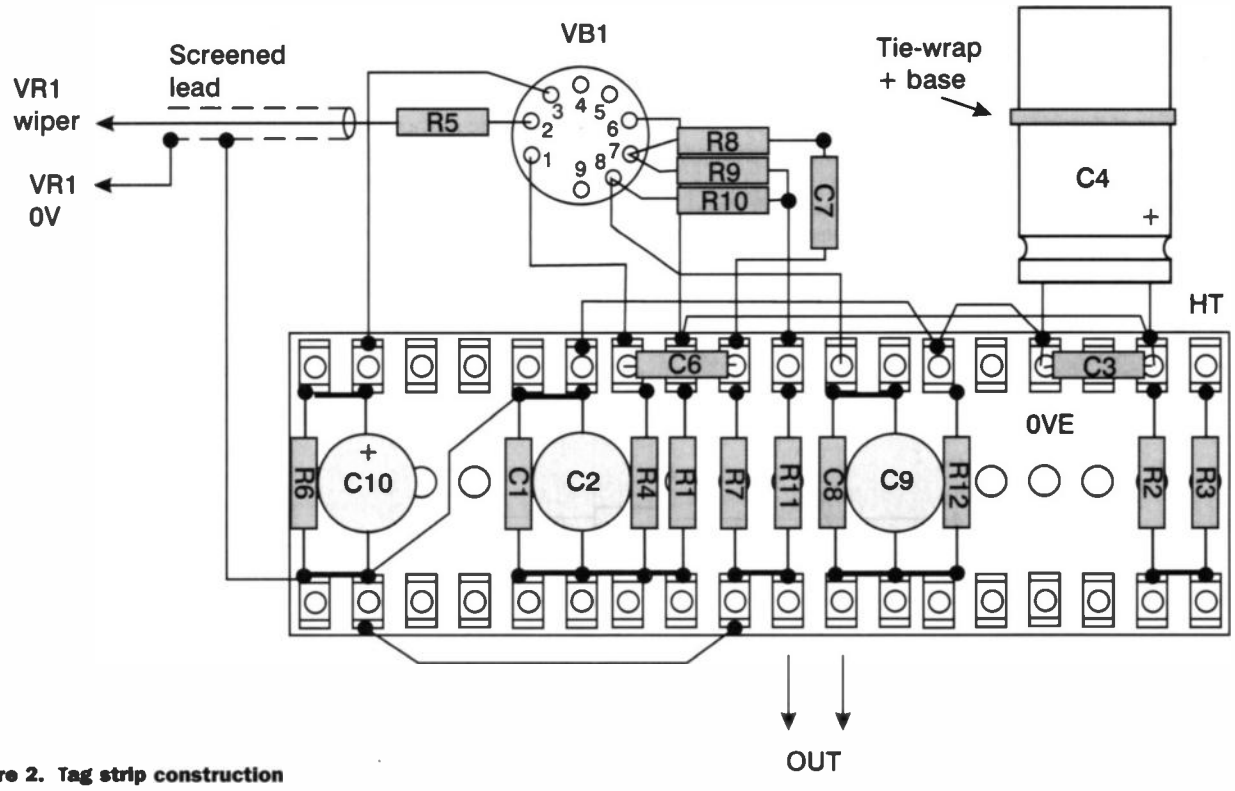


Figure 2. Tag strip construction

transformer preferably being centre-tapped, the tap connecting to 0V.

This results in equal and opposite potentials of 3.15V alternating about earth potential, the fields of which cancel in the twisted wire pair. This traditional method minimises hum pick-up in the amplifier. Furthermore the pair should be routed directly away from VB1 (towards the top in Figure 2), avoiding pin 2, and be pressed close to the chassis wall.

The heater connections are between the linked pair of pins 4 + 5, to pin 9, if 6.3V, or across 4 and 5 only if 12.6V.

Unlike the simpler two-part connection of single component lead and pad for a PCB, dry solder joints can happen quite easily where metal solder tags are involved, so you need to be doubly careful that all joints are made properly. To make sure you could solder each component lead as it is mounted - the tag holes are big enough to resist filling with solder initially - rather than wait until a whole group of wires are present on a tag. It is not unusual for a dry joint to remain hidden underneath what appears to be a correctly made joint!

In addition, each component lead should be wrapped at least one turn through the ring of its tag and then 'nipped' tight with pliers prior to soldering and trimming.

Adjacent tags that need to be linked together can be joined with the spare wire at the ends of component leads (i.e. don't trim on mounting). Longer links must be made with insulated wire, especially those carrying high voltage.

Don't forget to reserve spaces on the tag board for two mounting pillars and fixing screws! Also, both R5 and R8 must be close connected directly to the VB1 pins, not via long pieces of wire, and finally, due to its large size, C4 is best strapped to the panel with a tie-wrap through an self-adhesive base.

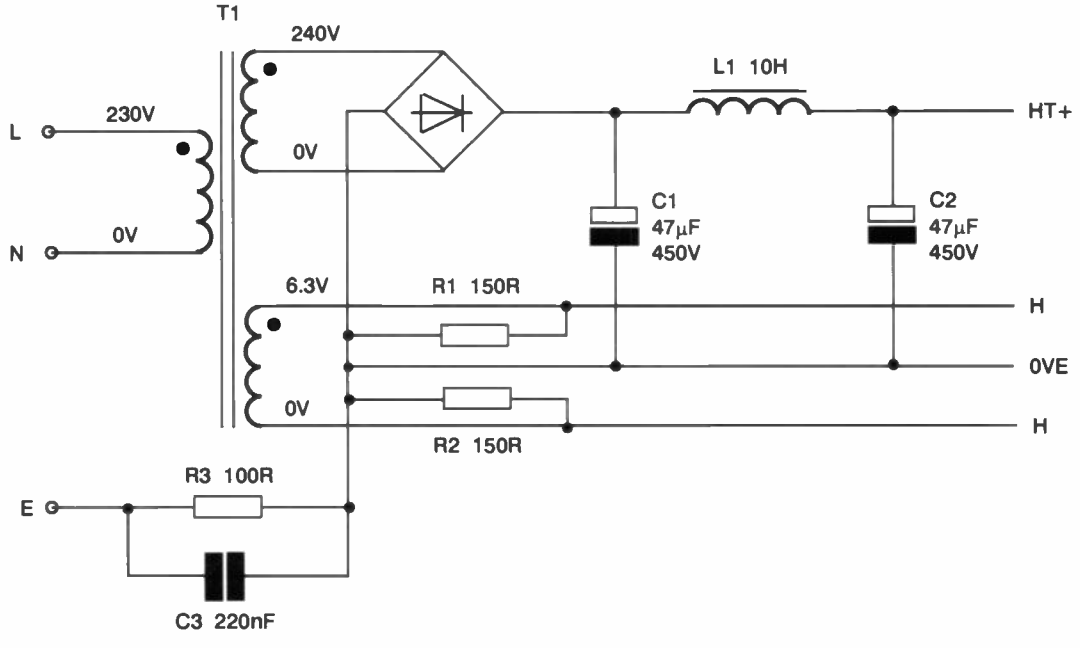


Figure 3. Suitable PSU circuit

PSU For Stand-Alone Use

Figure 3 shows a suitable power supply circuit for a mono or stereo pair of preamplifers as a stand-alone apparatus in its own chassis. At a pinch L1 & C2 may be omitted to save space or cost, but the π ('pi') filter formed by C1, L1 & C2 provides the minimum mains ripple on the HT line.

Because the 6.3V heater winding of T1 is not centre-tapped in this instance, resistors R1 & R2 emulate this by centring it about 0V.

Resistor R3 is inserted between circuit earth and mains earth to suppress hum loops being generated in screened connecting leads between this and other equipment. It follows from this that at no other point should circuit earth (0 V) be connected to chassis, and all audio sockets must be insulated from the chassis.

Footnote 1

* White noise generated by the action of independent clumps of electrons landing on the anode.

PROJECT PARTS LIST

AMPLIFIER PARTS LIST (MONO)

RESISTORS	**ALL 0.6W 1% METAL FILM UNLESS SPECIFIED**		
R1,11	10k	2	(M10K)
R2*,3*	2k2 2W 1% Metal Film	2	(D2K2)
R4	220k	1	(M220K)
R5,10	1k	2	(M1K)
R6	3k9	1	(M3K9)
R7,9	680k	2	(M680K)
R8	4k7	1	(M4K7)
R12	100k	1	(M100K)
VR1	1M Log Pot	1	(VQ06G)
CAPACITORS			
C1,3*,5,6,7,8	10nF 1000V Ceramic Disc	6	(JL04E)
C2,9	10μF 450V Radial Electrolytic	1	(VH25C)
C4*	47μF 450V Radial Electrolytic	2	(JL18U)
C10	47μF 25V Radial Electrolytic	1	(VH32K)
VALVES			
V1	ECC82 double-triode	1	(CR26D)
MISCELLANEOUS			
VB1	Valve Base B9A, Chassis Fixing	1	(CR31J)
	36-way Tag Board	1	(FL11M)
	Bell Wire Black	1 Pkt	(BL85G)
	Bell Wire Orange	1 Pkt	(BL90X)
	Single Coax Cable	1m	(XR16S)
	Gold Chassis Phono Socket Single (insulated mounting)	As Reqd	(JZ05F)
	M3 x 10mm Bolt	1 Pkt	(JY22Y)
	M3 Nut	1 Pkt	(JD61R)
	M3 Shakeproof Washers	1 Pkt	(BF44X)
	M4 x 10mm Threaded Spacer	2	(FG39N)
	M4 x 6mm Bolt	2	(JY13P)
	Heat Resistant Sleeving Red	1m	(BL70M)
	Cable Tie 100mm	1	(BF91Y)
	Cable Tie Base Small	1 Pkt	(FP21X)
OPTIONAL			
	Chassis AC86 2.5 x 6 x 8in.	1	(XB68Y)
V1a,101a	ECC83 double-triode	1	(CR27E)

* do not duplicate for stereo, see text

POWER SUPPLY PARTS LIST

RESISTORS	**ALL 0.6W 1% METAL FILM**		
R1,2	150R	2	(M150R)
R3	100R	1	(M100R)
Capacitors			
C1,2	47μF 450V Radial Electrolytic	2	(JL18U)
C3	220nF 250V Mylar	1	(WW83E)
SEMICONDUCTORS			
BR1	Bridge Rectifier W04 400PIV	1	(AQ97F)
MISCELLANEOUS			
T1	50VA Valve Transformer 240V 100mA	1	(XP27E)
L1	10H 100mA Choke	1	(ST28F)
	6A Wire Black	1m	(XR32K)
	6A Wire Brown	1m	(XR34M)
	6A Wire Blue	1m	(XR33L)
	M4 x 10mm Bolt	1 Pkt	(JY14Q)
	M4 Shakeproof Washer	1 Pkt	(BF43W)
	M4 Steel Nut	1 Pkt	(JD60Q)

The MPEG STANDARDS

PART 1

In this first part Reg Miles described the work of the Motion Picture Experts Group in developing the MPEG-1 standard and the broader and more versatile, but directly descended, MPEG-2.

The compression of digital video and audio is now becoming the norm; either to squeeze ever more programming into the same space or to open up new areas of communications. And those responsible for selecting and standardising many of the compression techniques are the Moving Picture Experts Group - MPEG.

The MPEG committee works under the joint direction of the International Standards Organisation (ISO) and International Electrotechnical Commission (IEC), to whom it recommends standards for official adoption. The committee itself is composed of representatives from companies, national standards bodies and academic institutions. It was inaugurated in 1988. Having been set the task of building on what the Joint Photographic Experts Group (JPEG) had achieved in its standard for still image compression.

JPEG images can also be compressed in real-time and used in sequence as moving images. However, this Motion-JPEG requires too great a data rate to be considered for general consumer uses (its main role has been that of non-linear editing). The MPEG committee, therefore, had to find a way of further reducing the data rate.

Discrete Cosine Transform

Both the JPEG and MPEG standards use the discrete cosine transform (DCT) in their algorithms to prepare the image for spatial compression. Firstly, the image is divided up into blocks of 8 x 8 digitised pixels, each pixel representing a value between 0 and 256 if 8-bits are used (which is normally so in JPEG and MPEG). The DCT is then performed, transforming the blocks into 8 x 8 coefficients representing horizontal and vertical energy components of increasing frequency. Such small blocks will generally contain little detail, so most of the information will be in the lower frequency bands and little in the upper frequency bands (Figure 1). If the area is uniform there will be just the one number and the other 63 will be zeros - if there are two uniform areas then a second number will be used to indicate the difference. Rarely will all 64 pixels have different numbers.

DCT just prepares the image for compression, although quantisation comes first. This divides each coefficient by an integer and rounds down the result. Many of the higher frequency components will already be zero, having details too small to be seen by the eye or of negligible amplitude, or will have low values and thus be turned into zeros. At this stage there is usually a choice as to how many of the higher frequency bands are reduced to zeros - thus providing a choice of compression ratios. The result is then diagonally scanned (Figure 2), from top left (lower frequencies) to bottom right (higher frequencies), giving increasingly longer runs of zeros. These are reduced to manageable proportions by run length coding (RLC), which just states the number of zeros rather than repeating them all. This will usually be followed by variable length coding (VLC), which assigns short codes to the commonly occurring sequences from the RLC process and longer codes to the less common ones.

The MPEG committee did have the advantage over the JPEG committee in that, while still images are meant to be scrutinised

Photo 1. Philips set top box.

lower frequencies

65	31	10	6	4	0	-3	8
45	-2	20	8	3	-4	-2	0
15	8	15	-1	0	6	-2	4
9	8	9	13	5	-1	0	0
6	-6	15	5	2	4	4	1
5	2	-8	4	-3	0	0	1
7	-4	0	0	-5	2	2	1
2	3	0	-5	0	5	-4	-5

vertical frequencies

horizontal frequencies

higher frequencies

Figure 1. 8 x 8 block of DCT coefficients.

72	-30	9	3	2	1	0	0
-21	18	-6	0	0	0	0	0
-6	9	3	0	0	0	0	0
-2	0	3	0	0	0	0	0
1	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0

Figure 2. Diagonal scanning for run length encoding.

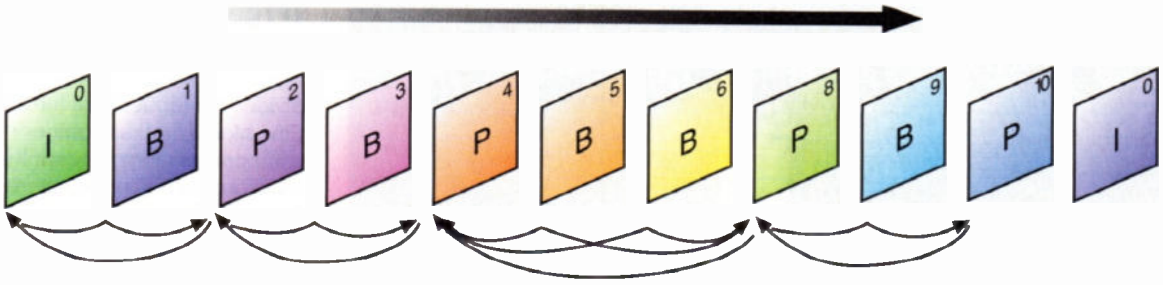


Figure 3. MPEG-1 frame types.

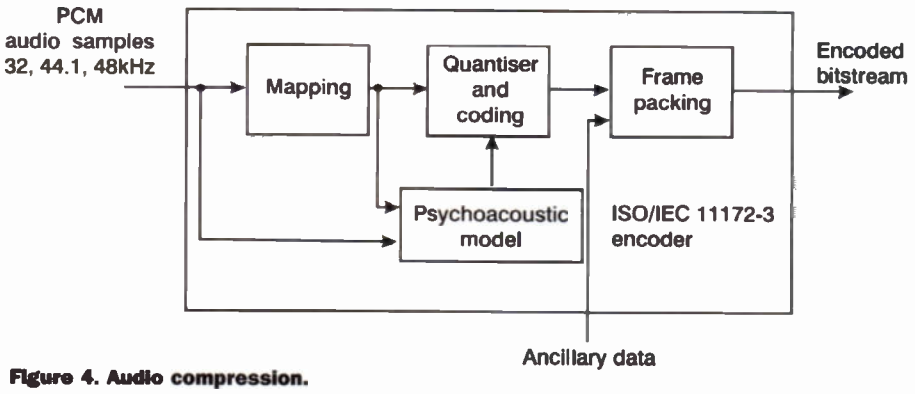


Figure 4. Audio compression.

(revealing any flaws in the process), individual images in a sequence of moving images will pass virtually unnoticed.

MPEG-1, therefore, halves the number of lines that constitute a normal interlaced frame - giving 50Hz progressive scanning, and also halves the number of pixels along the lines. This reduces the component resolution to 352 x 288 for Y, and halves it again to 176 x 144 for Cr and Cb - a 5:1 compression ratio. To avoid unwanted artefacts in the images due to overlap in the frequency spectrum this sub-sampling is done by a process known as decimation, with the data being filtered and then resampled at the new rate.

Photo 2. Denon DVD player.

Temporal Compression

The data rate is further reduced by using temporal compression. Frame differencing codes only for the changes that will occur in the image. If there are no changes, nothing more need be done than to repeat what has already been coded; where changes do occur just those are coded anew while the rest of the image continues to be repeated. Motion estimation prediction compares movement between images, and codes for just the amount of movement. This is achieved by dividing images into macroblocks of 16 x 16 pixels and comparing those with 16 x 16 blocks in the previously coded frame; searching horizontally and vertically over plus and minus a number of pixels to find the closest match between them (the greater the +/- displacement allowed, the more subject movement that can be encompassed). Each block is then assigned a motion vector which is the number of pixels it has moved in one or more directions - or given a zero if it has remained stationary.

This temporal compression is made possible by having predicted frames in addition to the real, spatially compressed ones. These predicted frames are inserted between the real frames and carry just the temporal changes. Three frame types are

Figure 5. Interleaving of AV packets.

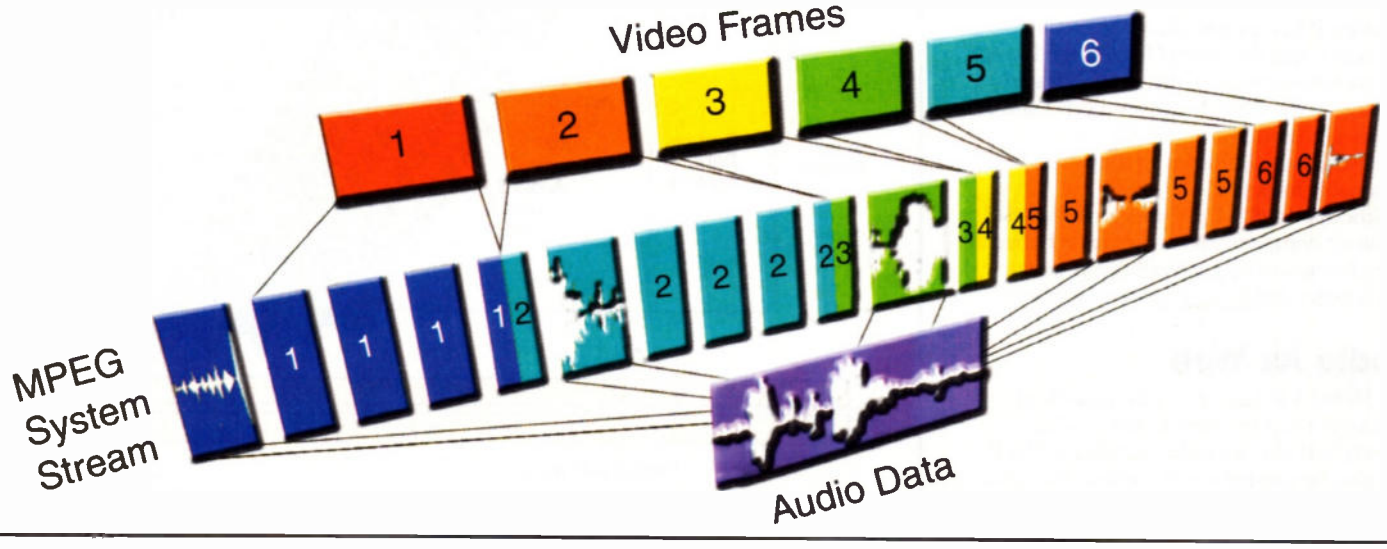


Photo 3. Sony Betacam MPEG camcorder.

used in MPEG-1 (Figure 3): the intra (I) frame is the real one, while predictive (P) and bidirectional (B) contain the changes. The I frame acts as a reference, and is necessary for random access; thus, after DCT, etc., it is left as it is. The P and B frames are interspersed between the I frames. The P frame is the predicted difference between it and a previous I or P frame. The B frame, which is interpolated between the I and P frames, is a halfway stage in differencing and motion estimation, and therefore requires less code to be stored but needs more processing by the encoder.

The numbers of the three frames used in relation to each other in a video stream will depend on the application. The distance between I frames will affect the ability to randomly access images, while the distance between P frames will affect the quality of the video; and the more I frames the lower the compression ratio, the more B frames the higher the ratio. However, both I and P frames are used by the decoder to reconstruct the B frames so they must be reasonably frequent.

Although MPEG-1 pictures look like VHS, no direct comparisons can be made between them because the quality of compressed video varies within and between frames.

Audio As Well

But MPEG-1 is not just a video standard - although it can be used as just a video stream, it is also an audio standard - which can also be used alone. It exploits the same psychoaccoustic phenomenon of auditory masking as do Sony's MiniDisc and Philips' Digital Compact Cassette (the standard is shared by the latter). If a loud and a soft sound occur simultaneously the ear only hears the loud, and if two sounds of similar frequency occur simultaneously with one just slightly louder the ear cannot hear the quieter one. The compression system can thus remove them along with any sounds below the threshold of human hearing anyway, and those beyond the perceptible frequency range.

Removing the Irrelevant Parts

To remove these 'irrelevant' parts of the signal the perceptual subband audio encoder divides the input signal into consecutive time blocks and determines the spectral components of each by applying a frequency transform (a polyphase filterbank with 32 subbands), then a psychoacoustic model is applied to estimate the threshold of masking (Figure 4). At the same time the signal is being time-to-frequency mapped, giving the spectrum components for subsequent coding. Data bits are allocated in a way that balances both bitrate and masking - a lot of masking, or silence, in one sub-band frees bits for others. And the information on how the bits are distributed over the spectrum is contained in the bitstream as side information. Which, along with the coded spectral components, is used by the decoder to synthesise an audio signal.

There can be a single channel for mono, or either dual channel or joint-stereo. Dual channel keeps the two channels completely separate to avoid crosstalk, and can therefore be used for alternative language mono soundtracks as well as stereo. Joint-stereo adds further compression by just noting the differences between the channels, and only sending those L/R difference signals together with the common information of a mono signal.

Three different layers are defined - I, II and III; each with increasing encoder and decoder complexity allowing greater compression for the same quality (while maintaining backwards compatibility). All share the sampling rates of 32, 44.1 or 48kHz. Bit rates range from 32-448kb/s for Layer I, 32-384kb/s Layer II, and 32-320kb/s Layer III. Compression ratios are about 4:1, 6:1-8:1 and 10:1-12:1 respectively. Layer II removes more irrelevant material and is able to apply the psychoacoustic threshold more efficiently, it also has more efficient coding of side information. While Layer III adds a Modified Discrete Cosine Transform to

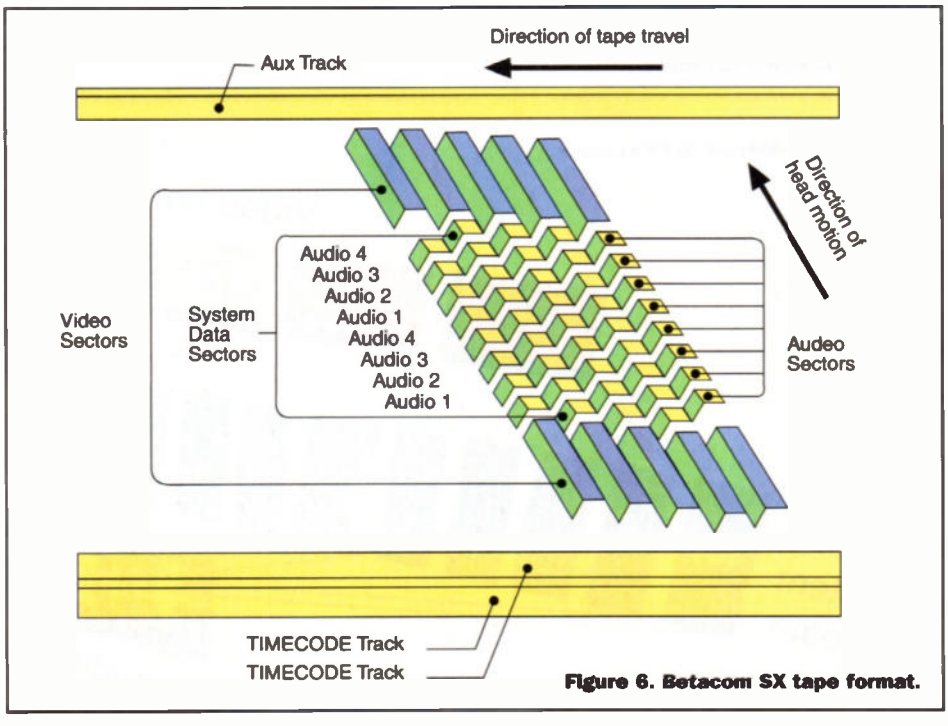


Figure 6. Betacom SX tape format.

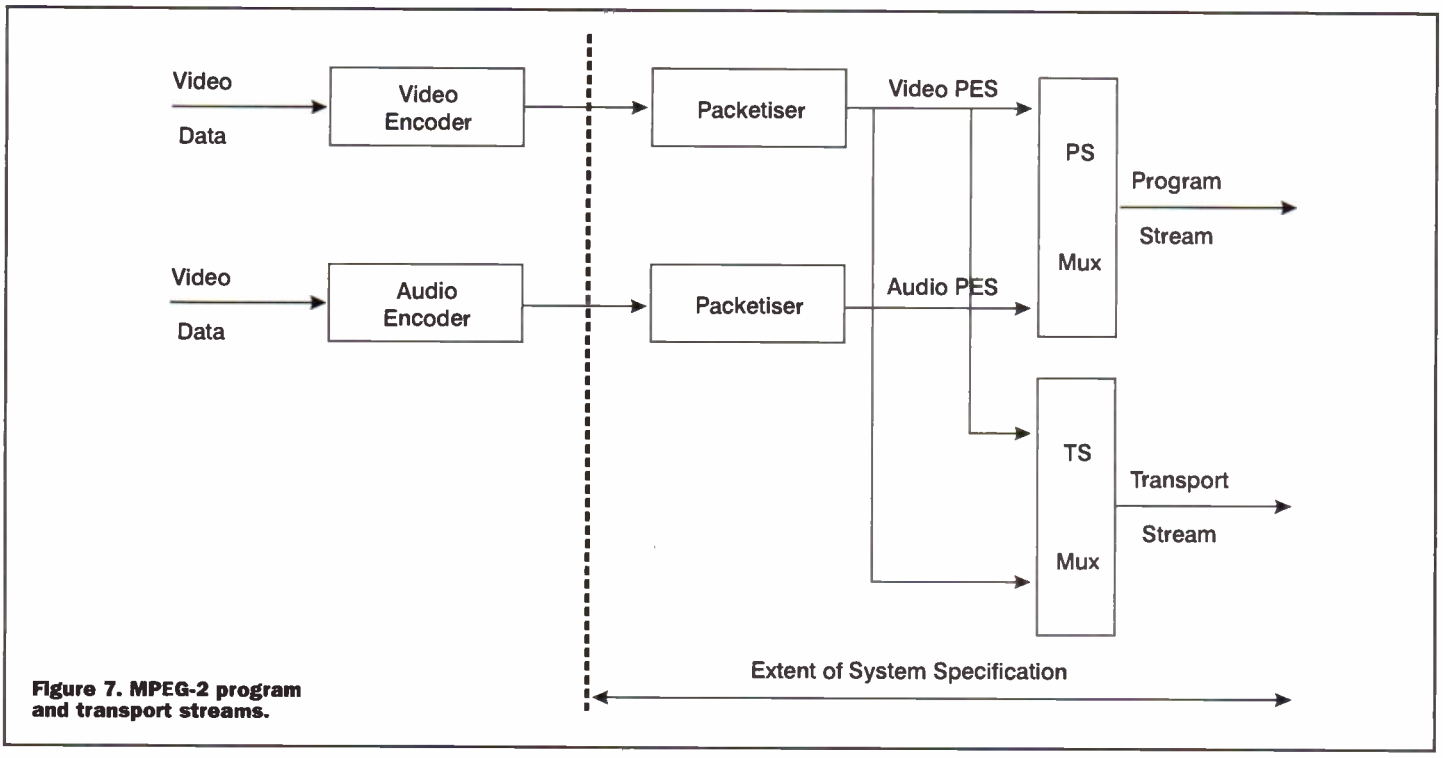


Figure 7. MPEG-2 program and transport streams.

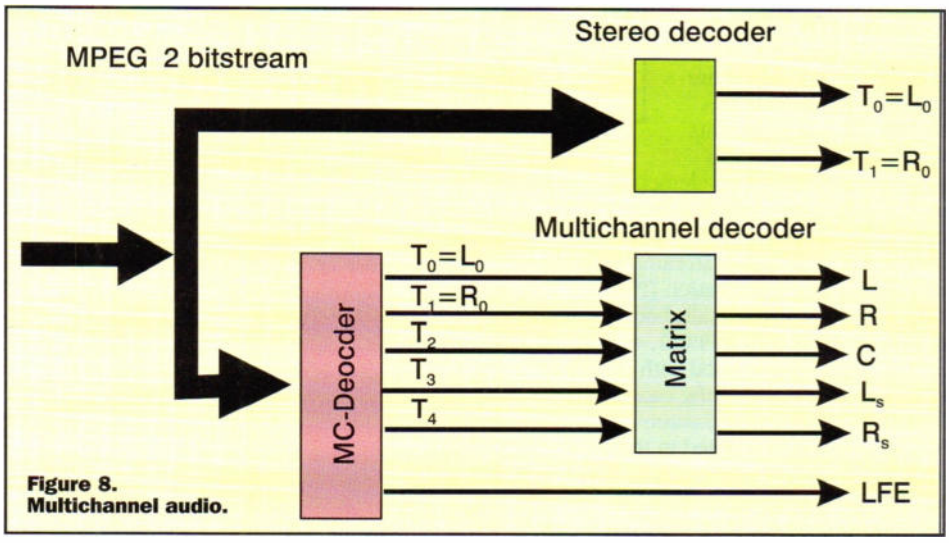


Figure 8. Multichannel audio.

and video streams are divided into packets of data which are then time-stamped and interleaved (Figure 5). For CD-ROM the video bitrate is normally fixed at 1.15Mb/s and audio at 192kb/s, allowing space for the data streams and some headroom for coding within the 1.5Mb/s ceiling. When used separately the video and, particularly, audio rates can be raised or lowered to suit the applications (MP3 is generally used at 128kb/s, for instance, in joint-stereo mode); and audio can use a variable bitrate - particularly MP3.

MPEG-2 is normally run at variable bitrate, for then the parts that require only minimal coding will compensate for those that require a lot, whereas the constant bitrate option is wasteful. The maximum depends on the medium; but for DVD, for example, it is 9.8Mb/s.

increase the frequency resolution by a factor of 18, a bit reservoir to suppress unwanted artefacts, and it may use more advanced joint-stereo coding.

Layer III, now popularly known as MP3, is revolutionising music on the Internet; with web sites springing up all over the place where you can go to download music and/or software players - or to upload your own music for others to download. According to Alta Vista, 'MP3' is the third most popular searched word on the web (I didn't discover the first and second). MP3 has also made small, solid-state hardware players possible - such as the

Diamond Rio. MPEG-1 video is also on the Internet. And increasingly being used for non-linear editing. It is also being used by some digital still cameras to record bursts of moving images.

Audio and video streams contain start codes that identify the data that has been encoded; and that data is then interpreted as sequences of audio frames or groups of pictures. A system stream combines the audio and video with data streams. In order to ensure their synchronisation the audio

Photo 4. Grundig Dolby Pro-Logic TV.

The MPEG-2 Committee

The MPEG-2 committee was formed in 1991 (the original committee then being renamed MPEG-1). Its task was to take what was being done with MPEG-1 and push up the data rates to achieve a much higher quality. Incidentally, the MPEG-1 committee's recommendation was approved as a standard in 1992. The MPEG-2 committee was originally briefed to work on data rates up to 10Mb/s, while an MPEG-3 committee would work on rates up to 20Mb/s for high definition applications. However, this was soon changed, and the MPEG-2 brief was expanded to include all data rates above 2Mb/s and MPEG-3 was laid to rest (MPEG-2 became a standard in 1994).

Because MPEG-2 is a development of MPEG-1 the compression system is essentially the same (and an MPEG-2 decoder can handle MPEG-1) - with video using DCT-based spatial and temporal compression.

Where it differs, in addition to the much higher data rates, is in having different profiles and levels that suit it to particular applications, with different definitions and resolutions, and different degrees of compression. The profiles are: Simple, which has the fewest tools; Main, which adds bi-directional prediction to those; SNR (signal-noise ratio) scaleable, which has top-up signals to improve the noise; Spatial scalable, with top-up signals to improve the resolution; and High, with all the previous tools plus the coding of line-simultaneous colour-difference signals instead of colour sequential. Two more profiles were added in 1996 - Multiview and 4:2:2: the former to encode video from two cameras shooting the same scene from slightly different angles, the latter, a refinement of the Main Profile, to give the full CCIR 601 colour resolution. The levels are: Low, using a one quarter picture as in MPEG-1; Main, using a full frame; High-1440, a high definition format with 1440 samples per line; and high, an HD format with 1920 samples per line.

The combination normally used is Main Profile@Main Level (MP@ML). In this each field is generally coded separately to maximise the quality; but with the option, when there is no movement within the image, for coding the frame as a whole. It uses a resolution of 704 x 576 for Y (although Cr and Cb are each sampled on alternate lines vertically as well as every other pixel horizontally, giving a colour resolution of 360 x 288 - a sampling structure of 4:2:0).

The CCIR 601 standard for component digital video recommends a resolution of 720 x 576 for Y and 360 x 576 for Cr and Cb - a ratio of 4:2:2, with sampling frequencies of 13.5MHz for Y and 6.75MHz for Cr and Cb.

The EBU has adopted the 4:2:2 Profile@Main Level. As Sony has done for the recently introduced Betacam SX digital VTR format - which also includes four uncompressed 16-bit 48kHz audio channels (Figure 6). The equipment range includes 4:3/16:9 switchable digital camcorders; a hybrid recorder, with a tape transport and disk drive in the same machine to form a non-linear edit unit; and linear and non-linear editing devices.

Non-linear editing software is also becoming available for MPEG-2 (and MPEG-1, of course), from consumer to broadcast levels.

System Streams

MPEG-2 also utilises two different system streams: Program Stream and Transport Stream Figure 7). The former is intended for largely error-free environments and is similar to MPEG-1 - combining one or more Packetised Elementary Streams (PES) with a common timebase into a single stream. These packets can be of variable length, and are multiplexed for sending. In the Transport Stream the packets are fixed at 188 bytes. This combines one or more PES with one or more independent timebases into a single stream; the PES packets being packetised in transport packets, which are then multiplexed. It is intended for environments where errors are likely to occur. In addition to the elementary video, audio and/or data streams a Transport Stream also carries signalling tables, to describe the elementary streams - called Program Specific Information (PSI).

MPEG-2 audio is generally backwards compatible (BC) with MPEG-1, so that MPEG-1 audio can be used with MPEG-2 video, and vice-versa. In the case of the MPEG-2 BC multichannel extension, a two channel downmix is carried in the main data field, and the ancillary data field carries the three audio signals of the multichannel extension (Figure 8). In addition to the five main channels a low frequency enhancement (LFE) channel can be provided - hence 5.1. Bitrates are variable up to 1Mb/s. There is also a 7.1 extension, to reproduce all eight digital tracks of modern feature films. Dolby Pro Logic surround sound can also be carried by applying a special coding matrix by the stereo downmix in MPEG-1 and 2 (Figure 9). MPEG-2 also allows lower sampling rates for the shared layers I-III: 16, 22.05 and24 kHz; with bitrates from 32-256kb/s for Layer I, and 8-160kb/s for Layer II and III.

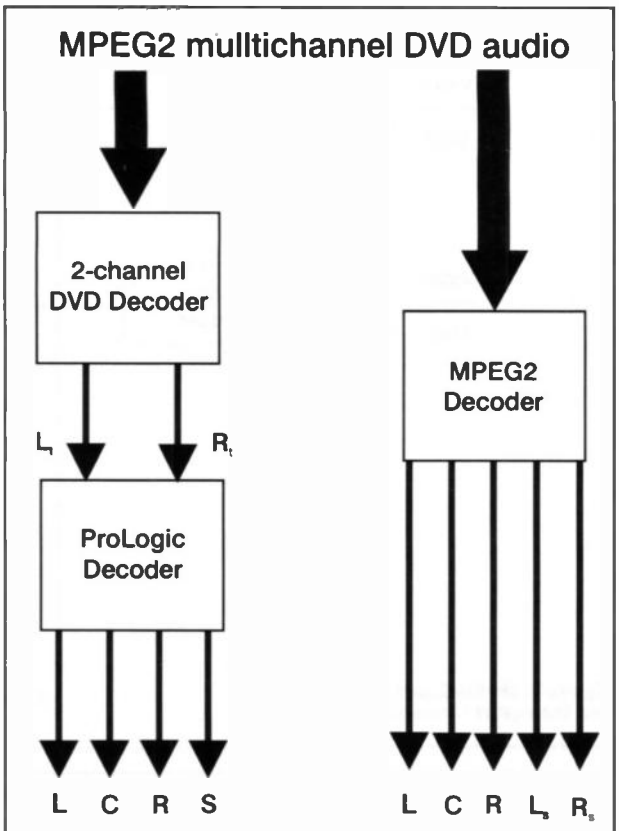


Figure 9. Dolby Pro-Logic addition.

Advanced Audio Coding

However, a new standard was declared in 1997 that is non backwards compatible called Advanced Audio Coding (AAC). This uses a plain MDCT, instead of the hybrid filter bank of Layer III (that was necessary for backwards compatibility), with an increased window length per transformation of 2048 instead of 1152 lines; temporal noise shaping; backward adaptive linear prediction; Huffman coding of quantised components; and dynamic range control.

An AAC audio stream can provide from 1-48 main audio channels, at a rate of 64kb/s per channel for multichannel operation, with 0-16 LFE channels, 0-16 overdub or multilingual channels, and 0-16 embedded data streams. And up to 16 programs can be described consisting of any number of the audio and data elements. Its sampling rates are 8-96kHz, with bitrates from 16kb/s per channel to over 192kb/s per channel. Three profiles are specified: Main, Low Complexity and Scaleable Sampling Rate; the first for use when processing and memory requirements are not constrained, the second when they are, and the third when decoders with different output sampling rates will be used. In listening tests, comparing five channel AAC at 320kb/s with five channel MPEG-2 BC at 640kb/s, the former was said to give slightly better audio quality.

DSM-CC

The final part of MPEG-2 is Digital Storage Media Command and Control (DSM-CC). This began life to provide VCR-like control of the video stream (including MPEG-1); using the clock-related Normal Play Time (NPT) to vary the video stream's speed, both forwards and backwards. But it has now been expanded to encompass the protocols necessary to deliver a variety of services, such as video on demand, Internet access, and video conferencing; from a wide variety of service providers; to a variety of means of receiving them - set-top boxes and integrated digital TVs, PCs, PCTVs, Network computers, Web-TVs, etc; without a multiplicity of dedicated interfaces being required.

Which takes the MPEGs into the next generation of standards and applications, that I will cover in the second part of this article.

COMMENT

by Keith Brindley

RSI is a pain. For computer users everywhere - although workers of all other categories are susceptible too - repetitive strain injury can be a quite debilitating form of ailment. It's a pain in two ways. First, physically, the person suffering from repetitive strain injury really does suffer. Computer users report a range of injuries; including soreness of the wrists and fingers (caused by ill-designed or badly arranged keyboard or mouse), neck and back strain (caused by poorly arranged desk and seating arrangements), and whatever other injuries can be caused by the working arrangements to do with computer use.

Secondly, repetitive strain injury is a pain because it has been impossible for sufferers to have their ailment established correctly. The medical profession has been split over it, with some practitioners (presumably those who don't suffer from it) arguing it doesn't exist at all. Till recently, repetitive strain injury was a phenomenon which has had no standing in law. It was not recognised legally as an illness of any kind, and there were legal precedence in the form of court cases that denied its existence. However, a recent court ruling found against the Midland Bank (now HSBC), and found in favour of five Midland Bank employees who claimed to be suffering from repetitive strain injury.

As a result of winning this court case, the employees will all receive compensation for their injuries from the bank. But, while significant in its own right, the compensation isn't the important thing. The point is that repetitive strain injury is now legally classified. From now on, employers should be aware that they have a legal duty to protect their employees. What this means for the future is that employees who use computers (although as I've already pointed out, repetitive strain injury occurs in workers of other categories too) should undergo regular checkups, breaks from repetitive tasks that may cause injuries, and training regarding how to avoid injury. The whole point of the manoeuvre (in case any employers are reading this and who haven't yet heard of the judgement) is that employers are now compelled - with legal penalties if they do not comply - to protect their staff. There is no soft option. All this is excellent news for employees who suffer from repetitive strain injury - and those who don't - as improved working practices might help to ensure they never do.

However, it is not necessarily the full and best solution. I can say this from personal experience. I am self-employed and so I have no-one I can turn to if I was to suffer from repetitive strain injury. I have no legal recourse if I was to suffer from repetitive strain injury. Yes, I can make sure I follow best practices in my working arrangements; have a chair that allows flexible and comfortable positioning to avoid back and neck strain; make sure my computer monitors are of high quality to avoid eyestrain (in itself a form of repetitive strain injury), position the monitors at eye level, and make sure my desk is the proper height. But there are other aspects of repetitive strain injury that must be taken into consideration.

For a start, computer keyboards are not the best of mechanisms. Their very key layout can create physical problems for users. The layout - commonly known as qwerty, called after the first six letters of the layout - was originally devised as a method of laying out typewriter keys. At the time (over a hundred years ago), the layout was used because it formed a reasonable solution to the mechanical problem of fitting in all the required keys of typewriters. Nowadays, of course, there is no reason why the layout needs to be followed because computer keyboards are electronic, so the mechanics of typewriter levers and pulleys is irrelevant but, purely for traditional purposes, it has continued. But this doesn't mean it should continue.

The computer mouse, too, is particularly prominent in its creation of repetitive strain injury. A sore wrist is common in computer users who use their mouse regularly to drive their computers. The very shape of the typical computer mouse defines that users will grasp it such that their wrists rest on the working surface. With time, the constant maintenance of that position can create wrist injuries.

So, while (legally, at least) the protection of employees lies with the employers, there's actually a wider responsibility at stake. In the large sense, it's not just employers who are responsible for repetitive strain injuries in their employees. Computer manufacturers too should be doing their collective bit to ease the situation. Computers themselves, and their use, almost dictate that repetitive strain injury will result, because they are not generally ergonomic in their configuration.

Of course, there have been many notable attempts to improve the computer interface. Various alternative keyboard layouts have been devised to create a more comfortable posture. There is no need to use a computer mouse at all for trackballs, trackpads, pens and so on are all available to ease the requirements of cursor control. Workstations can be laid out in better ways. High quality monitors are available to reduce eyestrain. So why don't computer manufacturers and employers use them?

The answer is cost. Alternative, improved keyboard layouts cost money and demand that users be retrained to use them. High quality trackballs are expensive, as are high quality monitors. Ergonomic workstations almost seem to cost more than the workers who sit at them. Computer manufacturers in general seek to reduce component costs so that they can sell their computer systems at competitive prices. This inevitably means a cheap keyboard, a cheap mouse, a cheap monitor, and so on. Employers in general choose the computer systems that provide the service they require at the most competitive (read 'cheapest') price. Small wonder then that repetitive strain injury occurs.

Previously, repetitive strain injury sufferers could be likened to King Canute, holding up their collective hands attached to their collective sore wrists, while the tide continued up the beach. What the recent ruling indicates, on the other hand, is a sea-change of legal, medical, and industrial opinion. This should help define that employees rights are, hopefully, properly ensured in the future. We're still not quite there: the tide's not yet going out, but at least it's on the turn. Now that employers will be made to realise the consequence of cheap and shoddy computer systems and use, then manufacturers will be forced to ensure their equipment is properly and ergonomically made. The alternative is legal compensation and fines. The five Midland Bank workers were awarded £60,000. There are another 30 or so employees pursuing similar claims against the bank. Once claims like these become the norm, employers and manufacturers will finally be forced to do their bit to improve employees' working practices, and ease repetitive strain injuries. About time.

8-Channel LOGIC ANALYSER WITH LCD READOUT

Richard Grodzik describes a logic analyser for 8-bit microprocessors.

Introduction

This logic analyser has been designed for use with 8-bit microprocessors having a multiplexed low-order data/address bus, such as the 8031,8088 and 80188.These processors have eight pins which serve as an 8 bit wide data bus (D0-D7) and also as part of the address bus (A0-A7). A control pin usually designated ALE (address latch enable) is used to demultiplex the shared data and address information. In order to do this an 8-bit latch, (74373 or 74573) is connected to the eight pins of the microprocessor. These lines are also connected to the data bus. The Q outputs of the latch are connected to the low-order address bus of the microcomputer. When the ALE line is asserted high, address information is present on the eight pins of the processor and these are latched through to the address bus. With ALE inactive, data is present on these pins. This analyser is therefore not suitable for use with other processors e.g. 6502, Z80 and the 68000 which have separate pins for the address and data bus.

What is a Logic Analyser?

When a program is written, usually in small pieces, it has to be tested for correct operation. A usual way of doing this is to invoke the use of a software simulator which can be run on a PC regardless of the target processor of the SBC. Here, all the registers of the processor are displayed along with the source code. Each line of the program is executed, step-by-step and the results can easily be checked. However, the software is run on a 'virtual processor' which in reality is just another piece of software run by the PC. When the user program is loaded into the target computer board, in the form of firmware in an EPROM, the actual hardware of the processor must run the program. You switch on (boot up) and nothing happens. Things are happening fast and how is one to know if the microprocessor has even got beyond the reset stage? This is the point at which the logic analyser comes in to play. It simply connects onto the data/address latch and collects data or address information every clock cycle. This information can then be examined at leisure on the LCD. Simple programs can be written to say, test the RAM by writing and reading a single byte to and from memory. The logic analyser will confirm if the byte is correctly sent and received.

A small example program was written to run on a 8031 based SBC to illustrate the execution of the program and how data and address bytes in the program are captured and displayed. The program starts at reset vector 00H, at which point a jump instruction causes execution to continue at address 69H. The accumulator is loaded with 30H and then incremented. Five NOP's (no operation) instructions are executed at which point a jump instruction loops to address 6BH.

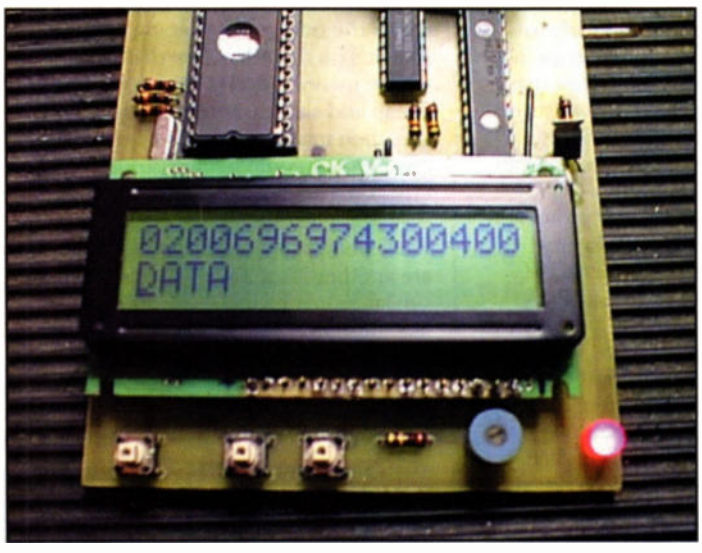
```
TRY.LST  Target Processor 8C31

                    .ORG 0H
00  02 00 69                LJMP START
                    .ORG 069H
69                  START:
69  74 30                   MOV
A,#030H
6B                  CYCLE:
6B  04                      INC A
6C  00                      NOP
6D  00                      NOP
6E  00                      NOP
6F  00                      NOP
70  00                      NOP
71  02 00 6B                LJMP CYCLE
```

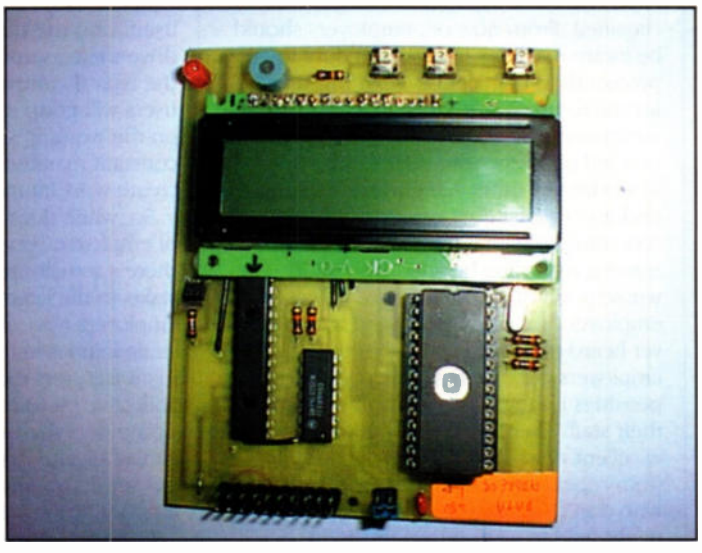
The procedure is as follows:

- Load the program into the EPROM for the target SBC i.e. using an EPROM Programmer.
- Connect the logic analyser via the ribbon cable and 20-way glomper to the octal data/address IC on the SBC.
- Apply power.
- The LCD will go into self-test displaying a block at all screen positions and finally clears the display.
- The red LED will be lit. (Ensure that jumper J1 is in 'DATA' position.
- Press and hold down the reset button on the SBC.
- Press the 'ARM' button on the analyser 'Armed' will be displayed.
- Release the reset button - the LED will extinguish.
- Press the 'ARM' button again. The following data will be displayed:

  0200696974300400
  Data
- Pressing the RH button will scroll the display sideways and additional data may be viewed.

  00000000000000000000020200
  Data
- Pressing the LH button scrolls the display in the opposite direction. Keeping either button pressed continuously will eventually HOME the data. i.e. 'Data' will be displayed on the LH side of display.





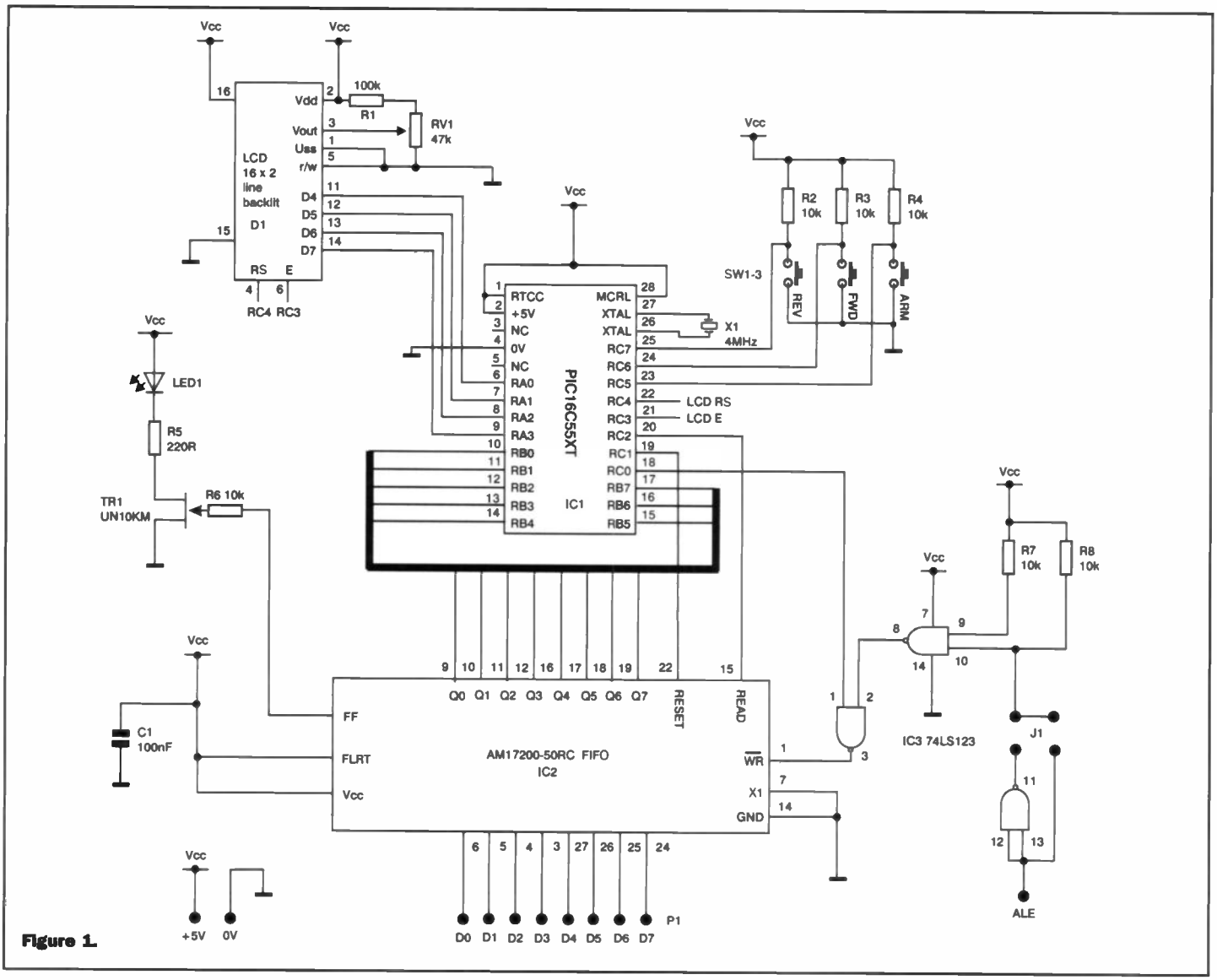


Figure 1.

Now repeat the entire process but with jumper J1 in the address position. The following will be displayed:

```
00010202696A6B6C
Data
6C6D6D6E6E6F6F7070710001
                    Data
```

It can be seen that some bytes are repeated. This is normal since some instructions take two machine cycles to execute and thus the same data persists on the data or address bus. Some instructions for the 8088 processor take up to five cycles and thus are repeated five times on a the analyser.

Data can also be captured 'on the fly' in this simple program since it is looping, by pressing the 'ARM' button twice.

How It Works.

The circuit diagram is shown in Figure 1. The data or address bytes are clocked into the FIFO (first in-first out) memory in real time by the ALE pin of the target processor. The ALE signal can be inverted by simply re-positioning J1,thus allowing data or address information to be collected. The ALE signal is qualified by a signal from the RC0 pin of the PIC - a 16C55. This qualifying signal is under firmware control and will not be asserted until the 'ARM' button is pressed. Subsequent high and low transitions of the ALE line will toggle the write line of the FIFO (pin 1) and allow data present on the bus to be written into the FIFO. When the FIFO is full, line FF will turn off FET (VN10KM) and the LED will extinguish. Pressing the 'ARM' button again will allow the PIC's firmware to read the data caught in the FIFO and display it on the LCD. Here, the read line of the FIFO (pin 15) is toggled by RC2 of the PIC and the 8-bit data is read into port B of the PIC. It is then split up into two nibbles and sent to the LCD along the 4- bit data bus pins (RA0 through RA3).The 4k7 variable resistor adjusts the contrast of the display which being backlit provides for a very readable display.

The connection between the logic analyser and the target SBC is constructed as follows:

- Cut a length of IDC ribbon cable which should not exceed 12 inches to prevent reflections.
- One end of the ribbon is terminated in a 20-way (2 x 10) IDC plug using a small vice.
- At the other end of the ribbon attach two identical IDC plugs approximately two inches apart. These are then simply inserted in the 20-way glomper.

PROJECT PARTS LIST

RESISTORS		
R1	100k	
R2, 3, 4, 6, 7, 8	10k	
R5	220R	
RV1	4k7 Pot	
CAPACITORS		
C1	100nF	
SEMICONDUCTORS		
IC1	PIC16C55XTP	
IC2	AM7200-50RC FIFO F.E.C. No. 459872	
IC3	74LS132	
TR1	UN10KM	
D1	5V 16 x 2 line LCD Display with backlight	
D2	Red LED	
MISCELLANEOUS		
X1	4MHz Crystal	
SW1, 2, 3	PCB Push Switch	3 reqd.
P1	10 x 2 0.1in Header Pins	
J2	2 x 2 0.1in Header Pins & Jumper	
	20-W DIL Glomper & IDC Ribbon Cable	
	20-W IDC Sockets	2 reqd.

A pre-programmed PIC, price £25.00 including p&p, is available from: R.Grodzik (MICROS), 53 Chelmsford Road, Bradford BD3 8QN.

```
LOC  OBJECT CODE     LINE SOURCE TEXT
  VALUE
                     0001
                     0002
                     0003 ;LOGLCD.ASM
                     0004
                     0005         LIST    p=16C55 ; PIC16C55 is the target
processor
                     0006
  0001               0007 RTCC       EQU 1       ;RTCC
  0002               0008 PC         EQU 2
  0003               0009 STATUS     EQU 3       ;STATUS REGISTER
  0005               0010 PORT_A     EQU 5       ;PORT A
  0006               0011 PORT_B     EQU 6       ;PORT B
  0007               0012 PORT_C     EQU 7      ;PORT C
  0008               0013 DLYCNT     EQU 8
  0009               0014 COUNT      EQU 9
  000A               0015 BUFFER     EQU 0AH     ;TRANSMIT BUFFER
  000B               0016 COUNTR     EQU 0BH     ;TIMING COUNTER
  000D               0017 INVERT     EQU 0DH
  000E               0018 DAT_A      EQU 0EH
  000F               0019 TWOFIVE    EQU 0FH    ;256 BYTE COUNTER
  0010               0020 LCDDATA    EQU 010H
  0011               0021 A_N        EQU 011H
  0012               0022 THIRTYTWO EQU 012H
  0013               0023 BAR        EQU 013H
                     0024
  0000               0025 ARM_GATE   EQU 0
  0001               0026 FIFO_RESET EQU 1
  0002               0027 FIFO_READ  EQU 2
  0003               0028 LCD_E      EQU 3
  0004               0029 LCD_RS     EQU 4
  0005               0030 SW_REV     EQU 5
  0006               0031 SW_FWD     EQU 6
  0007               0032 SW_ARM     EQU 7
                     0033
                     0034         ORG 0
0000                 0035 start
0000 0CFF            0036     MOVLW 0FFH
0001 0006            0037     TRIS PORT_B          ;PB0 - PB7 INPUTS
0002 0CE0            0038     MOVLW 0E0H
                     0039
0003 0007            0040     TRIS PORT_C
0004 0C00            0041     MOVLW 0
0005 0005            0042     TRIS PORT_A
                     0043
                     0044    ;AZ
0006 0C33            0045     MOVLW 033H
0007 0993            0046     CALL COMMAND
0008 09A5            0047     CALL LDELAY
0009 0C32            0048     MOVLW 032H
000A 0993            0049     CALL COMMAND
000B 09A5            0050     CALL LDELAY
000C 0C28            0051     MOVLW 028H
000D 0993            0052     CALL COMMAND
000E 09A5            0053     CALL LDELAY
000F 0C06            0054     MOVLW 6
0010 0993            0055     CALL COMMAND
0011 09A5            0056     CALL LDELAY
0012 0C0E            0057     MOVLW 0EH
0013 0993            0058     CALL COMMAND
0014 09A5            0059     CALL LDELAY
                     0060
                     0061
0015 0C10            0062     MOVLW .16
0016 0033            0063     MOVWF BAR
0017                 0064 B1
0017 0CFF            0065     MOVLW 0FFH
0018 09AC            0066     CALL WRITE
0019 09BA            0067     CALL SECOND
001A 02F3            0068     DECFSZ BAR,1
001B 0A17            0069     GOTO B1
                     0070
001C 0C10            0071     MOVLW .16
001D 0033            0072     MOVWF BAR
                     0073
001E 0CA9            0074     MOVLW 0A9H
001F 0993            0075     CALL COMMAND
0020 09A5            0076     CALL LDELAY
                     0077
0021                 0078 B2
0021 0CFF            0079     MOVLW 0FFH
0022 09AC            0080     CALL WRITE
0023 09BA            0081     CALL SECOND
0024 02F3            0082     DECFSZ BAR,1
0025 0A21            0083     GOTO B2
                     0084
                     0085
                     0086
0026                 0087 AZ
0026 0C01            0088     MOVLW 1
0027 0993            0089     CALL COMMAND
0028 09A5            0090     CALL LDELAY
                     0091
                     0092
0029 0407            0093     BCF PORT_C,ARM_GATE
002A 0547            0094     BSF PORT_C,FIFO_READ
002B 0527            0095     BSF PORT_C,FIFO_RESET
                     0096
002C 0C14            0097     MOVLW .20       ;.255 BYTE COUNTER
002D 002F            0098     MOVWF TWOFIVE
                     0099
                     0100
002E 0C01            0101      MOVLW 1
002F 0993            0102     CALL COMMAND
0030 09A5            0103     CALL LDELAY
                     0104
0031                 0105 POLL
0031 0004            0106     CLRWDT
0032 06E7            0107     BTFSC PORT_C,SW_ARM
0033 0A31            0108     GOTO POLL
                     0109
;.............................
0034 0CA9            0110     MOVLW 0A9H
0035 0993            0111     CALL COMMAND
0036 09A5            0112     CALL LDELAY
                     0113
                     0114
0037 0C41            0115     MOVLW 'A'
0038 09AC            0116     CALL WRITE
0039 099F            0117     CALL DELAY_DATA
003A 0C72            0118     MOVLW 'r'
003B 09AC            0119     CALL WRITE
003C 099F            0120     CALL DELAY_DATA
003D 0C6D            0121     MOVLW 'm'
003E 09AC            0122     CALL WRITE
003F 099F            0123     CALL DELAY_DATA
0040 0C65            0124     MOVLW 'e'
0041 09AC            0125     CALL WRITE
0042 099F            0126     CALL DELAY_DATA
0043 0C64            0127     MOVLW 'd'
0044 09AC            0128     CALL WRITE
0045 099F            0129     CALL DELAY_DATA
                     0130
                     0131
0046 0C07            0132     MOVLW B'00000111'  ;DEBOUNCE
0047 0002            0133     OPTION
0048                 0134 RELEASE
                     0135
0048 0061            0136     CLRF RTCC
0049 0004            0137 DEBOUNCE CLRWDT
004A 07E1            0138     BTFSS RTCC,7
004B 0A49            0139     GOTO DEBOUNCE
                     0140
004C 07E7            0141     BTFSS PORT_C,SW_ARM
004D 0A48            0142     GOTO RELEASE         ;STILL LOW? THEN GOBACK
                     0143
004E 0427            0144     BCF PORT_C,FIFO_RESET
004F 0527            0145     BSF PORT_C,FIFO_RESET
0050 0507            0146     BSF PORT_C,ARM_GATE  ;ARM ON
                     0147
                     0148
0051 0004            0149 A1  CLRWDT
0052 06E7            0150     BTFSC PORT_C,SW_ARM
0053 0A51            0151     GOTO A1
0054 09BA            0152 A12 CALL SECOND
0055 07E7            0153     BTFSS PORT_C,SW_ARM
0056 0A54            0154     GOTO A12
                     0155
                     0156
0057 0CA9            0157     MOVLW 0A9H
0058 0993            0158     CALL COMMAND
0059 09A5            0159     CALL LDELAY
                     0160
                     0161
005A 0C44            0162     MOVLW 'D'
005B 09AC            0163     CALL WRITE
005C 099F            0164     CALL DELAY_DATA
005D 0C41            0165     MOVLW 'A'
005E 09AC            0166     CALL WRITE
005F 099F            0167     CALL DELAY_DATA
0060 0C54            0168     MOVLW 'T'
0061 09AC            0169     CALL WRITE
0062 099F            0170     CALL DELAY_DATA
0063 0C41            0171     MOVLW 'A'
0064 09AC            0172     CALL WRITE
0065 099F            0173     CALL DELAY_DATA
0066 0C20            0174     MOVLW ' '
0067 09AC            0175     CALL WRITE
0068 099F            0176     CALL DELAY_DATA
                     0177
                     0178
0069 0407            0179     BCF PORT_C,ARM_GATE
                     0180
006A 0C80            0181      MOVLW 080H
006B 0993            0182      CALL COMMAND
006C 09A5            0183      CALL LDELAY
                     0184
006D                 0185 EMPTY
006D 0447            0186      BCF PORT_C,FIFO_READ  ;READ LINE LOW
006E 0206            0187      MOVF PORT_B,0         ;READ DATA INTO W
                     0188                            ;DATA IN W
006F 002E            0189      MOVWF DAT_A           ;SAVE DATA
0070 03AE            0190      SWAPF DAT_A,1         ;SWAP NIBBLES
0071 0C0F            0191      MOVLW B'00001111'     ;MASK OUT MOST SIG
NIBBLE
0072 014E            0192      ANDWF DAT_A,0         ;LEAST SIG NIBBLE IN
W
0073 09C6            0193      CALL ASCII
0074 09AC            0194      CALL WRITE
                     0195
0075 03AE            0196      SWAPF DAT_A,1         ;SWAP NIBBLES
0076 0C0F            0197      MOVLW B'00001111'     ;MASK OUT NIBBLE
0077 014E            0198      ANDWF DAT_A,0
0078 09C6            0199      CALL ASCII
0079 09AC            0200      CALL WRITE
                     0201
007A 0547            0202      BSF PORT_C,FIFO_READ
007B 02EF            0203      DECFSZ TWOFIVE,1
007C 0A6D            0204      GOTO EMPTY
                     0205
                     0206
007D 0004            0207 A3   CLRWDT
007E 07E7            0208      BTFSS PORT_C,SW_ARM
007F 0A26            0209      GOTO AZ
0080 0000            0210      NOP
0081 06C7            0211      BTFSC PORT_C,SW_FWD
0082 0A8A            0212      GOTO A4
0083 09BA            0213      CALL SECOND
0084 0C18            0214      MOVLW 018H
0085 0993            0215      CALL COMMAND
0086 09BA            0216      CALL SECOND
0087 0C18            0217      MOVLW 018H
0088 0993            0218      CALL COMMAND
0089 0A7D            0219      GOTO A3
                     0220
008A 06A7            0221 A4   BTFSC PORT_C,SW_REV
008B 0A7D            0222      GOTO A3
008C 09BA            0223      CALL SECOND
008D 0C1C            0224      MOVLW 01CH
008E 0993            0225      CALL COMMAND
008F 09BA            0226      CALL SECOND
0090 0C1C            0227      MOVLW 01CH
0091 0993            0228      CALL COMMAND
0092 0A7D            0229      GOTO A3
                     0230
                     0231
                     0232
;.............................................................
                     0233
0093                 0234 COMMAND
0093 0030            0235      MOVWF LCDDATA
0094 0390            0236      SWAPF LCDDATA,0
0095 0025            0237      MOVWF PORT_A
0096 0487            0238      BCF PORT_C,LCD_RS
0097 0567            0239      BSF PORT_C,LCD_E
0098 0467            0240      BCF PORT_C,LCD_E
                     0241
0099 0210            0242      MOVF LCDDATA,0
009A 0025            0243      MOVWF PORT_A
009B 0487            0244      BCF PORT_C,LCD_RS
009C 0567            0245      BSF PORT_C,LCD_E
009D 0467            0246      BCF PORT_C,LCD_E
009E 0800            0247      RETLW 0
                     0248
                     0249
                     0250
                     0251
009F                 0252 DELAY_DATA
009F 0C28            0253       MOVLW .40
```

```
00A0 0028               0254        MOVWF DLYCNT
00A1 02E8               0255 REDB   DECFSZ DLYCNT,1
00A2 0AA1               0256        GOTO REDB
00A3 0004               0257        CLRWDT
00A4 0800               0258        RETLW 0
                        0259
00A5                    0260 LDELAY
00A5  0C07               0261        MOVLW B'00000111'
00A6  0002               0262        OPTION
00A7  0061               0263        CLRF RTCC
00A8  0004               0264 L_DELAY CLRWDT
00A9  07E1               0265        BTFSS RTCC,7
00AA  0AA8               0266        GOTO L_DELAY
00AB  0800               0267        RETLW 0
                        0268
                        0269
                        0270
                        0271
                        0272
00AC                    0273 WRITE
00AC  0031               0274        MOVWF A_N
00AD  0391               0275        SWAPF A_N,0
00AE  0025               0276        MOVWF PORT_A
00AF  0587               0277        BSF PORT_C,LCD_RS
00B0  0567               0278        BSF PORT_C,LCD_E
00B1  099F               0279        CALL DELAY_DATA
00B2  0467               0280        BCF PORT_C,LCD_E
                        0281
00B3  0211               0282        MOVF A_N,0
00B4  0025               0283        MOVWF PORT_A
00B5 0587               0284        BSF PORT_C,LCD_RS
00B6 0567               0285        BSF PORT_C,LCD_E
00B7 099F               0286        CALL DELAY_DATA
00B8 0467               0287        BCF PORT_C,LCD_E
00B9 0800               0288        RETLW 0
                        0289
00BA                    0290 SECOND
00BA 0C07               0291        MOVLW B'00000111'
00BB 0002               0292        OPTION
00BC 0061               0293        CLRF RTCC
00BD 0C08               0294        MOVLW .8                ;.32
00BE 0032               0295        MOVWF THIRTYTWO
                        0296
00BF 06E1               0297 SHORT BTFSC RTCC,7
00C0 0AC2               0298        GOTO JMP2
00C1 0ABF               0299        GOTO SHORT
00C2 0061               0300 JMP2   CLRF RTCC
00C3 02F2               0301        DECFSZ THIRTYTWO,1
00C4 0ABF               0302        GOTO SHORT
00C5 0800               0303        RETLW 0
                        0304
                        0305
00C6                    0306 ASCII
00C6 01E2               0307        ADDWF PC
                        0308
00C7 0830               0309        RETLW 30h
00C8 0831               0310        RETLW 31h
00C9 0832               0311        RETLW 32h
00CA 0833               0312        RETLW 33h
00CB 0834               0313        RETLW 34h
00CC 0835               0314        RETLW 35h
00CD 0836               0315        RETLW 36h
00CE 0837               0316        RETLW 37h
00CF 0838               0317        RETLW 38h
00D0 0839               0318        RETLW 39h
00D1 0841               0319        RETLW 41h
00D2 0842               0320        RETLW 42h
00D3 0843               0321        RETLW 43h
00D4 0844               0322        RETLW 44h
00D5 0845               0323        RETLW 45h
00D6 0846               0324        RETLW 46h
                        0325
                        0326
                        0327          org     01FFh
01FF 0A00               0328          goto    start
                        0329          END
                        0330

SYMBOL TABLE

LABEL                             VALUE

A1                                0051
A12                               0054
A3                                007D
A4                                008A
ARM_GATE                          0000
ASCII                             00C6
AZ                                0026
A_N                               0011
B1                                0017
B2                                0021
BAR                               0013
BUFFER                            000A
COMMAND                           0093
COUNT                             0009
COUNTR                            000B
DAT_A                             000E
DEBOUNCE                          0049
DELAY_DATA                        009F
DLYCNT                            0008
EMPTY                             006D
FIFO_READ                         0002
FIFO_RESET                        0001
INVERT                            000D
JMP2                              00C2
LCDDATA                           0010
LCD_E                             0003
LCD_RS                            0004
LDELAY                            00A5
L_DELAY                           00A8
PC                                0002
POLL                              0031
PORT_A                            0005
PORT_B                            0006
PORT_C                            0007
REDB                              00A1
RELEASE                           0048
RTCC                              0001
SECOND                            00BA
SHORT                             00BF
STATUS                            0003
SW_ARM                            0007
SW_FWD                            0006
SW_REV                            0005
THIRTYTWO                         0012
TWOFIVE                           000F
WRITE                             00AC
__16C55                           0001
start                             0000
```

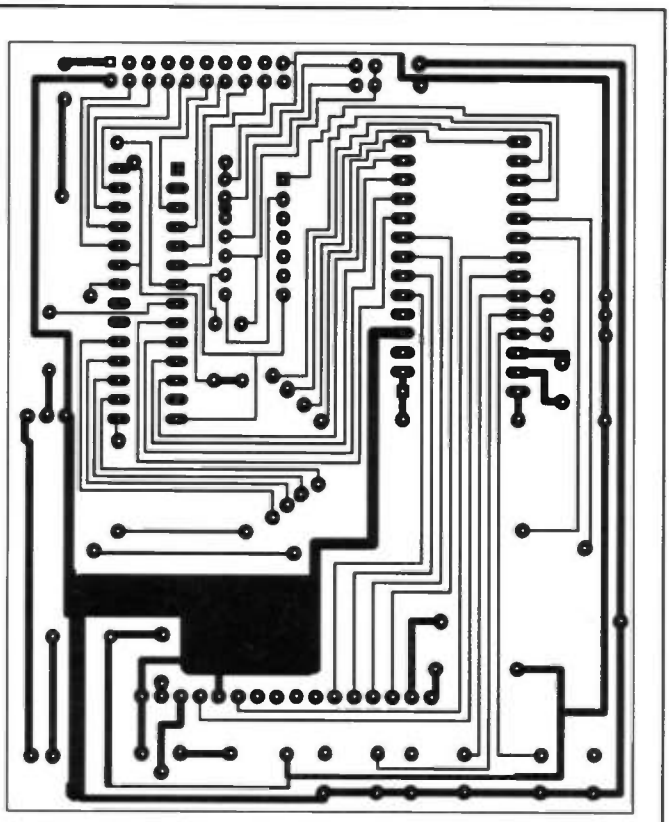


Figure 2. PCB track

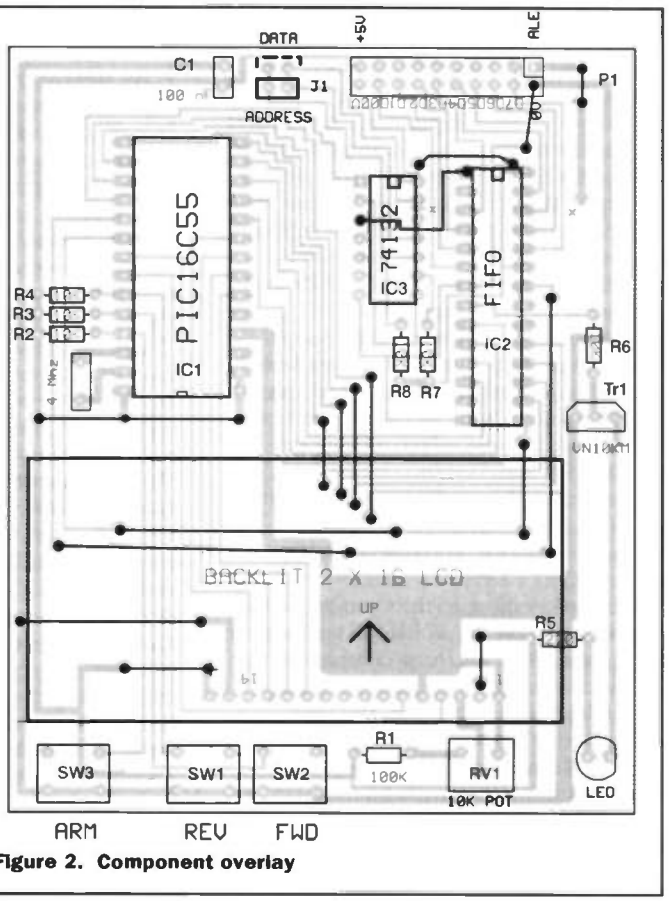


Figure 2. Component overlay

◆ Use a continuity tester to ensure correct polarisation and orientation of the connector. i.e. one side of the glomper carries:

0v d0 d1 d2 d3 d4 d5 d6 d7 0v

Note that if signals are missing check that the glomper pins are connected to the correct row of each plug.

Figure 2 is the PCB schematic and Figure 3 shows the component overlay, note there are several links that need to inserted first before any components are soldered to the board.

TECHNOLOGY WATCH

with Martin Pipe

LG's Phenom PDA which, like the Videophone, runs Windows CE. This was one of the first models to include a colour screen. Its physical size is restricted by the keyboard - the Videophone eschews this in favour of a 'touch screen' and handwriting recognition.

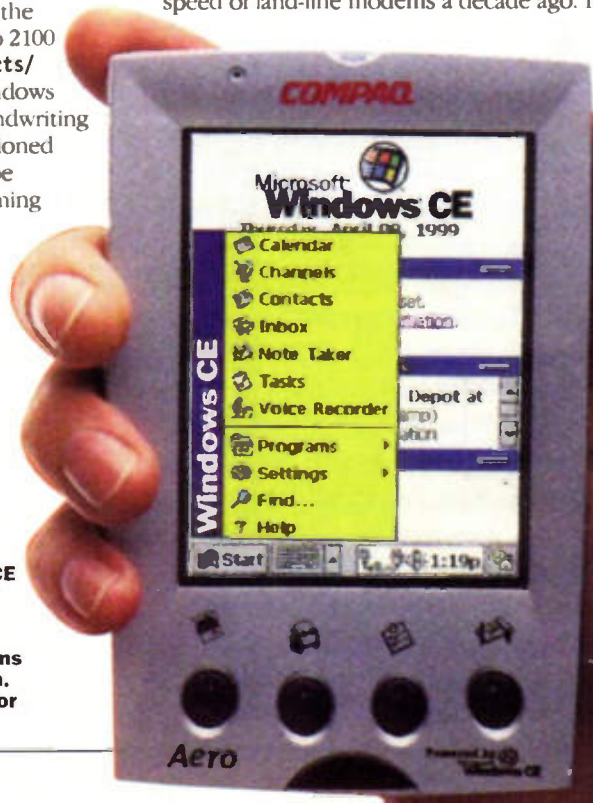
Next spring, mobile phone network Orange (http://www.orange.co.uk) plans to launch the world's first commercial mobile videotelephone. This unique handset was developed at the company's research facility near Bristol, and it's the first time that a cellular network has had such a direct involvement with the consumer terminals. Normally, phones from existing manufacturers' ranges are sent to the networks for type approval - a much simpler process. An advantage of Orange's somewhat expensive approach - development costs have reached several million pounds to date - is that the phone can be tailored exclusively to the unique features offered by the network. The first Orange videophone, which will sell for around £500 with contract, will be assembled on the production lines of an established manufacturer. Cheaper 'consumer' models, could be available for as little as '£150' if Orange's gamble pays off. There's rather more to the Orange product than videotelephony, which will take a while to establish. After all, many companies over the years have tried - and failed - to make videotelephony established. The poor takeup is due to the inevitable psychological barriers. Women don't, for example, like to be seen without their makeup...

To this end, the various elements of the videophone double up for other tasks. In other words, if videotelephony doesn't work out the customers haven't wasted their money and Orange won't have to suffer a PR disaster. Key to any videotelephone are a camera and display. When not used for videotelephony, the (colour) camera can be used to capture still frames (rather like a low-resolution digital camera) or multimedia-quality 'video postcards' that can be e-mailed to a friend or colleague. The display, meanwhile, is a 640 x 480 (VGA resolution) colour device, which isn't unlike that built into notebook computers. While most laptops have their display pixels arranged in a landscape aspect ratio - i.e. wider than taller - the Orange display goes 90° the other way, in favour of a portrait orientation. This screen will double up as the phone's user interface. This is rather advanced, and will offer PDA functionality. Indeed, the PDA will run a tailored version of Microsoft's Windows CE 3.0 (http://www.microsoft.com/windowsce). Some CE applications, such as Pocket Word and Pocket Excel, will be bundled with the device. Indeed, the Videophone will synchronise data with a desktop computer just as an ordinary PDA can. Unlike ordinary PDAs, though, you'll be able to synchronise SMS messages, e-mail and phonebook lists as well as spreadsheets and diary entries.

Colour-screened Windows CE PDA devices are available, but they're very expensive. LG's Phenom Express (http://www.lge.co.kr/english/product/handpc_all), for example, sells for £599. In other words, it's more expensive than the Orange Videophone, which offers the in-built cellphone, camera and so on. The well-received Phenom device is based around a conventional QWERTY keyboard and landscape screen. A more apt comparison could be made with the recently-announced Compaq Aero 2100 (http://www.compaq.co.uk/products/handheld/aero), a palm-sized Windows CE device with touch-screen, handwriting recognition and portrait-proportioned colour screen - all of which will be standard fixtures on the forthcoming Orange product. The photographs reproduced elsewhere in these pages are 'mockups', but an Orange spokesman reckons that the production Videophone will resemble 3Com's popular - and non-Windows - PalmPilot PDA (http://palm.3com.com/) in terms of physical size and styling. With battery, Orange estimates that it will weigh around 350g, which is about the same as two modern GSM voice-only phones.

One of the problems that affects most, if not all, current PDAs is that of battery life. The same is true of the prototype Videophone, which also includes a dual-band (900 as well as 1800MHz) GSM phone. The most recent prototype has a standby time of six hours, and hence won't last the working day. Making calls reduces battery life still further - a charge of the standard battery pack will deliver an hour of continuous calls. This could be a real problem, seeing that the first Videophone is going to be targetted at business users. Orange is hoping to lengthen this period to a practical figure by the time the phone is launched. Intelligent power management (turning off the camera and video processing circuitry when it's not needed, for example) is one of the techniques currently under investigation. A range of accessories, including powered car kits and extended-life battery packs, will also help customers to stay in touch whilst out mobile.

The integrated PDA and readable colour display are also important ingredients for practical Web access - which will be an important feature of the device. Unlike other Windows CE PDAs, you won't need to mess around with GSM phone cables and expensive PCMCIA data cards - all of the circuitry is built-in. The Videophone could hence be used as a self-contained Internet client, in the same way as devices like Nokia's Communicator can. At the moment, GSM data users can transmit and receive data at a sluggish 9600bps - the fastest speed of land-line modems a decade ago. In



Compaq's Aero 2100 Windows CE PDA. The physical ergonomic design of the final production Videophone will apparently be very similar. Note that the comms hardware will be built-in, though. There will also be an aperture for the video camera.

A mockup of one of Orange's Videophones. This one is nicknamed the 'Citizen'.

What the Citizen looks like with its protective doors closed.

Here's another Orange mockup. This conceptual model is known as the 'Future'.

this, the multimedia age, 9600bps is a limiting factor. Those with laptops, GSM phones and data cards tend to send relatively-small files, such as e-mails, faxes, non-enriched documents and - in a few specialist cases - very compressed images from digital cameras. Surfing the Web is an impractical proposition - pages will take ages to download. Although it's possible to configure a Web browser so that bandwidth-intensive images aren't downloaded, many Web sites won't work properly because they rely on graphics to convey information, or act as part of the user interface.

Although the Videophone will be capable of current low-bandwidth tasks, Orange will be partnering it with a new network service that's capable of boosting data speeds to a more useful 28.800bps. Such speeds are needed for acceptable videotelephony, although the video compression technology specified by the Videophone - SCT, developed at Strathclyde University (further info from http://www.sct.cs.strath.ac.uk) - will work at a 'worst case' 9600bps. However, the picture quality is of a much higher standard if the data rate is increased. Pictures reproduced elsewhere in this article show what SCT is capable of at various data rates, ranging from 9600bps - very blocky and in some cases barely recognisable - to 56,000bps. So how does Orange manage to triple the GSM data rate? It employs a Nokia-developed system known as HSCSD -High Speed Circuit Switched Data - which is being marketed under the user-friendler term of 'high-speed data'. First of all, it takes a standard GSM channel, but cuts back on the amount of error protection and replaces the availed 'space' with additional data. Two of these 14400bps channels are then 'pooled together', to give a total of 28800bps.

Because the error protection is greatly reduced, the system only works if radio signals are strong. However, Orange's GSM1800 system has to employ a denser network of cells to achieve good coverage, and so HSCSD coverage should be fairly reliable when the £10m network upgrade is completed by the end of the year. HSCSD has applications outside the world of the Videophone, and Orange will be selling a data-only GSM card that plugs into a notebook computer's PCMCIA socket. HSCSD data calls won't, according to Orange, be more expensive than regular calls. Interesting, seeing that users occupy twice the bandwidth of a regular subscriber! Apparently, it's because HSCSD connection cannot be guaranteed unconditionally. This is why SCT videotelephony will work at the standard GSM rate of 9600bps - it's a 'fall-back' provision for instances when a HSCSD connection can't be made due to a poor radio signal, or the network is congested. Theoretically, multiple channels could be added together to provide data rates that meet or exceed ISDN capabilities. Nokia's current standard, however, specifies a maximum of four channels (yielding 57600bps). Orange hasn't ruled out offering high-speed multi-channel data transfer at off-peak times for specialist applications, such as remote backup. We're sure that Internet addicts wouldn't mind a crack at

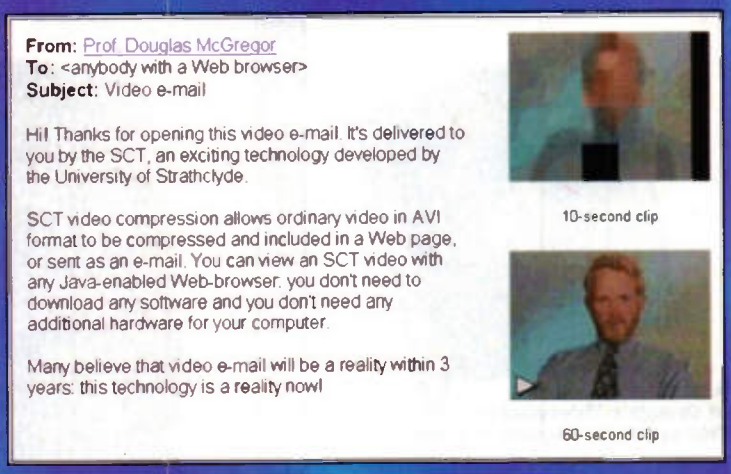
What SCT-compressed video looks like when it's been optimised for 9600bps. This is the lowest rate that SCT supports.

The results of optimising the SCT codec for 14400bps transmission. Note that blockiness and other compression artifacts are moderately less intrusive.

This picture gives you some idea of the best video quality you can expect from the Videophone. Here, the SCT codec has been optimised for 28800bps transfer rates.

At higher rates, such as the 56kbps of the video stream shown here, SCT is capable of delivering remarkably good picture quality with no obviously-intrusive artifacts.

Mobile phones have come a long way since this mid-80s analogue 'brick', which allowed a subscriber to talk to a colleague without the need to be tethered to a landline. Orange's Videophone adds wirefree data and video communication, and in a much cheaper and smaller package to boot!

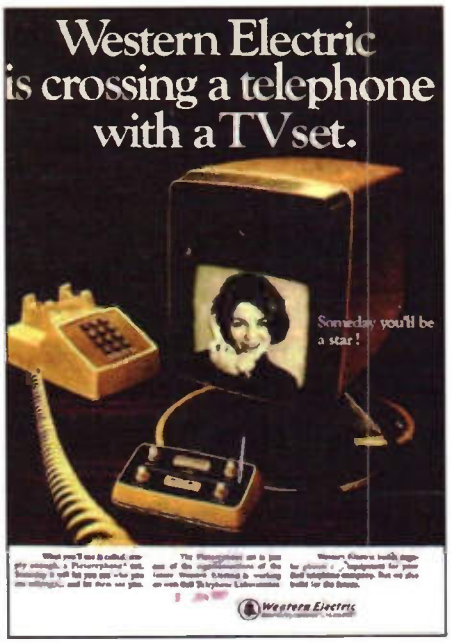


You could use your Videophone to generate a videoclip, which could then attached to an e-mail - as this example from Strathclyde University demonstrates.

that sort of speed either... The data rates offered by HSCSD will pave the way to GPRS, a packet-mode data transmission protocol which is itself a stepping stone to UMTS - the 'next generation' of mobile communications.

Orange will place a lot of emphasis on the Web potential of the Videophone, and it will be providing many new 'value-added' services on its site in the months that follow. Some of these features will be optimised for WAP delivery - fortunately, the Videophone's browser will be WAP-compliant. All part of the network's 'wirefree vision', as was the recent decision to become an Internet service provider in its own right. The forthcoming Web service will contain many elements that are optimised for Orange subscribers, such as local information directories. Orange tells us that Videophone-owning subscribers will be able to access video clips, such as news stories and film trailers, via special sections on its web site. One could also imagine a 'visual' version of Orange's recently-introduced 'Wildfire' virtual personal assistant - a system that talks to you in a female voice and responds to your vocal commands, allowing you to - for example - access voicemail. Some Orange executives feel that it's best to leave Wildfire as she is, but others quite like the idea of talking to a Lara Croft-type figure (and remember that the longer you're on-line to her, the more money will be filling Orange's coffers, seeing as you're paying for the call). Note that any moving video information offered by Orange's web sites will be processed with the efficient SCT compression algorithm, since the required codec is built into the Videophone.

SCT (Stratclyde Compression Transform) is a highly-efficient compression system that allows video to be transmitted over slow data links - like PC modems and GSM networks. As with other video compression algorithms, such as MPEG, the picture is broken down and analysed using a series of mathematically-intensive algorithms. Stationary elements of the picture, and those deemed as unimportant, are irretrievably discarded. Although SCT is more efficient than MPEG - and hence better for low bandwidth transmission - the picture quality isn't as good. To reduce data rates from the outset, Videophone's picture resolution is much lower than that of a standard TV picture, and isn't updated as frequently. During a videotelephone call, the 'raw' picture from the camera is passed to the SCT codec, which was written in the 'standardised' Java computing language. After compression, the compacted video data is transmitted to another Videophone subscriber across Orange's GSM1800 network. The Videophone at the other end has a SCT 'decompressor' that rebuilds a close approximation of the original video signal, and passes it to the display. The call recipient is able to send pictures using the reverse process. It's not yet known if Orange videotelephony is a 'full duplex' process (i.e. both sides of the conversation simultaneously sending and receiving video). If it is, then the maximum 28800bps provided by HSCSD will be shared by both video receive and transmit paths. 14400bps will limit the available picture quality.

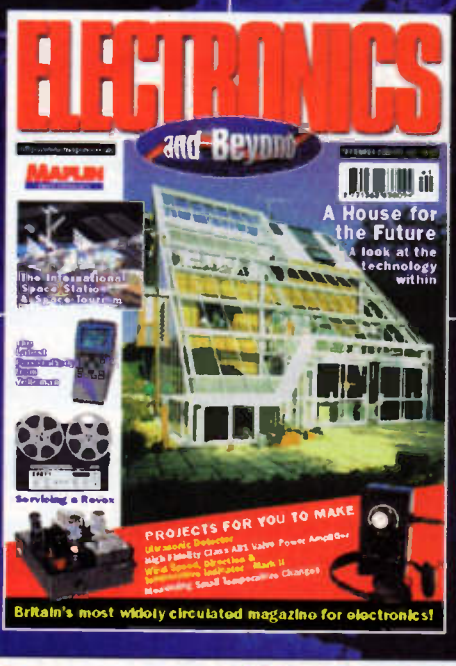


Videotelephony has been tried before, albeit rather unsuccessfully. BT tried it a few years back, but earlier examples date back to the late 1960s. Here's an 1968 US advertisement for Western Electric's black-and-white desktop videophone.

Martin Pipe welcomes comments and ideas. E-mail him as: whatnet@cix.compulink.co.uk Or look out for him online! His ICQ ID is: 15482544

BACK ISSUES

are available at all Maplin Stores or by mail order. Only £2.65 each. Call the Sales Hotline on 01702 554000 and include them in your order.



Issue 138 • Order as XD38R

PROJECTS Metal Detector Pt 2
★ Water Alarm & Metronome
FEATURES Year 2000 Compliance
★ PC Security ★ The Science of Scepticism
★ Modern Day Treasure Hunting
★ Towards a Theory of Everything
REVIEW Brother Has The Magic P-Touch

Issue 139 • Order as XD39N

PROJECTS Magnetometer
★ Sound Generator & Simple Light Show
FEATURES Better Soldering
★ Web Design ★ Why are we Here?
★ Web & TV Collide in Hypersoap
★ The First Radio War
★ Light-sensitive Circuits

Issue 140 • Order as XD40T

PROJECTS LASSIE
★ Wind Speed/Direction & Temp Indicator
FEATURES Cavorting with Chaos
★ Bell Labs ★ Bio-Feedback
★ Future Reusable Space Vehicles
★ The New Cambridge Store
★ Easy Web Page Creation

Issue 141 • Order as XD41U

PROJECTS Ultrasonic Detector
★ Measuring Small Temp Changes
FEATURES The Integer House
★ Cavorting with Chaos ★ Bio-Feedback
★ Future Reusable Space Vehicles
★ Easy Web Page Creation
★ Revox Restoration

Issue 141 • Order as XD42V

PROJECTS Solar Powered PSU
★ Multifunction Clock Display
★ Desktop Robot
FEATURES Car Audio Capers
★ Code Making & Code Breaking
★ Was Einstein Right?
★ Bio Feedback

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: ❶ 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; ❷ 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; ❸ Telephone your order, call the Maplin Electronics Credit Card Hotline on (01702) 554000; ❹ 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 panty, 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; ❺ 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; ❻ 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 5th November 1999 (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: ❶ Over the phone, telephone 0897 501353 between 9.00am and 5.30pm Monday to Saturday, except public holidays (calls charged at £1/min BT rates); ❷ By sending a facsimile. Fax (01702) 554001; ❸ 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.

Maplin 'Get You Working' Service

If you get completely stuck with your project and you are unable to get it working, take advantage of the Maplin 'Get You Working' Service. This service is available for all Maplin kits and projects with the exception of: 'Data Files'; projects not built on Maplin ready etched PCBs; projects built with the majority of components not supplied by Maplin; Circuit Maker ideas; Mini-Circuits or other similar 'building block' and 'application' circuits. To take advantage of the service return the complete kit to: Returns Department, Maplin Electronics PLC., P.O. Box 777, Rayleigh, Essex, SS6 8LU. Enclose a cheque or Postal Order for the servicing cost (£24/hr min + parts) as indicated in the current Maplin Catalogue. If the fault is due to any error on our part, the project will be repaired free of charge. If the fault is due to any error on your part, you will be charged the standard servicing cost, plus parts. A kit building service is on offer for any of our kits. Please contact our customer service department for any pricing details.

in the pipeline

ELECTRONICS and Beyond

Don't miss another great assortment of entertaining and easy-to-make projects and essential electronics information aimed at the novice constructor.

Issue 144 will be on sale Friday 5th November

PROJECTS

Digital Audio Recorder

10 Year Temperature Recorder

Guitar Effects

Velleman LCD Panel Meter

FEATURES

Brief History of Numbers

Astrobiology

Code Making & Code Breaking

Easy Web Design

Circuit Simulation & Analysis Software Competition

ELECTRONICS and Beyond

SUBSCRIBE TODAY AND QUALIFY FOR THESE AMAZING SAVINGS!

HURRY! OFFERS OPEN FROM 1st SEPTEMBER UNTIL 31st OCTOBER 1999

Subscribers' Special Offers

ULTRA VIOLET LIGHT EXPOSURE BOX

Catalogue Price £229.99
Subscribers' Price £199.99

SAVE £30

Code 72377

ETCH CRYSTALS

Catalogue Price £7.49
Subscribers' Price £5.99

SAVE £1.50

Code 72375

CLOCKWORK RADIO RECEIVER

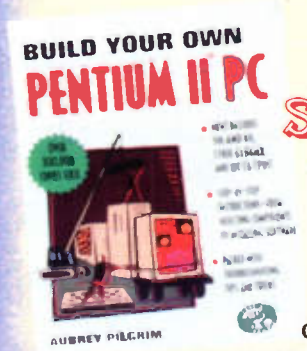
Catalogue Price £59.99
Subscribers' Price £49.99

SAVE £10

Code 72374

BUILD YOUR OWN PENTIUM PC

Catalogue Price £24.99
Subscribers' Price £19.99



SAVE £5

Code 72373

POLYFOAM CRACK FILLER

Catalogue Price £7.29
Subscribers' Price £5.99

SAVE £130

Code 72376

MAKING MUSIC WITH DIGITAL AUDIO

Catalogue Price £14.99
Subscribers' Price £11.99

SAVE £3

Code 53797

When ordering any of these special offers which apply only for Subscribers and new Subscribers of Electronics and Beyond, please quote your Subscribers' Membership number (telephone Customer Services on 01702 554002 if not sure) and the special order code number. All items are subject to availability. Prices include VAT. Catalogue prices refer to the 1998 Maplin Electronics Catalogue. Overseas subscribers telephone +44 1702 554000 Ext. 326 for carriage charges. A £3.95 Carriage Charge will apply to all UK orders under £30.00 (Maplin Electronics Account Holding Customers exempt).

http://www.maplin.co.uk

Interactive Internet Site - On Line Catalogue

Our new fully interactive on-line catalogue and ordering system improves accessibility of Maplin Electronics products to customers. This new service is a clever extension of paper-based and CD-ROM versions of the catalogue. Access to our full portfolio of over 30,000 products is quick, effective and user friendly

- Fully interactive on line secure ordering
- Fully interactive on line catalogue
- Interactive product sourcing and ordering
- Check product availability
- Option to reserve products
- Ability to build up orders
- Order confirmation e-mail
- Order reference no.

This site will also have product promotions: please be sure to visit regularly

you're just a click away