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

UKDL Newsletter

Issue 2 **December 2007**

Contents

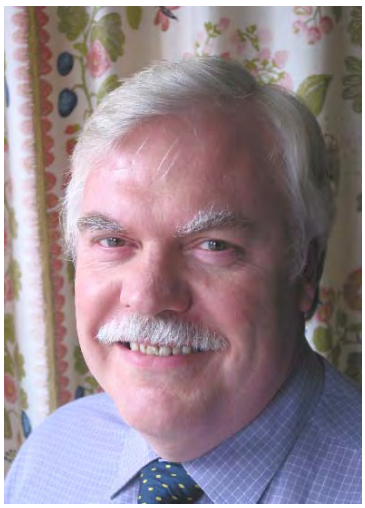
*The **UKDL Newsletter** is focused on bringing news and commentary about plastic electronics, displays, and lighting-related happenings in the UK. The **UKDL Newsletter** is published quarterly for the UKDL by Veritas et Visus.*

A view from the director…

by Chris Williams

Welcome to the second edition of the UKDL Newsletter. It is only a few short weeks since the first edition, but many developments and activities have occurred during that time.

UKDL mid-term review



The management team went en-masse to the Technology Strategy Board's Swindon premises at the end of October for the UKDL mid-term review. The first tranche of government funding for UKDL is scheduled to continue through to March 2009, subject to the Technology Strategy Board's satisfaction with the progress made in developing its membership base and supporting its members with a wide range of knowledge transfer activities. The mid-term review also provided an opportunity for UKDL and the Technology Strategy Board to assess the performance of UKDL to date, and to discuss its future direction. I am very pleased to report that we passed our review with flying colours, and will be continuing to develop our programme of activities and events as we move through into 2008 and beyond. I would like to extend my great thanks to all of the UKDL committee members who have so generously invested their time and efforts into helping make UKDL so successful, and in particular to John Mills of Plastic Logic who came along with us on our review and shared with the Review Board his robust views about our KTN!

Domestic activities

The last few weeks have seen events being held by UKDL around much of the UK. Whilst our headquarters are located at Bletchley Park, we do operate with distributed management, and our staff members are located at various locations around the UK – Kingsclere, Wantage, Tavistock, Swansea and Dundee. This allows us to give national coverage and support to our members, wherever they are located in the UK. The most spectacular event we held during the last few weeks has been the inaugural "Challenges in Organic Electronics", which was a meeting organised jointly with OMIC and held at the University of Manchester. With 105 delegates attending each of the two days we were fully subscribed, and had even been forced to turn people away! This event is reported separately within the newsletter, but I can confirm that this will become an annual event, and we are already in planning for 2008.

International activities

The KTN was fortunate to be invited by the Royal Society to participate in a Science Mission to Brazil in September. Chris and Cathy Williams represented the KTN on this short but fascinating insight into the activities that Brazil is planning in plastic electronics. It is clear that the topic has strong government support in Brazil, and is well represented in academic circles. We believe that there will be many cross-disciplinary opportunities for collaboration between UK and Brazilian companies and academics as both parties develop a better understanding of each other's areas of activity.

In November UKDL collaborated with UK Trade & Investment (UKTI) to host a visit from delegates representing 14 companies and academic institutions from South Korea. This four-day event allowed us to develop stronger links with the visiting delegates, and to encourage trade and collaborative research activities to be discussed. The visit included a two-day workshop in London, which was the 4th Annual UK-Korea Workshop on Flexible Displays. This year the scope was extended to include solid-state lighting, and the workshop proved to be of great value to all who took part.

The workshop was followed by two days of trade visits to companies in Oxfordshire and Cambridgeshire to showcase examples of the materials, equipments and devices that are under development and in production here in the UK. The site visits were very popular, and were perhaps exemplified by the delegate who wanted to buy a benchtop R&D inkjet printing machine with his credit card when we visited Xennia, as it was a very high specification machine being offered at a very reasonable price!

Collaborative research and development competition launched!

The Technology Strategy Board has announced that £100 million grant is being made available to support collaborative research and development in targeted high growth areas. The call is being split into three phases, with the first phase opened on November 8th and the second phase opening on December 19th. Members of UKDL with activities in the UK (and opportunity for exploitation in the UK) are well positioned to submit project proposals into at least two of the topics being supported in the first and second phases of the November competition. Full details of all three phases are available on the Technology Strategy Board website http://www.technologyprogramme.org.uk. If you would like to submit a project proposal please visit this website to identify the areas that best suit your activities. If you have a sound idea for a project but do not have a collaborative research partner(s) in an appropriate field(s), or if you wish to offer your company's services and resources as a collaborative research partner, please contact UKDL and we will help introduce you to relevant industrial and academic partners around the UK. This partnering service is completely free of charge, and is one of the many knowledge transfer activities that UKDL engages in to support UK-based companies and academics, regardless of whether they are members of UKDL or not.

Looking forward to 2008 and beyond

As we move closer to the New Year, we can look back over 2007 and be proud of the number of activities and events that we have held for our members. The level of engagement we have achieved with our members and stakeholders indicates that our implementation of knowledge transfer is meeting a real and present need within the community. But, like every company, we must innovate to stay at the forefront and to support our members in new ways as they seek to move to production readiness and commercially exploit their exciting technology platforms of plastic electronics and solid-state lighting.

One of the first new developments we will introduce in early 2008 will be a series of small, special interest workgroups. These will be created wherever members indicate a need, with the purpose of helping to identify common technology and commercial hurdles in the specific sub-sector, and helping to develop a strategy to address them as part of the wider activities of the KTN. As such, these workgroups will be empowered to drill down further to identify specific sector and topic needs than has been done to date with the higher level sub-groups. The workgroups will be supplementary to the wider-ranging sub-groups that we already have (FLEXYNET, LABL, ET and SPURSS). The outputs of the workgroups may be recommendations to the sub-groups to hold seminars on specific topic areas, or it may be a series of tightly specified workshops to explore and develop individual points of interest, with attendance limited to registered members only.

The first workgroups to be created will be on the topics of:

- Inkjet and other printing technologies
- Atomic layer deposition
- Gallium nitride LED fabrication
- Thermal management in solid-state lighting assemblies
- Thin-film real-time metrology

Other workgroups will be added throughout the year. We will promote the activities of these workgroups through our website, and through direct e-mails to members with known interests (see events listing on pages 37-38). Other developments in 2008 will include development of our web-based training facilities, and the wider exploitation of both the environmental test facilities at Bletchley Park run by UKDL, and the free-of-charge printing of functional materials consultancy activity that is run on behalf of UKDL by the University of Swansea.

On behalf of all of the UKDL staff may I extend seasonal greetings to all, and confirm that we look forward to working with you all in 2008.

With best regards,

Chris Williams
Director
UK Displays & Lighting KTN

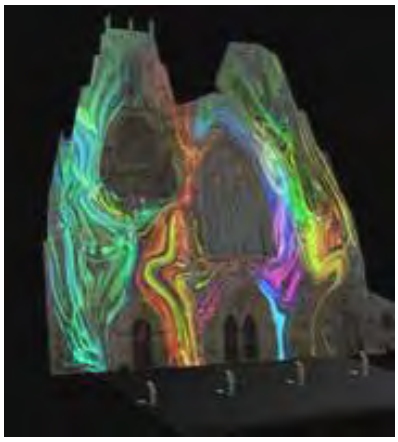
Display and lighting news from around the UK

excerpted from Veritas et Visus newsletters

"Evoke" interactively animates York Minster

A specially commissioned project for Illuminating York 2007 in northern England, "Evoke" is a massive animated 80,000 lumen projection, which will light up the facade of York Minster. The facade is brought to life by members of the public, who use their own voices to "evoke" colourful light patterns that emerge at the building's foundations and soar up towards the sky, giving the surface a magical feeling. The façade of the cathedral is designed to orient the gazes of passers-by upwards. As an attempt to continue this tradition, the patterns of "Evoke" are generated in real time by the words, sounds, music and noises produced collectively by the public, determined by their particular voice characteristics. The colours will skim the surface of the Minster, pour round its features and crevasses, emerging finally near the top of the facade where they will sparkle high overhead. This installation is voice activated, but studies are reportedly underway to enable similar illuminations based on the motions made by spectators as they walk by the cathedral. "Evoke" will be open to the public nightly between from October 26 to November 3, 2007 outside York Minster, in the City of York, England. http://www.haque.co.uk





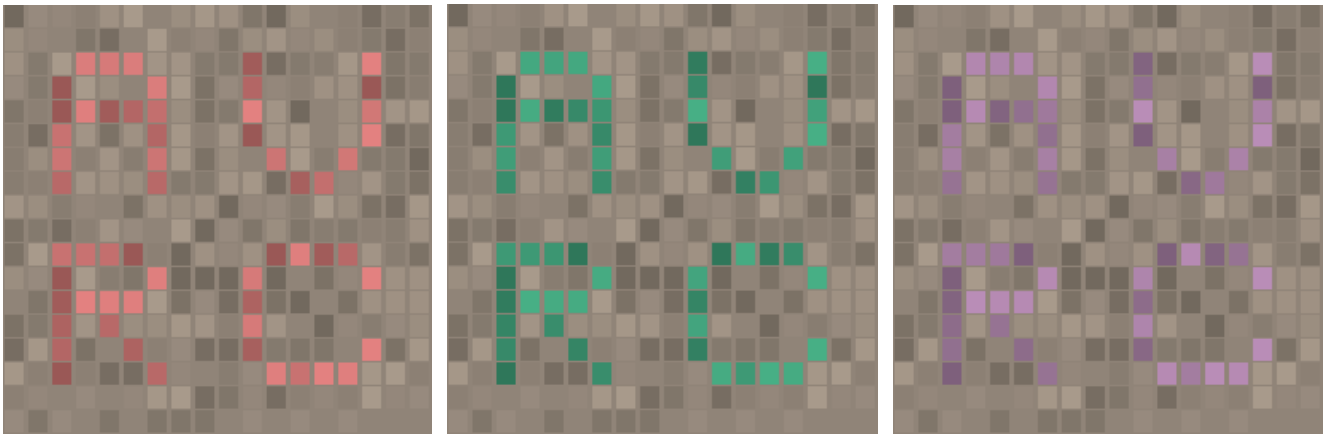

Moritz Waldemeyer showcases interactive Corian chairs with integrated LEDs

Moritz Waldemeyer has worked extensively with DuPont Corian, creatively experimenting with the incorporation of technology into furniture fashioned from the material. "By Royal Appointment" is an installation of three chairs made from Corian, with integrated illumination. Each chair creates an aura of light around the person seated, which automatically adjusts its colour to tone with the colour that the person is wearing. "Corian has a contemporary elegance, combining the sophistication of marble with the warmth and flexibility of wood," says Moritz. The "By Royal Appointment" exhibition is now showcasing in London. http://waldemeyer.blogspot.com



City University comes up with new colour blindness test

People with a serious fault or absence of red, green or blue cones in the retina cannot tell the difference between certain colours. The absence of one of these pigments makes people confuse some colours and this is described as “colour deficiency”. To diagnose colour deficiency, one needs to ensure that the subject can only make use of colour signals. Other things like luminance contrast must be eliminated, and this is not always easy. At City University (CU) in the UK, researchers developed a new colour vision test that works well with every kind of colour deficient observer and a simplified version of this test is now available at http://www.city.ac.uk/avrc/colourtest.html. (For a detailed description of the CU Dynamic Colour Vision Test see: *Barbur et al, Proc. Roy. Soc.B., 258, pp 327-334, 1994.*) The movie on the website displays a moving “coloured” square that is buried in flickering luminance contrast noise. The square changes colour as the movie plays. You may be able to see the colour for some or all of the time. If you have some form of severe colour deficiency, you will have difficulty in seeing the coloured square moving all the time. The movie lasts for 90 seconds and all you need do is play it and remember if the coloured square disappeared at any time during the movie. The absence of the moving square may only last for two to three seconds, before you see it reappearing in a different colour. This temporary disappearance of the pattern is what you have to watch for in the test. When this happens, you may like to confirm this with your optometrist who will be able to diagnose the type and severity of your colour deficiency loss. The web version of this test will run on a variety of monitors balanced for different phases of daylight. The movie was however prepared and will run best on a monitor balanced for ~9000K. This is usually the default factory setting for most colour monitors. The spectral characteristics of the pattern will be affected by ambient illumination and therefore this should be kept to a minimum (i.e., use the monitor in a dark room). The new version of the colour vision test was produced with support from the UK Civil Aviation Authority. The test is not yet in use for medical certification purposes.



From left to right are the L-cone, M-cone and S-cone tests for colour deficiencies developed by City University in the UK

UK visa department orders Cross Match fingerprint scanners

Cross Match Technologies has been awarded a $4.4 million contract via the United Kingdom’s Home Office Biometrics Framework Agreement for 1,385 livescan Guardian fingerprint scanning systems, as part of its new visa program implemented by UK visas. The L SCAN Guardian scanners will be in operation by the end of this year in UK overseas missions, including embassies and consulates around the world. Cross Match is delivering the systems in cooperation with its partner Steria UK. Britain is the first EU country to collect biometric data in the form of ten fingerprints and a digital photo from every visa applicant. Since the introduction of the first UK biometric visas, several hundred applicants have been detected while attempting to immigrate illegally to the UK. Fingerprints taken as part of the visa application process are checked against UK Government records to see if the individual is already known to the Border and Immigration Agency. Over 8,000 sets of prints have been matched quickly and successfully to individuals of concern using this technology. http://www.crossmatch.com

UK Haptics develops training simulator for vein treatment

UK Haptics has produced the Virtual Veins System, a virtual reality training simulator allowing healthcare practitioners to acquire, develop and maintain the skills necessary to perform venipuncture in a range of realistic scenarios within a safe controlled environment. A growing number of healthcare practitioners across a range of disciplines for nursing, paramedics, the blood transfusion service to sports specialists need to be able to gain confidence and competence, the company points out. Virtual Veins also provides metrics to allow the measuring of performance in this procedure and as an aid to certification. Virtual Veins is designed as an extensible collection of modules. Currently available there are Adult and Geriatric modules offering a range of clinical scenarios and including an Afro Caribbean model where the veins can be much more difficult to see. With the Virtual Veins reporting package each student generates their own learning record. http://www.ukhaptics.co.uk/VirtualVeins.aspx

Glasgow University develops vibrotactile aids for visually impaired

Researchers at the University of Glasgow in the UK published a paper entitled "EMA-Tactons: Vibrotactile External Memory Aids in an Auditory Display". The researchers point out that exploring any new data set always starts with gathering overview information. When this process is done non-visually, interactive sonification techniques have proved to be effective and efficient ways of getting overview information, particularly for users who are blind or visually impaired. Under certain conditions, however, the process of data analysis cannot be completed due to saturation of the user's working memory. The paper introduces EMA-Tactons, vibrotactile external memory aids that are intended to support working memory during the process of data analysis, combining vibrotactile and audio stimuli in a multimodal interface. An iterative process led to a design that significantly improves the performance (in terms of effectiveness) of users solving complex data explorations. The results provide information about the convenience of using EMA-Tactons with other auditory displays, and the iterative design process illustrates the challenges of designing multimodal interaction techniques. http://www.multivis.org

Zytronic's 37-inch PCT-based touch screen chosen for Abuzz kiosk

Zytronic's ZYTOUCH touch sensors have been selected by Abuzz Technologies for use in its way-finding kiosk product, the Edge. Using Zytronic's unique projected capacitive technology (PCT), the Edge satisfies the high ergonomic and safety requirements of installations that are typically situated in busy public areas. The interaction surface is a continuous piece of 8 mm toughened glass, which not only exceeds the safety requirements for public use, but also makes the unit splash-proof for robust operation. The 37-inch ZYTOUCH touch-screen is in portrait-format and is designed to be height-adjustable, enabling use by adults and children, and by wheelchair users. The slim, stylish Edge kiosk is designed for use in airports, shopping centres, corporate and government buildings for way-finding and displaying company information or directories. A typical way-finding application for the Edge, which is already deployed in over 30 locations worldwide, displays a visual "attract loop" to draw users' attention. On touching the screen, the user is presented with search options for their destination. Once the destination is chosen, an animated route is displayed on screen, via a map oriented relative to the position of the kiosk, to make navigation as intuitive as possible. Zytronic's' PCT enables these innovations by utilizing state-of-the-art capacitance technology in the form of a complex array of micro-gauge capacitors embedded below the sensing surface itself. The nature of the technology means that the touch-screen can be actuated with gloved and un-gloved fingers, as well as providing unrivalled durability, since the capacitor array can be embedded to depths of up to 20mm. http://www.zytronic.co.uk

Renesas and QRG to cooperate on capacitive touch sensing solutions

Renesas Technology and Quantum Research Group (QRG) recently announced that the two companies are collaborating to develop innovative capacitive touch sensing solutions. This agreement gives customers the benefits of QRG's capacitive touch sensing technologies on Renesas' MCU families. Capacitive touch sensing allows designers the freedom to create compelling user interfaces that would otherwise not be possible, including buttons, wheels and sliders on curved control surfaces, and touch screens or panels that enhance product functionality and appeal. Demand for touch controls is growing rapidly in a wide range of applications, including mobile phones, white goods, and automotive systems. QRG has worked with Renesas to deploy its QTouch technology on the R8C family of devices; a 2 button demonstrator is available using the R8C/29 MCU. QRG and Renesas are working together on a number of end customer applications worldwide. http://www.qprox.com

Atmel licenses QRG capacitive touch technology

Atmel Corporation and Quantum Research Group announced that Atmel has licensed Quantum's QTouch and QMatrix capacitive touch technologies. Quantum's intellectual property will be programmed into Atmel picoPower AVR microcontrollers (MCUs), enabling the devices to be used for both touch sensing and many other control functions, for example driving motor controls, LEDs and displays. QTouch technology is used for simple keys, while QMatrix is used for larger keypad arrays and keyboards. In addition, Atmel has obtained a license to QWheel and QSlide applications, which are used for rotary and linear touch controls respectively. Spread-spectrum modulation ensures a high degree of electromagnetic compatibility and a superior signal-to-noise ratio for reliable operation. Where touch keys are packed closely together, for example on a mobile phone, Quantum's patented Adjacent Key Suppression (AKS) technique avoids false triggering of nearby keys, only registering touch on the intended key. http://www.qprox.com

London's Olympic flame goes carbon neutral

Since the Sydney summer games, the Olympics have tried to lead the way in terms of environmental sustainability. All newly-constructed Olympic buildings have to meet stringent green standards, but the flame remained the same. The London organizers have decided that, as they wish to be remembered as the greenest Olympics ever, the flame will be carbon neutral. Instead of paraffin or other similar high carbon fuels, the London organizers are researching a low-carbon fuel to light and maintain the Olympic flame. "The Olympic Games and Paralympic games have the power to set agendas, and change behaviour, and applying sustainability principles to one of the most potent symbols of the Games will, we hope, help us do just that," a spokeswoman for London 2012 said. http://www.london2012.com

CDT and Sumation announce improved lifetimes

Cambridge Display Technology (CDT) and Sumation announced substantially improved lifetime data for green and red P-OLED materials. Data from spin coated devices using a common cathode and interlayer material demonstrate lifetimes for recently developed solution-processable green and red P-OLED materials of 78,000 hours and 67,000 hours, respectively, from an initial luminance of 1000 cd/m^2. This is equivalent to approximately 445,000 hours and 420,000 hours from an operating brightness of 400 cd/m^2 for these materials. These latest lifetimes represent a 60% and 280% increase in performance for green and red materials over results that were announced earlier this year. http://www.cdtltd.co.uk

Carclo acquires remaining minority interest in Conductive Inkjet Technology

The board of directors of Carclo announced that it has entered into an agreement to increase its equity investment in Conductive Inkjet Technology Limited (CIT) from 74.4% to 100%. CIT is a patented process to print pure metals onto plastics. The initial invention was made by Xennia Technology Ltd whilst undertaking an application development for mobile handsets on a contract funded by Carclo. It was recognized that the invention had applications well beyond mobile telephony and therefore Carclo and Xennia formed a 50:50 joint venture to safeguard, develop and exploit the invention. http://www.conductiveinkjet.com

British Museum chooses Barco projectors for latest exhibition

Barco has partnered with the British Museum to showcase the added value of its high-end visualization in a real life environment – "The First Emperor: China's Terracotta Army". To present the historical storyline for the First Emperor exhibition, the British Museum chose ten single-chip DLP, 1080p HD iCon H250 projectors, and had them arrayed in two five-channel set-ups. An additional Barco projector is being used at the main entrance to the exhibition and provides visitors with information on what they are about to see. Both five-channel display systems provide one complete and seamless image on a curved, 20-meter wide screen. Proprietary Barco technologies eliminate blurry overlap zones where projections converge, and ensure that the entire image has the same colour and brightness levels. The iCon H250 has a light output of 2,500 ANSI lumens, increased pixel count and deep colour saturation. http://www/barco.com

Researchers from the University of Surrey enhance polymer luminescence

One solution to improve the lifetime of organic-based solution-processable devices that has been investigated is incorporating carbon nanotubes in the polymer to form a composite. These "inorganics-in-organics" hybrid composites add many new dimensions and functionality to traditional organic films. However, the addition of the carbon nanotubes typically comes at a cost. For example, in light emitting materials, the presence of the CNTs reduces the emission from the composite, due to quenching of charge carriers at the nanotubes. This quenching reduces the emission efficiency of the devices. Researchers at the Advanced Technology Institute of the University of Surrey, in collaboration with researchers from China and the USA, recently demonstrated that this quenching effect is not an unavoidable problem. In fact, they demonstrate a 100-fold increase in the light emission from a nylon polymer sample, by incorporating multi-walled carbon nanotubes (MWCNTs). This increase in light-emission only occurred when they acid treated the MWCNTs prior to inclusion in the polymer. They propose that this increase is due to a novel energy transfer mechanism, from the acid-damaged surface of the MWCNT to the emitting sites in the polymer. In addition to the enhanced light-emission, the study also demonstrates that the MWCNT produced an improvement in the stability of the polymer to light-induced degradation. Professor Ravi Silva, Director of the Advanced Technology Institute states: "The mere fact that now we can have a predictable organic-nanotube hybrid composite, with enhanced properties should open the door for many new applications. The enhancement in the luminescence properties bodes well a new generation of organic devices that could potentially reach commercially viable figures of merit for large-scale production. We are very excited with these initial results." http://www.ati.surrey.ac.uk

Launch of Plastic Electronics Technology Centre website

The Plastic Electronics Technology Centre (PETeC) website has been launched. PETeC is a national prototyping institute for the development and commercialisation of printed electronics. Customers of the centre will be able to test design concepts and novel materials for a variety of products including thin film transistors (TFT) for flexible displays including e-paper, organic photovoltaic cells (OPVs) and solid state lighting (SSL) applications. http://www.ukpetec.com

ZBD assesses epop carbon footprint

ZBD Displays has commissioned Greenstone Carbon Management to calculate the carbon footprint of its electronic point of purchase (epop) wireless e-paper solutions. ZBD's displays will be reviewed to assess their potential environmental impact and the associated carbon savings. These findings complement the displays' existing green credentials and environmental benefits: reduced paper labels, decreased fresh produce wastage, zero power displays, and WEEE regulation. http://www.greenstonecarbon.com

Rohm and Haas and SKC form joint venture

Rohm and Haas and SKC have announced the formation of a joint venture that will develop, manufacture and market advanced optical and functional films used in the flat panel display industry. The joint venture combines the strength of Rohm and Haas and SKC to provide a broad portfolio of films used in today's most advanced liquid crystal and plasma displays. As part of the new joint venture arrangement, SKC will spin-off its Display Technologies business into a separate legal entity. Rohm and Haas will invest to become a 51% owner in the new company. Closing of this transaction is expected to occur in the fourth quarter of 2007 pending approval by regulatory authorities. http://www.rohmhaas.com

MED begins volume production of polymer OLED microdisplays

MicroEmissive Displays (MED) commenced volume production and commercial shipment of its polymer-based OLED microdisplays. It is also an important milestone for Vitex in its effort toward full-fledged commercialization of OLED displays leveraging the company's proprietary Barix thin-film encapsulation and Barix resin system material. John McEachran, director of operations for MED, noted: "The thin-film encapsulation process technology provided by Vitex has allowed our company to take full advantage of our unique polymer OLED microdisplay design. Our eyescreen product packs 76,800 pixels on a tiny, 6mm diagonal, silicon chip but delivers our customers a superior viewing experience. We are pleased to be working with both Vitex and its partner, ANS. The leading-edge encapsulation technology from Vitex and excellent support surrounding ANS's production equipment enabled us to meet our aggressive production ramp goals." http://www.microemissive.com

Greenpeace shows off dimmable compact fluorescents

According to the Inhabitat weblog, the UK's first fully dimmable energy efficient light bulb was launched September 24 at the London Design Festival, as part of a Greenpeace initiative at 100% Design London. Greenpeace commissioned top designer Jason Bruges to create an interactive garden of light, which responds to human movement through "touch pads" dotted around the installation. This is the first lighting project of its kind in the world to use fully dimmable, compact fluorescent bulbs. Greenpeace explains: "Energy efficiency is one of the most powerful tools we have for fighting climate change, and this installation will prove that going green doesn't mean sacrificing good design. The bulbs themselves have been nominated in the "most innovative lighting" category at the 100% Design London awards, and the installation has been moved to the front of house feature space. It's a sure sign that the exhibition organizers have realized that they have something new and exciting on their hands." http://www.greenpeace.org

Chatsworth poll reports UK businesses go green for image not environment

Big business is going green to protect its reputation rather than out of concern for the environment, a survey of opinion formers has found. The poll of trade journalists, sustainability experts and political groups revealed widespread cynicism about the motives of some of the UK's biggest companies. Nick Murray-Leslie, director of Chatsworth Communications, which carried out the poll, said: "Many opinion formers appear to be losing faith in the real intentions of UK corporations to meet their sustainable objectives and many detect more than a faint whiff of insincerity from the FTSE 100 and its commitment to sustainable practices." More than a quarter of those polled believed companies adopt green policies to protect their reputation, with around a fifth saying initiatives are the result of consumer pressure and good business sense. Only 1% believed genuine concern for the environment was the main motivation for becoming more environmentally friendly. http://www.chatsworthcommunications.com

OLED-T develops high efficiency green phosphorescent OLED

OLED-T announced a green phosphorescent OLED material with high efficiency. The new material called E255a has a high colour saturation making it ideal for a broad range of product applications in single colour and full colour displays. The material also has a very high efficiency delivering high brightness at low power making it ideal for mobile product applications with either passive matrix or active matrix driving. The University of Hong Kong has manufactured OLED demonstrators using E255a and has reported a device efficiency of 40 cd/A at 1000 cd/m^2 with a very saturated green colour coordinate of (0.28, 0.64) which is wider than commercially available LCD products. E225a will be available for customer sampling from January 2008 and can be deposited onto any desired substrate by vacuum coating methods. http://www.oled-t.com

Molecular Vision receives more UK funding for microfluidic photo-detectors

Molecular Vision Ltd (MVL) announced that it has received an investment of £500,000 from Imperial Innovations Group. The company will use the funds to strengthen its management team and to attract further partners to assist in developing its platform that combines microfluidics (technology) and organic semiconductor assay readers within single disposable devices. Microfluidic chemistry systems are typically fast and accurate, while organic photo-detectors provide accuracy at low cost. These characteristics allow MVL devices to provide laboratory-quality information at the patient's bedside, in the doctor's surgery, in the ambulance or in the home. MVL's device is based on research by Andrew de Mello, Donal Bradley, and John de Mello, all of Imperial College London. http://www.molecularvision.co.uk

Cyborg exhibition explores technology implications

"Our Cyborg Future?" looks at the shrinking divide between us and the technology we use. The word cyborg combines "cybernetics", which is about automated control systems, and "organism". The word cyborg was first coined in 1960 to describe a human-machine hybrid. During the event, artists and designers play with "technical textiles", "intelligent jewelry" and "smart architecture". Communities throughout the North East region of the UK will be involved in discussions and workshops during the build-up to the exhibition itself. The exhibition takes place in Newcastle until October 27 at the Victorian Great Hall in the Newcastle's Discovery Museum -- the main science museum for the North East of England. http://www.dott07.com/go/our-cyborg-future

Plastic Logic buys AIXTRON deposition tool

Plastic Logic purchased an AIXTRON Gen 3.5 deposition tool for thin film deposition of the key organic dielectric layer used in their manufacturing process for flexible organic TFT backplanes. The newly developed equipment, based on AIXTRON's proprietary Close Coupled Showerhead (CCS) technology, will be installed and integrated into Plastic Logic's new manufacturing line for production of Gen 3.5 substrates in early 2008 at its new facility in Dresden, Germany, the heart of "Silicon Saxony" alongside companies such as AMD and Infineon. The Plastic Logic facility will produce display modules for portable electronic reader devices. It will have an initial capacity of more than a million display modules per year with production starting in 2008. http://www.plasticlogic.com

AIXTRON takes over Nanoinstruments

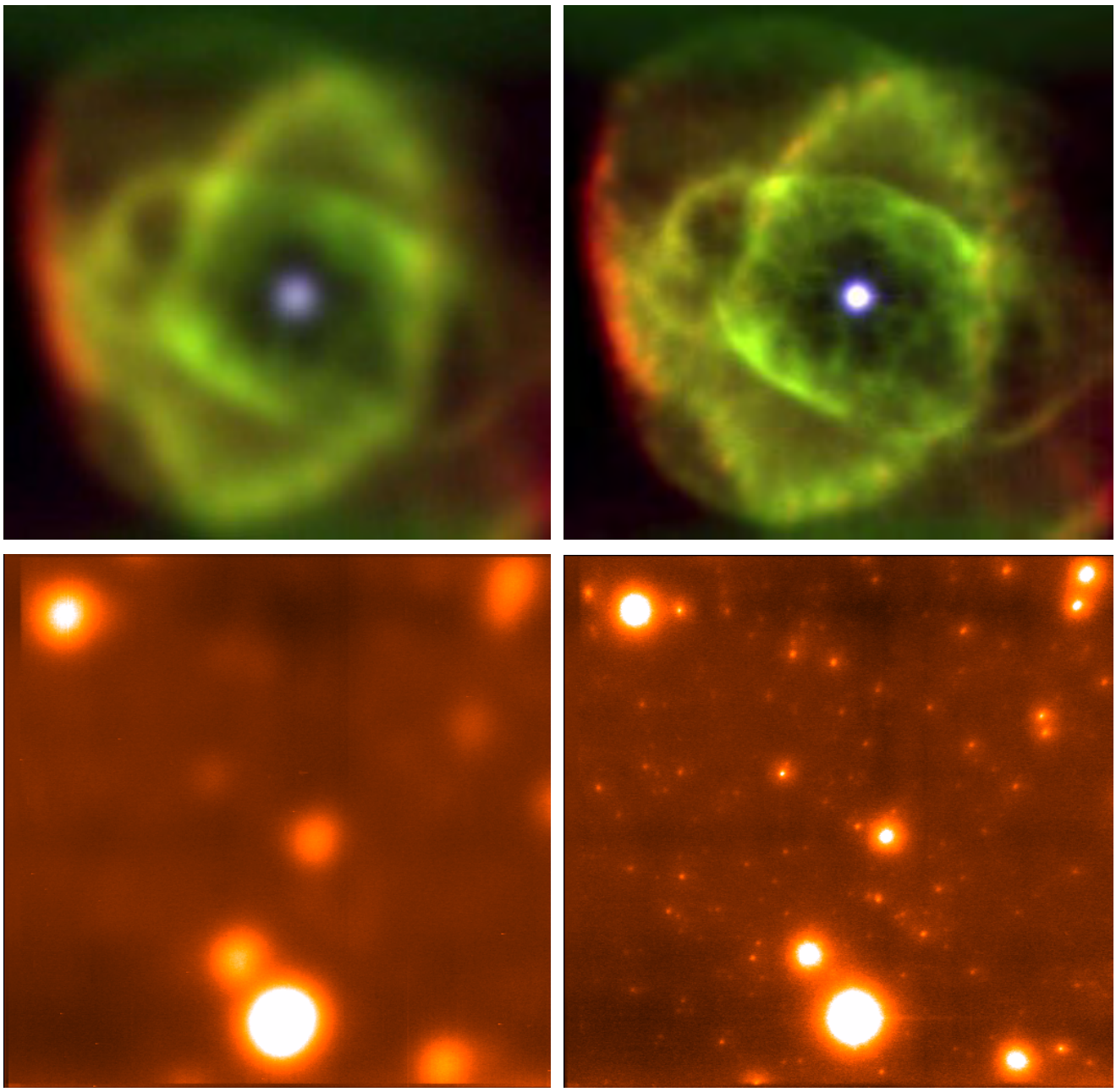
AIXTRON of Germany and Nanoinstruments of the UK have agreed on the acquisition of Nanoinstruments Ltd. business by AIXTRON. Founded in 2005 as a spin-off from the University of Cambridge, Nanoinstruments is a manufacturer of chemical vapour deposition (CVD) and plasma enhanced CVD research systems for carbon nanotubes (CNT) and other nanomaterials. CNT is currently being investigated by many research groups as a promising material to be used in flat panel displays, heat sinks, integrated circuits, sensors or as electron guns. The addition of Nanoinstruments' products to AIXTRON's portfolio of deposition equipment creates new potential opportunities in the mid and long-term within the nanotechnology application space for the company. Key members of the present Nanoinstruments management team will join the new AIXTRON Nanoinstruments technology unit, including Nanoinstruments' founders, Dr. Ken Teo and Dr. Nalin Rupesinghe. http://www.aixtron.com

Syntax-Brillian signs agreement to sell LCoS operations to UK group

In late October, Syntax-Brillian announced that it signed an agreement in principle to sell its operations in Tempe, Arizona dedicated to the manufacture of LCoS microdisplays and light engines. Under the terms of the agreement, the company will retain all patents and intellectual property associated with LCoS but will license the technology to Compound Photonics Ltd. (a UK-based company with an office in Portland, Oregon.) in exchange for an equity interest in Compound Photonics. Compound Photonics will use its equity to acquire the LCoS manufacturing equipment and inventory and will assume the lease on that portion of the Tempe facilities used in the LCoS operations. Syntax-Brillian will focus its efforts on its Olevia-branded LCD TV business. http://syntaxbrillian.com

Cambridge and Caltech scientists develop sharpest-ever astronomical images

A team of astronomers from the University of Cambridge and the California Institute of Technology have taken pictures of the stars that are sharper than anything produced by the Hubble telescope, at 50 thousandths of the cost. The researchers used a technique called “Lucky Imaging” to take the most detailed pictures of stars and nebulae ever produced – using a camera based on the ground.



Pictures using “Lucky Imaging” of the globular star cluster M13, which is 25,000 light years away, are so detailed that they were able to find stars as little as one light day apart. The images of the Cat’s Eye Nebula were so fine that they could pick out details separated by only a few light hours. Comparative images of a standard telescope view and the “Lucky Camera” view clearly show the improved results.

Images from ground-based telescopes are usually blurred by the Earth’s atmosphere – the same effect that makes the stars appear to twinkle when we look at them with the naked eye. The Cambridge/Caltech team, however, surpassed the quality of images taken from space by using a high-speed camera to take numerous images of the same stars at a rate of 20 frames per second. Because of fluctuations in the atmosphere, some of these were less smeared than others. The team then used computer software to

choose the best images, and these were combined to create pictures far sharper than anything that has been taken from space. Dr Craig Mackay, from the Institute of Astronomy at the University of Cambridge, who led the research, said: "These are the sharpest images ever taken either from the ground or from space and yet we are essentially using 'Blue Peter' technology. Amateur Lucky Imaging is popular because the technique is so cheap and effective. The low cost means that we could apply the process to telescopes all over the world." The Lucky Imaging technique was first mooted in the late 1970s and has enabled the discovery of many multiple star systems which are too close together and too faint to find with any standard telescope. The work was carried out on Mount Palomar, California, using the 200-inch telescope at the Palomar Observatory. Like all other ground-based telescopes, the images this produces are typically 10 times less detailed than those produced by Hubble. Using the Lucky Camera, however, it was possible to obtain images that are twice as sharp as those of the space telescope. The Institute of Astronomy is a Department of the University of Cambridge (http://www.ast.cam.ac.uk/). It is one of the foremost astronomy departments in the world. It is the home of the Astronomer Royal, President of the Royal Society and Master of Trinity College, Lord Rees of Ludlow. The Palomar Observatory is owned and operated by the California Institute of Technology. The Palomar 200-inch telescope was constructed before and after the Second World War and opened in the late 1940s. For many years it was the largest telescope in the world.

Ordnance Survey selects Intergraph for the UK's geospatial data management system

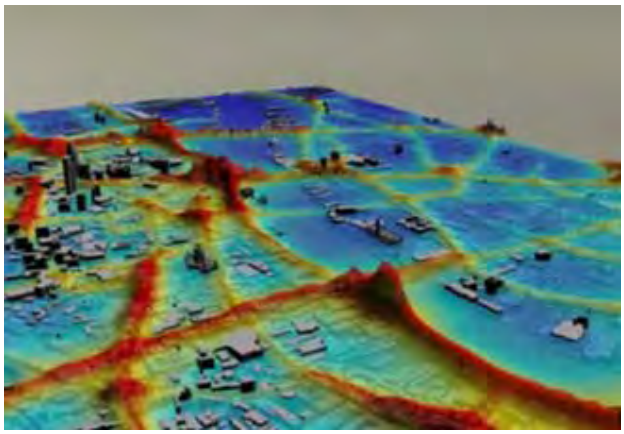
Ordnance Survey, Great Britain's national mapping agency, has selected an Intergraph Corporation-led team, including 1Spatial and Snowflake Software, to provide its next generation geospatial database and data management system. This selection followed an extensive tender exercise under the European Union Public Procurement Regulations, Competitive Dialogue Procedure. Ordnance Survey maps are internationally renowned and its data are essential to the country's government, business and individuals. The agency's national geographic database describes more than 440 million individual features – such as every house, road and field. Each year more than a million changes to the British landscape need to be measured and assimilated into this database. This equates to 5,000 changes every day. The system will provide enterprise-wide capabilities for the management, planning, coordination, and control of data capture and production activities. Ordnance Survey's large-scale data holdings will be managed in a centralized geospatial database, and a standards-based interface will integrate field and office-based editing tools as well as those from external contractors. The system will ensure consistency between Ordnance Survey products and enable it to develop new ones. http://www.intergraph.com

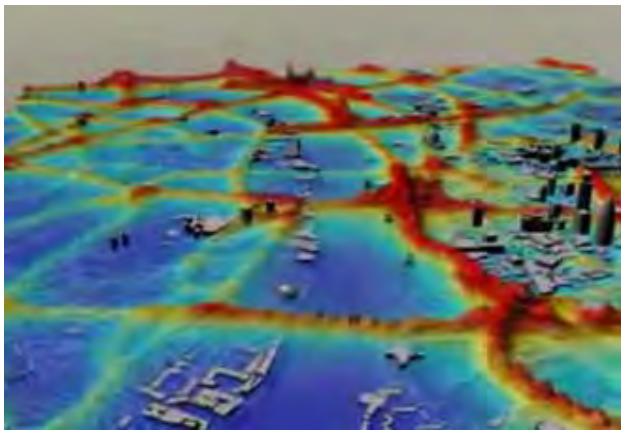
CASA develops virtual London in Second Life

Three Dimensional Collaborative Geographic Information Systems (3DC/GIS) are in their infancy. Google Earth opened up the concept of three dimensions to the mainstream but issues with data copyright, the inability to effectively tag data to buildings and the asynchronous nature of the platform have limited developments. Second Life however provides a synchronous platform with the ability to tie information, actions and rules to objects opening the possibility of a true multi-user geographical information system. It has been notoriously difficult to import 3D data into the Second Life but at CASA, developers recently managed to import a Virtual London model of 3 million plus buildings into a scrolling map. The map is built from prisms that "res" out of a central point to build accurate models based on the Ordnance Survey MasterMap with height data supplied by InfoTerra. CASA's next step is to import a live GPS feed of a tagged member of CASA onto a scaled avatar on the map, the 3D buildings will in theory scroll and build as the person walks around London in real life. They are also working on tagging information and textures to the facades, allowing perhaps for the first time a public 3DC/GIS to be feasible. In Second Life, visit: http://wlurl.com/secondlife/Second_Nature2/202/192/117

CASA develops London 3D air pollution map

A recently-developed interactive three-dimensional map that allows users to "fly" above London to see pollution hotspots was launched by the Centre for Advanced Spatial Analysis (CASA), University College, London, and King's College. The easy-to-use tool allows transport and urban planners to zoom in on different areas to see how clean particular neighbourhoods are. It is the first time air pollution for an entire city has been related to the built environment. The London Air Quality Network, which hosts the Web-based map, was aware that two-dimensional representations can be difficult for non-specialists to grasp, and so seized upon UCL CASA's suggestion to use their expertise in 3D mapping to create a simple but effective tool. Users can already choose to focus on roads and railways, the River Thames, green spaces and the congestion charge zone. Air quality can be viewed by overall level of pollution, or by key pollutants such as the particulate matter. http://www.londonair.org.uk/london/asp/virtualmaps.asp





UK Haptics develops training simulator for vein treatment

UK Haptics has produced the Virtual Veins System, a virtual-reality training simulator allowing healthcare practitioners to acquire, develop and maintain the skills necessary to perform venipuncture in a range of realistic scenarios within a safe controlled environment. Virtual Veins also provides metrics to allow the measuring of performance in this procedure and as an aid to certification. With the Virtual Veins reporting package each student generates their own learning record. The application stores the results from completed test sessions enabling the trainee and the course tutor or supervisor to view progress and performance over time. As users work, the system stores current results for viewing during that session within the Clinical Skills Trainer. When the session ends those results are added to their training record in the database so that they can be accessed externally later. This ensures that the system is freed up for practice rather than reviewing and past results are viewable either from the UK Haptics website where all users can login or through their own organization's MLE where this has been set up to take input from the clinical skills trainer. http://www.ukhaptics.co.uk

Minimaforms develops SMS "smoke signals"

This year's OFFLOAD festival in Bristol, England, included an installation that brought the ancient communication form, smoke signals, into the digital age. Onlookers had the opportunity to send text messages to the system, which would then project the message into plumes of smoke. The text is displayed one word at a time in huge letters, and the physics of the smoke combined with the fact that the size of the image is proportional to the distance from the projector creates a kind of 3D layer effect. Minimaforms was founded in 2002 as an experimental architecture and design firm that prompts new ways to communicate. http://www.minimaforms.com/smokesignals/

Julian Beaver's sidewalk chalk paintings continue to astound

London-based artist, Julian Beever, is renowned for his amazing chalk paintings, which so clearly show us the importance of perspective. The bottom pair of images serves to identify just how important the viewer's position is to a successful rendering of a 3D image on a 2D surface. In all of these images, the lines in the sidewalk serve to remind us that these really are 2D paintings. http://users.skynet.be/J.Beever

Clear Channel Outdoor enters partnership to sell advertising at landmark LED site

Clear Channel Outdoor has entered into partnership with MT2 to sell advertising on the new Land Securities' owned LED screen – Piccadilly Lite – situated in the iconic Piccadilly Lights complex in the heart of London's West End. The site, which measures 23 x 2 m, allows static or animated images. Campaigns of 30 seconds, 60 seconds or longer can be booked for between two and 12 weeks. Piccadilly Lite will also allow members of the public to post personal, rolling messages at the cost of £1,000 per minute. http://www.piccadillylights.com

Element Labs' Stealth LED displays chosen to add glamour to Take That tour

Element Labs' Stealth 2.5 LED display was chosen to add glamour to Take That's break-neck European tour. On October 12th, Take That's "Beautiful World" tour kicked off with its first concert in Belfast, UK. State-of-the-art Element Labs Stealth LED displays totalling 250 square meters acted as backdrops to the band's performance. The Stealth LED display, supplied by rental company XL Video, consist of three columns that are used as two columns of 16 panels wide and 25 panels high on either side of the stage, as well as one column center-back of 19 panels wide and 25 panels high. TT video production team conceived and designed a unique way of exploiting the Stealth fan-fold capacity to enable the 200 m^2 to be rigged at the speeds demanded. Dollies housing the processors allow for the screens to be hung and tested as they are rigged, greatly reducing the need for stagehands. The STEALTH system is comprised of modular panels, integrated power and data distribution, rigging hardware, and video processing. The panels are 40 cm square, weigh less than 1 kg, and contain 56 pixels on a 25 mm pitch. The latest version of the STEALTH system, STEALTH 2.5, has a very flat LED panel, which ensures it displays smooth video that remains consistent, regardless of the angle at which the panel is viewed. http://www.elementlabs.com

ITrans Modular from Screen Technology installed in central London

ITrans Modular, the "building block" display system from Screen Technology, has hit the high street with its first installation at Virgin Megastore, Piccadilly in London. A 91-inch screen has replaced the 62-inch system in the window on Piccadilly Circus. The screen was assembled on site by clipping together six ITrans modules in a 3 x 2 array, giving a screen size of 2.14 m, doubling the size of the original screen. The screen shows advertising content for the latest products sold within the Virgin Megastores, as well as up to date entertainment news on a scroll bar along the bottom – this is a feature that has now been applied to the other ITrans screens in the Virgin Megastores network. The ITrans Modular is daylight viewable and can be assembled into any shape or size based on the standard 34-inch ITrans video-cubes. http://www.screentechnology.com/ITransModular.php

ITrans performs under the spotlight at NPL

One of the most compelling claims made by Screen Technology is that their ITrans display technology is fully viewable in bright sun or artificial light. This claim has now been verified to the demanding standards of the National Physical Laboratory (NPL) after a number of tests were carried out on brightness and contrast levels. An ITrans 62-inch screen underwent four days of vigorous testing by the independent standards and test house in Teddington, UK. The results concluded that even under the extreme test of 110,000 lux, equivalent to a bright day in the Sahara, the screen still gave excellent image colour, brightness and contrast and so remained fully viewable. ITrans achieves this performance through the combination of two key features – high brightness and sunlight rejection technology. Backlights give 2000 cd/m² of illumination, whilst the ITrans tile gives the display its sunlight rejection qualities. Each ITrans fibre throws the desired image light forward; however, undesirable sunlight which hits the front face at an angle is steered away into contrast enhancing strips before it hits the underlying LCD panel. LCDs without an ITrans tile would suffer from surface reflections, significant loss of contrast (so-called "wash out") and in extreme cases the energy from the sunlight can cause the LCD panel to black out completely. http://www.screentechnology.com/NPL.php

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Interview with Craig Cruickshank from cintelliq

Craig Cruickshank founded cintelliq in 2002 in recognition that as basic research in organic semiconductors moves from the research laboratories towards early commercialisation it is imperative that organizations with a vested interest in the technology have access to sufficient industry information. cintelliq focuses on providing publications on the commercial and technology developments of the industry such as — the OSA Direct newsletter and the Organic Semiconductor Patent Analyst. cintelliq is also responsible for establishing the annual Organic Semiconductor Conference in 2003 and which was recently renamed the Organic Electronics Conference and held in Frankfurt, Germany. Prior to cintelliq, Craig gained first-hand industry knowledge and experience while working for Cambridge Display Technology (CDT) and Cambridge Consultants, one of the world's leading technology management consultants. Craig holds a BSc. Physics, MSc. Digital Systems, and an MBA from the Manchester Business School.

Please give us a bit of background information about cintelliq. cintelliq was founded in 2002 to monitor and analyse the technical and commercial activities in the "organic semiconductor" industry. Our emphasis is on collecting facts that we then analysis and turn into information for a wide audience. At the present time, cintelliq focuses on industry developments rather than market forecasts. Our skills are biased towards technology, and this is reflected in the products and services we offer. The tangible things cintelliq does is to provide consultancy, newsletters, journals, reports and conferences.

Is there a meaning behind the name? Yes there is a meaning behind the name cintelliq. It reflects what we do. cintelliq collects information or intelligence, then analyses it and puts it into various outputs – newsletters, reports, and consultancy. Our processes are aimed at making all this technical and commercial information and analysis easier for others to understand – we have essentially codified the intelligence – and so cintelliq is derived from these two words – codifying and intelligence.

There are many phrases used to describe the industry you cover; you've chosen "organic semiconductors". Please elaborate. cintelliq is often asked why do you use the term "organic semiconductors" rather than say organic electronics, plastic electronics, printed electronics, etc. This is an interesting question. If we think about the traditional electronics based on silicon then we can clearly see that there are companies that design and build "chips" these are the semiconductor companies, it also includes the equipment and material suppliers. Then there are all the electronics companies that make use of these "chips" to make products based on "chips". So we believe that there are parallels in the "organic" world – and we have organic semiconductor companies and organic electronics companies. At the moment they are one and the same. Over time this will change.

You recently completed the 5th rendition of your Organic Electronics Conference. Tell us about attendance trends over the years. Are you seeing any changes in the types of companies attending the event today as compared to when the conference first started? The first conference was held in Cambridge, UK in 2003 and was called the Organic Semiconductor Conference (OSC-03). At our first conference we had 66 attendees. In 2006 we partnered with the Organic Electronics Association, renamed the conference to the Organic Electronics Conference (OEC) and moved it to Frankfurt. This year at OEC-07 we had more than 400 attendees – a 33% increase over OEC-06. The companies who spoke at OEC-07 were fairly similar to those that spoke at the first conference, and in fact many of the delegates at the first conference have attended all five conferences. The main difference now is that we are seeing more companies who are starting to deploy the technology, or who intend to be active in some way, but who may not necessarily build devices themselves such as materials suppliers, equipment suppliers, and application developers.

Do you foresee a day when organic devices will displace inorganic electronic devices? It depends on which organic devices are included in the discussion. OLEDs for displays and lighting applications have the possibility to replace most of the incumbent technologies. For transistor circuits, the potential to replace silicon is far into the future, if ever. At the present moment in time there is a real need for simple electronics, operating at low frequencies and capable of being fabricated using printing techniques. Organic devices offer this whereas it is not possible with silicon. The opportunity for organic devices is to fill the space that cannot be achieved with silicon and not to replace silicon.

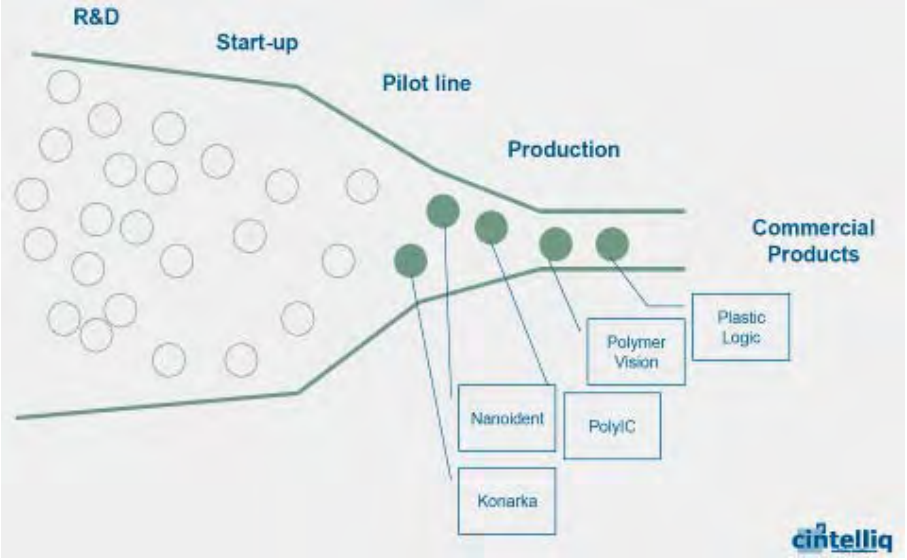
What do you think are the biggest barriers associated with the rapid commercialisation of organic electronics? The industry has spent much time and effort in developing the technology, however, much of the communication to interested parties, those that could make use of the technology, is still about technology performance. There is still a real need to educate end-users about the potential of this technology and how it can be used to develop new products. The market will grow much faster when there is sufficient market pull.

Several companies have been working for quite some time now on active-matrix polymer-based displays. What's taking so long for these efforts to achieve commercial success? Active matrix OLED displays in general have been slow to enter the marketplace. Polymer OLED materials have been cited as having insufficient lifetimes for commercial products, but this is rapidly changing as there are now polymer materials available with lifetimes acceptable for commercial use. By far the biggest factors affecting the commercialisation of AMOLEDs have been due to scale-up and backplane yield issues.

Do you see a time when OLEDs will simply displace LCDs? There is something magical about watching television on an OLED-based display; the viewing experience is so much warmer than a LCD. Once OLED displays have achieved something close to cost parity and larger diagonal displays, then they have a very good opportunity to replace LCD as the incumbent technology for displays. If this threat was not real, then why are all the major LCD manufacturers actively engaged in OLED development and production?

You've suggested that the number of companies who are likely to make the transition from R&D to mass production over the next three years is unlikely to be significant. Please explain. My initial comments were that the market forecasts will not be met. This is for several reasons. Looking at the

market forecasters they have all been indicating very aggressive growth between 2006 and 2010. However, to fulfill this market demand requires the necessary production capacity to be in place. At present there is virtually no significant production capacity available. There are only a few companies that have declared their intentions to go into production. Most of this capacity will only go on stream toward the end of 2008, and given the size of the forecasts then there is insufficient capacity. A consequence of this is a delay in market take-up. The forecasts are about two to three years earlier than is most likely.



The number of companies who are most likely to make the transition to production over the next 3 years is not significant

Tell us about your research in the area of patents in the area of organic electronics. cintelliq focuses on technology and facts. Patents are an important indicator of technical activity, and of course based on actual filings. Since 2004 cintelliq has collected patent information. This allows cintelliq to have a very clear picture of the level of technical inventions in the organic semiconductor industry. Each quarter a new report is produced detailing the activities of all companies filing related patents. These patents are then classified in terms of whether they are related to OLEDs, transistors, photovoltaics, memory, sensors or lasers. We then also classify them in terms of whether they are related to materials, deposition, fabrication, device architecture, patterning, encapsulation, or substrates. This allows a solid foundation on which to undertake further analysis.

Do you see regional trends related to patent applications or do all regions seem to be focused on similar areas of development? OLED patents dominate, accounting for nearly 70% of all patents filed. In 2006 more than 7000 patents were included in the patent database. Many of the OLED patents are focused on process related inventions, which is to be expected as they have commercialised first. European and US based companies are very active in filing transistor, sensor, memory and photovoltaic patents. From a country perspective the largest percentage of patents in our database are filed in Japan. However, different countries and different companies have their own patent filing strategies. It is not appropriate to judge one country or another simply in the number of patents filed. It is important to understand the content. Some patents have very broad claims while others are narrow. The Japan patent office encourages the filing of patents with narrow claims and this encourages more patents, whereas in the US and Europe patent offices patents with broad claims are acceptable and so fewer patents may be filed.

Are most patents related to organic electronics coming from small, start-up companies, or from large, well-established companies? OLED patents tend to be dominated by the manufacturing companies, which are generally the large and well-established companies from Korea, Taiwan and Japan. Outside of displays, the companies filing patents are evenly spread among large mature companies and young start-ups.

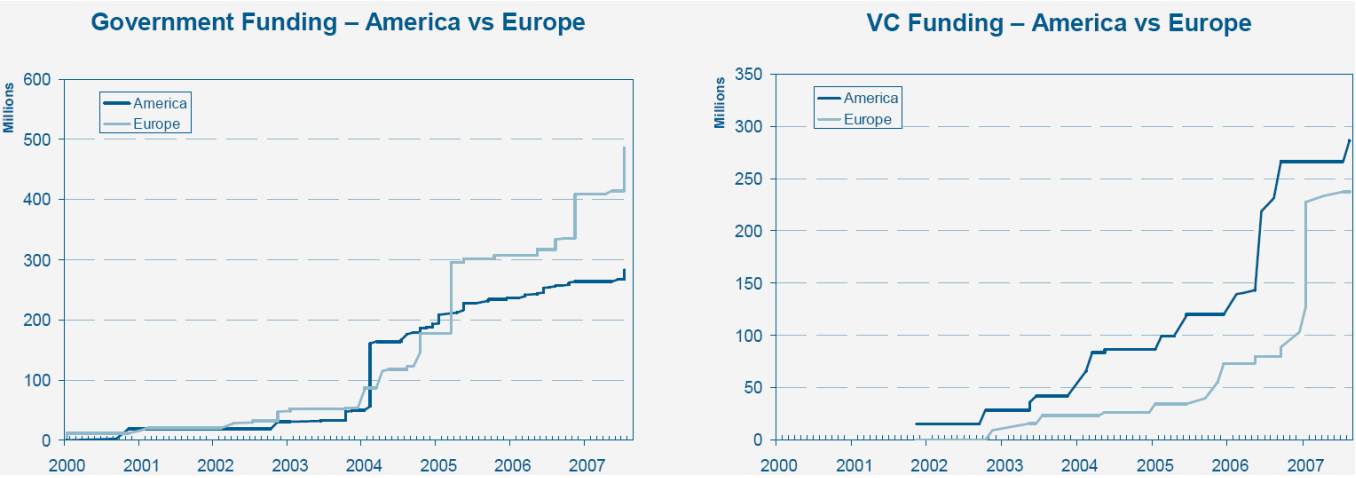
Do you see any areas related to intellectual property that may destabilize growth of the industry because of IP battles or monopolistic royalty positions? I am sure that as OLED technologies start becoming successful in the market place, then it is likely that companies will get sued over IP. It happens in most technologies, including LCD, so why should organic semiconductor technologies be any different?

In your opinion, in the field of organic electronics, can companies survive based solely on a patent licensing business model? The only companies adopting a technology licensing model have been those that own fundamental OLED IP. Non-display based companies such as PolyIC, Polymer Vision, Plastic Logic, Nanoident, etc., are all choosing to adopt a direct manufacturing business model. This is the way forward that the new entrants have chosen to commercialise their technologies. Product licensing strategies may surface in the future.

What do you think is the single most exciting thing that was newly presented at your recent conference? This is not an easy question. Picking a single thing means that I have to ignore many fascinating developments and possibly offend many people. So, I'll side step the question and say that the most exciting thing to be seen at the conference was the growing number of companies who have reached a stage where products entering the marketplace are now a reality.

Likewise, what is the most disappointing development (or lack of development) that seems to be looming on the horizon? There are simply not enough companies developing technologies and products.

Do you foresee a day when the mass production of organic electronic devices in Europe will be on a scale that is competitive with Asian manufacturing? This is an interesting question but it is too simplistic. At present much of the display industry is based in the Far East, however, there is a growing semiconductor industry based in Dresden. Organic electronics is also beginning to be established in Dresden, Plastic Logic is building its first fab there. Novaled and others are also based in Dresden. There is every possibly that a manufacturing cluster for organic electronics could be established in Dresden. As always economics will play a major role in deciding where production capacity will eventually be established.



Between January 2000 and September 2007 more than $1.3 billion in VC and government investment has been committed to organic semiconductor technologies in the US and Europe

In the next three years, what do you think will be the single area in the organic electronics industry that is most likely to achieve major strides into more traditional device manufacturing? OLED displays have the potential to erode the market share of LCD based displays. However, other devices such as transistors, sensors, photovoltaics, etc., will expend the market, and open new opportunities that are not possible with conventional electronics.

Interview with Mike Thwaites from Plasma Quest

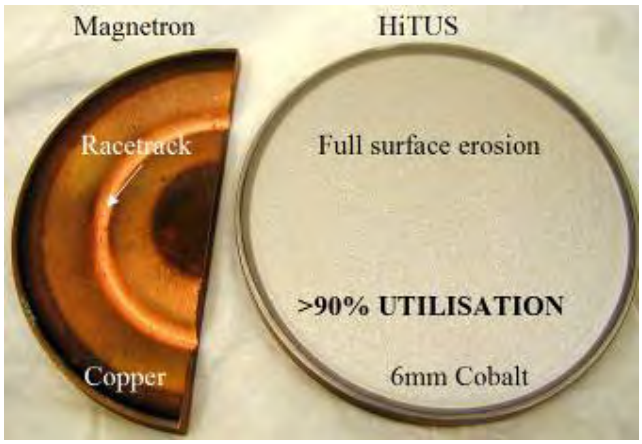
Professor Mike Thwaites, (BSc, PhD, CSci, CPhys, MIEEE, FinstP) is CEO of Plasma Quest Limited, an R&D company located in Hook, England. PQL specializes in the development of novel thin film deposition processes/systems, including those associated with the development of advanced amorphous silicon, polycrystalline silicon, and CIGS based photovoltaic devices. Thwaites spent over nine years developing thin film based solar cells at the BP Research Centre, followed by a further eight years leading the development of novel thin film devices and process systems for BOC. Overall, he has over 25 years experience in the development of thin film devices and deposition processes.

Please give us some background information about Plasma Quest. PQL is an R&D company specializing in the development of complex thin film deposition and plasma enhanced processes, mainly for external customers (this includes work for universities). Most of the processes are based on PQL's proprietary sputtering technology. We do sell equipment, which is designed by PQL but built externally. We also, in conjunction with some of the UK's leading universities, teach students up to doctoral level. In fact we have been called the "University of Hook".

Traditional magnetron-based sputtering has some deficiencies with regard to utilization and target stability. Can you elaborate? Due to the requirement of placing magnets behind the target to enhance the ion density in a magnetron sputtering process, this leads to the development of the well-known racetrack in the target surface. The combination of racetrack and reliance on the magnetic field propagating through the target leads to:

- Low target utilization.
- Poisoning of the target during reactive sputtering, requiring pulsed DC or optical feedback.
- The necessity to use thin targets and strong local magnets when sputtering from a ferromagnetic target.
- Problems with process stability whilst sputtering from a compound target. Once conditioned there are still changes in the thin film composition as a function of the development of the racetrack.

Tell us about your HiTUS sputtering process and how it overcomes the problems faced by magnetron systems. In our HiTUS ("High Target Utilization Sputtering") based systems, the plasma is generated remotely in a quartz tube adjacent to the main deposition chamber. With suitable magnetic coupling, a high density of low energy Ar ions (not energetic enough to sputter directly) is delivered to the target surface. Biasing the target negatively (as in conventional magnetron sputtering) accelerates the Ar ions across the sheath were they collide with the target and sputter the target. Because the plasma is generated remotely there is no need for local magnets behind the target, as required in magnetron sputtering. Therefore there is no racetrack and sputtering is now not reliant on magnetic field penetration through the target. The advantages are:



One of the advantages of the HiTUS system is the elimination of racetrack effects typical of magnetron-based sputtering processes, thereby substantially improving target utilization.

- High target utilization.
- Reduction in target poisoning during reactive sputtering. Pulse DC optical feedback control not

required. Deposition rate can be ten times faster than magnetron sputtering for a reactive sputtering process.
- One can sputter from thick targets even when using a ferromagnetic target.
- Stable process, even when sputtering from a compound target.

Does HiTUS enable any other advantages with regard to cost or performance when compared to magnetron systems? Yes. Advantages include:

- High deposition rates (particularly with reactive sputtering or when using ferromagnetic targets), which lead to high yield rates.
- Opto-electronics properties very close to bulk properties.
- Good stress control.
- Good adhesion.

Do you also claim advantages over other coating systems such as ion-beam, thermal evaporation, and CVD? Yes. We note improvements in overall physical properties and deposition rates.

You recently deposited ITO onto PI and PEN at room temperatures. Explain why this is important. PQL was able to deposit ITO with good electro-optic properties on to flexible PET and PEN without destroying the PET or PEN. This is useful for the development of flexible displays.

ITO layers have historically been problematic, particularly for flexible substrates, due to cracking issues when flexed. Does your solution reduce these ITO cracking issues? Not sure. Needs more investigation.

In Plasma Quests' HiTUS based systems, the plasma is generated remotely in a quartz tube adjacent to the main deposition chamber. HiTUS delivers very high quality thin film materials with near ideal physical properties, very low stress and excellent adhesion – whether on metal, glass or plastic substrates.

Typical ITO sputtering solutions tend to waste a substantial amount of the target. Can you quantify the level of efficiency of your process versus the incumbent processes? Clearly the target utilization is better for our technology, but this needs to be judged alongside the material transfer factor, which we have not yet optimised.

In addition to your recent work related to ITO, have you witnessed success with regard to any other transparent conductors? Yes, we've seen promising results with ZnO, InO_2, and SnO_2.

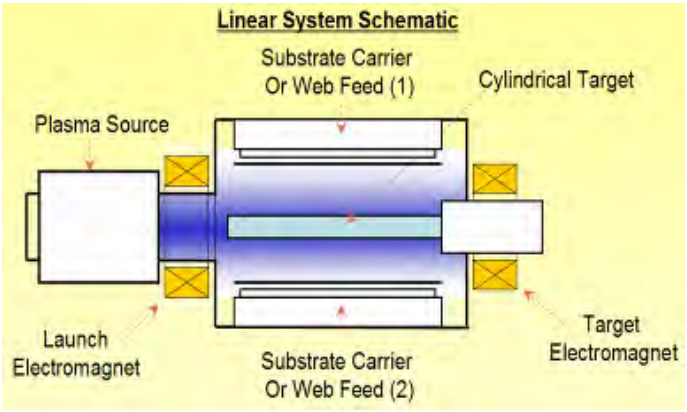
Please give us any additional observations about why you think HiTUS is well suited for flexible display solutions. We can deposit high quality material, with low stress at low temperatures and a high deposition rate.

Plasma Quest recently deposited gold on a plastic substrate. Why is this significant? Gold is difficult, primarily due to its poor adhesion to most substrates. The gold that we deposited had a specific resistivity close to bulk with very good adhesion, again all at ambient temperatures and without an adhesion promoting layer.

You have the ability to simultaneously sputter multiple target materials. Can this be done in other sputtering processes, and what advantages do you offer in this area? Yes, other sputtering processes can simultaneously sputter, it is called co-sputtering. With our co-sputtering technology we

analyze the chromaticity of the plasma and use this information to control the power to the individual targets, this gives us real time control of the sputtering process.

Plasma Quest recently announced a new plasma launch system. Tell us about some of the new features have been introduced. This is our linear sputtering process. Here the plasma is generated remotely as before, but instead of being steered through 90^{o} towards a circular target, the plasma is directed along the long axis of a cylindrical target. The entire cylindrical target can now be sputtered. Currently, we are able to sputter from a target 50 cm long by 7.5 cm in diameter. All the advantages of our HiTUS apply to the new linear technology.



Plasma Quest recently redesigned their plasma launch system (PLS) for use in sputter deposition production environments. One of the primary advantages of the new design is that the plasma can be directed along the axis of a cylindrical target that enables web processing.

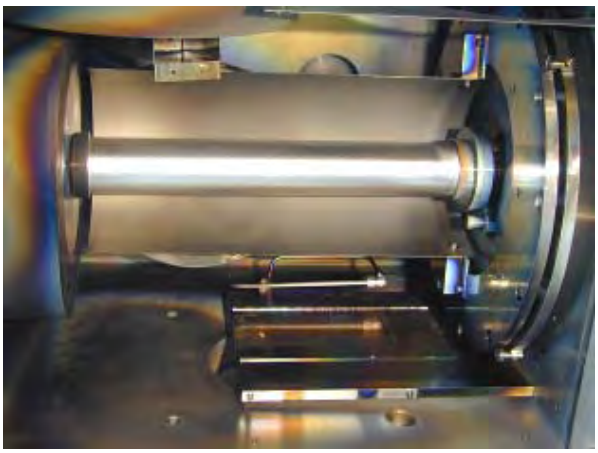
You currently operate primarily as an R&D centre. Are there any plans to expand your scope into a system manufacturer and/or a deposition service yourself? No.

Tell us more about how you enable web processing. Clearly using a target in the form of a cylinder is an enabling web processing technology, with the web width a function of the target length.

What are the biggest challenges that still demand improvement – either with regard to quality, performance, or cost? The development of a pre-production system to demonstrate the potential of our linear deposition technology.

Tell us a little about what you are doing with regard to flexible solar cells. We will be using our linear technology to deposit thin film amorphous silicon solar cells at low temperatures onto flexible substrates such as PEN/PET.

Tell us one of your favourite customer satisfaction stories. A large US-based company wanted to deposit a ferromagnetic material onto a flexible substrate with low stress. They had been trying for about a year with little success. They found it difficult to sputter the material for reasons mentioned earlier, but even when they did it just rolled up like a cigar due to the inherent stress. Representatives from this company came to PQL for a week. We sputtered the ferromagnetic material easily and deliberately produced the thin film with compressive stress and then with tensile stress, finally controlling the process parameters between the two types of stress condition, we managed to fabricate the film with virtually zero stress, which is what they wanted!



This is a 50 cm linear target, which enables concept related to in-line linear source coating systems that could support continuous feed, web, or carrier plate processes.

Interview with Mike Johnson from Conductive Inkjet Technology

Michael Johnson is the business development director at Conductive Inkjet Technology in the UK. A chartered engineer with a First Class Honours Degree in Mechanical Engineering, Mike was a company scholar of Metal Box Limited beginning his career in production management. Moving from the packaging industry into electronics, he joined Thorn EMI where he ran the manufacturing of one of their factories producing data communications products as well as the original Sinclair Computers. He then moved to become a director of Livingston Hire, a market-leading service organisation where he was involved with the transition of a complacent market leader into a truly customer focused growth-oriented company. He was then appointed managing director of Soundcraft Electronics Limited, a £40 million producer of music mixing consoles before moving to be MD of COIL – the leading designer and manufacturer of plastic optical parts. This was acquired by Carclo plc in 1998, which led to him being appointed business development director. The role of bringing new technologies to Carclo led to the formation of Conductive Inkjet Technology.

Please give us some background information about CIT. Carclo Technical Plastics was looking at methods to inkjet decoration onto mobile phone parts. Excellent samples were produced, but when the customer, Motorola, asked for its logo to be printed, which was silver, no process existed at that time for inkjet printing metal. Carclo funded work with Xennia – an inkjet integrator, and when the technology looked successful a joint venture, CIT, was created to hold the IP and to commercialise the technology.

You recently severed financial ties with Xennia and are now a wholly owned subsidiary of Carclo. Why did this happen? The board of directors of Carclo announced that it has entered into an agreement to increase its equity investment in CIT from 74.4% to 100%. CIT has highly attractive growth prospects across a broad range of applications including sensor and RFID applications, photovoltaics, and displays. To ensure that these growth opportunities are developed effectively and that the full benefit of this growth accrues to Carclo's shareholders, the board decided to acquire the remaining minority interest in CIT.

Do you still maintain a close relationship with Xennia? Yes indeed. Although CIT is now a stand-alone company with its own facility and relevant staff, Xennia is still the preferred supplier for flat bed inkjet platforms.

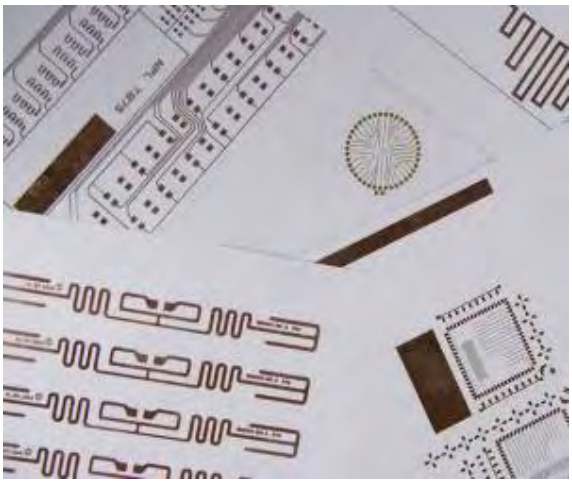
Tell us about your relationship with Preco? Preco is an established US company involved with the manufacture of screen print equipment as well as reel-to-reel web handling. We have chosen Preco as our preferred supplier for reel-to-reel inkjet equipment, as with them we have created the MetalJet 6000 high-speed digital printing system for producing low cost RFID antennas. In addition to Preco specifying, supplying and servicing the MetalJet 6000 platform, they have also decided to build one and offer a CMS service to those customers who want supply of reels of product.

What is it that makes your "conductive inkjet" formulations so special? The ability to inkjet a material that has been designed for reliable inkjetting is the unique feature. The ink does not contain metal particles and so is a single print process. The ink is then UV cured, so not requiring a heat/sinter process and then the metal is applied in a second process.

What advantages do you have over a nanosilver ink process? The key advantage is cost – the CIT process produces products that are significantly cheaper. In addition only one inkjet print pass is required, rather than repetitive passes to lay down sufficient metal, and there is an instantaneous UV cure process,

rather than a heat process that can deform flexible material. Moreover, excellent conductivity can be achieved using our subsequent metalization process.

Please explain how "autocatalytic deposition" works. This is standard electroless plating. The catalyst in the inkjet printed ink, when placed into electroless chemistry, causes the metal to form onto the pre-printed pattern and then on itself growing a layer of metal onto whatever has been printed. This is a standard process used in the PCB manufacturing industry.



CIT prefers to use copper on PET, but can work with a variety of metals on numerous different substrates

What metals seem to be most effective in your process? We work predominantly with copper – as it is low cost and gives high conductivity – but the process is suitable for any transition metal. We can plate with copper and then over coat with nickel and gold, again just as is common in the PCB industry. Silver is also a suitable metal.

What substrate materials seem to work best for your process? Our ideal substrate is PET but we are, of course, working with a significant number of other materials such as glass, silicon wafers, polycarbonate, etc. The key is that in order to get sufficient wetting and adhesion on other materials, we may need to amend the process, or perhaps amend the chemistry of our ink.

Can your inks be used in any printhead, or do the inks have to be formulated specially depending on the printhead? The inks have been designed to go through any drop-on-demand piezo driven print head.

Tell us about the tradeoffs between droplet size and the wetting properties of your inks? What do you see as the smallest feature sizes that you can reliably print? Using inkjet alone, the smallest feature size that can be printed will be around 50 microns. We can print this, but on lab-based systems using small drop size – not on systems needed for high volume production. When we run our high-speed reel-to-reel system we produce line widths of around 100-200 microns, which are ideal for applications such as printing RFID antennas. We would select the relevant print heads and platform for the specific application.

You've proposed to inkjet print course features and then cure finer features using a UV laser before the plating process. Please explain further and tell us what this means in terms of feature sizes. As the catalyst ink is UV cured we can offer two options. The first is to coat the substrate with our ink and then use a photomask to cure the ink using UV light. We then wash off the uncured ink and plate as per normal. Alternatively we can inkjet print a thin line and then using a laser, cure the centre of the line and wash off the balance. The choice of method is determined by the application. Using these methods we have demonstrated line widths as low as 2.5 microns wide, which are invisible to the naked eye.

The CIT process can enable very fine line structures, as small as 2.5 microns, which is invisible to the naked eye

Describe your "Print2Chip" solution. Print2Chip involves placing the chip on a substrate, pads facing upwards and then using a vision system to locate the pads. The print head then prints the relevant pattern to print the catalyst ink from the pad to either another component or to an antenna. It is possible to lay the chip down and then print the connection and the antenna in one go. This removes the need to accurately place the chip.

Can Print2Chip be done reliably on a flexible substrate? We have gone as far as demonstrating the process in a lab using flexible substrates satisfactorily, but this has not yet moved to a high volume process.

CIT has developed a plating process you call "random web". Tell as about why this is important. The random web is a way of placing a lot of web into a small bath of chemistry. The importance of this is only to reduce the footprint of the machine to produce reels of product. As the conductivity is dependent upon the length of time the web is in the plating chemistry, and as the inkjet printing can run at 0.5 meters per second, the random web enables a sensible run speed to be obtained to put down sufficient metal in a much smaller footprint.

In the next couple of years, what market segments do you expect will comprise the bulk of CIT's sales? We plan to focus in three areas: electronics – i.e. RFID antennas and flexible circuitry, displays, and photovoltaics.

How do displays fit into your long-term plan? The fine line work that we are developing is ideal for displays in three areas:

- Laser cured fine lines for "invisible" front conductors
- Reduction in wasted display area via fine line pixel interconnection
- Provides necessary conductivity assistance to ITO as screen size increases

This work is initially being undertaken with CDT to produce a technology demonstrator.

When you sell to electronics companies, it seems unlikely that the consumer printing model can be repeated, where money is made from selling ink. Is there an opportunity for reasonable profit margins when selling only ink? Indeed, the CIT business model is to:

- Supply, under a technology license, our patented UV cured catalyst ink (and metalization fluid)
- Through our approved partners Preco Inc and Xennia Limited, supply integrated technology platforms
- Reel-to-reel narrow web inkjet metal printer
- A4 lab based systems to A0 sheet fed
- Through our partner, Carclo Technical Plastics, the CIT process can be integrated with molded parts
- OEM partnerships for specific market applications
- Technology licensing

Do you expect the bulk of your sales to be in Europe or elsewhere? We are seeing an even split in interest from Europe, Asia, and the US.

Describe the "perfect customer" for your technology. The perfect customer has to be one where there is a match between his specification and the technology's performance, who has a high volume application and sees the CIT technology as enabling. He hopefully would then want to buy a lot of ink!

Please describe what you think CIT will look like three years from now. In three years, CIT will be supplying ink into the three market areas: electronics, displays and photovoltaics. Customers will be using MetalJet 6000 systems to produce reels of product and other customers will have application specific platforms integrated into their production processes.

Interview with Tracey Stephens from Xennia

Tracey Stephens joined Xennia Technology in April 2004. She is Xennia's VP Business Development and brings extensive high tech marketing, strategy, and business development experience to the role. Tracey was a founding employee of Plastic Logic, a leading developer of polymer electronics and VP Market Development for Polight Technologies, a pioneer in holographic data storage materials. Prior to this, she spent 15 years with Hewlett-Packard in management, marketing and engineering. Tracey earned her MBA from the Judge Institute, University of Cambridge, and holds a BA in physics and mathematics from the University of Northern Colorado.

Please give us some background information about Xennia. Xennia is the world's largest independent industrial inkjet integrator. We've spent more than a decade developing new applications for inkjet and one of our biggest differentiators is our chemistry-driven, total-solution approach. We've been involved in applications as diverse as photovoltaics, 3D product decoration, displays, smart textiles, ceramics, security, bio-dispensing and high-speed mail addressing.

What's the difference between "printing" and "functional materials deposition?" That's a very good question. What's good for the eye (graphics) can be very different from what's good functionally (materials deposition). We can borrow clever tricks from the desktop world to optimise industrial inkjet printing for graphics. Graphics inks are commonly water-based, solvent-based or UV curable and typically, visual performance and durability on a variety of substrates is key. For functional materials deposition, the requirements are diverse and can often require ultra-high precision substrate handling, drop visualization, and fiducial recognition for printing of multiple layers, not to mention the end-use requirements for fluids that may incorporate "difficult" ingredients such as nano or large particles which must remain in suspension, aggressive acids or alkalis, bio-fluids, magnetic materials, and in some cases, even radioactive substances.

Do your inks need to be customized for each printhead solution? For the most part, yes. While many inks have certain general characteristics that make them adaptable, printhead designs differ and it is important to ensure that the fluid is optimised for the particular printhead technology.

Does the ink need to be specially formulated depending on the substrate to which it is being jetted? Without question. As an example, a UV curable ink designed for printing onto a metallic film may never completely "dry" if printed onto a porous substrate such as paper. As another example, an ink formulated for Kapton may not adhere to glass. When developing a new ink, we always begin with a thorough understanding of the application requirements.

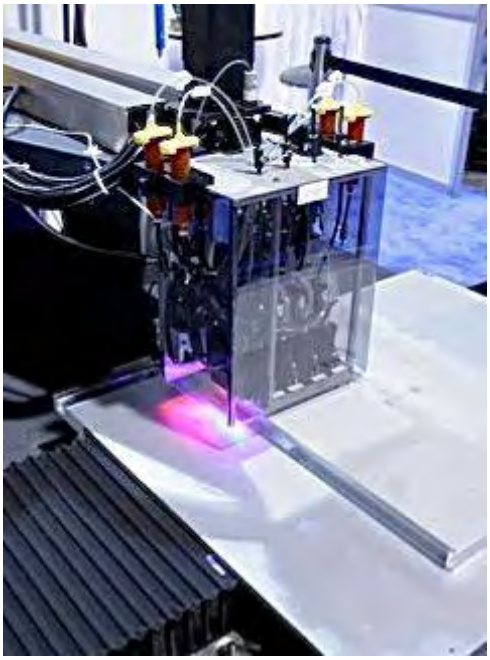
In what areas is Xennia currently involved with printable solutions for the electronics industry? Xennia has been involved with inkjet solutions (fluids and hardware) in the areas of plasma display phosphors, LCD colour filters, PI alignment layers, conductive metals for backplanes and antennae, OLED and PLED materials, anti-scratch, anti-reflective and optically precise coatings, solar cells, sensors, and MICR (magnetic) security just to name a few.

With regard to LCD and PDP manufacturing, can you give us a rough percentage breakdown between printed colour filters, plasma phosphors, LCD spacers, alignment layers, and others? I'm not a display market sizing expert but what I can say with confidence is that the opportunity for industrial inkjet for display manufacturing is enormous and only in its infancy.

Are the challenges of developing new solutions for the exiting LCD and PDP industries more or less challenging than developing solutions for the emerging organic-based display industry? They are both challenging, but in different ways. Simplistically, in the case of LCD and PDP manufacturing, there is an existing capital infrastructure and the challenge is to introduce new processes that fit with or displace what is currently there. For the organic-based display industry, challenges include materials development and novel device design.

Do you envision a day when an entire display will be inkjet printed? Yes, though I do think that we need to cautious about having goals for the sake of goals. An all-printed display may be seen as the "holy grail" but there is still plenty of room for hybrid printing/non-printing solutions that may be even more economically successful.

Xennia recently developed the world's first and only water-based UV-curable ink for use in thermal inkjet printheads such as HP, Canon and Lexmark. Tell us why that's important to the electronics industry. We are particularly proud of this breakthrough because many said it could never be done. Today, applications for the technology include high speed, durable coding and marking on non-porous substrates, but ultimately one could certainly envision robust industrial materials deposition taking the form of a clean, easily replaceable cartridge.



Tell us about your printer solutions. Xennia offers a variety of custom and off-the-shelf systems and fluids. These include scanning XY flatbed, fixed array single pass, continuous indexed and robot driven print systems. We also offer a range of inkjet lab tools including very flexible and configurable inkjet development systems and drop visualization and characterization equipment.

Is reaching sub-picoliter drop sizes mostly an issue with printhead technology, or is it more related to inkjet formulations? With inkjet, it really is difficult to talk about printhead technology and inkjet formulations in isolation as they go hand-in-hand. As drops get smaller, the energy needed to eject them from the printhead must increase in order that the effects of fluid surface tension can be overcome. Additionally, as drops become smaller, their surface area to mass ratio changes and as a result, they tend to decelerate more quickly which reduces the allowable throw distance. These challenges impact both printhead design and fluid formulation.

Xennia has developed a variety of inkjet printer solutions, including a range of inkjet lab tools including configurable development systems and drop visualization and characterization equipment.

Do you imagine that inkjet will be able to reliably print at 10-micron feature sizes in the near future? I suppose it depends on what you mean by "reliably" and what you mean by "near future"! Today, a printhead with the smallest drop size coupled with an optimised fluid formulation, coupled with the perfect ink/substrate combination, coupled with ultra-precise substrate handling might get you close and you could probably do it more than once in a lab environment. To further reduce feature sizes, there are a number of techniques presently under investigation such as self-aligned printing and surface energy patterning. While these pursuits are incredibly exciting and may prove to be significant, here at Xennia, we tend to focus on the real-world application of cutting edge industrial inkjet technology. We believe that materials deposition will enter the mainstream of manufacturing techniques not by chasing the ultimate in small feature sizes but instead by capitalizing on attributes which can be implemented in a 24/7 production environment such as precision dispensing, customized mass production, direct, additive and efficient deposition, non-contact printing and the ability to process very large and/or flexible substrates. There are countless existing potential industrial inkjet applications which don't require sub-10-micron feature sizes.

Interview with Edward Buckley from Light Blue Optics

Dr. Edward Buckley is responsible for worldwide business development activities at Light Blue Optics, working with customers based in Europe, USA and the Far East. Prior to his position at Light Blue Optics, he worked with a variety of organizations, including a telecommunications consultancy and a multinational aerospace & defence company. Dr. Buckley has authored and peer-reviewed over 20 papers and conference proceedings. He holds a Masters degree in electrical and electronic engineering from University College London and a PhD from the University of Cambridge

Please give us some background information about Light Blue Optics. Light Blue Optics (LBO) is a privately-owned company headquartered in Cambridge, UK, developing a radically new display technology: holographic laser projection. This completely unique approach to projection creates high-quality, full-colour images and enables highly efficient, low-cost miniature projection systems that have applications across a range of markets including automotive and consumer electronics. LBO was founded in 2004 by four post-graduates at the University of Cambridge, and is now funded by a group of investors including the FTSE 100 listed global venture capital firm, 3i plc. LBO closed a seed funding round of $2.5 million in July 2006, followed by an extension of $1.5 million in December 2006. In October 2007, we closed a Series "A" funding round of $26 million – the largest Series "A" funding round in the European electronics sector for five years. The money will enable us to accelerate our product development and commercialisation program towards high-volume manufacture of miniature projection systems. We estimate that the total available market for miniature projection systems will exceed $5 billion by 2012.

What is the origin of the company's name? The name refers to the University of Cambridge's team colours – light blue.

Tell us how your holographic laser projection system works. The holographic approach to projection has a range of features unlike any other display technology. The term "holographic" refers not to the projected image, but to the method of projection. The LBO approach to projection uses highly efficient algorithms to convert the desired 2D image into diffraction patterns (holograms), which are displayed on a tiny liquid-crystal-on-silicon (LCoS) microdisplay. When these holograms are illuminated by coherent laser light, the image is formed by the physical process of diffraction. This method of image projection has several key advantages over both conventional lamp or light emitting diode (LED) projection systems and competing laser projectors. The conversion of the image to a hologram representation gives LBO's technology a huge advantage in terms of power efficiency. This is because, unlike conventional projection systems which block light to create dark areas, LBO's holographic laser projection technology steers the light to exactly where it is needed, making the system highly efficient. Hence, if in the projected image only one pixel is illuminated, then only the power required to illuminate that pixel is used. The additional benefit of a very low laser modulation frequency gives a clear power consumption advantage compared to scanned beam systems. Furthermore, because the hologram pattern is not a 1:1 representation of the desired image, then the system is highly tolerant to microdisplay pixel failure – essential in safety critical applications in markets such as automotive. Unlike conventional projection, there is no need for a focus control as images remain in focus at all distances from the projector. Images can be projected onto curved or angled surfaces without distortion. Furthermore, our technology has a unique feature in that the throw angle (the angle at which the image leaves the projector aperture) can be greater than 100º, creating large bright images close to the projector aperture, whilst maintaining an acceptable laser safety classification. Finally, the system has no moving parts, no projection lens and is ideal for miniaturization since diffractive systems are increasingly effective at smaller sizes. Indeed, the technology is consistent with the production of light engines as small as 5 cc – smaller than a sugar cube.

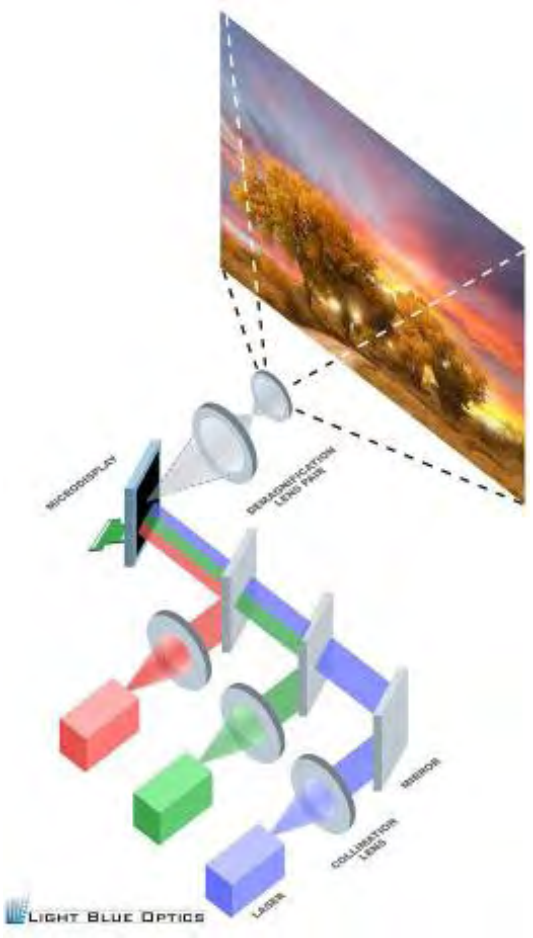
You claim to offer an "infinite focus image". What exactly does that mean and how do you implement it? In our system, when the diffraction pattern on the phase-modulated microdisplay is time-sequentially illuminated by coherent red, green and blue laser light, the desired image is formed. As a direct consequence of Fourier optics and, due to the properties of diffraction, the image is in focus at all distances from the projector.

What unique features does the LBO solution offer that other projection systems do not? LBO's unique holographic approach to projection has numerous advantages over the scanning and imaging-based miniature projection systems currently being developed by other companies. Our miniature projection systems simultaneously deliver a range of features and benefits including; an ultra-wide throw angle greater than 100º, infinite focus, low power consumption, in-built speckle reduction, no moving parts and a simple, robust optical design that naturally lends itself to miniaturization and low cost manufacture. Other projection systems offer some of these benefits, but only LBO's miniature projection systems can simultaneously deliver them all.

Lasers come with a connotation of something that can cause eye damage. Please comment in relation to your developments. LBO's miniature projection systems are unique in having an expanded beam output and ultra-wide throw angle. The combined benefits of the expanded beam and the wide-throw angle enables the production of large, bright images while simultaneously allowing a low power density at the projector exit aperture – thereby maintaining an acceptable laser safety classification. In the case of consumer electronics applications, it is anticipated that LBO's technology will meet the Class 1 laser safety classification, which is eye-safe under all operating conditions of normal use.

Do you refer to your product as a pico-projector? Why or why not? LBO is developing light engines for use in applications across a wide range of markets such as automotive, aerospace and defense, digital signage and consumer electronics. Our light engines will power such "pico-projectors".

Small mobile devices are limited due to the small size of the display. Do you foresee your projection solutions replacing displays in handheld devices or supplementing them? In hand-held applications, LBO's projection technology will free multimedia content from the constraints of the screen and give users a richer viewing experience with projected images that can be in excess of a 50-inch diagonal, depending on environmental conditions. Our technology will also make it easier for people on the move to share content from their hand-held devices with others, enabling comfortable viewing by multiple people for extended periods of time. We do not see our systems as entirely replacing the need for a conventional screen, since there are many use-cases where it would not be necessary to view content on a larger display or where sharing the content with others would not be appropriate.

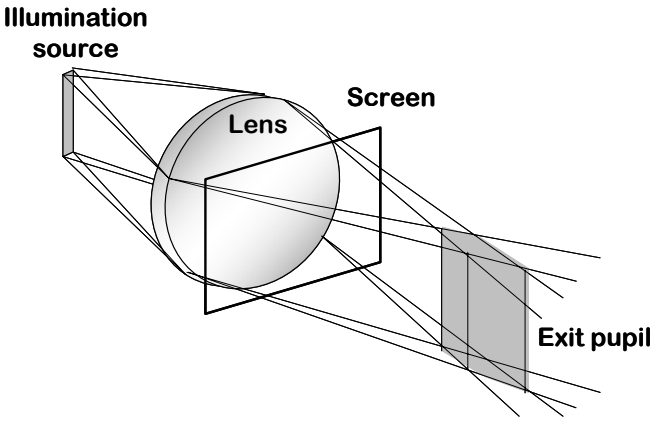


Do you foresee that your projectors will be built in to portable products or an additional external accessory to such projects? The ultra-wide throw angle, low power consumption and small form factor of LBO's holographic laser projection technology are entirely consistent with the production of both accessory and embedded mobile projectors.

What do you expect will be the first market to adopt your technology? We expect that the first products containing LBO's miniature projection systems will be released in the consumer electronics market from the end of 2008, with a roll out of products across a range of markets from 2009 and beyond.

Tell us about your involvement in the MUTED program. Whilst LBO is focused on the 2D projection systems market, there are numerous potential 3D applications for the company's holographic projection technology. The company is a partner in the De Montfort University-led Multi-User 3D Television Display (MUTED) project, which aims to develop a practical multi-user 3D television system using LBO's holographic laser projection technology to form a dynamic laser backlight. In addition to De Montfort University and LBO, there are five other participants in the consortium: Sharp Laboratories of Europe, Fraunhofer HHI, The Eindhoven University of Technology, University of West Bohemia and Biotronics3D.

What exactly is a "steerable backlight"? The core concept of the MUTED multi viewer display is to produce image regions, or exit pupils, in space in front of the screen at the viewer's eye positions. The accompanying figure illustrates this concept in which an exit pupil is formed with the use of a large lens and a vertical light source. Altering the position of the illumination source causes a corresponding change in the position of the exit pupil; this is the "steerable backlight" in question. In order for 3D to be observed, two adjacent exit pupils must be formed; this is achieved by placing a second illumination source to one side of the existing source to produce an additional exit pupil. The MUTED display uses an LCD panel with left and right eye images interlaced on alternate pixel rows. A lenticular screen is fixed and placed behind the LCD screen where it is used to focus a steerable backlight through the left and right image rows of the LCD. Crucially, steering of the viewpoint is accomplished not by lenticular movement but by movement of the light source. Provision of an additional light source, adjacent to the first, produces another exit pupil and provides scope for displaying a stereo pair.



Exit pupil formation with a lens

What are the advantages of using LBO's technology in a 3D projection system? The predecessor of the MUTED display, ATTEST, utilized a steerable LED backlight. This was fundamentally incompatible with the main requirements for a steerable backlight, namely the display of multiple point sources each with well-defined spectral characteristics. As a result, the ATTEST backlight was rather dim and inefficient. A far better alternative is to use a laser backlight; careful selection of the wavelengths and powers of the red, green and blue lasers to match the LCD panel colour filters enables the creation of a bright and efficient white light backlight. LBO's technology was chosen because it provides a highly efficient method of directing laser light into multiple, well-defined spots. The use of a conventional imaging projector for this application is prohibitively inefficient since the amplitude modulating characteristic of the display acts to block most of the incident illumination from the image. Scanning laser systems, which employ one or more MEMS mirrors to raster scan a beam of light whilst modulating the power of the lasers according to the image content, are similarly compromised since the high frequencies at which the lasers are modulated place an upper limit upon achievable brightness. LBO's projector provided by far the best method of producing a high efficiency, high-bandwidth white backlight at the powers required to produce a bright, uniform display.

How does LBO plan to make money – based on licensing, hardware sales, or design implementation services? LBO will develop, manufacture and provide customers with a common light engine platform, manufactured through a third party partner to ensure the lowest possible cost.

Please describe what you think LBO will look like three years from now. LBO believes it can become the world's largest supplier of miniature projection systems because it has a world-class team developing a novel, patented technology with multiple competitive advantages and excellent customer traction in a range of high-volume markets.

Interview with Justin Fry from Seamless Display

Justin Fry, CEO of Seamless Display, co-founded the company and now oversees corporate strategy and execution. Justin has 15 years experience in technology companies in the USA, Canada and the UK. Before taking over as CEO of Seamless Display, Justin was the CEO of Visual Click Software, a networking and security software company that grew considerably during his tenure. Previous roles include management and consulting roles with StreamBase Systems, Elron Software (acquired by ZixCorp), ON Technology (acquired by Symantec) and Future Electronics in North America and Europe. Justin holds an MBA from the Saïd Business School, University of Oxford winning the MBA Prize. Justin's BA is from the University of London. Justin has also studied computer science and software engineering at Imperial College London and Oxford University.

Tell us about how Seamless Display came into existence. We all met at the Saïd Business School in Oxford in 2002. I had been working in North America for technology companies and wanted to go back and do an MBA at a university with a good record in spinning out technology start-ups. Dr. Bernard Stark, at the time, was a researcher designing integrated electronic circuits and his frustration with the gaps between his two 19.0-inch Dell monitors led to a solution to enable seamless tiling of high-resolution, off the shelf LCDs. He showed me a concept prototype made from scrap sheets of plastic, so I suggested starting up Seamless Display to commercialise these ideas.

Please describe your basic technology. We overlay the display with a flat plastic cover, which, towards the join with another LCD, has a rounded surface. This acts as a lens and stretches the image across the inactive gap of the adjoining LCDs. In order to avoid the image appearing stretched, we also need to process the image before it gets to the LCD. We have patents granted and pending.

Is there any limit to the number of displays that you can tile together? For example, could you create a display system that would circulate completely around an individual? No limit, how much money do you have to spend? Seriously, it is simpler for us to tile in one direction than in two, but we have made prototypes that are tiled in two directions.

Does display resolution impact your stitching technique? The majority of the display is seen directly, so there is no loss in resolution. Over the join area there is a minor loss of resolution but it is not readily noticeable to the user.

Your current model is comprised of LCD panels. Are you limited to using LCDs, or could other display technologies also be used? Ideally we join display technologies that already have narrow borders, so for example OLEDs and LCDs. CRTs are more difficult but in principle possible.

Although your displays have no visible seams, there is some visible distortion at the seams. Are you working on ways to further mitigate the impact of these distortions? Yes, we are. There are a number of technologies we can utilize to further minimize this, but in user trials the display is usable and acceptable.

Can you tell us about any studies relating to work productivity gains that result from using multi-monitors. Reports from Apple, HP, Microsoft and the ATI-University of Utah study point to productivity improvements of 39% to 79%. Everyone we speak with say they see a step-change improvement when

using a larger screen. The problem most people have is that large screens are a) low resolution (a 40-inch panel only has HD quality – 2 million pixels); and b) large flat screens are great for TV viewing distances but not for desktop. The distance from the eye to the screen varies too much. We solve both these problems by offering a high-resolution wrap-around system.

What do you consider to be the primary benefits associated with the Seamless Display system?

1. Immersive display environments: as we can make wrap-around screens from existing LG screens, this offers a desktop immersion environment without the need for goggles or cumbersome projection systems.
2. High resolution: our customers need high-resolution displays and are not interested in compromises. We deliver on this and provide a seamless solution as well.

Do office programs like Word and Excel open so as to show a continuous series of pages or extra-wide spreadsheets? You can choose. Stretch Excel across the whole screen and you get 7,623 cells. View five pages at full size in Word or zoom out to get a perspective on the overall layout of your document – we couldn't do business without this.

One can easily imagine that gamers would be interested in your solution, as it certainly enhances the immersive experience. Do most gaming platforms run satisfactorily in a multi-monitor situation? We'd like to address this market, but it will take a few years more before the video cards to support our 5.76 million pixel resolution are available at prices that gamers can afford. In addition, over 60% of gaming PCs are laptops and have problems supporting a) high-frame rates, and b) more than two screens without extra hardware. Matrox's Triple-Head-To-Go product does help with creating a single logical desktop of up to 3840x1024 pixels from one VGA or DVI output but this does not use our full resolution of 4800x1200 pixels. Alternatives are coming along with USB to DVI and the Magma product, but again the frame rates and support for high quality 3D graphics at a price gamers can afford is just not there yet.

In applications like Google Earth or Virtual Earth, are you able to open the browser to fill up the entire multi-screen imagery? Yes you can and it's awesome. Google Earth's desktop application is pixel-challenged as it uses OpenGL or DirectX which cannot support the 4800 pixels horizontally. We prefer Microsoft Virtual Earth or using Google Maps via a web browser as the web browser doesn't care how big the screen is, it just keeps on grabbing content until the screen is full up.

In what market segment are you seeing the most interest for your product? Immersive data environments such as oil and gas exploration, computer-aided design, medical imaging and professional audio/video editing.

Are special graphics cards required? Our current product needs three DVI signals from one computer running up to 1600x1200 pixels. As with all video solutions, the faster/more memory, the better.

Since your solution requires more data to stream to the display all at once, do you need expanded bandwidth at the interface or cabling level? No.

Compared to buying three separate monitors and the connectivity solutions required to create a multi-monitor solution, about how much of a price premium are you currently asking for your Radius 320? We're selling to people who spend $10k-$80k on their workstations so these are not your average, not even your premium business users. Their alternatives include the Barco 56-inch panel (cost $42k) and we're less than 50% of that price.

Where are you currently manufacturing the Radius 320? That's confidential – we'll get gamers showing up at the door if I tell you.

In the long term, are you planning to sub-contract the manufacturing, produce yourselves, or license your know-how to existing display manufacturers? We are very interested to work with larger electronics companies to address the higher volume markets for business users.

What has been the biggest challenge you've faced to date in terms of technology? Our desktop displays are tiled horizontally and have optical covers that have rounded profiles at the vertical edges. Displays that are tiled in two dimensions have profiles on all edges and at the corners of panels. The corner profiles are complex 3D surfaces; our engineers have complained about the calculations involved here...

Tell us about one of your favourite customer success stories. One military client had a problem with tanks going missing in the gaps between screens; I hope we solved that one.

Please describe what you think Seamless Display will look like three years from now. We will have more premium desktop display product lines and be licensing our technology to more electronics manufacturers for low-cost displays as cheaper and more powerful video cards enable more and more people to benefit from larger and larger screens. In addition, we would really like to do more in the handheld space, imagine a three-screen Garmin mapping device with a small footprint but with a large and wide screen.

Are compact fluorescent lamps with integral ballasts fit to replace incandescent lamps?

by Robert Simpson

The UK Displays and Lighting Knowledge Transfer Network was asked to comment on the issues surrounding the possible phase out of conventional tungsten filament lamps and their replacement by CFLi lamps. This document has been prepared on behalf of the UK Displays and Lighting Knowledge Transfer Network (UKDL) by Robert Simpson, Chairman of the Advisory Committee of UKDL.

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The possibility that the majority of conventional incandescent lamps might be banned in the near future (as implied by a DEFRA announcement in September 2007) raises a number of issues, and the possibility that over-hasty action may result in an unwelcome dose of "the law of unintended consequences".

Cynics could ask questions along the lines of:

- Is the move the result of lobbying by the lamp manufacturing Industry to raise the unit price of lamps?
- Is the move motivated by the lighting, lamp and luminaire Industries wanting users to replace their existing luminaires (which work perfectly OK) by the introduction of incompatible lamps?
- Is the move "political" in the sense of allowing the government to be seen to be "green", and of apparently making it easy for the general public to make a "green gesture"?
- Is the move one that helps big business to gain "green brownie points" (also known as carbon credits) by off-loading the issue on to the general public?
- Is the move intended to lower CO_2 emissions worldwide, or only to improve the UK's own figures?

However, if a number of assumptions are made, it is possible to narrow the debate down to a single question. Let us take as our assumptions:

- There is no need to consider commercial/industrial lighting that is already regulated in respect of luminaire lumens per circuit watt (Building Regulations Parts L2A and L2B). This largely precludes the use of GLS incandescent lamps.
- The same regulations (Parts L1A and L1B) have application to new residential buildings and refurbishments and extensions of existing dwellings; the requirement is that for every 25 m^2 there must be at least one lighting circuit with more than 40 lumens per circuit watt, tending to ensure that intensively used lighting (e.g. in kitchens etc) is also of high efficiency.
- Many residential installations now also use relatively efficient tungsten halogen lighting. (It can be shown that for many applications the greater optical efficiency of luminaires based on tungsten halogen lamps makes much better use of the available lumens than equivalent wattage compact fluorescent lamps.)

We are then left with the use of “traditional” light bulbs in the home – i.e. GLS lamps in the range 25–150 W, which are the subject of the proposed DEFRA “phase out”. In a typical home these lamps will be used wherever there is a BC (bayonet cap) lampholder – for example in standard lamps, table lamps, pendant lamps, etc, and in places like the cupboard under the stairs, cloakrooms etc.

The assumption that appears to be being made both by the lamp manufacturing industry (which, incidentally, barely exists in the UK) and by organisations like DEFRA is that the GLS lamps will be replaced by compact fluorescent lamps with integral ballasts (CFLi lamps) since these can in theory be installed as direct replacements. So the simple question is: “Are CFLi lamps suitable as replacements for all GLS incandescent lamps in the residential environment?”

The debate

The possibility that the GLS lamp may be banned has been greeted with considerable dismay by many in the lighting business. It is unfortunately the case that the worldwide lamp industry has done itself no favours in the past (and in many cases right up to the present) by the sale of unreliable CFLi products, and also by introducing a huge range of products with different attributes in respect of colour rendering, suitability for retrofitting, tolerance of switching cycles, life etc – all of which have served to confuse the consumer.

While there is no doubt that the latest CFLi products from reputable manufacturers address many of the concerns that have been expressed by “opponents” of the CFLi, it is sensible to review these concerns. It will become clear that the major problem is that there are no enforced standards, so even if a problem is potentially soluble, in practice unsuitable or even dangerous products will get onto the market.

It seems an obvious statement, but surprisingly few organizations other than the Society for Light and Lighting have made it publicly, that CFLi lamps intended for GLS replacement should as far as possible perform exactly like a tungsten incandescent lamp as far as the user is concerned. Ideally this would mean, for example, that all would have the same colour rendering and colour temperature. Applications requiring different characteristics would then be met by using lamps with external ballasts. But this happy outcome at present seems unlikely.

Physical characteristics

Early CFL lamps were bulky and aesthetically unappealing – many still are. However the manufacturers have succeeded in greatly reducing the size of CFLi lamps, and in some cases have been able to reduce them to a similar size and shape to the GLS lamp. However there are no standard sizes, and users have to take a view as to whether the available lamps will fit into existing luminaires. Many users will be compelled to change luminaires because the CFLi lamp does not fit, or results in an unacceptable appearance, or gives a lower effective light output.

Colour rendering; colour temperature

The ideal is that the colour temperature matches that of a tungsten lamp (around 2700K) and that the colour rendering is Ra = 100 referred to Standard Illuminant A (a performance nearly achieved by the GLS lamp). In practice CFLi lamps have colour temperatures 2500 – 7000K and colour rendering anywhere down to Ra = 50. Such variations from the ideal have led to disenchantment with CFL. However there is technically no reason why such bad performance should be accepted.

The Energy Savings Trust’s “Energy Saving Recommended” accreditation specifies that CFLi lamps must have colour temperature in the range 2600 – 2800K. The European Lamp Companies Federation states that its manufacturers’ CFLi lamps have Ra = 80–85. In practice 80 is “borderline”, and it would be better if 85 was specified as a minimum. The underlying problem is that better colour rendering comes at the expense of efficacy.

While there are applications for lamps with a different performance, the discussion here is about lamps in

the home where users should reasonably expect comfortable lighting. As a human race nearly our entire evolution has been based on light sourced from the sun – we are "comfortable" with continuous spectrum light, and for reasons which we may not be able to express, feel uncomfortable with light that is derived from narrow spectra.

Light output: wattage equivalents

The main consumer complaints about the performance of CFLs have been about the apparently poor light output. A number of factors apply here:

- Most buyers will be guided by the "wattage equivalent" table provided by the manufacturer. For example that an 11 W CFLi is equivalent to a 60 W GLS lamp. Unfortunately many of these seem to be optimistic – taking the worst performance of a GLS lamp against the best possible performance of the CFLi.
- Lamps do not reach full output until some time after being switched on. This is highly unsatisfactory. Even the Energy Savings Trust "Recommended" accreditation says that CFLi lamps "will reach at least 60% of their full brightness in 60 seconds" which is hardly a good performance for those many applications (larder light, going to the loo at night, greeting a burglar) where instant light is expected.
- Light output is ambient temperature dependent (and to some extent lamp attitude dependent). A fluorescent lamp gives its rated output at a specified temperature. For example a typical performance is 100% at 25°C ambient, but only 70% at 10°C and 40% at 0°C. There is also a fall-off at higher temperatures, but the effect is not so bad, e.g. 80% at 50°C. To some extent the effect is mitigated by suitable luminaire design that ensures that the lamp heats up sufficiently (thus partly accounting for the delay in reaching full output).
- Light output declines through life. Performance here is variable; it depends both on the phosphors used and the quality of manufacture. Lamps from reputable suppliers give acceptable performance in this respect.
- Luminaires designed for GLS lamps may not give efficient light distribution when retrofitted with CFLi lamps, thus giving the appearance of lower light output.

Taking all these factors together may well mean that users will find it necessary to use a lamp of rating higher than expected to get acceptable performance – and therefore will not achieve the energy saving expected.

Power factor: harmonics

This topic may be the "elephant in the room". It is interesting that neither the Lighting Association nor the European Lamp Companies Federation address it in their "frequently asked questions", although they robustly rebut many other criticisms of CFLi. (An explanatory note on the meaning of "power factor" is given in Appendix 2)

Current CFLi lamps have an appalling power factor (around 0.5). This arises because of a loophole in the regulations. The majority of electronic ballasts for fluorescent lamps are required under European legislation to limit the introduction of harmonics, and the result of this is that all such ballasts have a power factor of 0.9 or better which is acceptable. However lamps below 25 W are exempted from this requirement. In practice this means that virtually all CFLi lamps are uncorrected. Interestingly reputable manufacturers of separate ballasts include power factor correction in small lamp ballasts (e.g. down to 9 W) recognising that there may be installations using many such lamps where the cumulative effect is unacceptable.

This exemption did not present a significant problem while comparatively few CFLi lamps were in use. But if the numbers of GLS lamps to be replaced are as large as claimed, the effect of this large uncorrected load will be considerable. As far as can be judged, the industry is taking the view that the supply network can absorb the harmonics, and it would make little difference if CFLi lamps were properly corrected (a

public statement of this attitude is the Lighting Industry Federation's Technical Statement No 11, but this dates back to 2002 and its attitude may now have changed). The consumer will benefit from lower electricity bills anyhow.

Of course this cannot be true – even if the consumer is not being charged for the VA directly, there will be higher generation costs ultimately reflected in prices. Most importantly, consumers are being fooled. The CO_2 reduction performance of such lamps will be only HALF the headline figure, because the power stations will still be belching out enough CO_2 to generate the VA. Large quantities of uncorrected lamps will also have a bad effect on power quality at a local level.

Flicker

There have been complaints that CFLi lamps "flicker". Both the Lighting Association and the European Lamp Companies Federation strongly refute this; pointing out that such lamps operate at between 30 kHz and 50 kHz, which frequencies are way beyond those which can produce perceptible flicker. Indeed it is the case that the quality of fluorescent lighting in the higher (separately ballasted) ratings has been enormously improved by the introduction of high frequency ballasts.

However, an uncomfortable fact from the CFLi protagonists' point of view is that because of the cheap (but highly ingenious) ballast circuitry used in CFLi lamps, such lamps (not necessarily from all makes) DO produce a variable light output.

The UK Health Protection Agency has measured significant (>7%) 100Hz modulation in the light output of CFLi lamps bought from high street retailers. Susceptibility to flicker varies greatly from individual to individual, and its effect can vary from the merely irritating to the triggering of migraine etc. Because of the dual nature of the eye (two different kinds of receptors) we are more sensitive to flicker through our peripheral vision, so it could be the case that the placement of lamps will make a difference. For example someone reading a book under main lighting could be disturbed by the modulation of light from a secondary peripheral source.

This report cannot authoritatively comment on whether this measured "flicker" would affect a significant proportion of the population, but clearly it is a factor that cannot be ignored. (Information informally given to the Health Protection Agency is that 18% of the population are able to detect a 7% modulation at 100 Hz). It is probable (but not a given) that were CFLi lamps compelled to operate at a power factor of 0.9 or better, and to have a CRI better than Ra = 85, this problem would go away.

Ultraviolet

Fluorescent lamps generate light by a two-stage process. An electrical discharge in mercury vapour at low pressure produces ultraviolet radiation. A phosphor coating on the inside of the discharge tube converts the UV to visible radiation. In theory the combination of the glass envelope, the phosphor coating and barrier layers inserted to reflect UV and to prevent contamination of the phosphor by the glass should stop any significant UV escaping. The European Lamp Companies Federation states that "for CFLis that generate higher quantities of UV, filters are now used to reduce radiation".

This tacitly admits there may be a problem. Again the UK Health Protection Agency has measured the UV output of CFLi lamps bought from high street retailers. Some of these were found to give significant output at 254 nm, whereas the best examples gave insignificant UV output. The poor performance is probably due to incomplete internal coating, particularly where tubes are bent or joined, leaving some parts of the tube either inadequately coated or not coated at all.

The effect of such UV is twofold. If the luminaire is fitted with any kind of plastic shade or diffuser, the UV may well cause the plastic to crack and break. While falling lampshades may not be considered a serious source of domestic accidents, such an occurrence will certainly be an inconvenience and expense to the user. More seriously, 254 nm is a dangerous wavelength (normally reserved for disinfection) and people should avoid exposure to it. Sufferers from Lupus and other light sensitive conditions could be particularly affected.

The International Commission on Non-Ionising Radiation Protection sets recommended exposure limits. The worst sample tested by the Health Protection Agency exceeded this limit in 4.28 hours at a distance of 200 mm. This may not be a realistic scenario for most users of CFLi lamps, but anyone using such a lamp for reading could be affected. In the case of tungsten halogen lamps there is a mandatory limit on UV radiation, but at present no such standard exists for CFLi. An informal opinion from the Health Protection Agency is that, under the General Product Safety Regulations a product with this amount of UV radiation would not be considered "safe".

Lamp life

There have been many claims that CFLi lamps do not in practice have the life claimed for them. In particular there has been an impression that these lamps only give a long life provided they are not subject to frequent switching. Obviously if this was really true the whole case for changing over to them would be completely undermined.

The Energy Savings Trust's "Energy Saving Recommended" accreditation requires 3,000 switching cycles per 8,000 hours of tested life. No surprise to find this is identical to the performance claimed by the European Lamp Companies Federation.

While this performance is both reasonable and helps justify the case for the use of CFLi, the suspicion remains that in the real world lamps are being sold that do not meet life expectations. In this and many other respects (especially colour rendering and possibly safety) the whole issue is bedevilled by the import of CFLi lamps from sources less reputable than the European Lamp Companies Federation. This fact is recognised by the Federation; in its document "Making the switch" the following special pleading appears:

> *We are urging the European Commission and member states to ensure that all lamps that do not satisfy the limits set out in this legislation should not be granted the CE mark and therefore should not be allowed to enter the European market. This would enable consumers to easily recognize compliant products.*
>
> *For this approach to be fully effective, we believe that Europe's market surveillance systems need to be strengthened to ensure that this ambitious legislation does not result in market distortion and incentives to free-ride the legal requirements. Huge numbers of low quality products enter freely in the European marketplace each year from unscrupulous manufacturers who exploit poor market surveillance systems. For lamps, this problem is particularly dangerous. Many of the "energy efficient" lamps on the European market are not only non-compliant with basic safety, functionality and CE performance standards but they also have very low life times and are threatening to undermine consumer confidence in energy efficient lighting technology as a whole. We will be working with national governments and market surveillance authorities to make sure effective and timely market surveillance systems are implemented in Europe.*

This report is not competent to comment on whether such policing is either in place or planned for the UK; but without it many users of CFLi lamps will be disappointed. It may also be remarked that there is a general feeling in the trade that the fictional "GungHo PekingDuck Lamp Company" regards the CE label as an example of the "printer's art" rather than conferring any technical obligation on the supplier.

Dimming and remote control

There are now millions of dimmers installed in homes throughout the UK. Many of them control new lighting based on low voltage tungsten halogen lighting and are not an issue. The problem is what happens if a user inserts a CFLi lamp into a dimmer-controlled standard lamp, table lamp, pendant light, chandelier or other luminaire previously fitted with a GLS lamp.

The short answer is that it won't work, and either or both of the dimmer and the lamp may be damaged.

The long answer embraces a number of separate points, which are set out in no particular order.

The human eye has a non-linear response. In dimming terms this has the practical result that dimmers are often set to give very low light outputs, and a good dimmer should dim smoothly to extinction. In practice dimmed lighting should give steady light at 3% of maximum. This requirement has always been easy to meet with incandescent lighting, but very difficult to meet with fluorescent lighting.

Claims are made that fluorescent lighting can be dimmed to 1%, but only under highly controlled ambient temperature conditions and with specific tube and ballast combinations. In practice architectural users are advised that 5% is about the best performance that can be consistently achieved, and this again can only be achieved with specific lamp/ballast combinations. Compact fluorescent lamps of the right specification and with external ballasts can also meet this performance.

The majority of CFLi lamps are unsuitable for dimming (and those from reputable manufacturers are marked as such). However there are now a number of lamps on the market that claim to be dimmable. With the exception of one long standing manufacturer it is too early to make any long term comments on performance, but as anecdotal information, the November 2007 issue of the trade publication “Lighting” carried a review of five different makes of “dimmable CFLis”. Some points made:

- When dimming tungsten filament lamps we expect to see a lowering of colour temperature as the lamp dims. A problem with fluorescent dimming is that often this does not happen; indeed the colour temperature may even go up. This makes low-level lighting look “cold” instead of the “warm glow” we are used to.
- Osram have had a product of this kind on the market for some time. Although criticised for being too big, it was praised for its efficacy, and its ability to give a steady 7% output. (Cautiously Osram only claims 15% on its packaging.) It is fair to assume that the life performance of this lamp is good.
- A UK developed lamp (Varilight DigiFlux) was praised as “best in class” and for achieving 4% output with a downward shift in colour temperature.
- The potential problem with this kind of lamp is that it is most stressed at low light levels, when cathodes are run at high current, and momentary high voltages maintain the discharge. Only when long life under all conditions is validated will this technology be considered secure. In one case in “Lighting’s” tests a dimmable lamp failed within one hour on a standard dimmer at low setting.
- Another lamp demonstrated a minimum achievable level of 12%, a very non-linear dimming performance, making it difficult to set a wanted light level, and very poor efficiency, with 65% of full “on” power being used at 12% light output. Unstated was the point that for some users such a lamp would probably give a worse financial and energy saving performance than the GLS lamp it replaced.

Another piece of trade information is that a leading architectural lighting dimmer manufacturer was asked to test samples of “dimmable CFLi lamps” on its range of dimmers. The lamps did not present any problem to the dimmers, but the results were disappointing. Smooth dimming could only be achieved down to 30% output, below this the discharge was unstable.

A significant piece of lighting industry news is that Philips has curtailed or discontinued its development efforts in respect of dimmable CFLi lamps and is instead concentrating on raising the efficacy of tungsten halogen technology. The reality may well be that it is technically very difficult to make a dimmable CFLi with a wide dimming range and which can be guaranteed to have a life that is not affected by being on a dimmer (or at any rate impossible at a price the public would willingly pay).

The promoters of CFLi lamps are remarkably reticent on the general question about what happens if a “non dimmable” CFLi lamp is connected to a dimmer – it cannot be assumed that every user will understand the package symbol or text warning indicating its unsuitability. But it can be stated that connecting a CFLi lamp that is not specifically designed to be dimmed by normal domestic dimmers can be dangerous. Appendix 3 gives some quantitative information about the very high currents that can develop.

It has also been stated that CFLi lamps are not suitable for use with PIR (motion) and photo-electric sensors. In fact there is no technical reason why such lamps cannot be used with sensors; however such sensors need to have a relay output interface. If they have a triac or other solid-state switching device, then the result may be the same problem that afflicts dimmers. This is why CFLi manufacturers take the cautious line of stating that the lamps cannot be used with either dimmers or sensors.

Mercury and re-cycling

CFLi lamps are based on the use of mercury vapour (typically around 1.6 mg per lamp in the best examples, but up to 5 mg in the worst) and the question arises as to what to do with spent lamps. Mercury is an emotive subject, the general public is now well aware that heavy metals are potentially dangerous. Various points can be made:

- The “pro CFLi” lobby claims that the amount of mercury that might get into the environment as a result of CFLi use is far less than the mercury that power stations would put into the atmosphere to provide the extra energy needed to drive GLS lamps.
- The “anti CFLi” lobby speaks darkly of 176 tons of mercury going into landfill annually in Europe as a result of the disposal of CFLis.
- It is stated that elemental mercury (as would be emitted by power stations into the atmosphere) is less harmful than organic mercury compounds (e.g. monomethyl mercury) that arise from landfill mercury by microbial action.
- While the procedures for the recycling of fluorescent lamps are becoming fairly well established in industry and commerce (with many companies aiming to achieve ISO 14000) the domestic consumer is likely at best to put used lamps in the black “non recyclable” refuse bag – resulting in either incineration or landfill.
- There is a pious hope that retailers will offer a recycling facility (indeed companies like IKEA already are); however it is not at all clear what percentage of lamps will be recovered in this way.

It is also not clear what the recycling process will do with the rest of the lamp. When a GLS lamp is disposed of, the result is reasonably benign. Its “ingredients” are largely inert. However, apart from the mercury, CFLi lamps include plastic and electronic components, which may be uneconomical to recycle in any meaningful way.

There is a subversive, but quite widely held, view that says that it is compact fluorescent lamps with integral ballasts that should themselves be banned because of the huge waste implied by throwing away the electronic ballast components (and also by implication the waste thereby of the energy that went into making them).

Technically it is much better to use external ballasts, which of course is already a better option for anyone starting from scratch. One reading of the Part L requirements is that those specifying new lighting for homes can only specify luminaires with ballasts fitted (to ensure that the lumen per circuit watt criterion is met) so users could only use the simple CFL (non-integrated) lamp, and disposal of spent lamps during the life of the installation would then not involve throwing away lots of electronic components.

Safety

The GLS lamp has, on the whole, a remarkable safety record. The main hazard is that of letting the bulb envelope come in contact with either human flesh or (in the case of high wattage lamps) flammable material. Very occasionally the fuse fitted in the lamp to deal with the end of life arcing condition does not work quickly enough, and there is a loud bang – but this has rarely caused injury, and if the lamp is in a luminaire with some kind of shade or diffuser, the risk is very low.

Is the CFLi as safe as or safer than the GLS?

- The Lighting Association says in “Energy Saving Light Bulbs: The Facts, Not Fiction”: “CFLis are much safer to use in confined areas as they produce very little heat when compared to very hot GLS bulbs. They are much safer where children are concerned and many are used in children’s light fittings for this reason.”
- In the article that is the source of the information in Appendix 3, readers are exhorted to “Never use a CFL as a night light for children. Lamp failure could result in toxic fumes and possible serious injury”.

The latter refers to the fact that failure of electronic components (especially capacitors and burning printed circuit boards) can indeed produce unpleasant and possibly hazardous fumes or even fire. In principle the risk ought to be the same whether external or integrated ballasts are used, but it could be argued that the integrated ballast represents a higher risk because it is working in a less friendly environment (and may be using less robust components).

In reality failures of this sort are most likely to arise with sub-standard products. However, the risk of overheating of CFLi lamps wrongly connected to a dimmer is real.

Conclusion

From the above it will be clear that there are valid doubts about the suitability of CFLi lamps to take over the role of GLS lamps. The situation is quite well summed up by the Society of Light and Lighting, which has posted the following statement:

SLL urges industry to consider impact of withdrawal of tungsten lamps

The Society of Light and Lighting (SLL) actively promotes energy efficient lighting solutions and accepts that a withdrawal of inefficient tungsten filament lamps could lead to a reduction in UK energy consumption but is concerned whether the current options will fully meet the lighting requirements for the spaces and tasks to be lit.

SLL's main concern is that in removing existing, albeit energy inefficient, lamps from the market, future lighting installations using the more efficient alternatives will not be able to achieve the lighting effects that current lamps can produce. Issues of concern to domestic users include: amount of light, warm-up time, ability to dim, flicker, colour appearance and rendition, lamp life, degree of sparkle, availability of suitable luminaires and lamp shades, and cost.

Information from manufacturers does indicate that many of the technical issues could be addressed and that lamps are currently under development that will meet most of the characteristics of tungsten filament lamps. While new lamps will use various approaches, such as fluorescent, LED or high efficiency filament technologies, they will be more energy efficient than current tungsten filament lamps.

The Society believes that all these new lamps must be manufactured to remove all the conditions listed above, and, together with a wide range of suitable luminaires, should be readily available before existing lamps are withdrawn. It therefore calls on all those in the supply chain, lamp and luminaire manufacturers, wholesalers and retailers to ensure that suitable lighting equipment is readily available to the market to meet the timescales for proposed withdrawal of current lamps.

SLL also calls on the government to require lamp manufacturers to produce compact fluorescent lamps (CFLs) that have electrical characteristics which minimise harmonics on the electrical supply network and operate at high power factors (e.g. greater than 0.9), prior to the proposed withdrawal timetable for the replacement of tungsten lamps.

It is probable that the claims for the potential energy saving by replacement of the GLS lamp by CFLi have been exaggerated, especially when the energy cost of replacing large numbers of luminaires prematurely is taken into account. While it may indeed be the case that “every house has 25 (or whatever number) GLS lamps” many of them are used for very few hours in a year.

It is clear that the availability of sub-standard CFLi lamps undermines the whole exercise. Another point is that consumers will not willingly spend large sums of money on something that has little immediate benefit, so unless the authorities get very heavy-handed we can certainly expect stockpiling of GLS lamps, and entrepreneurs moving into the GLS market (unfortunately with lamps likely to be of a lower standard than those currently available).

As implied by the SLL statement above, domestic luminaire design will have to change. If the luminaire has a bayonet cap or Edison screw (BC or ES) lampholder, then householders in Europe are going to want to insert a GLS lamp. Some people have proposed banning the BC lampholder for this reason (but disguised as a safety measure).

From a strategic point of view some objectives could be:

- A move to ensure all lamp/ballast combinations have a power factor 0.9 or better.
- The encouragement of luminaire designs that have built-in ballasts allowing the use of simple lamps (with low cost of replacement, and no "throwaway" electronics). It is assumed that low voltage tungsten halogen luminaires will continue to be available to provide accent lighting and sparkle to ensure that overall it will still be possible to have aesthetically pleasing lighting in the home.
- Effective enforcement of the Part L regulations, which in the long term will reduce the demand for GLS lamps that are on at high power for prolonged periods (as implied above, trying to drive out GLS lamps used for the cupboard under the stairs would be seen by the public as yet another example of Brussels interference).
- If CFLi lamps are to be promoted as GLS replacements, then, as suggested by the European Lamp Companies Federation, CE approval should only be granted on the basis of proven efficacy and proven life under frequent switching conditions. UV output and flicker (100 Hz or other low frequency modulation) must be within regulated limits (as for all light sources). Colour temperature should be the same as for GLS lamps, and colour rendering at Ra=85 or better. Power factor should be 0.9 or better (as recommended by Society of Light and Lighting) and when connected to a dimmer the lamp should do one of the following: (a) give an acceptable dimming performance, say smooth down to 15% light output. (b) operate with a steady light output or off, but at no dimmer setting take current in excess of the normal lamp current. (c) not operate at all, taking negligible current.

No suggestions are made as to how non-compliant products (even under today's regime) can be kept off the market, or how the re-cycling issue can be addressed in a practical, effective and acceptable way.

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Appendix 1
Some relevant links

http://www.defra.gov.uk This site carries the announcement that conventional incandescent lamps are to be phased out in the UK. Press release Ref 328/07 dated 27 September 2007.

http://www.energysavingstrust.org.uk Website of the Energy Savings Trust. Their publication, prepared for the government, "Energy Efficiency best practice in housing – guide for installers and specifiers", which is also promoted by the Lighting Industry Federation, makes good sense.

http://www.elcfed.org Website of the European Lamp Companies Federation. This group represents the manufacturers of 95% of the lamps manufactured in Europe. Two relevant documents can be downloaded from the site "Making the switch – the ELC road map for deploying energy efficient lighting technology across Europe" and "Frequently asked questions and answers on energy efficient lamps".

http://www.lif.co.uk Website of the Lighting Industries Federation, the UK-based trade association. As

long ago as 2002 the LIF issued a “Technical Statement No 11” which addresses the problem of harmonic content and power factor in self ballasted compact fluorescent lamps (CFLi). This concluded that the impact would be small, and it was better to promote CFLi, warts and all, than to seek perfection. This stance may now be due for revision.

http://www.lightingassociation.com Website of the UK-based trade association. Carries a document “Energy saving light bulbs, the facts not fiction” which essentially repeats many of the points made in the European Lamp Companies Federation documents.

http://www.sll.org.uk Website of the Society of Light and Lighting (part of the Chartered Institution of Building Services Engineers). It carries the statement quoted in this document.

http://www.savethebulb.org Website instigated by Kevan Shaw (of Kevan Shaw Lighting Design) articulating the arguments against banning conventional incandescent lamps.

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Appendix 2
Explainer on power factor

Power factor is a complex subject. In an AC power circuit it is only when a load is purely resistive (like a GLS lamp) that the power in watts (W) is numerically the same as the volt-ampere (VA) product. In this case the power factor is said to be unity (1). When there is a complex load, involving inductance and/or capacitance, current and voltage are out of phase, and the VA product is higher than the W value. A power factor of 0.5 would apply if the VA product was double the W value.

The problem this gives is that the consumer only pays for the watts, the effective power used; but the electricity supplier must have a generation system able to deliver the VA needed. In the case of traditional electromagnetically ballasted fluorescent lamps the problem is overcome by the introduction of “power factor correction capacitors”.

With electronically ballasted fluorescent lamps the situation is a little more complex. In principle the problem is now not as simple as current and voltage being out of phase; but that the ballast itself introduces significant harmonics (i.e. a load waveform that is a mixture of both the fundamental 50 Hz and many higher harmonics or multiples of the fundamental frequency). This has a similar result to the simple displacement of current and voltage phase, in that the VA product required from the supply is much greater than the W actually used. The mathematical expression for power factor under these circumstances is quite complex (and its measurement is not at all easy); however the practical results are easy to understand, and can be expressed with the same metric.

The problem is not limited to lighting. All kinds of power supplies that have changed from traditional (electromagnetic transformers working at 50 Hz) to electronic (high frequency switching at 20–50 kHz) operation can potentially have the same problem. It is for this reason that most such equipment, such as computer power supplies, must embody power factor correction. The aim is to achieve a power factor of 0.9 or better. Many electronic ballasts for fluorescent lamps achieve 0.98.

As mentioned in the main text the great majority of conventional fluorescent lighting has to meet this requirement by law. It is only low power lamps that are, at present, exempt.

It is only fair to mention that most dimmers installed in the home, controlling incandescent lamps, use a “phase cutting” technique that itself generates harmonics. However in practice the combination of the filters that form part of the dimmer and the low frequency of operation means that the effect on the supply network is less severe than that of switch-mode power supplies. In higher power and professional applications there is a move towards “sine wave” dimming that eliminates the problem.

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Appendix 3
The effect of putting a CFLi lamp on a dimmer

One report to be found at http://sound.westhost.com/articles/incandescent.htm describes an experiment of connecting CFLi lamps to a typical phase cutting dimmer. The results are somewhat alarming.

CFL Power	Current Drawn (RMS)		
	Nominal	Dimmer 75%	Dimmer 100%
13 W	83 mA	450 mA	245 mA
11 W	80 mA	420 mA	240 mA
8 W	80 mA	330 mA	190 mA
5 W	40 mA	260 mA	200 mA

The problem is that the CFLi lamp did work; so a user could be forgiven for taking the view that, provided he did not want a proper dimming function, but was willing just to have the lamp full on, it did not matter it was being fed through a dimmer. While, after a time, a fusible resistor in the lamp might blow, there is also a likelihood that local overheating could cause damage or even a fire. It might be considered a minor point that the majority of the claimed energy savings from CFLi will be lost under these conditions!

The same experiment also measured very high peak currents, typically representing a crest factor of over 9.0 (for example the 245 mA RMS shown for the 13 W lamp had a peak current of 2.2 A). It cannot be affirmed that these dangerous results would apply to all combinations of dimmer and non-dimmable CFLi, but the fact that they have been recorded at all is some cause for alarm.

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Appendix 4
Consequences of a GLS ban for a sample user

An indication of how one particular user would be affected by a ban on GLS lamps may seem trivial and not relevant. However the author of this report thought it worth examining how such a ban would affect him, since it might give pointers as to how other users might fare.

The house already uses energy efficient lamps in the hallway and on the stairs, as these lamps tend to be on for prolonged periods. No particular problems here, except that the delay in reaching full output is annoying.

The kitchen and laundry room use a mixture of concealed fluorescent lighting and downlighters based on reflector bulbs. Reflector bulbs are at present outside the scope of the ban, because it is admitted that CFLi lamps are useless when placed in downlighters (and anyway may overheat). It is reasonable to suppose that, were the kitchen and laundry room to be rewired in the future, mains voltage reflector lamps would be replaced by low voltage tungsten halogen. (Some “low energy” reflector bulbs have appeared on the market, and might work, but would also involve a change of luminaire.)

The bathrooms use low voltage tungsten halogen lighting. So far so good – the lighting that is used most does not use GLS lamps.

However, elsewhere it is clear that a GLS ban would be both inconvenient and expensive.

The library (grand name for a room full of books) is also used for home cinema. Lighting is by GLS equipped standard and table lamps, all on automatic dimmers that dim smoothly to extinction. “Dimmable” CFLi would be useless, so a GLS ban would require that all lighting was replaced with tungsten halogen. It would be very expensive to re-create the existing effect. The room is used infrequently so energy savings would be negligible.

This immediately identifies a problem that will affect many users. The house has larder and cupboard lights (using for example 40 W or 60 W GLS lamps) where instant light is required for short durations – one cupboard light has not been changed in 35 years. Replacing these lamps with CFLi is an investment that is unlikely to be repaid in the lifetime of the owners, and the low light level at switch-on means that a

practical economical and safe method of achieving instant lighting is being replaced with an unsatisfactory alternative.

Like the library, the dining room is an infrequently used room (because, as in many households, most meals are eaten in the kitchen). The dining room is illuminated by an antique over-table rise and fall lamp that uses three GLS lamps and is on a dimmer. CFLi lamps would not work (in respect of satisfactory dimming) and the currently available CFLi “equivalents” would look dreadful anyway. As is the case with the library it would be very expensive to recreate the existing effect, and the energy savings would be nugatory.

The study has a desk with an overhead pendant light fitted with a 100 W GLS lamp; similarly bedside lights in the bedrooms are typically table lamps with lampshades fitted with 100 W GLS lamps, and the living room is also served by standard and table lights with GLS lamps. Some of these are used for lengthy periods so are theoretically ideal candidates for change to “energy efficient”.

A simple test was carried out for the most critical lights; namely the study desk light, and a bedside table light. Both are functional in that they must provide adequate illumination for reading.

Illuminance readings were taken at the working plane (desk top or book) of the existing 100 W lamp. The lamp was then replaced by two kinds of “energy saving” lamp (both manufactured in Europe by a member of the European Lamp Companies Federation):

- A CFLi 20 W lamp, claiming 1200 lumen output and direct equivalence to a 100 W GLS. This was of the “six finger” design, which was the only kind easily available for this rating.
- An induction lamp (similar to those currently being used in the hallway) rated 20 W, 1152 lumens, and again claiming equivalence to 100 W GLS. This, though slightly larger, has a similar appearance to a conventional bulb, and is visually more acceptable.

In both the desk and bedside instances the CFLi lamp gave an illuminance of only 80% of that given by the GLS lamp (after 20 minutes). Whether this was due to the lamp not giving its rated lumen output, or due to uneven light distribution is beside the point. The fact is that there was less useable light simply confirms the gossip that in many instances you need to select a lamp rating one higher than the “on the tin” rating to get an equivalent performance.

The induction lamp fared better, giving the same results as the GLS lamp. In the case of the study it may be a viable replacement, provided the user doesn’t mind switching it on five minutes before he wants to start work. The long delay to reach a reasonable output makes this (induction) technology unsuitable for bedside light use.

Undoubtedly some of the table and standard lamps in the house could use CFLi; but in many cases it would be necessary to replace the existing shades, because the sight of the “fingers” of CFLi poking out above the lamps is wholly unacceptable. A point the CFLi evangelists seem to have overlooked is that in most cases users will not simply be faced with the extra cost of the CFLi, but will also be faced with the cost of replacement or modified luminaires.

So what is a user like this likely to do? Obviously as rooms get redecorated (whether by the present owners or by future owners) there is a probability that lighting will be upgraded. It is important, therefore, that, as emphasised by the Society of Light and Lighting, acceptable luminaires are available that are both aesthetically pleasing and meet energy saving criteria (and preferably are NOT based on CFLi technology). In the meanwhile owners like this are likely to want to do their bit to reduce energy consumption and will happily use CFLi or similar technology where it gives satisfactory results. But they will not make pointless changes that are inconvenient and reduce the lighting quality.

UKTI Displays and Lighting Mission to the UK

3rd UK/Korea Display Workshop

26 – 29 November 2007

by *Ric Allott*

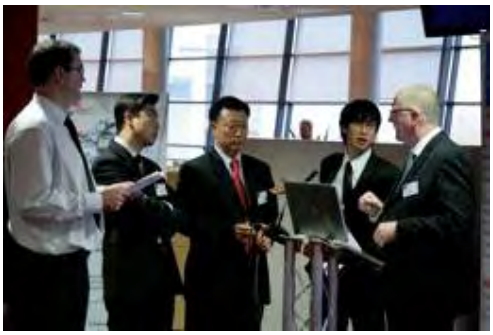
At the end of November UKDL hosted a four-day inward mission from Korea, organised in collaboration with UKTI and KOTEF (Korean Industrial Technology Foundation). This mission had 14 senior delegates representing the following companies and institutions: Samsung Electronics, Samsung Electric, Samsung Advanced Institute of Technology (SAIT), LG Display Centre, LG Elec. Institute of Technology, LG Innotek, ADRC-Kyunghee University, Korean Photonics Technology Institute (KOPTI), DPI Solutions, Taesan LCD, KDT, Decktron and Chongbuk University. The mission was focused technically in the areas of plastic electronics and solid-state lighting. Each of the Korean delegates had the specific objective of investigating new technologies and investment opportunities in the UK. Specific areas for collaboration include the standardisation and characterisation of LEDs, thermal/optical design and modelling and new flexible display technologies. Day 1 consisted of a workshop held at the BERR conference centre in London where academics from across the UK were invited to attend, speak and exhibit posters detailing their specific expertise and developing technologies. The day incorporated the UK-Korea STIP (Science, Technology and Innovation Partnership) workshop during which Ian Pearson, the Minister for Science and Innovation gave a speech. Importantly Dr Pearson specifically pointed out the huge potential and strategic importance of plastic electronics to the UK during his speech.

Minister Pearson delivers his speech

Prof Bradley of Imperial College

The UK-Korea STIP has been running for several years and last years workshop was held on Jeju Island in Korea. At the meeting in London a new contract extending the collaboration for a further four years was signed by the minister.

On Day 2 an Industrialists Workshop held at the Arsenal Emirates stadium in London provided an opportunity for UK companies to present their technologies and expertise alongside their Korean counterparts. Due to the large number of talks the morning was split into two parallel sessions, one covering plastic electronics and the other lighting technologies.



Preparing for the lighting session

A flat LED lighting panel from KDT

The 25 talks from UK and Korea were informative and engaging and provided the ideal “ice-breaker” for more detailed and intimate meetings. The afternoon provided ample opportunities for one-to-one meetings between

the UK and Korean delegates where business collaborations and partnerships could be forged.

One-to-one meetings at the Emirates Stadium proved lively and thought provoking

The more formal proceedings of the first two days were followed by a series of organised site visits to companies and academic departments around the Cambridge and Oxford areas. On Day 3 the delegates were split into two groups, one group were taken to Oxfordshire where they visited the Chemistry Department at Oxford University, the Science and Technology Facilities Council (STFC) Central Microstructure Facility and the Diamond Synchrotron Light Source. The second group travelled to Cambridgeshire where they visited Xennia, Xaar, Inca Digital and CDT in a programme focused on printing technology.

On the left is Big Science at the Diamond Light Source; on the right at Plastic Logic with VP Souk of Samsung

On the final day of the mission the lighting delegates visited Professor Colin Humphries' Research Group at the University of Cambridge where there was much interest expressed in future collaborations, in particular with regards to the GaN on silicon technology. Meanwhile the plastic electronics group was similarly impressed by their visits to Pelikon and Plastic Logic. At lunchtime the two groups merged and went on to meet with Conductive Inkjet Technology (CIT), the Cavendish Laboratory (where a tour of the Cavendish Museum proved to be a real bonus) and finally the Centre for Advanced Photonics and Electronics (CAPE).

Examining ultra-fine Cu lines at CIT *After the tour of the Cavendish Lab*

The mission was deemed a success by all involved and there is already positive news of collaboration. UKDL will continue to work closely with UKTI to ensure follow up and to help cement any new business opportunity that may arise from the hectic four days of activity. One point that is very clear from this mission is that the Korean delegates were very much focused on how emerging technologies can be put into volume production and strategic mechanisms have to be put into place to ensure that UK technology can match this expectation.

Governance of the UK Displays and Lighting KTN

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	Ken Vassie	(NPL) representing SPURSS
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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	

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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.

UKDL Events

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

JANUARY 2008			
15-16	Metalization & Dielectrics 2008	Billesley Manor Hotel, Alcester, Stratford-upon-Avon	2-day Residential Seminar
30-31	Grand Challenges for Emerging Technologies in Displays	The Moller Centre, Churchill College, Cambridge	2-day Residential Seminar
FEBRUARY 2008			
7	Health & Safety of Whiteboards and Projection Displays	Renaissance Hotel, Reading	Workshop
7	AC Electroluminescence	Swansea	Seminar
13	Technology Programme Dissemination Event	1 Carlton House Terrace, London SW1Y 5DB	Seminar

19-21	Swiss Mission: Plastic Electronics	Shrigley Hall Hotel and Moller Centre, Cambridge	Workshop and visits
21	Environmental Testing	UKDL Boardroom, Bletchley Park	Tutorial
26	Update on Transistors on Plastic	Shrigley Hall Hotel, Maccelsfield	Seminar
MARCH 2008			
11	Investigating 3D Technologies & Projection Displays	To be confirmed	Workshop
12	Modifying Surface Functionality	Oxford Advanced Surface	Tutorial
17	Optical Directive Strategy Workshop	To be confirmed	Workshop
APRIL 2008			
1	Lighting for Mood, Health & Well-being	Hesperia Hotel, London	Workshop
8	Characterizing Thin Films	To be confirmed	Workshop
14-15	3rd International Integrated Manufacturing by Printing Colloquia	Gregynog	2-Day Residential Workshop
15-16	Future Lighting Debate	To be confirmed County Durham	2-Day Residential Workshop
May 2008			
6-7	Introduction to Print for Electronic Manufacture	Welsh Centre for Printing & Coating, Swansea	2-Day Residential Workshop
8-9	JEMI S2K Conference: Plastic Electronics Workshop	City Hall, Cardiff	Joint Event Workshop
14	LEDS for Lighting	Cambridge University	Tutorial

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