UK Displays & Lighting

Knowledge Transfer Network





Knowledge Transfer Networks Accelerating business innovation; a Technology Strategy Board programme

UKDL Newsletter

A new Rockwell Collins Pro Line 21 avionics suite with four 8x10-inch LCD screens, that applies the latest in flight deck design, ergonomics, and systems technology, while lowering pilot workload and delivering increased situational awareness. The interior of the craft offers energy-efficient LED lighting. The aircraft is a Bombardier Learjet 60 XR.

Summer 2008

UKDL Newsletter

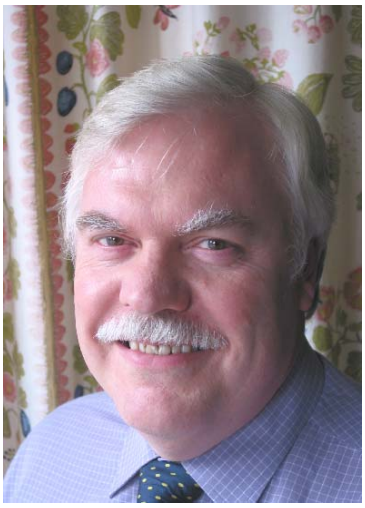
Issue 4 **August 2008**

Contents

*The **UKDL Newsletter** is focused on bringing news and commentary about plastic electronics, displays, and lighting-related happenings in the UK. The **UKDL Newsletter** is published quarterly for the UKDL by Veritas et Visus.* UK Display & Lighting KTN 2008

A view from the director…

by Chris Williams



As we move into August it is our pleasure to welcome you to this 4th edition of our UKDL Newsletter. Since its inception last year, this newsletter has grown from the original plan of "about 12 pages" to a mighty tome where we now are forcing ourselves to a limit of 60 pages for each of the four quarterly issues. To call it a "newsletter" is perhaps disingenuous – the data and information collated from our members across the UK for each issue make it a far more useful and interesting work – more of a "who's who" and "who's doing what, where" reference manual detailing the current activities of the companies and academics across the UK working in the areas we cover – plastic electronics, ultra-efficient lighting, and flat panel displays.

In these balmy summer days, with endless sun and warm breezes (sorry, I'm hallucinating – must have got too wet when I walked outside in the rain) or at the very least – in the summer period when government goes on holiday and news of any value is scarce, with the only "other" option for entertainment being the non-stop Olympics on digital TV, perhaps the UKDL Newsletter will occupy a few minutes, or hours, of your time and provide you with a greater insight into what's going on!

Our newsletter is a snapshot of the UK, but it is a dynamic landscape that changes every week and every month. To really know what is happening here, you need to come to our events and meet our other members. We charge modest fees to attend most of our events (and many events are free), but within every event we run, the networking is both free and invaluable!

Membership of UKDL is free, the newsletter is free, and attendance at our technical and commercial events is modestly priced. Whichever way you "cut the cake" UKDL offers good value for money. But, as with most things in life, your own "return on investment" depends on how much of your own resource you are willing to speculate. If you make the effort to come to the events, you will be informed, you will learn and you will be entertained. However, if you make the effort to "mix it" with the other delegates, you will reap the rich rewards that such focused networking brings – immediate access to kindred souls, and rapid access to new technologies, suppliers, and customers.

We now have a "war chest" of individual comments made to us by various members who collectively agree that membership in the UKDL and involvement with its activities has positively influenced their technical and commercial progress within the UK and beyond. Networking delivers new contacts, and networking delivers new business opportunities. To the management team of UKDL, this is all the proof we need that our formula works, and that by delivering to our members the events and activities they have asked for, and by facilitating networking at every level on every occasion, we are meeting our primary objective – to increase the wealth and job opportunities for UK plc within our sector.

If you haven't yet seen a commercial benefit from being a member of UKDL – perhaps you are not trying hard enough to network? Or not coming to enough events?

We look forward to seeing you all at our events over the next few months, and will be happy to introduce you to any of our other members who may be of interest – and benefit – to you.

Display and lighting news from around the UK

excerpted from Veritas et Visus newsletters

Mirics develops global solution for TV based on a PC using software demodulation

Mirics Semiconductor announced the Mirics FlexiTV broadcast receiver, a complete RF, host interface and software demodulation solution for the PC platform. Mirics FlexiTV enables reception of all global analog and digital broadcast standards (e.g. FM, DVB-T, ATSC, DTMB), to become a standard feature on all notebook PCs. Mirics FlexiTV also enables a sub-$5 bill of materials (BOM) for a complete PCTV MiniCard, allowing manufacturers to develop a single broadcast receiver for global deployment, thereby benefiting from simplified manufacturing logistics and substantial economies of scale. Mirics has combined its multi-standard RF tuner capability with its algorithmic expertise to develop the world's first universal antenna-to-LCD broadcast receiver solution. By implementing software demodulation running on a host processor, Mirics FlexiTV leverages the power and abundant system memory of today's PC platforms. This allows nomadic reception of global analog and digital broadcasts without requiring multiple silicon-based demodulators or additional system memory. In addition to reducing system cost and silicon real estate, the Mirics FlexiTV solution provides an easy standards upgrade path via software reconfigurability, enabling future-proofing against emerging or variant broadcast standards. Mirics FlexiTV solutions comprise a host-based software demodulator paired with a "SmartTuner" which performs the multi-band RF tuning and digital interfacing to the host. The MSi3101 is the first in a series of SmartTuner products, and combines Mirics' proven MSi001 poly-band tuner and the MSi2500 USB interface chip. The MSi2500 integrates analog to digital conversion, MSi001-optimized digital signal processing, a control host and standard high-speed USB2.0 connectivity. http://www.mirics.com

Microsharp breakthrough improves optical efficiency of Fresnel lenses

Microsharp has developed and patented an important innovation in mould cutting technology that leads to a more precise reproduction of optical facets in thin film optical structures. This innovation allows the manufacture of thin film, optical microstructures with significantly improved optical efficiency. Microprismatic films with sharp facet angles have been made for many years using single point diamond turning. However these films are restricted to one prism repeated across the entire film. Many film designs, such as Fresnel lenses, require variation in prism angle across the film. Included angle diamond turning (InADiT) enable such variation whilst creating sharper definition at the troughs and peaks of micro facets which significantly improves optical performance. Thin film, Fresnel lenses are significantly cheaper to produce than traditional cast lenses due to the continuous high-speed production process, but have suffered from inferior optical performance due to losses associated with the high number of micro facets used. With existing cutting processes such as single point or contoured diamond cutting, minor defects are caused at the peak and troughs of each facet, leading to optical losses that are made significant by the high number of facets in the lens. By employing the InADiT process, Microsharp can now produce thin film Fresnel lenses in both point focus and linear focus formats that exhibit optical efficiencies in excess of 85%. http://www.microsharp.co.uk/what-we-do/inadit/ Microsharp's Thin Film Fresnel Lens products are targeted primarily at two markets:

- Solar concentration devices where lenses are used to focus sunlight onto either photovoltaic cells or thermal collection devices. Depending on the application, concentration ratios of between X10 and X500 suns can be achieved.
- Large-area lighting luminaires where Fresnel lenses can be used to collimate LED point light-sources to efficiently produce large area, uniformly lit panels and in the production of devices that require light direction.

Nanoco appoints KISCO Ltd as exclusive Asian distributor

Nanoco Technologies signed a distribution agreement appointing KISCO as the exclusive Asian distributor of Nanoco's quantum dots materials, enabling business relations with Japanese, Korean, and Taiwanese electronics customers. Nanoco's quantum dots are used in products that include electroluminescent quantum dot displays (EL-QD), solid state lighting, and photovoltaic devices. Nanoco is unique in the nanomaterials market as a company that manufactures large quantities of quantum dots, using its patented manufacturing process. The bulk manufacture of quantum dots provides technology companies around the world the platform to develop a wide variety of next-generation products. Nanoco's development of high performance RoHS compliant cadmium free quantum dots is seen as a key breakthrough towards adoption of quantum dot technology in industrial applications. http://www.nanocotechnologies.com

PLM launches Uniled handrail light

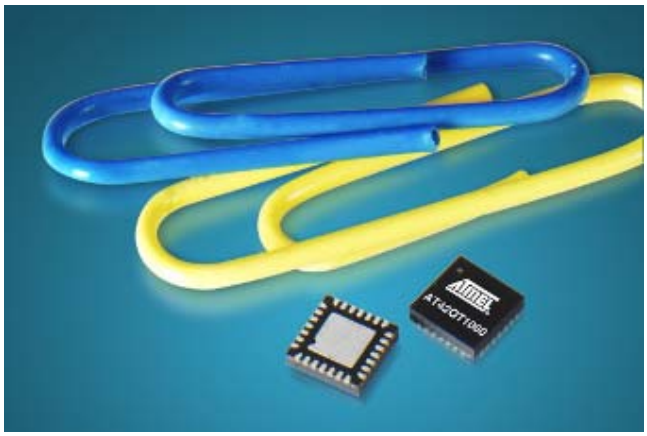
The Uniled handrail light is designed to fit 50-60mm outside diameter tubular steel handrails. The light is a 24V DC fitting and runs from dedicated switch mode power supplies, which are also manufactured and supplied by PLM. The handrail light is easy to install, requires no maintenance, and is extremely durable. As PLM switch mode power supplies are universal voltage input, the system is suitable for installation anywhere in the world. At 24V DC, the handrail light in inherently safe and takes away the need for mains voltage cables inside metal handrails. The soon to be introduced next generation of Uniled handrail lights will contain even brighter Nichia LEDs, with no increase in power consumption. In addition PLM will be upgrading the shell material from UV stable polycarbonate to transparent nylon. Independent laboratory tests have shown that transparent nylon has far superior through life impact resistant to polycarbonate. It is has better transmission properties than polycarbonate and stays clearer for longer. http://www.plmgroup.co.uk

Strathclyde University researchers develop novel bistable LCDs

Researchers at the University of Strathclyde say that they have demonstrated a flexible bistable reflective LCD and believe that it is ready for commercialisation. The display is passive matrix driven so not suitable for motion video or other fast response time content but the researchers say that their displays could be used for large format displays to replace paper displays. The technology is being tested for suitability to roll-to-roll manufacture and progress so far is favourable with several components having been proven. The LCD material is contained in small wells on one substrate rather than being a continuous layer across the whole display surface. The polygonal shape of the wells is used to define the LC alignment so there is no need for a rubbing process. The bistable nature of the device is also down to the shape of these wells. The display is constructed of two sheets of plastic, one with the LC wells embossed in it and the second bonded on top to seal the wells. ITO electrodes are patterned to form the addressing lines and the back of the display has a mirror layer applied through vacuum deposition and a polarizer is applied to the front. http://www.strath.ac.uk

Atmel introduces a touch controller for slider and buttons with integrated LED control

Atmel Corporation announced the AT42QT2160 - a touch controller IC combining touch key and touch slider functions in a single device. The AT42QT2160 can control up to 16 individual touch keys with a slider comprising between two and eight of the touch key channels. In addition, the chip can also control up to 11 LEDs through a PWM output function that is controlled by the host, eliminating the need for an external LED controller. With this combination of functions, this device is ideal for use as a multimedia HMI controller in mobile phones and consumer applications, such as personal media players, where it saves space, minimizes design time and allows the designer creative flexibility in laying out control keys. With its wide voltage range (1.8V to 5.5V DC) and low power requirements, it is well suited for other battery-driven applications, such as digital still cameras, PDA's or handheld gaming devices. The AT42QT2160 uses Quantum Research Group's (acquired by Atmel in March 2008) patented charge-transfer technology. This provides robust and reliable performance, high immunity to EMI through spread-spectrum modulation and filtering algorithms, calibration of the device over life and user-defined sensitivity thresholds for individual keys. An additional patented function, adjacent key suppression (AKS), intelligently suppresses signals present from nearby keys so that only intended keys register a touch. http://www.qprox.com



Titan Outdoor invests in digital roll out

Titan Outdoor, the dominant provider of advertising solutions in the UK Rail environment, will install over 100 digital six-sheets at major stations across London. The £2 million roll out is expected to be completed by the middle of October at key rail termini stations such as Waterloo, Victoria and Liverpool Street. It marks the first phase of Titan's digital expansion across its UK rail estate, building on its pioneering Transvision network established in 2002. The new digital six-sheets (known as D6s), supplied in partnership with iblink, use 65-inch high definition screens producing extremely clear, bright images. Uniquely, the units are thermally-managed and optically-bonded to ensure 100% up-time and allow passers-by to view the image clearly from any angle. The ability to deliver animated content gives advertisers far greater flexibility, and remote management of the screens speeds up changeover times between campaigns. The screens also have Bluetooth capabilities to enable advertisers to interact with nearby consumers on their mobile phones. http://www.titanoutdoor.com

European Fast2Light project focuses on lighting foils for lighting applications

European companies have joined forces in the form of a new integrated R&D project that aims to research and develop light emitting foils based on OLED technology. A group of 14 companies, research institutes and universities, leading in the fields of printing and electronics has formed the consortium of Fast2Light and will align efforts to demonstrate that high quality and cost efficient lighting foils are the future for lighting and signage applications. Fast2light aims to set in place the manufacturing platforms so as to accelerate the introduction of lighting foils into the market when the light-emitting polymers meet the product specifications. The project, partially funded under European Union's 7th Framework program as part of the ICT (Organic and large area electronics, visualization and display systems) priority, will address all layers that are part of a lighting foil. It will start with the plastic substrate, and introduce high-throughput deposition and patterning methods for all of the materials necessary to fabricate the final lighting foil. Ultimately, the project will demonstrate a 30x30cm, high quality lighting foil, manufactured with new optimised R2R processes. While the project will focus on polymers, the platforms developed will be fully compatible with SMOLEDs. Co-ordination of the project is performed by Holst Centre. The partnership comprises the key industrial players: Philips Research, Philips Lighting, Bekaert, Agfa-Gevaert, OTB Display, Hanita Coatings, Oxford Lasers, Huntsman and Orbotech. Research institutes include TNO-Holst Centre, IMEC and Gaiker. The university partners contributing in the project are Swansea University and Budapest University. http://www.fast2light.eu

MicroCat combines high-resolution printing with additive metalization

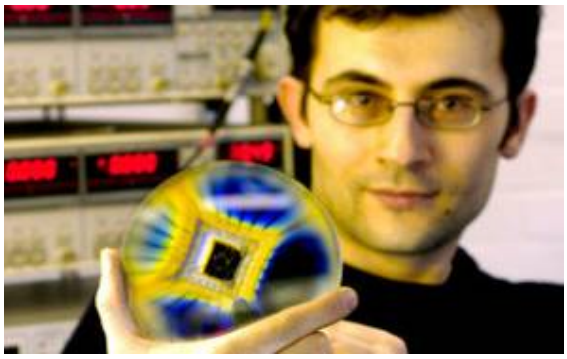
MacDermid Electronics Solutions has developed a novel additive circuit formation process called MicroCat, which represents the synergy of two innovations: high-resolution printing, and high productivity additive metalization. The two step MicroCat process results in solid copper circuit traces at a fraction of the cost of etched aluminium foil, etched copper foil, or conductive inks and has demonstrated proven capability in RFID, smart card, displays, membrane switch, and various other printed electronics and additive circuit formation applications. The deposited copper thickness can be varied to accommodate individual requirements and is nearly equal to ED copper foil in conductivity so electrical efficiency is maximized. MicroCat can be used in either manual batch or automated reel-to-reel process equipment and on a variety of flexible and rigid substrates including PET, PI, PEN, and PVC all without the need for any surface pre-treatment. Numerous high throughput printing technologies are also suitable for printing the MicroCat ink including flat bed and rotary screen, gravure, and flexographic printing equipment. http://www.macdermid.com/electronics

DuPont Teijin Films and Thin Film Electronics sign MoU on printed memories

Thin Film Electronics of Oslo, Norway, announced that it has entered into an MoU with DuPont Teijin Films UK Ltd to enable volume production of printed memory devices. The objective of the collaboration is to enable low-cost production of printed memories where DuPont Teijin Films will supply existing, commercially available substrates or specifically developed substrates to Thin Film's production partners and customers. Johan Carlsson, CEO of Thin Film Electronics stated: "Thin Film has found that substrates from DuPont Teijin Films have excellent performance as substrates for printed memory, making them highly suitable for the implementation of our polymer memory technology in a wide range of applications and products such as smart labels, smart packaging, game cards, smart cards, toys and RFID tags." http://www.thinfilm.se

University of Manchester researchers use graphene to create the world's smallest transistor

Researchers have used the world's thinnest material to create the world's smallest transistor, one atom thick and ten atoms wide. Reporting their peer-reviewed findings in the latest issue of the journal *Science*, Dr Kostya Novoselov and Professor Andre Geim from The School of Physics and Astronomy at The University of Manchester show that graphene can be carved into tiny electronic circuits with individual transistors having a size not much larger than that of a molecule. With most materials, their stability diminishes if shaped in elements smaller than 10 nanometers in size. At this spatial scale, all semiconductors – including silicon – oxidize, decompose, and uncontrollably migrate along surfaces like water droplets on a hot plate. But the Manchester team has shown that it is possible to create nanometer-scale transistors from a single graphene crystal. Unlike all other known materials, graphene remains highly stable and conductive even when it is cut into devices one nanometer wide. http://www.manchester.ac.uk



A Manchester researcher shows graphene quantum dots on a chip

Tesco orders ZBD EPOP displays for new milestone store

Tesco has ordered 2,500 electronic point of purchase displays (EPOPs) from ZBD for its latest milestone store. Continuing a relationship that has already seen ZBD's displays trialed in two Tesco stores in central and southern England, the new orders will be deployed in the dry groceries area. http://www.zbd.co.uk

TenCate acquires controlling interest in Xennia

Xennia Technology announced an agreement to sell a 75% stake in the company to TenCate. This is a strategic investment by TenCate for whom inkjet offers significant benefits across its smart and technical textile businesses. TenCate will use Xennia to drive the implementation of inkjet technology into several of its core textile businesses. At the same time, it will support Xennia's plans to become the leading integration company and solution provider for the fast emerging industrial inkjet sector. In addition to an increasing focus on inkjet technology for textiles, Xennia will accelerate its industrial printer and ink offerings through OEM partners and direct to end-users in key niche applications, such as ceramic tiles, product decoration and printed electronics. http://www.xennia.com

Molecular Vision and Acrongenomics unable to finalize acquisition

On April 7, the Board of Molecular Vision announced that discussions with Acrongenomics on the proposed acquisition of Molecular Vision have now ceased. Acrongenomics has been unable to complete on the terms and timetable agreed. Given this, the Board of Molecular Vision believes that the best interests of the company are served by bringing these discussions to a conclusion. Acrongenomics remains a significant shareholder in Molecular Vision, having recently acquired a 10.9% stake in the company, and work continues on the joint development agreement between the two companies that commenced in March 2006 relating to BIOLED technology. http://www.molecularvision.co.uk

SnapWatch patents flexible watch concept

SnapWatch Ltd, a UK-based start-up, has patented a flexible watch concept using e-paper display technology. The watch display is a multifunctional slim-line, buckle-less band that wraps around the wrist and is one of the first products selected from a host of designs using flexible e-paper from this one patent. The display band will feature coloured animations, time, date and a variety of icons and text combinations that run along the entire length of the band. The watch device is fully flexible, robust, consumes very little power and does not generate heat. SnapWatch's flexibility and capacity for day-to-day information on the wrist means it could be used as an accessory product for the mobile phone and could easily work in conjunction with GPS, a wearable MP3 player, or a ski pass.

Nokia and the University of Cambridge show off Morph concept phone

A stretchable, flexible, self-cleaning device that can be used as a mobile phone or keyboard that harvests solar energy and senses the environment by using nanotechnology was showcased in February by Nokia at the Museum of Modern Art (MoMA) in New York. Morph is a joint nanotechnology concept developed by Nokia Research Centre (NRC), Finland and the University of Cambridge that demonstrates how future mobile devices using nanotechnology might be capable of using flexible and stretchable materials, transparent electronics, and self-cleaning surfaces that can transform into different shapes. Fibril proteins are woven into a three-dimensional mesh that reinforces thin elastic structures. Using the same principle behind spider silk, this elasticity enables the device to literally change shape and configure itself to adapt to the task at hand. Nanotechnology could be used to:

- Integrate electronics, from interconnects to sensors, which could share flexible properties. The use of biodegradable materials might make production and recycling of devices easier.
- Create self-cleaning surfaces on mobile devices, ultimately reducing corrosion, wear and improving longevity.
- Become a natural source of energy via a covering of “Nanograss” structures that harvest solar power. At the same time new high energy density storage materials allow batteries to become smaller and thinner, while also quicker to recharge and able to endure more charging cycles.
- Use nano-sensors to examine the environment around them in completely new ways, from analysing air pollution, to gaining insight into bio-chemical traces and processes – it could be as simple as knowing if the fruit we are about to enjoy should be washed before we eat it.

The researchers believe that elements of Morph might be available to integrate into handheld devices within seven years, though initially only at the high-end. However, nanotechnology may one day lead to low-cost manufacturing solutions. http://www.nokia.com/A4852062

Lord Sainsbury opens centre of excellence in metrology

Lord Sainsbury of Turville, former Parliamentary Under-Secretary of State for Science and Innovation, has dedicated the new £1.3 million clean room at AMETEK Taylor Hobson's Leicester, England, headquarters. The new clean room, which consists of Class 7 (10,000) and Class 4 (10) areas, is equipped with the latest metrology instrumentation for micro and nano technologies (MNT). The facility is an expansion of Taylor Hobson's Centre of Excellence laboratory at Leicester, which provides measurement support, training and advice to UK manufacturing and research companies in the field of MNT through the CEMMNT (Centre of Excellence in Metrology for Micro and Nano Technologies) partnership.

OLED-T transport material outperforms industry materials

OLED-T, a developer and manufacturer of organic light emitting diode materials and device structures, announced the launch of its organic electron transport material E278ST. E278ST has been developed as a like-for-like replacement in manufacturing lines for aluminium quinolate (Alq3), the electron transport layer most commonly used throughout the OLED industry. E278ST provides significant technical and performance benefits compared with Alq3. The new electron transport material has lower toxicity, lower voltage, higher electroluminescent efficiency, longer lifetime and lower voltage drift. In customer trials, OLED-T has demonstrated a two-fold increase in device lifetime and a 25% reduction in device voltage. A fluorescent red device's voltage was reduced from 8V to 6V at 500cd/m2 and showed a 20% power efficiency improvement. Voltage drift was reduced by 25% over the first 500 hours of operation. The new material is organic and contains no metals. OLED-T will begin customer sampling of E278ST from the second quarter of 2008 and will commence volume production from the fourth quarter of 2008. http://www.oled-t.com

OLED-T sets out OLED electron injector and transport material advances

OLED-T, a developer and manufacturer of OLED materials and device structures, staked out its leadership in OLED electron injector and transport materials at SID in Los Angeles. Professor Poopathy Kathirgamanathan, CTO, presented an invited paper titled "Charge Transporters for OLEDs: Strategies and Performance" reviewing characterization results for OLED-T's electron injector and transport materials. OLED displays are manufactured from a sandwich of different materials including two different electron charge transport layers namely the electron injector and electron transport layers. The charge transport layers are critical layers within the make-up of an OLED display responsible for 60% of the power loss and fundamental to the device voltage and lifetime. In addition to optimising power consumption, device voltage and lifetime, OLED-T is focused on reducing the manufacturing temperature of its family of charge injector and electron transport materials. Reducing the manufacturing temperature of OLED materials cuts the cost of manufacture and the potential damage to the underlying layers of the display, thereby improving the lifetime and voltage drift over the lifetime of the OLED device. OLED-T has made important advances across its ranges of OLED materials and several new OLED materials launched:

- EI-101 is OLED-T's first generation low temperature direct replacement for lithium fluoride (LiF), the material typically used by manufactures as the electron injector layer within an OLED display. In customer trials using EI-101 as a direct replacement for lithium fluoride in displays the electrical efficiency was improved by as much as 15% and the lifetime of the display increased by up to 15%.
- EI-111-2Me a direct replacement for the lithium fluoride (LiF) as the electron injector layer within OLED displays enables display manufacturers to improve efficiency and, as well as reduce the operating voltage and minimizing voltage drift. In customer trials using EI-111 as a direct replacement for LiF, display efficiency improved by 25% and lifetime by 10%.
- In customer characterization trials OLED-T's new electron injector material named E225 had a 66.3% performance improvement in brightness and a 30% reduction in driving voltage when compared with materials typically used as the industry benchmarks.
- E246 is OLED-T's first generation replacement for aluminium quinolate (Alq3), the electron transport layer most commonly used throughout the OLED industry. The material is a like-for-like replacement in manufacturing lines for Alq3 and provides a high mobility, highly thermally stable electron transport layer suitable for the manufacture of organic light emitting diodes (OLEDs).
- E278ST provides manufacturers with a lower toxicity, lower voltage, higher electroluminescent efficiency, longer lifetime and lower voltage drift when used as a replacement for aluminium quinolate (Alq3), the material commonly used as the electron transport layer in OLED displays. In customer trials, OLED-T has demonstrated a two-fold increase in device lifetime and a 25% reduction in device voltage. http://www.oled-t.com

OLED-T announces new electron injector OLED material and third-party validation

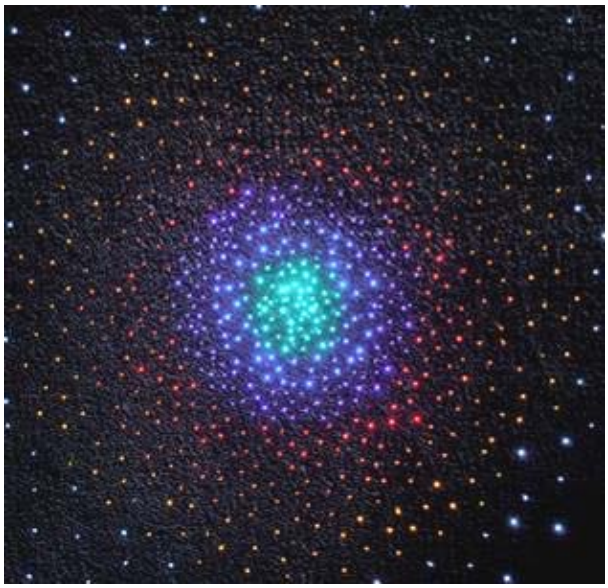
OLED-T announced a new electron injector material together with third party verified performance results. The new electron injector material named E225 had a 66% performance improvement in brightness and 30 per cent reduction in driving voltage. These results are based of test displays where E255 was used in combination with OLED-T's electron injector EI-101 and compared with standard configurations of electron injector and transport materials typically used as the industry benchmarks. A phosphorescent red display device using a combination Alq3 as the electron injector and lithium fluoride, as the electron transport had a brightness of 9.8 lumens per Watt, whereas by replacing the injector and transport layers for a combination of OLED-T's E225 and EI-101 respectively, the brightness improved to 16.3 lumens per Watt. Display devices were driven for more than 520 hours at a current of 40 mA/cm^2. http://www.oled-t.com

Pro-Lite brings out fast and affordable LED measurement

Pro-Lite Technology has released an LED measurement system based around the USB4000 CCD spectrometer from Ocean Optics together with integrating sphere collection optics. Measurements are provided of spectral radiant flux, luminous flux, CIE chromaticity, correlated colour temperature, dominant wavelength, spectral purity and colour rendering. The compact, 38mm diameter integrating sphere included with the USB4000 LED spectroradiometer is particularly well suited to measuring the forward (or partial) flux in lumens from individual LED emitters. For LED clusters, or for testing the output of those LEDs mounted in reflectors or with lenses, Pro-Lite offers a range of larger integrating spheres from Labsphere. These interior access integrating spheres are available from 25cm to 2m diameter and provide for the measurement of total as well as forward flux. In addition, the upgrade spheres provide for auxiliary correction, which fully compensates for the self-absorption errors which arise when the LED is measured in the sphere together with optics, heat sinks or drive electronics. Without auxiliary correction, the flux readings would be under-recorded. Auxiliary correction also corrects for reflection errors if the LED sample is placed at the sphere port. The 3648 element CCD detector used in the USB4000 records the complete spectral flux from the LED in a fraction of a second. Rapid sampling times benefit overall measurement accuracy as the output of the LED does not have time to drift during the scan. The USB4000 LED system provides for calibrated measurements at wavelengths from 350 to 1000nm, which covers the full visible (photopic) range. Integrating sphere collection optics allow for measurements at up to 260,000 lumens, accommodating any size or power of sample. The pre-configured LED system ships complete with CCD spectrometer, optical fiber patchcord, FOIS-1 integrating sphere, LS-1-CAL calibration source and SpectraSuite application software. http://www.pro-lite.co.uk

Top Floor develops the Luminoso rug

The Luminoso is a creation from Top Floor, a London-based interior design company focused on flooring. The Luminoso rug has hundreds of tiny LEDs woven into it creating an animated light pattern. Top Floor's rugs and carpets are made to order to virtually any size and colour scheme. http://www.topfloorrugs.com



Tom Lawton invents wind-powered LED light

Created by UK inventor Tom Lawton, the Firewinder was inspired by his desire to "see the wind". Lawton hopes his new design will inspire people to think about the invisible beauty, awesome power and endless resource of the alternative energies that encircle us. Transforming wind into light, the Firewinder is a hanging, wind-powered LED light. Unlike most wind turbines that spin vertically, the Firewinder spins in a horizontal direction, illuminating its LEDs in a spiralling helix of light. The Firewinder is visibly reactive to subtle changes in the environment. How bright the LEDs glow corresponds directly to how fast the turbine spins, enabling observers to visualize the power of wind. £99.95 from http://www.firewinder.com

UK Trade & Investment funds more printed electronics initiatives

UK Trade & Investment announced a "Challenge Fund" to support the UK Chemical Sector Initiative on Printed Electronics. The supply chain for this sector, whilst still in its evolutionary stage, is developing rapidly and embraces the design, synthesis, manufacture and formulation of high value added organic and inorganic chemicals, together with the printing of these materials onto a wide range of substrates. This national initiative aims to inform/update UK chemical companies on this fast moving technology sector and ensure that the UK builds on its strengths and capitalizes on all available opportunities. Working together with IDTechEx, the Displays and Lighting Knowledge Transfer Network and OMIC the initiative starts with a Masterclass on July 1st at Haydock Park Racecourse, Merseyside, outlining what printed electronics is, where the chemical sector fits in, who the major players are (and where), what the opportunities are for UK chemical sector companies. The second stage, for companies who wish to come on board, is a UK trade delegation to "Printed Electronics Asia" in Tokyo, 7-10 October, where "full package" delegate rates have been negotiated providing access to further masterclasses, company visits and key networking opportunities. UKTI travel grants have also been secured for up to 10 eligible SMEs. http://printedelectronics.idtechex.com/printedelectronicsasia08/en/

Ceravision introduces Ecolumination range of products

Having been working quietly in the background, Ceravision has now developed various different variants of the microwave powered, electrode-less lamp system, with product platforms covering from visible light to UV radiation. The white light systems are attracting interest from markets ranging from Projection to General Lighting, Medical lighting to fiber optic distribution systems, and the UV products are pulling in customers for colour graphic ink curing, as well as for water and air sterilization. Power ranges for the different lamp platforms now vary from 40 Watts to 200 Watts with solid-state power sources, and from 150W - 5kW with magnetron sources. The use of HID white light in Projection continues to be a major opportunity, but this new technology also offers unique benefits to rear illumination of LCD-based digital signage. http://www.ceravision.com

IDTechEx publishes new report: "Printed and Thin Film Photovoltaics and Batteries"

IDTechEx recently launched a comprehensive report that gives a thorough analysis of printed and thin film photovoltaics and batteries – covering the technologies, markets and players. Photovoltaic technologies covered include CIGS, CdTe, DSSC, a-Si and organic PV. Each is at a different stage of development and they are all driven forward by both government incentives in different countries and leading companies in the field. The report also describes materials (both organic and inorganic) and device structures for thin batteries and photovoltaics as well as various high-speed printing technologies. http://www.idtechex.com/pv

Report reveals lessons for UK switchover

A report on the UK's first digital television switchover highlights lessons to be applied across the rest of the country as analogue signals are turned off over the next four years. The report from Digital UK, the independent body established to co-ordinate switchover, is based on research into the experiences of 25,000 households in Copeland, Cumbria, including the town of Whitehaven. In a two-stage switchover during October and November 2007, four analogue television channels were replaced with approximately 20 Freeview channels. The timing of Copeland's switchover was brought forward to test plans for the nationwide program to upgrade the UK's terrestrial television network to digital. The next switchover will be for viewers served by the Selkirk transmitter group in the Border TV region, which will go fully digital from November 6 this year. It will be followed by 14 switchovers affecting 4.6 million households during 2009, with the rest of the UK switching to digital TV by the end of 2012. The report includes the following findings: viewers were well prepared. Everyone was aware of the switch, and 95% understood what to do in order to be ready. Virtually all households had converted their television by the completion of switchover on November 14. Most found it straightforward. 81% had no problems with their digital television equipment and 50% found installing equipment easier than they thought. Some needed extra help. Approximately 10% of households took up the Switchover Help Scheme. Digital UK estimates 5% rang its help line or visited one of its locally run help centres. A further 5% of households sought help or advice from retail outlets. http://www.digitaluk.co.uk

Industry facilitates supply chain communication on substance content in electronic equipment

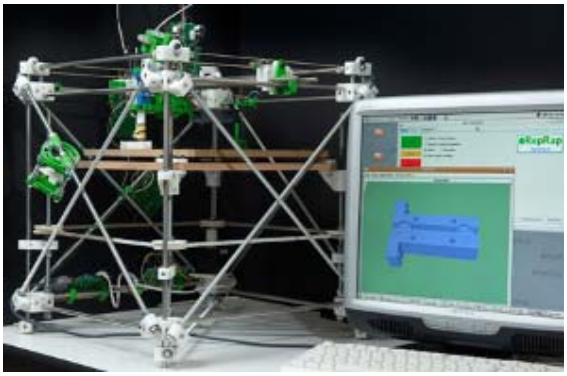
The Consumer Electronics Association (CEA), European Information & Communications Technology Industry Association (EICTA) and the Japanese Green Procurement Survey Standardization Initiative (JGPSSI) announced a partnership to conduct an extensive revision of the Joint Industry Guide for Material Composition Declaration for Electronics Products (JIG) version 101A. JIG version 101A - an industry materials declaration standard, will be revised to address future substance declaration requirements due to new developments, such as the European Union's Registration, Evaluation, Authorization and Restriction of Chemical Substances ("REACH") Regulation. Common industry-wide approaches, such as the new JIG, which helps to manage REACH and other materials restrictions, can improve the protection of human health and the environment through the better and consistent identification and reporting of chemical substances contained in electronic products. The original JIG 101, published in 2005 by the Electronics Industries Alliance (EIA) and JGPSSI, and supported by the Electronic Components Association (ECA) and the leading developer of standards for the solid-state industry, JEDEC - provides a standardized list of substances for supply chain disclosure that may be present in parts or components supplied to electronic manufacturers and that are relevant for disclosure due to regulatory or other purposes. JIG version 101A was released by EIA and JGPSSI in 2007 in order to reflect recent regulatory changes since the JIG was initially published and is now available at http://www.jedec.org and http://www.eia.org.

ZBD launches new electronic point of purchase display

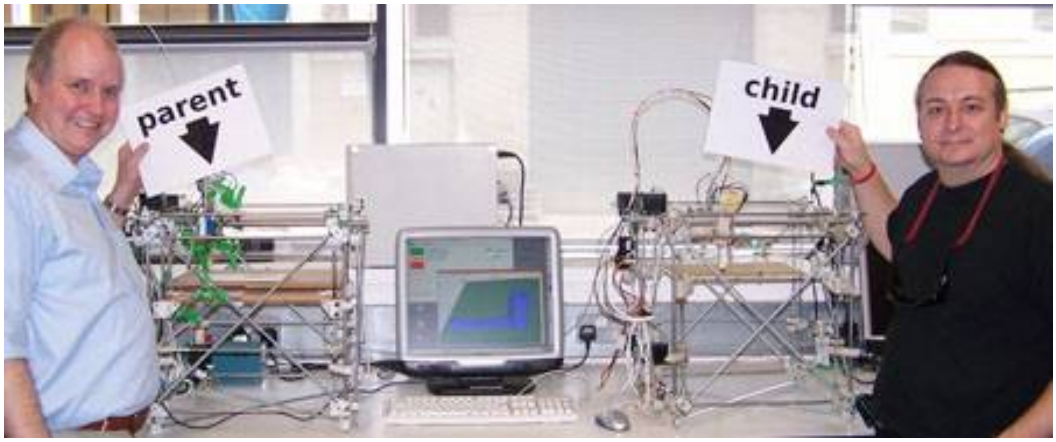
ZBD announced the latest addition to its family of electronic point of purchase displays. The EPOP 300 expands the choice of display sizes on offer from ZBD and, for the first time, gives the option of employing high-impact promotional colour. The e-paper quality of the EPOP 300 display is achieved by incorporating a patented nano-grating into the design of the bistable LCD. This production process provides the capability to control the optical performance and is a key element in achieving the screen's contrast, while at the same time delivering a truly bistable display that needs zero power to display an image. Dr Cliff Jones, ZBD's chief technology officer, said: "Two aspects of the EPOP 300 development program are particularly remarkable. We have been able to radically simplify the production process, making it even more cost-effective for large-scale production. Also, the extension of our wireless RF protocol further improves the throughput speed and system scalability to support the deployment of large volumes of EPOP's in retail stores while still maintaining an exceptional five-year battery life." http://www.zbd-retail.com

University of Bath leads research team that develops 3D replication machine

A University of Bath academic, who oversees a global effort to develop an open-source machine that "prints" three-dimensional objects, is celebrating after the prototype machine succeeded in making a set of its own printed parts. The machine, named RepRap, was exhibited publicly at the Cheltenham Science Festival (4-8 June 2008) in the UK. RepRap is short for replicating rapid-prototyper; it employs a technique called "additive fabrication". The machine works a bit like a printer, but, rather than squirting ink onto paper, it puts down thin layers of molten plastic which solidify. These layers are built up to make useful 3D objects. RepRap has, so far, been capable of making everyday plastic goods such as door handles, sandals and coat hooks. Now, the machine has also succeeded in copying all its own 3D-printed parts. These parts have been printed and assembled by RepRap team member, Vik Olliver, in Auckland, New Zealand, into a new RepRap machine that can replicate the same set of parts for yet another RepRap machine and so on ad infinitum. While 3D printers have been available commercially for about 25 years, RepRap is the first that can essentially print itself. The RepRap research and development project was conceived, and is directed, by Dr. Adrian Bowyer, a senior lecturer in engineering in the Faculty of Engineering & Design at the University of Bath, UK. Dr Bowyer said: "These days, most people in the developed world run a professional-quality print works, photographic lab and CD-pressing plant in their own house, all courtesy of their home PC. Why shouldn't they also run their own desktop factory capable of making many of the things they presently buy in shops, too?" Complete plans for the prototype RepRap 3D printer and detailed tutorials to aid motivated amateurs (and professionals) in assembling one are available, free-of-charge, at the RepRap website. The materials, plus the minority of parts that the machine cannot print, cost about £300. All those non-printed parts can be bought at hardware shops or from online stores. http://reprap.org/bin/view/Main/PartsSupplies



The RepRap 3D printer can make all sorts of objects, including itself



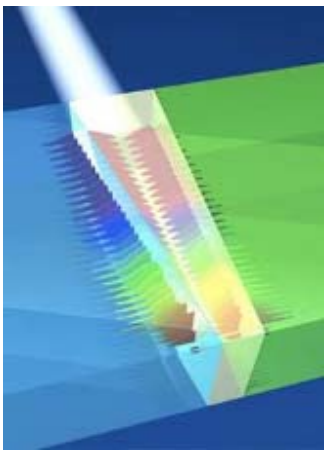
The parent RepRap gave birth to another RepRap

Light Blue Optics demonstrates miniature projection systems

Light Blue Optics (LBO) demonstrated its latest miniature projection systems at SID Display Week. These highly efficient, low-cost miniature projection systems are based on LBO's proprietary holographic laser projection technology and have applications across multiple high-volume markets, including consumer electronics and automotive. The company will make evaluation units available to key customers and strategic development partners from June 2008 as part of its product development program. LBO demonstrated bright, efficient miniature projection systems with a range of differentiating features that can be tailored to suit specific customer applications. The systems deliver superior image quality with in-built speckle reduction, variable resolution and focus-free operation. Due to the unique properties of holographic laser projection, LBO's systems also offer the option of enhanced image brightness for use in higher ambient lighting conditions. http://www.lightblueoptics.com

Surrey and Salford researchers slow down and trap light

University of Surrey and Salford University researchers have revealed a technique that may be able to slow down, stop and capture light. The technique would allow the use of light rather than electrons to store memory in devices such as computers, enabling an increase in operating capacity of 1,000% by using light's broad spectrum rather than single electrons. Slow light could also be used to increase the speed of optical networks, such as the Internet. At major interconnection points, where billions of optical data packets arrive simultaneously, it would be useful if we could control this traffic optically, by slowing some data packets to let others through. This system would work in the same way as traffic congestion calming schemes do on our motorways, when a reduction in the speed limit enables swifter overall flow of traffic. Previous attempts to slow and capture light have involved extremely low or cryogenic temperatures, have been extremely costly, and have only worked with one specific frequency of light at a time. The technique proposed by Professor Hess and Kosmas Tsakmakidis involves the use of negative refractive index metamaterials along with the exploitation of the Goos Hänchen effect, which shows that when light hits an object or an interface between two media it does not immediately bounce back but seems to travel very slightly along that object, or in the case of metamaterials, travels very slightly backwards along the object. Professor Hess' theory shows that if you create a tapered layer of glass surrounded by two suitable layers of negative refractive index metamaterials a packet of white light injected into this prism from the wide end will be completely stopped at some point in the prism. As different component colours of white light have different frequencies each individual frequency would therefore be stopped at a different stage down the taper, thereby creating a "trapped rainbow". http://www.ati.surrey.ac.uk



Immersive theatre for BERR in London

The UK Department for Business Enterprise and Regulatory Reform (BERR) recently acquired a Delta Media Server for use in their "Futurefocus" Immersive Theatre in London. Delta provides 3 channels of 1280x1024 media serving from a single PC, allowing facilitators to mix movies, images and live video input from PCs and a DVD player in order to create cutting edge presentations for groups planning their future strategy. In the Immersive Theatre a facilitator may present some change images or future scenarios to stimulate the group's thinking and begin the debate among participants on what the future might look like and what challenges they could face. BERR has a variety of films presenting alternative views of issues affecting society, technology, environment, economics and politics. These films are particularly useful when a group of people comes together who may not have worked together before. The facilitator can also help the group build their own scenarios from scratch or can introduce examples from other areas. The key messages from the images are around the way society influences change, the speed with which things are changing and the need to widen consideration in order to provide the best types of solution. The theatre prompts discussions and moves the participants into a higher level of strategic thought. The theatre can also be used by participants to launch the day with key speakers, film shows, PowerPoint or other media resources. It can also engage in video conference facilitation or access the Internet for further research into a particular area. http://www.berr.gov.uk

Plastic Logic receives $50 million round of venture capital

In early August, Plastic Logic announced it has raised a new round of $50 million in equity finance led by existing venture capital investors Oak Investment Partners and Amadeus Capital Partners, joined by its previous investors. To date, the company has raised more than $200 million.

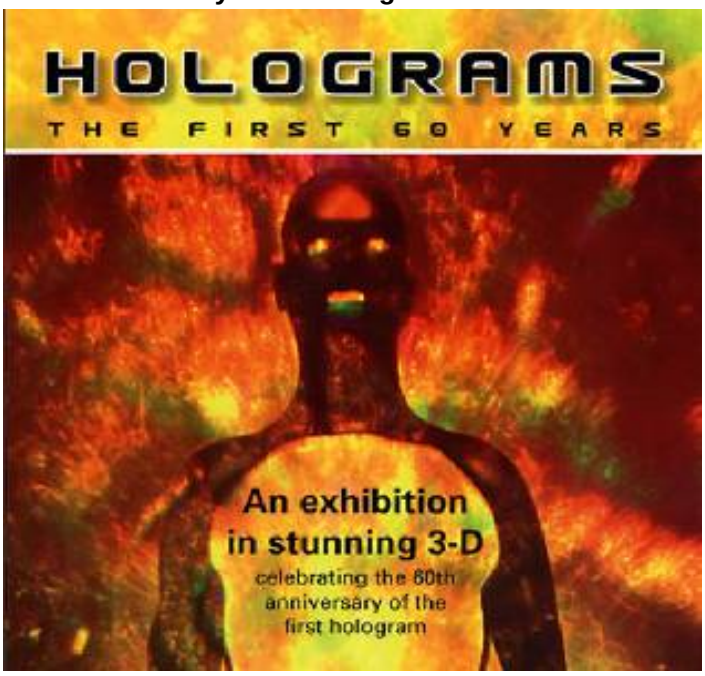
> "We are approaching very significant milestones in the creation of the plastic electronics industry with the opening of our Dresden plant and the pending launch of our first commercial consumer electronics product," said CEO Richard Archuleta. "This new investment will enable expanded business operations in support of our first commercial product early next year while we continue to develop our IP to deliver on our broader long-term vision."

Plastic Logic maintains research and development in Cambridge, England, and is bringing online a new high-volume, state-of-the-art manufacturing facility in Dresden, Germany that is scheduled to open Sept. 17, 2008. The company also recently established a Mountain View, California, headquarters for management, product engineering, product supply chain, sales and marketing. http://www.plasticlogic.com

Foster + Partners develop green complex for Singapore

As the winning design from an international competition, Singapore's new eco-complex from UK-based architecture firm Foster + Partners is pushing the green envelope from top to bottom in this sophisticated downtown design. The complex will fill an entire city block between Singapore's Marina Centre and the Civic District with commercial, residential, retail, hotels, and a green link to a Mass Rapid Transit (MRT) station. All façades will be fitted with solar cells and, to help control solar gain, direct sunlight will be filtered through ribbon-like canopies rising from the base of the entire complex to the exposed east and west elevations of the towers. The canopies will form vertical louvers at the elevations and provide more renewable on-site energy with integrated thin-film solar arrays. Vertical green spaces and extensive sky gardens are also important components of the towers, further greening the whole structure with natural vegetation and ambient temperature moderation. The 150,000 square meter mixed-use project features slanted façades designed to catch the wind and direct it downwards for natural cooling of the ground floor spaces. A rainwater harvesting system, geothermal heating system, chilled beams and ceilings, and an ice storage cooling system are also planned for the complex. http://www.fostersandpartners.com

Banbury Museum features the 60th anniversary of the hologram



An exhibition at the Banbury Museum in Oxford celebrates the 60th anniversary of the hologram, which was invented by Hungarian scientist Dennis Gabor in Rugby in 1947. The exhibition, devised by Jonathan Ross in association with curators from Banbury Museum and the Oxfordshire County Museum has been mainly drawn from the Ross collection with support from various leading hologram makers. It comprises over 60 holograms, plus display cases containing stereoscopes, anaglyphs and lenticulars – illustrating other types of 3D imaging – and examples of applied holography, books, comics, toys, packaging etc., making it probably the most comprehensive survey of the medium to be seen in the UK. The holograms on show include a large selection by international artists, alongside examples of the best in display holography. Following its two-month run at Banbury, "HOLOGRAMS, the first 60 years" will tour to Woodstock, Rugby, and Aylesbury. http://www.jrholocollection.com

Duggan Morris Architects design photo-luminescent observatory

Duggan Morris Architects designed a structure that will supplant an obsolete radar tower with a luminous cathedral-like observatory in Liverpool, England. The plan for observatory is composed of two elements – an event accommodating "bowl" and a daylight suffused "lamp" that will act as an observatory as well as a cultural beacon. Duggan Morris states that: "The observatory will be required to meet high standards of sustainability, including using renewable energy sources. It must not impact negatively on the site's important nearby wildlife habitats, especially the foreshore." The tower's exterior will be constructed of sheets of steel-supported glass that are spun around a central core. Concrete "ribs" and "ligaments" offer support, and the team intends to incorporate a photo-luminescent material into the structure, "enabling it to glow without the need for artificial lighting. In this way the building becomes seasonal, responding to the quantity of light available and stored throughout the year." http://www.merseyobservatory.com

Reebok launch advertisement for re-signing of Amir Khan in 3D

Reebok and Amir Khan announce a new multi year endorsement deal. To celebrate the signing of one of Britain's most exciting and talented young athletes. M & C Saatchi contracted The3DFirm to produce a stunning 3D film of Amir Khan, showcasing his astonishing hand speed, agility and boxing skills. The film was screened in front of 100 press and invited guests at the BFI and will appear on selected websites and cinemas over the coming months. http://www.w3digital.com/3dfirm/videos/Amir_ShortEdit_MPG1.mpg

The3DFirm completes world first live 3D satellite transmission at Six Nations rugby match

On March 8th, the BBC test-screened the RBS Six Nations rugby match between Scotland and England live in 3D HDTV, as a joint venture between BBC Sport and The3DFirm. The3DFirm is a consortium comprising Inition, media communications firm Can Communicate, and hire and post-production house Axis Films. The match was beamed live from Scotland to a venue in West London in front of an invited audience of industry and press. A number of new 3D technologies were deployed at both the game and the studio venue. http://www.the3dfirm.com

By using only three cameras, the production was said to have a minimalist feel and later one camera was withdrawn due to rain. As the audience emerged blinking from the auditorium, several likened the experience to that of being at a live game. A few of the press coverage:

- "Scrums appeared to be just feet away, while the sense of depth within the crowds in the background took you right into the stadium."

  – BBC

- "I have seen the future of big-event sports broadcasting and it wears funny plastic glasses and sits in the dark with its mouth wide open."

  – The Times

Forty years after the inaugural color TV broadcast was shown at the Riverside Studios, in west London, the same venue hosted another first this month: a live 3D test transmission beamed in by satellite. The event was England's RBS Six Nations rugby match against Scotland, shown to a select group of 200 people from across the sport, music and media industries.

Interview with Paul Carter from Axis Films and David Wooster from Can Communicate

We questioned two of Britain's pioneers involved in bringing 3D to various sporting events about their impressions of the medium. While 3D television may still be some ways into the future, their responses suggest that special live 3D cinema events may not be so far away.

Paul Carter **has served as head of Axis Films and subsidiary companies for the past 15 years. Paul has overseen the company's rapid growth in the digital and now data acquisition formats. Axis started life 20 years ago as a 16mm facility company and has matured into a high-end company that has never forgotten its broadcast roots but has brought the film disciplines into new areas of high end camera rental. The company, despite its expansion, has retained its very personal relationship with a wide variety of clients from all areas of production. Axis is always looking as new opportunities to keep itself ahead of the competition. This strategy has seen Axis become a leader in the European 3D market. Axis has partnered with Can Communicate and Inition in a company called The3DFirm to offer a portal of 3D excellence for any aspect of 3D production. Also Axis has been pushing into the data camera arena and was early on the take-up of the RED cameras and the SI-2K.**

David Wooster **is head of production at Can Communicate Ltd. He entered the business working in feature films like a "Fish Called Wanda" and "The Living Daylight". Then joined Worldmark and was involved in many sports, corporate and documentary productions including official films of World Cups. Eventually he took full control of Worldmark in 1998. He produced a feature film called "Trinity" in 2000 prior to forming CAN with three other partners in 2002. David has produced most forms of programming from feature films and documentaries to commercials and image films. This has included working on productions for major sports federations including FIFA, IOC and UEFA and many major brands including Coca-Cola, Visa, MasterCard, Philips, and Carlsberg.**

Please tell us how you got involved in the production of 3D sporting events.

Carter: Axis Films partnered with Can Communicate and Inition to form a company called The3DFirm that aims to provide a 3D resource to potential clients in all aspects of acquisition and post-production. For its part, Axis invested heavily in 3D post-production with the purchase of the Quantel iQ Pablo with 3D plug-in to allow us to edit 3D material a lot faster than traditional workflows. Axis has also been testing a number of cameras such as the SI-2K and the Iconix cameras as well as the traditional Sony and Panasonic broadcast cameras depending upon the subject material and the look of the show. Obviously the smaller the camera the closer the IO distance of the camera lenses. Sport is just one area that we are look to promote 3D as an event – we are talking to a number of music producers about 3D concerts but the rugby was an event that the BBC had editorial control over and we had been developing and testing transmission techniques with the BBC over a number of months.

Wooster: Can Communicate was formed in 2002 and specializes in brand communications, especially in sports. The key personnel within the organization have a wealth of experience in communicating brand messaging through the visual media and not only have some of the world's biggest brands as clients but also some of the world's biggest sporting federations. CAN first became involved in 3D in the lead into the FIFA 2006 World Cup with a job for Coca Cola, the World Cup Trophy Tour. The tour showcased the genuine trophy around the world and was accompanied by a 3D animated film.

Tell us about the Scotland vs. England rugby match – the first live satellite 3D broadcast event ever.

Carter: The 3DFirm and BBC Resources produced a stereoscopic (2x HDTV) signal from a 3D camera Outside Broadcast to Murrayfield Stadium in Edinburgh and delivered the signal via satellite to an invited audience in London. The event was hosted by The3DFirm, drawing upon its big-screen knowledge to give the audience a "best seat in the house" experience. The3DFirm used 3D camera rigs that have been specifically designed to bring 3D to the entertainment industry.

Wooster: It became apparent to us quite early on that live 3D broadcasts of sports events were a very exciting area to explore. Big screen shared experiences in 3D would not only offer the viewer "the best seat in the house" but also become an exciting option for global brands to deliver their messaging! After a series of discussions and tests into the feasibility of satellite transmitting a stereoscopic signal CAN & BBC Resources wanted to demonstrate its viability. BBC Resources discussed the opportunity with BBC Sport who liked the idea and through their relationship with the RBS "6 Nations" it was decided that the Scotland v England rugby international would provide the ideal platform for this unique broadcast event. The broadcast of the match was a test and therefore we only had a limited three-position set up. We used our own bespoke 3D rigs that were designed specifically for sports coverage and can use standard broadcast equipment. We named the rig after the event the "Calcutta". Each camera was gen-locked. These feeds were then sent to the vision mixer where they were paired together so the mixer saw them as one (when you cut to camera one you actually cut the two cameras that were on position one) and then a fairly standard OB edit took place between camera positions. The output from the mixer or broadcast feed was then compressed as two SCPC ASI streams, multiplexed together and transmitted via satellite. This satellite signal was then received in London, decoded and fed to two Christie 8K HD projectors and projected onto a 25-foot screen. We built a mini grandstand to re-create the seating effect of being in the stadium and used a surround sound atmosphere mixed with the Radio Scotland commentary. The feedback from the audience was excellent with many saying that it exceeded expectations and also was a good way of recreating the stadium experience in a way that normal TV coverage cannot do.

Is rugby the optimal sport for 3D events?

Carter: No – due mainly to the size of the sporting arena and most rugby games take place in the elements so there are a number of factors that have to be considered – such as rain spots on the lens as was the case in this match.

Wooster: There are many sports that lend themselves to 3D, rugby being one of them. Rugby with its inherent physicality does work particularly well. Certainly in the future CAN will deploy more cameras, probably six or seven, to give the viewer a better experience. We also found that the pitch side camera was particularly effective and the reaction from the audience was they wanted to see more of that. Sports in enclosed arenas like tennis, basketball and boxing will work particularly well and set up right as do the bigger events like football. We believe that in the first instance an event has to suite 3D and the way coverage works, which is very different from traditional TV. Secondly it needs to be an event where there is major over subscription of tickets like a major final, a title fight, music concert or it needs to be exclusive, something that will only ever been seen by a limited audience. The key for us is that 3D should offer something different and this in our eyes is that it should be experiential and place the viewer as close to being at the event as possible. Therefore the shot choice and the way the cameras are edited is very important along with ensuring one has a powerful sound as well.

You were also recently involved in filming the World Ice Hockey Championships in 3D. Tell us more.

Wooster: We were asked by Host Broadcast Services if we could assist them in carrying out a live test 3D shoot of the semi finals, 3rd/4th place play off and final. This was coordinated through HBS who contracted a local OB company to supply the cameras, OB truck and crew. We took over our Calcutta rigs and set up and coordinated the stereo side of things. It was a good test as we also had slow-mo action replays on all positions.

What are the differences between rugby and hockey in terms of creating a good 3D experience?

Wooster: The play is so much closer in ice hockey compared to rugby and the pace of the game is so much quicker. This creates certain problems when the cameras pan fast. Frame sizes and how the cameras are set up vary from both sports and in a way both have positive and negative elements to overcome.

Has the theatre venue proved popular as an alternative to the stadium?

Carter: Yes, but in the future I would consider the stadium to be a viable alternative although there is little control over the lighting and sound as there would be in a theatre.

Wooster: Theatre venues will become more relevant in terms of live sport in the future. Essentially sport is a tribal shared experience event that can easily be enjoyed by fans gathering together either at the event or in other venues to enjoy. We see this with fan parks and pubs for major events. 3D brings a new opportunity for events, sponsors and broadcasters to add value and leverage events outside the live venue. This will become a whole new set of rights in the future. I also think it does not step on traditional broadcast as it will be to cinemas or bespoke venues for the time being until the genre goes mainstream TV in a few years time.

Is it affordable?

Carter: With the right partnerships, with merchandise outlets, and other revenue streams including ticket sales, then this is an affordable medium.

Wooster: Live 3D broadcasting is not much more expensive to produce than 2D. It requires fewer camera positions but two cameras per position. It uses standard OB kit. The issue at the moment is where it can be viewed. The cinema chains do not have the bandwidth yet to cope with a full HD 3D signal but that is being overcome. So for the time being one has to look at bespoke venues to make this work and that is where sponsorship comes in.

How important is the 4K level in terms of showcasing 3D content?

Carter: Not essential, especially when it comes to satellite transmission of this amount of data.

Wooster: This would be fun to do but the bandwidth for anything other than fibre locally would be prohibitive right now.

From a production standpoint, do you prefer optical fiber or satellite transmission?

Wooster: Fibre would be a lot cheaper to use but is limited by where it is available. Satellite is more flexible but is more expensive

What is the financial incentive for 3D telecasts? Is the goal to bring in alternative revenues to movies or will revenues ultimately come from broadcasts to the home?

Carter: Both of the above.

Wooster: Once the technology is in place for movie theatres then it is a genuine opportunity to generate new revenue streams and they are all looking for these opportunities at the moment. They can earn more out of non-film related events.

With a typical movie theatre seating only a couple hundred people, it would seem the economics will only make sense if demand exists for a large number of theatres to take up the transmission. Please discuss.

Carter: The whole process is dependent upon the demand – the market will determine the size of the venue but a plan must be in place to accommodate either.

Wooster: Once they can have the bandwidth and the network then live events into a multitude of cinemas is a reality and financially viable.

Do you see s being used primarily to satisfy away-game enthusiasts, or can the theatres supplement home-game sell-out situations as well?

Wooster: That depends on the game. I'm not sure at this stage that 3D is relevant to just any old game. I would see this being more a case of creating larger bespoke 3D viewing areas for major games. The Champions League Final, for example, could have been screened into 10,000+ venues in Liverpool and Manchester. Packaged with the right sponsor could have been an easy sell out.

Is 3D really necessary – won't the sports fans also be satisfied getting a big-screen, immersive, crowd-based experience if it's in 2D?

Carter: You in the States probably have a better handle on this than we do – since you have always been trying new innovative ways of getting material to the public.

Wooster: It's about moving forward developing sport, creating new experiences. It will only work if the ROI is there and we will see in the next couple of years whether brands and events see the value. The reaction we are getting is that there is the interest to develop this from brands, rights holders and even broadcasters. Rather like HD, one day, 3D will be screened into the home. Unlike HD it will bring a massively new experience to its audience.

Is there a risk of 3D becoming popular too quickly – such that there is not enough equipment, venues, skilled operators, and adequate production skills – resulting in poor quality 3D renderings, which will then have a negative impact on the growth of the industry?

Carter: This is a good point – alternatively we could all sit around and wait for the perfect transmission and miss a good opportunity to be leading the field in this innovative technology.

Wooster: I think it will be a slow burn as the viewing public needs to see more 3D to get it and the release of 3D movies over the next two years will help build the awareness. The main problem is if bad 3D events are produced as they could do serious damage to the early growth of the genre.

Are some seats in the theatre better than others in terms of an optimised 3D experience?

Carter: The optimum position is level with the audience that you are sitting in the stadium. For instance, you don't want to be looking down when people start moving around on screen.

Do the cameramen need to learn special tricks when filming in 3D? Is this a big learning curve or does it come naturally?

Carter: No. As long as the cameramen adhere to some basic principles of shooting in 3D then it doesn't take long for the cameramen to learn what does and doesn't work.

What are the biggest negatives you've been hearing related to 3D sporting events?

Carter: Amongst the very positive feedback from the event – as though being part of the event itself – some people wanted to get a lot more close-up and personal to the action on the pitch as they would within the 2D traditional broadcast.

Wooster: How are we going to see the 3D? Does this conflict with the TV coverage? Can we find the additional positions for you to put your cameras?

Stereoscopic 3D camera rig at England vs. Scotland rugby match – the world's first 3D satellite broadcast of a sporting event

Overall, what one thing did you find most satisfying about your 3D sports experience?

Carter: The positive response from people who witnessed the event – we really feel that there is a future for 3D live transmission for sport, theatre, music, etc.

Wooster: For rugby it was that the audience really enjoyed the experience, the 3D didn't hurt their eyes and they got the potential. The ice hockey was all about pushing the 3D experience to the next level and achieving that…

What will we see next from you?

Carter: Watch this space; in all likelihood it will be a music event.

Wooster: More sport and brand related 3D films and in the near future live music

Interview with Bob Stevens from the Rutherford Appleton Laboratory

Bob Stevens is a principal scientist at the Science and Technology Facility Council. He is based at the Micro and Nanotechnology Centre at the Rutherford Appleton Laboratory near Didcot. He manages a team of eight, who are focused on developing new processes and devices for STFC large scale facilities and partnerships which lead to world-leading technologies. His PhD focused on thin film electroluminescent devices for electro-photographic printing and miniature head mounted displays. More recently he has assisted with the development of high temperature pressure sensor devices and developed partnerships to exploit the potential of electrospun nanofibres. He has twenty years experience in top-down MNT and just over 3 years related to nanofibres synthesis. The wide variety of projects undertaken over the past 20 years has led to a good understanding of many MNT processes and how they can be used to provide real solutions. His broad knowledge of the UKs MNT capability has lead to the formation of the ALDSIG.

Please tell us a bit about the primary work done at the Rutherford Appleton Laboratory. The Science and Technology Facilities Council is an independent, non-departmental public body of the Department for Innovation, Universities and Skills (DIUS). We were formed as a new Research Council on 1 April 2007 through a merger of the Council for the Central Laboratory of the Research Councils (CCLRC) and the Particle Physics and Astronomy Research Council (PPARC) and the transfer of responsibility for nuclear physics from the Engineering and Physical Sciences Research Council (EPSRC). We are one of seven national research councils in the UK.

STFC is a science-driven organisation. We make it possible for a broad range of scientists to do the highest quality research tackling some of the most fundamental scientific questions. We do this by:

- funding researchers in universities directly through grants particularly in astronomy, particle physics, space science and nuclear physics.
- providing in the UK access to world-class facilities, including ISIS, the Synchrotron Radiation Source (SRS), the Central Laser Facility, and HPCx. We are also a major stakeholder in the Diamond Light Source, which started operating this year.
- providing in the UK a broad range of scientific and technical expertise in space and ground-based astronomy technologies, microelectronics, wafer scale manufacturing, particle and nuclear physics, alternative energy production, radio communications and radar.
- providing access to world-class facilities overseas, including through CERN, the European Space Agency (ESA), the European Southern Observatory (ESO), the European Synchrotron Radiation Facility (ESRF), the Institut Laue-Langevin (ILL) and telescope facilities in Chile, Hawaii, La Palma, Australia and the MERLIN/VLBI National Facility, which includes the Lovell Telescope at Jodrell Bank Observatory.

We supply highly skilled scientists and engineers and generate ideas and technologies that have a much broader social and economic impact. We encourage researchers to create new businesses based on their discoveries and we help established companies to use the fruits of our research as the basis of new or improved products and services.

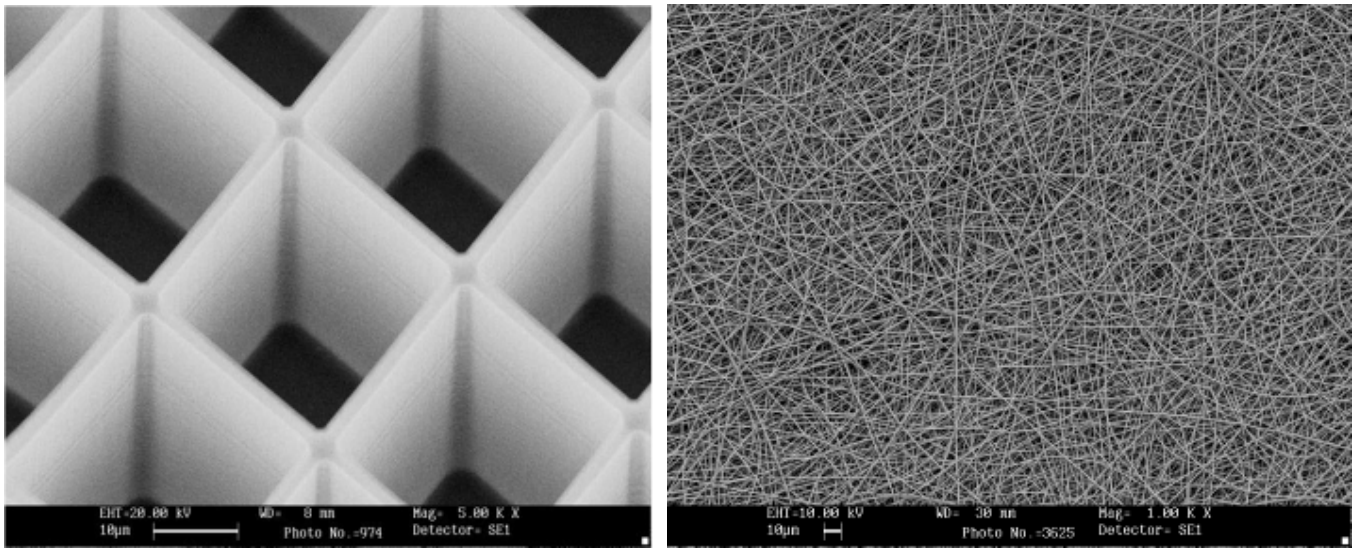
Our staff are deployed at seven locations, namely: Swindon where the headquarters is based; the Rutherford Appleton Laboratory, which is part of the Harwell Science and Innovation Campus in Oxfordshire; the Daresbury Laboratory, which is part of the Daresbury Science and Innovation Campus in Cheshire; the Chilbolton Observatory in Hampshire; the UK Astronomy Technology Centre in Edinburgh; the Isaac Newton Group of Telescopes on La Palma in the Canary Islands; and the Joint Astronomy Centre in Hawaii.

To what extent is the work done at the Laboratory sponsored by government relative to work commissioned by industry? A key part of the Science and Technology Facilities Council mission is to ensure

that its investment in major facilities in the UK and overseas and peer reviewed funding within UK universities, has a positive impact on the UK's economy through innovation. To meet this challenge the STFC will ensure that knowledge generated from its facilities, research and technology programmes, and interactions with universities and academic partners will be transferred to the wider economy for enhanced productivity and economic growth. Activities include delivering growth through innovation, strategic planning, science and innovation campuses, industry focus, commercialisation, funding opportunities, education, training and capacity building, brokering and strategic partnerships, advisory bodies, institutes, publicity, KITE Club, and various events.

When working with industry, does the MNT Centre give your commercial partners over your equipment or do you typically partner with them to help find appropriate solutions? The Micro and Nanotechnology Centre at Rutherford Appleton Laboratory has an open access policy to academia and industry. We are rapidly building a critical mass of users where their targeted applications range from Biotechnology to Aerospace. The Centre has spun out three companies in the past 5 years based on IP generated by the staff within the Centre. Oxsensis Ltd, has developed the World's first 1000ºC dynamic pressure measurement system for testing and condition monitoring of Gas Turbines and has recently launched its I-Phire product (www.oxsensis.com). Microvisk is taking micro-cantilever technology to the Point of Care Medical market to analyse body fluids and the Electrospinning Company Ltd has been incorporated in 2008 to market nanofibre synthesis process systems and contract research services. Additionally the Centre hosts three Spin-In SME companies embedded within its infrastructure. Qudos Technology Ltd and Applied Microengineering Ltd (AML) have operated from the Centre for over ten years. Access to the core Micro and Nanotechology process tools and cleanroom infrastructure, along with their expertise and unique products has allowed both companies to become established as Nodes of the UK MNT Network. Qudos Technology operates the UK's National Prototyping Centre and AML the UKs Bondcentre.

What is MNT? Micro and Nanotechnology (MNT) has two streams. The first employs a top-down approach, where bulk materials e.g. silicon wafers are structured using lithography, etch, deposition, bonding and surface modification to make devices for a wide spectrum of applications. Such as Ink jet printer heads, airbag sensors and micro gyroscopes. The other stream is bottom-up, where self-assembly of molecules creates a range of nanoscale materials, from particles, fibres and thin films. The Micro and Nanotechnology Centre researches both streams, where nanolithography tools such as electron beam lithography and nanoimprint systems are used to create nanoscale structures. A summary of the full capability of the centre can be found at http://www.scitechconnections.com.



On the left is an example of top-down MNT; the right image shows a bottom-up MNT

What sort of spin-out companies have resulted from the activities of the MNT?

- Oxsensis Ltd was incorporated in 2003. It was formed to translate STFC IP in novel fibre optic pressure sensors for medical and industrial applications. Currently, Oxsensis employs 23 staff in

the UK and has launched its I-Phire and Wave-Phire products. Their system enables dynamic pressure measurements of extreme environments, such as gas turbine engines where temperatures can soar to 1000ºC.

- Microvisk Ltd is concentrating on developing point of care systems to provide essential information to optimise the drug management profile of patients. One sector targeted by Microvisk's Microsystem based product is patients who are taken blood-thinning medicines.
- In 2008, the Electrospinning Company Ltd was incorporated to provide solutions to industries that require large volumes of nanofibres. IP generated with the Micro and Nanotechnology Centre has the potential to provide unique products for aerospace, wound care, energy, pharmaceuticals and filtration.

Tell us about the work you are doing in nano-engineering. The MNT Centre delivers the MNT requirements to the Science and Technology Facilities Council. Nano-engineering activities include synthesis of mesoporous materials for sensors, fabrication of synthetic and natural nanofibres for tissue engineering. One key area is the development of a tissue scaffold based therapy to repair damage in the Central Nervous System. Nanofibre samples have also been developed and are being tested for repair of eye disease. We are making devices from multilayer nanoscale coatings for ultra fine pitch electrical interconnects and optical components. Other work utilises engineered nanoparticles to create high-resolution X-ray detector screens, which will be enable improved crystallography data to be captured.

In what ways can your work related to atomic layer deposition improve display devices? Atomic Layer Epitaxy, which is commonly referred to Atomic Layer Deposition has unique thin film qualities. The method has the ability to coat extremely high aspect ratio structures with pinhole free, extremely dense thin films. Planar Inc. use ALD to manufacture thin film electroluminescent displays. The technique is used because it provides high-quality dielectrics with high voltage breakdown performance. A wide range of materials can be deposited including metals, dielectrics and luminescent materials.

How can ALD help create low cost substrates and such things as diffusion barriers? The pinhole free nature of the ALD films combined with their density enables coatings to be deposited which act to prevent diffusion of moisture and ionic elements. For the plastic electronic and display industry, microfluidic devices and electronics industry this is essential quality. For example a low-grade glass substrate could be used for coatings that would be poisoned if the glass was uncoated. The same applies for polymer substrates.

What's going on with the ALD network? The MNT Centre has recognised the need for an ALD capability in the UK that can coat three-dimensional objects with a wide range of specialized coatings. To raise awareness, the MNT Centre and the UK Displays and Lighting KTN held the first UK ALD Workshop at STFCs Daresbury laboratory in October 2007. This was well attending with over 60 delegates. Presentations were made by UK researchers and companies with an interest in ALD. The outcome of the workshop was that STFC and UKDL KTN would launch the Atomic Layer Deposition Special Interest Group, ALDSIG. Over the past year STFC has been investigating a suitable web-based platform to host the members and on-line forum. We have decide that we will grow the ALDSIG within the living marketplace know as Scitech Connections (http://ww.scitechconnections.com). Bob Stevens will chair the ALDSIG and board members have been assembled from UK industry and academia and good links have been established with the Finnish ALD network. We aim to launch the ALDSIG before the end of 2008. Its focus will be to obtain funding and establish an R&D capability for coating sizeable 3D structures and to develop new systems for advanced flexible materials.

One of your projects was related to a scintillator – sort of the reverse of a display – that blocks light. Tell us more. Scintillators are used as a transfer medium to enable imaging of X-ray diffraction pattern for synchrotron beam lines. Powder and thin film systems are used for this, which exhibit wave-guiding and scattering of the generated light emission. This reduces the resolution of the screen. By using MNT processes such as deep reactive ion etching of silicon and thin film coating techniques, we can create micro-structured boundaries around each pixel. We are then using novel filling techniques to create highly compressed scintillator nanomaterials. The process lends itself to screens up to 70x50mm with a pixel pitch of 14µm at the present time.

Mission accomplished – India July 2008

by Chris Williams

In July, The UK government's overseas Trade and Investment Department in India (UKTI) commissioned UKDL to deliver a 2-person 1-week scoping mission to India to identify the opportunities for the UK's lighting communities in this rapidly expanding marketplace. UKDL's director, Chris Williams, led the mission and was accompanied by Dr Gareth Jones (CTO of Enfis Ltd, and a member of the UKDL Advisory Board). The hectic mission visited Mumbai, Bangalore, and Delhi, visiting multiple companies in each location. The trip followed an initial visit made by Chris Williams in 2006, and developed further the information gathered for a UKTI market analysis report published in spring 2008. The objectives for this visit were to:

- Explore the market opportunities for UK companies in lighting in India by visiting a wide cross-section of lighting companies.
- Identify whether UK and Indian companies can work together on technology development in the area of energy efficient lighting.
- Identify the opportunity for joint manufacturing, or other JV activities, between UK and Indian companies.
- Determine the "next steps" strategy in terms of a follow-up mission and other activities.
- Raise the awareness in India of UK strengths in the ultra-efficient lighting area.

The visits organised by UKTI spanned a variety of companies from small start-ups to multi-billion pound global industrial companies. In addition, a seminar was organised by the MNRE (Ministry of New & Renewable Energy) at the national Solar Energy Centre. The seminar was on LED Lighting and Solar Energy and both Gareth Jones and Chris Williams were featured speakers in this seminar. A number of companies and researchers attended including foreign companies Nichia and Osram, two leading LED manufacturers with a strong presence in India.

Company visits

During each of these visits the same format was adopted. Chris Williams provided an overview of the role of the UK Displays and Lighting Knowledge Transfer Network (UKDL KTN), describing how UKDL represents the full supply chain in the UK for lighting technologies and associated accessories. He also talked through the wide range of activities taking place in this area around the UK, and invited the Indian companies to join the network. After this introductory session, he then provided an overview of the new highly energy efficient microwave-powered HID lighting technology developed by Ceravision based at Bletchley Park.

Following on, Gareth Jones gave an overview of the LED activities around the UK, and then focussed on the Enfis high-power, high-quality LED based lighting technology. The meeting then opened up with a broader discussion based on the visited company activities and interests.

Other UK competences at individual companies (such as optical films, lens arrays and low-cost secondary optics) were then mentioned as and when necessary. This format worked very well and stimulated much exchange of views and information.

Summary of the mission and general conclusions

This was an extremely valuable mission, and the delegates wish to thank UKTI for their sponsorship of the event. The conclusions that were drawn from the mission are as follows:

- All companies visited in India acknowledged the government-led strategy to implement ultra-efficient lighting. At most of the companies visited there were active development programmes, with inorganic LEDs for lighting applications a key part of this move.
- Many companies visited see the system integration of photovoltaic (solar cell) modules with battery storage and illumination element (LEDs) as the solution for off-grid applications. This applied to individual kerosene lamp replacements and to community-wide, micro-generation lighting systems.
- The companies in India appear to have a strong affinity for working with British companies. Language is generally not a barrier as the level of English speaking competence is very high.
- Under the government tax regime, electronic components are imported at 0% duty, but added-value assemblies incur an 83% import duty. This appears to be an implicit policy of supporting Indian

companies to make their own assemblies and components rather than import assembled items.

- Indian companies value UK innovation but also expect the price of such innovative components to be low-cost.
- India has high fuel costs in common with the rest of the world. The existing electricity generation and distribution network is not robust and clearly fully stretched. Short power cuts are commonplace. During one week, we experienced several power cuts and "brown-outs". This has implications with regard to lighting technologies that can be used. Conventional high power metal halide lamps require a 10-minute "cool off" period if the supply is interrupted before they can be switched on again. This causes problems in many applications – including sports stadia.
- The Indian market is extremely cost-sensitive as the wider level of disposable income is very low. Approximately 50% of lighting across the nation is still provided by inefficient, high carbon footprint kerosene lamps.
- According to Lawrence Berkeley National Laboratories (LBNL), the primary source of greenhouse gas emissions in the developing world comes from dirty, hazardous and expensive fuel-based sources such as kerosene for lighting. The sensible way to meet the increasing lighting energy demands is to replace fuel-based lighting with ultra-efficient electronic lighting systems.
- With the strong drive to deliver energy efficiency lighting the compact fluorescent lamp (CFL) is seeing huge growth, spurred on by the government-sponsored energy conservation programme aimed at replacing conventional lighting in government organisations, public places and commercial establishments.
- The Indian CFL market, currently valued at around Rs70B (£81M) and growing at nearly 40% over the last couple of years, is also expected to get a further boost with the introduction of the Indian government's proposed public-private partnership scheme to utilise the clean development mechanism (CDM) of the Kyoto Protocol to increase penetration of CFLs among domestic consumers. There are over 900 million light fittings that are mostly dominated by incandescent technologies (GLS bulbs). The CFL and fluorescent tube are expected to replace most lighting technologies for general and commercial use in the next five years. The domestic manufacturing capacity for CFLs has now reached 65 million units per year.
- Whilst CFLs are expected to penetrate widely due to their lower cost and wide availability, all manufacturers visited already have active research and development programmes to promote solid-state lighting (SSL) for certain applications. Manufacturers recognise the limitations of CFL compared with SSL but do not expect SSL to enter the mainstream lighting markets in Indian homes for several years. However, they are already active in promoting SSL for a number of lucrative and large (India is a very large country!) markets. These are summarised as:
    - Decorative lighting
    - Architectural lighting mainly internal but new building projects also an opportunity
    - Street and car park lighting
    - Kerosene replacement lanterns
    - Safety lighting (India has many power cuts and safety lights are essential)

During the visit, multiple opportunities were identified for LED-based solutions such as those developed by Enfis, and for high intensity discharge lamp solutions such as those developed by Ceravision. We assess that there is an excellent opportunity for UK companies to participate in a multi-billion pound business in ultra-efficient lighting in the Indian market during the next decade. This opportunity is not restricted to LED and HID products. There are also significant opportunities for photovoltaic cells of all technologies (crystalline silicon, amorphous silicon, organic, etc) optical accessories such as lenses and optical films, battery technologies and micro-generation systems. In every case, the opportunity for success for UK companies will be enhanced if they are willing to consider some degree of collaborative manufacturing with Indian partners.

The opportunity for success has subsequently been demonstrated for Enfis, with one of the companies visited having already placed initial orders for some of their products that were discussed during the visit. For Ceravision, the immediate result has been for Indian companies to visit their facility in the UK to review the microwave powered electrode-less HID system.

UKDL has taken part in many overseas missions over the last four years, but we can say without demur that this has been the most immediately successful mission of them all!

Trade Mission to the International LED EXPO and FPD Korea Show

24-27 June 2008, Kintex Arena, Seoul Korea

by Nick Kirkwood

At the end of June, UKDL lead a trade mission of six UK companies supported by UK Trade and Investment to the LED & FPD Exhibition and Seminar held at KINTEX (Korean International Exposition) located by Lake Park in Gyeonggi, just a 30 minute taxi ride from the centre of Seoul, Korea. It has become one of the most important LED & FPD exhibitions in Asia, bringing together leading industry manufacturers in an exciting head-to-head presentation of next generation technologies with applications across a wide range of industries and products. Last year 195 companies from over 12 countries occupied 383 booths with a reported 15000 visitors. A similar number of booths and companies where present this year, however, the influence on the exhibition floor was overwhelmingly towards LEDs with Samsung the one of the only FPD companies in evidence with their dynamic LED back light unit.

On the left, Samsung shows dynamic LED backlighting; on the right is a huge array of LED applications

A vast array of new LED products were on show such as chips, lamps, laser diodes, high brightness modules, back lights, domestic lighting, automotive, traffic signal, architectural, large area displays and signage. In recognition of the significance of FDP Expo 2008 to the industry, the Ministry of Commerce, Korea Energy Management Corporation, China Association of Lighting Industry, and Photonics Industry & Technology Development Association supported the event.

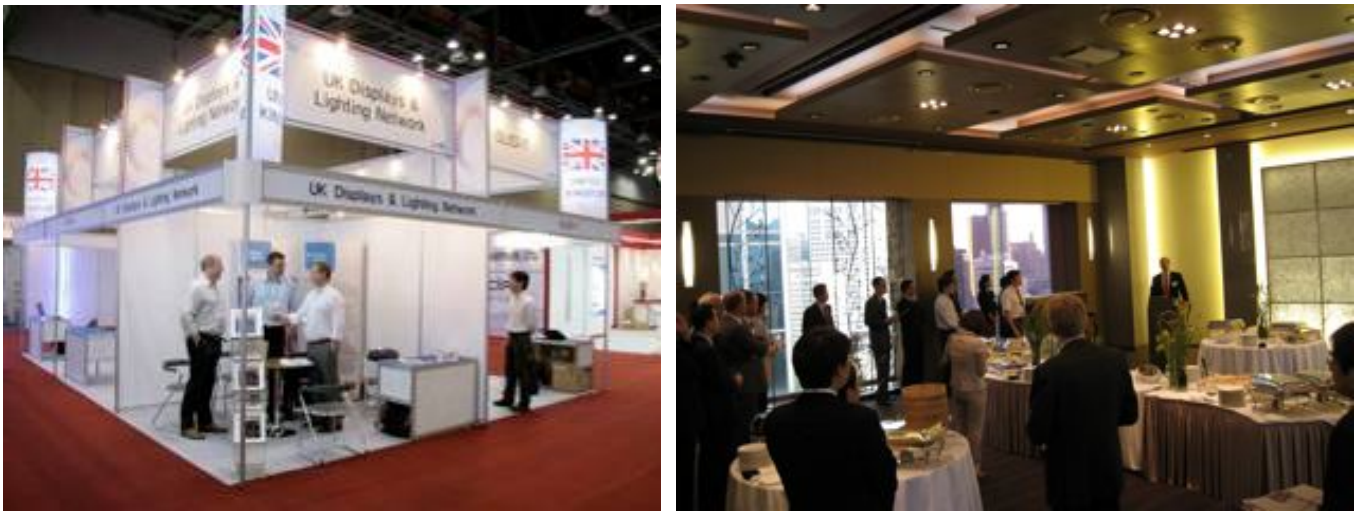
The exhibition featured both flat panel LED lighting and large area LED screens

The event was hosted by OIDA (Optoelectronics Industry Development Association) and jointly organized by ExponU (LEDEXPO.COM) Kintex, KAPID (Korean Association for Photonics Industry Development) and KOTRA (Korean Trade –Investment Promotion Agency). UKDL organized the delegation of six UK companies with liaison through UKTI and KOTRA; a process not to be taken lightly, detailing a very packed schedule for the week's events. We would like to thank all involved for their hard work. A list of the companies involved in the mission together with a summary of the activities of those companies is included at the end of this article.

On day one of the show, Ric Allott, Deputy Director of UKDL was whisked away after breakfast to Arirang TV studios to be interviewed for an English speaking chat show programme called "Heart to Heart", to promote the UKDL network, its members and UK Plc. Ric was filmed again later in the day walking the floor of the exhibition hall explaining the different technologies and applications on show to the Korean TV host.

The TV cameras were in attendance at the afternoon panel session of Executive Forum discussing, "The Impact of OLEDs on The Future of Flat Panel Displays". Ric was one of the expert panellists who all concluded that OLEDs would make a significant impact at some point in the future.

On the second day alongside the seminar on LED technology, business to business sourcing meetings took place. The UK delegates met with Korean companies to discuss possible trade links. This proved to be very useful for the UK companies. On the exhibition floor traffic was brisk and the UKDL Newsletters were being very well received, there were also rather a lot of enquiries at the UKDL booth for contacts for UK and European distributors of LED based products.



On the left is the UK Village at the Expo; on the right, delegates enjoyed a networking dinner hosted by UKTI

A networking dinner arranged by the British Embassy at the Seoul Plaza Hotel took place in the evening; seven journalists including one from the *Digital Times* interviewed Ric Allott. All the delegates found the evening most useful and some very good contacts were made.

On day three, presentations were given at the technical seminar by Ian Underwood (MED), Myrddin Jones (OLED-T) and Ric Allott (UKDL). The seminar was enhanced by excellent simultaneous translation delivered by the Korean organisers that really helped to get the message across and allow for lively discussions to take place after the session.

In summary this was an excellent trade mission with all the UK delegates coming away with positive results, new contacts and potential business for the future. UKDL gave out 350 newsletters and as a direct result of the media interviews had an excellent meeting with two representatives of the Korean Display Industry Association (KDIA) that will lead to future events and collaborations with Korean companies.

UK companies who attended the trade mission

James Lee, **Cambridge Display Technology (CDT),** http://www.cdtltd.com: A member of the Sumitomo Chemical Group of Companies, a global pioneer in the research, development and commercialisation of

technologies based on polymer light emitting diodes (P-OLEDs). CDT is based in Cambridge, UK with a technology development centre in Godmanchester, near Huntingdon and offices in Japan and USA.

Ian Underwood, **MicroEmissive Displays (MED**), http://www.microemissive.com: A leader in polymer organic light emitting diode (P-OLED) microdisplay technology. MED's headquarters are at the Scottish Microelectronics Centre, Edinburgh and its manufacturing site is in Dresden, Germany. The company employs over 70 people and also has sales representatives and applications support located in Asia, the US and Europe.

Myrddin Jones, **OLED-T Ltd.,** http://www.oled-t.com: OLED-T invent patents, develops, manufactures and licenses high performance small molecule organic materials for use in the manufacture of OLED displays. The materials are suitable for both active matrix and passive matrix OLED displays, and can also be used for lighting and flexible displays. OLED-T is based in Enfield in the UK.

PETeC. http://www.ukpetec.com: The Plastic Electronics Technology Centre based within NETPark, is the Engineering and Technology Park for the commercialisation of cutting edge R&D. Based in County Durham, the PETeC Centre provides 3,000 square meters of cleanroom and laboratory space that houses an impressive range of equipment and staff.

Richard Kirk, **PolyPhotonix**, www.polyphotonix.com: PolyPhotonix was founded by a world-class management team, in early 2008 as a new venture to exploit polymer OLED technology in applications such as architectural lighting, medical devices and automotive interiors. PolyPhotonix is developing a pilot manufacturing plant at its plant, based in the PETeC facility in the North East of England.

Dr Geoff Williams, **Thorn Lighting,** http://www.thornlighting.com: Thorn Lighting in Spennymoor, County Durham is leading a project to develop OLED materials and efficient device structures for large area lighting applications.

Touchscreen and Interactive Display Technology

UKDL Seminar: 8 October 2008

Venue: The Microsoft Lecture Theatre, Needham Building, Cambridge

Touch screens have become commonplace since the invention of the electronic touch interface in 1971 by Dr. Samuel C. Hurst. Now familiar in retail settings, point of sale systems, ATMs, Satellite Navigation units, PDAs, Game consoles and many other types of information devices. The acceptance and popularity of these devices is helping to drive the demand for more advanced touchscreens and interactive display technologies. The event will explore what's new and happening in touch screen and interactive display technology. Leading figures from industry and academia will be presenting with speakers from:

Shahram Izadi	Microsoft	Andy Murray	iSuppli
Mark Fihn	Veritas et Visus	Steven Abbott	MacDermid Autotype
Stephan Herron	Wacom	Dave Bhattacharjee	Touchbase

The event will be held at Microsoft's Research Lab in Cambridge at the Lecture Theatre in the Roger Needham Building. Delegates will get the opportunity to network and see tabletop demonstrations. For further information and registration: http://www.ukdisplaylighting.net or email info@ukdisplaylighting.net

OLEDs – The Future of Architectural Lighting

24 June 2008, Building Design Partnership, Brewhouse Yard, London

The LABL (Lighting and Backlighting) sub group has for some time been trying to raise its profile within the lighting designers and architectural sphere. Historically LABL had in its member database the “lighting technology inventors and providers”, but there was a distinct lack of what could be called the “lighting technology specifiers and users”. This event brought people from these two groups together for the first time. Feedback from the event would indicate that we are on our way to realising a “full width lighting community”. Further discussions will potentially allow the establishment of an “end to end lighting community”.

The OLED talks, from Scott Brown CDT, Andy Monkman Durham University and Andrew Evans Aberystwyth University gave an excellent overview of this area. The level of interest from the audience was significant and was reflected by the sheer number of questions that were asked. OLEDs are seen as an excellent means of lighting architectural projects. The fact that they can be formed to cover an area, combined with the ability to emit light from the surface diffusely make these very attractive for use by these professionals.

The LED talks gave an excellent overview from two very different perspectives. The first talk from Tim Whitaker (LEDs Magazine) was an excellent overview of where we are at present and concluded by informing us of what is likely to come. This was followed by Kevan Shaw from Kevan Shaw Lighting Design (also Sustainability Director of the PLDA); the talk covered his experiences as a lighting designer who can be tasked with using LEDs to light architectural projects. He outlined in his view some of the problems as he sees them at present; lack of definitive standards was his main complaint.

The last two talks of the day were organised by our host, Martin Lupton, BDP. The first talk was from Douglas James, Architectural Lighting Designer, Mindseye. Douglas gave a fantastic and fascinating account of what he as a lighting designer would like the OLED future to look like. This talk went down very well and was seen as an excellent first step in trying to get more understanding between as mentioned earlier the “lighting technology inventors and providers” and “lighting technology specifiers and users”. The final presentation of the day took a light hearted look into the future, 2028 to be precise. Sam Neuman, NDY Light, entertained us with his vision of the “lighted” future, an excellent and very entertaining end to the presentations.

Intense concentration -- Tim Whitaker LEDs Magazine; very informative Q&A session

The day concluded with a Q and A session. All presenters were asked to participate in an informal debate. This part of the arranged schedule went over the allotted time and indeed it was well after our allotted end time before we finally concluded proceedings. The overwhelming output from this final session was the desire that this should be seen as the beginning! Each side expressed the wish that there should be follow on events. A major issue was the need to have some form of “user friendly” standards introduced; this would be seen as a positive step and should allow the fast adoption of OLEDs by the Lighting Design and Architectural communities.

In total 56 delegates attended, of this number 27 were from the lighting designer/architectural community. The take home from this event would read something like this;

- Hold more events similar to this
- Create a vibrant community
- Push to get some standards defined

Our next major lighting event is scheduled for the 17th September in London. This is our "Future Lighting Debate", most of the original speakers from our 2006 debate will return and bring us up to date on their previous predictions, they will then give us their new vision of the future. The main themes will be OLEDs, LEDs and Gas Plasma. Please see our website www.ukdisplaylighting.net for further details.

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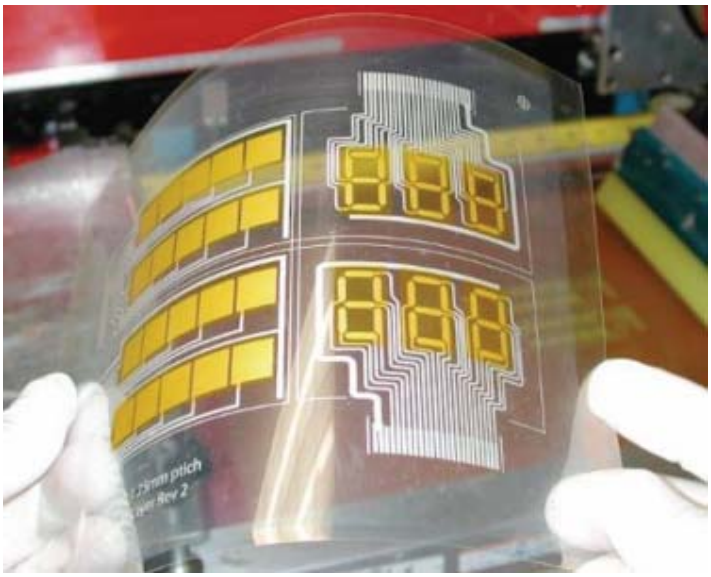
Scott Brown, VP R&D at **Cambridge Display Technology**, gave a presentation on polymer OLEDs (P-OLEDs) and solid-state lighting applications. He first gave a short history of CDT, the dominant IP holder in the use of P-OLEDs for the creation of display and lighting devices. The case for alternative lighting products is global, he said: 2650 TWh of electricity consumption is used for lighting per annum representing ~19% of global electricity and equivalent to the output from 1265 power stations. A global switch to efficient lighting systems would trim the world's electricity bill by nearly one-tenth.

In the UK, in 2000, lighting accounted for 23% of the total amount of electricity consumed. Internal domestic lighting accounted for ~18TWh of electricity consumption in 2006, which is expected to rise to 21TWh by 2020. About 50% of current lamp sales by volume are inefficient tungsten light bulbs where only ~5% of electricity is converted to light (11-15 lm/W).

There are issues with compact fluorescents (CFLs). They have slow turn-on (improving), poor colour rendering (improving), and produce electrical noise (improving). Lifetimes can be shorter than advertised. For example, 6000-15,000 hours continuous use vs.1000 hours if turned on and off every 5 minutes. CFLs contain up to 5mg of mercury producing the potential for widespread Hg contamination in incinerators and landfill. Practical efficiencies drop due to fixture losses (drivers, reflectors etc) -- installed luminaire efficiencies are around 30-60 lm/W.

Many organizations are investigating OLEDs for lighting; in many cases, governments are funding developments. The drivers for OLEDs in solid-state lighting include: potential for long lifetime (important cost savings in buildings, transport systems, etc.); high efficiency (energy savings, fewer new power stations); and a lower bill of materials than CFLs. OLEDs are best suited to applications requiring uniform, diffuse large area emission. OLEDs are not a good match for point source or highly directional applications. Inorganic LEDs are best suited to applications requiring point sources of light. Inorganic LEDs are not a good match for uniform, diffuse large area emission. That would require diffuser materials, arrays of LEDs, costly assembly and integration. Inorganic and organic LEDs are complementary and together will be able to cover a wide range of lighting needs.



The future potential is flexible SSL panels (Add-Vision)

Turning to small molecule OLED devices, Brown said that many layers are required for optimum performance. Each layer requires precise thickness control. Yield remains an issue. Materials are deposited by evaporation under vacuum leading to poor material utilization. The cost of vacuum equipment scales as ~dimension cubed. P-OLED devices, on the other hand, require significantly fewer layers. The colour is controlled during polymer manufacture through solution processing producing a higher lm/$.

Brown turned to producing white from two colours (blue and red) and three colours (RGB). Different

coloured components are combined to give white P-OLED emission. Colour is fixed during polymerisation of components giving good colour reproducibility. The ratio of R,B or R,G,B emitters can be controlled to give the desired colour point. The Three-colour approach gives higher efficiency as emission is enhanced in the eye sensitive 480-560nm region.

Brown then described the "Topless" project, standing for thin organic polymeric light emitting semiconductor surfaces. This UK consortium consists of Thorn Lighting Ltd (lead partner), Sumation UK (industrial partner), and the University of Durham (academic partner). It is sponsored by a UK government grant from the Technical Strategy Board, Department of Innovation, Universities and Skills. The objective is to produce efficient single white light emitting polymer devices with 40lm/W @ 1000cd/m^2 and >10k hours lifetime.

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Andy Monkman of **Durham University** gave a presentation entitled "What can we do with the plastic light bulb?" He listed the reasons for organic lighting: cheap fabrication on flexible substrates for reel to reel; high efficiency - Novaled have reached 130lm/W in the green, Philips/Novaled report 30lm/W in the white with 2000 hours lifetime; and it is energy saving - 25% of all electricity is used for lighting - saving 30% of this by going OLED would mean 500 fewer power stations in the US alone. There is also less waste - only 100nm active material of small organic materials, no heavy metal waste.

Monkman then detailed the current state of the art including Novaled, Universal Display Corporation, Siemens, Philips, GE, and Sony. He went on to point out with examples that lighting is not just white - patterned ceiling lights are compatible with printed OLEDs. He also showed using visuals the possibility of transparent OLEDs as windows.

Using the possibility of transparent OLEDs

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Andrew Evans of the Centre for Advanced Functional Materials and Devices (CAFMaD) at **Aberystwyth University** covered science issues in OLED fabrication: materials and interfaces. The scientific themes of research are organic conductors and molecular electronics, extreme materials, sensors and devices, and characterization and modelling. It covers small organic molecule research, single molecule device research, and polymer device research. He described the advantages of OLEDs: low power consumption; "warm" colours; large area panels; transparent, reflective or black when off; flexible and lightweight; low power consumption; non-toxic materials. The disadvantages are cost compared to existing technology; narrow band colour emission; manufacturing technology not established; small panel size; low voltage, DC supply; lifetime and degradation.

The technology challenges for OLED are OLED vs. conventional lighting (fluorescent, translucent); OLED vs. inorganic LED; OLED materials: polymers vs. small molecule vs. hybrids; manufacturing: vacuum deposition, printing; common production for lighting, displays and photovoltaics; device architecture; colour definition; efficiency; lifetime; degradation; thermal management; compatibility; and encapsulation.

Evans made the point to the meeting verbally that there was an opportunity for the lighting community to say what they want in terms of added value rather than developers chasing the $30/foot magic target. Thermal challenges were not zero and there were serious encapsulation problems. All challenges needed numbers and targets. A figure of 10^{-6} for permeability was sufficient but the Vitex barrier system at 10^{-3} g/cm^2/d was not adequate.

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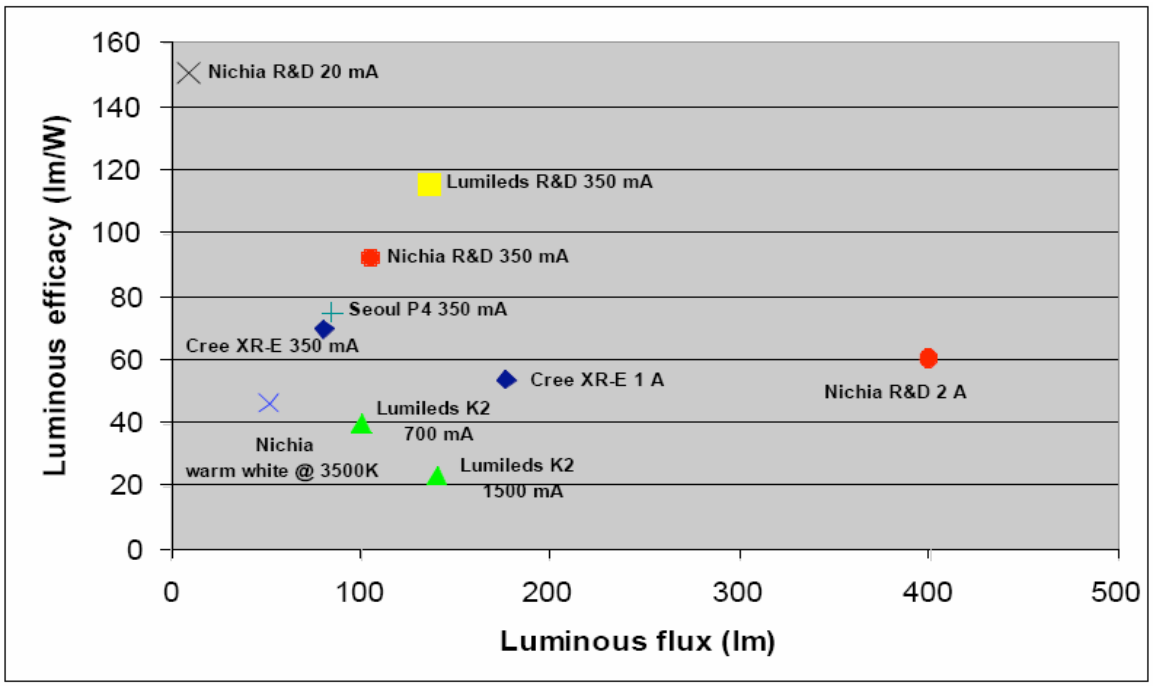
Tim Whitaker, publisher of ***LEDs Magazine,*** talked on "Technology Developments & Challenges for LEDs". Why use LEDs he asked. The rationale depends on application and objectives. LEDs are not always the optimum solution. Improvement in LED performance is continuous, ongoing development. Efficacy continues to improve and has now reached 100lm/W in production (for 1W devices), but it is driven by non-illumination markets - mobile appliances, backlighting, vehicles. He pointed out that high-power LEDs are less efficient than lower power ones. Thermal management is a key issue. Heat decreases LED output and life. Continuing efficiency improvements are crucial. Some LEDs are more tolerant to higher temperatures. Optical and electrical (driver) issues are also important.

Efficacy hits technology barriers. Higher current equals more lumens but efficacy is lower. Efficacy and lumens are lower for warm white vs. cool white. And higher color rendering usually means lower efficacy. What do the numbers mean? "Nichia reports 150lm/W white LED." Whitaker said that this was a small chip driven at 20mA – the light output is approximately 9 lumens – an R&D result, not for mass production. However, he said, 100lm/W devices will be in production soon. What do the numbers mean: R&D or production? Can they be bought? In production, results could be: typical values, best possible, or minimum guaranteed. Do devices have high reliability? Is there a significant colour shift over time?



Flux and efficacy on some selected LEDs

He then discussed the testing of commercially available luminaires (DOE CALiPER Testing – Early results showed big discrepancies (manufacturers' claims vs. measured results). There is a huge range in performance and effectiveness in SSL implementation. Luminaire efficacy is likely to be at least 20% lower and there are electrical and optical losses - worse for poor luminaire designs. LED data not measured under "real-world" conditions. LED datasheet measurements are made instantaneously at LED junction temperature (T_J) of 25 ºC. In real-world applications, the LED T_J will be higher (= lower output). Luminaire output settles to a steady-state value after about two hours. Key data points are efficacy (lumens/watt); input power (current and voltage); lumens; chip size; correlated color temperature (CCT); color rendering index (CRI); lifetime/reliability; was testing at thermal equilibrium/was third-party testing involved? As to LEDs penetrating the lighting industry, stop making over-ambitious/untrue claims, Whitaker pleaded – LEDs are not the answer for every lighting problem/situation. http://www.netl.doe.gov/ssl/comm_testing.htm).

In a Q&A session, Whitaker said that although there was no mercury in LEDs, there were others – GaN, phosphors, etc. "It's nothing as bad as Hg but in the end do we want it in the groundwater. There have been no studies. Managements should publish the processes they are using which can be pretty nasty". On a question about recycling, he said that the cost would be more than the intrinsic cost of the materials.

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Below are some examples of architectural integration of lighting in the entirely visual presentation by *Douglas James* of **Mindseye Lighting**:

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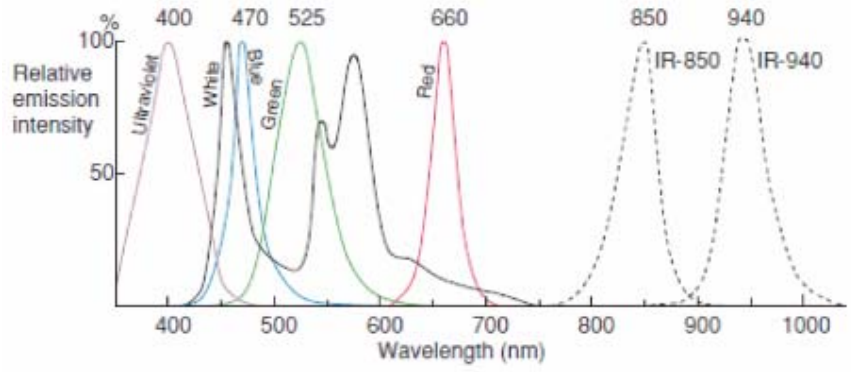
Kevan Shaw of **Kevan Shaw Lighting Design** entitled his talk “LED Technology At the Bleeding Edge!” For LED colour, each type of LED emits light in a narrow band width. That’s good for saturated colour, but is limited for RGB mixed white (*see graph*). For white LEDs, fluorescence uses a blue die with a phosphor. The combination of blue from the die and yellow from the phosphor gives visual white, but the colour is not even across LED and warmer colours are less efficient. The research goal is to create white light directly from the die. Zinc selenide is a candidate technology but not high output. There is also development of zinc oxide nanostructure semiconductors for RGB.

Binning is a much discussed aspect of LEDs. At the end of the production line measurements are made that take a fraction of a second with the device at room temperature of 25°C in a fully automated process. This is the first stage of quality control and possibly the most important. Aspects tested are colour, lumen output, and forward voltage. LED performance data are mostly measured at a junction temperature of 25°C with data

samples taken on a pulse of power too short to heat the chip. This results in an overstatement of performance and is similar to tests for binning. Bins match published criteria but do not match operating conditions. Fitting manufacturers must re-bin at operating temperatures. Out of tolerance LEDs are a problem because products made in batches may match, but each batch differs. It is difficult to replace faulty fittings to match originals especially for lighting purposes (*see photo*). Manufacturers have failed the specifier and end user, Shaw said. Manufacturers create their own standards – measurement, binning, and specification criteria. "We have to learn to interpret information presented in different formats. Do your own research!"



Temperature in the die determines LED survival, operating life, light output and efficiency. The higher the temperature the lower the life, the lower light output, and the lower the efficiency. Critical temperature is much lower than with conventional lamps. Another problem is dressed up as an advantage. The time scale of architectural projects is longer than the time for changes in LEDs. Specified products are frequently "improved" with new devices or the same device with "improved" output. This can create design problems with balance of light levels. The "best" bins of best LEDs achieve efficiency of approx. 60lm/W. But the stock of best LEDs is expensive and limited. There is no information on manufacturing performance: which bins are highest yield? What is the likely availability of specific bins at highest output and best colour? The automotive business takes all the highest bins, Shaw said in the Q&A.

Network Rail Passenger Information Display

Photographic Survey and Strategy Workshop

18 September 2008: Ambassador Hotel, London

In February 2007 UKDL completed a case study on Network Rail's Passenger Display Technologies, which illustrated the difficult task and process of developing a series of standards and specifications for use by Network Rail and its contractors to create a common protocol for display readability.

Network Rail contacted UKDL again in early 2008 to see how it could help resolve some of the issues they were having. After meeting with Harvinder Bhatia, National Telecoms Technology Engineer and Dave Carter, Customer Engineer, at the National Specialist Engineering Department, UKDL undertook a photographic survey of the different Display Technologies used on UK railway stations and agreed to arrange a strategy workshop with invited guests from industry and academia. The photographic survey indicates clearly how current display technologies are affected by sunlight and reflections and will be used as the starting point for discussions at the Strategy Workshop. Readability issues associated with constantly changing lighting conditions are compounded when the display is encased in a vandal proof box, making it very difficult for the display to meet the very specific and exacting standards required by the industry. The workshop will explore constructive solutions, and new ideas relating to the issues encountered in the dynamic and harsh environment of railway platforms and stations.

Network Rail and the Department of Transport will give presentations to set the scene. The invited delegates will be encouraged to engage in the debate to deliver display solutions achievable by the manufacturers, affordable by transport providers and usable by the public. A short movie has been put together from the photographic survey and can be viewed at http://www.ukdisplaylighting.net

Grand Challenges for Emerging Technologies

January 30-31, 2008, Møller Centre, Cambridge, England

"Grand Challenges for Emerging Technologies in Displays" was held in Cambridge in January. This was the first full-scale event organised by the Emerging Technologies. The event was summarized in the last edition of the UKDL newsletter; this edition completes the event report.

Laterally Emitting Thin Film Electroluminescent (LETFEL) Devices
Wayne Cranton, **Nottingham Trent University,** Nottingham, England

Wayne Cranton from Nottingham Trent University introduced to TFEL devices and gave a focused discussion about "laterally emitting thin film electroluminescence" (LETFEL) display technology. He also offered a summary of a project related to a sunlight readable electroluminescent display. LETFEL devices utilise the inherent light-guiding of TFEL whereby light emission is redirected via reflecting microstructures about 3 microns wide. The LETFEL technology does not require transparent electrodes and features a very high luminance (> 3000cd/m^2). Potential LETFEL applications are as a miniature high intensity see-through information display, a motorcycle or motor sport, sports scuba diving, military and public safety organisations, instrumentation and measurement, fitness and leisure (heart rate, GPS, winter sports etc.). They devices also have potential in vehicular applications as high intensity direct indicator displays.

LETFEL devices for information displays measure 4x4mm with an average pixel luminance of 500-7000 cd/m^2 (geometry dependent)

Cranton reported about the SRELD Project (Sunlight Readable ELectroluminescent Displays), which is supported by the UK Technology Programme. The program is to investigate the feasibility of LETFEL indicator displays for avionic cockpits. The aim is a generic sunlight readable display element that can be used in a "plug and play" manner. Partners in the project include: Ultra Electronics Ltd, Electrics Division, Nottingham Trent University, Central Microstructure Facility, STFC, Extec Integrated Systems Ltd, and Qudos Ltd.

A different view of the future: "Path to What the Eye Demands"
Mark Fihn, **Veritas et Visus,** Temple, Texas

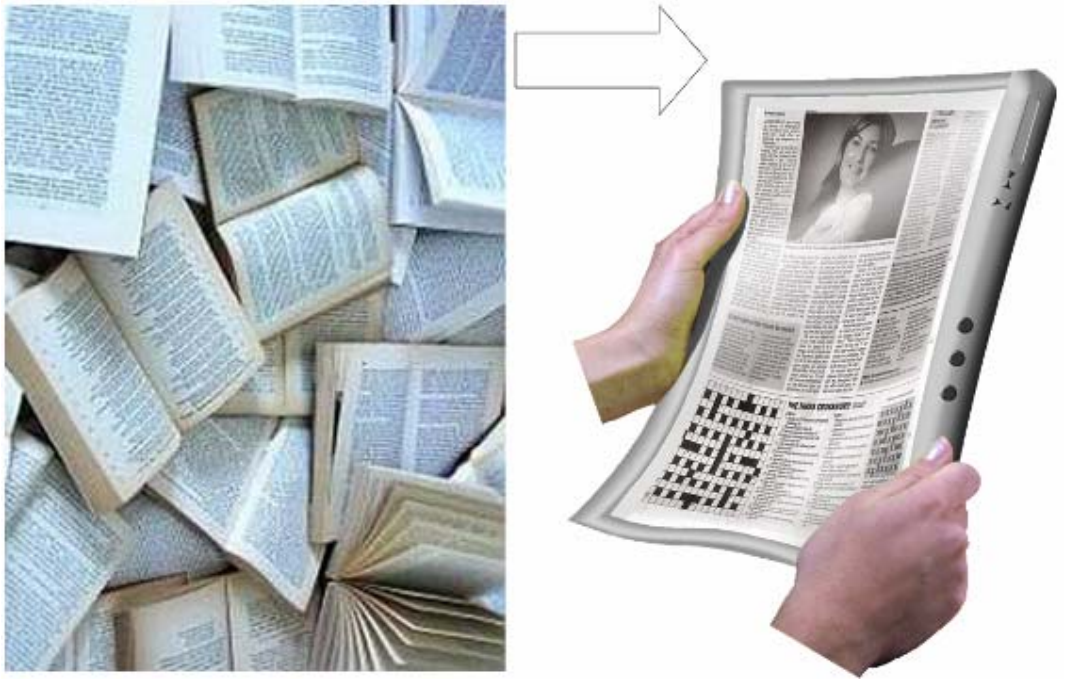
Mark Fihn from Veritas et Visus gave a talk that started with a discussion about the problems of forecasting the future of the display industry accurately. He asserted that many forecasts fail to incorporate human factors considerations linking the human visual system to display performance are likely to be flawed. The future of displays is inextricably linked to the capability of the human visual system. As such, Fihn reviewed facts related to the human visual system and applied them to performance capabilities and shortcomings of display technologies.

Based on information related to such things as visual acuity/resolution, motion blur, contrast, and color gamut, Fihn concluded with some discussions related to next generation display devices, particularly related to 3D display technologies, display aspect ratios, panel size, and higher resolution displays.

"I wish that I knew what I know now when I was younger": Musings on the songs of Rod Stewart
Stuart Evans, **Independent Consultant,** Cambridge, England

Stuart Evans gave an entertaining talk that reviewed many of his personal experiences in the world of electronics, particularly his role at Plastic Logic. He offered several "laws for success in hi tech start-ups":

- Find customers from the start – preferably early adopters you can learn from in all sorts of ways. But you want them to have a greedy eye on the Big Prize and be able to put up cash to help make it happen.
- Remember a proof of concept is not a prototype, never mind a product – the difference is often several years and tens of millions. Just read any good book on the Product Creation Process.
- Watch out for the Big Prize – it will keep changing so you have to be nimble. But it motivates the team when the going gets hard. Which it will.
- Keep innovating and inventing – most effort ends up on gritty real world engineering. But if your first invention is your last, you are doomed.
- Build teams within teams – creating a massive new industry is a big job, and you can't build an ecosystem on your own. Build teams from employees, investors, customers, suppliers, governments and universities.
- Focus on industry structure – mandatory to understand this; shape it if you can. Analyse this before you think of business models.
- Search for low cost capital – you want the right price, terms, value and patience. Need funding to start and grow. When/where to IPO?



Evans remains one of the industry's most outspoken supporters of the plastic electronics revolution, suggesting that electronic paper will increasingly displace books: "Coming soon to a bookshop near you"…

Evans added several additional commentaries about other "lessons learnt along the way":

- Working with journalists
- Working with financiers (bankers, investors and hybrids)
- An exit is not the end
- Shareholders: a privilege or a burden?
- Press releases: gospel or propaganda?
- Understanding the life cycles of VCs
- Directors vs. Vice Presidents
- How Boards of Directors really work

Reflective colour – challenges
Adrian Geisow, **HP,** Bristol, England

Adrian Geisow from HP discussed various problems associated with reflective colour display technologies, particularly related to colour and contrast. While reflective technologies have tremendous advantages in terms of power consumption and are ideal for monochrome text-based solutions, efforts to achieve acceptable colour levels have not yet been successful. Stacking solutions are fraught with problems, but seem to be the most likely path to achieving an acceptable reflective colour display.

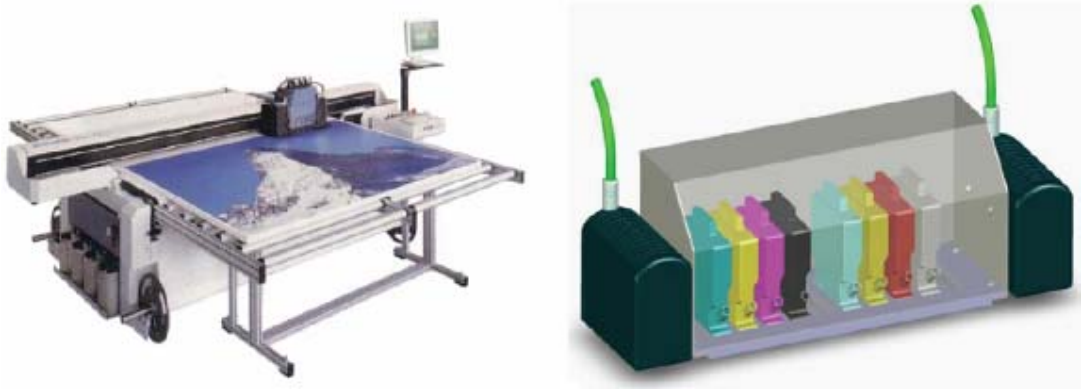
Micro manufacture by printing
Tim Claypole, **Welsh Centre for Printing and Coating,** Swansea, Wales

Tim Claypole from the WCPC discussed the advantages of printing displays, including points related to additive manufacturing processes, high volume output, disposability, large area capabilities, low capital costs, use of flexible substrates, and low energy consumption in the manufacturing process. Advanced high volume manufacture for printing graphics and packaging requires advanced micro-manufacturing. Things like the economics of speed (minimizing non-productive downtime), registration, sensitivity to process variation, and line edge details are all very important for these applications. Challenges associated with printing displays are related to eliminating discontinuities and film thickness variations, achieving higher resolutions, printing at < 50µm levels, improving registration, achieving good quality assurance at line speeds, using active materials to make inks, processing at low temperatures and high speeds, nanoscale rheology, and reducing costs.

Printing presses enable roll-to-roll production at a rate of 80m/minute on a 600mm web

Inkjet Printable, Ultra Violet Curable, Organic Electronics
Stephen Clemmet, **Polymertronics,** Oxford, England

Stephen Clemmet discussed the development of UV Inkjet OLED, a blend of OLED, UV-curable resin, and a photo-initiator. Properties include high durability and very fast curing, enabling zero lead-time for production, OLEDs printable with UV-curable colour graphics, and the ability to retrofit to existing UV-inkjet printer platforms Clemmet also discussed issues associated with longevity, irradiance, and conductive polymers.

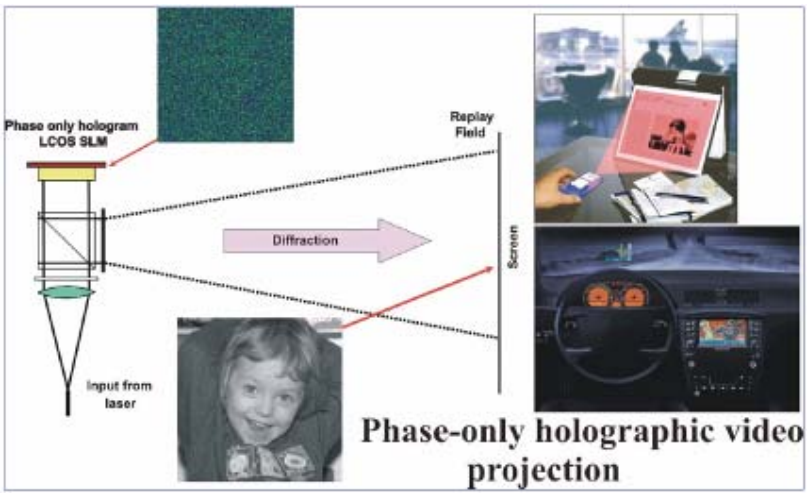


Polymertronics's technology can be utilized on 12,000+ existing flatbed and roll-to-roll platforms using a CMYK OLED printer carriage with 10 print-head slots and 2 UV lamps. The current implementation supports fast, bi-directional printing using printheads with 250+ inkjet nozzles per print head at droplet sizes of 1-10 pico-litres.

CIKC Project 'PASSBACK': 'Photonic & Sensing Systems based on CMOS Backplanes'
Bill Crossland, **CIKC,** Cambridge, England

Bill Crossland from Cambridge University discussed prototype development under the PASSBACK program, (Photonic & Sensing Systems Based on CMOS Backplanes). Three different areas are under investigation:

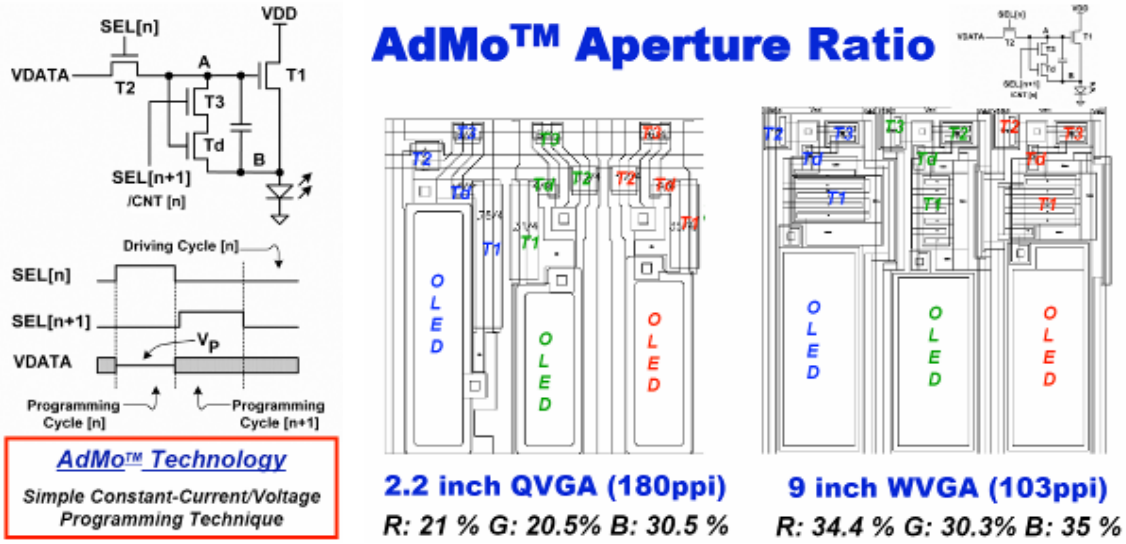
- Holographic projection engines for micro-projectors, where business development is in-hand via industrial partner (ALPS).
- WDM add-drop multiplexer for the metropolitan network; commercialisation process within CIKC
- Explore Lab-on-a-chip techniques for the control and identification of particulates e.g. virions, proteins and DNA strands. This effort is still speculative – IKC role is technical validation.



As part of the PASSBACK program, the CIKC has developed a phase-only holographic video projection system with industrial partner ALPS. On the right is the Wyko NT1100 3D optical profiling system that utilizes optical phase-shifting with white light and vertical scanning interferometry

Low-Cost Stable a-Si TFT Backplanes for AMOLED Displays
Arokia Nathan, **London Centre for Nanotechnology,** London, England

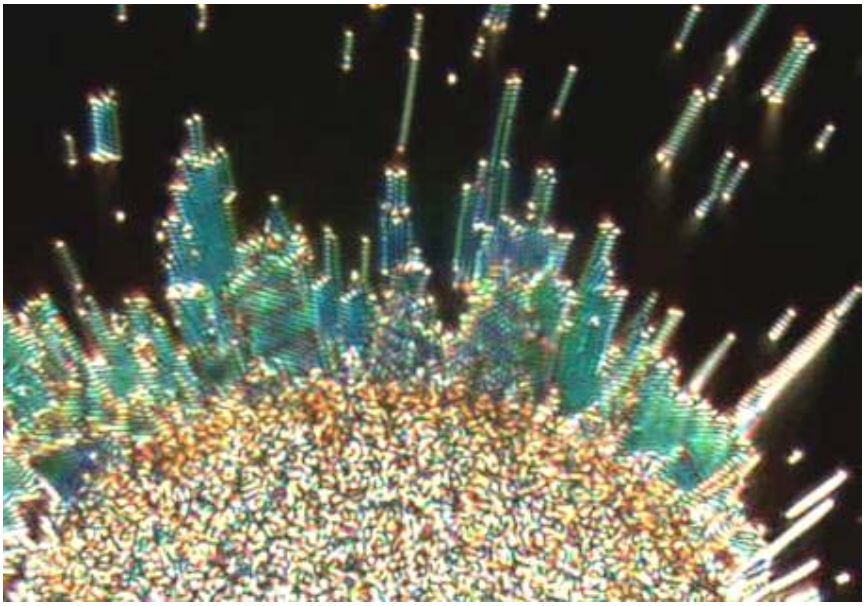
Arokia Nathan from the London Centre for Nanotechnology talked about charge-based compensation for advanced mobile technology dubbed as AdMo technology. The technique involves a programming cycle where the node A is charged to a voltage consisting programming and compensating voltage and a compensation cycle where there is a discharging part of voltage at node A through Td. The discharged voltage is a function of VT shift.



The Admo technique utilizes a novel pixel structure with variable sub-pixel sizes

Electrically Tunable Photonic Crystals for Display Applications
Chris Bower, **Kodak,** Cambridge, England

Chris Bower described Kodak's development of tunable colloidal crystals where they actively control the lattice spacing of colloidal crystals using time dependent e-fields. The solution is liquid-based and enables fast switching times using field sequential colour. The technique utilizes low-cost, non-toxic materials and is constructed using a simplified architecture with a single layer structure where red, green, or blue can be derived from a single pixel. Kodak has demonstrated electrically tuneable photonic crystals in liquid solution in various geometries, including quadrapole and parallel plate. The wavelength range is approximately 200nm, at a speed of 100ms to 0.5ms. Kodak has developed a model of colloidal interaction and optical response.



Illumination with white light at 33 degrees; objective lens numerical aperture 0.28. World's smallest fibre optic cable?

EPSRC Funding Opportunities
Nicolas Guernion, **EPSRC,** Swindon, England

The Engineering and Physical Sciences Research Council is the main UK government agency for funding research and training in engineering and the physical sciences. The EPSRC invests over £800 million a year to prepare the UK for the next generation of technological change. According to Guernion: "Our vision is for the UK to be the best place in the world in which to engage in research and innovation" EPSRC investment routes include funding to universities, training to support individuals, and partnership with industry and other stakeholders. With regard to the electronics sector, the EPSRC is heavily involved, as outlined below:

EPSRC **Remit of EPSRC Electronics Sector**

Examples of research areas include:

General: electronics, optoelectronics, photonics, electronics manufacturing, components, devices, subsystems, circuits, integrated circuits (ICs), Very Large Scale Integration (VLSI), Printed Circuit Boards (PCBs), interconnects, packaging, electronic.

Magnetics and data storage: sensors, actuators, memory [e.g.MRAM].

Semiconductors: Silicon (Si), compound semiconductors, Group IV semiconductors, III-V semiconductors, II-VI semiconductors, organic semiconductors, inorganic semiconductors, gallium arsenide (GaAs), gallium nitride (GaN), silicon carbide (SiC), silicon germanium (SiGe).

Processing: growth, deposition, lithography, ion implantation, etching.

Displays: LCD (liquid crystal display), LED (light emitting diode).

Devices: MicroElectroMechanical Systems (MEMS), microsystems, transistor, diode, logic (analogue, digital, mixed-signal), deep sub-micron (DSM), wafer, System-on-Chip (SoC), CMOS, MOSFET, spintronics, single electron transistor (SET).

Design: electronic design (including test, verification, synthesis), EDA, design tools (e.g. CAD), electronic product design.

Physics and materials: quantum information processing (devices and circuits), molecular electronics (bulk and single molecule devices), optical switch, optical amplifier, electronic structure of materials, superconductors, ceramics/electroceramics, diamond.

How to accelerate the growth of a company
George Whitehead, **NESTA Investments,** London, England

George Whitehead described NESTA's "angel" investment activities. NESTA invests in early-stage companies, those still in a start-up stage. Whitehead emphasized that of primary importance to them is an indication from early-stage companies that they truly understand the end-use customer for their products. There's a need to prove that someone will really buy the product once it's built. He also emphasized the need to get a competent mentor or advisor to help "ground" the start-up aspirations and to encourage an appropriate level of risk-taking. He also warned that technical development is just one milestone measurement necessary to build a successful company. .

Proof of Concept VC Funding
Mark Rahn, **Enterprise Ventures,** Preston, England

Mark Rahn from Enterprise Ventures reported that proof-of-concept investors look for 10x returns, so they are focused on finding a team that can deliver such returns. A ready-assembled expert team implies a high valuation. It's better to invest in no team rather than a bad team, while a good team can be assembled around a good idea if the inventor/founder is enlightened to team development. He advised that investors typically require a significant minority equity stake, powers, and board representation. Ongoing, a business plan and strategy must be agreed at the outset. In the proof of concept phase, the business plan and strategy are in constant flux, which is OK, but the Board must watch for "strategic creep". VCs can help ensure that a plan is put in place to address any shortcomings. But of course the primary thing that VCs provide is cash, which ultimately enables things to get done.

Technology Strategy Board
Nick Appleyard, **TSB,** Swindon, England

Nick Appleyard gave an overview about the activities of the Technology Strategy Board. With regard to the UKDL KTN, he reviewed funding opportunities associated with Advanced Lighting, Lasers & Displays, Technologies for Health, Low Carbon Energy Technologies, and Gathering Data in Complex Environments. Specifically in the area of Advanced Lighting, Lasers, & Displays, the scope of TSB support includes:

- Electronic, packaging, and optical coupling techniques to enable reliable, sustainable, cost-effective, high-brightness, quality, high-efficacy organic and/or inorganic general and task lighting systems as well as mood lighting, indicator lighting and display lighting systems.
- Research, development and design of advanced diode and non-diode laser systems such as solid-state and fibre lasers and their innovative use in healthcare, manufacturing and other applications.
- Integration of component technologies to provide physical proofs of principle and demonstrations of practicality. Proposals could involve advances in thermal/power management, packaging technologies, improve optical extraction technologies, driver integration or other techniques.

Finance rules include:

- TSB will fund a maximum of:
  - 75% of Basic Research work packages
  - 50% of Applied Research work packages
  - 25% of Experimental Development work packages
- and a maximum of:
  - 100% for Universities [that's 100% of 80% FEC!]
  - 60% for SMEs
  - 50% for larger companies (>250 employees)
- Eligible costs are detailed in the Guidance for Applicants.
- Any public sector contribution (e.g. RDA, EU, NHS) counts as part of the grant, not part of the matching contribution.

Report on SID Display Week

by Robert Simpson

Robert Simpson is founder director of the Electrosonic Group, and a retired director of Helvar (an international manufacturer of fluorescent lighting ballasts and dimmers). He is the author of the industry textbook "Lighting Control – Technology and Applications" (Focal Press 2003). He is an associate member of the Institution of Lighting Engineers, and a member of the Illuminating Engineering Society of North America.

The Society for Information Display's main annual event is "Display Week". This encompasses a trade show, a symposium with up to eight parallel tracks, a business conference, an investors' conference, a seminar programme, applications tutorials and short courses on fundamentals. Thus any report on the event can only be selective. Here I cover things that I found of interest (and that I could more or less understand!) but make no claim to completeness. It should also be understood that the SID event, with its 290 oral presentations and 260 poster presentations includes much that is speculative, or embryonic – and this even applies to exhibits on the show floor, which are mostly prototypes. Therefore it cannot be assumed that all the items I mention will actually come into production.

3D Cinema: An unusual (for SID) special event was an afternoon session devoted to 3D cinema. This was supported by a Barco cinema projector equipped with the RealD filter. As a reminder, in today's digital cinema world 3D movies are stored as files with left and right eye images stored alternately. The underlying frame rate is 24fps, so together the original material runs at 48fps. This is too slow for viewing, the flicker would be intolerable. So each image is shown three times, resulting in a projected frame rate of 144fps. In the RealD system a fast electrical switching filter changes the plane of polarization of the projected light, so all left eye images have one type of polarization, and all right eye images have its opposite. Viewers wear suitable passive glasses to see the end result.

The audience was treated to extensive clips from "U2 3D", "Beowulf" and "Kung Fu Panda". In addition, live action sports sequences and other demonstration material was shown. The results were impressive – I was particularly struck by the fact that viewing was "comfortable", and that I would be happy to watch full-length movies presented this way. From the accompanying talks it became clear that this was due to a number of factors, in particular:

- the high frame rate
- the low crosstalk between left and right images. In some shots there was evidence of ghosting, but this was minimal.
- the avoidance of "gimmick" or "stick in the eye" images and unnatural image compositions (especially "out of frame" artefacts, where, due to poor composition, parts of images seem to be outside the screen boundary).

DreamWorks: Phil MacNally of DreamWorks Animation used the clip from "Kung Fu Panda" (which, he emphasized, would not actually appear as a 3D movie – the sequence was developed by DreamWorks to gain experience in 3D production) to illustrate several important points. He regards "3D" or, more strictly stereoscopic, images as providing a "fantasy space" that is neither 2D nor real life. Even though it is technically possible to derive 3D images from 2D images, this is unsatisfactory for some scenes. Some depth cues in 2D images (especially standard effects like defocused backgrounds) simply don't work when translated to 3D. DreamWorks Animation has now announced that all its animated movies from 2009 onwards will be available in both 2D and 3D.

Sony Pictures Imageworks: Rob Engle from Sony Pictures used "Beowulf" as his example. This film is a combination of live action (presumably blue screen) and CGI. He commented that "contrast was not his friend" because with bright foreground images, and very dark backgrounds (e.g. in torch-lit scenes) some crosstalk (ghosting) was inevitable. Thus scenes had to be tweaked to minimize the problem. He explained the use of "virtual multiple cameras" to make some scenes look natural. Scenes where characters were in foreground and background simultaneously were difficult to make look natural, and needed to be composed as if the

foreground and background figures had been shot with cameras with different focal length lenses. He emphasized the need to fully understand how the movie would be shown. Ideally the files for single projector and dual projector presentation would be different. 3D IMAX was a special case, allowing more latitude because the image fills the field of view. Engle issued a plea to the display community to provide suitable displays for preview during post-production. At present a hodge-podge of different methods, ranging from simple anaglyph glasses to fully equipped screening rooms is used. Sony Pictures have also had to have their "Maya" production platform modified to support 3D.

3Ality: John Ridell of 3Ality explained that his company specialized in live action 3D. Until recently this was mainly sports events, including car racing and American football. However, a new and successful venture was concert material, with U2-3D being the major example. He reiterated the point that, "Bad 3D gives you a headache". With live material it was essential to minimize discomfort by addressing the problems arising from:

- imperfect synchronization of the two images
- imperfect alignment of the two images (whether when shooting or projecting)
- differences in chroma/luma performance between the two channels
- differences in taking lens performance
- inappropriate image separation

It was clear that, in the case of U2-3D, a lot of post-production work had been done on the original footage to achieve the very effective end result. Riddell made the point that commercial broadcasts of major sporting events in 3D would be being relayed to suitably equipped cinemas this year.

Quantel: Representatives from Quantel gave an impressive demonstration of their 3D post-production suite. The live demonstration showed how some of the problems identified by John Riddell could be quickly "fixed" in post-production – especially artefacts arising from channel differences. Quantel's point was that their system that made 3D production fit into familiar workflow patterns, and minimized the overhead associated with 3D.

Dolby: This was really disappointing. Dolby has a single projector 3D system that in theory could rival the RealD system. Given the technical audience one would have expected a good description of the technical basis of their system, even if it was not practical to run a demonstration. In the event their representative gave a very short and not very informative talk, so I don't know what progress they are actually making. The Dolby system uses the Infitec color filter system to achieve separation. It is notable for its almost complete absence of crosstalk, and for not depending on the use of polarized light.

Real D: Rod Archer of RealD announced that RealD had so far equipped 1225 cinemas with the system. They had just received an order from Regal Entertainment for 1500 systems, and had other orders for 750 more. RealD is developing its system to produce more light, and its new XL product should be available later this year. Presumably this involves some kind of "light re-circulation" to convert the rejected light to light of the correct polarization. The RealD system uses circular polarization. Archer identified around 20 movies that are either already in production or are due to be produced in 3D within the next year or so.

3D in the home: Out on the show floor the idea of 3D in the home was being promoted. While the display technology already exists, it is unclear to me how the media is going to be delivered to consumers – presumably some variant of DVD/Blu-ray that allows two transport streams. The "home" technology is based on having displays running at 120Hz, with alternating left and right eye views (i.e. 60Hz each). The displays are viewed using active shutter glasses. One example seen at SID (also seen at NAB) is the Samsung 61-inch rear projection TV (based on DLP technology with LED illumination) that retails for only $2100 and is only 11 inches deep. The additional cost for the shutter glasses and the IR synchronizing box is expected to be only around $150. Flat screen displays operating at 120Hz are also suitable for this application.

Sony GLV projector: Sony gave an interesting paper describing the latest developments in its G×L (say G-by-L) projector. This is still a prototype and no plans have been announced as to its commercial introduction. Sony's first public demonstration of the use of the Grating Light Valve was at EXPO 2005. Since then Sony has re-directed its efforts towards a projector for visualization and simulation applications. Specification of the new projector includes:

- Light output: 1000 lumens
- Contrast ratio: 30,000:1

- Laser wavelengths and power 642nm (12W). 532nm(3x2W), 445nm(6W)
- Standard image 1920x1080 at 240 frames per second
- Wide image 3840x1080 at 120 frames per second
- Panorama image 7680x1080 at 60 frames per second

The wide and panorama images are achieved by an auxiliary five-facet polygon mirror rotating at 1440rpm. While the standard image is intended for a flat screen, the wide images are intended for cylindrical screens. The new projector is based on a new version of the GLV (which Sony described in a paper for SID 2007). Its design enables a higher contrast to be achieved and, by using tilted grating elements, it has a higher diffraction efficiency of around 70%. Bit depth is 12 (compared to the earlier version's 10). In a separate paper the Air Force Laboratory describes an evaluation of this projector for simulation purposes. Interestingly the comparison was with CRT performance. The Air Force liked the projector, but recommended use of 240Hz operation to completely eliminate motion tracking blur.

LCD displays: The themes here were "Bigger", "Faster", "Greener", "Blacker" and "Thinner". The following gives representative examples – there is no implication that the manufacturers mentioned are the only players for the devices described.

Bigger: "Bigger" was represented by Samsung's very impressive 82-inch display with 3840x2160 (quad HD) resolution. While I have admired the 56-inch displays of this resolution (now available from several vendors) I have always thought that they are too small. 82-inch is a much better size for the group viewing of high resolution images. The Samsung display operates at 120Hz.

Faster: "Faster" was represented by the concentration on displays running at 120 frames per second. A problem with large displays is motion blur, and several papers were devoted to the subject, both defining the problems and proposing a variety of solutions. The main problem arises with LCD displays, because the "hold" time is long, and, on big displays, a fast moving object moves a considerable distance between frames. The initial solution is to use impulsive drive to reduce the hold time, but this introduces the unfortunate side-effects of flicker and a reduction in luminance. Then the idea is to increase the frame rate, but if this is done by simple frame repetition, motion artefacts result. One of the current "ideals", described in a paper jointly presented by AMD and Samsung, is to interpolate completely new frames in between the original 60Hz images using motion estimation and motion compensation. This sounds a simple statement, but it involves an extraordinary amount of computation – the paper casually remarks that the AMD MediaDSP platform used carries out one trillion operations per second. The paper announced that the majority of Samsung's big (40-inch – 56-inch) LCD TVs will have this 120Hz interpolation feature by the end of 2008. It is incredible that a consumer TV will embody the computing power of a main frame computer of only a few years ago.

Samsung's 82-inch 3840x2160 display

Greener: "Greener" was represented by new illumination systems. Comments that the new generation of flat screen TVs use much more power than the CRT sets they replace have been taken seriously by the display manufacturers, and at SID everyone wanted to show their green credentials, and in many cases demonstrate that they can get the power used down to the "old" levels. Solutions all depended on sophisticated, controlled, backlighting. While great improvements have been made in CCFL (cold cathode fluorescent lamp) backlighting – which remains the norm, the big advances arise from the use of LED backlighting which allows more control possibilities. Some manufacturers had displays with "power meters" showing instantaneous consumption. LG had a particularly interesting demonstration that compared best "conventional" backlighting that gave 500cd/m^2 with 185W backlight, with the latest "three way dimmed" LED backlight that used only 95W average, but by

varying the backlight power could deliver up to 1500 Cd/m^2 peak luminance for parts of the picture that needed it. LG pointed out that when watching films the average screen luminance required is only around 35% of peak, whereas when watching sports this may jump to 70%. The only problem I can see with this development is that we shall be right back in CRT projector country when it comes to claims of display luminance – expect to hear of displays with 3000 cd/m^2, and, in very small letters "5% peak".

On the left, the LG booth (in common with others) was keen to demonstrate its green credentials with power meter displays to show the reduction in power consumption achieved by backlight dimming. On the right, the Dolby HDR demonstration showing HDR and "standard" displays side by side.

Blacker: Backlight control leads to a greater overall contrast ratio and therefore "Blacker" pictures. For example the company AUO from Taiwan was demonstrating prototype LCD displays with claimed 20,000:1 contrast ratio using dynamic backlight control. The most sophisticated backlight scheme appeared to be that offered by Dolby. Dolby's claim is that a standard CCFL illuminated LCD display has a contrast ratio of around 1500:1, but the contrast ratio of the best "local dimming" technologies offered by the display manufacturers is in the range 8,000:1 to 20,000:1. Dolby's HDR (High Dynamic Range) technique is claimed to give contrast ratios exceeding 100,000:1. It achieves this by having a multiple LED backlight that itself produces a low resolution "luminance image" of the displayed picture. Instead of only a few backlight zones, it uses "pixel like" zones, giving a far wide range of control and the equivalent of 16-bit colour. Dolby announced at SID a partnership with Sim2 of Italy, whereby Sim2 is embodying HDR technology in its top of the range TV's (based on Sharp glass).

Thinner: All the LCD manufacturers were keen to show that they could make really thin displays. AUO's prototype large screen LCD display with LED backlight was only 13.8mm thick. This was trumped by a small display from CMO, a 13.3-inch WXGA display that was only 3.7mm thick!

OLEDs: With regard to OLEDs, of course thin displays are expected to become the norm as active matrix OLED displays come onto the market. While huge progress is being made, it is not easy to determine how soon AMOLED will have a significant market. There are still process issues, and the huge existing investment in TFT LCD displays will be a barrier. However the low-power consumption, high-contrast, good colour rendering and thin form factor make it a very attractive technology.

4.3-inch diagonal full colour OLED display made with DuPont materials and Dai Nippon equipment.

A significant announcement at SID came from a joint development between DuPont and Dai Nippon printing. This links DuPont's solution process OLED technology with Dai Nippon's printing expertise, and the aim is to deliver integrated manufacturing equipment for the mass production of AMOLED displays. However, the initial offering will be for comparatively small displays (I was told "up to Gen 4.5 glass") ideal for markets like the automobile market, but not big enough for TV.

But once again it was Samsung who was throwing down the size challenge, showing what was claimed to be the "world's largest AMOLED display" at a 31-inch diagonal.

The possibility of making flexible displays using OLED technology was demonstrated in a prototype jointly presented by LG and materials manufacturer Universal Display. This featured Universal's FOLED technology for flexible displays and was in the form of a miniature TV with curved screen.

On the left are samples of Samsung's 31-inch AMOLED display. On the right is a prototype from LG Display using Universal Display's OLED materials demonstrating the flexibility of the technology.

Light sources for projection: The subject of light sources for projection received a lot of attention. However, this is an area where claims need evaluating with some caution.

Matthew Brennesholtz of **Insight Media** gave a useful review of the current state of play. Briefly his paper can be summarized as saying:

- UHP lamps are the dominant light sources for projectors in the "mid lumen" range, using lamps in the range 100 – 350W. Problems with arc-jump have been solved by, for example Philips and Ushio, by special ballasts. Philips has also introduced special ballasts to improve colorimetry with the UHP-DLP combination. Philips has demonstrated the 50W Ujoy lamp for 250 lumen projectors, and the 900W CPL (Compact Power Lamp) for high power projectors, but neither is in commercial products yet.
- Xenon lamps remain the favourite for high power projection because, despite their comparatively low efficiency, they have the best optical and colour rendering properties for this application (especially cinema).
- Electrode-less lamps (lamps that use microwaves to maintain a plasma within a quartz envelope) have the potential for long life and good colour rendering (since it is possible to fill the bulb with any gas mixture, now not affected by the presence of electrodes). Take-up here has been slow, with the only significant reported application being a Panasonic rear projection TV (thought to be using Luxim technology).
- LEDs are expected to have a significant impact. They have good colorimetry and are suitable for low output projectors. Their disadvantage is high étendue and sensitivity to temperature. At present price is also an issue at higher powers. - Lasers have great potential because of their low étendue and large colour gamut (if the right wavelengths are used). They are likely to be the preferred choice

for “pico” projectors, but may also be found in mid-range products. Some specialist products at the high end of the visualization and simulation markets (e.g. from Sony, Evans & Sutherland and Jenoptik) user laser illumination. (étendue is a geometric property related to the area of a light beam and its divergence. A device, such as a DMD modulator, with small angular acceptance has a low étendue. An LED source may have high étendue, meaning that it cannot effectively be coupled to a DMD – the excess light is wasted. It is always the part of an optical system with the smallest étendue that determines how efficiently light can be used).

LEDs: Despite the initial problems, LED manufacturers are targeting the projection market with designs that overcome the thermal and optical coupling problems. Luminus Devices developed the PhlatLight LED array based on the “photonic lattice”. This has allowed the development of a source that can couple to micro displays, and chipsets have been developed for the Rear Projection TV and miniature projector markets. The PT120 chipset gives 3000 lumens in continuous operation or 2000 lumens in pulsed (colour sequential) operation at 8000K color temperature.

Incidentally Luminus Devices won the Gold Award for the SID “Display Component of the Year” for their development of an LED backlight unit for LCD displays based on its PhlatLight technology.

Osram was actively promoting its LED technology for projection applications. Interestingly it did so by showing a prototype desktop panoramic display (from Ostendo, but badged NEC) that first appeared at the CES show earlier in the year. The display gives a 2880x900 seamless image on a 1026x320mm screen using LED illuminated DLP projectors.

The Luminus Devices PhlatLight LED chip used in RPTV applications is pictured on the left. On the right is a prototype desktop panorama display using Osram LED illumination. The system is expected to be available Q4’08.

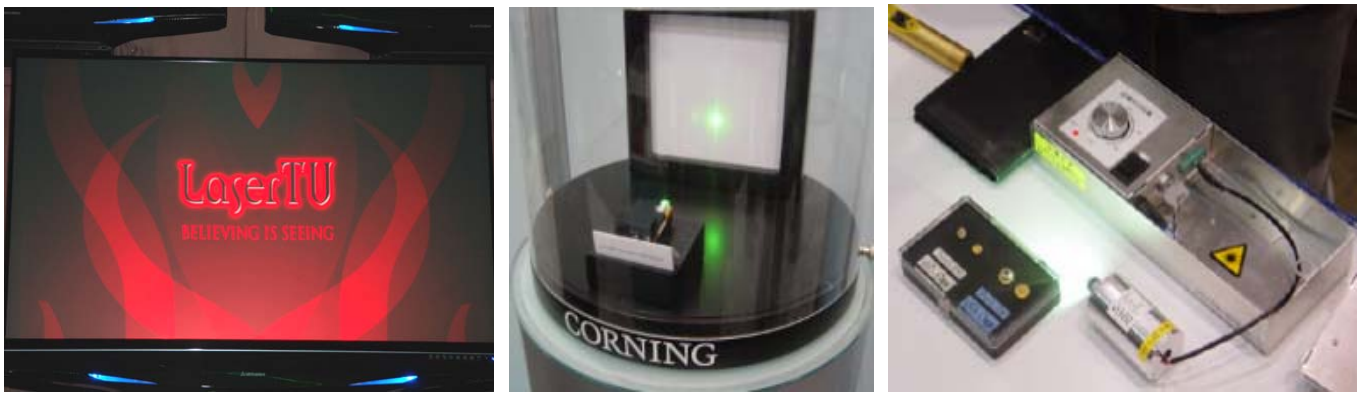
The most bullish estimate of the impact of LEDs on projection came from Ken Livesay, marketing director of Goldeneye Inc. He reckons that in 3-4 years that LED illumination will have completely displaced conventional lamp technology in the low-medium light range (say up to 2000 lumen) projectors. Goldeneye is offering chipsets employing its “light recycling cavity” technology, claimed (by virtue of improved étendue) to deliver twice the light output per unit area compared with LEDs in a flat array. But I was not able to establish whether the technology has yet been adopted for a significant volume product.

Lasers: Some of the things that grabbed my attention in respect of laser technology were as follows:

- Mitsubishi gave an interesting talk about its development of a 65-inch TV using laser illumination. The prototype is only 255mm deep. This is the culmination of several years work. Although the presenter was careful to say that there were no official plans for the commercialisation of the product he talked about, it is a fact that Mitsubishi did announce earlier in the year that it will have laser TVs on sale by year end. Mitsubishi’s paper emphasized the importance of the development of the green laser to the success of the project (in fact Mitsubishi gave a separate paper describing this laser). The prototype TV has a colour gamut 208% of that of ITU-R BT.709 and this introduces an interesting problem of compatibility with actual video signals. Mitsubishi uses its “Natural Color Matrix” (NCM) image processing technology to solve the problem.
- Corning presented a paper on its development of a compact green laser. Such a device is essential

for some kinds of pico-projector. At present red lasers used in DVD players and blue lasers used in Blu-ray players can form the basis of lasers suitable for projection, but there is no sensibly priced green laser. Corning's new green laser is based on the output of an IR 1060nm laser being fed through a second harmonic generator (frequency doubler) to give 530nm green. The problem is getting effective coupling between the two elements, which can be affected by temperature. In Corning's new device the alignment problem is solved through the use of SIDM (Smooth Impact Drive Mechanism) devices from Konica Minolta. These piezo-electric based devices (also used for auto-focusing in cell phone cameras) keep the optical system in perfect alignment regardless of temperature.

- Nichia presented an interesting one-watt blue laser diode. This device provides one watt at 445nm and has a projected life of 30,000 hours. The presenter stated that Nichia's next target was a green laser of comparable performance – but in the meanwhile he showed a sample of the blue laser equipped with phosphors to produce a white light. This was very impressive, and it could be imagined that such a device could form the basis of a white light projection source.
- QPC Lasers set out its stall as a supplier of a full range of lasers to match all projection requirements from pico to auditorium. QPC is already known as a supplier of high power lasers, but this has been to traditional laser markets. It will be interesting to see if it can match the price expectations of the volume markets. QPC claims that its "Brightlase" technology allows the laser and frequency converter to exist as a single package, avoiding alignment problems.



On the left, is an image of the LaserTV described by Mitsubishi (not actually shown at SID); in the centre, Corning's new green laser incorporating adaptive optics on show at SID; and on the right, Nichia's white light laser demonstrator.

Pico projectors: "Pico projector" is now the accepted term for very small hand held projectors that are available either as a stand-alone device or as an item built in to a cell phone or PDA. Currently prototypes of such projectors have light outputs of only a few lumens, but the optimists foresee three figure lumen outputs in the medium term. Clearly an important criterion is power consumption, and it is generally agreed that this must be small enough to allow a two to three hour battery life. The initial street price of such projectors is expected to be around $300. There is much hype, but it is doubtful if serious product will appear before the later part of 2009.

- 3M actually does have a product which OEMs can buy, and gave a paper at SID describing it in some detail. My own opinion is that the light output is a bit too low for practical use; however useable images up to around 35cm wide should be achievable in darkened surroundings (3M claim images up to 50-inch diagonal). The specification is interesting:
    - Light output: 5.6 lumen
    - Checkerboard contrast: 80:1
    - Resolution (RGB) 640x480
    - Module size mm: 43.7 x 34.0 x 12.5
    - Weight: 21g

The 3M CF-! mobile projector module

- Luminous efficiency: > 5 lumen/W

The technology can be regarded as “miniature conventional”. The projector is based on a colour filter LCOS display panel from Himax Display. Illumination is by a high brightness white LED with special collection optics to reduce the angular output. 3M’s expertise in thin film optics and plastic moulding has been used in the design of the miniature polarizing beam splitter and recycling optics.

- Displaytech gave an excellent paper describing possible architectures for “pico” and “personal” projectors based on the use of Displaytech’s fast switching ferro-electric liquid crystal on silicon (FLCOS) microdisplays. Here illumination is by separate red, green and blue LEDs operating sequentially. The paper tabulates results using different LED assemblies from Osram, LumiLeds and Luminus, showing that:
  - the most compact package for an embedded projector would use Osram OSTAR giving 7.5 lumen from 2.1W
  - the most efficient package for an embedded projector would use LumiLeds Rebel giving 9.0 lumens from 1.4W
  - a bright “companion” projector could use Osram Diamond Dragon to achieve 17.8 lumens from 4.4W
  - a small stand-alone projector could use Luminus PT54 to achieve 110 lumens from 42W

  Displaytech is working with OEMs on actual projector products. As I understand it the first of these was announced just before SID in early May. This is the “Sunview” portable media player (PMP) being introduced by iView Electronics of Hong Kong.

- Microvision highlighted another school of thought reckons that laser illumination is more suitable for pico projectors because potentially it simplifies the optical system and can be more efficient. A working example was shown on the Microvision booth, with the claim that product would be available in Q4 of 2008 (others in the industry were not so sure indicating that there were still supply problems to overcome). Resolution is stated as 848x480 and light output as 10 lumens. Battery life is 1.5 hours per charge and the device can be powered and charged from a USB port. The Microvision prototype projector. Below it in the showcase are examples of the MEMS scanning mirror device.

The Microvision SHOW pico projector prototype uses a single bi-axial scanning mirror assembly. This is a MEMS device, and the mirror is only one millimeter in diameter.

- Light Blue Optics: as might be expected, the standard of presentation at the SID Symposium varies enormously. But someone who would be a finalist in the “Best Presenter” award if there was one would be Dr Edward Buckley of Light Blue Optics. (In fact he gave two papers, the first of which was recognized as a “Distinguished Paper”, and the second, referred to here, was an “Invited Paper”.) He gave an excellent paper entitled “Holographic Laser Projection Technology” which was notable for the clarity of its exposition. The paper described the theoretical basis of Light Blue Optics’ projection engine. It takes a completely different approach to projection, which becomes possible when laser illumination is used. Instead of using a modulator that carries a complete image (as might conventionally be done with a DLP or LCOS microdisplay) the idea is that the modulator carries a hologram of the image. This is possible if the modulator can change the phase of incident light, which LCOS can (but DLP cannot). When the hologram is illuminated with coherent laser light, diffraction causes the reconstruction of the original image. Clever points here are that the light is used efficiently (i.e. light is not blocked as with normal imagers, but is directed to where it is needed) and that no focusing optics are needed – the image is always in focus. Another significant point is that, as the light leaves the modulator as a complete conventional image, the intensity of the light is moderate. There is no safety issue as there can be with scanning systems above quite a low threshold. Light Blue Optics (LBO) from Cambridge (UK) – and now also based in Colorado Springs in the USA – invented algorithms for the very rapid transform of pixel data into the

corresponding hologram data. LBO also invented the technique of presenting hologram sequences very rapidly (kHz rates) as a means of eliminating hologram quantization noise. FLCOS modulators have the right characteristics for hologram display and are also very fast, so it is no great surprise that LBO is currently using Displaytech's FLCOS displays as the optical basis of its projection engines. Edward Buckley's paper also addressed the problem of laser speckle. An interesting feature of the LBO system is that the rapid presentation of successive images reduces speckle in itself. Not surprisingly LBO is currently talking to many potential OEM partners, and prototypes (and pictures of same) are under wraps. Realistically, products are unlikely to appear before 2009, partly because the supply of compact low cost green lasers must be assured before any quantity production can start.

Eyewear: Over recent years there have been significant advances in "eyewear" – head mounted display devices that allow a user to see video or computer images. Usually the optical systems of such devices magnify or collimate the image so that it appears at a distance, thus avoiding accommodation difficulties. Sometimes the display is transparent so the image appears overlaid on the "real world". Applications range from low cost consumer devices that allow "personal viewing" to very high resolution displays used for professional visualization and simulation applications. All depend on the use of microdisplays, and now several different technologies are being used. A limited selection of what was to be seen at SID follows.

Sensics – the personal stereoscopic video-wall: Starting right at the top of the market, Sensics, in an invited paper, described its high resolution, wide field of view head mounted display (HMD). The aim here was to create a display that fills the human eye's field of view, and which is of high resolution – ideally it would provide 60 pixels per degree, but in practice 20 pixels per degree is satisfactory for the application. While it is possible to obtain microdisplays of reasonably high resolution, it is not possible to obtain them with a wide field of view. In order to achieve a "total immersion" viewing experience, Sensics' solution is to use tiled displays.

In effect each eye is given its own private "video-wall". In the original development Sensics used 16 microdisplays per eye! Now the piSight product is offered in a variety of configurations offering different fields of view, 58° to 187° horizontal and 29° to 84° vertical. Depending on the field of view and binocular overlap this requires between three and 16 microdisplays per eye. Each microdisplay is fitted with a lens of 17mm focal length, and together the whole display is as if it is on a spherical surface. Overlap is about 8°, and as a result each microdisplay offers about 23° field of view.

On the left is the Sensics piSight head mounted display; on the right, showing off the Sensics HMD in action

The microdisplays are OLED devices from eMagin. The overall result is a display of 400cd/m^2 and 800:1 contrast. Obviously it is necessary to have appropriate image processing to "split and blend" the original image,

to colour match the individual displays and to provide precise alignment. In practice this task is shared between the Sensics package and the user's image generator. The device is successfully being used in the fields of product design and prototyping, academic research and tele-robotics. Examples of each are use by Honda in car design, the Johns Hopkins Wilmer Eye Institute (where the original research for the project was done) and NASA in tele-robotics.

Sony and Fraunhofer: In other papers devoted to head mounted displays a team led by the Fraunhofer Institute presented the idea of a "bi-directional" HMD. The idea here is that the display itself is also a camera that tracks the eye. This allows so-called "gaze control" whereby the user can modify input images simply by looking at the appropriate part of the image. The resulting eyewear provides a transparent image as the intended applications include driver assistance, surgeon assistance and mobile communications.

A "distinguished paper" from Sony presented an elegant see-through display with 85% transmittance and luminance of 2500 Cd/m2. The clever bit here is that the microdisplays are at the side of the "glasses", and the view through the glasses is unobstructed. Delivery of the images to the eye is done using a waveguide principle (total internal reflection) with the inward coupling from the imager and outward coupling to the eye being done by holographic reflectors.

This is more complicated than it sounds. Diffraction is wavelength dependent, so there are different holograms for each of red, green and blue on both the input and output.

Kopin: Kopin is a long established manufacturer of microdisplays based on active matrix LCD. Camera viewfinders represent a major market, as now do OEM display sub-assemblies for head mounted displays. A typical OEM customer for Kopin is Vuzix. Its iWear AV920 product is for personal viewing of DVDs etc. Mini "loudspeakers" are built in, and the battery is claimed to give six hours use per charge. The device is "3D enabled"; resolution is 640×480 with a 32° field of view.

MicroEmissive Displays: MicroEmissive Displays of Edinburgh exhibited at SID alongside Cambridge Display Technology (CDT). MED's "Eyescreen product is the smallest display screen in the world, and is the only microdisplay based on P-OLED (polymer organic LED) technology. The emissive technology results in a display with a high "fill factor" (no visible pixel artefacts) wide operating temperature range, and ultra-low power consumption from a 2.5V supply. The eyescreen display is only 6mm diagonal with 320x240xRGB resolution and is now in full production at MED's Dresden factory. In April MED announced that it had received an order for 60,000 units from Hong Kong based Estar Displaytech for incorporation into personal display headsets.

On the left is the Vusix personal viewer shown with the Kopin sub-assembly on which it is based. On the right an example of video glasses from Estar Displaytech Co. Ltd containing eyescreen from MED.

Touch screens: Touch screens are now ubiquitous and are accepted as an everyday interface to IT and information systems. They were very well represented at SID; market leaders Microtouch (3M) and Elo Touch Systems (Tyco) jostled with many other vendors. Technologies included resistive, acoustic pulse recognition, infra-red, capacitive and surface wave. Items that I found of interest were:

- The promotion of optical bonding of the touch and AR layers to the display, to improve display integrity and optical performance.
- The move to large format (e.g. 46-inch) touch screens. Here, for example, 3M was promoting its DST (Dispersive Signal Technology) system which uses piezo-electric sensors to detect bending waves in the glass substrate.

- The availability of “force feedback” touch screens. These work by including actuators on the edge of the screen that, although they vibrate the whole screen, give the illusion of a push button with force feedback. Prototypes were shown by SMK Electronics, already available products by 3M.

Zytronic (from Blaydon-on Tyne, UK) was promoting its patented PCT (projected capacitive touch) technology, which is widely used in heavy-duty point of sale applications like fuel pumps and takeaways. Representatives from Zytronic remarked that the SID show was the “only” show for them. PCT technology is suitable for large area displays and “through shop window” displays and Zytronic’s booth featured a rear projection display on thick glass with touch-screen ability.

3M demonstrated its “Tactile touch” screens which embody force feedback. Zytronic demonstrated a “through shop window” touch screen based on projection.

Odds and sods: As will now be clear there was a huge amount to see at SID, and the above barely scratches the surface. However, this report is already too long, so I conclude with a variety of unconnected items that caught my interest.

Speckle reduction: Laser illumination brings with it the problem of speckle. Edward Buckley in his presentation mentioned above dealt with the subject at some length and explained how LBO is eliminating speckle. A more general solution was being offered by Dyoptyka (based in Dublin). The actual optical elements and the way they work was under wraps (and I probably would not have understood them anyway) but by all accounts it is an elegant, low cost solution with low light loss.

Circular LCD displays: We tend to assume that all matrix displays such as LCD must be rectangular. But it ain’t necessarily so – vendors at SID were showing circular and oval displays, suitable for both practical (e.g. instrumentation) and fun applications.

ZBD Displays Ltd: ZBD Displays Ltd (head office in Windsor, Technology Centre in Malvern) had a large display promoting its Zenithal Bistable Display. This is a reflective LCD display that, because it is bistable, requires no power other than when the information displayed on it changes. The main market being addressed is retail display with the SELS “Smart Electronic Labelling Solution”, already being used in large scale field trials. The “labels” have a five year battery life in normal use. A combination of the EPOP Communicator and the Bounce software suite allows multiple displays to be updated by wireless connection. Although initially targeted at the retail POS market, there seems no reason why the same technology could not be used for dynamic labelling in museum and exhibition displays and similar applications.

On the left, round LCD displays from Toshiba; on the right is the Smart Electronic Labelling Solution from ZBD

Electronic paper: In the area of electronic paper, several vendors including Epson and Bridgestone showed examples. Polymer Vision demonstrated its rollable display. This device called the Readius has a 5.0-inch diagonal screen when opened out, but folds down to the size of a cell phone when not in use. Battery life is sufficient for 30 hours reading. It is equipped with Bluetooth, triband/3G cellphone and USB connectivity. The device is expected to be available in Q4 this year, initially under a subscription plan with Telecom Italia.

On the left are electronic paper displays from Bridgestone. On the right, a representative from Polymer Vision demonstrates the Readius device.

Autostereo displays: Autostereoscopic displays (no glasses needed for 3D) were not widely in evidence, although Samsung had a nine points-of-view 56-inch lenticular display that was quite impressive. But it is worth recording that, as mentioned earlier, Edward Buckley gave a "Distinguished Paper" on the MUTED project that is being led from De Montfort University. (Again UKDL members who attended the March event in Leicester will know all about this!)

The paper "Multi-Viewer Autostereoscopic Display with Dynamically-Addressable Holographic Backlight" described the EU funded MUTED project aimed at creating autostereoscopic displays that can be seen by multiple viewers simultaneously. This requires independent head tracking for all the viewers, and a means of directing the backlighting to individual viewers' eyes. Edward Buckley gave a lucid explanation of a complicated concept.

FUTURE GENERATION SOLAR CELLS

Research and Exploitation in Low Cost and Large Area Devices

4 November 2008
Daresbury Science & Innovation Campus, Cheshire, UK

Provisional Programme

9:30	Registration & coffee	
10:00	Welcome	Chairman
10:05	Keynote presentation	Christoph Brabec, CTO, Konarka
10:50	OMIC and Research in materials for OPVs	Mike Turner (OMIC, Manchester)
11:25	Physics of OPVs	Jenny Nelson (Imperial)
11:50	Coffee, networking & posters	
12:10	Thin film hybrid PVs	Tim Jones (Warwick)
12:35	Carbon Trust PV Project – the science	Neil Greenham (Cavendish/Cambridge)
13:00	Lunch, networking & posters	
14:00	Carbon Trust PV Project - exploitation	The Technology Partnership (tbc)
14:25	Worldwide developments in non silicon PV	Harry Zevros, IDTechEx
14:50	Advances in commercial organic PV materials	Jonathan Halls, CDT
15:15	Next generation dye-sensitised thin film solar cells	G24i (tbc)
15:40	Development of printed organic solar cells	Mary Boone, Plextronics, USA
16:05	Thanks & close	Chairman

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	Chris Winscom	(Kodak) representing LABL
	Ken Vassie	(NPL) representing SPURSS
Tim Claypole	University of Swansea	
Bill Milne	University of Cambridge	

FLEXYNET (Plastic Electronics) Sub group Industrial Committee

Chairman	Keith Rollins	DuPont Teijin Films
Committee Members:	Plastic Logic, Kodak, CDT, MDS, Dow Corning, Merck, DSTL, Xaar, Oerlikon, WCPC, Qinetiq, CENAMPS, CPI, PRL, M-solv	

LABL (Lighting & Backlighting) Sub group Industrial Committee

Chairman	Chris Winscom	Kodak
Committee Members:	Vossloh-Schwabe, Elumin8, LEDs Magazine, Polymer Optics, Enfis, WOF, NPL, University of Durham, University of Cambridge, University of Sheffield, Thorn Lighting, Ceravision, WCPC, Sharp Labs, MARL International, Pilkington Group, PRL, Tridonic Atco, M-solv	

ET (Emerging Technologies) Sub group Committee

Chairman	Chris Rider	Kodak
Committee Members:	Pelikon, Sharp Labs, HP Labs, Dow Corning, CAPE, University of Swansea, University of Manchester, CDT	

SPURSS (Systems, Professional Users, Regulations, Safety, Standards) Sub Group Committee

Chairman	Ken Vassie	NPL
Committee Members:	CAA, Ginsbury Electronics, DSTL, POPAI/IQ Group, Philips Lighting, iSuppli, Commonwealth Broadcasting Association, PACSnet, RNIB, HSE, Health Protection Agency, U o Middlesex, DeMontfort University, CIE	

Contacting UKDL

Most of the information you will need about the UK Displays & Lighting KTN and its events and activities are found on the website: http://www.ukdisplaylighting.net. General queries can be sent to info@ukdisplaylighting.net, but if you would like to have direct contact with us, please feel free to do so:

In Scotland: Our Scottish office is located in Dundee, and is manned by Robbie Sharpe, who is also responsible for our national activities in the LABL Sub group. Robbie@ukdisplaylighting.net.

In Wales: Dr. Eifion Jewell, who is located at the University of Wales, Swansea, is seconded to UKDL, and is responsible for part of our FLEXYNET and ET activities, particularly with skills training in printing of functional inks. eifion@ukdisplaylighting.net.

In England: Dr. Ric Allott, Deputy Network Director, has responsibility for organization and delivery of all domestic events and activities, and is specifically responsible for FLEXYNET and ET. ric@ukdisplaylighting.net.

All marketing and promotion of UKDL activities is handled by Nick Kirkwood, who is also responsible for SPURSS. Contact Nick at nick@ukdisplaylighting.net.

All event planning, including location booking around the UK and overseas, is handled by Louisa Chanter Louisa@ukdisplaylighting.net.

Administration is handled by Kay Davenport. Kay is based at our Bletchley Park Headquarters, and is the friendly voice that enquirers will first meet if phoning through to us. Kay can be contacted at Kay@ukdisplaylighting.net.

Finance and accounts matters are handled by Cathy Williams, cathy@ukdisplaylighting.net.

Overall responsibility for the KTN, and specific responsibility for UKDL's overseas activities lies with the Director, Chris Williams. He can be contacted at chris@ukdisplaylighting.net.

If you prefer to contact us by phone, the general number is +44 (0)1908 276665. This number is manned during normal UK office hours, and reverts to voicemail at all other times.

From left to right: Louisa Chanter (Events & Exhibitions), Nick Kirkwood (Marketing Manager), Cathy Williams (Managing Director of UKDN Ltd, the administration company that runs UKDL), Ric Allott (Deputy Network Director), Chris Williams (Network Director), Robbie Sharpe (Knowledge Transfer Coordinator), Eifion Jewell (UKDL Embedded Research Fellow Swansea University), and Kay Davenport (Bletchley Park Administrator)

UKDL Events

The UKDL is hosting/sponsoring numerous events in the coming months. Dates highlighted in **red** are still tentative. For the latest updates and registration information: http://www.ukdisplay.net

September 2008			
9	The Future of Electronics	Electronics KTN & Cambridge Network	Seminar
10	Display Measurement	NPL Teddington	Tutorial
11	Plastic Electronics Morning Briefing	Glasgow Science Museum	Seminar
17	Future Lighting Debate	Ambassadors Hotel, London	Workshop
18	Passenger Information Display	Ambassadors Hotel, London	Strategy Workshop
19	Centres of Excellence	PETech, Teeside	Seminar
22-23	Visit by ITRI	North East & Cambridge	Seminar
25	Barrier Layer Workshop	Institute of Physics	Workshop
29-1	OSC-08 – Printing Workshop	Frankfurt	Workshop
30	Framework 7 / Partnering	Institute of Material, Minerals & Mining	Workshop
October 2008			
7	Innovate 2008	Business Design Centre, London	Exhibition
8	Touchscreen Technology	Microsoft Research Centre, Cambridge	Seminar
13	BERR Lighting Workshop	Billesley Manor, Stratford	Workshop
15	Medical Displays	Hesperia Hotel, London	Seminar
30	Light and Scale	Liverpool	Seminar
November 2008			
4	Future Generation Solar Cells: Research & Exploitation	Daresbury Laboratory	Workshop
5	Solid State Lighting Masterclass	North West England **TBC**	Workshop
6-7	Commercialising Novel Electronic Device Technologies; Policies to Maximise the Benefits to UK plc	CIKC, Cambridge	Seminar
19	Showcase Event	Moller Centre, Cambridge	Workshop
January 2009			
13-14	Metalisation	Radisson, Stansted Airport	Seminar

Driving the UKDL Network forward

by Chris Williams

The UKDL KTN is 100% funded by a UK government grant administered by the Technology Strategy Board. UKDL is one of twenty-four KTNs covering a very wide range of science, technology, and engineering topics across the UK. Our first grant period runs from April 2006 to March 2009, and the management team have their "final review" with the Technology Strategy Board on September 25th to review performance against original targets. We will take this opportunity to present our initial plans for the next three-year funding period, i.e. from April 2009 to March 2012.

The Technology Strategy Board is currently in the process of reviewing its complete KTN strategy. A very wide-ranging review is looking to develop clear guidelines for the future direction and development of the KTN programme, and to determine best practice guidelines for each KTN that is funded to the next period.

This does leave us in a bit of a "chicken and egg" situation – we will be delivering our proposals on how we would like to develop UKDL over the next three years before we are able to receive the revised guidelines from the Technology Strategy Board on what KTNs should be and do! With the "health warning" that everything that is printed in this article may change without notice if the TSB requirements are materially different to our assumptions, I would like to inform you of the outcome of discussions that were held at the steering committee and advisory board meetings of UKDL during July. In developing the outline proposals to be submitted we agreed that the objectives of the KTN should be:

- Establish a community with clear rules for engagement
- Establish a national presence to support members throughout the UK
- Signpost directions to technical, business and financial resources
- Educate, train and inform our members
- Facilitate technical and commercial links between members
- Facilitate consortia to bid for funding
- Act as the voice of Industry (in our sector) to TSB, EPSRC, DAs, RDAs and government
- Evangelise our members' activities into other UK sectors and globally to increase wealth and job creation prospects for the UK!

We further agreed that UKDL should NOT:

- Write proposals or business plans for our members (*we will advise how to, and comment on what is done, but we won't do the writing ourselves*)
- Offer paid consultancy services to members *(that can be done outside of all KTN-funded activities)*
- Participate in commercial award panels *(we do not pick winners or losers from our members).*

We agreed that UKDL should considerably strengthen its activities in plastic electronics.

1. Recent developments in plastic electronics have far exceeded the original expectations when the FLEXYNET network was first established under the LINK ISD programme in 2004. Accordingly, we agreed that for the next period of activity, the FLEXYNET sub-group should be renamed **Plastic Electronics**, as this more accurately describes the breadth of activities now taking place.
2. We will strengthen the collaborations we have in place with the regional and national-funded Centres of Excellence CIKC, OMIC, CPI/PETeC and WCPC.
3. We will develop a series of focused **Special Interest Groups** to supplement existing KTN activities. These SIGs will be targeted at CEO/CTO level.
4. We will develop a series of "evangelising events" to promote the use and benefits of and encourage early engagement with plastic electronics across multiple alternate sectors.
5. We will strengthen our road-mapping activities, and liaise with the other organisations active in this area in the UK and around Europe and beyond. A clear focus will be on developing credible value analysis and gap analysis reports that can be used to drive the sector forwards.
6. We will directly engage with potential major end users of PE to encourage their early involvement with our PE community.

We agreed that UKDL should also strengthen its activities in lighting.

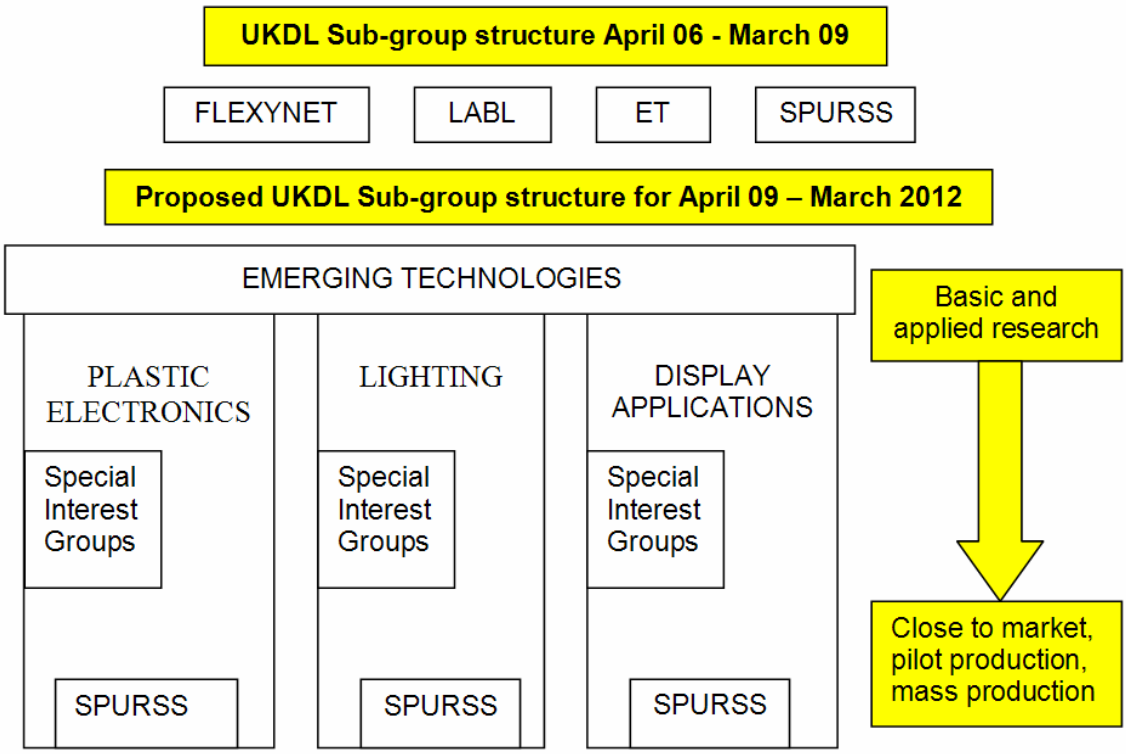
1. It was proposed that the LABL Sub-group would be more readily identifiable if the name was changed to **LIGHTING**.
2. It was also agreed that we should identify an alternative acronym to SSL (solid state lighting) as this potentially limited the technologies that could qualify for involvement. Accordingly, the name ultra-efficient lighting (UEL) was felt to be more technology-independent, and would be promoted to our members.
3. We will develop a series of focused **Special Interest Groups** in lighting to supplement existing KTN activities. These SIGs will be targeted at CEO/CTO level.
4. We will engage more widely with UKTI to develop opportunities for sales of product and collaborations in technology.
5. We will identify and promote to our members financially-supported opportunities for lighting hardware platforms and programmes such as “Lighting Africa” and its Indian counterpart.

We agreed that UKDL should introduce a new Sub-group to handle **Displays Applications** for glass-based displays. This will cover:

1. Training on specifying FPDs to be “fit for purpose” in different applications.
2. Encouraging the local supply of optical films and accessories (e.g. to improve performance in direct sunlight).
3. To lead the discussions and promote participation in programmes to develop efficient FPD recycling and waste disposal facilities.

We agreed that the scope of the Emerging Technologies Sub-group (ET) should be extended to cover all KTN activities and related areas, and that it should look to develop strong links into the government’s Science and Innovation (SIN) Network. It was agreed that ET would receive considerable input and direction from the SIGs that will be established in plastic electronics and lighting.

We agreed that the SPURSS Sub-group (System Integrators, Professional Users, Regulations, H&S) should be modified to allow each of the primary Sub-groups (Plastic Electronics, Lighting, Displays Applications) to have its own mini-SPURSS Sub-group. We also agreed that we should identify a much more user-friendly acronym for this Sub-group – *does anyone have any suggestions*? The impact of these discussions and agreed proposals is summarised below in the detail of the proposed structure changes.



As mentioned previously, these are the proposals we will submit to the Technology Strategy Board at our meeting in September, and are “subject to change without notice”. If any member would like to comment on these in advance of our meeting, please contact any member of the management team, or e-mail me directly.

If we are funded for the next period and are able to implement these changes, we believe that we will be able to continue to develop and deliver increased levels of support to our members, which in turn will help deliver wealth and prosperity for our sector across the UK. We will report on our progress in the next issue of the UKDL Newsletter.