# ELECTRONICS and Beyond

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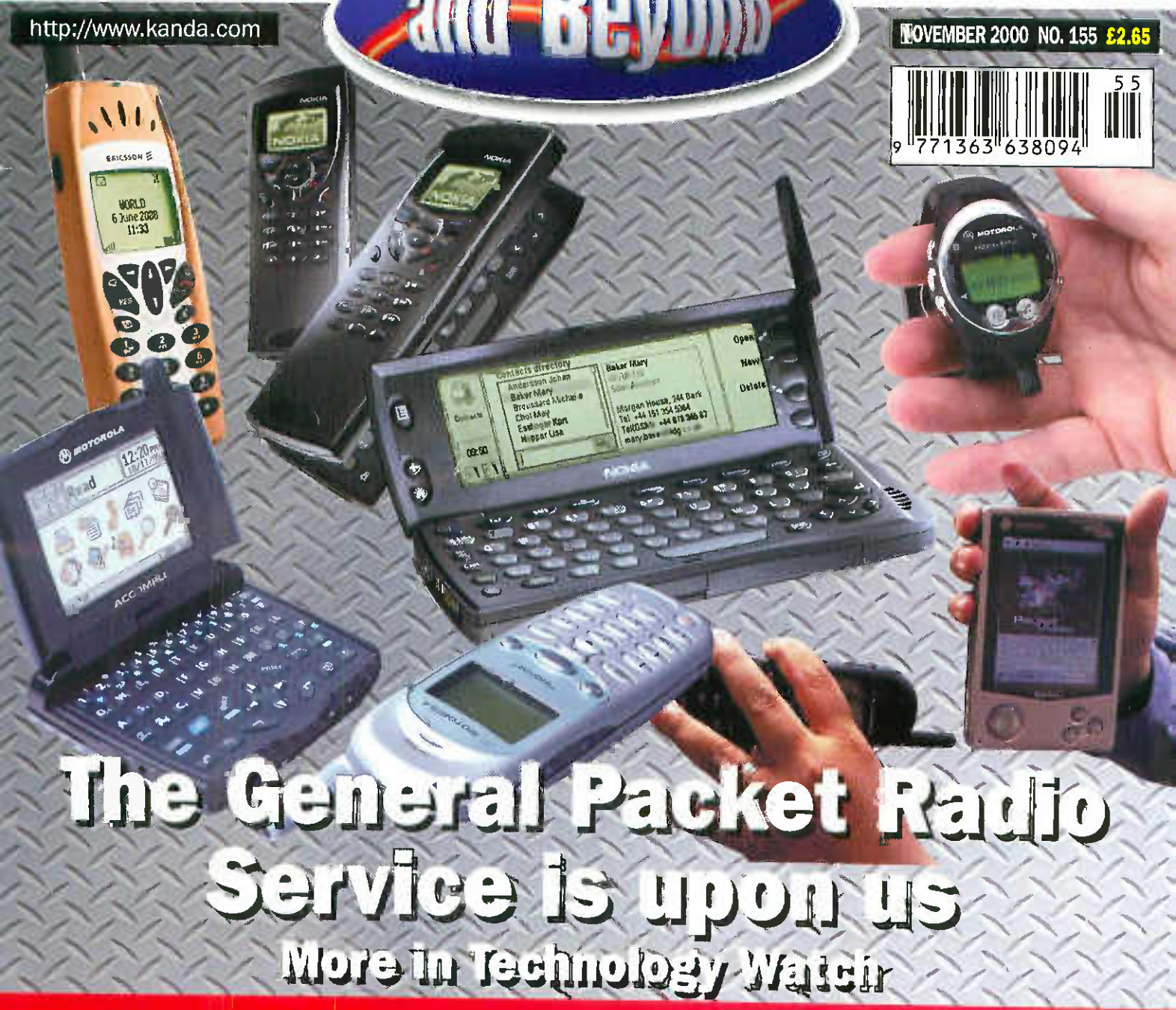


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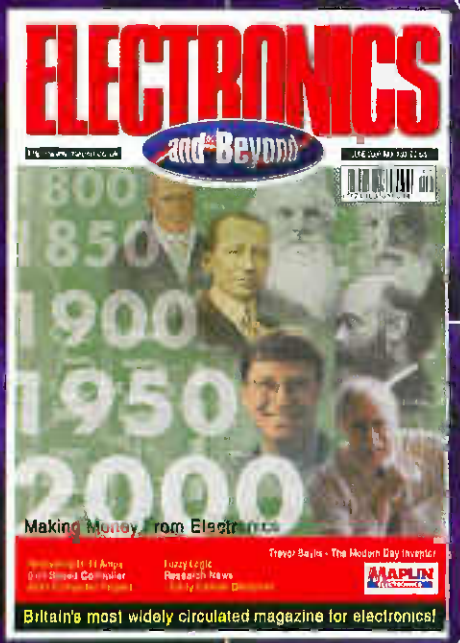


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# ELECTRONICS and Beyond

November 2000 Vol. 19 No. 155




## Regulars



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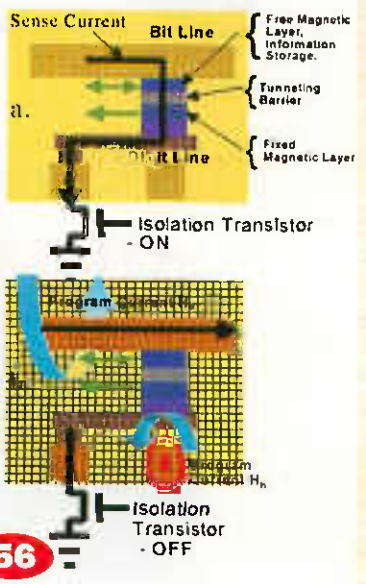



# ELECTRONICS and Beyond

We've an interesting mixed bag of items this month, but first we must report that Electronics and Beyond is now under new ownership. As you'll see there are no major changes to the magazine at present but in order to remain a popular and interesting read, Electronics and Beyond needs to know what you think and what you would like to see in the magazine. Our centre pages therefore contain a readership questionnaire. Please do fill it out in order that we can plan the best strategy ahead and include the sort of items you are looking for. And remember if you are a budding experimentalist, you could win a Xicor Development kit for your efforts in returning the form. That flash of inspiration for an application could bring big financial rewards and a big future for combining your creativity with embedded systems, so get designing and we will look to publishing your ideas to promote that great idea. In fact your ideas for using embedded systems could find us providing you with the equipment to try it out. You only have to read our article on Automated Environments to see how embedded electronics will affect our future, particularly in the home.

With more big changes in the world of memory storage ahead, all eyes at present look to be on magnetic principles at the nanometre level. This could give the solid state semiconductor memory industry a run for its money in future.

There's more on wearable electronics in the form of smart textiles from Philips research and with the world going crazy with the thirst for mobile phone technology, is this industry going the same way as PC computer development? The chances are that your mobile phone does not provide you with what the industry thinks you ought to have. The 'comms' business requires you to buy the next improved service in GPRS. Read Technology Watch for the latest developments!

Enjoy your read.

Paul Freeman-Sear


**Britain's Best Magazine for the Electronics Enthusiast**

# NEWS REPORT

## Intel Announces Wireless and Internet Infrastructure Microarchitecture


Intel has disclosed details of a new chip microarchitecture designed to benefit a wide variety of wireless Internet and networking infrastructure applications. Called the Intel XScale microarchitecture, it has the flexibility to handle requirements for both ultra-low power and high performance in devices ranging from Internet-ready cell phones to Internet infrastructure equipment.

Building on Intel StrongARM technology, the Intel XScale microarchitecture core is manufactured on Intel's advanced 0.18-micron process technology. It offers low power operation ranging from one ten-thousandth of a watt to 1.6 watts, and performance that allows it to operate at clock speeds approaching 1GHz. This lets the new microarchitecture meet the needs of a diverse set of Internet client devices as well as networking and storage equipment.

Intel has enhanced the low power capabilities of the Intel XScale microarchitecture with Intel Dynamic Voltage Management and Intel Media Processing Technology. Dynamic Voltage Management allows developers to scale the clock frequency and voltage dynamically to adjust performance to application needs, while maintaining battery life. Intel Media Processing Technology is a co-processor engine that enables more power-efficient multimedia processing for increasingly content-rich Internet applications.

The Intel XScale core includes extensions from the ARM architecture, such as ARM Thumb instructions to reduce code size and ARM media extensions to add digital signal processor (DSP) functionality. The Intel XScale core is compliant with version 5.0 of the ARM Architecture, enabling compatibility with operating systems, applications and tools.

For further details, check: **<developer.intel.com/update>.**

Contact: Intel.
Tel: (01793) 403000.

# Nintendo GAMECUBE Console and Portable Game Boy Advance Unveiled

Nintendo has unveiled the new Nintendo GAMECUBE console and the portable Nintendo Game Boy Advance. While each system will be the most powerful in its category, they have been designed to work together to provide a game play experience that is unprecedented and totally unique to Nintendo.

Game Boy Advance is powered by a 32-bit processor developed by ARM. Its screen size increases by 50%, and screen resolution is up 60% thanks to an ew, reflective TFT colour LCD using a high contrast white panel.

Its processor runs 17 times faster than that of the Game Boy Colour; it's capable of displaying 32,000 colours simultaneously; boasts PCM sound playback for infinitely improved audio; and with a special cable, allows up to four machines to be linked for full, four-player action.

Game Boy Advanced will be available in Japan in March 2001, and in the US and Europe next July.

Nintendo GAMECUBE sets new technical standards in a compact (6in. x 6in. x4.3in.), transportable housing. It features a highly customised, 405MHz, copper wire central processor from IBM; a revolutionary graphics co-processor from ATI with Mosys 1-T SPRSM memory embedded directly onto the chip; and 40MB of memory, including one of the largest implementations of static memory in consumer product history. This integrated design creates the fastest and most efficient video game system ever brought to market.

Storage media comes in the form of a small (8cm diameter), 1.5GB proprietary optical disk from Matsushita. Accessories will include a 56K modem and in the future a broadband modem; the 'Wavebird' wireless RF controller; (2) Digicard slots for either 4MB Digicard flash memory cards or a 64MB SD-Digicard adaptor; and a variety of high speed ports and both analog and digital AV outputs.

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

Contact: The Games (UK Nintendo distributor), Tel: (023) 8065 3377.

# Philips Merge CD and MP3 on Playback Products

Philips is set to introduce the first examples of a new range of audio products which combine the Compact Disc - now the world's most popular music carrier - with MP3 compressed digital audio technology.

In the coming months, Philips will roll its eXpanium CD portable, and the FW-M55 mini system. in addition to reading standard audio CDs, both products are capable of reading CDs encoded with MP3 files, improving the storage capacity and versatility of CD technology.

Because compressed digital audio files, like MP3, occupy considerably less storage space than conventional digital audio files, consumers can create CDs containing up to 10 hours of compressed audio on them to play on the eXpanium and M55.

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

Contact: Philips, Tel: +31 40 272 20 91.

# Singapore Wafer Fab Completed In Under A Year

The new Singapore wafer fab of SSMC, in which Philips has a 48% stake, has been completed in just 11.5 months. The $2 billion plant, which will have a monthly capacity of 30,000 wafers, is expected to begin production by the end of next month.

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

Contact: Philips, Tel: +31 40 272 20 91.

# Intel Unleashes the PC Camera


Intel has unleashed the PC camera to offer users the capability to shoot Internet-ready photos and record video at, and away from, the PC.

The Intel Pocket PC Camera is an inexpensive and easy-to-use product that includes a detachable PC Camera that can be taken to backyard barbecues, summer softball games and family vacations.

The package comes with a software suite so that when the digital PC Camera is reattached to its PC, consumers can make video phone calls, create personal Web pages, send e-mail postcards, create PC movies, edit photos and play PC Camera games.

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

Contact: Intel, Tel: (01793) 403000.

# NEWS BYTES

## Switch Breaks 200 Gbps Record

Applied Micro Circuits has demonstrated the S2090, the industry's first very high-speed Silicon Germanium (SiGe) 68 x 69 differential crosspoint switch with full broadcast switching capability.

Targeted at high-speed applications such as Dense Wavelength Division Multiplexing (DWDM) switching, digital video, high-speed automatic test equipment (ATE), and data or telecommunication switches, the S2090 can handle data rates up to 3.2 Gbps per channel with corresponding output rise/fall times of 85 picoseconds.

For further information, **check: <www.amcc.com>.**

Contact: Applied Micro Circuits, Tel: +1 800 755 2622.

## Fujitsu and Entone in Digital Alliance

ARM announced the availability of Fujitsu and Entone Technologies have announced an alliance to develop and promote solutions for digital television distribution via broadband networks.

The two companies will collaborate on a broad range of networked digital media delivery initiatives including ATM-based digital television broadcasting, adaptive rate video streaming and methods to protect against unauthorised use and piracy.

For further details, check: **<www.fujitsu-fme.com>.**

Contact: Fujitsu,

Tel: + 33 1 45 13 12 12.

## Philips to Double CD-RW Production Capacity

Philips is to double production capacity of CD-RW drives based on growing market demand. The company's optical storage group expects to reach this goal by the end of next year, achieving a total output capability of 20 million units annually.

Experts predict that industry wide shipments of CD-RW drives will exceed 35 million this year, and that media manufacturers will ship more than 3 billion CD-R/RW discs in the same timeframe.

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

Contact: Philips, Tel: +31 40 272 20 91.

# NEWS BYTES

## Power-up for Back-to-School

Think about the calculator you had in school - basic functionality, right? Now think about a calculator on steroids, with a large display screen, cursors with directional buttons, even electronic upgrades and add-on software applications that allow you to view the periodic table or store school schedules and email addresses. It's what students will be using this winter.

Texas Instruments has transformed the calculator into a powerful handheld graphing device by combining the capability of a desktop computer, the functionality of math and science software and the portability of a paperback book. Add to that the ability to upgrade the unit's operating system, add software applications through the Internet, and connect additional tools, and you have a powerful and flexible learning device essential to students not only in class, but even after the bell rings.

Much like digital cameras and MP3 players, TI Flash-based calculators offer handheld technology that is flexible and evolves as classroom curriculums change. Students may quickly become bored with simple, static tools that perform only basic calculations and analysis, but provide them with products that can be customised and upgraded like a computer as their learning advances.

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

Contact: Texas Instruments, Tel: (01604) 663000.

## MIT and Gartner Study 21st Century Workplace

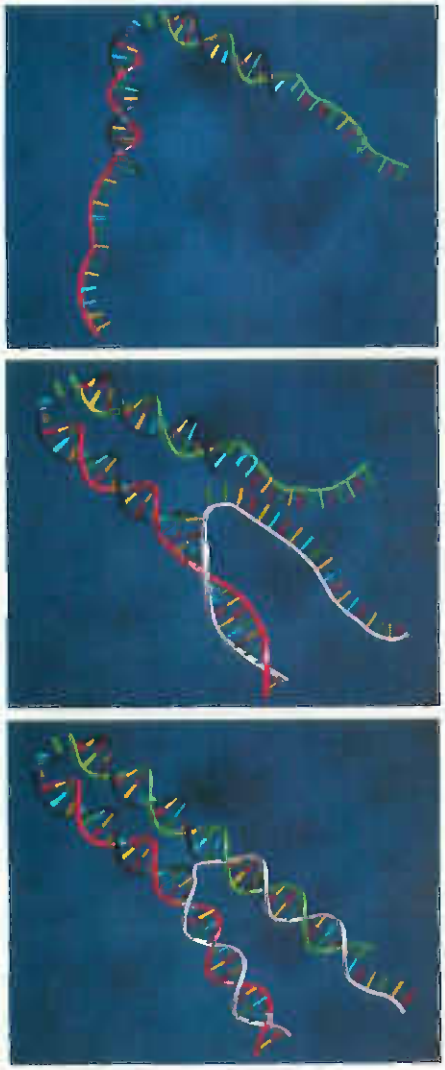
Gartner and the Massachusetts Institute of Technology (MIT) are set to study the global trends, best practices and new business models that will create, maintain, and service the 21st century workplace.

Gartner and MIT have combined their research capabilities, resources and global market access for this study. This project brings together two world-class competencies: Gartner's unique perspective on the e-business environment and IT, and MIT's world-renowned knowledge of changing workplace trends.

For further details, check: **<web.mit.edu> or <www.gartner.com>.**

Contact: Massachusetts Institute of Technology, Tel: +1 617 253 1000.

# Researchers Create First DNA Motors



Scientists from Bell Labs, the research and development arm of Lucent Technologies, and the University of Oxford have created the first DNA motors. The devices, which resemble motorised tweezers, are 100,000 times smaller than the head of a pin, and the techniques used to make them may lead to computers that are 1,000 times more powerful than today's machines.

The DNA motor research is part of a burgeoning field known as nanotechnology, where dimensions are on a nanometer scale - a billionth of a meter. Scientists believe nanoscale devices may lead to computer chips with billions of transistors, instead of millions - which is the typical range in today's semiconductor technology.

The researchers designed pieces of synthetic DNA that would recognise each other during each step of making the DNA motors. As a result, the only necessary ingredients in a laboratory test tube were DNA itself.

While DNA typically exists in a double-stranded form - similar to a twisted ladder - the researchers began with three single strands, each resembling a ladder sliced down the middle. Strand A has the correct DNA sequence to latch onto half of strand B and half of strand C, and so joins them all together. Strand A also has a hinge section between the parts that bind to B and C, so that the two arms - AB and AC - can move freely.

On its own, the DNA structure floats with its arms wide open. The arms are pulled shut by adding a DNA fuel strand, which is designed to attach to the dangling, unpaired sections of strands B and C. To re-open the tweezers, the fuel strand is removed by adding another strand with the right DNA sequence to pair up with it.

Because the DNA motors are too small to be observed with available microscopic techniques, the researchers relied on the phenomenon of fluorescence to detect the closing and opening actions. A pair of dye molecules was attached to the ends of the DNA motors, and when laser light excited the dyes, the amount of fluorescent light indicated the distance between the two ends.

For further details, check: **<www.ox.acu.uk>**

Contact: University of Oxford, Tel: (01865) 270000.

# New AMD Chip Release Preserves x86

AMD has released the x86-64 Architecture Programmers Overview, the instruction manual the software community can use to begin incorporating x86-64 technology support in their operating systems, applications, drivers and development tools. AMD's x86-64 technology will first be supported in the family of processors codenamed Hammer, planned to be announced at the end of 2001.

AMD x86-64 technology is designed to enable platform suppliers, developers, and corporations to transition to 64-bit environments while continuing to have leading performance on the vast installed base of existing 32-bit applications. 64-bit computing is ideal for memory hungry applications such as large databases, CAD tools, and simulation engines that are currently limited by the 4GB addressing limitation.

AMD is enhancing the x86 architecture to include a 64-bit mode that has both a 64-bit address space and a 64-bit data space. AMD's 64-bit processors will be designed to detect which mode is needed (32- or 64-bit) and compute accordingly.

The computer industry has extended the x86 instruction set twice previously, from 8-bit to 16-bit and from 16-bit to 32-bit. AMD's x86-64 architecture is a straightforward approach to extending the instruction set, and will allow developers to employ their experience and the tools they have accumulated since the inception of the x86 instruction set more than 20 years ago.


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

Contact: AMD, Tel: (01276) 803100.

# Fuji Releases Most Advanced Digital Design Camera


Fuji Photo Film is taking its 900 series digital cameras in a new design direction with the introduction of the FinePix 4900 ZOOM, a camera that delivers a host of advanced photographic features and controls to the serious photo enthusiast.

Radically different from traditional Fujifilm digital models in terms of style, the FinePix 4900 ZOOM will appeal to the profession and consumer market on a number of levels when it becomes available later this month.

Its new, cylindrical design offers the handling-flexibility shutterbugs demand, as two strategically placed shutter-release buttons make it easy to shoot either horizontally or vertically.

In addition to working as a traditional point-and-shoot camera, the FinePix 4900 ZOOM can be operated manually, empowering the user to adjust shutter speeds, select aperture (13 steps) and control camera focus as well as white balance.

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

Contact: Fujifilm, Tel: (020) 7586 5900.

# Data Storage Cartridges Enable 20MB/s Transfer


Fuji Photo Film has announced Linear Tape-Open (LTO) Ultrium 1 100GB tape cartridges. The LTO specification was developed after three years of collaboration between Hewlett-Packard, IBM and Seagate by using best-of-breed technology from all three companies to deliver high performance tape capabilities.

Using single-reel media with capacities of up to 100GB native and data-transfer rates of up to 20MB/s, Ultrium technology combines the advantages of linear multi-channel, bi-directional formats with enhancements in servo technology, cartridge memory, data compression, track layout and error correction code to maximise capacity, performance and reliability.

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

Contact: Fujifilm, Tel: (020) 7586 5900.

# LED Light Leaves Other Lights in Dark on Flight Deck

B/E Aerospace has introduced a longer-lasting reading light that consumes less power and can be used in aircraft.

Using a light-emitting diode (LED) technology, the new LED Reading Light leaves existing incandescent and halogen reading light installations in the dark by consuming only 50% of the power, and lasting 10 to 12 times longer.

The secret behind this success is a patent pending temperature compensation circuit designed to increase lamp longevity while generating a high quality white light.

For further information, check: **<www.beaerospace.com>.**

Contact: B/A Aerospace, Tel: +1 561 791 5000.

# MGI Announces PhotoSuite Release

MGI Software has announced a new version of its PC photo software, MGI PhotoSuite 4 - Platinum Edition. Designed to be the most Web friendly edition ever, PhotoSuite 4 offers extensive support for sharing photos and projects online, step-by-step guides for creating and publishing image-rich web sites, advanced photo enhancement features and a wealth of new templates and content.

For further details, check: **(www.mgisoft.com) or <www.photosuite.com>.**

Contact: MGI Software, Tel: (0800) 973830.

# NEWS BYTES

## ON Semiconductor Launches Portable Voltage Protection Device

ON Semiconductor has introduced a new over-voltage protection (OVP) analogue integrated circuit (IC) for portable and other low voltage applications.

The NCP345, is ideal for use in designs where sensitive electronic circuitry must be protected from over-voltage transients and power supply faults.

The device will sense such conditions, and quickly disconnect the input voltage supply before damage can occur.

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

Contact: On Semiconductor,

Tel: (01296) 395252.

## Siroyan Secures £12 million Funding

Siroyan, the silicon intellectual property (SIP) company, has completed a £12 million second-round funding, the highest ever obtained by any SIP, EDA or fabless semiconductor company.

This funding will enable Siroyan to bring to market its unique softcore processor technology for next-generation Internet connectivity, digital TV and 3G mobile communications.

Siroyan will deliver first evaluation products to its partners in 2001.Siroyan has designed the first pure-bred processor architecture that truly integrates RISC and DSP capabilities, creating a 'processor of choice' for the converging voice, video and data communications markets.

The funding - financed by a consortium of leading US and European high-technology venture capital companies led by nCoTec - will facilitate the commercial realisation of the company's unique processor design.

A key contributor was Tudor Investments, the venture capital firm that recently invested in high profile start-up, Transmeta; whilst Transmeta targets a different market, the company shares Siroyan's pioneering vision in VLIW (very long instruction word) processor architectures.

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

Contact: Siroyan,

Tel: (0118) 949 7028.

# NEWS BYTES

## Gartner Provides Analysis on Pentium 4

At the end of August, Intel released details of the Pentium 4, its next generation of microprocessors for PCs. Intel plans to make Pentium 4 chips available by the end of the year. Intel says that Pentium 4 will have a speed of at least 1.4 GHz.

According to Gartner, the international analyst house, Pentium 4 is Intel's most significant microprocessor enhancement since Pentium II, announced in early 1997. Pentium 4 represents Intel's next-generation microprocessor architecture and will serve as the foundation for future desktop and laptop processors.

Despite the hype surrounding the clock speed or 'Megahertz' race between Intel and Advanced Micro Devices, Pentium 4's NetBurst microarchitecture will boost performance beyond just simply increasing the speed. These enhancements include:

* The pipeline depth has doubled to 20 stages, thereby increasing frequency capability.

* Integer instructions run at twice the speed of the rest of the processor, resulting in higher execution throughput and reduced latency of execution.

* The system bus has three times more bandwidth than Pentium III's to provide a 3.2 Gbyte transfer speed between processor and memory controller.

* Pentium 4 caches decoded instructions, thus removing the decoder latency from the main execution loop and using cache memory storage more efficiently.

Gartner said that Intel has also added 144 instructions to the core x86 instruction set that focus on improving multimedia functions. However, software vendors will need to rewrite applications to exploit the new instructions fully.

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

Contact: Gartner,

Tel: (01784) 431611.

# Cirrus Maverick Processor Powers Electronic Book

Cirrus Logic's Maverick processor is the engine of Thomson Consumer Electronics' REB1100 eBook.

The Maverick processor has demonstrated considerable breadth in the consumer appliance market in recent months with product announcements that include Ceiva's Internet picture frame, S3 Diamond Rio's networked home Internet jukebox and PhatNoise's digital audio system.

Similar to its early entry into the Internet audio market, the Maverick processor enables the second generation of Internet products such as the REB1100 eBook, just as consumer interest and adoption begins to swell.

eBooks are book-shaped, portable electronic reading tablets that allow consumers to download digitised content to read at their convenience.

Unlike earlier devices, Thomson's eBook can directly download content, since it comes equipped with its own built-in Maverick processor enabled 56k modem.

The electronic device is capable of holding about 20 books simultaneously and allows the reader to view text both in daylight and at night by utilising a backlit, touch-sensitive liquid crystal display that enhances reading in any lighting situation.

For further details, check: **<www.maverickaudio.com> or <www.cirrus.com>.**

Contact: Cirrus Logic, Tel: (01628) 472211.

# Operating System is Guaranteed 99.999% Reliable

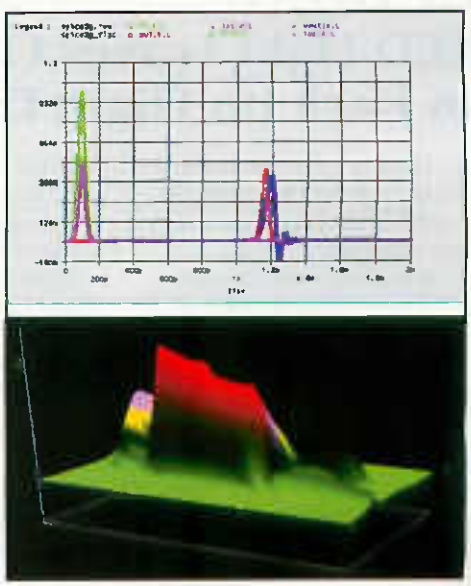

Wind River has launched the latest version of its VxWorks real-time operating system (RTOS). Previously code-named Cirrus, this new development platform will help developers meet demanding reliability, availability, serviceability and security (RASS) requirements in embedded computers.

The VxWorks AE platform is targeted at manufacturers building service critical Internet infrastructure equipment and Internet appliances, mission-critical defence and aerospace systems, and life-critical medical products. It enables 99.999% up time, a requirement for telecom and electronic service providers as well as manufacturers of smart devices.

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

Contact: Wind River, Tel: (01793) 831831.

# 3D Simulator Takes Realistic Approach to Time Domain Analysis



Applied Simulation Technology has announced a 3D-full wave electromagnetic non-linear signal integrity, power integrity and EMI simulator.

The company believes that the release is the first of its kind. ApsimFDTD-SPICE integrates a Finite Difference Time Domain electromagnetic field solver with the industry standard circuit simulator SPICE. The simulator is targeted at signal integrity and EMI simulation beyond the 1GHz frequency range but is applicable at any frequency.

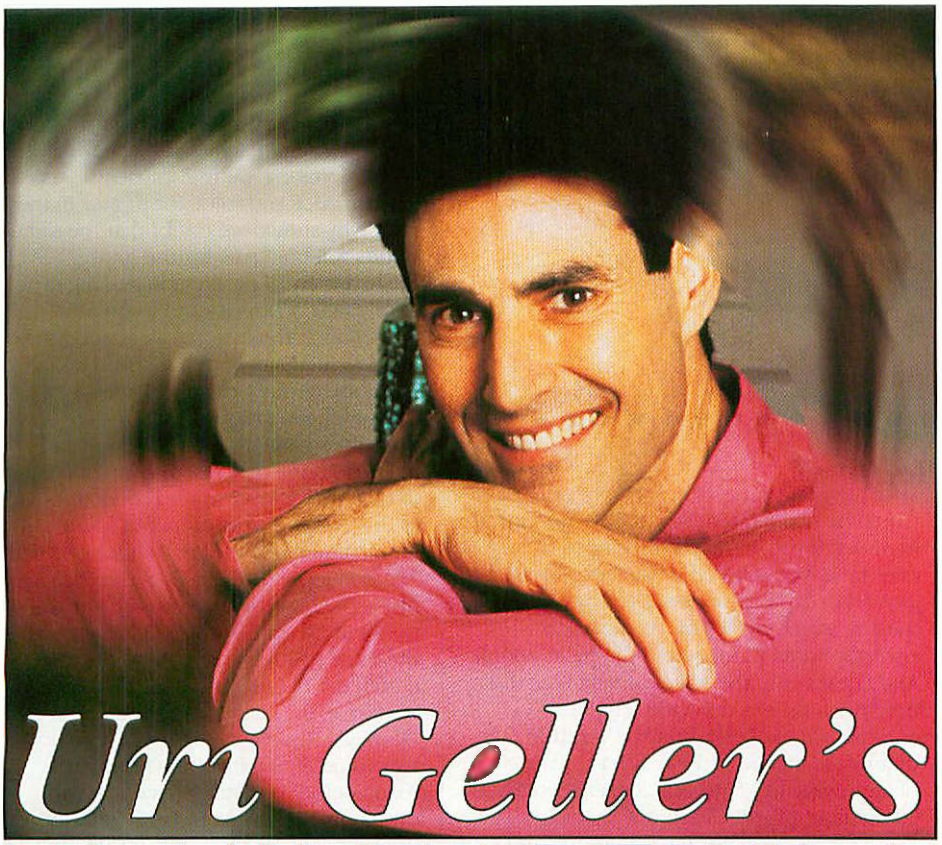
Traditional finite element, finite difference and integral equation solvers have been used for SI/EMI problems before. However the direct solution from the solvers is only useful in linear circuits.

In order to be useful for time domain simulation with non-linear elements such as semiconductors, it was first necessary to produce an I.CR type of circuit or matrix that a circuit simulator would understand.

With that approach accuracy and frequency effects are compromised, thus limiting its usefulness to designs where other static approaches or approximations would do. ApsimFDTD-SPICE solves this problem by a direct approach without any approximation.

For further information, check: **<www.apsimtech.com>.**

For further details, check: Applied Simulation Technology, Tel: +1 408 436 9070.



# Uri Geller's EXTENDED REALITY

## Sick Building Syndrome

Does your office make you sick? I don't mean that you just don't like it for whatever reason, but that it actually makes you physically ill. If no, you are suffering from what has come to be known in the last 20,years as Sick Building Syndrome. This is now recognised by the World Health Organisation, and it is reckoned to cause the loss of millions of pounds a year in loss of production and absenteeism due to sickness,

A survey carried out in 1987 found that a staggering 80 percent of office workers were made ill by their daytime environments, symptoms ranging from lethargy (57 percent), stuffy nose (47 percent) dry throat and eyes (45 percent) to headaches (43 percent). Chief culprits were viruses and spores coming out of the air conditioning, fluorescent tubes giving out light of a kind quite unlike natural daylight, (often flickering as well), ozone coming out of photocopiers, plus all kinds of vapours, fibres and volatile organic compounds originating in carpets and furniture.

On top of all that was the feeling of claustrophobia and isolation from real life felt by people who spent all day staring at a computer screen under a low ceiling beside a tinted window that, of course, they couldn't open. All of this combines to create what environmentalists call a 'sub-lethal environment', one in which while we may not be struck dead the minute we walk into an office, we can be steadily and almost imperceptibly weakened over the years, to the point where our natural resistance to serious disease just collapses.

In some buildings the problem is really serious, especially, it seems, the brand new ones such as the handsome Public Record Office at Kew, London which had to close down soon after its opening for a complete overhaul of the air conditioning. Another state of the art building, the hospital claimed as the most technically advanced in Britain, Fenland House in Peterborough, certainly made its staff sick, whatever it did for the patients. A local union official was reported as being "inundated with complaints from staff about the working conditions". Another union survey found that an alarming 40 percent of the staff at the huge new Kensington Town Hall blamed the building for their sneezes, wheezes, headaches, eyestrain and 'afternoon malaise'.

To add to all this misery, office workers who complain are often made to feel worse by members of management refusing to admit that there is a problem.

There have certainly been improvements lately, with increasing use of pot plants and bright paintings to cheer people up, but can't help feeling there is a wider problem here. It isn't just the sick buildings, but a whole sick lifestyle of agonising journeys to work in crowded trains or traffic jams moving slower than a dying snail, hastily gobbled mouthfuls of junk food and fizzy drinks, another ordeal getting home and another evening glued to the television. Where has real life gone?

There are some encouraging signs that all this is about to change, or at least to begin to change here and there as far as domestic buildings are concerned. There has been a lively 'biohouse' movement in Germany for some years, based on the principle that natural materials are better for us than synthetic ones. The large Schlatbruhl housing estate near Tubingen was built with such devotion to eco-principles that the architects even had special paint made that is coloured only by natural plant dyes.

One of the most immediate results reported by those who first moved to the new bio-estate was how much better they felt in general and how less often they were ill. Another was that although there are nearly 4,000 people living on the estate, crime and vandalism are virtually unknown. There seems to be a pretty obvious lesson to be learned here.

Another place of good news comes from Turkey, where teams of architects from M.I.T. are planning housing for the victims of the recent devastating earthquakes there. They too plan to use only natural materials and traditional Turkish design instead of putting up soulless chunks of concrete.

Uri Geller's ParaScience Pack, an incredible 3-D exploration of the unkonwn, is published by Van Der Meer at £30.
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# Memory & Storage - BEYOND SILICON & DISKS

*by Mike Bedford*

To the majority of PC users, working storage is synonymous with semiconductor memory and backup storage is synonymous with magnetic disks. And there's a good reason for this - semiconductor memory was introduced in 1970 and has been the prominent form of working storage for most of the intervening period. Similarly, magnetic disks have been the de facto form of backup storage for longer than most people can remember. But it hasn't always been this way.

Semiconductor memory replaced magnetic core storage in the 70s, and in the pioneering days of computing, technologies including thermionic valve circuitry, CRT tubes and mercury delay lines were used as the basis of main memory. And for mass storage, punch cards, paper tape, magnetic tape and magnetic drums are just a few of the ancestors of today's hard disks. After such a long period of stability - stability in the basic technology, that is, certainly not in capacity and speed - technologists are now suggesting that another fundamental change may be not too far down the line. Both semiconductor memory and magnetic disks are starting to approach the limit of their respective technologies so researchers are currently developing alternatives. This article is an investigation of some of these exciting new developments encompassing such futuristic sounding possibilities as holographic storage and molecular memory.

## The Challenge

First of all we need to look at why semiconductor memory and magnetic disks can't go on forever. After all, both technologies have a history of providing us with vast improvements in capacity, in speed, and in the cost per byte. For example, Intel's First RAM chip, the 1103, which was brought to the market in 1970, had a capacity of 1024 bits, that's just 128 bytes. Not surprisingly, it cost an arm and a leg but prices dropped rapidly. 1974 marked the point at which the price of semiconductor memory equalled that of core memory and from this point onwards, the days of magnetic core were numbered. That cross-over price was one cent per bit, a price at which the 64MB of memory in today's entry-level PC would cost almost £3.5 million. You'd actually pay around £60 for that memory today and it would come as a single module instead of the 512,000 separate 1103 chips which would be needed to give you this amount of memory. If you were to plot various trends over time, you'd find the usual exponential growth in capacity, as predicted by Moore in the law, which carries his name, and a corresponding reduction in the price per bit. And advances in the realm of magnetic disks have been no less dramatic. The first commercial hard disk unit was the IBM 305 that was launched in 1956. It had a capacity of approximately 5MB but actually contained 50 separate platters, each one 24 inches in diameter. Its areal density was about 2,000 bits per square inch and the transfer rate was 8.8KB/s. Today, of course, disk drives contain a single platter, the diameter is generally 3.5" (although smaller disks are used in laptops), the areal density is measured in billions of bits per square inch, capacities of up to 60GB are widely available, and if you go for a SCSI drive, the data transfer rate may be as high as 160MB/s. Figure 1 shows how the capacity of IBM products has increased since 1956. It's not quite the straight line of Moore's Law - since this applies only to semiconductors - but it's an impressive rate of growth, nevertheless. You'll notice that the line is projected to 2005 and beyond suggesting IBM's confidence in the future of magnetic disk technology. So we come back to the question "since both semiconductor memories and magnetic disks have given us such impressive gains in capacity, performance and value for money in the past, why should we doubt that the same trends will hold true for the future?".

The potential problem in making ever smaller silicon chips - and a continual reduction in the feature size is necessary for improvements in both the speed and the memory density - have been well documented. To summarise, these difficulties relate to the lithographic manufacturing process, to heat dissipation, to quantum effects, and to economics. None of this is going to call a halt to further improvements in the next decade, though. According to Franz Exenberger of Hitachi, memory chips for the year 2010 are already on the road map and they'll use essentially the same technology as today. Chips at the end of the decade will be 4Gbit devices and, of course, they'll be much faster than today's offerings. Nevertheless, few people doubt that some, if not all, of the potential roadblocks will derail semiconductor development sooner or later - differences in option relate mainly to when that time will come.

Development of magnetic disks also looks set to plateau some time in the future. Specifically, as the areal density increases, a point will be reached when the magnetic domains are so small, they'll no longer be thermally stable. Once again, experts differ as to when this point will be reached. Salim Mehta, Product Manager for SCSI drives with Fujitsu, doesn't expect undue problems before 16TB disks are possible, and extrapolating current trends suggest that this will be well into the next decade. On the

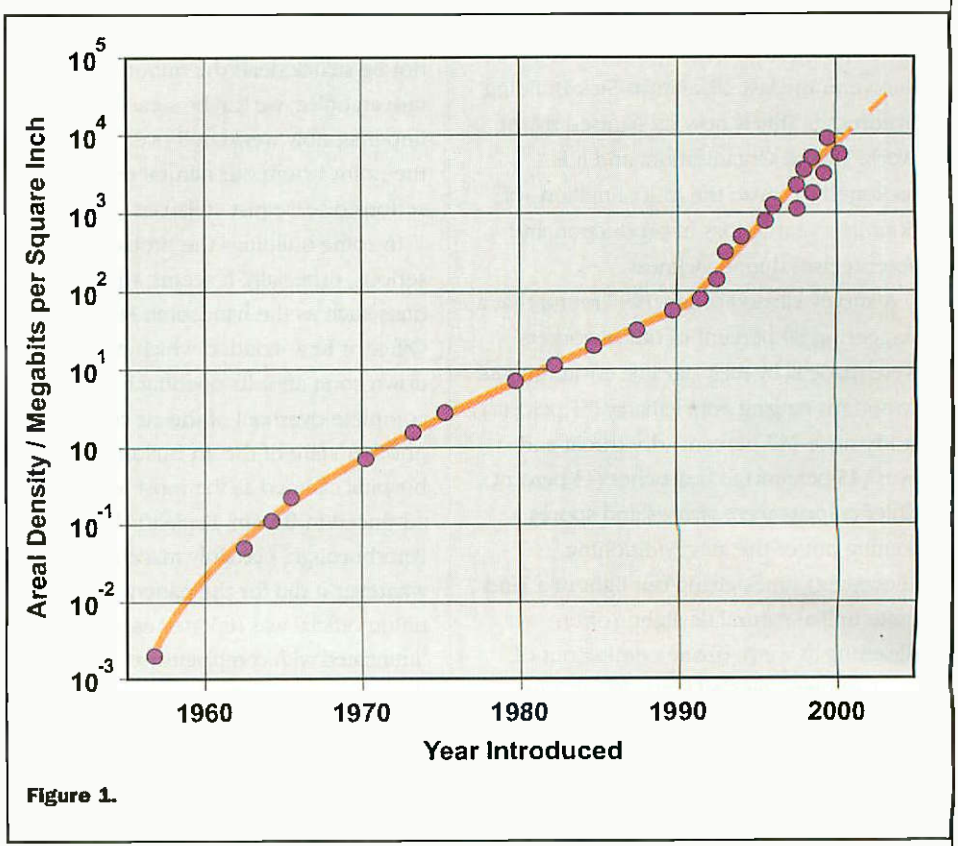



**Figure 1.**

other hand, C3D, a company touting an alternative technology which we'll look at shortly, suggest that 30Gb per square inch, an areal density which has already been demonstrated and will be in production by 2003, is about the limit. And if this proves true then further increases in disk capacity will be possible only by reversing the trend of ever smaller platters.

And although our discussion so far has centred on technologies with a long heritage, we shouldn't loose sight of the comparatively recent forms of optical storage, namely CD-Rom and DVD-Rom. Here too, fundamental laws of nature threaten to step in and curtail development beyond the near to mid term. Specifically, diffraction will mark a limit to the areal density of rotating optical disks. C3D's view of the world, showing both magnetic disks and conventional optical disks plateauing in the near future is shown as Figure 2. That graph also shows the multi-layer fluorescent disk, the first new technology which we're about to look at in the next section.

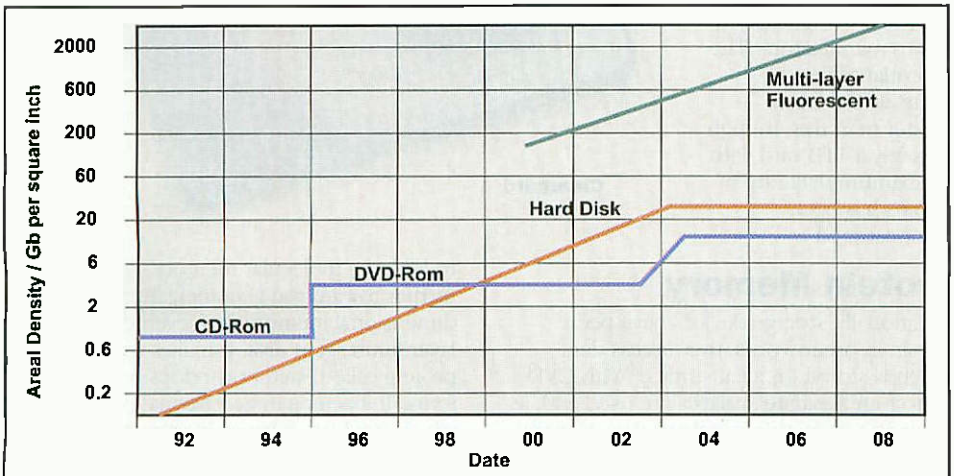



**Figure 2.**

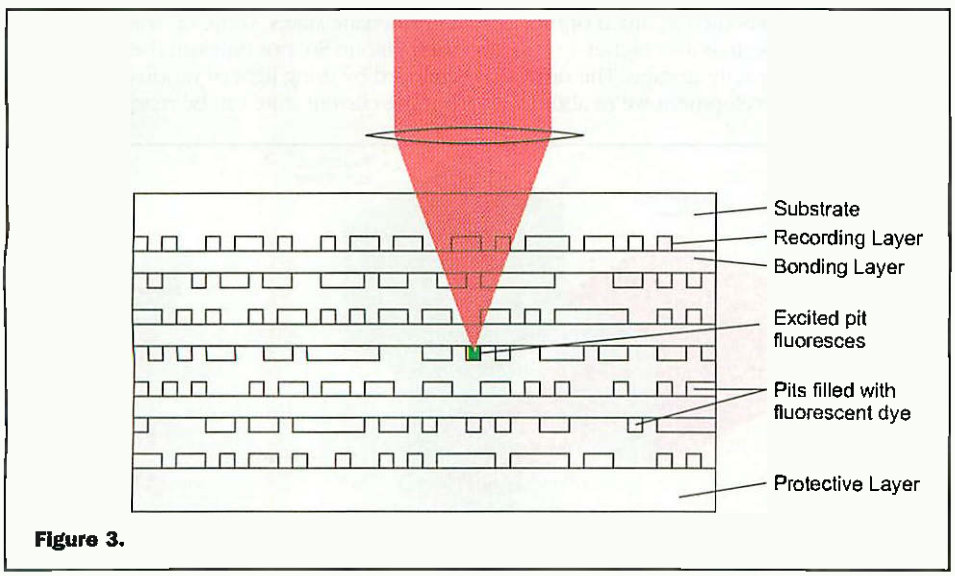



**Figure 3.**

## Fluorescent Disks

The zeros and ones in a CD-Rom or DVD-Rom are represented by so-called pits and lands, the presence or absence of indentations in the aluminium recording layer which is buried in the plastic of the disk. Since pits and lands have different reflectivities, the data can be read by shining a laser onto the disk as it rotates and measuring the amount of light which is reflected back. Two different approaches were taken to increase the CD-Rom's capacity of 600MB to give the DVD-Rom's maximum of 18GB. First of all the pits were made smaller, something which required a reduction in the wavelength of the laser light used to read the data. Secondly, two separate layers are used, one being read through the other by the use of clever optics. Provision has also been made for double-sided disks - thereby increasing the number of layers to four - although today's generation of DVD-Rom drives are only able to read one side at a time. To read the other side the disk must manually be turned over. Further improvements to the basic CD/DVD technology are possible. Specifically, by shifting to a blue laser even smaller pits can be used and this could allow, perhaps, a four-fold increase in the recording density. An increase in the number of layers is also possible although a law of diminishing returns applies as it becomes increasingly difficult to prevent degradation of the signal as the light has to pass through the multiple layers not actually being read.

These are the problems that have led Constellation 3D Inc. (C3D) to develop a multi-layer fluorescent disk (MFD). In fluorescence, material is excited by light of a particular frequency resulting in it emitting light at a different, lower frequency. Clearly, therefore, the presence or absence of fluorescent dye on a recording layer can be used to represent binary data. And as with reflective recording, such as CD and DVD, multiple recording layers can be incorporated into a single disk and these can be read by focussing onto a particular layer.

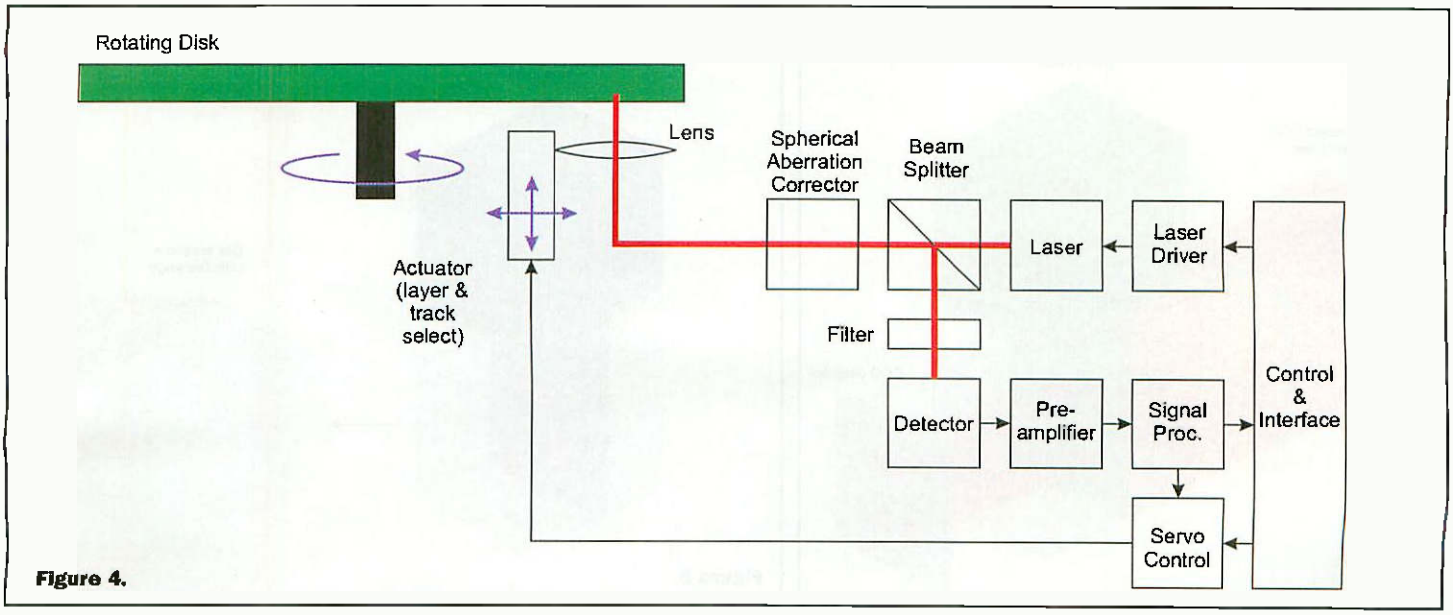
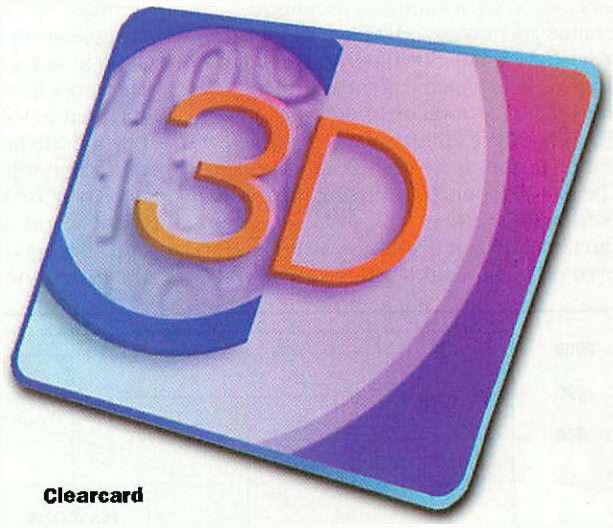



**Figure 4.**

Unlike reflective recording, however, the degradation of the signal caused as the light passes through intermediate layers is much reduced and disks with up to 100 layers have been demonstrated. The basic principle is illustrated in Figure 3 whereas Figure 4 is the block diagram for a MFD drive. By using this number of layers and moving to the use of a blue laser to reduce the spot size, a possible capacity as high as 1TB (1,000GB) has been suggested on a disk the same size as a CD or DVD. In addition to ROM disks, in which the fluorescent material is applied at the manufacturing stage, write once - read many, and re-writable variants are also possible. In the nearer term, though, the company plans to launch a 10-layer read-only disk with a capacity of 140GB. We can expect to see this in production around the first half of 2001.

The same multi-layer fluorescent technology is also being applied by C3D to a mass storage device with fewer moving parts than drives for rotating disks - the ClearCard. It is to be available in various form factors including the postage stamp sized SmartMedia and credit card sized. The ClearCard uses a combination of a multi-pixel CCD as the reading element and stepper motors to direct the laser beam onto different portions of the card. The reduced motion compared to a rotating disk makes the reader far more robust and, therefore, suitable for portable equipment and the parallel access using the CCD permits a high rate of data throughput. The initial product offering will have twice the capacity of a single-sided DVD-Rom but will cost significantly less to manufacture. The potential of the ClearCard is much greater than this, though - already a 1TB card with a maximum data rate of 1Gbit/s has been demonstrated.



**Clearcard**

## Protein Memory

Traditionally, storage devices have been planar, in other words, they access data which is stored on a flat surface. With DVD up to four separate surfaces are used and, as we've just seen, this is increased to as many as a hundred layers in the fluorescent disk.

In fact, this move toward a volumetric rather than a planar mechanism is embodied in much of the research into higher capacity storage. The next development we're about to look at - molecular memory - goes much further toward the genuinely three-dimensional memory than even the 100-layer fluorescent disk. It makes use of a protein called Bacteriorhodopsin which is found in bacteria in geothermal pools, and which exhibits an extensive range of photochemical reactions which are summed up in Figure 5. Specifically, by using different colours of light, the chemical structure can be changed to a number of stable and intermediate states, some of which differ in their colour. So, not only can the state be changed by using light of various colours, but the current state can be read out by

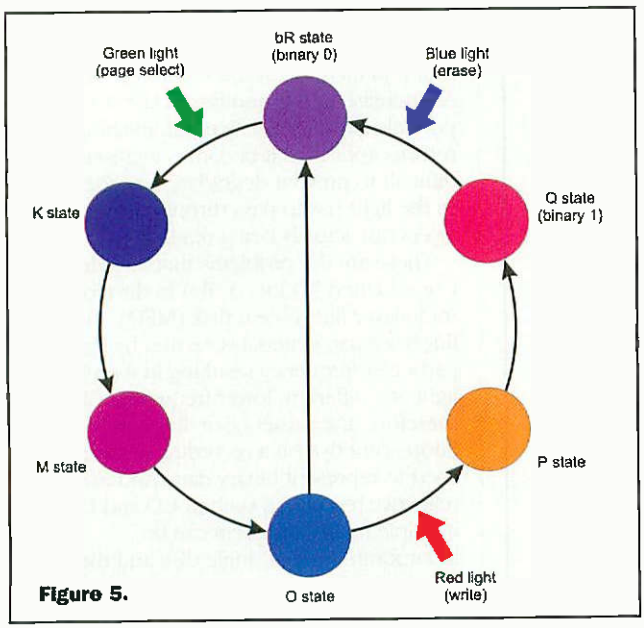


**Figure 5.**

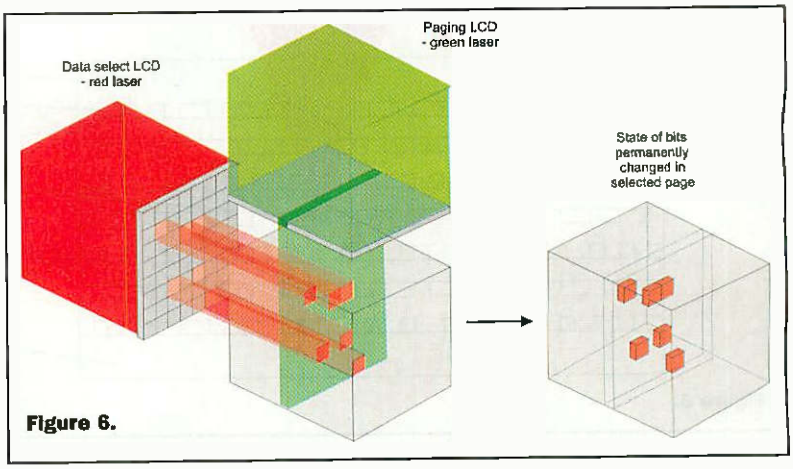


**Figure 6.**

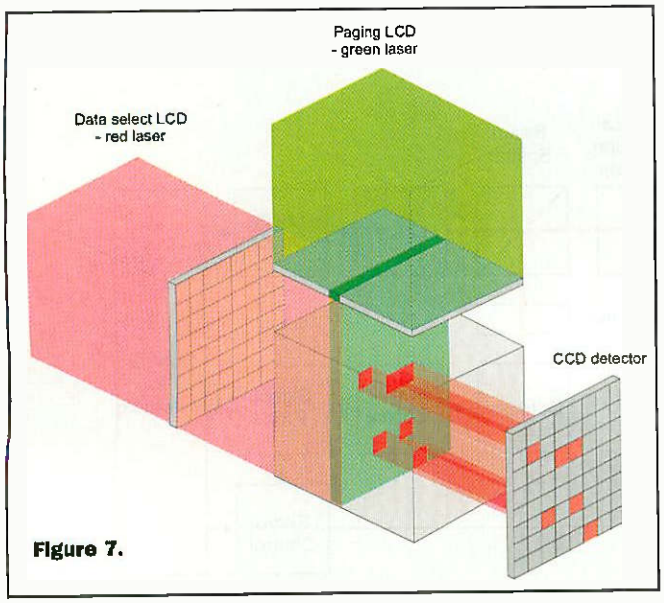


**Figure 7.**

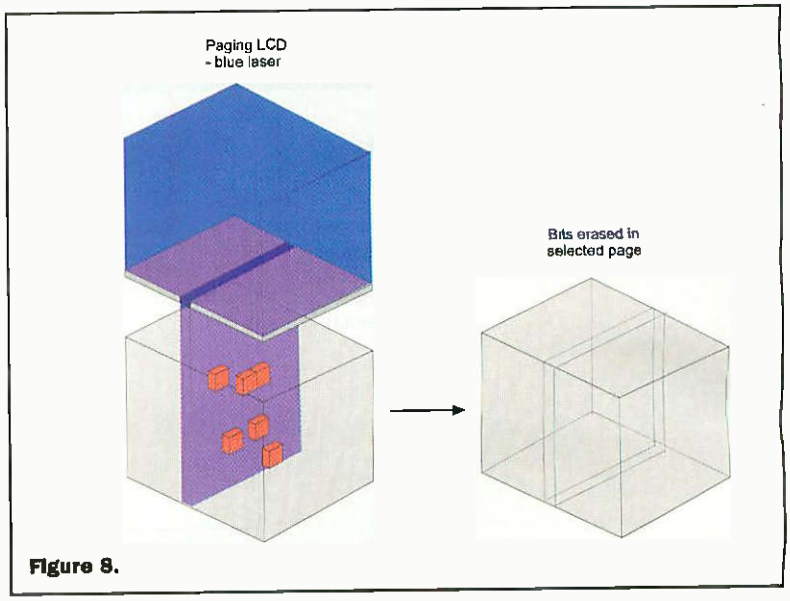


**Figure 8.**

determining the amount of absorption of certain colours of light. This is summed up in Figure 5.

With that bit of chemical background behind us, let's now turn to technology and see how the unique features of this protein has been harnessed for use as a memory. In particular, we're looking at some interesting research that has been carried out at the W M Keck Center for Molecular Electronics at Syracuse University, NY. In the following description we'll refer to the diagrams shown as Figures 6, 7 and 8 which relate to writing, reading and erasing respectively. The memory is a cube of inert transparent gel into which bacteriorhodopsin has been introduced. Along one face of the cube is an LCD array that allows a green or a blue laser to illuminate a vertical slice through the cube. This slice is referred to as a page of memory. At right angles to this LCD is another LCD that allows a red laser to illuminate the cube in a checkerboard pattern representing the 0s and 1s of the data in the particular page to be written. And at the opposite side of the cube from this LCD, a CCD detector is used to read the data from the memory, as we'll see later.

First of all let's look at how data is written to this memory and we'll assume that the initial state is a completely blank memory. In other words, all the molecules are in their bR state that represents binary zero. Data is written a page at a time and the first stage of this process is to select a page, i.e. a slice through the cube, using the green laser and the paging LCD to select a particular slice. As the slice is illuminated in this way, all the molecules in the page are transformed into the O state via the intermediate and unstable K and M states. If the green laser was now turned off, all the molecules in that page would revert to the bR state since the O state is also unstable. However, while the green laser is still illuminating the page, a red laser fires at right angles, selectively illuminating columns through the memory in the checkerboard pattern determined by the data LCD. Where the columns of red illumination intersect with the slice of molecules in the O state, the molecules will be changed to the Q state via the P state. The Q state, which is stable for up to five years, represents binary one. Portions of the cube which were illuminated only by the red laser (i.e. areas outside the page addressed by the green laser) will be unaffected and those molecules which were transformed to the O state by the green laser but were not also illuminated by the red laser will return to the bR state when the lasers are turned off. The overall result, therefore, is that individual blocks within the cube, each representing a bit, are selectively transformed from the bR state to the Q state.

To read the data back, the green laser illuminates a slice of the memory as in the writing process. As before, this changes those molecules in the bR state to the unstable O state whereas those molecules in the Q state will be unaffected. Now the memory is flooded with red laser light via the data LCD. This is only at a low level to prevent a permanent change of state. Those portions of the memory which were in the

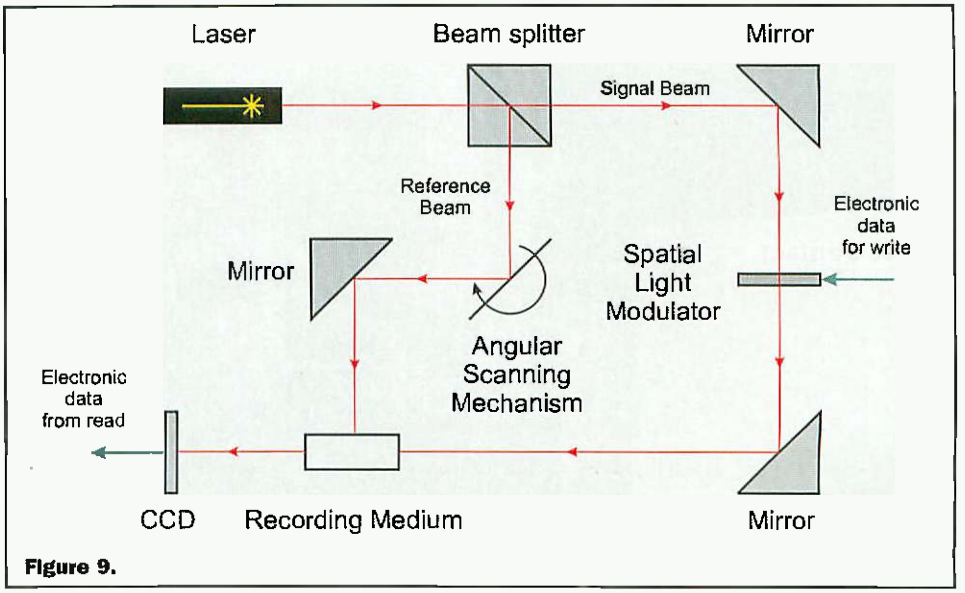



**Figure 9.**

bR state (and are now temporarily at the O state due to the green paging laser) and which represent binary zeros, will block the red light. However portions in the Q state, which represent binary ones, will allow the light to pass through the memory to be detected by the CCD. And since portions of the memory in either the bR state or the Q state don't absorb red light, the data in the other pages which haven't been illuminated by the green paging laser don't affect the read operation.The only other operation that is required is erasure. This is achieved a page at a time by using a blue laser. The light from this laser is directed by the paging LCD onto the slice in question thereby transforming molecules from the Q state to the bR state.

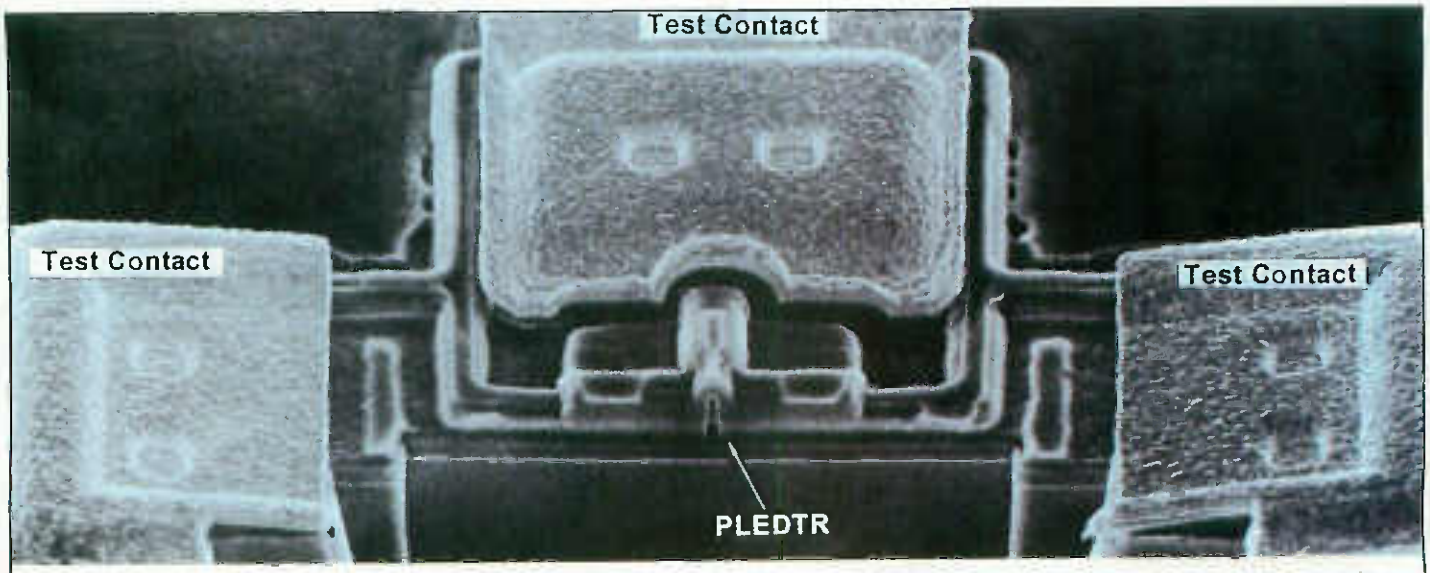
Unlike the vast majority of memory technologies, including all in widespread use, this memory provides parallel access to data. Data is written, read and erased a page at a time so it isn't possible to modify an individual byte. At first sight this might seem to be a disadvantage but it's really not too difficult to make the memory byte-addressable. To write to single bytes, the content of the relevant page is cached to some other form of memory, the page is erased from the molecular memory using the blue laser, the new byte is written to the page which is now in conventional memory, and this data is then used to re-write the page to the molecular memory. But, despite this convoluted way in which a single byte has to be written, there are, of course, major gains to be had from memory which can be accessed in parallel, most notably speed. Chemical reactions are inherently slow - this form of molecular memory has an access speed of 10 milliseconds - about million times slower than the fastest semiconductor memory. However, when the number of bytes in a page multiplies this up, a very respectable speed is achieved. Pages up to 4096 x 4096 bits have already been demonstrated and this allows read or write operations on 16 million bits or 2MB simultaneously. So although this is just an early prototype, the resultant speed is equivalent to that of semiconductor memory. But unlike semiconductor memory, the capacity of such a device can be huge and, as we've seen, molecular memory is non-volatile.

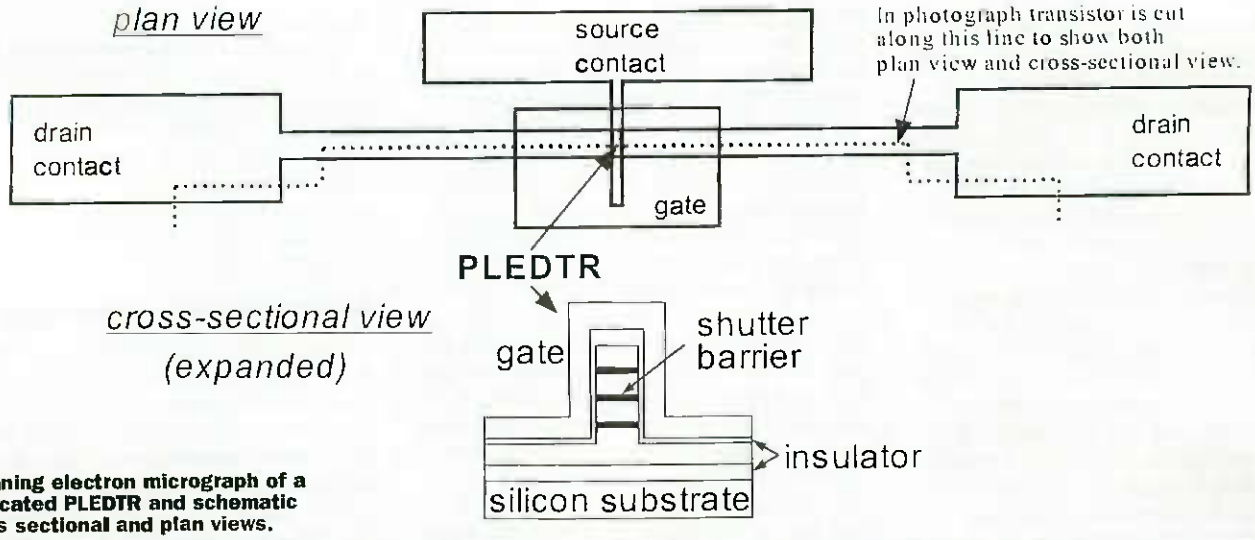
A practical prototype, demonstrated back in 1997, contains a cube measuring one inch by one inch by two inches and can store 800Mbits, i.e. 100MB. And dramatic improvements are expected as the technology matures. The developers have estimated that the technology could, eventually, yield a two cubic inch device with a capacity of 125GB.

## Holographic Storage

Holography is well known as a means of recording a scene in three dimensions. To cut a long story short, the method of generating a hologram is to arrange for two laser beams, derived from a single laser using a semi-silvered mirror, to fall on a piece of photographic film, one directly and the other after being reflected off the objects in the scene being recorded. The result is that an interference pattern, caused by the interaction between the two beams, is recorded on the photographic emulsion. The exact nature of that pattern depends on the phase difference between the two beams and, hence, the distance each ray of light reflected off the objects in the scene had travelled relative to the reference beam. Since the shape of the objects in the scene defines the distance travelled by each of those rays, full three-dimensional information is recorded and, a reverse process can be used to view the hologram in full 3D.

Effectively, a hologram is the sum total of lots of views of a scene, each as seen from a different angle. So as you move your head from side to side, different parts of the scene comes into view as objects previously obscured objects in the foreground are revealed. Now let's assume that, instead of a real-world scene, we want to use a similar technique to record hundreds or thousands of images, each a matrix of light and dark squares representing a page of binary data. The set-up to do this is much the same as that used to create an ordinary hologram except that an LCD screen is the object being recorded. This is shown in Figure 9. Now, to record the data, the first page is displayed on the LCD and an exposure made. Now the second page of data is displayed on the LCD, the angle between




**Scanning electron micrograph of a fabricated PLEDTR and schematic cross sectional and plan views.**

the LCD and the film changed slightly, and another exposure made. The process continues in this way, changing the angle for each exposure by the minimum permissible by the resolution of the film. The sum total of all these exposures is a hologram that will reveal a different page of information at each viewing angle. The process of reading it, therefore, involves altering the angle between the film and a CCD to select the appropriate page and illuminating it with a laser beam. The image for the page is sensed by the CCD and transmitted to the computer as binary data.

At first sight this all seems rather odd. We know that holographic film has a much higher resolution than ordinary photographic film but how can this rather convoluted holographic recording process improve on the data density achievable simply by using it as a sort of digital microfiche? The answer lies in the fact that holograms have been shown to store different information at different depths within the photographic emulsion. In other words, just like the molecular memory and, to a lesser extent, the multi-layer fluorescent disk, holographic storage is volumetric rather than planar. And as we've seen, this is a key to improving the data density beyond that achievable today by a significant margin. So what has been achieved using this technique and what's its potential? Because of the low speed of writing and the fact that data would have to be written a page at a time, the main emphasis of research has been into a read-only device. And an areal density up to five times that of the DVD-Rom has been demonstrated already. A conservative estimate is that this technology will be able to provide 10 times the capacity of DVD-Rom and - because of the inherently parallel nature of the read-out - it will achieve read-out rates better than 200Mbytes/second. This is twenty times faster than DVD-Rom and more than sufficient for storing movies in HDTV (high definition television) format.

**Multi layered fluorescent disk**

## A Half-way House

Despite all we've heard about silicon-based semiconductor technology starting to run out of steam, it has to be admitted that, in the short to medium term, new memory types based on silicon are more likely to come to fruition than some of the very different technologies we've looked at so far. One such possibility which a lot of people are getting very excited about, while still made out of silicon, is really quite different from the chips you'll find in a PC today. What I'm referring to is memory based on the single electron transistor as developed by Hitachi and the Cavendish Laboratory at Cambridge University.

Needless to say, the promise of a device that relies on the storage of a single electron is ultra-low power consumption. A significant increase in density is also on offer. But how does a single electron memory cell work? Well, the first thing to point out is that is actually relies on the phenomenon of quantum mechanical tunnelling, a process which has threatened to limit size reduction in conventional ICs. Quantum mechanical tunnelling is the counter-intuitive process whereby, due to its wave-like nature, one solid object can pass straight through a solid barrier without destroying it. And whereas the probability of it occurring is vanishingly small for most objects, electrons are sufficiently small and have a sufficiently high velocity that the probability of them tunnelling through a thin insulating barrier is significant. In the single electron transistor - the basic building block of a single electron memory - the flow of a small number of electrons from one electrode to the other via an insulating barrier by quantum mechanical tunnelling is controlled by the charge on the gate of the device. At a high level, the operation of the device is analogous to that of an ordinary FET but on a much smaller scale. Development has been rapid. The first single electron memory cell that could operate at room temperature was produced in 1993 and Hitachi demonstrated the first memory chip in 1996. This was a 64-bit device, smaller even that that first semiconductor memory, Intel's 1103. From these humble beginnings, though, a 128-megabit device built with a commercial 0.25-micron CMOS process was produced at the end of 1998. Hitachi have described this chip as an early prototype for giga-scale single-electron memories, indicating that if present progress continues, a product could come to the market at around the 16-gigabit generation.

Another silicon-based technology developed at the Hitachi Cambridge Labs is the Phase-state Low Electron (hole)-number Drive Memory (PLEDM). In fact, like the more distant single electron device, the operation of this memory cell relies on the presence of much fewer electrons than with ordinary memory. A standard DRAM uses a capacitor to hold an electrical charge that represents a binary bit. A MOSFET, situated close to the capacitor, is used to charge or discharge the capacitor in a write operation or to sense the charge in a read operation. In the PLEDM, the comparatively large capacitor is eliminated with a resultant decrease in the size of the chip. This, in turn, will lead to higher speed and greater capacity. The reason that the capacitor can be removed is tied up with a very small transistor called a Phase-state Low Electron (hole)-number Drive TRansistor (PLEDTR) which is fabricated onto the gate of the main MOSFET. A zero or a one is represented by the absence or presence of a small number of electrons trapped between wafer-thin insulating layers on the PLEDTR. The first prototypes have an access time of 10ns and major improvements are expected as the technology matures. Hitachi expects memory chips to be in production by 2004 and a non-volatile variant is also expected in the near future. This latter development is particularly interesting since it's being touted as a solid-state replacement for the hard disk, a replacement that is much close to reality than holographic storage or molecular memories.

## An Optical Future

Three months ago, when we first investigated the much vaunted end of the road for the silicon chips, we saw that even if silicon does run out of steam in the next decade or two, there are plenty of potential alternative technologies for the processor of tomorrow. Interestingly, though, despite public perception to the contrary, with one possible exception, the optical processor was not a contender. As we've seen in this article, the merchants of doom are also suggesting that the days be numbered for silicon-based memory. Single electron and PLEDM devices might make this prediction premature but even if the doom mongers are correct and the future isn't silicon, alternatives abound. And in contrast to alternative processing technologies, the majority of the research into new forms of working memory and backup storage relies on optical technology. One way or another, therefore, it looks like we can be assured a bright future for storage after all.

# 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.

## September 2000

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

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

**13 to 14 Sept.** OnBoard - Electronics Assembly Exhibition, Olympia. London. Tel: (01799) 528 292.

**13 to 14 Sept.** ECIF - Electronic Components Industries Fair, Olympia, London. Tel: (01799) 528 292.

**17 Sept.** National Vintage Communications Fair, NEC, Birmingham. Tel: (01392) 411 565.

**19 to 20 Sept.** Call Centre Expo, NEC, Birmingham, Miller Freeman. Tel: (0208) 742 2828.

**21 to 24 Sept.** Live - Consumer Electronics Show, Earls Court, London. Tel: (0208) 742 2828.

**22 to 23 Sept.** Leicester Amateur Radio Show, Donington Exhibition Centre, Derby. Tel: (01455) 823 344.

**26 to 27 Sept.** Business Systems Show G-MEX Centre, Manchester. Tel: (07000) 464 336.

**26 to 28 Sept.** GIS - Geographic Information Systems Exhibition, Earls Court. London. Tel: (0208) 742 2828.

**27 to 28 Sept.** Communications for Business, Barbican Centre, London. Tel: 01923 676 867.

## October 2000

**3 to 5 Oct.** Coil Winding 2000, NEC, Birmingham. Tel: (0207) 417 7400.

**4 to 5 Oct.** Softworld Accounting & Finance, NEC, Birmingham. Tel: (0208) 541 5040.

**9 to 11 Oct.** TMA33 - Telecommunications Managers Association Exhibition, Stakis, Metropole, Brighton. Tel: (01372) 361 000.

**11 to 12 Oct.** SIT - Small Business IT Show, Bournemouth International Centre. Tel: (01934) 420 365.

**11 to 12 Oct.** TEST - Electronic Testing Exhibition, NEC, Birmingham. Tel: (02476) 230 333.

**11 to 12 Oct.** Webmaster - Web & Internet Show Olympia, London. Tel: (01256) 384 000.

**11 to 12 Oct.** JAVA - Computer Software Trade Exhibition & Conference, Olympia, London. Tel: (01256) 384 000.

**15 Oct.** National Vintage Communications Fair, NEC, Birmingham. Tel: (01392) 411 565.

**17 to 18 Oct.** Property Computer Show, Barbican Centre, London. 01273 836 800.

**18 to 19 Oct.** PHOTONEX/FIBRE EXHIBITION, NAC, Stoneleigh, Coventry. 01932 866 766.

**25 to 26 Oct.** Accounting IT, Business Design Centre, London. Tel: (0207) 221 1155.

**24 to 25 Oct.** OSPMA FieldComms - Industrial Networking Show, Telford International Centre. Tel: (0207) 417 7400.

**31 Oct to 2 Nov.** Voice Europe Olympia, London. Tel: (01244) 378 888.

**Please send details of events for inclusion in 'Diary Dates' to: News Editor, *Electronics and Beyond*, P.O. Box 777, Rayleigh, Essex SS6 8LU or e-mail to swaddington@clx.compulink.co.uk.**

# What's On?


## BBC Director General Dyke Pledges Access for All in Digital World

BBC Director-General Greg Dyke has announced a portfolio of BBC channels backed by an unprecedented 30% increase in spending on BBC programmes and services over the next three years - £480 million a year more by 2002.

Delivering the prestigious MacTaggart Lecture at the Guardian Edinburgh International Television Festival Dyke also confirmed that BBC ONE would be moving the BBC News at Nine to 10pm next year.

The planned portfolio of seven services across five publicly funded BBC channels will feature two new daytime children's services - one for pre-school children and a second for children between five and thirteen.

The total portfolio will include BBC ONE, BBC TWO and new channels BBC THREE and FOUR, which will evolve out of the current digital channels BBC CHOICE and BBC KNOWLEDGE, plus BBC News 24 and the two new children's channels - running in the daytime on BBCs THREE and FOUR. All will eventually be available to every licence fee payer via digital access.

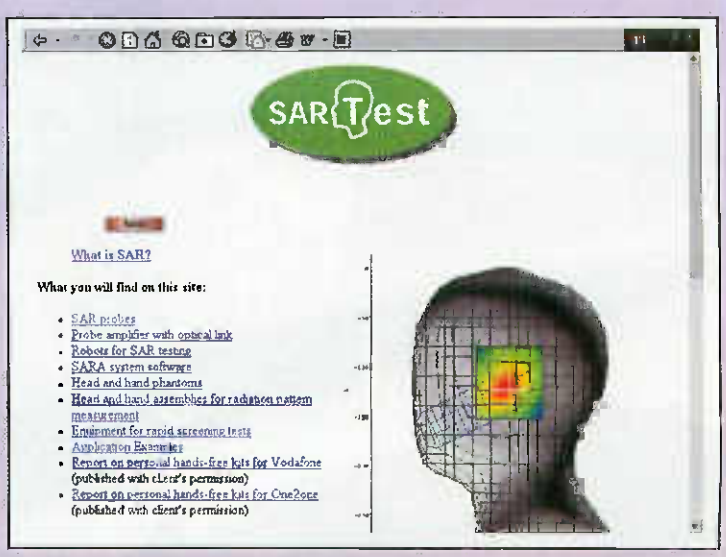
But in the meantime, the Director-General stressed, that the priority remained BBC ONE and BBC TWO. "Our aim is to make BBC ONE the gold standard of mainstream television," he said, adding that more than half of the money to be spent on the BBC overall would go on improving BBC ONE and BBC TWO.

Dyke underlined the importance in the future of universal access, underpinned by the licence fee.

Expressing concern about the danger of the "emergence of a digital underclass, a world where some are information rich while others are information poor". He said, "Universality has been one of the core principles of public service broadcasting in the past and should remain so in the digital age.

"It means that everyone regardless of race, creed or bank balance will have access to the BBC's services. The BBC should be the essential glue that binds this society together in the digital age," he said.

Dyke said he was devolving more power to the Nations and English Regions, handing back control of production facilities in Scotland, Wales and Northern Ireland to the national controllers and increasing the budgets in the Nations and English Regions by £50 million a year over the next two years.


## Hands Free Kit Reduces EMF Exposure

E-Minister Patricia Hewitt has published a report which confirms that using Personal Hands Free kit with mobile phones reduces exposure to electromagnetic fields.

Ms Hewitt said, "The report confirms that hands-free kits reduce exposure for mobile phone users. It is important that the public is provided with clear and unambiguous advice about the use of hands free kit."

The report concludes that PHF kits offer substantial reductions in exposure compared to the normal use of a mobile phone.

SARtest, an independent consultancy specialising in the measurement of radio frequency fields from mobile phones, was commissioned by the DTI to carry out tests on PHF kit following a report from the Consumers Association which stated that the ear-piece wire on the PHF kits "acts as an aerial - and channels three times as much radiation to your head."

The Independent Expert Group on Mobile Phones and Health (IEGMP) noted that other studies have been carried out which claim a substantial reduction in exposure when using PHF kit, but recommended further work.

All measurements taken of the phones themselves were comfortably within exposure guidelines of the National Radiation Protection Board (NRPB) and the International Commission on Non-Ionising Radiation Protection (ICNIRP), and that undertaking these tests does not suggest any problem of compliance with the guidelines. Misuse of the equipment was also investigated but exposure levels were low in all cases.

The full text of the SARtest report can be found on the DTI Web site at **<www.dti.gov.uk/cli/sartest.pdf>.** Details of the testing procedures used by SARtest can be found on its Web site at **<www.sartest.com>.**

## Blue Plaque for Electrical Industry Pioneer

Colonel Rookes Evelyn Bell Crompton (1845-1940), one of the first men to bring electric street lighting and a public electricity supply to London, whose workshops produced one of the first domestic cookers and who developed the military searchlight, has been honoured with an English Heritage Blue Plaque

The plaque was unveiled last month at 48 Kensington Court , London W8, by the President of the Institution of Electrical Engineers, Dr Malcolm Kennedy

The building was where Crompton's Kensington Court Lighting Company began producing one of the Capital's first practical electricity supply schemes in 1887 and was his London home for almost 50 years.

Crompton was the first major British manufacturer of electricity generators. The developments he made to the generator made his the most efficient design of the time. His manufacturing company, Crompton and Cp, not only produced the generating equipment for his Kensington power station, but also some of the first domestic electric cookers.

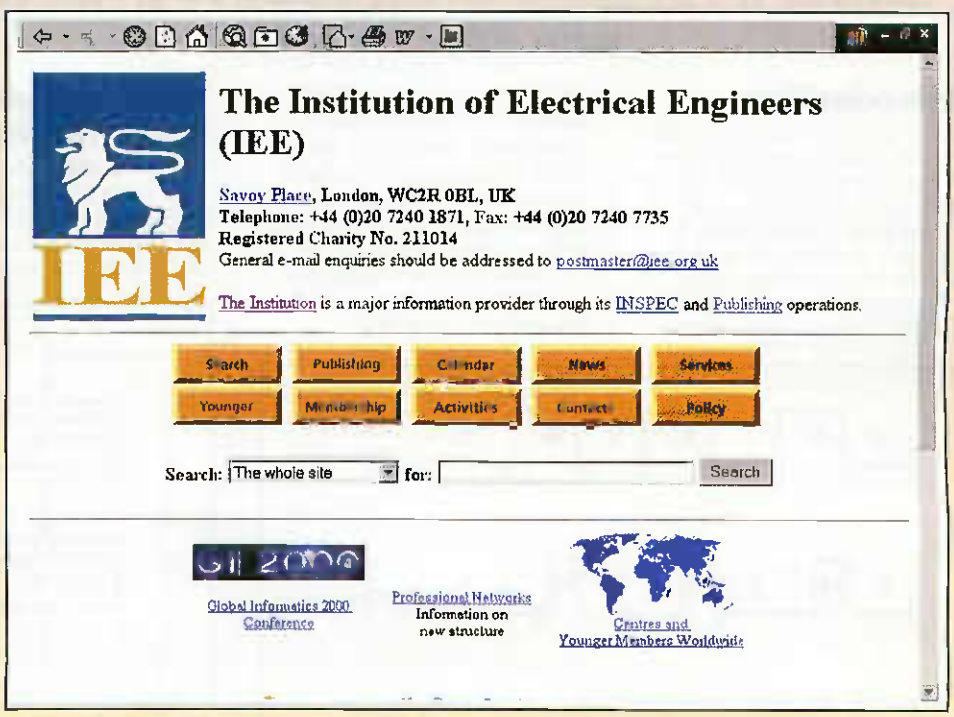
The company kept the Crompton name until the 1900s when it was taken over by Hawker Siddley, whose splinter company Brush are market leaders in making generators today.

So fervently did Crompton champion the use of electricity in its early days that he took portable generators to the Henley Regatta and Alexander Palace and wowed the public spectacular demonstrations.

In London Crompton's street lighting installations included those for Kings Cross Station and Law Courts. He pioneered linking a chain of lamps to just one generator where previosuly each lamp had needed a generator of its own.

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

Contact: **IEE, Tel (020) 7240 1871.**




# Model Motor CONTROLLER

## *Driving a 12V Motor through an ST7 series Timer with PWM Function*

## Introduction

There are many ways in which model motors, say for slotcar racing or model railways can be controlled. Electronics and Beyond has covered a few in the past, but this article looks at a different approach using a microcontroller. It is based on the ST7 series of chips from ST Microelectronics and suitable software control generates pulse width modulated waves PWM at its output. This signal is tuneable in frequency and its duty cycle. As an example this project uses is based on controlling a motor using the the ST72251G2 device to control a model motor.

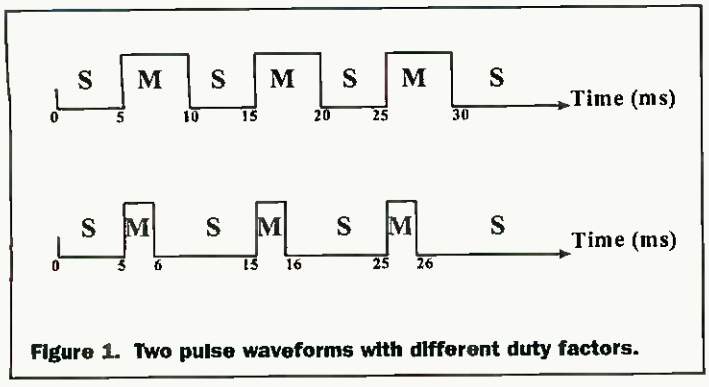



**Figure 1. Two pulse waveforms with different duty factors.**

## What is Pulse Width Modulation

Pulse Width Modulation enables us to generate a signal with a frequency and pulse length determined by the value of the OC1R and OC2R registers in the chip. As the heading suggests you can vary the width of the pulse within the cycle.

The pulse width modulation uses the complete output compare 1 function and the OC2R register.

## Mark-to-Space Ratio and Duty Factor

Figure 1 below shows two pulse waveforms which have the same time period T, and hence the same pulse repetition frequency, but yet are clearly different from one another. The difference between them can be expressed in two different ways:

## Mark-to-Space Ratio

If the duration of each positive voltage is known as a mark and each period for which there is either no pulse or there is a negative pulse is known as a space, then the mark-to-space ratio is the ratio of mark time/space time.

For a square waveform, as shown in the first diagram of Figure 1 above, the mark-to-space ratio is unity. For the second waveform in Figure 1 the mark-to-space ratio is given by (6-5)/(15-6) or 1/9.

## Duty Factor

The duty factor of a pulse waveform is the ratio (mark time)/(mark time + space time). For a square waveform the duty factor is equal to 1/2, and for the second waveform in Figure 1, the duty factor is given by (6-5)/(15-5) or 1/10.

The average, mean, or d.c. value of a pulse waveform is equal to its amplitude, or peak value times the duty factor. Average Output Voltage Vav = Vpk x Duty Factor So in the example above if Vpk = 12V Output would be 6V and 1.2V respectively

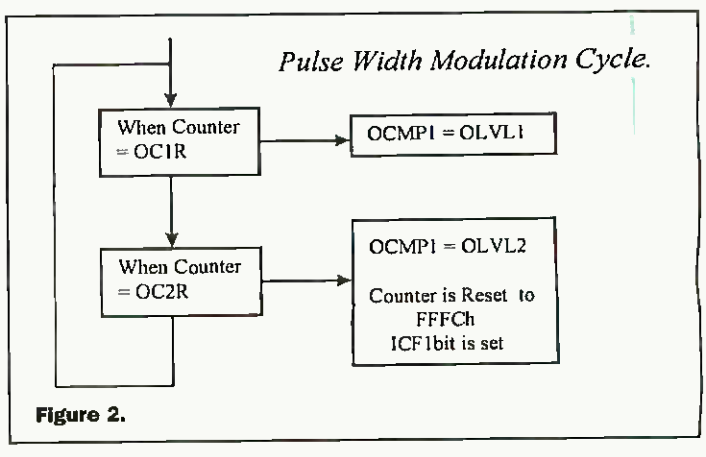



**Figure 2.**

## Loadinng up Procedure

To use the ST72251 microcontroller in pulse width modulation mode first of all:

1. Load the OC2R register with the value corresponding to the period of the signal.
2. Load the OC1R register with the value corresponding to the length of the pulse if (OLVL1=0 and OLVL2=1).
3. Select the following in the CR1 register:

- Using the OLVL1 bit, select the level to be applied to the OCMP1 pin after a successful comparison with OC1R register.
- Using the OLVL2 bit, select the level to be applied to the OCMP1 pin after a successful comparison with OC2R register.

4. Select the following in the CR2 register:

- Set OC1E bit: the OCMP1 pin is then dedicated to the output compare 1 function.
- Set the PWM bit.
- Select the timer clock (CC1-CC0).

If OLVL1=1 and OLVL2=0 the length of the pulse is the difference between the OC2R and OC1R registers. The OC iR register value required for a specific timing application can be calculated using the following formula:

$$\text{OCiR Value} = t \; \frac{f_{CPU}}{t_{PRESC}}$$

Where:

- t = Desired output compare period (seconds)
- f CPU = Internal clock frequency
- t PRESC = Timer clock prescaler

The Output Compare 2 event causes the counter to be initialised to FFFCh.

## Model Motor control

Note: After a write instruction to the OCiHR register, the output compare function is inhibited until the OC iLR register is also written. The ICF1 bit is set by hardware when the counter reaches the OC2R value and can produce a timer interrupt if the ICIE bit is set and the I bit is cleared. Therefore the Input Capture 1 function is inhibited but the Input Capture 2 is available. The OCF1 and OCF2 bits cannot be set by hard-ware in PWM mode therefore the Output Compare interrupt is inhibited. When the Pulse Width Modulation (PWM) and One Pulse Mode (OPM) bits are both set, the PWM mode is the only active one.

## Voltage Setting (Duty Cycle)

The output power supply voltage is controlled by the duty cycle of the generated PWM signal. The OC1R register in the chip controls each duty cycle percentage of the timer PWM mode. Timer A Output Control Register 1, and 2 are both 16 bit registers, with 8 bits set in a low register and the other 8 bits set in the high register. For the purpose of this project the Timer A Output Control High Registers were set to 00 hex at all times. This was because an accurate output could be achieved by only using the low registers. The low output control of register 2 was also set to a constant value of FF hex throughout the project. This was set to a constant level in order to set a maximum pulse period equal to that of FF hex. Timer A Output Control register 1 was used throughout the project to input different values. These values were defined as "bytes in memory" at the beginning of the program. The waveforms shown here give the output PWM voltage that was recorded from the Output Compare 1 of Timer A. The project used five different settings altogether which ranged from an off state, to 100%. The two waveforms that are shown here are that of the 25% setting, and the 75% setting.

If each square going across the oscilloscope screen represents 100? seconds, and hence every mark within that square represents 20? seconds the following can be concluded:

If we multiply the amplitude of the waveform which is 5 volts by the duty factor, we will get the overall voltage we require:

Average Voltage = 5 volts x 0.231 = 1.155, which is approximately 25%.

If we multiply the amplitude

For waveform 1: Duty Factor = (Mark Time) / (Mark Time + Space Time)

$$= \frac{60 \times 10^{-6}}{60 \times 10^{-6} + 200 \times 10^{-6}}$$

$$= \frac{60 \times 10^{-6}}{260 \times 10^{-6}}$$

$$= 0.231$$

For waveform 2: Duty Factor = (Mark Time) / (Mark Time + Space Time)

$$= \frac{200 \times 10^{-6}}{200 \times 10^{-6} + 70 \times 10^{-6}}$$

$$= \frac{200 \times 10^{-6}}{270 \times 10^{-6}}$$

$$= 0.741$$

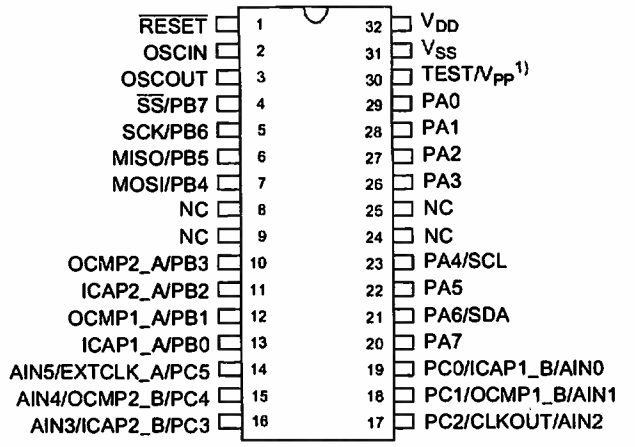



**Figure 2a. ST72251 SO28 Package**

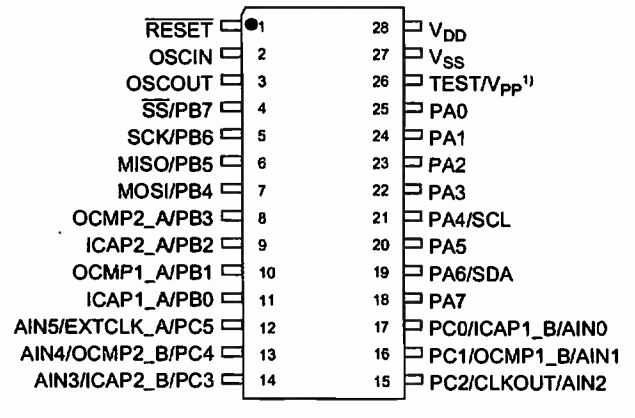
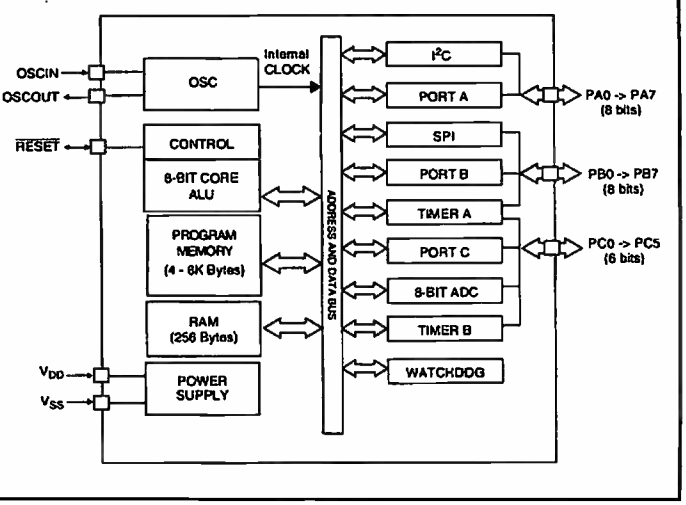
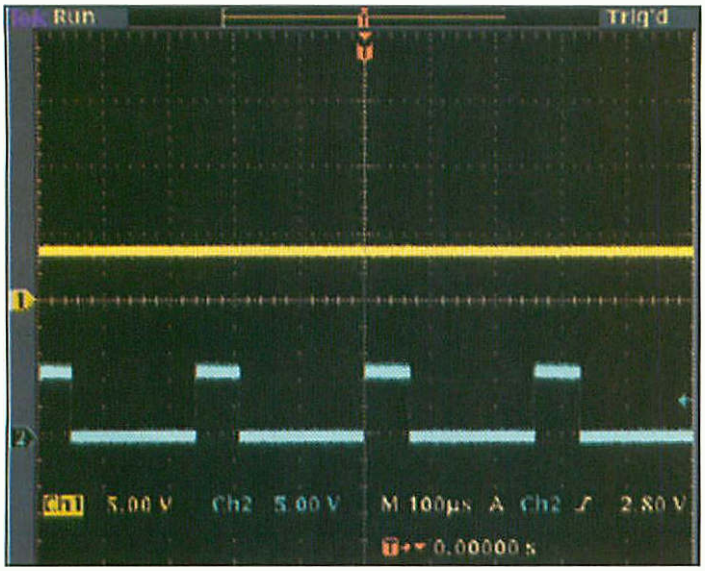


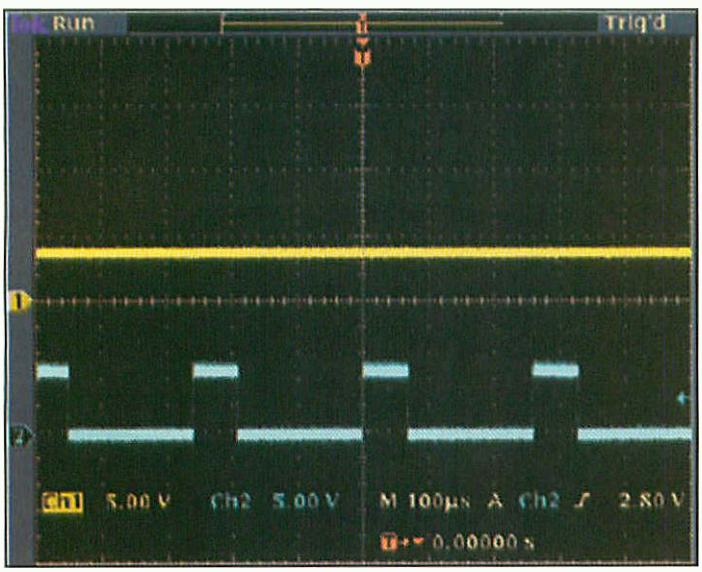

**Figure 2b. ST72251 SO28 Package**

**Figure 3. Block diagram of ST225IG2**






**Waveform 1. 25% Duty Cycle.**




**Waveform 2.**

of the waveform which is 5 volts by the duty factor, we will get the overall voltage we require:

Average Voltage = 5 volts x 0.741 = 3.71 volts, which is approximately 75%.

## Simple Amplifier Circuit

The above shows that the ST7 microcontroller, like many other microcontrollers is only capable of supplying a maximum of 5 volts. However in order to control model cars or railways a voltage range of between 0 and 12 volts is required. This can be achieved by inserting the output OCMP1_A of the ST7 device into an amplifier circuit such as the one shown below in Figure 2.

The first part of the amplifier shows an RC network, which is used to filter the input signal to the amplifier. The operational amplifier used is the L272 op. amp. This is capable of supplying an output current of approximately 1 amp if the one side of the device is adequately soldered to a heat sink. However for supplying a motor we need to give the output a bit more current capacity, hence the two transistors inserted into the feedback path of the circuit in a Darlington configuration. The Darlington pair will supply a current gain approximately equal to the product of the individual betas of the transistors. The Darlington circuit is normally required when a high current or a high input impedance is needed. R3 and R4 of the circuit shown above in Figure 3 set the gain of the circuit in the feedback path, the gain set by the above amplifier is 2.5. Therefore if a voltage of 5 volts enters the amplifier the output will give the required 12 - 12.5 volts. In the diagrams above waveform 1, and waveform 2 the yellow (above) waveform shows the dc level that was output from the amplifier circuit. It should be noted that these are approximately 2.5 times greater than the average PWM input voltage.

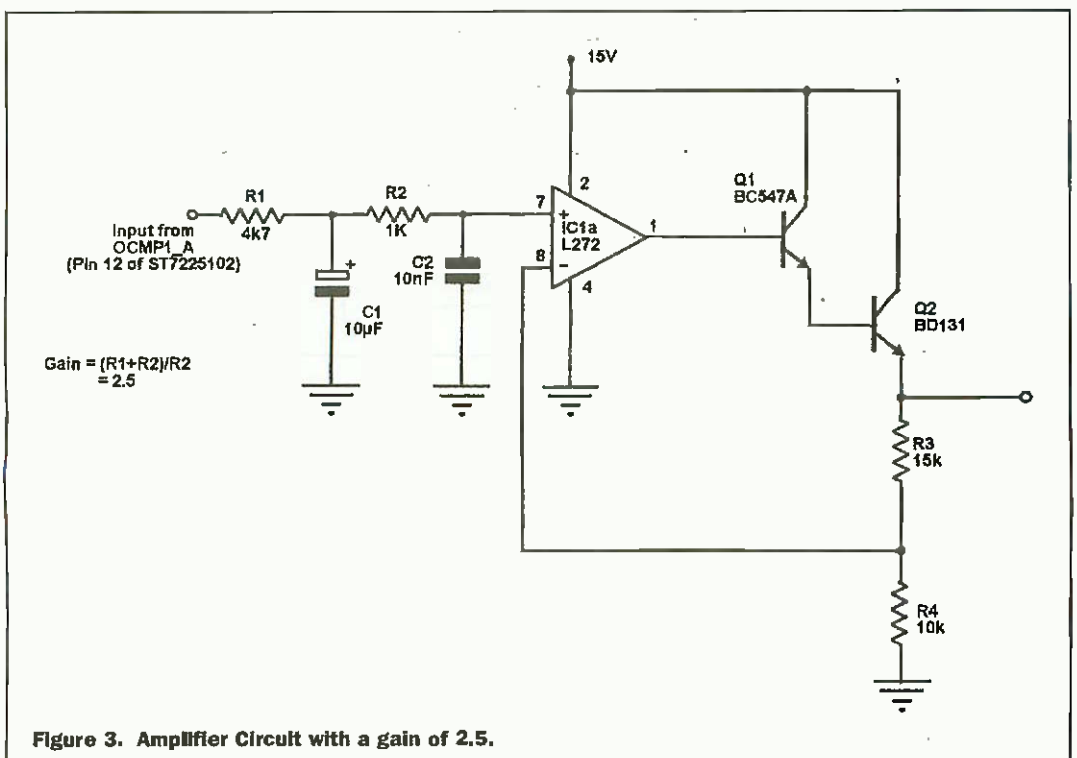



**Figure 3. Amplifier Circuit with a gain of 2.5.**

## Appendix - Software

```
;ST7 Setup File - Created by Application Builder
; ** Devicename is set by the project and tells the Assembler
; ** which device definition file to use. To change device, use
; ** Project-Configure-Device
; Setup File Created with Device Set to ST72212G2

.Include $DeviceName   ; Include Device Definition File (ST72212G2.str)
segment 'Rom'    ; Code segment - Address defined in Definition file (.str)

Start:    ; Reset Label
          ; ********** Timer B Setup Code
        ; *Timer A Initial Value is always $FFFC
        ; *Timer A Control Register 1
        ld a, #$04; IC1 Disabled
        ld TACR1, a ; Forced Compare 1 Off
        Forced Compare 2 Off
        ; Interrupts : Input Capture Disabled

        ; *Timer A Control Register 2
        ld a, #$98    ; Output Compare 1 Disabled
        ld TACR2, a ; IC2 Disabled  Clock = Fcpu/2

        ; *Timer A Output Compare Register 1
        ld a, #$00    ; PWM On - Pulse Length
        ld TAOC1HR, a         ; High Byte
        ld a, #$32    ;SETS THE PULSE
        ld TAOC1LR, a         ; Low Byte

        ; *Timer A Output Compare Register 2
        ld a, #$00    ;PWM On - Pulse Period
        ld TAOC2HR, a         ; High Byte
        ld a, #$ff    ;SETS THE PERIOD
        ld TAOC2LR, a         ; Low Byte

        ; ********** Port A Setup Code
        ld a, #$00    ; Bit On = Output, Bit Off = Input
        ld PADDR, a; Port A Direction Register
        ld a, #$ff ; Option Selects Input or Output Type
        ld PAOR, a ; Port A Option Register

        ; ********** Port B Setup Code
        ld a, #$FF ; Bit On = Output, Bit Off = Input
        ld PBDDR, a ; Port B Direction Register
        ld a, #$FF ; OCMP1A,
        ld PBOR, a ; Port B Option Register
        ; ********** Port C Setup Code
        ld a, #$ff ; Bit On = Output, Bit Off = Input
        ld PCDDR, a ; Port C Direction Register
        ld a, #$ff ; OCMP1B,
        ld PCOR, a  ; Port C Option Register

        ; ********* Control Registers
        ld a, #$00 ; Main Clock Out Off
        ld MISCR, a  ; Normal Mode : Fcpu = 8000000Hz
        ld a, #$FF ; Stack Pointer Low Byte
        ld s, a ; Stack Pointer High Byte set by hardware
        ld a, #$7F ; Watchdog Control Register
        ld WDGCR, a ; Watchdog Disabled
        ;rim ; Global Interrupt Enable

        ;ST7 Main File - Created by Application Builder
        ; Author : Tony Ashton
        ; Company : Kanda Systems
        ; Comment : Power Supply Using PWM
        ; ** includes all the setup code for this project. The default file
        ; ** extension is .STS. Renaming this setup file will also update the
        ; ** Project so the assembler will always find it

        ; File Created with Device Set to ST72212G2
        .include $SetupFileName ; Set up file (.sts) is included here
        segment 'Ram0'  ; RAM Page Zero segment - Always at ADDRESS $80-$FF
```

```
        ;Define user variables here if required -
        Example Syntax is
        ;COUNTER DS.B 1
        ;COUNTER2 DS.W 1
        ;PIN_NUMBER EQU 6

segment 'Rom'
        ; Code segment - Address defined in
        device file (.str)
pwm_00l dc.b $00    ;loads 00 into memory
                    location
pwm_00h dc.b $00    ;loads 00 into memory
                    location
pwm_25l dc.b $34    ;loads 03 into memory
                    location
pwm_25h dc.b $00    ;loads 00 into memory
                    location
pwm_50l dc.b $7a    ;loads 16 into memory
                    location
pwm_50h dc.b $00    ;loads 00 into memory
                    location
pwm_75l dc.b $bd    ;loads 24 into memory
                    location
pwm_75h dc.b $00    ;loads 00 into memory
                    location
pwm_100l dc.b $ff   ;loads 34 into memory
                    location
pwm_100h dc.b $00   ;loads 00 into memory
                    location
offl dc.b $01       ;loads 04 into memory
                    location
offh dc.b $00       ;loads 00 into memory
                    location

main:    ;Main Code here
ld a,#$FF           ;loads FF hex into the
                    accumulator
ld pbdr,A           ;loads FF hex into port a
                    direction register
ld a,pwm_00l        ;loads 00 into accumulator
ld x,pwm_00h        ;loads 00 into register x
call time           ;calls time sub routine
main_1
nop                 ;no operation
nop                 ;no operation
btjf padr,#0,off    ;bit test and jump to off
                    routine
btjf padr,#4,percent_50
                    ;bit test and jump to 50 %
btjf padr,#3,percent_25
                    ;bit test and jump to 25 %
btjf padr,#5,percent_75
                    ;bit test and jump to 75 %
btjf padr,#6,percent_100
                    ;bit test and jump to 100 %
call del   ;calls delay sub routine
jra main_1          ;returns to main_1

off:
**********NOVOLTAGE....OFF**********
t0
nop                 ;no operation
nop                 ;no operation
call del            ;calls delay sub routine
bres pbdr,#0        ;turns on led on bit 0 of
                    pbdr
btjf padr,#0,t0     ;debounce routine
ld a,offl           ;loads 01 into accumulator
ld x,offh           ;loads 00 into register x
bset pbdr,#0        ;turns led on bit 0 of pbdr
off
call time           ;calls time sub routine
jp main_1           ;jumps to main_1

percent_100:
**********100%SUB_ROUTINE**********
t1
nop                 ;no operation
nop                 ;no operation
call del            ;calls delay sub_routine
bres pbdr,#6        ;turns on led on bit 6 of
                    pbdr
btjf padr,#6,t1     ;debounce routine
ld a,pwm_100l       ;loads ff into accumulator
ld x,pwm_100h       ;loads 00 into register x
bset pbdr,#6        ;turns led on bit 4 of pbdr
                    off
call time           ;calls time sub routine
jp main_1           ;jumps to main_1
percent_50:
**********50%SUB_ROUTINE**********
t2
nop                 ;no operation
nop                 ;no operation
call del            ;calls delay sub_routine
bres pbdr,#4        ;turns on led on bit 4 of
                    pbdr
btjf padr,#4,t2     ;debounce routine
ld a,pwm_50l        ;loads 7a into accumulator
ld x,pwm_50h        ;loads 00 into register x
bset pbdr,#4        ;turns led on bit 4 of pbdr
                    off
call time           ;calls time sub routine
jp main_1           ;jumps to main_1

percent_75:
**********75%SUB_ROUTINE**********
t3
nop                 ;no operation
nop                 ;no operation
call del            ;calls delay sub_routine
bres pbdr,#5        ;turns on led on bit 5 of
                    pbdr
btjf padr,#5,t3     ;debounce routine
ld a,pwm_75l        ;loads bd into accumulator
ld x,pwm_75h        ;loads 00 into register x
bset pbdr,#5        ;turns led on bit 5 of pbdr
                    off
call time           ;calls time sub routine
jp main_1           ;jumps to main_1

percent_25:
**********25%SUB_ROUTINE**********
t4
nop                 ;no operation
nop                 ;no operation
call del            ;calls delay sub_routine
bres pbdr,#3        ;turns on led on bit 6 of
                    pbdr

btjf padr,#3,t4     ;debounce routine
ld a,pwm_25l        ;loads 34 into accumulator
ld x,pwm_25h        ;loads 00 into x register
bset pbdr,#3        ;turns led on bit 6 of pbdr
                    off
call time           ;calls time sub routine
jp main_1           ;jumps to main_1

**********DELAYROUTINE**********
DEL:
push x              ;pushes x onto the stack
ld x,#$02           ;push x onto stack
DEL1:
dec x               ;decrements value of x
jrne del1           ;jumps to del1 if value not
                    equal
pop x               ;pops x from the stack
ret        ;return from del subroutine

time; ;*Timer B Output Compare Register 1
ld TAOC1HR, x    ; High Byte, loads current
value in x register into TAOC1HR
ld TAOC1LR, a    ; Low Byte, loads current
value in accumulator into TAOC1LR ret
; Interrupts in use. so .STV File called here
; This file contains shell Interrupt Service
Routines (ISR)
; and Interrupt Vector Table.  Add Your ISR
Code to this file

.include $VectorFileName  ; Interrupt and
Vector file (.stv)
end
; ST7 Vector File - Created by Application
Builder
; ********** Interrupt Service Routines
; File Created with Device Set to ST72212G2

segment 'Rom'    ; Code segment - Address
defined in Definition file (.str)

TimerA:  ; ******** TimerA Interrupt ISR Code
Here

TAOC1:  ; Test OCF1 Flag (TASR.6) iret
TAOC2:  ; Test OCF2 Flag (TASR.3) iret

; ******** End Timer A Interrupt

segment 'Vectit'    ; Vector segment - Address
defined in Definition file (.str)
        DC.W  0
        DC.W  0
        DC.W  0
        DC.W  0
        DC.W  0
TimA:   DC.W  TimerA
        DC.W  0
        DC.W  0
        DC.W  0
        DC.W  0
        DC.W  0
reset:  DC.W  Start

        end
```

***This software routine will be available on the magazine website:***
**<electronicsandbeyond.com.>**

## PARTS LIST

**For Simple Amplifier Cirucit**

**RESISTORS:**
- R1 4K7
- R2 1K
- R3 15K
- R4 100K

**CAPACITORS**
- C1 10µF
- C2 10nF

**SEMICONDUCTORS**
- TR1 BC547
- TR2 BD131
- IC1 LL272

**MICROCONTROLLER**
- ST72251G2
- ST Microelectronics

# RESEARCH NEWS

by Dr Chris Lavers

## Wearable electronics-the indispensable fashion necessity of the future!

Having spent a couple of weeks pleasantly wandering the chalk downlands of Somerset and Wiltshire lugging an inevitable plethora of electronics devices which today are indispensable, namely the mobile phone, video camera, camera, and digital watch, it is my personal views that the trend in modern electronics should be to minimise the sizeable logistics burden. Individually taking up little space and effort, the sum carried soon mounts up. To this end it strikes me that one route to a solution lies in a radical marriage/forced partnership between electronics and modern fashion design. Namely is it possible to design clothes with modern electronics requirements in mind?

It would appear that at least one of the electronics giants, Philips, is moving part way towards this goal, of creating clothes that fundamentally incorporate electronics devices. A project headed up by Dr Paul Gough of the Department of Software Engineering and Applications group and Mr David Eves, project leader of the Wearable Electronics project at Philips Research Laboratories, Redhill,UK is developing the first generation of products bringing together for the first time the electronics and fashion industries. According to Project leader David Eves "Together with Philips Design we provide the basic technical building blocks for this new industry, while for the design of the clothes we hope to find a partner in the fashion industry. We are also investigating the social issues surrounding this new concept and provisional results are very promising: our first testers wanted to wear these clothes and wanted to be seen in them."

Philips have taken to heart the ideal of integration, not just designing clothes with a clip on for the microphone of a handsfree mobile phone, but actually integrating the microphone directly into the collar (wash proof we hope), with a keyboard or display integrated into the sleeve (figure 2b), with all the necessary connections concealed in the layers of a jacket's fabric for example. It could also mean the sharing of functions between different applications, for instance one voice-controlled input device for both the phone and the CD or MP3 player, and one display for phone, E-mail messages and access to the internet just as we discussed last time in the example of the Amstrad E-Mailer personal communications centre which is reasonably matched in applications by BT Easicom 1000 and other Philips products (if not in price).

People's lifestyles have changed considerably in the last 100 years with the unsurprising result that people are increasingly on the move. Incidentally 'typical' average figures for annual travel from turn of the century to now, have risen from no more than a couple of hundred to over six thousand, (perhaps in another hundred years at exponential rates our grand-children will travel to the moon for summer breaks)?

The analogy of the trend towards wearable electronics may follow closely the carriage clock of the 1650's, which subsequently through the microminiaturisation of its day became first the pocket fob watch, and then wrist watch worn now not only through its necessary practical function but as a fashion accessory. Unfortunately not all superb functioning timepieces, such as those manufactured by Omega, the leading Swiss watch manufacturer, are affordable by everyone!

Nonetheless wearable personal electronics devices will probably become items that can be worn simultaneously as clothing, jewellery and other accessories. Wearable electronics is more than adapting electronics devices to our new modern lifestyle and making them mobile. The designers see the real challenge as integrating them into fashionable clothes that people 'feel good in' and want to wear, and ultimately will want to buy.

Philips want applications that stay with you wherever you go, especially indoors where reception of signals by many modern electronics devices is still uncertain, and will be constantly on the alert, working in the background.

The project began about 3 years ago in 1997 with the production of a number of concept garments presented at a Philips fashion show to highlight awareness to the possibilities of products bridging the gulf between traditional electronics and clothing technologies. Enthusiastic reception of the concepts and the parallel developments of other key components such as: smart textiles, robust materials, and conceptually Personal-Area Networks (PAN) have now laid the foundations for these composite material high-technology fabrics.


**Figure 1. Wearable electronics. Courtesy of Philips Research.**

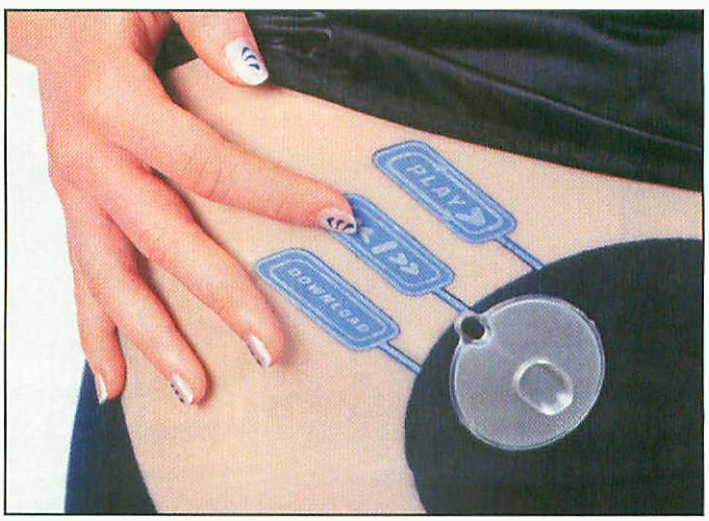



**Figure 2a. Wearable electronics. Courtesy of Philips Research.**

## Smart Textiles

Textiles that are electrically conductive but are also soft and warm to the wearer's touch are now in production. As a result, the ability to move power, being the key to audio, visual and data functions, around the garment

**Figure 2b. Wearable electronics. Courtesy of Philips Research.**

becomes possible. Twistable conductive fibres can be integrated as a part of conventional knitwear or woven fabrics, and conductive inks (deposited by variants of screen printing) allows electrically active patterns to be printed directly onto fabrics. Redhill is conducting extensive experimentation on a number of new textiles and a new generation of sensors based on the SMART fabric. They have even made a jacket that can sense the arm movements of the wearer. One idea is that this could be used to monitor and assist people when playing sports. The analysis of forehand tennis strokes through feedback to help improve it, would provide all the benefits of a personal tennis coach at a fraction of the cost.

The Redhill's group has already demonstrated a complete MP3 player integrated into a jacket styled for the streets of New York. New York user tests have indicated that this fashion/technology mix could be a highly desirable and profitable combination.

## Issues of Wear and Care

Even moderate exposure to weather for most electronics devices spells disaster, through short-circuiting, rusting and other deleterious processes! Unfortunately an inevitable feature of clothes is that they require cleaning from time to time, and the environment within a washing machine is definitely wet. Hence a key decision at an early stage was to develop wearable electronics which would allow a substantial part of the integrated wiring, peripherals and connectors to be washed without intense operator efforts, if you will 'wash-and-forget'.

## Personal Area Network

The Personal Area Network is a project to provide a backbone for wearable electronics in terms of the transport of data, power and control signals within the user's 'personal space'. Modular devices with functions shared by different applications can be hooked up to it: for example, a single display can be used for phone call information and CD track selection. Intelligent digital software ensures that the devices co-operate in a natural way: muting the CD player when the phone rings. This modular network architecture and user-centric design make it possible to configure the system to match the user's preferred interaction styles, rather than requiring the user to adapt his or her behaviour to the system. Personally I believe the future lies in a marriage between glass optical fibres as well as conventional conductive fabrics, for a number of reasons. Optical systems offer a significantly wider bandwidth availability for control signals to be sent as well as a much higher tolerance of aqueous environments as well as an already mature technology for both sensing and communications applications. In the future clothes will become an important part of the user's personal electronic network although as yet a long way from the 'high-tech' designs worn by Marty McFly in 'Back to the Future 2'! For basic and more advanced designs to be achieved a number of issues need to be addressed included in Table 1.

**Table 1.**

**Key Components of system design and requirements**

| | |
|---|---|
| Materials requirements | Robust<br>Low Cost<br>Low Power<br>Reliability<br>Able to be washed with minimum effort. |
| Radio reception provision | Through the use of fabric antennas |
| Devices communications | Devices must cooperate with other devices or peripherals plugged into the clothes |
| Device sensors | Sensors must be incorporated into clothes to understand the current context and circumstances. |
| Communications Network | Network nodes and sensors integrated in the clothes. |
| Volume of Sales required | In the region 2 to 4 million items per season. |

A combination of upgradeable software and trainable neural networks for individualised wear is still a generation away, (and not necessarily a good idea as clothes are often passed on to new 'owners' with very different preferences as well as movement patterns), but considerable progress is taking place. Until then hill walkers will still have to take with them those items that they regard as indispensable!

Perhaps the logic of horizontal architecture may also allow you to get away with a reduced logistics burden as all you need potentially is a single Personal Communications video camcorder Centre. How? Firstly a next generation digital camcorder could be configured to use the video screen to display SMS messaging and for text to be prepared for transmission (eye-controlled feedback easier here?). The existing microphone for

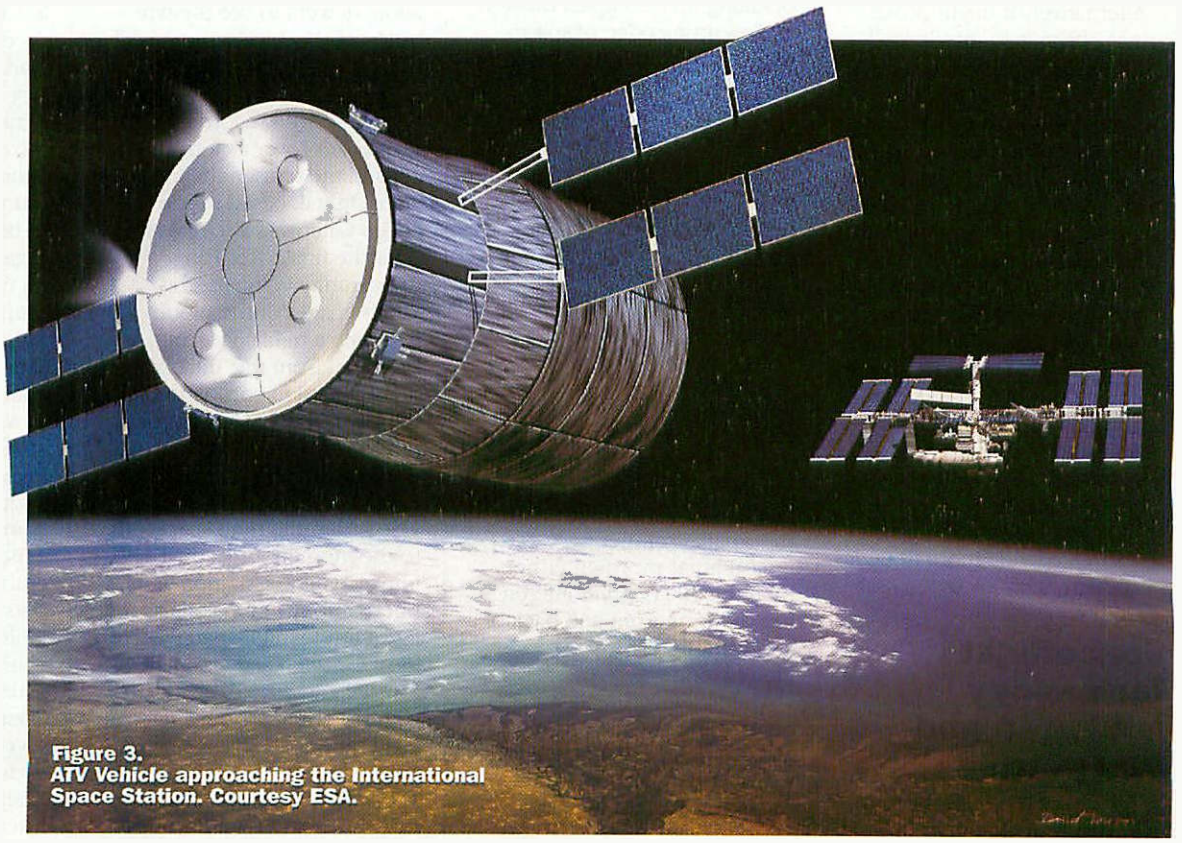


**Figure 3.**
**ATV Vehicle approaching the International Space Station. Courtesy ESA.**

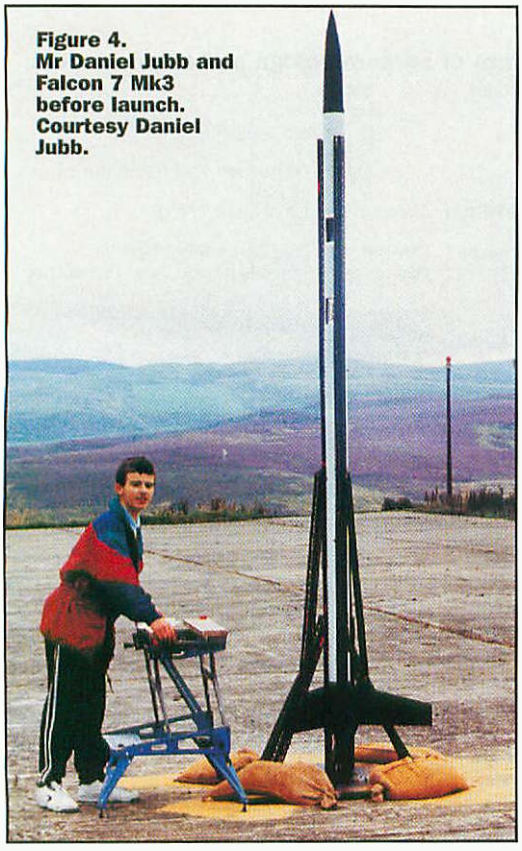


**Figure 4. Mr Daniel Jubb and Falcon 7 Mk3 before launch. Courtesy Daniel Jubb.**

recording audio could also be configured for transmission of speech, and output of incoming audio to the camcorder user. Picture stills and with greater available bandwidth video (and digital TV reception?) would permit real-time video-phone conversation so you could share with your (envious) friends back home the great views you are enjoying on your holiday.

Alternatively it might prove just as effective to interlink all your personal communications devices together so that they can 'talk' with each other using digital data transmission. This would allow a mobile phone left in the car (e.g. Siemens S35i) to communicate up to a moderate range with the digital camcorder capable of receiving either directed SMS messages, attached files or audio. In both cases radio could either be directly integrated into the camcorder, or routed from the digital car radio through the personal communications network. Having said that the main reason I go walking is to escape the pace of modern life made more frenetic by modern technology!

## Spaceflight Technology Advances and Discoveries

The year has already been a busy one with a number of significant milestones in technology development; commercial investment and satellite data which if interpreted as suggested indicates the presence of water seepage on the Martian surface.

The Indian Space Research Organisation (ISRO) announced back in July the beginning of a 6-month feasibility study into the launching of an unmanned mission to the moon in 2005. India is a satellite mature country, keen to go one step beyond the achievements of Nasa's Lunar Prospector and Clementine launch back in the 1990's.

A 350 kg craft could be launched by an uprated Polar Satellite Launch Vehicle booster with an extra upper stage to demonstrate to the world that India, likely to be the most populous nation on the planet within a generation, is capable of taking up a complex mission at the cutting edge of space development. The spacecraft is likely to be a Lunar Orbiter equipped with cameras and science instruments.

Not to be outdone LunaCorp in the USA plans to launch its first spacecraft, the Icebreaker Moon Rover, in late 2003 to explore the Moon's polar regions, investigated recently from above by the Lunar Prospector strongly indicating the presence of ice in deep, perpetually dark craters. The Icebreaker will drive around the moon at high latitudes in reduced solar intensities, enabling it to be subjected to the smaller temperature of a typical lunar morning rather than the 400 degree difference between the front and back of a spacesuit in direct solar illumination.

The initial Icebreaker Moon rover will explore near the Moon's poles prospecting for water. LunaCorp believe the mission will be funded by

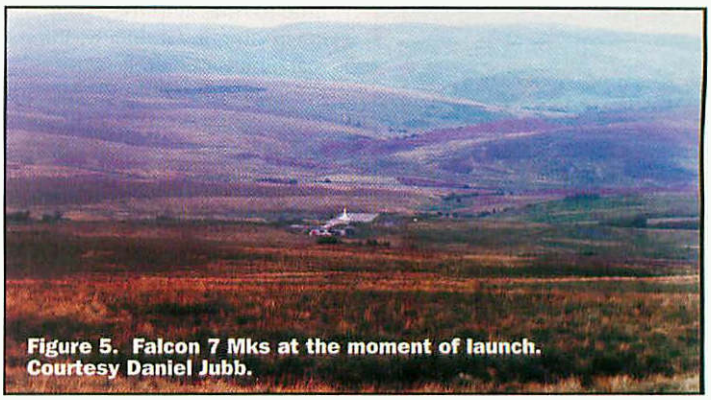


**Figure 5. Falcon 7 Mks at the moment of launch. Courtesy Daniel Jubb.**

corporate sponsors, television contracts, internet access, remote telepresent platform control and government researchers. LunaCorp have already signed up corporate sponsors for the mission, with RadioShack first off the block. A prototype rover will be tested in July 2001 in the Canadian Arctic where it will circle a local area in 24 hours as the sun moves around the horizon. Nasa has a strong stake in the mission via a $1 million grant already provided.

Taking things a stage further US company TransOrbital is seeking potential customers for the first commercial spaceflight to the moon. The 2001 Trailblazer is planned to be launched by a Russian booster rocket. The aim would be to return high resolution, digitally enhanced images of the lunar surface for use as internet content. The images are expected to be good enough to allow viewers to see the tyre tracks of the Apollo rovers still in a virtually pristine condition in the lunar vacuum, or hopefully even recording the Icebreaker rover as it trundles around the chosen lunar pole. TransOrbital, based in San Diego California also aims to offer the first advertising opportunity in lunar orbit. Video images of the moon featuring a mini-spacecraft launched from the Trailblazer emblazoned in corporate logos is likely to be a real hit in peak-time TV viewing. The craft will produce an atlas of the entire lunar surface, and de-orbiting video from the mini-spacecraft to the moment of its final impact. High-resolution aerial photography of lunar sites, and low altitude, high-speed video is ideal for science fiction film footage and virtual reality games as well as providing the first really deep space e-mail service!

In late June it was announced that the first of nine European Space Agency (ESA) Automatic Transfer Vehicles or ATV's (figure 3) is to be launched to the International Space Station (ISS) in 2003. Arianespace will launch the ATV on 9 Ariane 5s between 2003 and 2014 in the first stage of the station's expected lifetime in probably the largest launch services contract in European space history. Each 20 tonne ATV will be placed in a 185 mile orbit from where they will slowly manoeuvre to rendez-vous and dock with the ISS.

Slightly closer to Earth, Dr Steve Bennett of Starchaser Industries based at Dukinfield, a former laboratory technician, successfully launched a 6m (20ft) tall 2 stage test rocket to the impressive height of 20,000 feet from England's Morecambe Bay on 6th July. The test confirmed the rocket's emergency escape system designed for use on Starchaser's Thunderbird booster, coming less than a year after the successful launch of the Starchaser 3a also from Morecambe in August 1999. Dr Bennett hopes to win the $10M prize offered by the X-Foundation created primarily by retired and ex-NASA scientists, to be the first commercial organisation to launch 3 people on two consecutive spaceflights during two weeks in 2004. Although in the lead Starchaser is only one of 18 international contestants all bent on the lure of winning the X-Prize and MORE importantly the potential investment which could create another Bill Gates of commercial spaceflight.

Bennett is not the only UK enthusiast for rocketry, another outstanding and determined individual is the very much younger Mr Daniel Jubb from Astley, Manchester who has already had a number of successful rocket launches right up to the Falcon 7 Mk4 designed to reach an altitude of just under 20,000 feet from the

Otterburn ranges in Northumberland. In figure 4 the young rocket designer is seen pictured beside his Falcon 7 Mk3 rocket before blasting off to a height of 10,000 feet on 04/09/98 from the successful launch (figure 5). These vehicles have been designed to test the computer and guidance system designed for future orbital vehicles. It was also providing a test vehicle for the Falcon Project's new successful propulsion system.

Jubb is going after the same multi-million-dollar prize offered by the private American X-Foundation consortium that has attracted many competitors into the world of rocket technology.

Daniel has been interested in rocketry since he was 3 years old and began the Falcon Series back in 1994 and with adequate financial backing could very well beat Starchaser to the prize. Good luck to him and his team.

Mars fever picked up again in July/August this year with the announcement by NASA of Mars Global Surveyor pictures showing characteristic water seepage patterns in the walls of the central area of Valles Marineris, the 6,000km long fracture in the planet's crust. If correct this has profound implications for establishing a future Mars base with pumped water and oxygen down in the canyon. The Flashline Mars Arctic Research Station, a prototype Mars habitation module, is being assembled on Devon Island in the Arctic for a 3 week shakedown test before becoming fully operational in 2001. The $1.3 million Mars habitat module, funded privately by the Mars Society with contributions from the Discovery Satellite Channel, adding to the ever increasing numbers of commercial sponsors of spaceflight projects, will be located at the 20km diameter Haughton Crater, which is very similar in some ways to craters on the Martian surface. The base will be used by Arctic scientists who have previously operated from only temporary structures.

Finally NASA's X-38 prototype crew return vehicle for the International Space Station (ISS) has now successfully completed its fifth atmospheric test flight at Nasa's Dryden flight Research centre in Edwards Air Force Base, California. In the highest, fastest and longest test of the X-38 to date (figure 6), the vehicle was released from an altitude of 39,000 feet and flew free for 44 seconds reaching a speed of over 500 miles an hour before deploying its parachutes. The 60 foot diameter drogue parachute slowed the X-38 to a more sedate 70 miles per hour whereupon a new 5,500 square foot parafoil as wide as the wings of a Boeing 747 provided a more stable ride in its 11.5 minute descent. The X-38 project has been developed at a tenth of the cost of previously estimated systems, relying as it does on significant contributions from the European Space Agency. A space test of an unpiloted X-38 is planned for 2002 with a vehicle already under construction by NASA in Houston, Texas for release from a Space Shuttle to fly back to Earth. The X-38 was originally developed from a partially successful 1970's US Air Force project- whose unfortunate claim to fame lies in the opening credits of the 6 Million Dollar Man where the prototype unceremoniously ripped to shreds.

Advances have also been significant on NASA's first X-34 (figure 7), which according to NASA is a flying laboratory for technologies and operations applicable to future low-cost reusable launch vehicles. It is one of a family of technology demonstrators aimed at significantly lowering launch costs from $10k to $1k per pound. The X-34 tests have just begun at Edwards base with the X-34 being towed behind a kind of truck for up to 10,000 feet along a desert lakebed. Orbital Sciences Corporation responsible for the X-34's construction, plans to conduct 16 tests. On the ground the X-34 will be released at speeds up to 80 miles per hour on the end of a specially designed 500 foot rope with electrical connections carrying telemetry from the truck to confirm the craft's guidance and navigation systems, responsiveness and control surfaces. The next stage will involve a move to White Sands Missile Range for release from about 35,000 feet for unpowered glide flights to allow characterisation of its control surfaces and validation of the flight software that controls guidance and other key factors before even risking powered flight. The suborbital X-38 is 58.3 feet long and 27.7 feet wide. It will be capable of flying up to eight times the speed of sound and reaching an altitude of about 50 miles. The X-38 is scheduled to make a total of 27 unpowered and powered flights from US government ranges in New Mexico, California and Florida.

## For further information on wearable electronics contact:

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Starchaser Industries and the Thunderbird project may be found on-line at **www.starchaser.co.uk also www.therocket.co.uk & www.nasa.gov**

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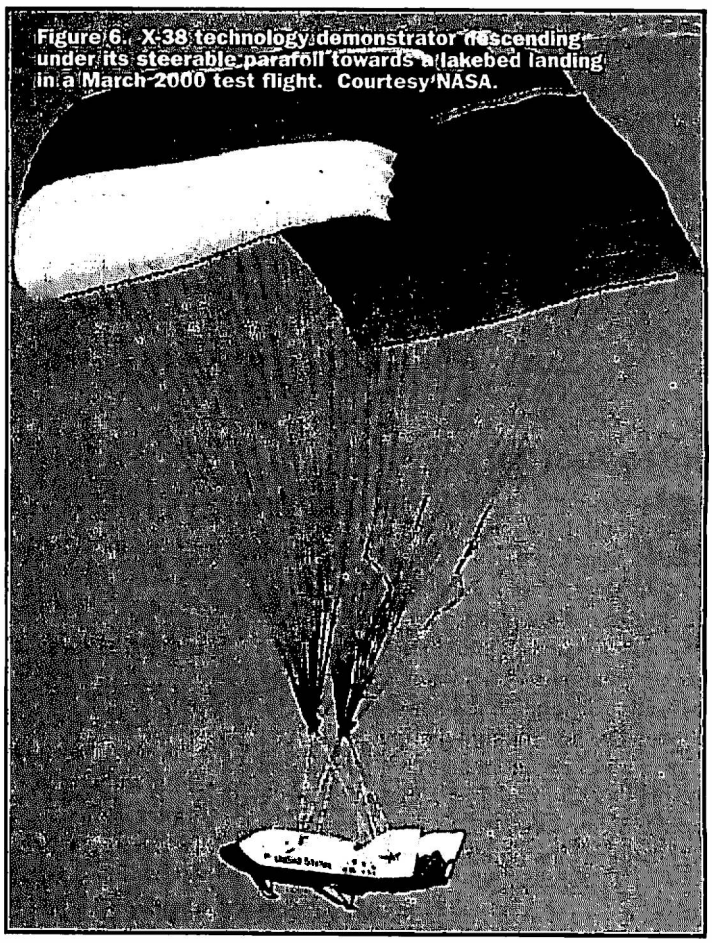


Figure 6. X-38 technology demonstrator descending under its steerable parafoil towards a lakebed landing in a March 2000 test flight. Courtesy NASA.

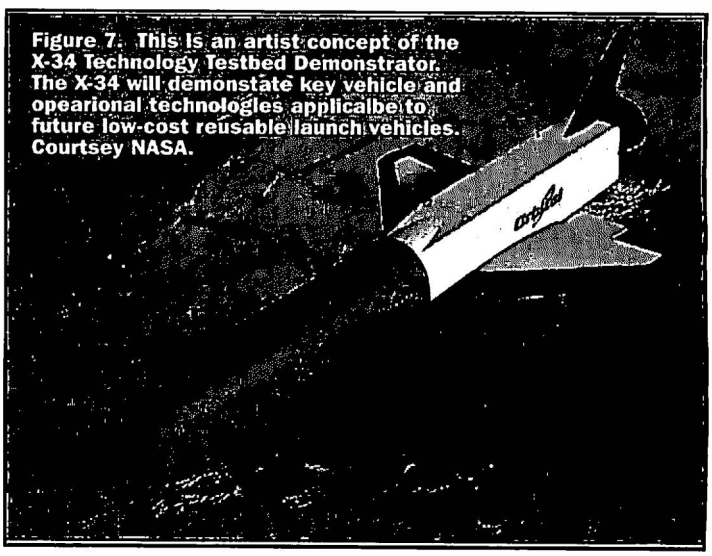
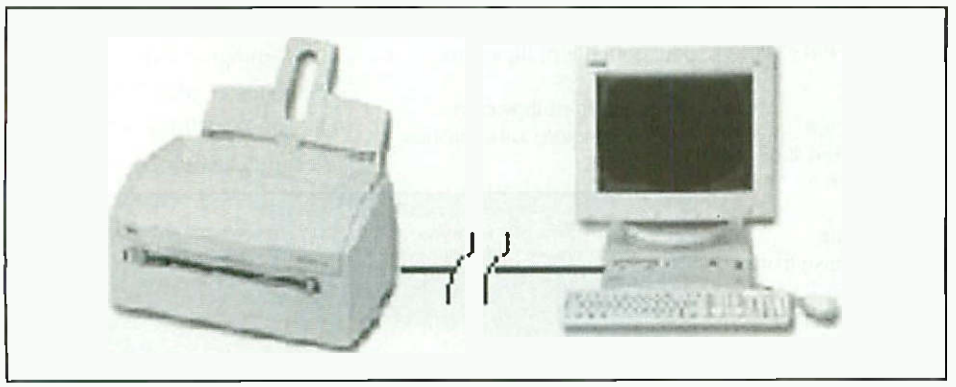


Figure 7. This is an artist concept of the X-34 Technology Testbed Demonstrator. The X-34 will demonstate key vehicle and opearional technologies applicalbe to future low-cost reusable launch vehicles. Courtsey NASA.

# Remote Printer CONNECTOR



*A novel transmission line connection from a PC to a printer*
*by M Blyzniuk and I Kazymyr*

## Introduction

Sometimes in our daily work of using a PC there might be a need to place a printer in a remote location some distance away. This might be in another room or a remote place in the same room. The normal parallel printer cable will just not do in this instance. So here is a project that will satisfy all requirements of the user.

So taking into account that the length of a typical cable for a normal printer connection via the LPT port has its obvious limitations, we felt there was a need for a simple device to provide a direct printer connection via a line over a long distance. With this in mind we wanted to develop a specific way of doing this. What we used here was a Parallel to Serial Converter through a Line Transceiver and then back through a Serial to Parallel Converter (PSC LT SPC) at the other end.

The transmission line remote printer connection works around the AT90S2313 microcontrollers and uses the AVR Studio Development Tool for the AVR family of microcontrollers.

## Hardware Design

The principle parts used in this project are the following:

**ATMEL AT90S2313** - The AT90S2313 micro controllers are used to control components and data flow;

**SN75176B** - SN75176B differential bus transceivers are used for bidirectional data communication along the transmission line;

**74LS155A** - 74LS155A 2-line to 4-line decoder/demultiplexer is used for signal decoding;

**2.4MHz oscillator for MCU;**

## Schematic

The schematic diagram of the transmission line printer device is shown in Figure 1. The schematic diagram consists of two separate parts, namely the CPU Device and the Printer Device.

The CPU Device and Printer Device are hardwired as two separate parts at each end.

The CPU is connected through the parallel interface Centronics port to the LPT port of the PC. It provides the parallel to serial conversion of printed data, control of data flow and transmission/receiving of data and control signals via the transmission line.

The output printer device is connected to the parallel interface Centronics port of a printer and provides the serial - parallel conversion of printed data, control of data flow and transmission/receiving of data and control signals via the transmission line.

All the components used in the design are supplied by +5V voltage source. To provide power for the CPU Device and Printer Device we can use either power adapters for each device or the voltage source +5V from PC (for example, via the special connector-adapter to the keyboard, which was used for the testing of the remote printer connection).

## The Components, their features and limitations

The AT90S2313 microcontrollers were used for both devices in order to organize and provide the protocol of serial/parallel and parallel/serial conversion with data transmission and reception going through the transmission line.

The AT90S2313 provides the following features:

2K bytes of In-System Programmable Flash
128 bytes EEPROM
128bytes SRAM
15 general purpose I/O lines
32 general purpose working registers,
flexible timer/counters with compare modes, internal and external interrupts,
programmable serial UART
programmable Watchdog Timer with internal oscillator
SPI serial port for Flash Memory downloading and two software selectable power saving modes.

One of the AT90S2313 devices features a full duplex Universal Asynchronous Receiver and Transmitter (a UART with separate receive and transmit registers). We should point out that we didn't use the internal protocol for data transmitting and receiving because it puts a limitation on the baud rate (up to 115200 bit per second). We organized our own protocol, which allows us to run at a higher rate. We do not operate with bytes but with bits. The CPU Device transmits the eleven bits, namely: START_BIT, D7, D6, D5, D4, D3, D2, D1, D0, INIT, AUTOFEED and PARITY_BIT. We can regulate the baud rate depending on the value of the quartz crystal oscillator (up to 500K baud at 10MHz oscillator for MCU and higher).

Unfortunately the AT90S2313 has one 8-bit bi-directional I/O port and one seven bit bi-directional I/O port only. We used the 8bit Port B (PB7-PB0) for printing data. Port D, the seven bit (PD6-PD0) is used for serial data receiving/transmitting. (PD0-PD1) and PD4 is for opening and closing the transmission at bus transceiver. As a result we only have PD2, PD3, PD5, PD6 for the control signals of the Centronics parallel interface. For Centronics full control we need at least 8 I/O, namely for /DATASTROBE, /ACKNOWLEDGE, BUSY, PAPER_END, SELECT, AUTOFEED, /ERROR and /SELECT_IN. Luckily not all the signals are necessary. The CPU Device requires /DATASTROBE, /ERROR, /INIT and AUTOFEED. The Printer Device uses /DATASTROBE, /ERROR, /INIT, BUSY and AUTOFEED. In the Printer Device area we use the additional decoder 74LS155A in order to form three output signals /DATASTROBE, /ERROR and AUTOFEED from two binary signals.

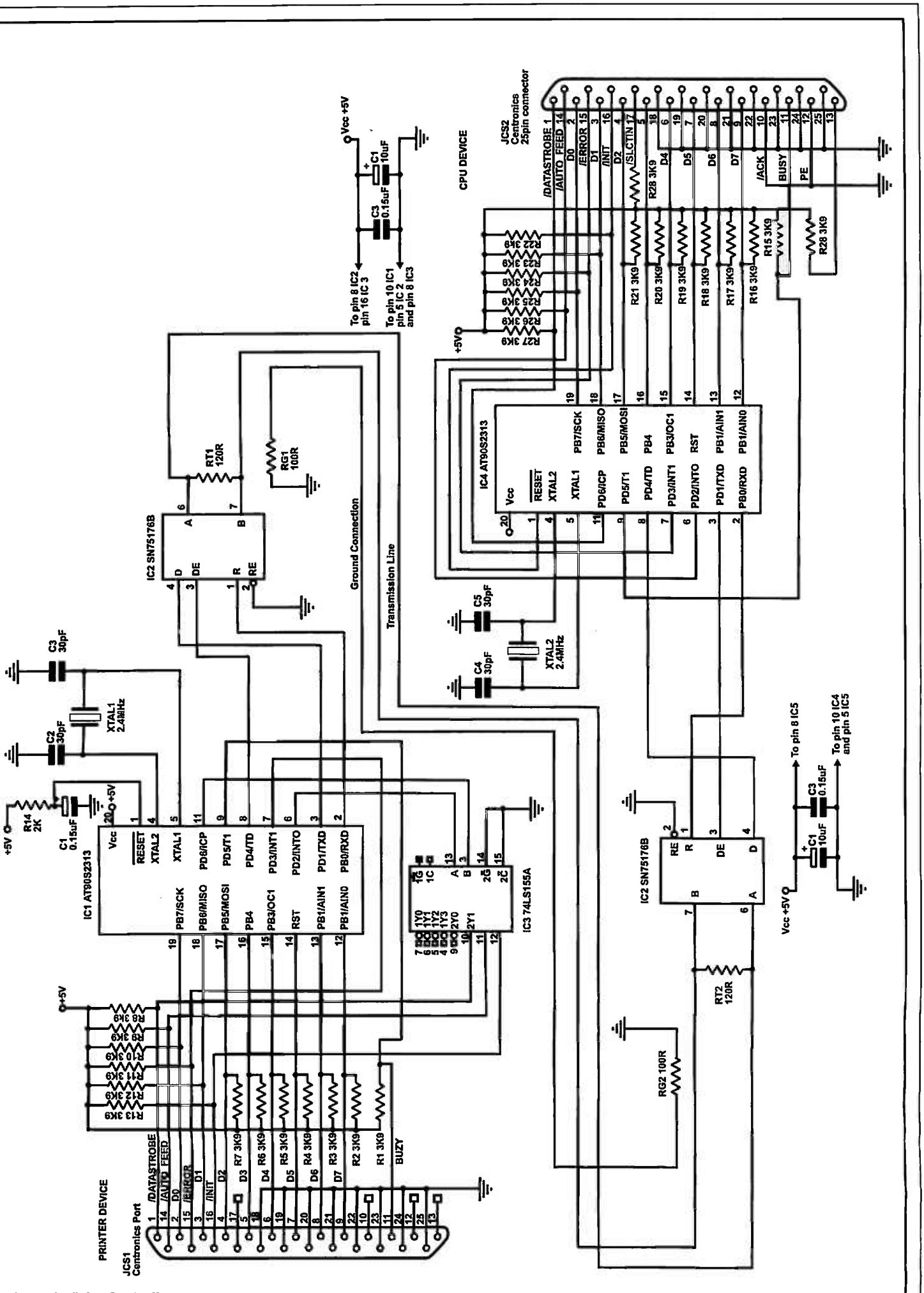



**Figure 1. Print Controller**

As a result of these limitations we omitted the control of ACKNOWLEDGE, PAPER_END, SELECT, /SELECT_IN signals in this version of the project. It may cause incorrect work of our remote printer connector if the printer driver uses some of these signals. But this limitation depends on the kind of microcontroller. If we use the microcontrollers with three ports all the problems will be solved.

For bi-directional data communication via transmission line we use SN75176B differential bus transceivers. We have chosen this kind of transceiver because the single driver/receiver pair SN75ALS176B currently is the best-selling device. It has high-speed capability (up to 35 Mbps) on the long distance (theoretically up to 1200m) and can be bought for a competitive price.

We used half-duplex communication between our CPU Device and the Printer Device.

We used a 2.4MHz oscillator for the MCU in this version of the project. It is explained by the fact that we used 9600 baud rate in order to allow the debugging of our devices through the COM port of the PC. Obviously in our final version of the project we will use a higher value of oscillator freequency and it will provide the higher baud rate.

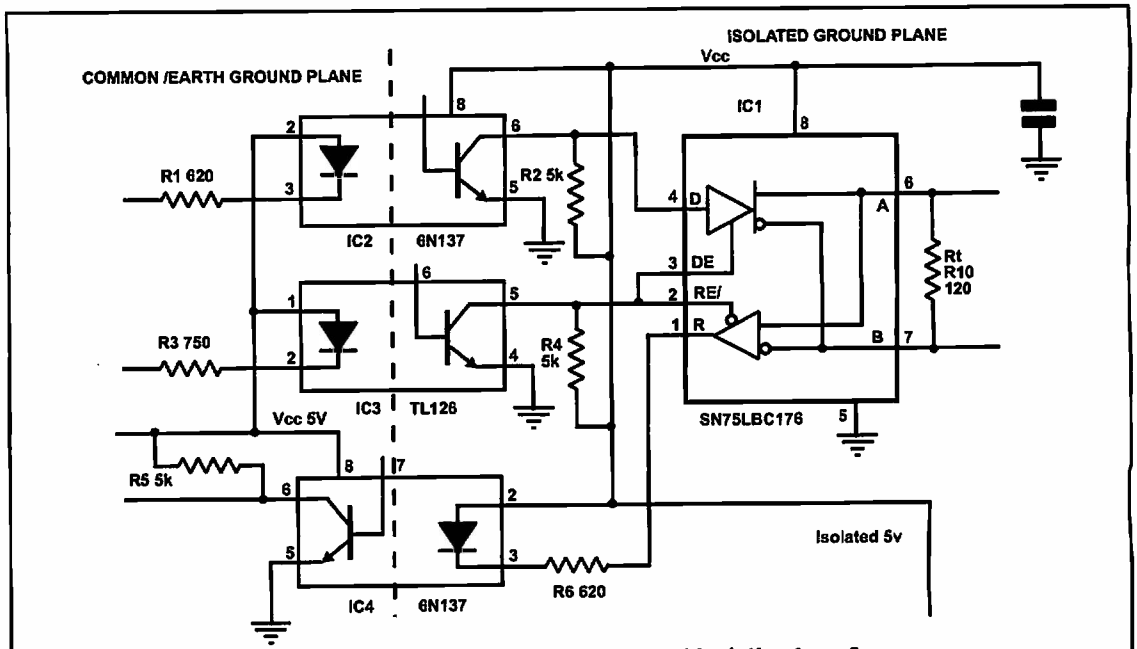



**Figure 2. Galvanic isolation through the use of optocouplers and isolation transformer.**

## Design Results

Needless to say, the remote printer connector worked successfully. We tested our device in different operational environments (Windows 95, Windows 98, Windows 2000, MS DOS) in different printing regimes (text, graphics, different quality) for different printers (different drivers of printers) at different distance between the PC and the printer. In our case this was up to 100 metres. And so what were the results of our tests?

The set up works correctly, excluding the processing of the PAPER_END signal by the printer driver. Printer drivers do not inform about the end of paper. In this case they wait without indication until the time out signal appears.

We should note that one of the tested printers, namely PANASONIC KXP1121, does not print correctly under Windows 95 and Windows 98 (under Windows 2000 and MS_DOS this printer works properly). It could be explained by the fact that the printer driver for Windows 95 and Windows 98 uses the ACKNOWLEDGE signal which is omitted by us. However it is not a problem and we can remove this in future.

## What could we do differently next time?

Obviously we will continue improving and testing this device in order to make sure it provides correct and reliable printed information. We shall also investigate the maximum distance between a PC and the printer and the maximum baud rate possible.

At the moment, the CPU and Printer interfacing Devices are different in make up and the AT90S2313 microcontrollers have different programs. When we use more complex types of microcontroller, for example two AT90S2313's in the CPU Device and two AT90S2313's in the Printer Device) some of the above described limitations will disappear, in which case the CPU Device and Printer Device will be identical.

Given more time we would propose to add galvanic isolation through the use of optocouplers and an isolation transformer as shown in Figure 2.

We know computer and industrial parallel interfacing to be very vulnerable. Some incorrect actions of users, for example, connection of some devices to the parallel port without ground or without turning off the supply, may cause immediate failure of the parallel port. We know this only too well when we tested the designed device. So, another application of an improved design may be found: for example, for the safe use of different devices (evaluation boards, programmers etc.) which are connected to a parallel interface we propose to supply these devices by our transmission line device with galvanic isolation as in Figure 2. It will be safe and, furthermore, users will be able to put the evaluation board, programmer etc. in a convenient place!

In order to provide full duplex communication between the CPU and Printer Devices we propose to use two SN75176B differential bus transceivers in the CPU end and two SN75176B differential bus transceivers at the Printer Device end. It should be noted that full duplex communication for the remote printer connector is not necessary. We will need full duplex communication only for another application of this device.

There is also one more advantage to the SN75176B differential bus transceivers. They allow us to connect up to 32 devices to the line. So we can connect several PCs with one remote printer without a network.

## Programs and Programming Devices

For program development we used the AVR Studio Development Tool for the AVR family of microcontrollers. Assembler code CPU Device.asm for CPU Device and Printer Device.asm for Printer Device are presented in an Appendix. This will appear on our website:

**<electronicsandbeyond.com>**

Results of assembling these codes are shown in the Appendix as well, namely: CPU Device.lst, and CPU Device.hex, Printer Device.lst and Printer Device.hex.

For device programming we use the In System Programming ATMEL_AVR_ISP (Release 3.31b) and STK200 evaluation board.

## Conclusions

The Remote printer connector has been successfully used to print this report using a DeskJET 400 printer in Windows 98. The

# TECHNOLOGY WATCH

**With Martin Pipe**

The UK's first GPRS (or 'G2.5') network, from BT Cellnet, went 'live' on June 22 this year. It's built around technology from Motorola and Cisco Systems and interestingly, the two comapnies have since formed a joint mobile data venture known as Invisix. GPRS (General Packet Radio Service) is an extension of the existing GSM standard. Indeed, older networks can be upgraded to the new technology, which is seen as a 'stepping stone' to the third-generation UMTS (Universal Mobile Telephone Service). This is because GPRS, like UMTS (and the Internet, for that matter), is a packet-based technology.

Bandwidth is allocated to the user when it's required. Compare this with the conventional circuit-switched model employed by conventional GSM data, which allocates a guaranteed bandwidth regardless of the load being placed on it by the user. GPRS is hence more efficient. Seeing that radio spectrum is becoming ever more scarce - and data applications ever more plentiful - the industry's move towards packetisation is hardly surprising.

**Ericsson lifestyle. 3G/GPRS services being accessed via design-prototype (mockup) devices**

One of the main advantages of GPRS is that users can be connected semi-permanently - even when their handsets are in 'standby' mode. There's an initial problem here, which we'll discuss shortly. Users will - to start off with, certainly - be charged according to the amount of data transferred across the network. At present, GSM data users are - whether they're sending e-mails from a linked palmtop computer, or accessing WAP pages on their WAP phones - are charged according to the amount of time spent on it. Without wishing to seem cynical, the networks are probably doing very nicely out of the current generation of WAP services (but then again, they've got to recoup their UMTS licence investment somehow!). Today's user interfaces, which are limited by the shrinking sizes of handsets (a fashion/lifestyle statement), are simply not suited to text entry. They slow down the entry of e-mail messages and text boxes on WAP sites. What may take a few seconds on a PC keyboard may involve minutes of frustrating work with a multi-function numeric keypad - and you're paying connection charges for the duration! With GPRS, this needless expense will end! As for today's currently-infuriating user interfaces, readers will be pleased to know that handset manufacturers are working on new data-friendlier versions. Expect to see voice-recognition or PDA-style 'wands' in time.

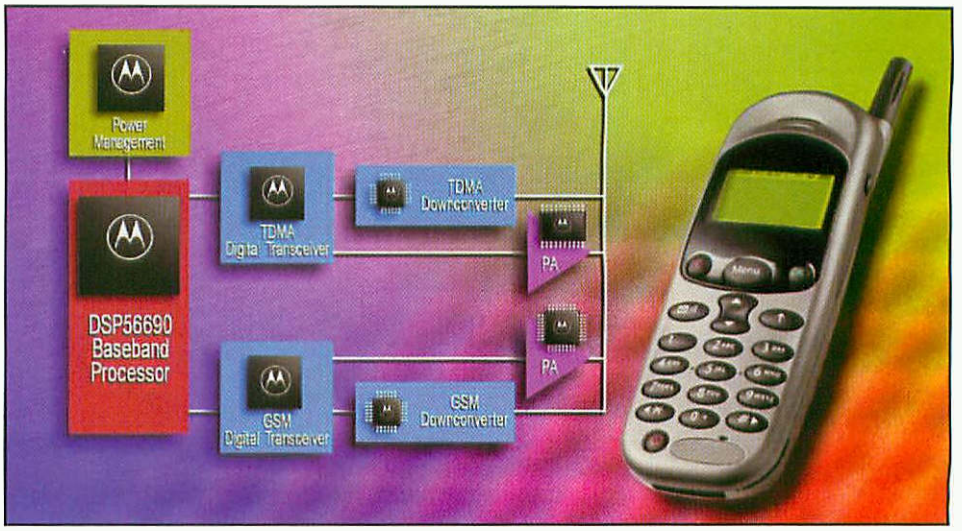
A second advantage is that GPRS data rates are faster than 'regular' GSM's 9600bps. The data rate initially offered by BT Cellnet's GPRS service - which has been dubbed PocketOffice - is 18.1kbps for receive, and 9.05kbps for transmit. Data rates will improve, but they won't come close to the 0.5Mbps promised by the first release of UMTS. GPRS data rates will be explained in more detail later. The scalable PocketOffice is aimed squarely at corporate users, and is priced accordingly. There's a £5,000 charge for connecting a company's LAN to the Cellnet GPRS service, plus £16,000 for the secure server needed at BT Cellnet's end. Each GPRS handset - a Motorola p7389i model - is £199. On top of all this is a £45 per month charge per user, although it does

**Motorola p7389i. The world's first commercial GPRS handset.**


**Erricson r520. Erricson's first GPRS handset.**

include 50MB of data traffic. PocketOffice will deliver a wide range of Internet services to mobile devices, including access to email and scheduling applications. BT Cellnet has designed its services around notebook computer clients, the Motorola phone - which will interface to the computer via IrDA - acting as nothing more than a wireless modem.

Cellnet's initial GPRS coverage focused on the South-East of England. By the time you read this, it will be available throughout the UK. The speed of the network upgrade is largely due to the fact that much of the existing infrastructure (GSM radio gear, masts and aerials) is retained. It has, in fact, taken a fair amount of time (and £50 million) to carry out the upgrade - BT Cellnet quietly started some time ago - but at least one important element of what they've put in will last into the UMTS age. This, of course, is the network of leased lines that will communicate the greatly increased amounts of data traffic envisaged. Other equipment at each base station includes a Cisco router, and a packet control unit (PCU) that interfaces with the GSM radio transceivers. The transceiver firmware is also upgraded. Other networks are looking at GPRS - Vodafone, for example, announced that it was conducting trials some time ago - but no definite plans have yet been announced. There's a distinct possibility that some will move straight to UMTS - or '3G', as it's more commonly known.




**Motorola produce chipsets for digital mobile phones (both GSM, and the American TDMA standard). one can surmise that a GPRS chipset is, by now, also emanating from its fabs!**

BT Cellnet plans to bring GPRS to a wider audience early next year - by this time, the choice of compatible hardware will be wider. At present, the only handsets available are the aforementioned Motorola p7389i (which will be rechristened the Timeport 260) and a new model - the R520 - from Ericsson. The latter product is also interesting insofar as it's one of the first to sport a Bluetooth RF data interface. Soon, portable computers with Bluetooth will be available. Indeed, a Bluetooth module for the Palm-derived Handspring Visor PDA is already available across the Atlantic. Another GPRS product due shortly is Blackberry, a pager-like device from Canadian manufacturer Research in Motion (RIM). At a recent press event, Motorola showed journalists a conceptually-similar unit, known as Accompli. This device - which features a colour screen, some PDA-like functionality and a miniature QWERTY keyboard - is currently available in the US as a 'two-way' pager. Motorola plans to redesign it for GPRS and release it some time next year. At the same press event, Motorola demonstrated a working prototype of the 6188A - a 'flip' PDA/phone with stylus input. Text can be entered using a 'virtual' (on-screen) QWERTY keyboard, or handwriting recognition. We couldn't get the latter to work, because the 6188A sample we played with was optimised for the Hong Kong market!

Let's delve more into the technical aspects of GPRS and GSM. Each GSM channel (or carrier) - of which there are 125 in the UK's GSM900 (900MHz) band - is split into 8 dynamically-allocated timeslots. Depending on how the busy the cell is, it can be allocated a maximum of three sectors, each of which has 4 or 5 carriers. The carrier frequencies themselves are allocated across the country on a repeating basis, to maximise the resource while preventing overlap. In GSM voice mode, two timeslots - one for each side of the conversation - are involved. The two are offset by four timeslots. In other words, one complete voice call might occupy timeslots 1 and 4, the next 2 and 5, and so on. As a result, each channel will support four such calls. From this, we can see that each cell is capable of serving a maximum of (4 x 3 x 5=60) 60 voice calls.

**Nokia's Communicator - expect a dual-band GPRS version soon....**


**The colour screen of Motorla's Accompli PDA - running the type of applications (stock ticker, e-mail and still images) that will feature early on in GPRS' lifetime.**

**The Motorola Accompi, a combined GPRS terminal and PDA that could be available some time in 2001.**

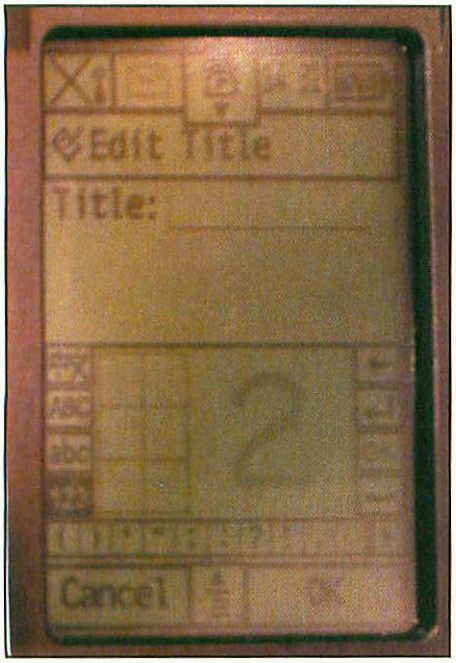
**A concept product from Motorla - a GPRS terminal in a watch. Dick Tracy, watch out!.**

With the popularity of cellular telephony at an all-time high, is it any wonder why Cellnet and Vodafone are supplementing this with further 'urban-infill' coverage courtesy of the GSM1800 (1800MHz) band? For this reason, it's now virtually impossible to buy a handset that isn't dual-band (i.e. capable of operating on either GSM900 or GSM1800). There is one high-profile exception, though. Nokia's revered 9110i Communicator phone/PDA- which, out of interest, is now WAP-enabled - is GSM900-only. The company will, no doubt, soon be releasing a new dual-band Communicator with GPRS and possibly Bluetooth.

Which brings us nicely back to GPRS. In this mode, the GSM timeslots are allocated in a different manner. BT Cellnet's current implementation of GPRS - and the Motorola p7389i - allocates two timeslots for download, and one slot for upload. Downloading is hence potentially twice as fast as upload. For some applications, this won't pose that much of a problem. Take the Web, for example. Here, the upload channel is typically used for page requests and so on - most of the traffic (the page content, in other words) goes the other way from the server to the client. The imbalance could, however, affect more symmetric applications such as e-mail (with attachments) and video-conferencing. Note, however, that a similar imbalance affects the 56k/v.90 modems that connect many of our desktop PCs to the Internet. Most such modems seldom (if ever) connect to an ISP at the full 56kbps speed. Even if it did, that rate applies only to downloading. All such modems will only upload at the v.34 rate, which has an upper ceiling of 33.6kbps.

The exact speed depends on the coding system employed. There are four coding schemes, designated CS1 to CS4. These trade off data integrity with speed. The most reliable, CS1, offers a transfer rate of 9.05kbps per timeslot - but the chance of an error occuring (bit error rate) is 10 to the power of -9 to one. CS1 would be used for secure applications, e-mail and so on. At the other end of the scale is CS4, which is capable of a transfer rate of 21.4kbps per timeslot. Unfortunately, it suffers from a bit error rate of 1%. Although this is unacceptable for many applications, it will suffice for others like fax, video and still images. BT Cellnet's system does not employ CS4, because simply it's not robust enough for the business applications of its subscribers. Instead, the most reliable (CS1) is used. Combine it with BT Cellnet's two slots-download/one slot-upload ratio, and you end up with the aforementioned transfer rates of 18.1/9.05kbps. CS4 does have its place, and will really come into its own when multimedia-enriched GPRS consumer-orientated services start appearing. The other two coding schemes

**Motorola staged a MPEG-4 video-across-GPRS demo with a closed network. What you see here is a p73891 handset communicating with a Casio PDA via IrDQ. Unfortunately, the video in question was sourced from a static camera, and exhibited no movement.**




**Motorola 6188a screen.**

(CS2 and CS3) offer midway compromises between error rates and transfer speed. CS2 will deliver 13.6kbps, while CS3 is capable of around 15kbps. All four coding schemes are, according to Motorola, supported by the p7389i. Developers would choose the schemes that best fit their applications.

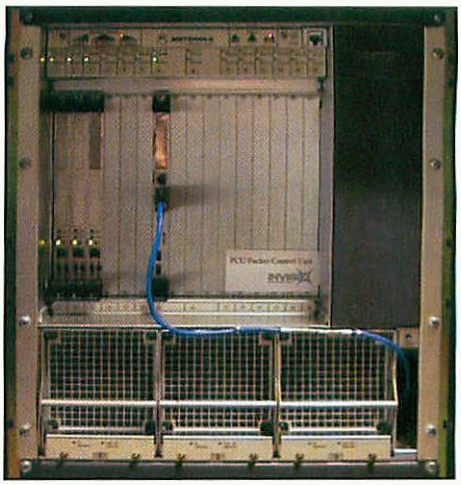
Motorola's second-generation GPRS units are capable of harnessing additional timeslots, thereby increasing the potential data transfer rates. One such unit will allocate one slot to upload - but four slots to download (giving a maximum download throughput, with CS4, of 85.6kbps). Some devices - possibly data-only products - will allocate two timeslots to the upload channel. We're unlikely to see handsets with this capability, because the RF output power is doubled if you're transmitting on two simultaneous timeslots! This raises implications for safety (does anybody want that radio energy close to their head?) and battery life. For these reasons - and that of thermal management - the only ever

**Motorola 6188a GPRS pda.**

equipment able to transmit on more than two timeslots will probably be the GSM base station itself!

In the early days of GPRS, much hype was given to transfer rates of 'over 170kbps'. The numbers in this puffery (which, sadly, includes Motorola's own GPRS website - `http://horizongprs.motorola.com/`) are derived from the assumption that you'll be able to use all eight timeslots in the same direction! Hardly surprising, they've specified CS4 in their calculations, giving a theoretical maximum of 171.2kbps. In reality, we'll never encounter this configuration! Indeed, it's unlikely that real-world transfer rates will reflect their hypothetical limits. Remember that the GSM network is also used for voice communication. If it's busy (early evenings, for example) and capacity is at a premium, chances are that the network will revert to the bare minimum of a 1 slot-download/1 slot upload (i.e. the bandwidth occupied by a GSM call)! OK, those timeslots may be dynamically-allocated - but the networks would want undoubtedly to support as many of their existing voice subscribers as possible during such periods. The switching and allocation of timeslots, like cells, is only so fast! Note that Motorola's p7389i cannot be upgraded to support future 4-slot download configurations. These could begin as early as next year, according to BT Cellnet - but only expect the full benefit to be realised during off-peak periods!

As regards voice and data, all presently-available GPRS devices are Class B-compliant. This means that simultaneous voice and data is not possible. If there's an incoming voice call during a GPRS session, then you'll have to put your surfing on hold if you want to take the call. Class A GPRS devices, on the other hand, can handle simultaneous voice and data, but it's not yet known when these will appear on the market. Another limitation of the present incarnation of GPRS is that incoming data calls



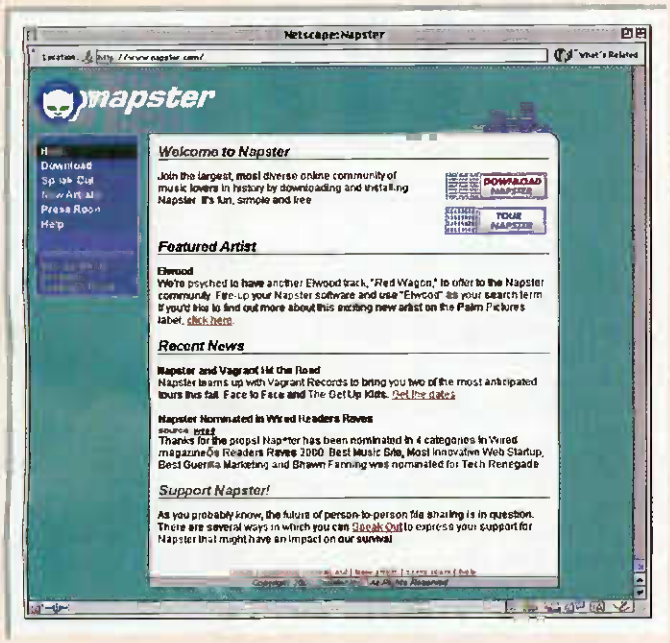
**The Packet Control Unit - another essential part of the GSM/GPRS infrastructure.**

cannot be terminated automatically by the handset. Currently, only the handset is able to set up a data session. In other words, data cannot be 'pushed' towards subscribers when their handsets are switched on - a major restriction for a system that claims to be 'always on'. For same reason, one GPRS handset cannot make a data call to another! The data (e-mail, for example) has to go via an intermediate server - just as it does with the Internet! Cellnet's PocketOffice gets around the problem with client software that 'polls' the server. In other words, the phone dials up the server at frequent intervals to check for new e-mails, faxes and so on. The problem will only be fixed sometime next year, with the introduction of a network software upgrade known as 'packet data protocol context'. Motorola claims that it will be supported by the p7389i.

***Martin Pipe welcomes comments and ideas. E-mail him as: martin@webshop.demon.co.uk Or look out for him online! His ICQ ID is: 15482544***

**The GPRS test cell operated by the Motorola/Cisco partnership Invisix.**

**Cisco routers like these are being installed at BT Cellent radio sites across the country.**




## Napster's fine - for now

Readers of last month's issue will recall details of Napster's fight in the American courts. Napster is an MP3 service that allows its users to share MP3 files. And, of course, MP3 files are - in case you've been asleep for the last year or so - highly compressed digital audio files, usually of music taken directly from audio CDs.

Napster works by users logging onto Napster's servers on the Internet using a client program running on their computers, then allocating folders of MP3 files on their computers to be shared with other users. Any user logged on can search Napster's database of files shared this way, or can view each individual users' allocated folders, and download MP3 files to their own computers to listen to. Simple as that.

Well, it would be simple if the record industry didn't think that sharing files this way was a breach of copyright. While it's perfectly OK for users to allow friends to borrow audio CDs of music, the industry says it's not OK to share them with millions of Napster users. That's why there's an on-going court case against Napster. Currently the judge has sided with the record industry, and has said that Napster must close down. However, the judge has given Napster time to build its case against this, so the service is still operational for the time being at least.

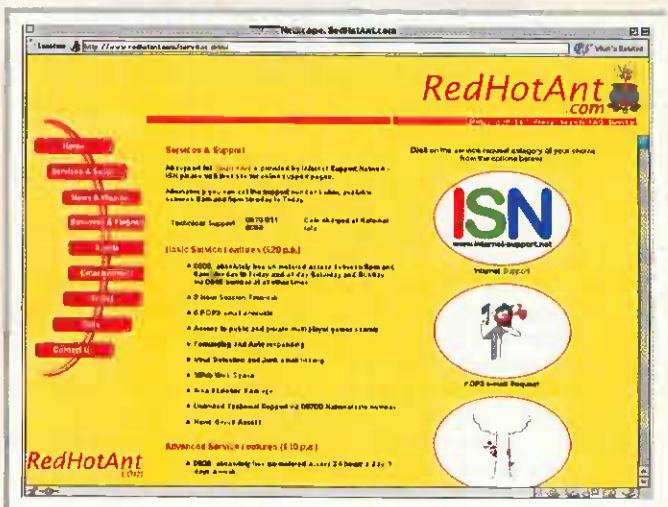
The court battle in the US is likely to be decided sometime during October, so for any readers who haven't yet tried Napster this could be your last chance. Checkout the Napster Website, at: **<http://www.napster.com/>** for details of the system, and up-to-date news regarding the court case. A client for Windows-based computers can be downloaded directly there, too. Mac users can use either of two Napster clients: Macster, downloadable from **<http://www.blackholemedia.com/macster/>**, or Rapster, downloadable from **<http://www.macnews.com.br/overcaster/products/rapster.html>**.


## One Man's Meter

Many readers looking for free and unmetered Internet access may have been badly let down recently by LineOne, CallNet 0800 and AltaVista's announcements that their respective unmetered Internet access services were to be cancelled. However, all is not yet lost, and other free services still do exist. It's worth checking out the alternatives and one of the best resources to do that is 12Free, at: **<http://www.12free.co.uk/>**, which lists and compares as much as possible the various remaining solutions.

If you read this month's Comment, you'll see that the service deemed most likely to succeed is ntl's ntlworld. If you're within an ntl service region this is undoubtedly your best bet for unmetered Internet access. Even if you've not in an ntl region, you can still signup for ntlworld. Find out details, at: **<http://www.ntlworld.com/>**.

Some smaller organisations are still battling valiantly to maintain an unmetered Internet access service, although some are doing so for a nominal fee. RedHotAnt, at: **<http://www.redhotant.com>** is one such service. Various types - and, hence, fees - of service are available, and the system by all accounts is regularly bogged down at peak times (although RedHotAnt is working hard to overcome any problems).



## Internet Salaries Back to Reality


Pricewaterhouse Coopers' Unfit Network at **<www.unifi.com>** Internet Compensation Survey 2000, has found that as Internet companies mature, so do the pay practices of the online industry.

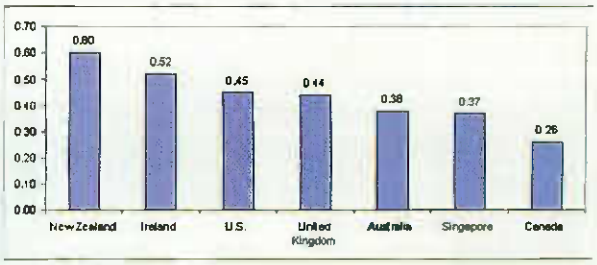
The survey found that online companies are rewarding top executives with greater total cash (base and bonus) compensation packages than they did last year, while at the same time more carefully granting equity to employees across the board.

The survey also found that Internet companies are increasingly adopted short-term incentives and bonus plans that are tied to more traditional business performance metrics such as increased revenue or nearing profitability - than in the past year.

However, despite the focus on short-term incentives, equity still remains a key component of Internet executives' over all compensation. The survey showed that equity compensation has continued to climb since 1999, with an average 1% increase over comparable data from that year.

As the dot.com industry matures, many companies are paying increased attention to bottom line numbers. However, because recruiting top talent is still critical to expansion, compenstion packages are being structured differently given the downturn in the stock market, according to the survey results

## Nielsen//NetRatings Reports Global Rankings of Top Ad Banners




Nielsen//NetRatings at **<www.nielsen-netratings.com>** has released the first-ever rankings of the top ad banners in Australia, Canada, Ireland, Japan, New Zealand, Singapore, the United Kingdom and the United States.

The results showed a strong advertising presence by global Web properties, and a correlation between advertising by global properties and the top-ranked property in each country.

The findings are from Nielsen//NetRatings' unique BannerTrack service, which reports on top banner ads by impression, domain, and company. Findings for the month of June cover eight major Internet markets worldwide, and reveal heavy ad buys by major Internet companies in most overseas markets.

Global properties Yahoo! and MSN ran heavy ad schedules - primarily on their own properties - in Canada, Japan, New Zealand, Singapore and the UK.

At the same time, those properties ranked first or second in terms of unique audience in each market for the month of June, according to Nielsen//NetRatings' audience measurement service.

## BT Rebuts AltaVista Claim


In an unprecedented move BT at **<www.bt.com>** went on the offensive last month when AltaVista at **<www.altavista.co.uk>** announced that it was abolishing its unmetered Internet access service despite the fact that it had over 200,000 users signed up.

BT's director of regulatory affairs, Ian Morfett, said, "AltaVista is standing reality on its head as it tries to wriggle away from the consequences of its ill-considered marketing hype.

"Back in February the UK Internet world was buzzing with innovative unmetered offers from BT, NTL Telewest and AltaVista. Even the Prime Minister welcomed announcements from all four. BT has delivered working unmetered access for BT Internet and other leading ISPs. The cable companies have delivered offers restricted to their own ISPs. AltaVista has delivered nothing.

"AltaVista's claim that the launch of their service was dependent on BT inventing new products is not what they told the world last February. When they announced their offer last March, they had held no talks with BT nor, as far as we know, with any other telecoms operator.

Back then, it was as much a surprise to BT as it was to the whole industry - many observers asking how AltaVista could make such an offer before having negotiated a deal with a telecoms supplier. Now, with the press exposing the emptiness of their hype, they appear to be resorting to bluster, blaming everybody except themselves.

"Using BT's Surftime, BT phone customers are able to dial any one of around 30 ISPs, including Freeserve and from this month Demon, with others joining all the time. We have over 200,000 registered Surftime customers already, proving that unmetered Internet access is entirely possible if you have a business model based in the real world," said Morfett.

"At the same time, BT Internet customers have enjoyed unmetered surfing since February, and we have no intention of taking that away. In each case, people are paying a fair price for a good unmetered deal.

Around the turn of the year, some ISPs were offering too-good-to-be-true services that were never sustainable. In AltaVista's case it appears they simply issued a press release and signed up customers, but the press tell us they've been unable to find a single customer who's ever received an actual service.

"Even if AltaVista couldn't make the business add up using the same products as the successful, unmetered ISPs, there's been a BT wholesale unmetered product (FRIACO), agreed with the regulator, that has been on the table since the end of May. That no other operator had taken it up says more about the difficulty of establishing credible business models than it does about BT's innovation and competitiveness. BT is continuing to innovate, and has offered enhancements to FRIACO following discussions with the industry.

"Overall, BT and the UK in general have some of the lowest Internet charges in the world, especially in the vital off-peak mass consumer market. But if you're prepared to pay nothing, in the long term, you get nothing."

## Kaspersky Demystifies Wireless Virus


According to news published at the end of August by key international information agencies, the Norwegian Internet Company for wireless technologies has discovered a security breach in some models of Nokia mobile phones.

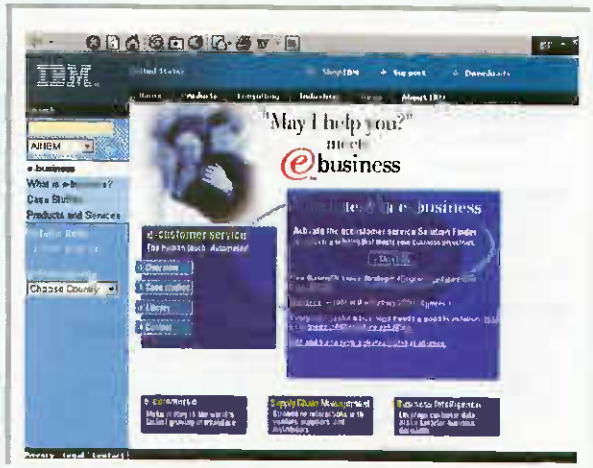
This breach allows a special SMS text message to be sent to the phone that will freeze its keys and disable normal operation. Functionality can be restored by the removal of the phone's battery.

This announcement has been repeated by many sources and has caused the story to be widely misunderstood. Many mobile phone owners took the news as if the first true wireless virus had been discovered that is able to operate inside the phone's memory and cause harm to the phone's environment.

Kaspersky Lab at **<www.kaspersky.com>** claims that this security breach is not a real virus threat. It is known that the main distinctive attribute of a virus is its ability to self-replicate. The previously mentioned Nokia phone models simply do not have the necessary hardware or software capabilities to enable a malicious program to plant itself into the phone's management system.

Kaspersky Lab affirms that mobile phone owners do not need to trouble themselves about this issue. Firstly, Nokia has not officially confirmed the existence of this vulnerability as yet. However company officials stated that if they do find something, they would make the necessary changes to prevent further exploitation of this breach.

## IBM Announces Web Site Personalisation Solution




IBM at **<www.ibm.com/e-business>** has announced a software application which it says allows companies to deliver a personalised experience to Web, intranet and extranet users.

WebSphere Personalisation is the newest addition to IBM's WebSphere software platform - Web infrastructure software that helps companies at each stage of e-business development, from start-up to handling high-volume Web transactions typical of business-to-business (B2B) e-marketplaces.

According Giga Information Group, the market opportunity in this area is $1 billion this year and will be $6 billion by 2003. Giga also estimated that by the end of this year, IBM will have 24% market share - up 50% over 1999.

## JunctionMaster Goes Live


Junction Master at **<www.junctionmaster.com>** is a Web based service for any UK motorist that uses the UK motorway network. It solves a problem faced by everyone and is accessible to anyone who has either a PC or a WAP mobile phone.

Have you ever wondered what alternatives there are between service stations on the UK's Motorways? Now you can find out, with Junction Master.

Junction Master provides details of facilities that are a short time and distance from the motorway. Users may choose to use it in planning for a journey, or as an immediate solution out on the road.

But what if you are already in your car? The good news is that, Junction Master has been designed to be used simply from any WAP mobile phone at wap.junctionmaster.com.

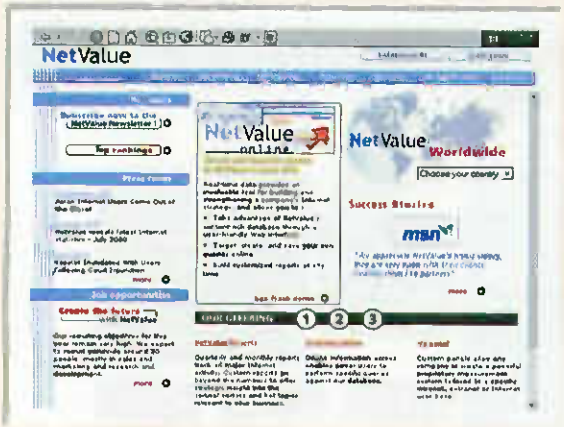
## British Music Dot Com Site Booming


The British Underground Rock Bands Web site, BURBs at **<www.burbs.co.uk>** has completed the first year of trading since switching on its site 12 months ago.

The site acts as a portal to all unsigned bands in the UK, although some bands have secured record deals recently, this in itself being no disqualification to membership of the site.

The CD Store was set up to generate sales for the bands own self produced CD titles. Artists ship the CD direct to the purchaser and receive a 75% payout of the total transaction.

## NetValue Reveals Latest Internet Statistics




According to the latest report from Internet monitoring agency NetValue at **<www.netvalue.com>** the US remains way ahead in terms of Internet penetration with over 51 million households connected (49.8% of the US population).

The UK is leading the way in Europe with 30.8% of its population connected to the Internet, representing 7.3 million households. Germany comes next with 24.7% (8.5 million households), followed by France with 16.6%, accounting for almost 4 million households online.

Users across measured countries are connected an average of 10.2 days to the Internet (all activities: Web, e-mail, audio, video) per month, somewhat less than the average US user, who is connected an average of 11.9 days.

Women currently represent only 46% of the US online population but are more active on the Internet than their male counterparts. Over the past three months, women have consistently spent 32% more time surfing the Web and have viewed 30% more unique pages than men.

And since women are being exposed to more advertising by being on the Web more, women also click on more banners. In July, women clicked on an average of 4.3 banners, compared to just 2.2 for men.

The number of home Internet users is still increasing in Europe. The UK now stands at 10.20 million, Germany at 10.47 million and France at 5.81 million.

## Three.co.uk Domain Names Registered Every Minute


There are now 150,000 new.co.uk domain names registered every month, that works out at a whopping three domains registered per minute. Registering domain names has now become more popular than stealing cars in the UK; during 1999 an average of two cars were stolen per minute.

These figures were issued by the UK naming authority Nominet **<www.nominet.org.uk>** at its Annual General Meeting. Analysis of the figures reveals that the number of co.uk names registered hit a peak in March 2000, with 245,000 names registered, and is now levelling out at around 150,000 per month.

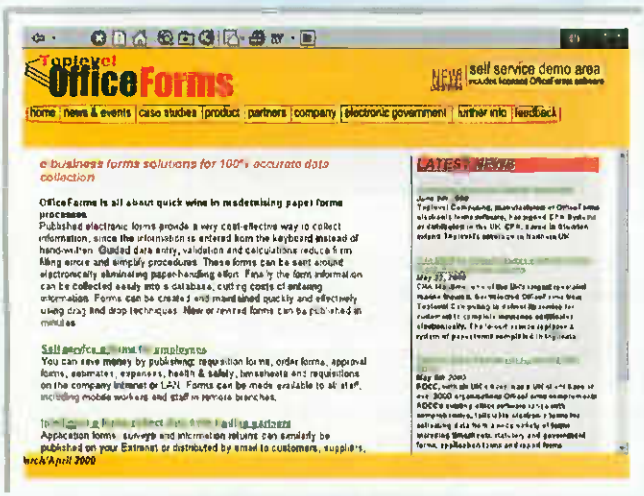
Just over 10% of the total number of domain names registered worldwide are now .co.uks. According to DomainStats at (www.domainstats.com), as of July 2000 there were 17,804,717 domains registered worldwide - 9,482,427 were dot coms and 1,938,740 were .co.uks.

After .com, .net and.org, .co.uk is the most popular country domain, beating Germany's .de into second place.

The success of the .co.uk domain backs up research carried out by The Henley Centre at **<www.henleycentre.co.uk>**, which revealed that amongst UK shoppers 50% of the most trusted sites have a .co.uk suffix. So it seems that snatching up a great .com domain name isn't the holy grail of e-commerce.

This will come as good news for those yet to buy a domain name, considering there are no three letter dot coms left and 97% of the words in Webster's dictionary have already been registered as dot coms.

## Government Internet Targets Won't Be Met




Research from UK electronic forms manufacturer Toplevel Computing at **<www.toplev.com>** indicates that central government is way off course for meeting the targets for 'joined up government'. Less than 4% of survey respondents use electronic statutory and government forms, making government the most paper-dependent of all categories assessed.

Requisitions have the highest degree of being considered electronic (40%) among UK organisations, although only 13% of respondents claimed to be successful in eliminating paper entirely from the equation.

The survey revealed that in fact the majority of companies that use some kind of electronic form are also using paper for the same document. Printing out an expenses claim form completed on a spreadsheet accounts for about one quarter of the usage of expenses forms.

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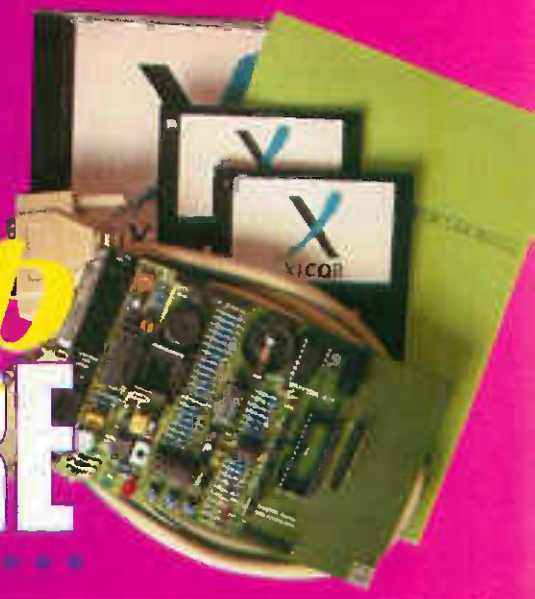

# Readership QUESTIONNAIRE

*Please indicate what you think of editorial coverage in the following areas:*

| | EXCELLENT | GOOD | AVERAGE | POOR |
|---|---|---|---|---|
| Projects | ☐ 001 | ☐ 002 | ☐ 003 | ☐ 004 |
| Features | ☐ 005 | ☐ 006 | ☐ 007 | ☐ 008 |
| Reviews | ☐ 009 | ☐ 010 | ☐ 011 | ☐ 012 |
| News | ☐ 013 | ☐ 014 | ☐ 015 | ☐ 016 |
| Chat Columns | ☐ 017 | ☐ 018 | ☐ 019 | ☐ 020 |

*Please indicate whether you would like to see more or less space devoted to the following areas:*

| | MORE | ABOUT RIGHT | LESS |
|---|---|---|---|
| **PROJECTS:** | | | |
| Beginners' | ☐ 021 | ☐ 022 | ☐ 023 |
| Intermediate | ☐ 024 | ☐ 025 | ☐ 026 |
| Advanced | ☐ 027 | ☐ 028 | ☐ 029 |
| **PROJECTS CATEGORIES:** | | | |
| Computer | ☐ 030 | ☐ 031 | ☐ 032 |
| Audio | ☐ 033 | ☐ 034 | ☐ 035 |
| Amateur Radio | ☐ 036 | ☐ 037 | ☐ 038 |
| Innovative Ideas | ☐ 039 | ☐ 040 | ☐ 041 |
| Radio Control | ☐ 042 | ☐ 043 | ☐ 044 |
| Model Railway | ☐ 045 | ☐ 046 | ☐ 047 |
| Electro-Music | ☐ 048 | ☐ 049 | ☐ 050 |
| Motors/Automotive | ☐ 051 | ☐ 052 | ☐ 053 |
| Test Equipment | ☐ 054 | ☐ 055 | ☐ 056 |
| Security | ☐ 057 | ☐ 058 | ☐ 059 |
| Car Electronics | ☐ 060 | ☐ 061 | ☐ 062 |
| Robotics | ☐ 063 | ☐ 064 | ☐ 065 |
| Photographic Electronics | ☐ 066 | ☐ 067 | ☐ 068 |
| Video Electronics | ☐ 069 | ☐ 070 | ☐ 071 |
| Satellite TV | ☐ 072 | ☐ 073 | ☐ 074 |
| Novelty/Gadgets | ☐ 075 | ☐ 076 | ☐ 077 |

WIN WIN WIN WIN WIN WIN

*Please indicate what you think of editorial coverage in the following areas:*

| | EXCELLENT | GOOD | AVERAGE | POOR |
|---|---|---|---|---|
| **Projects** | ☐ 001 | ☐ 002 | ☐ 003 | ☐ 004 |
| **Features** | ☐ 005 | ☐ 006 | ☐ 007 | ☐ 008 |
| **Reviews** | ☐ 009 | ☐ 010 | ☐ 011 | ☐ 012 |
| **News** | ☐ 013 | ☐ 014 | ☐ 015 | ☐ 016 |
| **Chat Columns** | ☐ 017 | ☐ 018 | ☐ 019 | ☐ 020 |

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| **Model Railway** | ☐ 045 | ☐ 046 | ☐ 047 |
| **Electro-Music** | ☐ 048 | ☐ 049 | ☐ 050 |
| **Motors/Automotive** | ☐ 051 | ☐ 052 | ☐ 053 |
| **Test Equipment** | ☐ 054 | ☐ 055 | ☐ 056 |
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| **Car Electronics** | ☐ 060 | ☐ 061 | ☐ 062 |
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| **Video Electronics** | ☐ 069 | ☐ 070 | ☐ 071 |
| **Satellite TV** | ☐ 072 | ☐ 073 | ☐ 074 |
| **Novelty/Gadgets** | ☐ 075 | ☐ 076 | ☐ 077 |
| | **MORE** | **ABOUT RIGHT** | **LESS** |
| **FEATURES:** | | | |
| **Multimedia** | ☐ 078 | ☐ 079 | ☐ 080 |
| **Computer Hardware** | ☐ 081 | ☐ 082 | ☐ 083 |
| **Computer Software** | ☐ 084 | ☐ 085 | ☐ 086 |
| **Audio** | ☐ 087 | ☐ 088 | ☐ 089 |
| **Radio Control** | ☐ 090 | ☐ 091 | ☐ 092 |
| **Model Railways** | ☐ 093 | ☐ 094 | ☐ 095 |
| **Science & Technology** | ☐ 096 | ☐ 097 | ☐ 098 |
| **Electro-Music** | ☐ 099 | ☐ 100 | ☐ 101 |
| **Internet** | ☐ 102 | ☐ 103 | ☐ 104 |
| **Construction Techniques** | ☐ 105 | ☐ 106 | ☐ 107 |
| **Amateur Radio** | ☐ 108 | ☐ 109 | ☐ 110 |
| **Video** | ☐ 111 | ☐ 112 | ☐ 113 |
| **Satellite TV** | ☐ 114 | ☐ 115 | ☐ 116 |
| **Telecommunications** | ☐ 117 | ☐ 118 | ☐ 119 |
| **Professional Electronics/Manufacturing** | ☐ 120 | ☐ 121 | ☐ 122 |
| **Testing/Fault-Finding** | ☐ 123 | ☐ 124 | ☐ 125 |
| **NEWS:** | | | |
| **Consumer/Domestic Electronics** | ☐ 126 | ☐ 127 | ☐ 128 |

| | | | |
|---|---|---|---|
| Industrial/Commercial Electronics | ☐ 129 | ☐ 130 | ☐ 131 |
| **REVIEWS:** | | | |
| Embedded Development Tools | ☐ 132 | ☐ 133 | ☐ 134 |
| Compilers and Emulators | ☐ 135 | ☐ 136 | ☐ 137 |
| Embedded Internet Packages | ☐ 138 | ☐ 139 | ☐ 140 |
| Language Products | ☐ 141 | ☐ 142 | ☐ 143 |
| **REGULARS:** | | | |
| Technology Watch | ☐ 144 | ☐ 145 | ☐ 146 |
| Comment | ☐ 147 | ☐ 148 | ☐ 149 |
| Circuit Maker | ☐ 150 | ☐ 151 | ☐ 152 |
| Research News | ☐ 153 | ☐ 154 | ☐ 155 |
| Readers' Letters | ☐ 156 | ☐ 157 | ☐ 158 |
| Competitions | ☐ 159 | ☐ 160 | ☐ 161 |
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|---|---|---|---|
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| Regulars | ☐ 176 | ☐ 177 | ☐ 178 |

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|---|---|---|---|---|---|
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| Electronics Weekly | ☐ 189 | ☐ 190 | ☐ 191 | ☐ 192 | ☐ 193 |
| Elektor Electronics | ☐ 194 | ☐ 195 | ☐ 196 | ☐ 197 | ☐ 198 |
| Electronics & Wireless World | ☐ 199 | ☐ 200 | ☐ 201 | ☐ 202 | ☐ 203 |
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| Music Magazines | ☐ 214 | ☐ 215 | ☐ 216 | ☐ 217 | ☐ 218 |
| Video/Satellite TV Magazines | ☐ 219 | ☐ 220 | ☐ 221 | ☐ 222 | ☐ 223 |
| Computer Magazines | ☐ 224 | ☐ 225 | ☐ 226 | ☐ 227 | ☐ 228 |
| Amateur Radio/CB Magazines | ☐ 229 | ☐ 230 | ☐ 231 | ☐ 232 | ☐ 233 |
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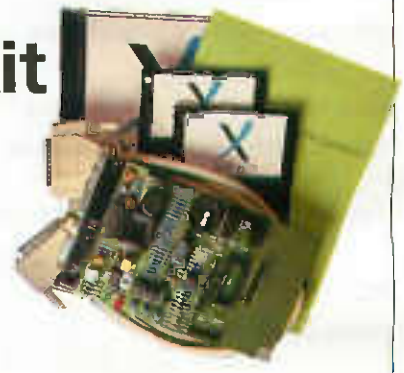


## A New Class of E-mail Launches on the Internet

Businesses need no longer expose themselves to the security risks of sending ordinary e-mail, as a new class of electronic messaging and document exchange has been officially launched by e1mail - Encrypted 1st Class Mail.

Using encryption technologies, e1mail.com at **<e1mail.com>** has created a new class of electronic messaging that ensures privacy for firms communicating over the Internet.

Businesses can use e1mail.com to set up a secure group account to exchange encrypted documents between their staff members and external clients. A firm can manage and track their secure online communications.

## Demon Goes Live With Remote E-mail and WAP content

Customers on the move now have access to a range of WAP content through Demon, the Internet brand of Thus at **<www.letitbethus.com>.**

Its service, Demon Now, has been designed to give mobile users access to particular content for WAP and real-time information, as well as send and receive e-mail. Demon customers can now access Demon content whenever and wherever they are.

The new service has been developed after Thus linked up with Nokia earlier this year to provide WAP solutions.

In the initial phase, customers will be able to use a service to read and reply to e-mails and access content from their mobile phones, via WAP. This will be done remotely from their existing Demon account so there will be no need to set up a new account.

The e-mails will also be sent to the customer's PC, so when they return to the office or home, the same e-mails can be read there.

Plans are also underway for employees of Demon corporate customers to be able to access corporate information from their WAP-enabled mobile phones. This will provide employees with mobile access to company news, employee contact directories and business critical information.

## Go2Call Provides Free Web-based Calling


International PC-to-phone service provider, Go2Call, has announced expansion of its free, one-click calling service to the US and Canada after initial trials in the UK since June 2000.

Using Go2Call's Web-based technology, online consumers from anywhere in the world can now easily place calls from their computers to telephones in the US and Canada, as well as the UK, Ireland and Germany.

Since the introduction of free calling services, the number of Go2Call members has doubled every two weeks and members from 170 countries have placed millions of minutes of calls.

Internet calling is a rapidly growing market and according to recent analyst projections published in Business Week, is expected to account for 17% of global telecom traffic by 2003.

To place free calls using Go2Call, members simply log-on from the Go2Call home page at **<www.go2call.com>** enter the number they wish to call and hit 'go'. For convenient access to frequently called numbers, members can also place a one-click call from their personalised, Go2Call address book.

Go2Call's free calling service is available to anyone with Internet access, a multimedia computer, speakers and a microphone. For the best quality calls, a 28k or greater connection speed, and a headset, are recommended.

## Herds Go Mobile as Farmers Trace Cows via WAP


Farmers can now send details of their cattle herds to a central database, over a WAP mobile phone. Braidgrove.com at **<www.braidgrove.com>** has adapted its Elite Traceability software to allow animal records to be instantly updated, no matter how remote the location of the farmer.

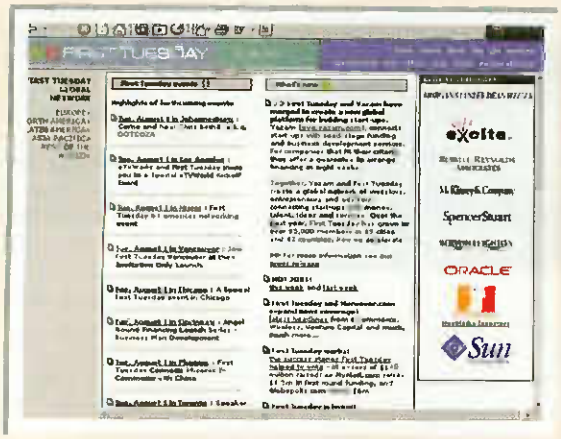
The tracking system centralises herd information, gives access to all data, including family history and movement details and provides evidence of quality in the event of future health issues. Providing this information electronically reduces farmers' administrative burden and helps them to comply with the legal requirements of cattle registration.

A cattle movement was recorded via WAP for the first time at the recent Royal Highland Show. A farmer notified a local cattle mart of his intention to move an animal. When the cow arrived, a mart official confirmed its presence over his WAP phone, by identifying the UK tag number.

When the Mart Office checked which animals were on the premises for sale, the data was already there and the British Cattle Movement Service (BCMS) had also been notified.

Farmers can access Elite Traceability to conduct all statutory record-keeping and BCMS notifications via the Braidgrove call centre or their PC. The addition of WAP may be followed by the ability to record cattle and sheep data through set top satellite and cable TV boxes, via the Internet.

## First Tuesday Seeks Cure for WAPlash



Apparently people frequently ask Bob Geldof, "Is the Internet the new rock and roll?" To which he answers, "Yes, but there's a lot more sex in rock and roll!"

Or so Theresa Wise, senior consultant with Andersen Consulting, related at the First Tuesday Classic Event in London at the beginning of September.

First Tuesday at **<www.firsttuesday.com>** is the global meeting and market place for startups, connecting people, ideas, money and services. Founded in October 1998 it swiftly grew to 17 cities by September 1999.

The event was devoted to the subject of wireless, bringing together "all of us who are trying to grasp the potential of this ubiquitous platform," as First Tuesday's Chief Executive Officer, Reade Fahs, put it.

Moderator Tom Standage, technology Correspondent for The Economist, opened by observing that wireless today reminded him of the Internet in 1994. Everyone was complaining then about the lack of interesting content and applications.

Despite the hype, consumers so far were disappointed by the limits of wireless - and so, the WAPlash has occurred.

Steve Bowbrick, founder of another.com, reminded the audience of wireless' appeal to the young. 50% of his users were between 15 and 24. Fifty percent of them shopped online, although only 60% were old enough to own a credit card.

Theresa Wise, of Andersen Consulting, said wireless applications opened the way for increased revenue streams, however, these brought with them increased variables.

Johan van de Steen, founder of digitalRUM, introduced his business model as a case study. DigitalRUM is providing technology to Virgin Mobile enabling shoppers to compare the prices of products and to transact online, while in stores looking at the products they'd like.

In discussing the potential profitability of wireless, Malcolm Ross, Business Development Director for the incubator iWorld said his company eschewed the pursuit of cutting edge technology. Instead, he drew inspiration from the film, 'Butch Cassidy and the Sundance Kid'.

"When asked, 'why do you rob banks?' in the film, they answer, 'because that's where the money is'."

In other words, iWorld's take was shameless in terms of how clever, or, not, applications were, as long as they could be profitable.

To which an audience member later felt moved to deride the panel for failing to acknowledge that, "Wireless should be just like TV - able to deliver an audience to an advertiser".

And drew from moderator Tom Standage the concession that perhaps wireless was indeed not like the Internet in 1994, but more like - the Internet in 1995.

## AOL Unveils New Look UK Web Site

AOL UK has redesigned its **<www.aol.co.uk>** portal to make it even more convenient and easy for members to use and to give non-members a better 'taste' of the AOL proprietary service.

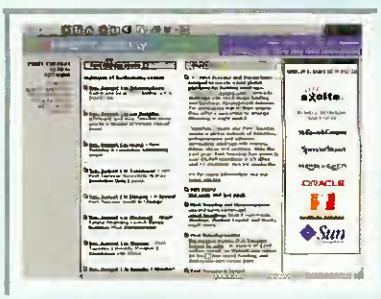
The portal has been structured to give current members a Web-based 'home away from home' - an additional means of gaining access to key AOL features such as e-mail and AOL Instant Messenger when they are away from their own PC and cannot gain access to the AOL proprietary service.

Members can access these services using any computer with Internet access - from the desktop at work in the office to an Internet cafe on the other side of the world. This forms an important extension to the 'AOL Anywhere' strategy, to make AOL's world-class services and features available to members anytime, anywhere across a range of devices.

Key services on offer include shopping, Web centres and daily essentials. Web centres include some proprietary AOL content including AOL guest columnists such as Russell Grant, John Gribbin and Matt Whyman, as well as the best of the Web. 'Open all hours' chat rooms, including the ever-popular AOL Pub, also offer lively discussion on a range of topics and interests.

Prospective members will get a clearer idea of what's on offer on the AOL proprietary service with the introduction of the 'AOL showcase'. Here, Connie, AOL's online genie, will take visitors on a quick tour of the service, showing its key features. There is also information about AOL's current pricing, downloads and order forms for a free trial of the AOL service.

## Bango.net Provides 400 Million Home Pages for GSM Phones



Bango.net at **<www.bango.net/sms>** announced today that it has reserved approximately 400 million Bango Numbers for immediate, free availability to any mobile phone user.

By sending a single SMS message to Bango.net, a user can claim their mobile number as a Bango Number and can create their first message that can be seen by tens of millions of WAP and Web users worldwide - at no further cost to the phone user.

The initiative represents massive future expansion of the Bango Service. This allows people anywhere in the world to send SMS messages to Bango.net to update their Bango Text entry or Web page URL without relying on Internet access.

This new offering expands the Bango Service to enable mobile phone users to share and broadcast up-to-the-minute information quickly and conveniently. Bango users simply send an SMS message from their mobile phone to Bango.net and a Bango Text number will be created which matches the user's full international mobile number.

After establishing the Bango Text number, any SMS message that the user sends to the Bango Service will be linked to the Bango number as Bango Text, allowing Internet or WAP users to read the message from anywhere in the world by entering the international mobile number as a Bango number.

## Must Have High-Tech Accessory

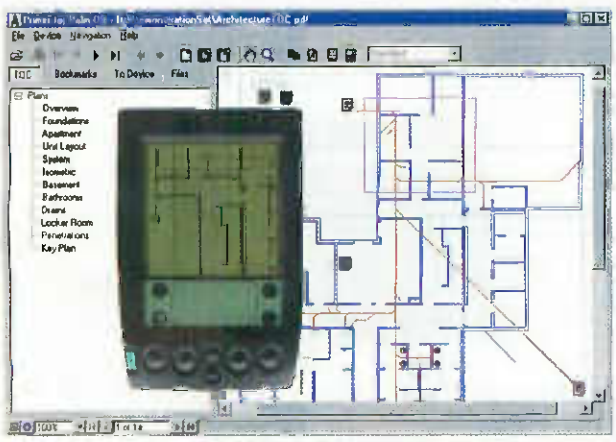

According to new research from Jupiter Communications at **<www.jup.com>**, nine out of 10 university students are now Internet users. This has changed the way they communicate with family and friends.

While email is still very popular, more students are taking electronic communication further by using small, affordable PC video cameras to send video clips with their email messages, as well as engaging in video chat.

Beyond video mail, others are using an exciting variation on the Internet video camera theme-the Webcam. From taxicabs to backstage areas of popular TV shows to college dorms, Webcams are now letting people share their lives online.

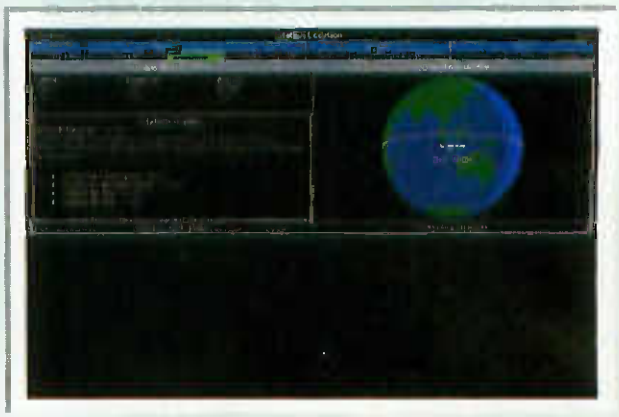
The Logitech QuickCam Web includes the SpotLife Personal Broadcasting feature, which enables users to stream live video and audio over the Internet for free with the simplicity of point, click and broadcast. The technology provides students away at school with a new way to visually share life's ongoing experiences - live, over the Internet.

## PDF Viewer for Palm Announced



Ansyr Technology has launched a PDF viewer for Palm OS enabling users of Palm OS to access documents published in the Adobe PDF standard. For further information, check: **<www.ansyr.com>.**

## NASA Web Site Lets Sky Watchers Track International Space Station



As orbital assembly of the International Space Station begins to pick up speed, star gazers and space enthusiasts can track the progress of construction on the ambitious space research facility - and they can do it with the naked eye.

A Web site developed at NASA's Marshall Space Flight Centre is making it easy and exciting for enthusiasts across the country and around the world to catch a glimpse of the orbiting facility. The Liftoff to Space Exploraion Web site at **<liftoff.msfc.nasa.gov>** lets users identify the orbiting Space Station - and determine in advance when it will pass over their location.

The site relies on a Java-based program called J-Pass, developed by Patrick Meyer, a data systems engineer at the Marshall Center. J-Pass displays user-friendly tracking information provided by the North American Aerospace Defence Command (NORAD). It permits site visitors to track not only the International Space Station, but also the Russian station Mir, Space Shuttle missions, and other objects in Earth orbit.

Orbiting at more than 200 miles above the Earth, the Space Station is quickly growing into one of the brightest permanent fixtures in the night sky. Currently consisting of the American connecting module Unity and the Russian modules Zarya and Zvezda, the Station circles the planet approximately 16 times per day, traveling at 17,500 mph in an orbit varying 208 to 285 miles from Earth.

Because it reflects sunlight down to Earth, the Space Station often looks like a slow-moving star as it crosses the sky. That deceptive appearance can fool a casual viewer. But it also makes sighting the Station easier if one knows when and where to look for it.

The best time to catch a glimpse of the Space Station is near dawn or dusk, when the viewer is in near-darkness and the passing Station continues to reflect light from the rising or setting Sun.

The J-Pass program provides users with optimal visibility times for their locations. Detailed sky charts, including positions of visible planets and bright stars to use as reference points, can be printed for outdoor use. The program even estimates the expected brightness of the Space Station as it passes overhead.

Viewed under optimal conditions, the Station has been observed to appear nearly as bright as the star Sirius. When construction is complete, estimates suggest the 470-ton city in space will be brighter than the planet Venus.

## Web Acceleration Company Finds Unexpected European Market


SolidSpeed Networks at **<www.solidspeed.com>** a new company organised to speed up the viewing of Web pages in the US, received an unexpected bonus when European Web site owners began to tap into their service.

"We launched on June 6, and among the first 300 Web sites signing up for service are several from the UK, Germany and France," said SolidSpeed spokesperson Dean Massab.

"European Web site operators wanting to do business with Americans have found we have the answer to their most pressing need—faster content delivery."

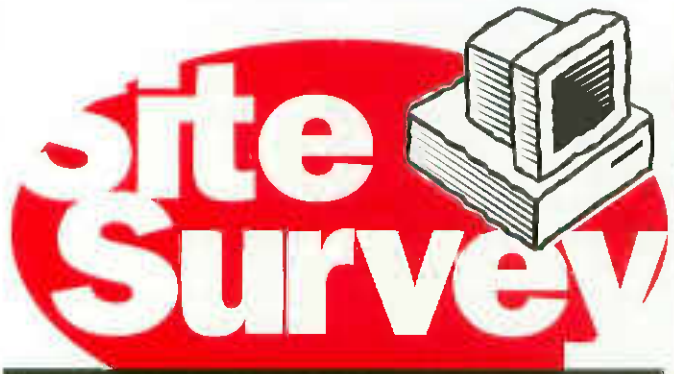
"If your European Web site is cached in a network in the US, viewing a Web page will be much quicker than going back and forth to Europe."

"And if your site is located at several sites throughout the US using the SolidSpeed solution, your Web page will load up to 1000% faster. That is a tremendous benefit for European Web owners wanting to sell products or convey information to the US."

SolidSpeed Networks, Inc. uses intelligent routing that allows pages to bypass Web traffic jams delivering the content from multiple locations.

"By employing multiple sites, when users come into our system we route them to the quickest site which avoids the bottlenecks," says Zeeff.

SolidSpeed Web acceleration service is free to Web sites receiving 30,000 or fewer hits per month. To sign up, go to **<www.solidspeed.com>.**




## Destinations of the month


Anyone planning a purchase of a digital camera obviously likes to read reviews of them and find out technical details and specifications before they buy. A number of Websites on the Internet can help in this respect. First off, try the Digital Camera Resource Page, at: **<http://www.dcresource.com/>**, where'll you'll find details of most available digital cameras, plus hints and tips. Next, try: Steve's Digicams, at: **<http://www.steves-digicams.com/>** ; Imaging Resource, at: **<http://www.imaging-resource.com/>** ; and Digital Photography Review, at: **<http://www.dpreview.com/>.** One way or another, you should be able to locate all the information you need about any digital camera prior to making your selection.

The US government is planning a large scale initiative to open up its work and resultant documents to the general public, and the front-end of is the FirstGov Website, at: **<http://firstgov.gov/>.** Although at the time of writing the site isn't fully operational (well, not operational at all, really), it should be up-and-running by the time this issue is published.


For those interested in maps, a number of new Websites aim to please. The UK's Ordnance Survey has recently launched its Get-a-map service that allows users to locate area maps easily. It's available at: **<http://www.ordsvy.gov.uk/home>** . For younger map enthusiasts, the Ordnance Survey's Mapzone, at: **<http://www.mapzone.co.uk>** presents information in a more fun-filled way. Finally, first edition historic maps are available for many places, at the Counties Gazetteer, at: **<http://www.old-maps.co.uk>.**

# Automated ENVIRONMENTS

## *Your home will never be the same again! An overview by Reg Miles*

The last century saw many ideas for homes and environments of the future in which automation was a central feature (with the underlying message that technology brought and was essential for a happy life). In this century it actually looks as if these visions are going to come true: everybody, or so it seems, is working on automating the home and the workplace, *and* everywhere in between. Plans and projects, developments and demonstrations are coming at an accelerating rate - happiness is just around the corner!

What has been lacking up to now has been a practical and acceptable means of integrating the many similar and disparate parts into a coherent whole. The solution has been a three part one. The development of embedded microelectronics of a cost and size and with a computing power that makes them suitable for integrating into just about everything. The means of interconnecting the devices - with and without wires. And the means for them to communicate with and comprehend one another via those interconnections.

This 'ubiquitous computing' approach was first mooted in the Computer Science Laboratory of the Xerox Palo Alto Research Center (PARC) in the late 1980's and early 1990's. The concepts that make the headlines today, such as microwave ovens connected to the Internet for downloading recipes, were thought of in Xerox PARC. The basic idea was that the computer, through its multiplicity, should become invisible to the user - a background environment (the opposite to the concept of the computer as a personal helper, where it is the centre of attention). What we think of as computers now would metamorphose into inexpensive peripheral devices consuming little power, wirelessly interconnected to each other and to workstations, and software systems implementing ubiquitous applications, with which people would be continually interacting. The people at Xerox PARC developed three prototype devices: the Board, the Pad and the Tab - large, medium and small, as an initial stage in the development of ubiquitous computing. The first was a large display equivalent to a whiteboard or a video screen, the second equivalent to a notepad, and the third equivalent to a Post-It note. It was envisaged that there would be one or two Boards in an office or a home, ten to twenty Pads, and anything up to a hundred Tabs; the idea being that people would use whatever was the right thing for the moment - going to a Board or having Pads and Tabs on desk or table (the computer 'desktop' returned to a real desktop for work in progress).

The Board measured 40x60in (the same 1.5:1 aspect ratio as 35mm film), with a black and white display of 1024x768 pixels; and was used with 'electronic chalk', either in contact with the display surface or at a distance. This was subsequently manufactured by Xerox as the Liveboard (now discontinued). The Pad had a 640x480 writing and display surface, using a PARC designed electronic pen with an integral microphone. It used infrared communication to be compatible with the Tab and near-field radio communication - it could also be plugged into a 1Mb/s Ethernet connection, with power supply and battery charger. The Tab had a touch sensitive LCD black and white screen with 128x64 pixels. In addition to displaying an on-screen keyboard for 'typing' in messages, they could be written using a new alphabet called Unistrokes, based on the English alphabet (see Figure 1). The full screen was used for writing each character, and the English equivalent was displayed. As the name implies, each character could be written in a single stroke.

Some examples of Tab applications were a weather forecast display, a calendar manager, a dictionary, a thesaurus, a Unix file browser (which, in the context of the user and their location, could filter the information to show only the files that were relevant), the means of minimising a running application on a workstation and transferring its icon to the Tab for subsequent use in another place, a connection to the World Wide Web, media windowing to receive a low-resolution frame of slow-scan video, e-mail, a mouse-like pointing device, and a remote control.

The Ubiquitous Computing project has ended at Xerox PARC; but the ideas are kept alive by researchers in other places. One such being the Center for Strategic Technology Research at Andersen Consulting (also in Palo Alto). Their HomeLab employs an environmental user interface to replace the GUI (the latter invented at Xerox PARC, incidentally); the idea being that ubiquitous computing needs a ubiquitous interface. Thus, in addition to employing speech processing to receive and respond to spoken commands, a variety of appliances and objects are treated as input and output devices - including chairs, and the home itself responds to the occupants through a disributed system of agents (small programs) that are each responsible for a particular aspect of the environmental interface. This multimodal interface requires quite a degree of parallelism to cope with multiple, simultaneous events; but the information that is gleaned from each modality can be compared with the others to aid its comprehension of the whole and fine-tune its responses. HomeLab is also capable of learning peoples behaviour patterns (for example, if someone sits down in a chair every night and switches on a desklamp, it will associate the two and start to switch it on for them). So it is also an intelligent environment.

The University of Colorado has something similar in its Adaptive House - but this is a real house in Boulder. In this case it is designed to balance the comfort of its occupants with conservation of energy. Thus, it will switch on the lighting at a low level and only raise that if the occupants continually increase the level; likewise, its anticpation of when to switch on the heating and at what level is governed by both conservation and its occupants behaviour patterns.

Its control system is known as Adaptive Control of Home Environments (ACHE), which manipulates 22 banks of lights (each having 16 intensity levels), 6 ceiling fans, 2 electric space heaters, a water heater, and a gas furnace, using 75 sensors. The system also relies on information such as outdoor temperature, the varying costs of gas and electricity, and the time of day and day of the week to perform its balancing act and serve the learned habits of its occupants.

Returning to rooms in laboratories, the Massachusetts Institute of Technology's Artificial Intelligence Lab has been experimenting with intelligent environments for some years: rooms filled with cameras, microphones and video projectors, with a variety of sensors in walls and ceilings, to recognise people, track their movements, hear them, decode their

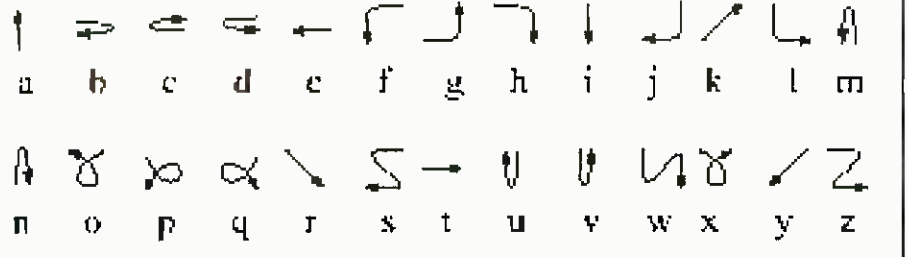



**Figure 1. The Unistrokes alphabet**

**Figure 2. Philips radio tokens in receiving vase**

speech, and recognise when (and to what) they are pointing. All these disparate aspects are linked in order that they may reinforce each other. Knowing where people are located can improve the accuracy of speech recognition - at least in limited circumstances: if they are near to, and pointing at, a projected map, for example, they are more than likely to be discussing some aspect of that map, which limits what the speech recognition software has to cope with.

In order to facilitate the running of the system the MIT researchers have developed a dedicated programming language called 'Metaglue' - an extension of the Java programming language - designed to address the specific needs of intelligent environments. Such as interconnecting and managing all the disparate hardware and software components; controlling assemblies of small, interacting software agents; adding and removing components without stopping the system; changing or upgrading components without taking everything apart; controlling the allocation of resources; and providing a means to retrieve information about the state of any part of the system at any time past or present.

To expand on these activities the Laboratory for Computer Science and the Artificial Intelligence Laboratory has instigated the MIT Oxygen Alliance: a five year project with the aim of 'making computer power as pervasive as the oxygen in the air we breathe'. Oxygen will involve configurable generic devices, either handheld or embedded in the environment, which will bring computation wherever and whenever it is needed; and as people interact with these 'anonymous' devices, they will adopt our information personalities. MIT researchers will work with those from six companies: Acer, Delta

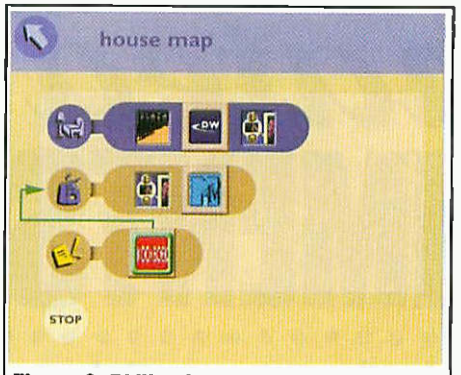



**Figure 3. Philips house map screen**


**Figure 4. Philips finder screen**

Electronics, Hewlett-Packard, Nippon Telegraph and Telephone, Nokia Research Center and Philips Research.

The Oxygen Alliance is mainly concerned with increasing productivity. However, Philips Research is taking a broader approach in its own 'future home environment' project - Window on the World of Information, Communication and Entertainment (WWICE). Three rooms in the laboratories at Eindhoven have been turned into lounge, kitchen and study for realistic testing of the home system. And, as part of the new Philips High Tech Campus, a new laboratory called HomeLab (coincidence?) is being built - a real house, with the addition of observation and control rooms.

WWICE is a networked system of digital audio and video devices together with a PC, having a uniform user interface that enables people to think of performing 'activities' rather than thinking about the equipment and programming that performs them. These activities are mobile, so that someone listening to music in the lounge can go into the kitchen and continue to listen, or someone using a computer in the study can take the screen display to the TV in the lounge.

One way of achieving this movement is by the use of a 'Token' (see Figure 2): this relies on RF identification (RFID) technology; each one contains a transponder and each room has a detection area - the vase with an antenna in its rim (which also helps to prevent them getting lost). When a Token is taken from the vase the current activity is selected for relocation, and the movement is accompanied by a tinkling sound with up-going pitch (apparently to create the feeling of using a magic wand); when the Token is placed into a vase in another room it is accompanied by a down-pitch tinkling sound. There are also LEDs in the base of the vase to provide feedback when a Token is moved. An earlier version of activity relocation used a simple infrared remote control to switch between rooms. Alternatively, the House Map can be used to relocate, or stop, activities (see Figure 3). Starting activities is the province of the Finder (see Figure 4), which provides an overview of all content and activities, and is started by accessing the content - eg, a TV

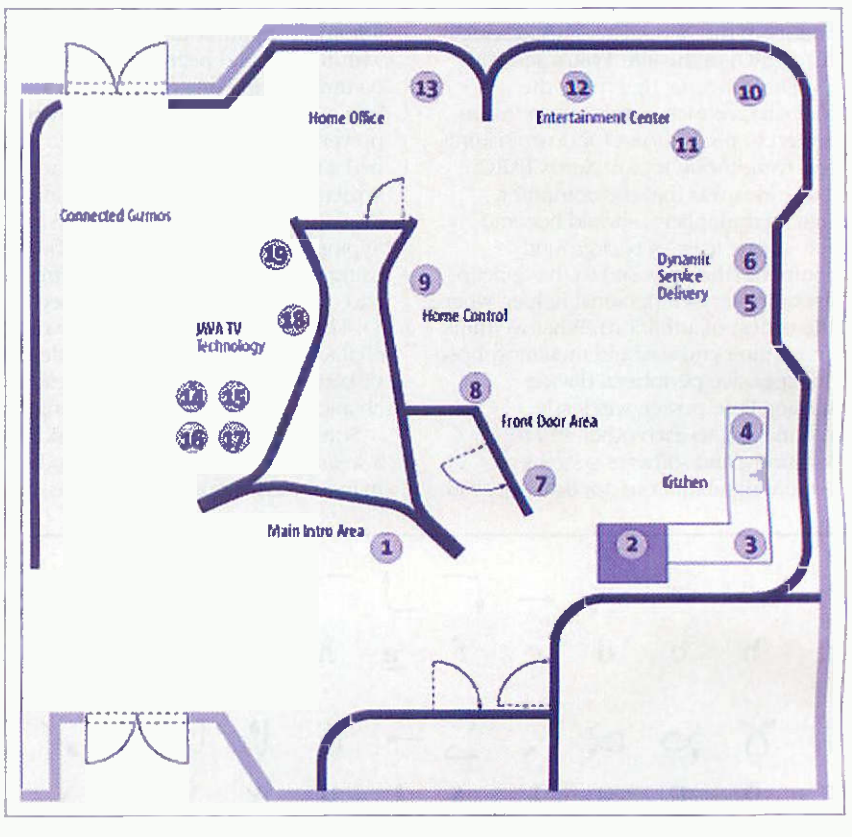



**Figure 5. Sun.com home floor plan**

programme - rather than the activity. A screen Menubar shows all the activities in that location, and allows switching between them, in addition to accessing the House Map and Finder. A further development is the use of voice control.

The network is based on IEEE1394 (i.Link or FireWire). This has the advantage of low cost but high performance, with data rates of up to 400Mb/s and support for plug&play - with higher rates and wireless connection being under development.

Philips has also exhibited a broader concept, The Home of the Near Future. This included 'Emotion Containers' and 'Interactive Family Tree' - personalised devices that store memories in the form of sound, dates, images, text and even smell; a 'Food analyser' that weighs food and provides information about its calories, carbohydrates and vitamin levels; a 'Bathroom Mirror' that displays information and entertainment programming, and recharges personal products; a 'Bookshelf' with interactive books; an 'Interactive Tablecoth' that provides inductive, cable-free power to all chargeable objects on the table surface.

Another house of the future is the Sun Microsystems .com Home (dot com), exhibited early this year in conjunction with Cisco Systems and GTE. This used Sun's Java and Jini to integrate a wide range of products, including prototypes, from a range of manufacturers (Java, a set of technologies for creating and running software programs in both stand-alone and networked environments; Jini, a set of Java APIs that enable transparent networking of devices and services without the need for user intervention). The floor plan illustrates how it was divided up into functional areas; with the numbers representing individual products or groups of co-functioning products (Figure 5).

In the Entrance area the Cisco Internet Home Gateway server (1) enabled all the networked appliances to communicate with each other and with a variety of Internet services via an always open broadband connection. Standards for this are being developed by the Open Services Gateway initiative (OSGi). In the Kitchen area the Whirlpool refrigerator (2) had a handheld Web panel, used for controlling other appliances and accessing the internet for recipes and shopping. In the Entertainment area Sony had a range of consumer products in an IEEE1394 network (10), and a MiniDisc camcorder with a PersonalJava powered touch panel (11); while at (12) there was the Sharp Multimedia phone, with customised applications possible using PersonalJava API. In the JavaTV Technology area BBC America demonstrated an interactive version of "Top of the Pop's" on a Philips digital STB (16), highlighting the JavaTV API for interactive programming. And, the last example, Connected Gizmos with its Digital Meeting Assistant turns any whiteboard into an electronic whiteboard.

Another computer company, Intel, has developed and exhibited the e-Home. Again,with the emphasis on linking everything to the Internet. According to the press backgrounder, 'Intel envisions that essentially every home worldwide will


**Figure 6. Intel Dot.Station web appliance**

ultimately become an e-Home, where communication, content and commerce are available anywhere in the home. This vision is independent of infrastructure, topology, or product and device type; it assumes only that the Internet is the common transport mechanism.'

One product that has emerged from this is the Dot.Station web appliance (see Figure 6), that combines e-mail, Web access, a built-in phone and home organiser applications. And, something that is not usually addressed, toys: the Intel Play Line includes a computer microscope, and the Me2 Camera that simulates an on-screen virtual reality experience.

As an extension of the e-Home, Intel and Sony have begun collaborating to facilitate the sharing of electronic content between consumer devices and PCs. They will work on the possibility of bridging Universal Plug & Play (uPnP) and Home Audio Video interoperability (HAVi). In addition, they will attempt to establish industry-wide adoption of the Digital Video Interface (DVI) for the next generation flat panel PC displays. They are also working on 5C Digital Transmission Content Protection (DTCP) bus encryption technology, and will work on establishing interoperability between the Intel Software Integrity System and Sony's OpenMG copyright protection technology. Both companies plan to announce products that support the e-Home vision.

Most of these experimental homes and offices combine a variety of network interconnections, and there are a growing number of them that are suitable for different purposes, with different ranges in the case of wireless devices, and the ability to carry different data rates. These include HomePNA (phone line), CEBus, Lonworks and X10 (AC power line), Bluetooth (named by Ericsson after a 10th Centry Viking king, Harald Blatand (Bluetooth) - see the application and training toolkit, Figure 7) and HomeRF (radio frequency), and IrDA (infrared). Yet another computer company that is anticipating a great future for what it calls 'Pervasive Computing' is IBM. It has joined forces with other IT and telecom industry leaders to develop and promote a variety of global standards initiatives, including Bluetooth, Wireless Application Protocol (WAP), OSGi, and others. Which also ties in with the Next Generation Internet - always on, broadband, and increasingly accessed through mobile devices (the new Internet Protocol version 6 (IPv6) will provide addresses for them all by changing from 32 to 128 bits, with enhanced security - the Internet Protocol is the numbers behind the domain names). What it cannot do is provide a person with a single, portable address that can be switched between all their devices and that accompanies them wherever they go.

Xerox PARC was attempting to overcome that same problem for the needs of Ubiquitous Computing, but never succeeded.

More recently, researchers there have been experimenting with embedding electronic tags in documents, printers, books and appliances that would be activated in the proximity of a triggering device, such as a special wristwatch or portable computer. These could provide automatic identification, and additional information and functions. A lost item could be easily located, a book could provide more information about its author than could be printed, an appliance could transmit its

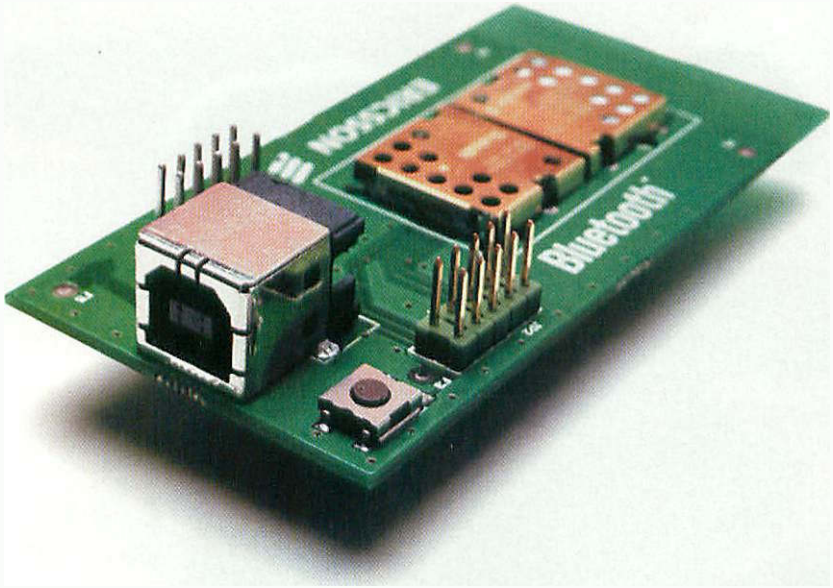



**Figure 7. Ericsson Bluetooth application and training toolkit**

service manual to a technician, etc.

Tags would also be ideal for automated shopping. With everything in the shop having an electronic tag in its label and every shopper the means of activating that tag. Possibly embedded in a mobile phone, which has a useful range of inputs and outputs together with the means of communication. Although the embedded device would need to be inaccessible to the phone company for personal security.

Upon entering an unfamiliar supermarket, a floor plan could be called up to show the location of everything. And if an electronic shopping list had been stored in the device, it could additionally show the location of all the items. Tags would also provide additional information about the products, their price, any special offers, competitions, even provide an Internet link to the company if that were insufficient.

The check-out would be a thing of the past: all the tags would identify themselves to the store computer as a customer was leaving, and the computer would make a request to the customers' device for payment (more unemployment, or a shift in employment?). The customer could then contact their bank, entering a PIN for security - or perhaps voice or fingerprint recognition? The money would be transferred to the stores bank account; and the store would receive a confirmation code from there. The computer would then download an itemised receipt to the customer's device. All anonymous to the store.

At Andersen Consulting researchers have developed the Pocket BargainFinder that enables a shops' prices to be compared with online retailers. This uses an SPT 1500 PDA, which is a Palm III combined with Symbol Technologies' barcode scanner. It only works on items that have a unique ISBN number (mainly books) at present: these are scanned in and, via a portable modem, prices are compared. Another Andersen Consulting development is Shopper's Eye, designed to elicit approaches from shops in an area like a mall. The user enters preferences that include items to purchase; this is then transmitted to the stores who download specially packaged offers as the person passes by. Thus facilitating the choice of shop to visit. A third idea from them is Magic Home: people keep images of their home interiors, furnishing and clothes on the Internet; then when they want to buy they can compare real and virtual items to see whether they suit, including rearranging rooms to fit in furniture

Worries have been expressed over the possibilities of abuse of privacy. Theoretically people could have greater anonymity, by hiding behind code numbers. In practice governments and companies would probably not like that. However, the user should be able to set the security of the device to their own satisfaction. And, ultimately, be able to switch it off.

## The smart car

A growing number of companies are announcing telematic packages for cars, including Delphi Automotive Systems, Motorola, Nortel Networks and Visteon. Ford has teamed with QUALCOMM to form Wingcast: a company that will develop in-car and in-truck services, first for its own products and then those of other companies. While Ericsson, Volvo and Telia have announced the formation of WirelessCar Corporation. The packages are broadly similar, including some or all of the following: Internet access, e-mail, streaming media, navigation aid, security, remote diagnostics, and voice control. Gentex is the largest supplier of telematic rear view mirrors; and expects them to become the communications centre of tomorrow. Mirrors being ideally positioned to incorporate antennas, receivers and wireless modems; and the car manufacturers can use them on different models and make changes without redesigning the interior.

Mercedes Benz envisions cars sending information to mainframe computers about traffic, road and weather conditions; this would then be processed and sent back to the cars to provide an overview of driving conditions. This instead of the much more expensive intelligent roads that others advocate.

At a more advanced level the Institute of Transport and Computer Sciences in Germany is developing the driverless i-Car - i-Buses and i-Trucks are also envisaged. The car combines cameras and ultrasound sensors in a 360 degree arc, together with a traffic sign recognition system, and the ability to recognise lines on the road and other cars and objects. In automatic mode the steering wheel and pedals are disengaged, and the car asks the person where to go, using a navigation system to find its way. Of course, there is always the facility for manual operation. At present the researchers are seeking funding, so if you have a few million to spare they will be pleased to hear from you.

All these things can happen in the 'smart communities' that are starting to appear - mainly in America; however, The World Foundation for Smart Communities has been set up - in America. In these, '...residents, organizations, and governing institutions are using information technology to transform their region in significant, even fundamental ways.'

Ironically, the CeBIT HOME 2000 exhibition in Germany, that covers such things, has been cancelled for lack of interest. And the majority of the worlds' population can barely afford to live, let alone avail themselves of this flood of technology.

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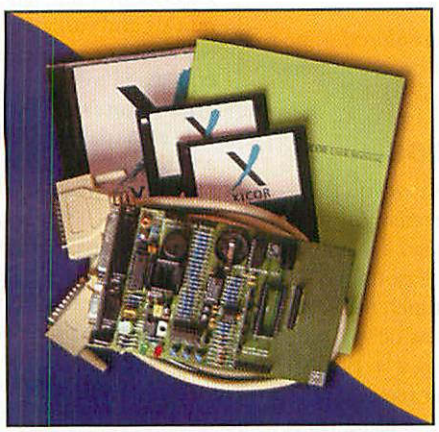

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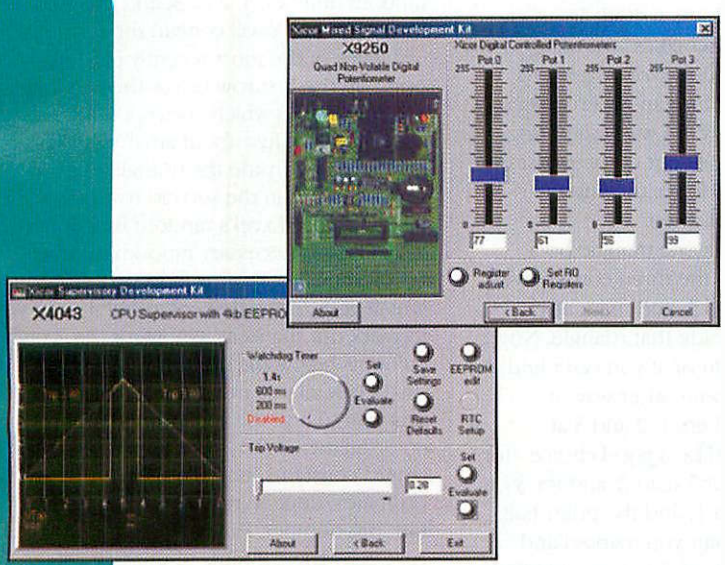


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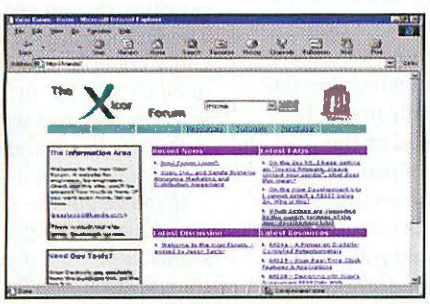


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# Excursions INTO EXCEL

PART 1

*by Mike Bedford*

Specialised software packages for electronics engineers are by no means in short supply. Circuit simulation, PCB CAD with auto-routing, computer-assisted filter design, PIC assemblers and emulators, PC-based oscilloscopes and data loggers, and searchable data sheets are just the tip of the iceberg. But in addition to the very specific tasks this sort of software is intended for, engineers frequently have a need for something which they can use for general scientific calculations and perhaps a bit of graph plotting. Of course, there are packages which are eminently suitable for this sort of thing - Mathcad, MatLab, Mathematica and Maple being the best known. Unless you're doing a lot of mathematical and technical problem solving, though, the investment in one of these packages might not be justified. Not only this but some of them are heavyweight packages so if you're not using them on a regular basis, you'll struggle to get the best out of them. For these reasons, I tend to use Excel for the vast majority of my technical calculations and much of my scientific illustrative work. It's a package which is installed on the majority of PCs in industry and many home PCs too, it's intuitive and easy to use and, despite the fact that it's normally considered a business tool, includes a wealth of mathematical and engineering functions.

This is the first article in our new regular column - Excursions into Excel - which will demonstrate how this well-known spreadsheet can be used for technical computing. It would be wrong to consider these articles as tutorials, though, instead my aim is to show the sorts of things which can be done and provide a few hints on how I've tackled each problem. My hope and expectation is that these examples will open your eyes to the possibilities of what you might formerly have considered to be a dull and boring package for bean counters. And so on to my first example...

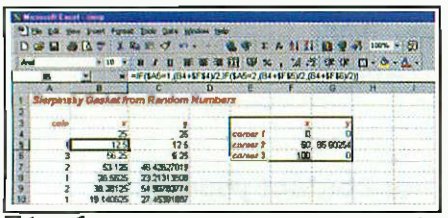


**Figure 1.**

## Order from Chaos

The example I'm going to show you this month isn't taken from the realm of electronic engineering, instead it's a purely mathematical exercise. My reason for choosing this example to launch the series is that it's so simple - very few people would have had difficulty in creating a worksheet to do this - but, on the other hand, few people would have thought of using Excel for this particular job. The background to this exercise is that I was writing an article on recreational mathematics and was investigating the tendency of systems to organise themselves into an ordered state. To put that another way, I was suggesting that order often comes out of the midst of the purely random. Here's the line of argument which I followed.

Draw a large equilateral triangle on a piece of paper, label the three corners with the numbers 1, 2 and 3, and mark any point, at random, inside that triangle. Now flip a three-sided coin or, if you can't find one of those, find some other way of generating the numbers 1, 2 and 3 at random. A die would be a good choice - for 1 or 4 read 1, for 2 or 5 read 2, and for 3 or 6 read 3. If you flip a 1, find the point half way between the point you marked and corner 1 and mark it on the paper. Similarly, if you flip a 2 or a 3, mark the point half way from the marked point to corner 2 or 3 respectively. Flip the coin many more times, each time, marking the point which lies half way between the most recently marked point and the corner indicated by the random process. What sort of pattern do you think will build up as you continue to flip that coin and mark points on the paper? Intuitively, many people would expect that they'd end up with a random distribution of dots inside the triangle and that none will lie outside it. Certainly you don't get any points outside the triangle but the pattern is most definitely non-random as you'll discover of you try out the experiment.

But flipping a three sided coin (or even a die) and using a ruler and pencil is a long-winded process, especially since you'll need to do this is few hundred times. A much better solution is to simulate the process in Excel, something which you could do very quickly and easily. First of all, place the XY co-ordinates of the three corners of an equilateral triangle in six cells somewhere. These figures will be used as constants later. I chose a triangle with sides 100 units long and the first corner at the origin, thereby placing the three corners at (0, 0), (50, 86.6) and (100, 0). Of course, you don't have to work out the co-ordinates of the middle corner manually, just use Excel's trigonometry functions, COS and SIN, remembering that it works in radians rather than degrees and that 60 degrees is evaluated as $\pi/3$. Now, set up three columns, labelling them as coin, X and Y. The column headed coin will contain the random number, 1, 2 or 3, and the columns headed X and Y will contain the co-ordinates of the most recently plotted point. In the first row below the headings insert numbers which correspond to the starting point. Just about anything will do, so long as it's inside the triangle - I used (25, 25). Now, in the second row below the headings, use Excel's random function to generate the necessary random number - =INT(RAND()*3)+1 will do the trick - which goes in the first column. I'll leave you to work out the exact syntax for the X and Y columns below the starting point, but essentially all you need to do is use the IF function to find the point half way from the co-ordinates in the previous row and the stored constants for the corner co-ordinates, depending on the value of the random number. Having done this for one row, copy the contents of this one row down into lots of other rows - I went really over the top and generated 10,000 points. The final job is to select the values in the X and Y columns and use the Chart Wizard to draw an XY plot. By default you'll end up with labelled axes with tick marks but since were only interested in the pattern, it will be less distracting if you turn all these off.

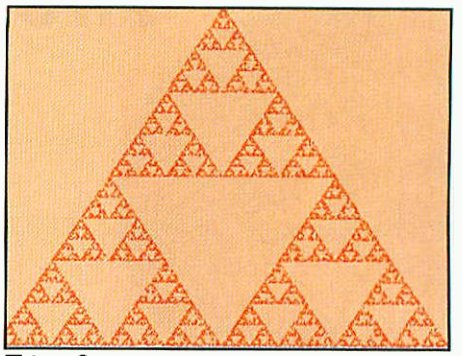

**Figure 2.**

If you've got this right, you should end up with something similar to the XY plot shown here. And if you're at all familiar with things fractal, you'll immediately recognise this as the Sierpinsky Gasket. Order out of chaos and surely this Excel workbook must be one of the simplest ways to illustrate this amazing mathematical curiosity.

***Workbooks from this series will be available from our website:***
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# Artifical Life

# THE MAN-MACHINE INTERFACE

***In this article David Clark looks at some of the science fiction-like scenarios the field of Artificial Life (A-life) might produce in the near future.***

molecule 1 + molecule 2 + specific chemical reaction → molecule 3

is equivalent to:

Information 1 + information 2 + mathematical or logical operator → information 3

**Figure 1. DNA computing.**

| Base 1 | Base 2 | Base 3 | Represents |
|---|---|---|---|
| A | A | A | a |
| A | A | G | b |
| A | A | T | c |
| A | G | A | d |
| A | G | G | e |
| A | G | T | f |
| A | T | A | g |
| A | T | G | h |
| A | T | T | i |
| G | A | A | j |
| | | | etc |

**Figure 2. Coding the alphabet.**

Artificial Life, the field of science operating where technology and biology overlap, promises (or threatens) to be the most important science of the twenty-first century. Already devices such as biosensors are making inroads into everyday life and in the medical sphere progress is well underway towards making routinely possible the growing of artificial tissues and even complete organs to replace worn or damaged body parts. On the not-too-distant horizon however are some even more incredible possibilities if current cutting-edge research comes to fruition. This article takes a look at some of these future options, including some that many people may not wish to see realised, potentially making the controversy caused by the release of genetically modified crops into the environment seem insignificant.

## Biological Computers

Silicon-based devices for computing may be reaching the limits of their speed capability and DNA computing may be a way of breaking through this barrier [1]. The DNA (deoxyribonucleic acid) molecules in a living cell code for the production of proteins, which define the growth and maintenance of a complete organism, and virtually every cell of an organism contains its own complete version of this code in the form of chromosomes. Each chromosome is a long twin helix of DNA that is divided into the sequences of the four "sub-molecules", or bases, labelled A (adenine), G (guanine), C (cytosine) and T (thymine), that make up individual genes, each of which is specific to the manufacture of a particular protein. DNA has therefore evolved into a very effective method of storing information, and a living organism is a very effective mechanism for utilising that information. Part of the reason for this is that DNA is a very stable molecule, which only takes part in very specific chemical reactions (which is also why it is a very effective system for passing information from generation to generation). These qualities make it very suitable for encoding information and for taking part in clearly defined operations, ie reactions, with other molecules that also represent information (see Figure 1).

Exploiting these mechanisms for computational purposes is relatively straightforward - enzymes ensure that the reactions that occur are very specific. Particular sequences of A, G, C and T need to be defined as representing a particular piece of information and those sequences need to be created biochemically first, ie each "input" DNA molecule needs to be individually engineered. Also of course the "output" or "result" molecule needs to be analysed biochemically. These are relatively slow processes, however once all the molecules are "prepared" and in the test-tube all the reactions effectively occur at the same time, in other words the computations are massively parallel, the key to high speed. It does however need a "wet" environment to maintain the stable

structures of the DNA molecules and the enzymes, so it is difficult to see at the moment how this will translate into taking over from the desktop PC. Nevertheless it has already been reported that calculations have been performed with the DNA attached to glass [2] in a first step to removing the need for a "test-tube" type environment.

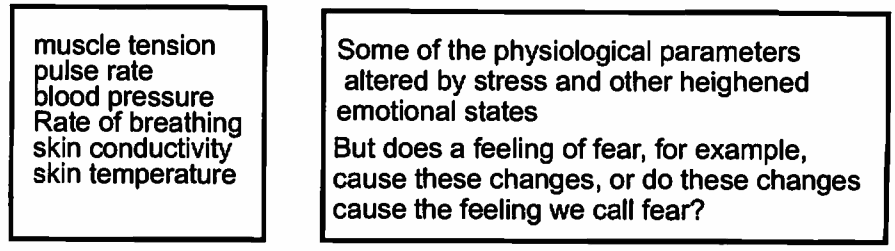
Interestingly a newspaper report (based on an article in the journal Nature) recently described another use for which DNA might be employed in representing information other than the biological type for which it evolved. The article speculated on the possibility of DNA being used as an espionage tool, by having sequences of three of the four DNA bases represent letters of the alphabet; hence messages might ultimately be coded as a sequence of DNA and hidden in the DNA of a living organism [3]. Figure 2 shows a simple example of how this coding might be done in principle; it is of course analogous to the digital coding of characters in electronic computing.

## Computed Biology

The opposite side of the coin of using biology for computing is the increasing use of computers to model biological systems. Examples of this are the "virtual pet" type toys and computer software. These may seem trivial applications but in fact they are simple manifestations of some powerful tools that may one day provide an understanding of how the brain works and controls the behaviour of individual organisms. They can also at another level of complexity provide models of how groups of organisms interact, and so model social behaviour. This has already been used to simulate the behaviour of bank customers in order to predict the amount of time people are prepared to queue for services, and to compare their behaviour in city-centre and rural branches. [4]. Even "speeded-up" evolution can be simulated, based on the modelling of not only individual organisms and groups of organisms but their interaction with an evolving environment. The Internet itself is considered by many to be an electronic model of an "organism". Some believe that it might eventually evolve some sort of behaviour if not intelligence of its own, particularly with the deliberate "releasing" of "software robots", sometimes called "bots", into the Internet environment, for example the "spiders" that trawl the net for information and addresses. There is also self-replicating software to be considered, software such as Tierra developed at the University of Delaware and the ATR Human Information Processing Research Laboratories in Kyoto, used initially to study Artificial Life by reproducing Darwinian-like evolution. This application incorporates software mutation, recombination and natural selection of successful results to give an evolving instruction set, a sort of "virtual computer" within a computer.

Perhaps of more immediate use is the development of software that mimics the behaviour of biological systems such as the heart. The sophistication of the software is such that it can model the activity of single cells down to molecular level, as well as the interactions between the cell and other similar and dissimilar cells within the organ. Using the model various, diseases of the heart and even a sudden heart attack for example can be induced in simulation. Software models of drugs designed to treat the particular condition can then be introduced into the scenario and the effectiveness of the drug evaluated, ineffective ones being discarded early, without any detrimental consequences for a real patient. Eventually it is hoped there will be an electronic model of a complete body available, which pharmaceutical companies can use to test their products [5]. Not only

**Figure 3. Emotional Responses.**



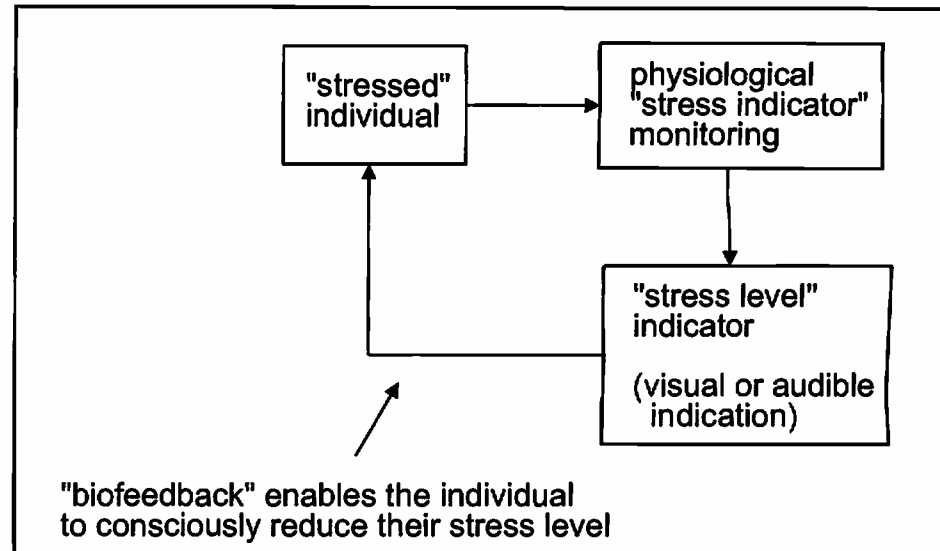




**Figure 4. The Principle of Biofeedback.**

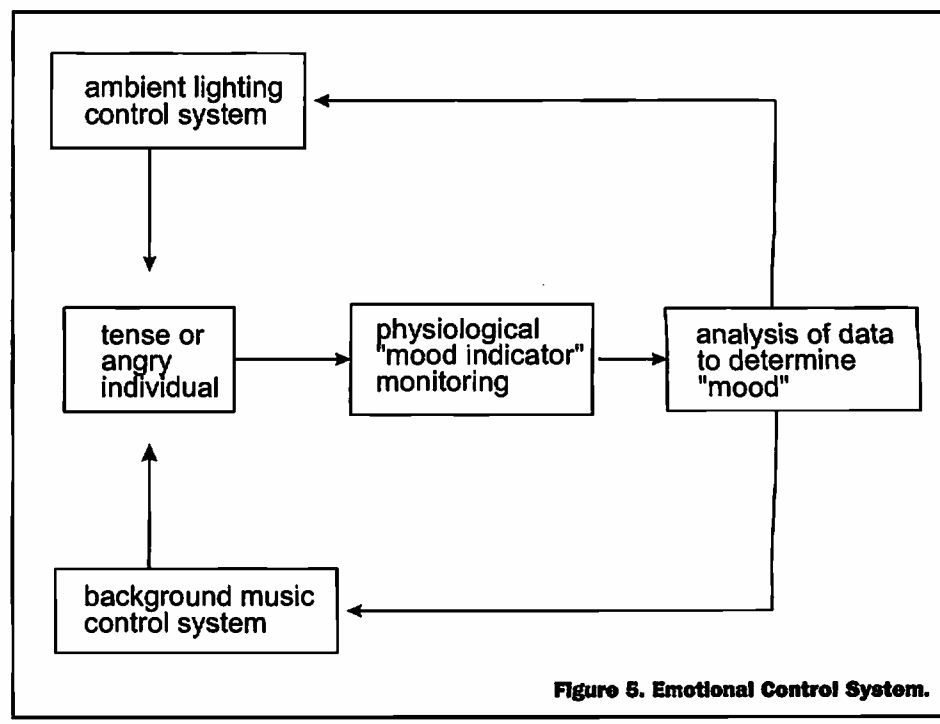
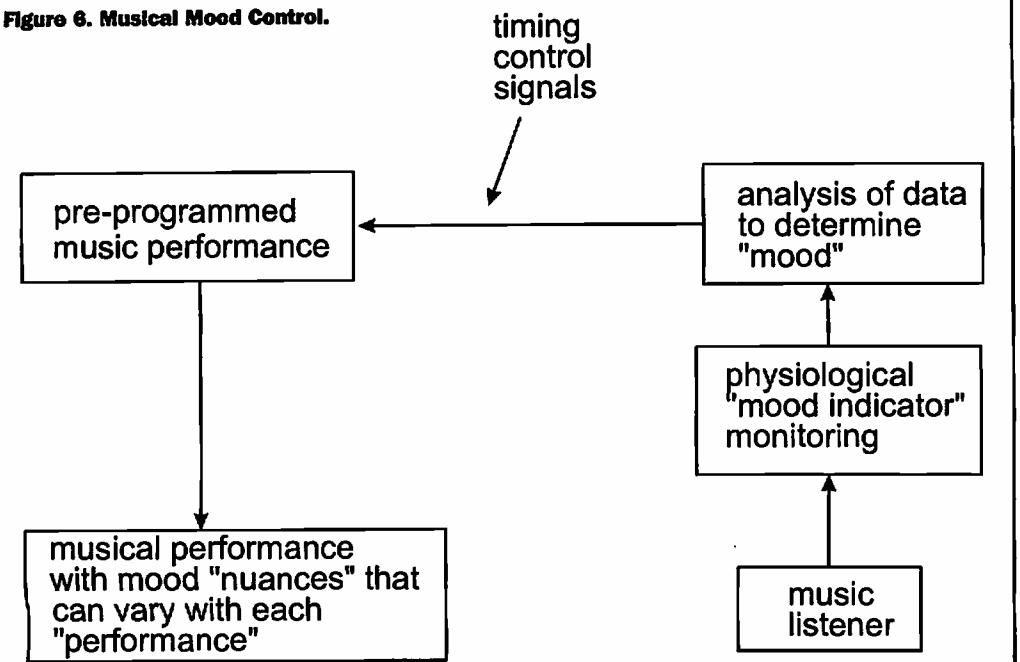



**Figure 5. Emotional Control System.**

**Figure 6. Musical Mood Control.**




an individual's knowledge. However the advent of 'wearable computer' type technology where the sensors and computer processing are built into clothing will make such a system relatively easy to put in place if an individual wishes it. Along the same lines attempts are being made with visual recognition systems to enable computers to 'recognise' the mood an individual is in based on their facial expression. If this were to be successful it would of course be very easy through secret surveillance to determine a person's mood without their knowledge of such an invasion of privacy. The next step in this so-called 'affective computing' might be that a computer is allowed to make decisions and take action on behalf of an individual based on what it decides the individual's emotional state is, a situation that many people might not want to come about [7].

will this reduce the need for clinical trials on animals and humans it should also reduce the final cost of the drug

## Emotional Control

The heart is usually considered to be the location of the emotions in the world of poetry, music and literature. In the cold-hearted (!) world of fact, emotions are of course generated in the brain, a consequence of the neural and hormonal activity necessary for an organism to survive. And the emotions appear to be another area where electronics and technology are about to intrude into the interface between man and machine. Sophisticated emotions and feelings seem to be a particularly human characteristic, which suggests that they are part of the activity of the higher part of the brain along with creativity and consciousness.Nevertheless emotional states are associated with physical conditions of the body that are relatively easily measured (see Figure 3). These are parameters that are often used in biofeedback techniques (see Figure 4) where an individual can be trained to change their mood, for example stress level, by being presented with an indication of a particular parameter and learning to control it.

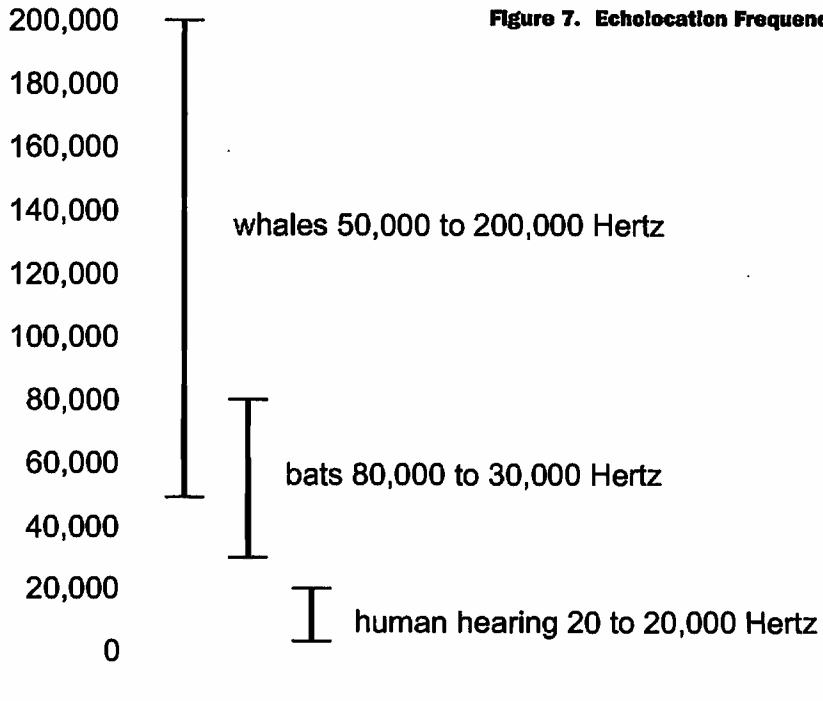
It also seems that although extreme emotional states fairly obviously prevent 'sensible', rational behaviour and decision-making, a lack of emotional involvement also prevents 'good' and of course socially acceptable decisions to be made [6]. Research is underway into ways of monitoring the physical parameters associated with changes in mood and using these to allow computers to interpret the mood of an individual. Using this 'emotional state' knowledge a computer interface for example at which the individual was working might alter the form in which information was presented, or the speed at which it was presented to the operator. Matching this to the mood of the operator would enable the individual to work more comfortably and presumably more effectively. The 'emotion' information might even be used to alter the mood of the individual, for example by changing the ambient lighting or adjusting the volume of background music (see Figure 5).

Hopefully this kind of manipulation would be subject to some kind of ethical consideration and would not occur without the operator's knowledge. In fact currently this secret 'interactive' mood changing would not be possible as the physical parameters could not be measured without

## Artificial Creativity

So it appears that pretty soon computers will be able to recognise emotions. Already software can exhibit artificial intelligence (although some might question how effective this is). Intelligence and emotional response are arguably the most important aspects of that uniquely human attribute, creativity. Will that too ultimately become part of the repertoire of the computer? Artificial Intelligence programs have been used in the past to analyse the work of the great composers and these have recognised

**Figure 7. Echolocation Frequencies.**




(frequency data from encyclopaedia CD-ROM)

some creatures gain information for their "internal map" of their environment from high frequency sound energy

subtle patterns and so on that somehow give a recognisable style to a particular composer [8]. This has made it possible to create new works in that style. That doesn't of course give the piece any emotional content. But neither does the original score of a great work. The emotion is injected by the performer of the work with the score as a starting point, whether the performer is the original composer or an individual or group of subtly interacting individuals performing the work possibly hundreds of years later, by subtle changes in timing and playing technique. Nevertheless some time ago a computer was developed that played a pre-programmed piece of music but with subtle nuances of timing based on the playing of a "real" accompanying musician [6]. See Figure 6.

But we can have no idea what the world is like to an insect, snake or bat. Even a superb sense of imagination can't come close. We can have no idea what another living creature's sense of itself is. So could a machine have some sort of sense of itself that we can have no comprehension of? We know that all the activity going on in the interconnectedness of the Field Programmable Gate Arrays (FPGAs) of artificial intelligence hardware systems is unpredictable and incomprehensible. Could it be some sort of consciousness? Medical EEG (electro-encephalogram) measurements of brain electrical activity show it as waves and patterns on a monitor, reflecting various activities within the brain, waking sleeping, dreaming, thinking, controlling muscle movement and so on. Displaying the activity of the interconnections between FPGAs on a screen would also display patterns. Can we be so sure it is not some form of machine 'dreaming', an 'inner state'?

And what of creativity? Where do ideas come from? It has long been thought that original thoughts might stem from some form of random activity in the brain. But current thinking would say that this form of randomness is not truly random but simply too complex to model and hence predict. It is often believed in fact that the only truly random behaviour occurs at the sub-atomic, quantum mechanical level. One line of thought proposes the possibility that quantum effects are involved in the working of the enzyme that controls the replication of the DNA chain in biological cells [10]. Could quantum effects in the neurons of the brain be the seed of something that evolves into a thought? And given the fact that semiconductor action is a property of quantum mechanics is it possible to declare that it is impossible that quantum effects might be harnessed one day to give some form of 'artificial creativity'?

Another line of (human!) thought is based on work with artificial neural networks. A researcher in this field found that a neural network trained to perform relatively straightforward tasks began to behave in an apparently creative way when some of the connections within the network were altered after the network had been trained for its task. (An artificial neural network 'learns' by modifying its own internal interconnections according to how close its output is to a desired output for a given input, abandoning changes that give a poor result but keeping those that give a close result, the output thus becoming 'better' over time.) When the internal connections were disturbed by a form of 'noise' the network produced an output even if there were no inputs [11]. Could this be analogous to some form of biological noise in the human brain?

Real creativity of course involves putting ideas to some deliberate use, nevertheless could this behaviour within the artificial neural network be the first stage of creativity, the origination of ideas? Could a more complex neural network develop the ability to put its own ideas to some use, possibly via external actuators, and develop those ideas into something useful, perhaps by selecting ideas that move closer to a pre-determined objective and discarding those ideas that move away from that objective? Would that be distinguishable from 'real' creativity?

cyborg (noun) a fictional or hypothetical person whose physical abilities are extended beyond normal human limitations by mechanical elements built into the body.
-ORIGIN 1960s: blend of cyber- and organism.
(from The New Oxford Dictionary of English database)

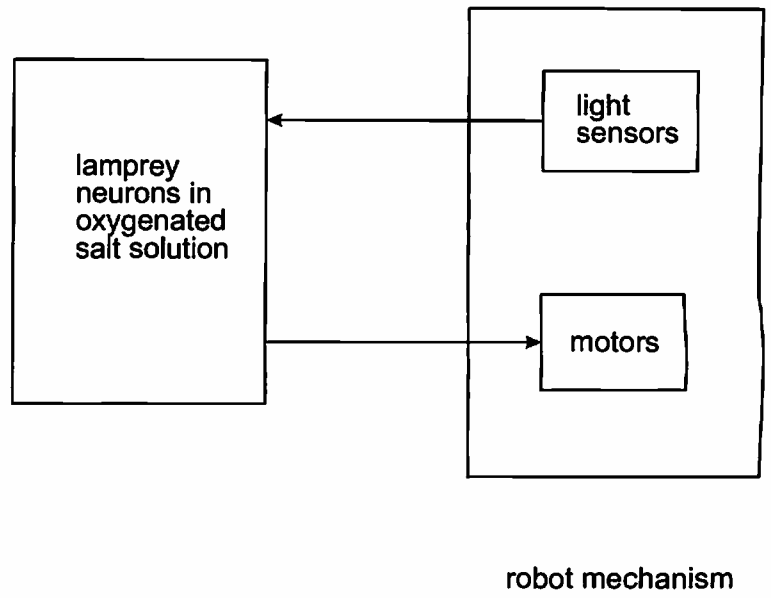


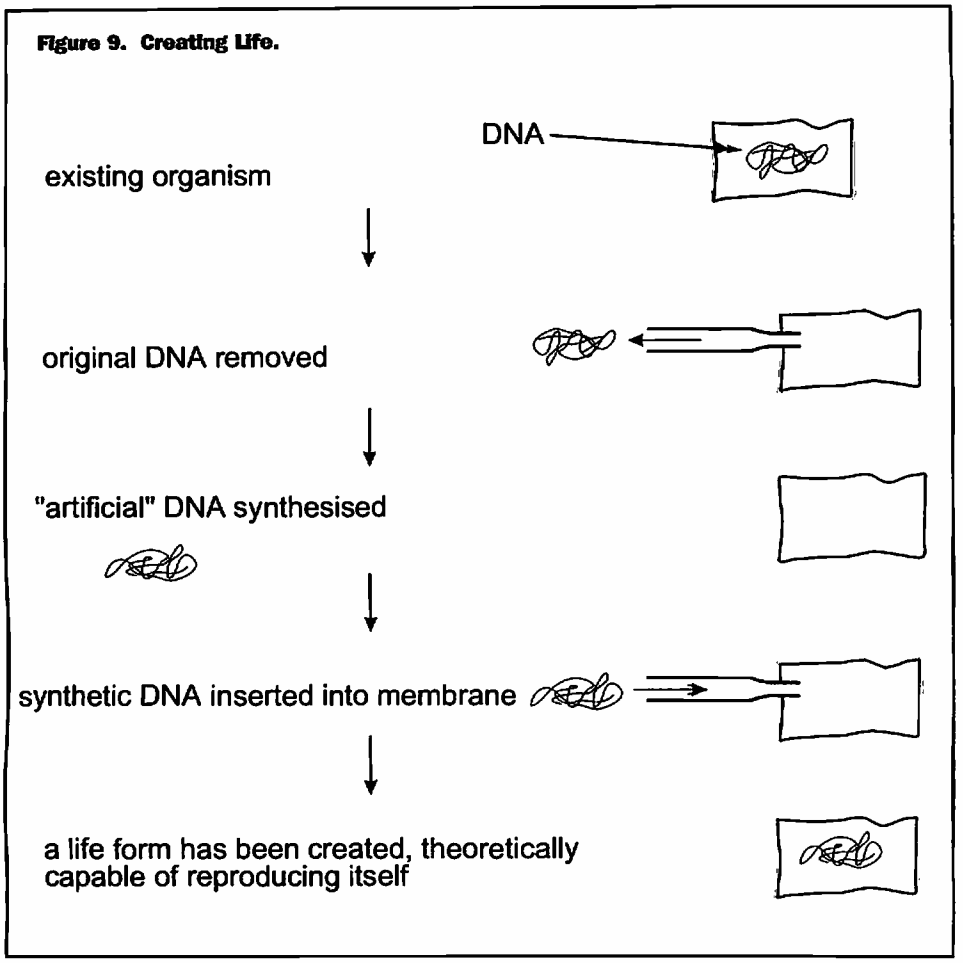

**Figure 8. Artifical Animal.**

## Artificial Animal

Many people of course believe that crediting any electronic system with any form of capability like a biological brain, especially the human brain, is ridiculous, if not sacrilegious. If we accept then that nothing can match a biological brain, is there an alternative to trying to mimic it electronically? How about connecting it directly to the outside world? Already existing in the laboratory is a robot controlled by the brain of a lamprey, an eel-like creature that lives in coastal and freshwater regions of the world [12]. It is a descendant of some of the first creatures that evolved a spinal column and because of its primitive nature, the lamprey has many fewer neurons as part of its nervous system than modern vertebrates. It does however have well-developed eyes.

It has been possible to remove the nervous system from the creature, keep the cells alive in a salt solution with an oxygen supply, and connect the cells via wires to a commercially available robot with light sensors for 'vision' and motors for mobility (see Figure 8).The light sensors were connected to the 'input' neurons corresponding to the lamprey's

**Figure 9. Creating Life.**




normal sensory cells and the 'output' neurons connected to the motors corresponding to the lamprey's muscle cells. Under the control of the lamprey brain the robot responded to various light stimuli and moved accordingly, demonstrating complex behaviour patterns that correspond to how the living lamprey controls its orientation in the sea. The purpose of these experiments is to understand brain behaviour and learning, and should also make possible more effective artificial limbs for people who could benefit from this. But also as a consequence of this some scientists are inevitably dramatically pointing out the future possibility, formerly science fiction, of transferring a human brain, cyborg-like, from an ageing body to a robotic body. The experience of science is that if something is possible someone somewhere will attempt it no matter how undesirable it might be to large sections of the population, so how soon will it be before these experiments are taken further? And is anything beyond this extreme possible?

## Creating Life

The cloning of sheep is now a well-known fact, the infamous Dolly having been born several years ago. Until recently the cloning of human cells has not been authorised in the UK for any purpose. However as this article was being written it was announced that approval was to be recommended for the 'therapeutic cloning' of human cells and that this was likely to become law during the next session of Parliament. This means that the cloning of human embryo cells for the purpose of engineering and growing tissue in order to treat disease will be possible, and this should mean that there will hopefully be forms of treatment for problems for which there currently is no treatment. Although there are some groups who oppose this, a great many people will welcome the possibilities. Nevertheless it seems unlikely that this is not the first step towards the eventual approval of the cloning of human cells for reproductive purposes.

Since the cloning of Dolly there have been other major advances, fuelled no doubt by a mixture of quest for knowledge, desire for medical advances and surely not least an eye to the enormous financial profit likely. On the 25th of January 1999 the Independent newspaper carried a report that a leading expert on genetics had told the American Association for the Advancement of Science that he had asked religious leaders and experts in ethics what were the moral implications of creating a synthetic organism [13]. The organism in question was the simplest known life form, a tiny human parasite. The expert wanted to synthesise the 300 or so genes thought essential to the particular organism's existence, and insert these genes into an existing cell with its own genes removed. (This was out of a total of 470 genes - the function of around 100 of the 470 was still not known at the time.) This would be a process not dissimilar to current genetic modification and cloning techniques (see Figure 9).If successful this procedure would create self-reproducing cells. In effect a living organism would have been created 'from scratch'. The expert was quoted as saying that he and his team were "trying to understand the minimum number of genes necessary to comprise a living cell", and went on to say that though he wouldn't do the experiment yet it didn't mean to say that someone else wouldn't. Over a year has passed since the report. The regulation of these procedures is a matter for individual countries, perhaps more importantly a matter for the consciences of the individuals capable of carrying them out. It is also surely impossible to regulate every laboratory throughout the world with the facilities for carrying out these procedures. Might there right now be an artificially created living organism quietly growing and reproducing in the corner of a laboratory somewhere, its creator awaiting a suitable moment to reveal its existence?

## Sources of Information


[1] Beyond the Silicon Microprocessor
Electronics and Beyond August 2000

[2] News Bytes
Electronics and Beyond April 2000

[3] A genetic code for secrets
The Independent 11 July 1999

[4] Agents from Albia
New Scientist 9 May 1998

[5] The heart that just won't die
New Scientist 20 March 1999

[6] You're Wrong, Mr Spock
New Scientist 27 April 1996

[7] I know how you feel
New Scientist 8 May 1999

[8] Requiem for the soul
New Scientist 9 August 1997

[9] Reading your mind
New Scientist 12 August 2000

[10] Life Force
New Scientist 15th April 2000

[11] The Creativity Machine
New Scientist 20 January 1996

[12] Half fish, half robot
New Scientist 10 June 2000

[13] Geneticist proposes to create life from scratch
The Independent 25 January 1999

# What's New In SILICON

***A view from our American correspondent, Michael Storm***

So I'm hanging around the office, something, mind you, that shouldn't be done if you're trying to avoid taking on any new projects. Which, I was. Between arranging new distribution channels, playing American representative, and doing all I can to facilitate the set up of the American offices, baby, new home... the plate is starting to fill up. To continue... I'm at the office and the magazine comes up. The Director asks me if I would be interested in writing an article on "What's New in Silicon". I think to myself, Sure, I can handle this, I wrote for my college newspaper, I've written uncountable copy for radio, no Prob. "I'm in." I say. "Did I mention, 2 weeks 'til first issue." "Oh."

Now committed, and wondering if the Director shouldn't be. I set out to accomplish my task. I open up MSWord 2K, and stare at a virtual piece of blank paper. Still staring, time goes by, the page is still blank. Close my eyes, open them, still blank. Time to reassess. "What's New in Silicon?" New is easy, Silicon, that's another story. There are many new devices introduced all the time. Where do I start? I began to think of things like demographics, "What's my target audience?" "What will they be interested to know?". "How old are they, where do they live...?" This only succeeded in perpetuating a whopper of a headache to go with the blank piece of virtual paper. "When was that article due again?"

I'm not a Design Engineer by trade; my opinion of a new Devices functionality is not one that I could give. I have to stick to what I understand to be the facts, and what sounds "cool" about it. One thing I am though is a man, and men love toys, from Lego's to cars to computers and video games. Toys. I pulled apart my first radio, and many of the ones since. That is to say, men also like to tare things apart. I'm no different in either respect, so I'm always on the lookout for cool new toys, which I will eventually tare apart. "Brilliant, That's my angle, what cool new toys can be made from new devices?"

I present to you, after much used space and ink, "What's New in Silicon". (And the contest to rename the column!) Winner will get a Kanda.com "Cool Tool" worth at least $50.00. Send your ideas to mstorm5@hotmail.com You know what direction I want the column go now, so run with it.

One new Device for you this time, I'll do more per article, and more about each Device in the future.

## The Part: Texas Instruments TRF4900

**Datasheet Link:**
www-s.ti.com/sc/psheets/slws092/slws092.pdf
(need Acrobat reader to view, www.adobe.com)

**Tool Link:**
http://focus.ti.com/docs/tool/toolfolder.jhtml?PartNumber=TRF4900EVM

| TRF4900 | |
|---|---|
| Frequency (MHz) | 850 - 950 |
| Standards Supported | FSK, narrow-band FM |
| Power Output (dBm) | 9 |
| Operating Voltage (V) | 2.2 - 3.6 |
| Standby Current (uA) | 2 |
| Package | 24-pin TSSOP |

**Features**

- Single-Chip RF Transmitter for 868 MHz and 915 MHz ISM Bands
- 850 MHz to 950 MHz Operation
- FM/FSK Operation for Transmit
- 24-Bit Direct Digital Synthesizer (DDS) With 11-Bit DAC
- On-Chip Voltage-Controlled Oscillator (VCO) and Phase-Locked Loop (PLL)
- On-Chip Reference Oscillator
- Minimal External Components Required
- Low Power Consumption
- Typical Output Power of 7 dBm
- Typical Output Frequency Resolution of 230 Hz
- Ultrafast Lock Times From DDS Implementation
- Two Fully-Programmable Operational Modes
- 2.2-V to 3.6-V Operation
- Flexible Serial Interface to TI MSP430 Microcontroller
- 24-Pin Plastic Thin-Shrink Small-Outline Package (TSSOP)

**Quote:** "The TRF4900 single-chip solution is an integrated circuit intended for use as a low cost FSK transmitter to establish a frequency-agile RF link. ...and is designed to provide a fully-functional multi-channel transmitter."

**Cool Uses:** Portable short-range wireless applications like, wireless mice or keyboards, security systems and remote controls for toys.

**Killer Feature:** The chip is designed for (FM), or digital (FSK) modulated applications in both the new 868 MHz European band and the North American 915 MHz ISM band.

**Caution:** Limited built-in ESD protection. So no dancing on carpet with it in your pocket!

That's it for now. For future articles I will work with an engineer to come up with a small project for one or more of the Devices featured, and you are always welcome to send in any designs that you come up with based on parts I've highlighted (or perhaps you would like to see highlighted). Just drop an email to mstorm5@hotmail.com (no attachments please, we will make other arrangements.)

* "Don't Panic", **Michael Storm**

* Douglas Adams, Hitchhikers Guide to the Galaxy

# XICOR SEMINAR
# 26th October 2000


Location: Aston Villa F.C.

## Kanda one day seminar to promote Xicor devices, tools and Engineering Forum web site

Topics include:

- Introduction to Xicor and Kanda;
- Architecture of RF, Mixed Signal,
- System Managment devices;
- Device features;
- Applications in industry;
- Development tool support;
- Technical and sales support;
- Xicor Forum for engineers;
- Featuring the new Xicor Fibre Optic devices.

**All this and a Xicor Development Kit for £80.00**

Complementary Tickets for this seminar are available from Kanda on **01970 621 030**. Xicor Development kits will be available to purchase prior to the seminar for the discounted price of £80.00.

Kanda:com

For further information contact: Peter Eastwood, Kanda Systems Ltd, 17/18 Glanyrafon Enterprise Park, UK. Tel: 01970 621030. Fax: 01970 621040. E-mail: peastwood@kanda.com.

# Magnetic RAM for MOTOROLA

## *Reg Miles reports on an exciting new development*

Motorola Labs, the research arm of Motorola, Inc., in conjunction with the DigitalDNA Laboratories of the Semiconductor Products Sector, has demonstrated a memory chip that will potentially replace today's semiconductor memory technologies. This Magnetoresistive Random Access Memory (MRAM) will allow the integration of multiple memory options within a single chip. A true 3-volt nonvolatile MRAM with an address access time of less than 15 nanoseconds has been successfully demonstrated by Motorola Labs. Initial data of several billion read and write cycles indicate the potential for unlimited endurance. An individual MRAM cell is based on a single transistor and magnetic tunnel junction (MTJ) structure, with the MTJ on top of the transistor to minimise the size. This arrangement is expected to result in a competitive cost; which, in conjunction with the fast read and write speed and claimed unlimited read and write cycles, should enable MRAM to replace Flash, DRAM and all but the fastest SRAM. It will not require the high-voltage tunneling of non-volatile Flash memory, and so its write characteristics are expected to be better. It will also not require the background refreshing of DRAM, so there will be less drain on the battery of portable devices; and it will not require the battery back-up of SRAM to achieve non-volatility. Also, it can come on instantly so eliminating the long start-up times of computers and some other devices. Motorola believes that the speed and low power requirement will enable single chip solutions for a variety of devices, such as wireless applications, organizers, appliance electronics, car electronics, personal computers (especially notebooks) and consumer electronics. Since MRAM is readily integrated with conventional CMOS, single chip solutions will considerably reduce the cost of current multichip memory/processor applications. And where the speed of microprocessors is currently limited by the transfer of data between memory chips and processor chips MRAM will expedite the process by having the memory directly on top of the microprocessor.

The MTJ material stack is shown in Figure 1. It consists of two magnetic layers - free and fixed - separated by a dielectric tunneling barrier. Data is written by changing the polarisation of the free magnetic layer relative to the fixed layer: the same direction giving a low resistance (zero) memory bit and opposite direction a high resistance (one) bit. This magnetoresistance ratio, or spin dependent tunneling, is a result of the distribution of states in the magnetic layers for spin-up and spin-down electrons when the direction of polarisation changes. In the same direction there is an equal distribution across the dielectric barrier giving a high probability of tunneling and low resistance; in the opposite direction there is an unequal distribution which reduces the probability of tunneling occuring and gives a high resistance. The fixed magnetic layer is pinned by a layer of anti-ferromagnetic material to prevent its changing during writing. When reading, the resulting signal depends on the resistance of the MTJ.

Accessing the individual cells is achieved by row and column selection, see Figure 2. The digit line below the MTJ is electrically isolated, while the bit line above is in contact with the MTJ and is used for both reading

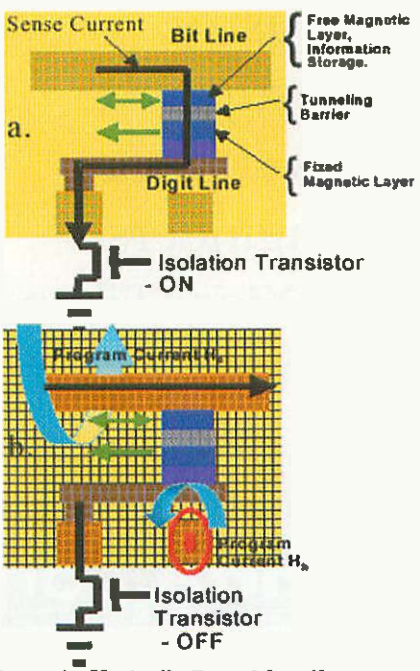



**Figure 1. Magnetic Tunnel Junction memory cell structure (a) Read and (b) Write mode operations.**

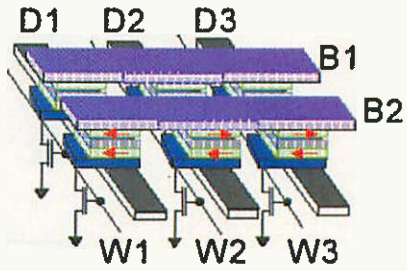



**Figure 2. MTJ cell cross point matrix of bits showing digit and bit lines with isolation transistors controlled by word lines.**

and writing. When writing, each line provides just half the current necessary for switching, thus, they cannot affect other cells on the same lines but generate a sufficient magnetic field where they cross. When reading, individual isolation transistors are turned on to select each cell.

In a fully fabricated 256x2 MRAM an address access time of 14ns and cycle time of 24ns has been achieved, using 800μA of current at 3 volts, with only 0.6μm geometry. The further integration of CMOS and MRAM is expected to significantly increase this performance.

"The 'smart' phones of tomorrow will require increased memory. This means that local, on-chip memories capable of communicating with multiple processor configurations will be needed to provide better performance and lower power," said Peter Gill, vice president and director, Materials & Structures Laboratories of Motorola Semiconductor Products Sector. "In addition, MRAM has no known wear-out mechanism, is non-volatile and is expected to meet commercial and industrial temperature requirements. To the consumer, this means exciting new possibilities such as real-time wireless video."

According to Herb Goronkin, vice president and director, Physical Research Laboratories, Motorola Labs has demonstrated a small test chip that is fully integrated. "We've demonstrated full integration of MTJ with standard low cost CMOS circuitry and we have been able to achieve exciting performance characteristics. In addition, we have made significant progress toward increasing the signal from an MTJ cell and reducing the resistance of MTJ-based material. The current resistance levels are ideal for our memory architecture. We have been ahle to achieve these parameters uniformly across 150mm wafers."

Products incorporating MRAM technology are expected to be in production within a few years.

For further information contact: Anne Stuessy, Director, Communications Motorola Future Businesses and Technology, 1303 East Algonquin, Schumburg, IL 60196. E-mail: anne.stuessy@motorola.com

# Triac Principles AND CIRCUITS

PART 1

***Ray Marston describes basic triac principles and looks at practical triac circuits in this special 2-part feature article.***

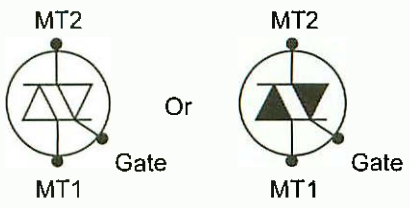



**Figure 1. Triac symbols.**

A triac is a controllable medium- to high-power semi-latching solid-state AC power switch. This 2-part feature article explains its basic operation and shows various ways of using it; most of the practical circuits show two sets of component values, for use with normal domestic/commercial 50Hz or 60Hz AC voltage supplies with nominal values of either 240V (as used in most of Europe) or (in parenthesis) 120V (as used in most of the U.S.A.); in each design, the user must use a triac with ratings to suit his or her own particular application.

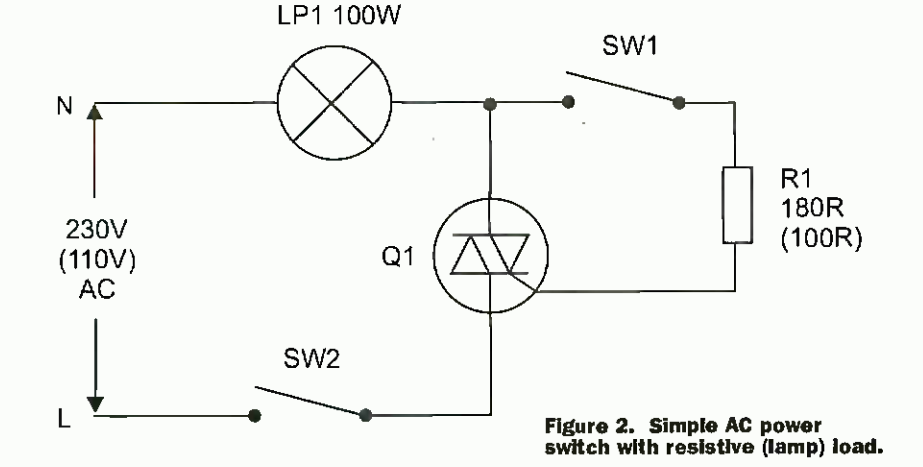



**Figure 2. Simple AC power switch with resistive (lamp) load.**

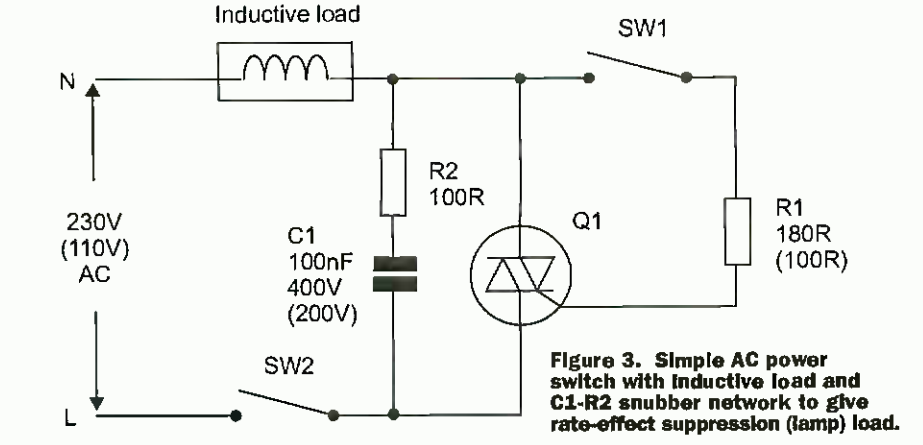



**Figure 3. Simple AC power switch with inductive load and C1-R2 snubber network to give rate-effect suppression (lamp) load.**

## Triac basics

A triac is a three-terminal (MT1, gate, and MT2) solid-state thyristor that uses the alternative symbols of Figure 1 and acts like a pair of SCRs wired in inverse parallel and controlled via a single gate terminal. It can conduct current in either direction between its MT1 and MT2 terminals and can thus be used to directly control AC power. It can be triggered by either positive or negative gate currents, irrespective of the polarity of the MT2 current, and it thus has four possible triggering modes or 'quadrants', signified as follows:

| | |
|---|---|
| I+ | Mode = MT2 current +ve, gate current +ve |
| I- | Mode = MT2 current +ve, gate current -ve |
| III+ | Mode = MT2 current -ve, gate current +ve |
| III+ | Mode = MT2 current -ve, gate current -ve |

The trigger current sensitivity is greatest when the MT2 and gate currents are both of the same polarity (either both positive or both negative), and is usually about half as great when they are of opposite polarity.

Figure 2 shows a triac used as a simple AC power switch, driving a resistive lamp load; assume that SW2 is closed. When SW1 is open, the triac acts as an open switch and the lamp passes zero current. When SW1 is closed the triac is gated on via R1 and self-latches shortly after the start of each half-cycle, thus switching full power to the lamp load; the triac automatically unlatches at the end of each AC half-cycle as the instantaneous supply voltage (and thus the load current) briefly falls to zero.

In Figure 2, the task of R1 is that of limiting the peak instantaneous switch-on gate current of the triac to a safe value; its resistance (combined with that of the load) must be greater than the peak supply voltage (roughly 350V in a 240V AC circuit, 175V in a 120V circuit) divided by the triac's peak gate current rating. This is usually given in the triac manufacturer's extended data sheets.

Note in Figure 2, and in most other triac circuits shown in this mini-series, that - for safety reasons - the load is wired in series with the AC supply's neutral (N) line, and master on/off switch SW2 can isolate the entire circuit from the live (L) line.

## Triac rate effect

Most triacs, like SCRs, are susceptible to 'rate-effect' problems. Internal capacitances inevitably exist between the main terminals and gate of a triac, and if a sharply rising voltage appears on either main terminal it can - if its rate-of-rise exceeds the triac's dV/dt rating - cause enough break-through to the gate to trigger the triac on. This unwanted 'rate-effect' turn-on can be caused by supply line transients; the problem is, however, particularly severe when driving

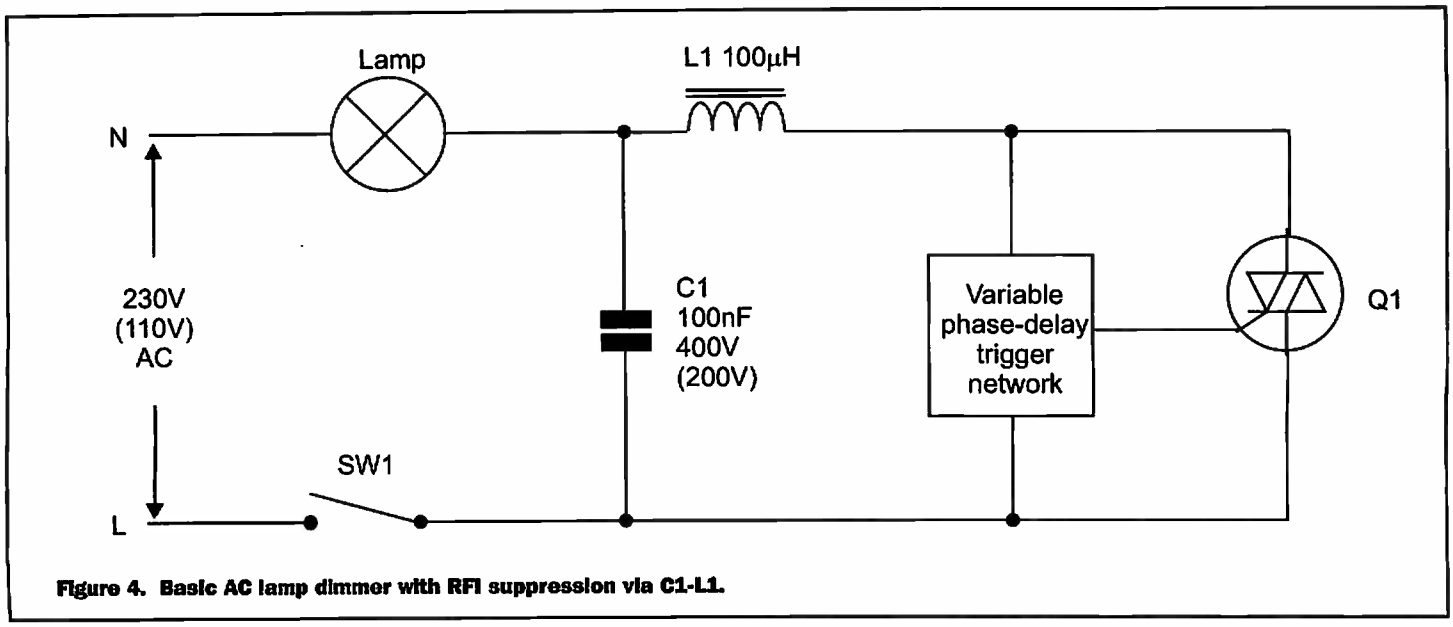



**Figure 4. Basic AC lamp dimmer with RFI suppression via C1-L1.**

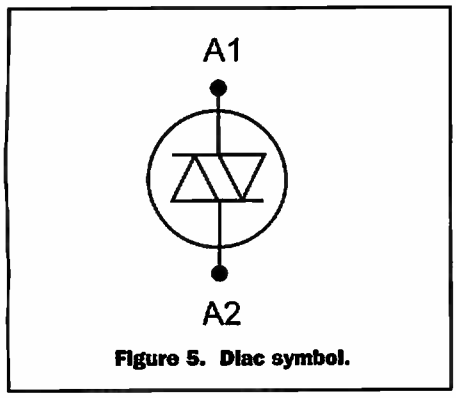



**Figure 5. Diac symbol.**

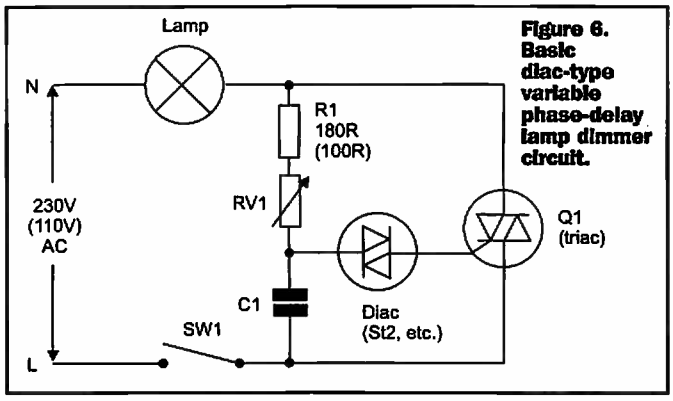



**Figure 6. Basic diac-type variable phase-delay lamp dimmer circuit.**

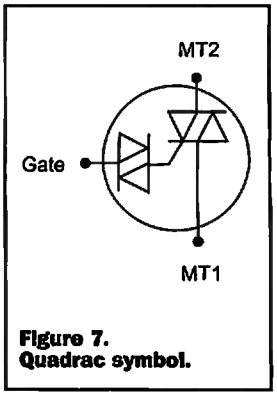



**Figure 7. Quadrac symbol.**

inductive loads such as electric motors, in which load currents and voltages are out of phase, thus making a large voltage suddenly appear on the main terminals each time the triac unlatches as its main terminal current falls to near-zero in each operating half-cycle.

Rate-effect problems can usually be overcome by wiring an R-C 'snubber' network between MT1 and MT2, to limit the voltage rate-of-rise to a safe value, as shown (for example) in the triac power switch circuit of Figure 3, where R2-C1 form the snubber network. Some modern triacs have enhanced dV/dt ratings (typically 750V/(S) and are virtually immune to rate-effect problems; these triacs are known as 'snubberless' types.

## RFI suppression

A triac can be used to give variable AC power control by using a 'phase-delayed switching' technique, in which the triac is triggered part-way through each half-cycle. Each time the triac is gated on its load current switches sharply (in a few microseconds) from zero to a value set by its load resistance and instantaneous supply voltage values; in resistively loaded circuits such as lamp dimmers this switching action inevitably generates a pulse of RFI, which is least when the triac is triggered close to the 0° and 180° 'zero crossing' points of the supply line waveform (at which the switch-on currents are minimal), and is greatest when the device is triggered 90° after the start of each half cycle (where the switch-on currents are at their greatest). The RFI pulses occur at twice the supply line frequency, and can be very annoying. In lamp dimmers, RFI can usually be eliminated by fitting the dimmer with a simple L-C filter network, as shown in Figure 4; the filter is fitted close to the triac, and greatly reduces the rate-of-rise of the AC power line currents.

## Diacs and quadracs

A diac is a 2-terminal bidirectional trigger device; it can be used with voltages of either polarity and is usually used in conjunction with a triac; Figure 5 shows its circuit symbol. The diac's basic action is such that, when connected across a voltage source via a current-limiting load resistor, it acts like a high impedance. This is until the applied voltage rises to about 35V, at which point it triggers and acts like a low-impedance 30V zener diode. 30V is developed across the diac and

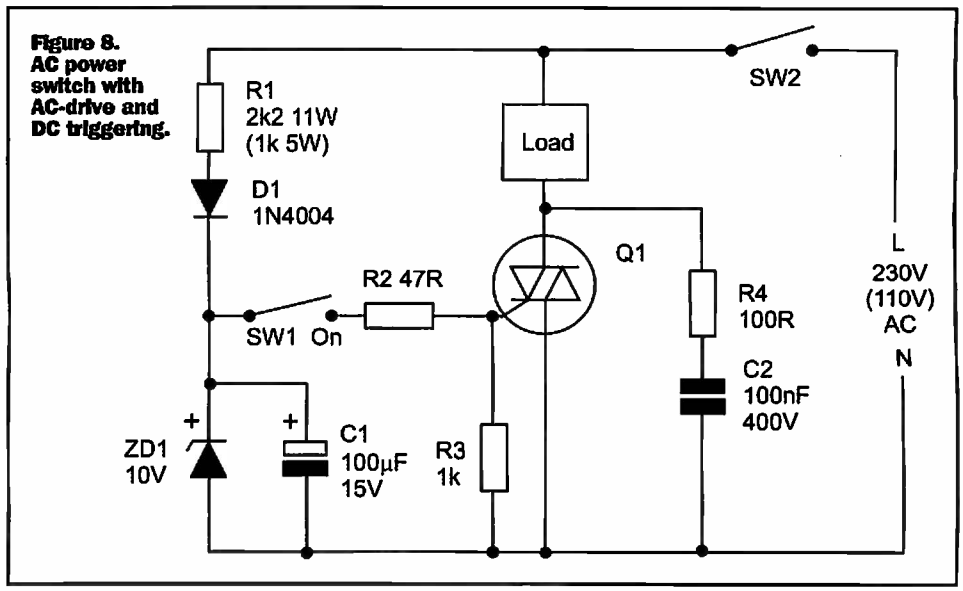



**Figure 8. AC power switch with AC-drive and DC triggering.**

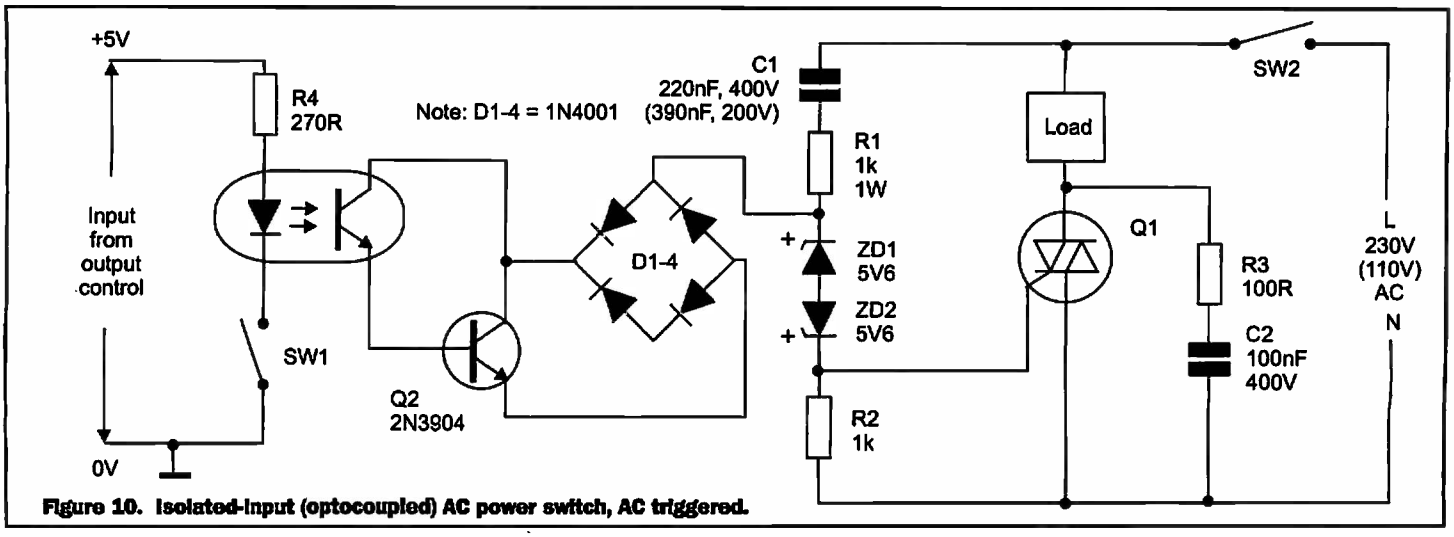



**Figure 10. Isolated-input (optocoupled) AC power switch, AC triggered.**

the remaining 5V appears across the load resistor. The diac remains in this state until its forward current falls below a minimum holding value (this occurs when the supply voltage falls below the 30V 'zener' value), at which point the diac turns off again.

The diac is most often used as a trigger device in phase-triggered triac variable power control applications, as in the basic lamp dimmer circuit of Figure 6. Here, in each power line half-cycle, the R1-RV1-C1 network applies a variable phase-delayed version of the half-cycle to the triac gate via the diac, and when the C1 voltage rises to 35V the diac fires and delivers a 5V trigger pulse (from C1) into the triac gate, thus turning the triac on and simultaneously applying power to the lamp load and removing the drive from the R-C network. The mean power to the load (integrated over a full half-cycle period) is thus fully variable from near-zero to maximum via RV1.

In the early development days of the triac some specialist devices were manufactured with a built-in diac in series with the triac gate; such devices were known a quadracs and used the Figure 7 circuit symbol. Quadracs were not a commercial success, and are now obsolete.

## AC power switch variations

The simplest type of triac power switch is that of Figure 2, in which the triac is gated on via R1 when SW1 is closed; only 1V or so is generated across the triac when it is on, so R1 and SW1 consume very little mean power; Figure 3 shows the same circuit fitted with a 'snubber' network. There are many useful variations of these basic circuits. Figure 8, for example, shows a version that can be triggered via an AC-derived DC supply. C1 charges (via R1-D1) to +10V on each positive AC power line half-cycle, and this charge triggers the triac when SW1 is closed. Note that R1 is subjected to almost the full AC line voltage at all times, and thus needs a fairly high power rating, and that all parts of this circuit are 'live', making it difficult to interface to external control circuitry.

Figure 9 shows the above circuit modified to give 'isolated' interfacing to external control circuitry. SW1 is simply replaced by transistor Q2, which is driven from the phototransistor side of an optocoupler. The coupler's LED is driven via an external DC supply via R1, and the triac turns on only when SW1 is closed; SW1 can be replaced by electronic switching circuitry if desired.

Figure 10 shows a variation in which the triac is AC triggered in each half-cycle via the AC impedance of C1-R1 and via back-to-back zeners ZD1-ZD2, and C1 dissipates near-zero power. Bridge rectifier D1-D4 is wired across the ZD1-ZD2-R2 network and is loaded by Q2; when Q2 is off, the bridge is effectively open and the triac is gated on in each half-cycle, but when Q2 is on, a near-short appears across ZD1-ZD2-R2, and the triac is off. Q2 is

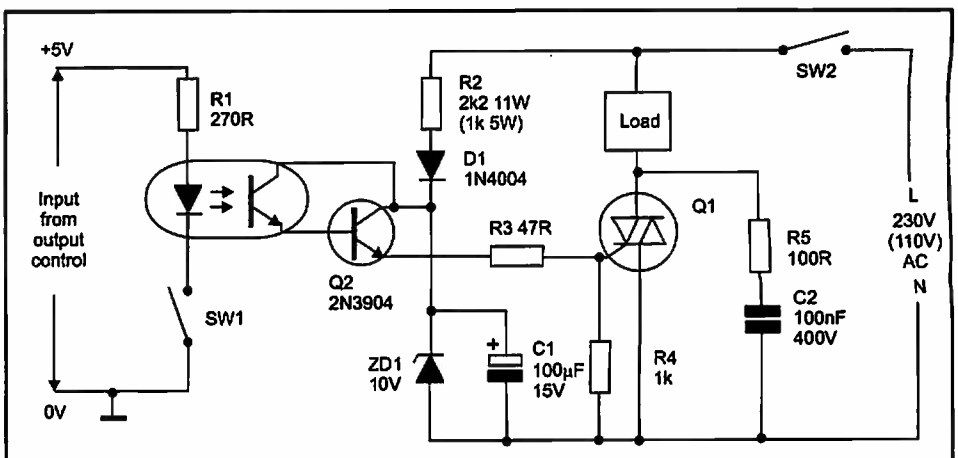



**Figure 9. Isolated-input (optocoupled) AC power switch, DC triggered.**

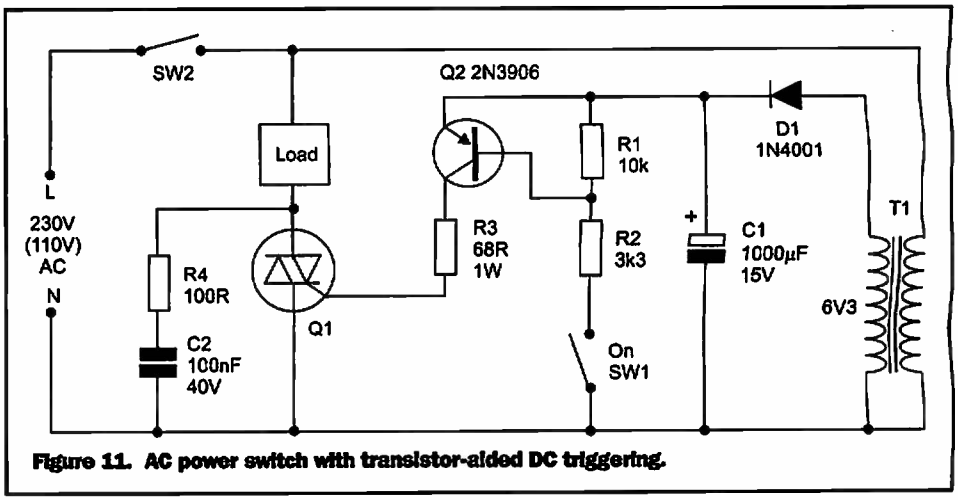



**Figure 11. AC power switch with transistor-aided DC triggering.**

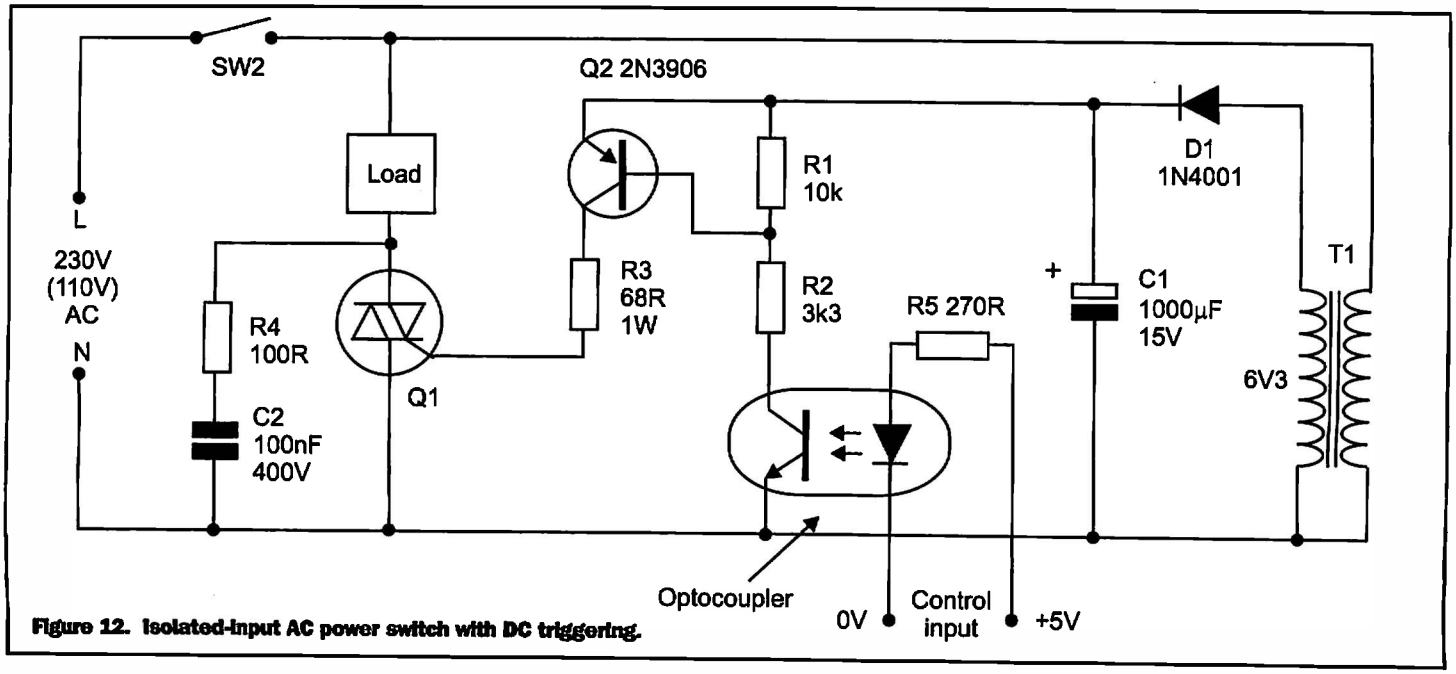



**Figure 12. Isolated-input AC power switch with DC triggering.**

driven via the optocoupler from the isolated external circuit, and the triac is on when SW1 is open and off when SW1 is closed.

Figures 11 and 12 show variations in which the triac is triggered via a transformer-derived DC supply and a transistor-aided switch. In Figure 11 Q2 and the triac are both driven on when SW1 is closed, and are off when SW1 is open. In practice, SW1 can be replaced by electronic circuitry, enabling the triac to be activated via heat, light, sound, time, etc. Note, however, that the whole of this circuit is 'live'; Figure 12 shows the circuit modified for optocoupler operation, enabling it to be activated via fully-isolated external circuitry.

## UJT triggering

Another way to obtain fully isolated triac switching is via the UJT circuits of Figures 13 and 14, in which the UJT is an old 2N2646 type or a modern near-equivalent. In these circuits the triggering action is obtained via UJT oscillator Q2, which operates at several kHz and feeds output pulses to the triac gate via pulse transformer T1, which provides the desired 'isolation'. Because of its fairly high oscillating frequency, the UJT triggers the triac within a few degrees of the start of each AC power-line half-cycle when the oscillator is active.

In Figure 13, Q3 is in series with the UJT's main timing resistor, so the UJT and triac turn on only when SW1 is closed. In Figure 14, Q3 is wired in parallel with the UJT's main timing capacitor, so the UJT and triac turn on only when SW1 is open.

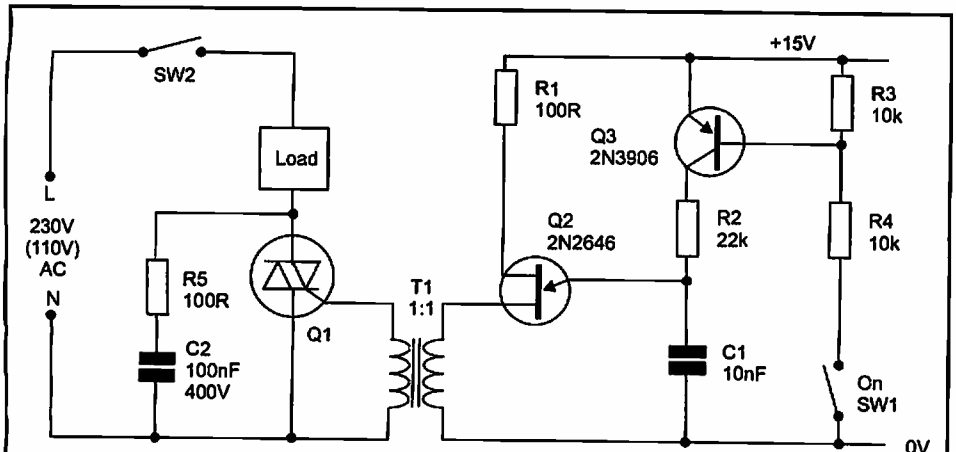



**Figure 13. Isolated-input (transformer-coupled) AC power switch.**

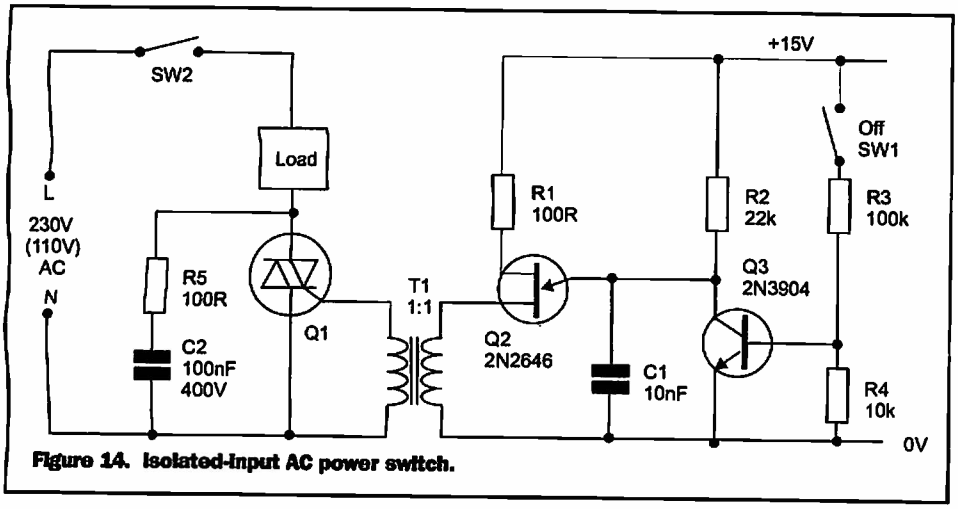


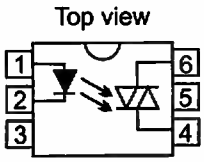

**Figure 14. Isolated-input AC power switch.**

## Optocoupled triacs

The gate junctions of a 'naked' triac are inherently photosensitive, and an optocoupled triac can thus be made by mounting a 'naked' triac and LED close together in a single package. Figure 15 shows the outline and lists the characteristics of a typical six-pin DIL version of such a device, in which the LED has a maximum current rating of 50mA, the triac has maximum ratings of 400V and 100mA r.m.s. (and a surge current rating of 1.2A for 10µs), and the entire package has an isolating voltage rating of 1.5kV and a typical input current trigger sensitivity of 5mA.

Optocoupled triacs are easy to use and provide excellent electrical isolation between input and output. The input is used like a normal LED, and the output like a low-power triac. Figure 16 shows the device used to activate an AC line-powered filament lamp, which must have an r.m.s. rating below 100mA

**Figure 15.**
**Typical optocoupled triac outline and operating characteristics.**




| Parameter | Optocoupled triac |
|---|---|
| LED characteristic $I_F$ (max) | 50mA |
| Triac characteristic $V_{MAX}$ | 400V |
| $I_{MAX}$ (rms) | 100mA |
| $I_{SURGE}$ | 1.2A |
| Coupling characteristic Isolating voltage | ±1.5kV |
| Input trigger current | 5mA typical (20mA max) |

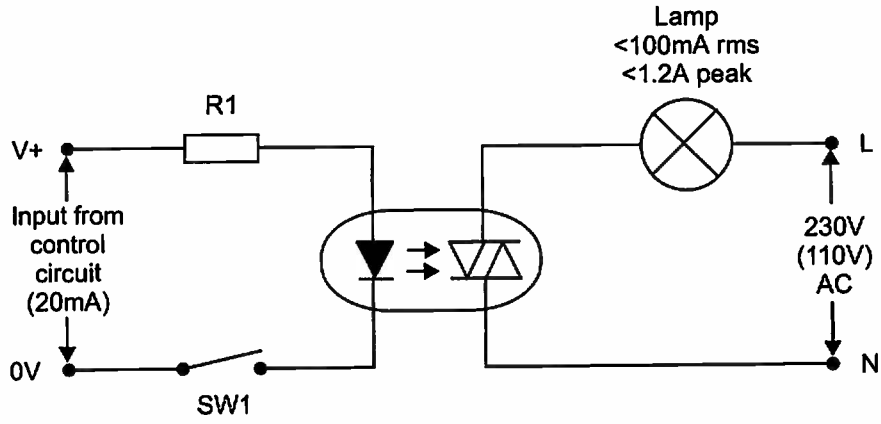



**Figure 16. Low-power lamp control via an optocoupled triac.**

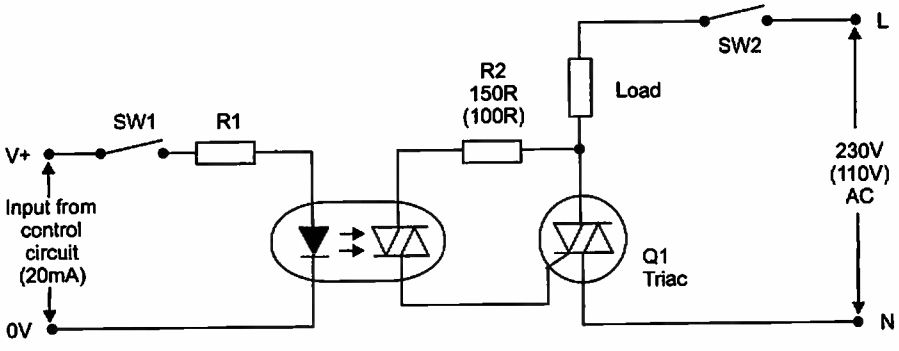



**Figure 17. High-power control via a triac slave.**

and a peak inrush current rating below 1.2A.

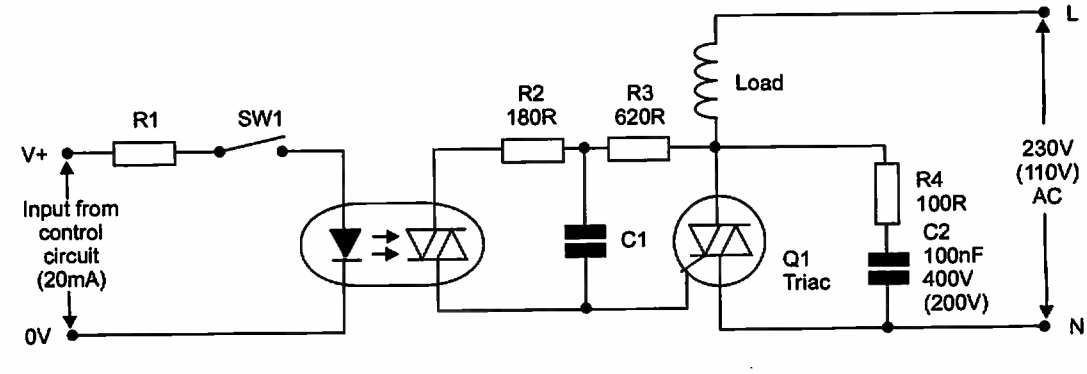
Figure 17 shows an optocoupled triac used to activate a slave triac, thereby driving a load of any desired power rating. This circuit is suitable for use only with non-inductive loads such as lamps and heating elements. It can be modified for use with inductive loads such as electric motors by using the connections of Figure 18. Here, the R2-C1-R3 network provides a degree of phase-shift to the triac gate-drive network, to ensure correct triac triggering action, and R4-C2 form a snubber network, to suppress rate effects.

## Synchronous 'zero-voltage' power switching

A synchronous 'zero-voltage' (or 'integral cycle') power switch is one in which the triac invariably turns on just after the start of each power half-cycle (i.e., near the waveform's zero-voltage point) and then turns off again automatically at the end of it, thus generating minimal RFI. In most power switching circuits shown so far in this article the triac turns on at an arbitrary point in its initial switch-on half-cycle, thus producing a potentially high initial burst of RFI, but then gives a synchronous zero-voltage switching action on all subsequent half-cycles.

A truly synchronous zero-voltage circuit uses the switching system of Figure 19, in which the triac can only be gated on near the start or 'zero-voltage' point of each half-cycle, and thus produces minimal RFI. This system is widely used to give on/off control of high-current loads such as electric heaters, etc.

Figure 20 shows a practical synchronous zero-voltage AC power switch. 10V DC is AC-derived via R7-D1-ZD1 and C2 and is switched to the triac gate via Q2, which is controlled via SW1 and 'zero-voltage' detector Q3-Q4-Q5 and can supply gate current only when SW1 is closed and Q3 is off. In the zero-voltage detector, Q4 or Q5 are driven on whenever the AC line voltage is more than a few volts (set by RV1) above or below zero, thereby driving Q3 on via R5 and inhibiting Q2. Thus, gate current can only be fed to the triac when SW1 is closed and the instantaneous AC line voltage is within a few volts of zero; this circuit thus generates minimal switching RFI. Figure 21 shows the circuit modified so that the




| C1 | Load power factor |
|---|---|
| 220nF | 0.75 |
| 330nF | 0.5 |

**Figure 18. Driving an inductive load.**

triac can only turn on when SW1 is open. Note in both cases that only a narrow pulse of gate current is fed to the triac, and the mean gate current is thus only 1mA or so. SW1 can be replaced by an electronic switch or optocoupler, if desired, thus enabling the load to be activated by light or temperature levels or by time, etc.

In practice, the simplest way of making a really efficient synchronous 'zero-voltage' triac-driving circuit is with the aid of a special-purpose IC that functions as an optocoupled low-power synchronous 'zero-voltage' triac that can easily be used as a slave for synchronously driving a normal high-power triac. Next month's concluding episode of this 2-part article will give practical details of such circuits, together withwith other triac-related circuits and information.

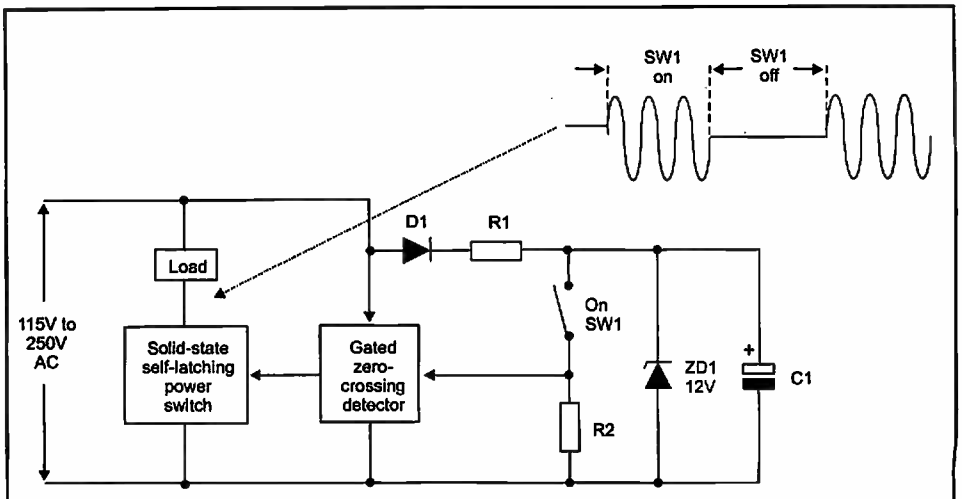



**Figure 19. Synchronous zero-voltage AC power switching system.**

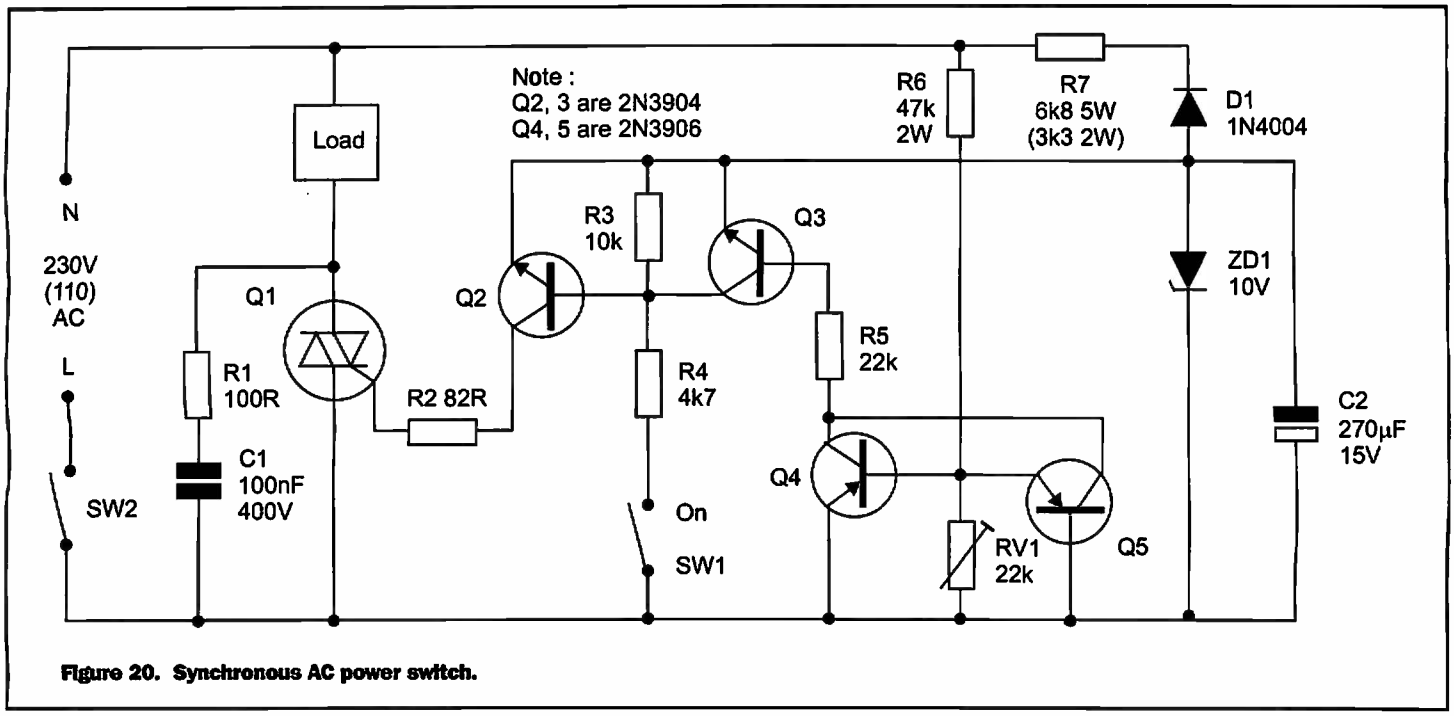



**Figure 20. Synchronous AC power switch.**

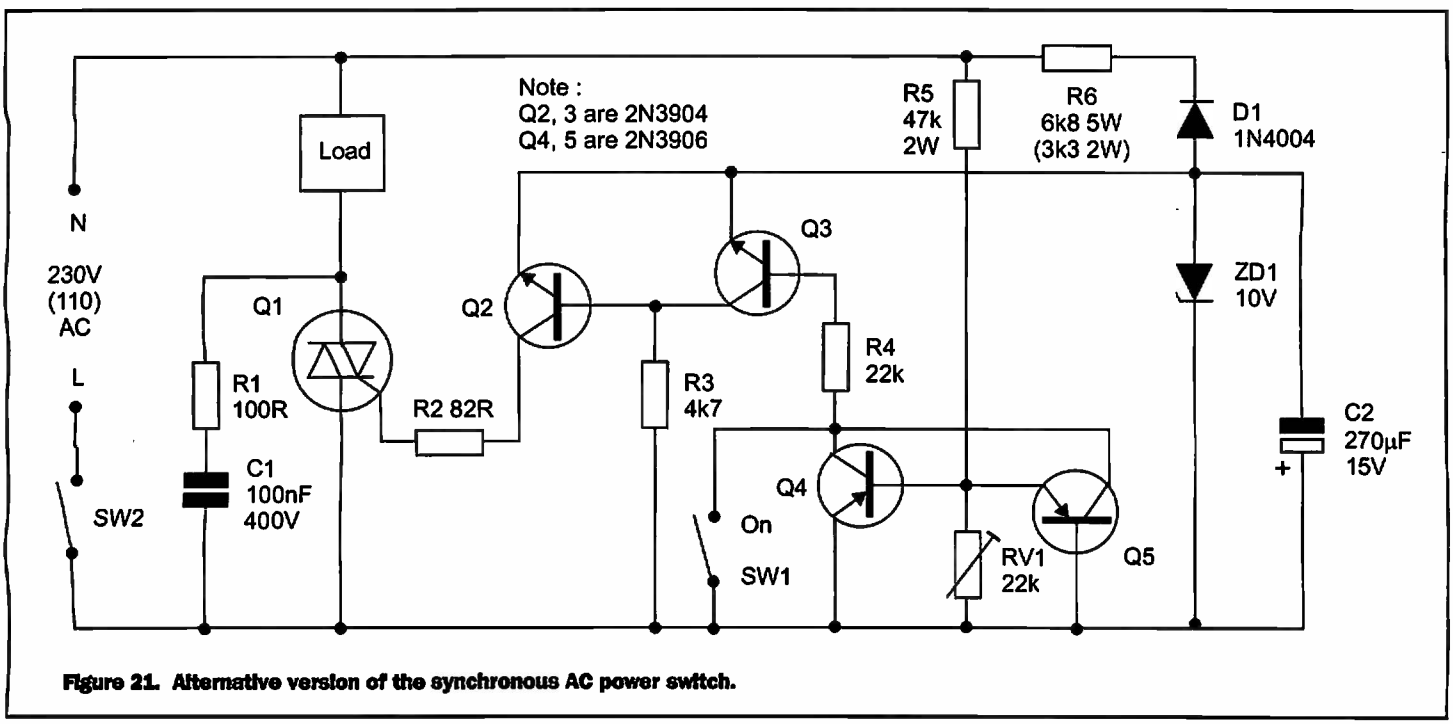



**Figure 21. Alternative version of the synchronous AC power switch.**

# COMMENT

by Keith Brindley

## Is there such a thing as a free lunch?

There are those who would say there isn't. If anyone buys you lunch, it's usually with a motive in mind. For example, if it's a salesperson who is buying you lunch, it's because he or she wants you to buy his or her product. A 'free' lunch is only free insofar as it's not personally costing the buyer anything. But you can bet the price of the 'free' lunch is built into the product's cost. In the sales business, it's a legal sort of backhander, whereby everyone's seemingly happy - the buyer because he or she has been entertained, and the seller because his or her product has been bought.

So it's been so far with free and unmetered access Internet service providers. Most of them work - or, at least, were intended to work - by renting telephone network usage from British Telecom. The rented usage is at heavily discounted rates because of renting in bulk, so the Internet service providers can balance users' unmetered free Internet access against users' purchase of telephone usage from them instead of BT. Theoretically, everyone wins: BT sells huge chunks of telephone usage so makes its profit; the unmetered access Internet service providers buy and sell discounted usage of BT's network so make a smaller profit, and - last but not least - users get slightly discounted phone calls and unmetered Internet access. To make this all work, users typically get what's known as a smart box that plugs between the user's telephones and the BT master socket. This automatically adds a prefix number to whatever number the user dials. The BT exchange registers it as belonging to whatever Internet service provider the system is, and bills the provider, who then in turn bills the user.

This all sounds like a jolly good free lunch, and several Internet service providers announced systems based on the model. The biggest name was AltaVista - the company better known for its Internet search engine - and the general consensus was that if AltaVista can do it, it could be a viable proposition. However, AltaVista's service never even came to market and has since been cancelled. A few smaller systems were developed - Callnet 0800, for example - and while these did work, they tended to be very busy at peak times. Most of those now have bitten the dust too.

It appears that everyone - BT included - has underestimated the pent-up demand for free Internet access in the UK. While models like these work quite well in the United States, because local calls in the US are cheaper anyway, they aren't viable here, simply because BT holds the trump card of the local loop between users' telephones and the local exchange. Until the local loop is taken out of BT's majority control it would appear that BT can - and will - always define the price of Internet access. Therefore, it's highly unlikely that unmetered free Internet access over BT telephone lines will exist in the near future. There are plans to take the local loop out of BT's direct control, but this won't happen until next year.

There is, on the other hand, an exception to this impossible dream rule of unmetered free Internet access that, so far at least, looks like being a winner for all concerned: the company and its users. It works simply because because BT does not control the system's local loop. The system, ntl's ntlworld service, gives totally free and unmetered Internet access 24 hours a day, and appears as reliable as any.

ntl is a cable company, of course, which has invested many millions in a new digital local loop and national network. As such, it doesn't rely on how BT prices its discounted services to third parties, and this is the key factor. In effect, ntl charges what it wants - not what BT defines - for local loop access. A summary of user costs is useful here.

For exactly the same price that BT charges in line rental - £9.25 a month - ntl provides users within its cable network regions with a phone line, several channels of television, plus its unmetered free ntlworld Internet service (you can opt for two phone lines plus ntlworld if you prefer for the same monthly charge). To cap this off, ntl's telephone charges are generally lower than BT's too, and all calls between local ntl users on evenings and weekends are free.

For potential users who aren't in a cabled region, ntl also allows access to the unmetered free ntlworld service by way of a smart box connected to a BT phone too. This is offered as long as these users spend at least £10 a month on telephone calls made through the ntl network via the smart box.

Because ntl doesn't have the overheads of having to rent BT telephone usage, ntlworld looks like being a success. ntl is a growing company (it's still, nevertheless, large - it's just not as large as BT in comparison) so its profits are not going to be compromised by a hugely popular unmetered free Internet service. On the contrary, its user base is going to grow exponentially, so its profits will go up - despite a significant number of users using the Internet for free. BT, on the other hand, is a massive company, whose ongoing profits are - and can only be - compromised by unmetered free Internet access. Currently BT makes millions and millions out of users dialling up to the Internet. If these users were all to get the free lunch of unmetered free Internet access, then BT's profits will plunge accordingly.

There are two things that BT needs to worry about over the coming time. First, local loop deregulation will mean that BT will inevitably be forced into providing cheaper and cheaper Internet access, until - eventually - it must be provided for free. This will happen over the next two to three years. Second, users will bleed away to ntl - the extra services ntl provides for the same price, plus cheaper phone calls, plus unmetered free Internet access will make that happen as sure as night follows day. At the moment this is occurring quite slowly, but as more and more ntl users start to shout about unmetered free Internet access to their BT-using friends and colleagues this bleed will turn into a flood. Again, BT can expect this to happen over the next two to three years. However you look at it, BT's profits are set to tumble. BT's free lunch days are over.??

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# The Fibre PROVIDER

***Hold on to your modems, the fibre optic revolution is here. Stephen Waddington takes a comprehensive look at the fibre optic market.***

**Photo 1.**


**Photo 2.**

There has been a phenomenal growth in the volume of traffic travelling through telecommunications networks, which is only expected to become greater. This traffic takes on a variety of forms including voice, data and video transmission, all of which demand increasing bandwidth as their deployment becomes ever more widespread.

## Fibre Optics Response to High Bandwidth Requirements

It became clear more than 30 years ago that copper wires couldn't hack it as the mechanism for shifting these huge amounts of data from one end of the country to the other and indeed from one side of the world to the other. The answer was to switch from using electrons transmitted via copper cables as the communication mechanism to photons transmitted via glass fibres.

The theory is relatively straightforward. Photons share many of the properties of electrons and so are ideally suited to communications. Fibre optics is a technology that converts digital information into light and beams it through ultra-fine strands of glass. A single strand of fibre can carry vast amounts of data. A fibre optic system is composed of four basic parts:

1. The first is the light source in the transmitter, which can be a light emitting diode (LED) or a laser. This source is modulated, that is, turned on or off in a digital system to represent the binary digits (1s and 0s) it receives from an electrical transmission system.
2. The next is the fibre optic cable, which can consist of a single strand of specially manufactured glass or multiple strands bundled together. Each fibre optic strand is as thick as a human hair, but the actual cable may measure a quarter inch to 1 ½ inches in diameter after the strands have been wrapped in protective coverings.
3. The third part of the light wave system is the regenerator. As a photonic signal travels through a fibre optic strand, it attenuates, beginning to loose its shape. If it isn't regenerated periodically, the signal won't be recognisable at the receiving end. These regenerators can either be optical-electrical-optical devices, usually found in terrestrial systems, or all-optical systems found in undersea light wave systems.
4. The fourth part of the system is the photo detector in the receiver, which takes the optical signal from the fibre and converts it into an electrical signal for transmission through the non-optical portions of a network.

## One Fibre, Many Channels

Up until a few years ago a strand of fibre, the width of a human hair, could carry a single stream of data on a light wave moving at 2.5 million bits per second. But a development known as dense wave division multiplexing (DWDM) means that up to 160 streams of data can be stuffed down the same fibre, each identified by a unique colour or wavelength as shown in Photo 3.

DWDM facilitates the optimum use of service providers' existing long distance fibre backbones by employing more of the optical fibre's inherent bandwidth thus avoiding expensive investment in new backbones and higher data-rate time division multiplexing (TDM) transmission. In addition it provides the means to simplify the equipment needed to operate networks and create more efficient topologies for the future.

Today a single fibre using wave division multiplexing can carry 1.6 trillion bits per second. That's sufficient to handle 100 million simultaneous phone conversations, 12 million high-quality audio feeds or 500,000 full motion video streams.

But believe it or not, there could *still* be further improvements in the bandwidth capacity of a single fibre. Nortel Networks claims to be developing a systems that could further quadruple the rate at which data travels, raising the potential capacity of a strand of fibre to 6.4 trillion bits per second.

## Bandwidth Glut

These very improvements leave some analysts to predict a bandwidth glut. They look at all the fibre that it being laid across ocean floors, multiply it by latest transmission speeds and conclude that the world has gone bandwidth crazy. For instance with existing technology you could stuff all of the voice traffic for the UK down half a dozen strands of fibre.

In reality fibre optic technology is not being rolled out as neatly as theory would like to predict. The majority of fibres in use are currently being used in single channel mode and its going to take five to ten years for Nortel's latest technology to be proven and reach the market.

A lot of the fibre lying at the bottom of the sea, and in pipes under the pavement in the UK is still dark, meaning it is not currently being used for transmission. Lighting up fibre optic cables is not a cheap exercise. Its reckoned that for every £1 spent on installing a cable underground, another £20 needs to be spend on equipment to light up the network.

## More Theory

The term light wave is a bit of a misnomer, since what we think of as light

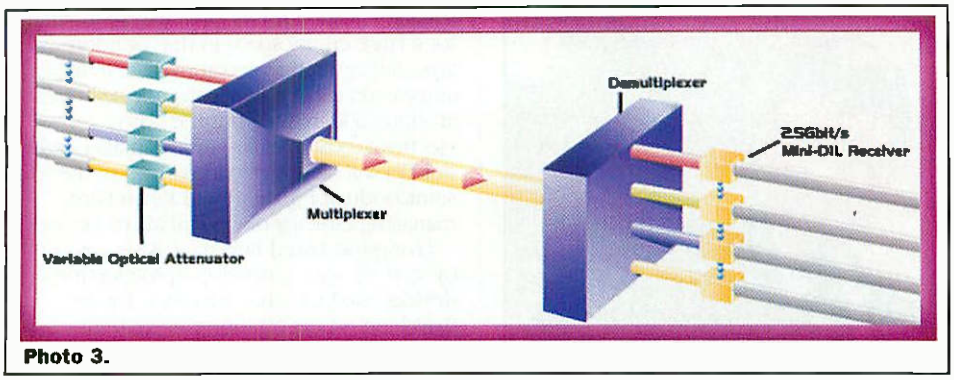

Photo 3.

refers to that portion of the electromagnetic spectrum that is visible to the naked eye - 770 to 330 nanometers (770x10$^{9}$ metres to 330x10$^{9}$ metres).

However, optical fibre communication uses that portion of the spectrum which is least affected by attenuation and supports the longest cable spans - the infrared regions at 1550, 1300, and 850nm, which are invisible to the human eye.

## Getting Photons from A to B

If you think of glass as a fluid that has been frozen, then you'll appreciate the fact that glass has the capacity to bend. It is this flexibility that makes fibre optic cables so useful. They can be bent in any direction. You can even tie a fibre optic strand in a knot, although such treatment is not recommended.

Light, on the other hand, wants to go in a straight line, so how is it kept inside the fibre optic cable? The glass portion of an optical fibre consists of two regions, the core that runs through the center of the strand, and the cladding that surrounds the core. While light rays want to go in a straight line, when they are aimed, or coupled, by a light source into a fibre, some of the photons will enter the core at widely divergent angles.

The cladding, which has a different refractive index than the core, acts as a mirror. It causes the light rays to relect back into the core during their transmission through the system. Since the light rays are traveling through the core at a different angle, they will arrive at diferent times at the end of their journey. The result is an optical signal that is dispersed, and spread out over time. The wider the pulse spread, the less bits per second that can be transmitted on the system.

## UK Discovery

When glass fibres of core/cladding design were first introduced in the early 1950s, the presence of impurities restricted their employment to the short lengths sufficient for endoscopy.

In 1966, electrical engineers K.C. Kao and G.A. Hockham, working in the UK, suggested using fibres for telecommunication, and within two decades silica glass fibres were being produced with sufficient purity that infrared light signals could travel through them for 100 km (60 miles) or more without having to be boosted by repeaters.

Plastic fibres, usually made of polymethylmethacrylate, polystyrene, or polycarbonate, are cheaper to produce and more flexible than glass fibres, but their greater attenuation of light restricts their use to much shorter links within buildings or automobiles.

## Boom Market

Today electrical and optical manufacturing are boom areas of the UK economy. Figures released at the beginning of September by the Office for National Statistics show that manufacturing output in these categories was up 5.3% in the three months to July compared to the previous three-month period.

"The telecommunications industry is failing to keep up with demand for optical components. For every mobile phone, there's a demand for more bandwidth in the optical part of the network. If the industry carries on this way, it is expected to have to employ hundreds of thousands of people and occupy millions of square feet of space to assemble these components," said Bookham's Rickman.

In fact fibre optics is one area where venture capitalists on both sides of the Atlantic have continued to invest heavily over the last six months despite the perceived slowing down of technology stocks caused by the high profile failures of a number of so-called dot com companies.

In the UK established companies such as Bookham Technology and early stage businesses such as Southampton Photonics, Optical Micro Devices and Kymata are propelling growth in the sector.

## Manipulating Photons

When researchers first considered developing products to switch and amplify fibre optic signals one of the first materials considered was silicon because of its dominance in the electronics industry. As luck would have it silicon has excellent optical properties, particularly in the range utilised by fibre optics so it have been broadly adopted by the fibre optics industry.

Because silicon is a well understood material having been used for the last 50 years or so in the electronics industry, the fibre optic manufacturers have been able to quickly adopt manufacturing techniques from the electronics industry for their own requirements. Photo 5 shows a series of fibre optic components and highlights how similar the look is to electronic components.

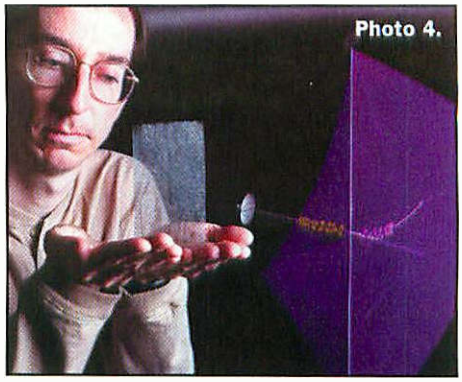
Photo 4.

There are three basic approaches to manufacturing fibre optic components. The first two outlined below are based on convention techniques developed in the electronics industry, whilst the third is a novel system still under development.

A. High temperature silica-on silicon - manufactured using high temperature, low-pressure chemical vapour deposition to etch silica channels on a silicon substrate for the light to *travel along*. Companies that use this approach include Optical Micro Devices and Lucent Technologies.

B. Silicon-on-insulator - here the silicon wafer is selectively doped to create channels, which as act as light insulators. UK firm Bookham Technology uses this approach.

C. Flame hydrolysis silica-on-silicon - in this process, doped silica is sprayed onto a silicon wafer. It is then masked and etched to produce silica wave-guides. These wave-guides are buried by a cladding layer. Optical gratings can be written onto the wave-guides to produce various passive properties, and switches may be added to perform active functions.

Silica-on-silicon technology has been around for some time, and many of the fundamental patents have now expired. However, in recent years process and device developments and the emergence of market opportunities have brought an impetus to commercialise this technology. Kymata is developing this approach.

## Who's Doing What?

In August Micro Photonix Integration (MPI) a manufacturer of integrated optical devices completed a £20 million third round financing exercise. The company designs and produces components and modules that allow communication service providers and

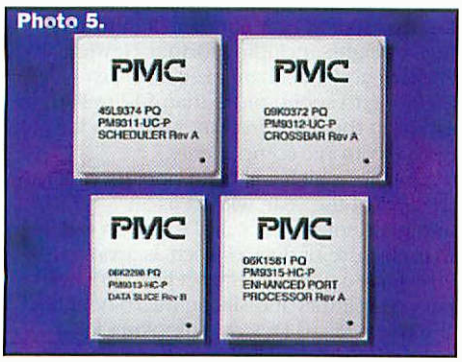

Photo 5.

Photo 6.

**Photo 7. Sir Peter Bonfield with Microsoft's Bill Gates.**

network system manufacturers to maximise the bandwidth of their optical networks.

The first of MPI's components are modulators that are designed to transmit broadband voice, data and video signals over optical media.

"The MPI story is interesting not only for advanced optical technology, but also because their proprietary manufacturing process lends itself to higher yields, higher quality and a favourable cost structure for the future," said Charles Willhoit, a telecommunications analyst at JP Morgan Securities.

Mitel, traditionally one of the world's top ten microchip manufacturers has taken a strong position in the fibre optic market. According to the company it has developed an optical device that combines as many as 80 beams of light on a single strand of glass at a lower cost per beam than existing products made by competitors such as Nortel Networks and Lucent Technologies.

AMCC another semiconductor company, specialising in developing products for optical networks such as the switch shown in Photo 6. The company utilises a combination of high-frequency, mixed-signal design expertise and multiple silicon process technologies to develop silicon products for the telecommunications market that address the SONET/SDH and ATM transmission standards.

## UK Success Story

Bookham Technology is a UK success story and that has been developing fibre optic technology for more that a decade. A flotation of the London stock exchange earlier in the year saw the company enter the FTSE 100 in June, to join ARM that other UK chip success story.

The key to the Bookham's success is its ability to make optical switches on silicon chips. This allows it to produce many of the opto-electronic components used in fibre networks using high volume semiconductor production methods.

The manufacturing technique developed by Bookham shifts the complex alignment and adjustment of fibre optic components from manual processes on an optical workbenches into electrical adjustments of solid state silicon.

Bookham has more than doubled its workforce in the last six months in its bid to position itself as the "Intel of Optics" - "We want to be to the telecommunications infrastructure industry what Intel has been to the personal computer industry. The critical factor in our expansion is our ability to recruit people," said Andrew Rickman, president and chief executive of Bookham.

Bookham's staff numbers currently stand at around the 500 mark and are expected to increase further. Many of the staff will work at a facility, which Bookham is building in Swindon.

## UK Fibre Optic Start-ups

Southampton Photonics, a spin-out from Southampton University's opto-electronics research centre, raised around £34 million this summer in first round funding from US venture capitalists. The money will be used to continue product development and start manufacturing a range of devices for dense wavelength division multiplexing and optical telecommunications equipment.

Staffed by a management team, which includes a number of ex-Bookham staff, the Southampton Photonics expects to have prototypes of optical amplifiers and filters within a few months and be in production by the end of next 2001. The company said that it expects to create 200 jobs in the UK over the next 18 months.

Southampton Photonics products will include distributed feedback lasers, optical filters with enhanced performance to deliver more channels per spectral bandwidth and broadband optical amplifiers.

Another UK start-up, Optical Micro Devices staffed by a number of industry heavyweights including former Hewlett-Packard and Bookham executives, is planning to spend more than £12 million to establish the UK's first 8in. wafer fab for opto-electronic components.

The fab, which will be in operation before the end of the year, will act as an independent foundry, and focus on the manufacture of devices such as arrayed wave guide gratings, transceiver benches, passive splitters and silicon micro-benches.

Optical Micro Devices is looking for a suitable location for its fab. "We are looking for a large empty space in the Swindon area, tall enough to accommodate a highly automated clean room. Fabs normally cost around £600 million, but the opto electronics volumes are much smaller and out fab will be tiny in comparison to the semiconductor giants," said Kevin Ford, managing director of Optical Micro Devices.

Livingston-based Kymata was set up just over a year ago to develop opto-electronic devices used for what are called Dense Wavelength Data Multiplexing systems. Kymata designs and makes chips that can, for example, expand the capacity of a single optic fibre by up to 32 times.

Kymata reserves the approach of many high-technology start-ups in being primarily a business idea, which has gone in search of the appropriate technology, rather than the other way round.

The company was founded two year ago by computer consultant Brendan Hyland and Richard Laming, former deputy director of telecommunications at Southampton University's Opto-electronics Research center. They identified the potential in manufacturing opto-electronic chips necessary to enable expansion of fibre-optic capacity. Their eye was caught by work at Glasgow University developing a process called flame hydrolysis deposition - a sophisticated means of implanting, or "writing" devices on to glass.

In the longer term, Kymata sees a demand for 'single chip' subsystems, which will involve adding active devices to silica on silicon substrates, using the techniques established by the hybrid IC industry.

## Where Does BT Fit In?

One of Kymata's primary investors is BT. Since BT it was privatised in 1984, the company has invested more than £30 billion in a UK fibre optic network. Copper wires have been replaced with optical fibres in all trunk lines. There is now more than 3.5 million kilometres of optical fibre in the UK - enough to go around the world more than 80 times.

To switch this huge amount of traffic, BT has deployed a synchronous digital hierarchy (SDH), transmission systems. SDH is the emerging standard for digital transmission used in core communications networks over which broadband, video, data and voice services run. It provides a reliable and responsive transmission network infrastructure for broadband traffic.

SDH networks can repair themselves in the event of a fault, and can be more easily re-configured in event of failure, enabling BT to provide a more flexible and reliable service to its customers.

BT is deploying wavelength division multiplexing technologies in both its UK and European networks to enable them to be scaled-up over time. The world's first land-based systems carrying live traffic using optically protected WDM were installed by BT between Newcastle-Edinburgh and Carlisle-Belfast in 1999.

Under the leadership of Sir Peter Bonfield pictured with Microsoft's Bill Gates in Photo 7, BT is working with six of its joint-venture partners to create the largest pan-European high-speed network. The network already comprises some 45,000 route kilometres of fibre optic cable with points of presence in

more than 200 cities. It uses wavelength-division multiplexing to give an initial bandwidth capacity of 160 Gbit/s, soon to be increased to 320 Gbit/s.

BT's researchers at Adastral Park have recently demonstrated for the first time the ability to read the destination address of optical data signals and route them correctly - all at the incredible speed of 100 billion bits per second, which is well beyond the speed capability of even the very fastest electronic circuits. It has also demonstrated how optical data signals can be regenerated (refreshed and retransmitted) without the need for electronic equipment, but has yet to announce how this has been achieved.

## Internet Resources

### Photonics Online

**(www.photonicsonline.com)**

The Information Source for the Photonics Industry. Photonics Online, the Internet's leading source of cutting-edge technical information about the laser, optics, opto electronics, fibre optics, and imaging industries.

### Inter@ctive Week

**(www.zdnet.com)**

Inter@ctive Week is a weekly newspaper that covers all aspects of the Internet and interactive technology - alliances, events, issues, key players, products, services and strategies. We also discuss the business and political issues impacting the marketplace.

### Internet Week

**(www.internetwk.com)**

InternetWeek is the news and analysis source for IS/network managers applying Internet technologies to transform enterprise networks.

### IEEE

**(www.ieee.com)**

The IEEE promotes the engineering process of creating, developing, integrating, sharing, and applying knowledge about electro- and information technologies and sciences for the benefit of humanity and the profession.

### All Optical Networking Consortium

**(www.ll.mit.edu)**


The All Optical Networking Consortium was formed by AT&T Bell Laboratories, Digital Equipment Corporation, and the Massachusetts Institute of Technology to investigate architectures for, and build prototypes of all optical networks.

### EURESCOM

**(www.eurescom.de)**


European Institute for Research and Strategic Studies in Telecommunications.

### International Society for Optical Engineering

**(www.spie.org)**


SPIE is a non-profit professional society dedicated to advancing research, engineering, and applications in optics, photonics, imaging, and electronics.

### Optical Internetworking Forum

**(www.oiforum.com)**


The Optical Internetworking Forum (OIF) is an opportunity for the industry to accelerate the implementation of these next generation optical internetworks. Service providers, optical networking vendors and data networking vendors around the world are invited to join the OIF to work towards this goal.

### Photonics Resource Centre

**(www.optics.org)**

Photonics resources for scientists and engineers

# New 'Film Look' video equipment FROM SONY

Sony has launched a range of video production equipment specifically aimed at cinema and TV users requiring the 'film look'. This CineAlta equipment is part of their digital HDCAM format range of high definition equipment, and is specifically designed to shoot 24 frames progressive scan (24p) to match the motion picture standard of 24 frames per second.

The highlight of this CineAlta range is the HDW-F900 24P camcorder. It contains three newly developed 2/3in 1920x1080 pixel CCDs, exclusive CCD output signal processing circuits, a new 12-bit A/D converter giving a greater dynamic range with improved tonal and colour reproduction, and new DSP processing. It also features switchable frame rates of 24, 25 or 30 progressive, and 50 or 60 interlaced (CineAlta is the first professional television product range to feature this compatibility). And its sensitivity of F10 at 2,000 lux - comparable to a film speed of 600 ISO - is claimed to give noise-free and grainless pictures (I always thought that grain was supposed to be an innate part of the 'film look').

The camera is mated to a small HDCAM VCR. This component format uses ½in metal particle tape like Digital Betacam; but with a particle length of 0.125μm against Betacam's 0.25μm and 1658 Oersteds against 1570 Oersteds. The recorded wavelength is 0.49μm. And the tape speed is 96.7mm/sec (giving a maximum of 124 minutes with the Large Cassette, and 40 minutes with the Small Cassette). The sampling frequency is 74.25MHz for the luminance signal (Y) and 37.125MHz for the colour difference signals (Pb/Pr) - giving a 4:2:2 ratio with quantisation of 10bits per sample (or 8bits with bit reduction). The four channel audio uses a sampling frequency of 48kHz; with 20bits quantisation.

The high definition resolution of 1920x1080 at 60, 50, 30, 25 frames and 24 progressive scan and 60 and 50 fields/sec interlace scan has been adopted as the global Common Image Format (CIF) for high definition production and programme exchange. This can easily be downconverted to the alternative 720 lines at 60p HDTV format, or to SDTV formats that includes 480 at 60p/30p/60i and the European 576 at 50i/25p, or even analogue PAL and NTSC.

The Sony BPE 24p switchable HDCAM family includes acquisition, production, post-production and display products. Among the products that will be commercially available this year are the digital movie camcorder (HDW-F900), and digital recorder (HDW-F500), a multi-format digital system camera (HDC-950), a multi-format HD digital multi-effects system (HDME-7000), three multi-frame rate switchable HD switchers and a new series of HD-capable monitors (BVM-D Series).

The camcorder has been in the news because it is being used to shoot most of the live action scenes in 'Star Wars: Episode II', following four months of testing by Lucasfilm and Industrial Light & Magic, a division of Lucas Digital. Sony and Panavision had been approached jointly by Lucasfilm in 1997 urging development of a digital HD system that would support the making of the new Star Wars: Episodes I, II, and III, from the early planning stages, to improve the flexibility of shooting and to reduce production times and costs on both stage and location.

The Phase I prototype camcorder was modified by Panavision to accept its new series of Primo Digital F1.5 zoom lenses - designed to maximize the performance of the HDW-F900, given a new viewing system, and the capability to accept the Panavision range of film-style accessories. The initial tests concentrated on the performance of the individual parts of the camcorder - optical, digital camera, and digital recording. These were followed by tests on the whole operational system; which included subsequent computer processing of the images, and a series of scenes shot in parallel with 35mm motion picture film. All the scenes were composed for a final 2.40:1 aspect ratio, which was extracted from the 16:9 digital capture. And the digital pictures were transferred to 35mm film for comparative viewing. According to George Lucas: "The tests have convinced me that the familiar look and feel of motion picture film is fully present in this digital 24P system, and that the picture quality between the two is indistinguishable on the large screen."

Wim Wenders has also used the camcorder for the music clip 'The Ground Beneath Her Feet', featuring a song by U2 from his movie 'The Million Dollar Hotel'. "I worked with people from Sony and Panavision once I received the camera and within a remarkably short timeframe, I was shooting complex scenes quite easily with it," said Wenders, during the one-day shoot in Dublin. "I was amazed at the quality of digital images produced using Sony's HDW-F900 and how well it intercut with the film footage shot on 35mm."

Also the French cinematographer, Pitof, noted for his directorial debut - 'Vidocq', the world's first motion picture to be shot entirely in high definition said "It's an extremely exciting adventure" .
"However, even though we may be seeing the future of the moving image, there is no question of replacing traditional 35 mm film with the high definition HDCAM format. It's just that digital has a specific look and a special texture, and it offers new opportunities, which we are keen to explore. HDCAM is a development that considerably expands the director's palette. All we need to do now is to fully exploit its potential."

And the continuing relationship of Sony and Panavision has taken a further step forward with the formation of a new company to supply the Panavision modified CineAlta cameras to the industry. Meanwhile Sony has longer term development plans for a full 1080/60p system in the future.

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**Reg Miles**

# Self Assembling Magnetic Particles FROM IBM

Scientists from IBM's laboratories in New York and California have discovered chemical reactions that cause tiny magnetic particles, each only 4nm in diameter and uniformly containing a few thousand atoms of iron and platinum (FePt), to automatically arrange themselves into 3D superlattices, with each particle separated from the others by the same distance. The new reactions will also enable control over both the size of the particles and their separation distance, factors that are important in increasing data density. Their uniformity of size is also much greater than has previously been achieved.

The smaller the magnetic particles, the smaller the data bits that can be written. The more uniformly the particles are separated, the more they can retain magnetisation. While the more uniform the their size, the easier it is for smaller particles to be read by existing signal detection and error-correction schemes.

Up to now the synthesis of FePt particle thin films has mainly relied on vacuum deposition techniques; however, it has proven difficult to control particle sizes and to prevent clumping by that method. Solution phase chemical synthesis, conversely, has proven successful in overcoming those defects.

The iron and platinum coalesce to form the FePt particles. The stabiliser molecules then arrange themselves around the particles like spokes. After pouring the liquid onto a substrate, the film is heated and, as the solvent evaporates, the 'spokes' keep the particles separated as they self-assemble into the 3D superlattices. Further heating (or annealing) in the absence of oxygen bakes the stabiliser coating around each particle into a carbon shell that fixes the particles into place and prevents their corrosion when subsequently exposed to air. This annealing also causes a critical change in their atomic structure: the FePt atoms rearrange themselves from a form that does not retain its magnetic orientation, a crystal structure known as face-centered cubic, into one that does - face-centered tetragonal.

The composition, size and spacing of the particles can be controlled: the first by adjusting the molar ratio of iron carbonyl to platinum salt; the second by growing 3nm monodisperse seed particles and then adding more reagents to enlarge them - up to 10nm. There is a third method by ligand exchange of the long chain molecules to shorter chains.

Experiments with the resulting thin film have shown it to be capable of writing and reading data bits at reasonable linear densities at room temperature. If the film can be reduced to 4nm, then it is estimated that it should be capable of ten times the recording density of present day media.

"This scientific discovery could lead to new solutions for storing the huge volumes of data generated worldwide as our customers incorporate the Internet and e-business into their livelihoods," said Currie Munce, IBM Research's Director of Storage Systems and Technology. "Many practical considerations must still be addressed before this new process will be suitable for manufacturing disks, but it's an exciting and promising laboratory development."

Among a number of these considerations that must be addressed first are: the durability, smoothness and chemical stability of the material; the means for controlling magnetic orientations, long-range packing uniformity and consistency over an entire 3.5-inch disk surface; manufacturing costs and throughputs; compatibility with the other materials and processes used to make disks and the relative gains in noise performance compared with media made by extending existing sputtered-film media. Even then the benefits of the new material would have to outweigh the costs of installing new equipment and making changes in the existing manufacturing process: it may require a return to the spin-on-film method of disk coating that sputtering replaced a decade ago, while still retaining the high precision now required.

If it does work, it could lead to one bit per particle storage in the future. "But achieving such a lofty goal entails even more daunting challenges." says Dr. Dieter Weller of the Almaden Research Center. "Scientifically, we must understand the science of single-particle magnetization, while on the engineering side, we must be able to align the read/write head precisely over each particle as it passes rapidly on the spinning disk."

For further information contact:
Mike Ross, Media Relations Communications Dept., K03/G2 IBM's Almaden Research Centre, 650 Harry Road, San Jose, CA 95120.
Email: mikeross@almaden.ibm.com.

Reg Miles

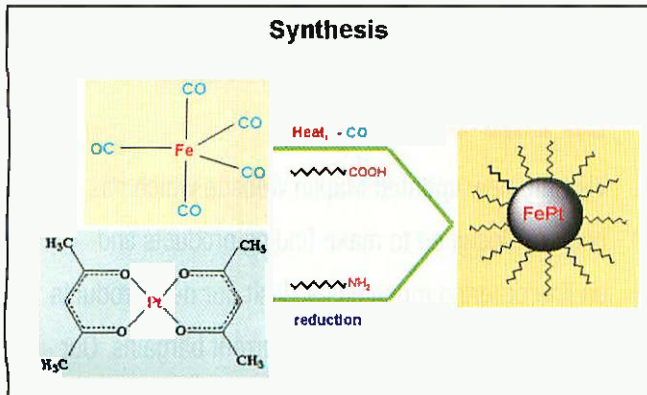


**Figure 1. Making Nanoparticles. Diagram shows the chemical reactions that create the iron-platinum nanoparticles. Two specially selected iron- and platinum-containing molecules (iron carbonyl and platinum acetylacetonate) are heated in solution with surfactant molecules similar to olive oil (oleic acid and oleyl amine). As the molecules react with each other, the iron and platinum separate from their organic segments and coalesce into spherical nanoparticles of an iron-platinum alloy. Each 4-nm diameter nanoparticle contains several thousand atoms. The surfactant molecules arrange themselves around the nanoparticle like spokes extending in all directions from the center of a ball. After pouring the liquid onto a substrate, the next step is to heat the film.**

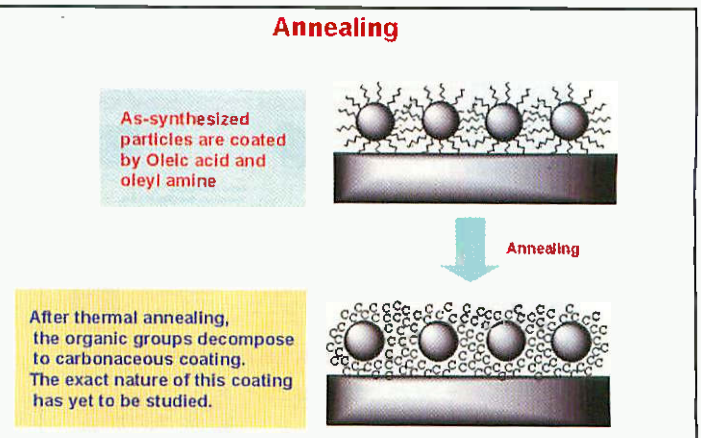


**Figure 2. Annealing The Film. As the solvent is evaporated, the surfactant molecules keep the iron-platinum particles physically and magnetically independent as they self-assemble into a regular array. Further heating in the absence of oxygen bakes the surfactant coating around each particle into a hard shell of carbon char that locks the particles into place and prevents corrosion of the film when it is subsequently exposed to air. This additional heating (also called "annealing") also causes a critical change in the atomic structure within each particle: The iron and platinum atoms rearrange themselves within the nanoparticle from a useless form that does not retain its magnetic orientation (face-centered cubic) to a very useful one that does (face-centered tetragonal).**

# in the pipeline

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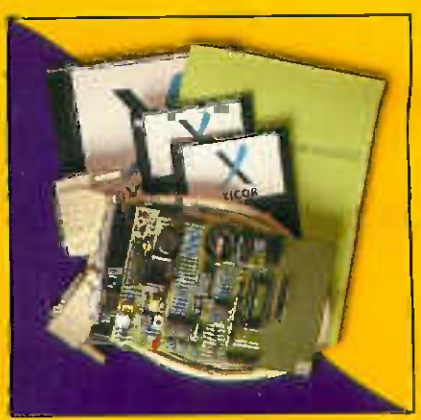

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