The adoption of high-end additive manufacturing or 3D printing in the aerospace sector has already led to innovation in that industry. Optical circuit board technologies provide a platform which can accommodate hundreds of times the volume of data in comparison with conventional circuit boards. IECQ has put forward its "LED initiative", to provide manufacturers, suppliers and buyers with the confidence that the products they sell or purchase have been independently verified and meet all requirements and specifications. Call for papers – The CIGRE/IEC Symposium will take place in Cape Town, South Africa, on 26-30 October 2015. Every year the IEC honours individuals who, through their leadership and technical expertise, have contributed to making products and electrical systems safer, more energy efficient, more reliable and more compatible. The first IEC International Standard aimed at defining measures to detect, prevent and react to cyber-attacks on computer-based systems in nuclear power plants has just been published.

Nanotechnologies and printed electronics

Not a month goes by without new technological developments and new applications in the fields of nanotechnologies and printed electronics. Issue 06/2014 of e-tech looks at how IEC covers the standardization needs of these fields.
Not a month goes by without new technological developments and new applications in the fields of nanotechnologies and printed electronics.

Nanotech has been a buzz-word for quite some time. The general public often associates nanotechnology with new types of materials and substances and their potential related health impacts. What is less known is that the term also applies to a wide variety of electrotechnical applications from semiconductors, nano-composites, nano-electrodes to microfabrication and organic and printed electronics. The definition reflects a general trend to miniaturization. Some of the less obvious applications where nanotechnology promises to be the key to success include light and energy generation according to the findings of a study commissioned by the IEC. Issue 06/2014 looks at how IEC covers the standardization needs of the nanotech industry for all electrical and electronic products and systems.

It also focuses on how printed electronics are revolutionizing the manufacturing and range of applications of electronics and how the IEC is supporting this trend. The technology has opened a vast array of new applications from flexible displays to lighting, textiles, batteries, sensors and more. Their light weight and flexibility makes them also ideal for aerospace and medical applications as well as packaging materials and even interactive posters.

Prototype microfibre nanogenerator: two fibres rub together to produce a small electrical current. Many pairs of these fibres could be woven into a garment to produce a “power shirt” (Photo: Georgia Tech / Gary Meek)
Aerospace 3D printing takes off
The aerospace industry moves from fast prototyping to additive manufacturing

Peter Feuilherade

Demand for products made by 3D printing, also known as AM (additive manufacturing), is expanding in both consumer and industrial markets as the technology, which has been around since the 1980s, becomes more widespread. The adoption of high-end AM in the aerospace sector has already led to innovation in that industry.

Fast-growing sector
The AM global market grew by about 35% in 2013 to reach more than USD 3 billion, the highest annual growth rate in 17 years, according to Wohlers Associates, a 3D printing consulting company based in Colorado, USA. The market is currently dominated by a handful of companies that own the core technologies.

The US currently has a 38% market share of the total worldwide AM industry, followed by Japan with 9.7%, Germany (9.4%), China (8.7%), the United Kingdom (4.2%), Italy (3.8%), France (3.2%) and South Korea (2.3%).

US based consultants Allied Market Research forecast in mid-2014 that the overall global 3D printing market could reach USD 8.6 billion by 2020, registering a CAGR (Compound Annual Growth Rate) of 20.6% from 2014 to 2020. Although products made for the consumer market will dominate demand, metals and alloys are projected to be the fastest growing materials segment, forecast to grow at a CAGR of 40.5% during 2014-2020.

Wohlers reported growth of almost 76% in the metal 3D printing sector in 2013, based on the number of metal-based AM machines sold worldwide.

Hi-tech sectors to drive high-end 3D printing systems
Aerospace, along with healthcare, is one of the sectors leading the adoption of 3D printing processes, starting with non-critical parts because of stringent safety testing rules. In 2012, the aerospace and defence industry accounted for about 10.2% of additive manufacturing’s total global revenues of USD 2.2 billion.

A growing number of leading manufacturers of airframes, engines and components, among them Boeing, GE (General Electric) Aviation, Lockheed Martin, Airbus and BAE Systems, are now using AM to produce complex aircraft and spacecraft parts not only from plastic but also metal. GE, which is already the world’s largest user of 3D printing technologies in metals, expects to have manufactured 100,000 cobalt chrome fuel nozzles for jet engines using 3D printing by 2020.

The US, the largest aerospace manufacturer in the world, is also at the forefront of AM technology, with the UK not far behind. Investment is being driven by big corporations as well as governments. In July 2014, GE Aviation announced plans to invest USD 50 million in its own AM plant in Alabama. In January 2013, US jet engine manufacturer Pratt & Whitney announced that it would invest USD 9 million over 5 years in developing powder-based AM technologies to further refine electron beam melting and “laser powder bed” AM. The UK government has allocated GBP 49 million (USD 81 million) to fund research on 3D printed aerospace technology.

Saving time and materials
The most successful AM processes currently being used to make metal products of various shapes include direct metal laser sintering, developed by the German company Eos, and the Swedish firm Arcam’s electron beam melting process. Both are powder-based processes that make components from metal powders by building up layers of titanium or other raw materials using computer-driven machines.

The advantages for aerospace firms include time savings, reduced waste and design flexibility.

Using computer-generated design models, AM uses lower quantities of raw materials than do subtractive production methods, produces negligible levels of waste and allows precision engineered replacement parts to be printed in situ in a matter of hours. This gives it the potential to replace traditional forging, casting and machining processes.

*The technology is expected to have far-reaching consequences for the aerospace industry… and especially
Ensuring safety and quality

Ensuring safety and product quality are critical considerations when using 3D printing to produce components for aircraft and spacecraft. It is vital that parts in aircraft engines and bodies can resist corrosion and vibration and are free from defects that could leave them prone to mechanical or heat induced stress.

Selective laser melting technology, for instance, produces parts that can contain microscopic voids within the structure of the material and are prone to heat-induced stress, so these components cannot be used in critical load-bearing applications. Electron beam technology, however, is a higher quality alternative to laser melting and able to produce components free from residual stress.

Product quality and cost are also major considerations. So far, 3D printing has been used primarily for manufacturing prototypes and demonstration specimens, but that is changing, as GE’s commitment to the large-scale production of fuel nozzles demonstrates.

The costs of 3D printing machines and the metal powders that they use are expected to decrease as the technology improves and becomes more widely used for mass production rather than specialist applications only. But the speed of 3D production would also have to increase and outpace conventional manufacturing methods to make it feasible for large scale adoption of 3D printing by aerospace companies in producing the more common parts and components.

The additive manufacturing presence in the aerospace industry is extremely low, at 0.002% of a market totalling USD 150 billion, according to Vivek Saxena, vice-president of aerospace operations and supply chain at the US consulting firm ICF.

For the time being, 3D printing is an additional process that is best used for manufacturing certain parts used in the aerospace industry; it has not yet replaced traditional manufacturing. Most components still require costly finishing work after the additive manufacturing process.

Although the use of 3D printing in aerospace factories is certain to spread, the extent of this growth is uncertain at present, which reflects the embryonic stage of AM development. Because regulatory approval is “the biggest issue right now”, the quickest adoption of 3D printing is likely to be in applications that face the least regulatory scrutiny, such as UAVs (unmanned aerial vehicles) and experimental aircraft, Saxena predicts.

Researchers at global defence firm BAE Systems are studying the feasibility of equipping military aircraft with on board 3D printers to create different types of UAVs on demand, depending on the mission objective.

Space – the next frontier

Space-based 3D printing also offers future opportunities. Both NASA (National Aeronautics and Space Administration) and the European Space Agency are looking at 3D printing for products ranging from rocket engine components to food that astronauts could prepare in deep space. But given the numerous environmental factors that affect 3D printing, including zero gravity and extreme temperature fluctuations, these projects are still largely ground based.

A July 2014 report by the US National Research Council concluded that while AM could contribute positively to space operations, the specific benefits and potential scope of the technology’s use in space remain undetermined, and “its application in space is not feasible today, except for very limited and experimental purposes”.

IEC sets Standards for quality, safety

A number of IEC TCs (Technical Committees) and SCs (Subcommittees) work on identifying, developing and coordinating International Standards for the electric and electronic components that are installed in the 3D printers being used in additive manufacturing processes.
Amongst many other relevant parts and components are switches and relays (TC 17: Switchgear and controlgear, TC 121: Switchgear and controlgear and their assemblies for low voltage), servo and stepper motors used to move the extrusion head or the sintering laser (TC 2: Rotating machinery) and power supplies (TC 96: Transformers, reactors, power supply units, and combinations thereof). Most important are the different types of lasers used for sintering metals and polymers.

TC 76: Optical radiation safety and laser equipment, is the leading body on laser standardization, including the high-power lasers used in industrial and research applications. Its work will be essential to the future of 3D printing in the aerospace sector as, increasingly, parts for the industry will be produced using metal powders that require laser technology for their manufacture.

Rolls Royce introduces 3D printing to make parts for its next jet engines (Photo: © 2010 Rolls-Royce plc)

The light alternative

Optical circuit boards light the way past the data cliff

Richard C. A. Pitwon, Secretary of IEC TC 86/JWG 9

Over the past decade, the volume of digital information being captured, processed, stored and conveyed from one place to another has truly exploded with the proliferation of mobile data devices and media communications. This exponential increase in data demand is pushing modern communications systems beyond their limits and towards a crippling “data cliff”, but optical circuit boards offer a way past this risk. Standardization work of optical circuit board technologies by IEC TC (Technical Committee) 86: Fibre optics, will be instrumental in bringing forward commercial adoption of the technology.

Fibre flexplane optical circuit board

Light in the box

Printed circuit boards lie at the heart of all modern electronic systems, from computers to planes, to phones, to satellites, to washing machines, to cars, and in all areas of embedded electronics. The rate at which data is transmitted along the printed circuit board – its bandwidth – is increasing.

The rise in data communication speeds exposes electronic systems to some of the fundamental physical constraints implicit in the conveyance of high frequency electronic signals along the copper channels in conventional printed circuit boards. Dielectric absorption and resistive loss mechanisms will attenuate more strongly the higher speed signals conveyed along a copper channel, while reflections, signal skew and interference from other electronic channels will distort the data. Furthermore, the environmental effects of system operation, such as temperature and humidity, will cause changes in the circuit board substrate, thus altering the carefully balanced characteristics of the electronic channels.
Many of these constraints can be mitigated to some degree, albeit at ever mounting cost to the overall system design and with higher power consumption. It is for this reason that the projected increases in capacity, processing power and bandwidth density in future information communication systems must be and are being addressed by the migration of optical channels into the system enclosure itself. The introduction of optical circuit boards is a critical part of this migration.

**Optical interconnect and the Cloud**

One area in which this migration is apparent is in modern data centres. One consequence of the widespread adoption of smaller mobile data devices (smart phones and tablets) over fixed larger computer terminals (PCs and laptops) is that a dramatic shift is now occurring in where customers want to store their information. Until recently, data was mostly stored locally on the hard drive of a desktop or laptop; now the amounts of data generated “on the fly” are so large that the storage available on mobile devices is rapidly becoming insufficient for long term accumulation and retention of data.

So-called “Cloud” services are therefore emerging to meet swelling customer demand to store data remotely and securely. Data centres provide the dedicated computer, storage and server equipment needed to meet the remote data processing and storage requirements of these emerging Cloud environments. However, in order to cope with rapidly changing customer demand, the fundamental architectures underlying the data centres themselves need to evolve. A critical part of that evolution is the deployment of optical connections at all levels of the data centre environment.

This migration is reflected by the emergence of a new technology ecosystem including board-mountable optical transceivers and very high density parallel optical interfaces. Major international collaborative research and development initiatives such as the European PhoxTrot project and the US HDPuG Optoelectronics project are also helping evolve the approach.

**Optical circuit boards**

Embedded optical interconnect technologies, whether deployed at the cable level, circuit board level or chip level offer significant performance and power advantages over conventional interconnect. These include higher channel density, higher data rates, no electromagnetic interference, reduction in power consumption and reduction in materials.

Optical circuit board technologies provide a platform which can accommodate hundreds of times the volume of data in comparison with conventional circuit boards. They are therefore seen as a key enabler in modern data communication systems.

Many types of optical circuit board technology exist today including fibre-optic laminate, polymer waveguides and planar glass waveguides.

Laminated fibre-optic circuits, in which optical fibres are glued into place on a substrate, benefit from the reliability of conventional optical fibre technology. However these circuits have some shortcomings. They cannot accommodate waveguide crossings in the same layer; i.e. fibres must cross over each other and cannot cross through one another. With each additional fibre layer, backing substrates must typically be added to hold the fibres in place, which increases the thickness of the circuit significantly. This limits the long term usefulness of laminated fibre-optic circuits in PCB stack-ups. At best they can be glued or bolted onto the surface of a conventional circuit board.

Embedded polymer waveguides provide a mid-term – and potentially very low-cost – solution to short range optical links within the system, such as inter-chip connections on a board or board to board connections. They are also suitable for applications in which thermo-optic, electro-optic or strain-optic coefficient properties of the polymer can be used to support advanced switches or long range interconnections.
Embedded planar glass waveguide technology combines some of the performance benefits of optical fibres, such as lower material absorption at longer operational wavelengths and lower modal dispersion with the ability to fabricate dense complex optical circuit layouts on single layers and integrate these into PCB stack-ups. The Fraunhofer Institute of Reliability and Microintegration (Fraunhofer IZM) in Germany is one producer of planar glass waveguide based optical circuit boards.

Widespread adoption of optical circuit boards will herald substantial performance, cost and environmental benefits for the data communications industry, but there are still a number of inhibiting factors that need to be addressed. Though optical circuit board technology has advanced considerably over the past decade, commercial maturity will also be constrained by the availability of additional conformity standards for forging future design, performance and measurement procedures.

**International standardization can accelerate commercial adoption**

Standardization of optical circuit board technologies will be instrumental in speeding up commercial adoption of the technology and the IEC is leading in this area. IEC TC 86: Fibre optics, develops standards for fibre-optic technologies and IEC TC 91 does the same for electronics assembly technology.

TC 86 and TC 91 formed IEC TC 86/JWG 9, a joint working group, the purpose of which is to prepare International Standards and specifications for optical circuit boards. This JWG has already published a number of Standards in this area and is developing more. In particular, it is strongly active in developing new Standards for measurement, assembly and connectorization. These are crucial to helping optical circuit boards mature and bringing the substantial benefits of this technology to the market.

This standardization work will be central to bringing optical circuit boards to communications systems, allowing the data gap to be bridged.

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**Printed electronics: from lab to fab**

Printed electronics is becoming pervasive

Alan Hodgson, Chairman IEC TC 119: Printed electronics

For a number of years printed electronics has been a technology that promised much but delivered little, but it is now moving from the laboratory into industry. In response to the need to support this transition the IEC created TC (Technical Committee) 119: Printed Electronics.

From lab to fab

There has been a lot of research into printed electronics as well as marketing hype surrounding the topic, but the gap between lab and fab (laboratory project to industrial fabrication) seemed never to be narrowing. However, this has now changed and real industrial applications have emerged.
There is also substantial interest within industry. A number of companies and research and technology organizations are investing in pilot line or production scale manufacturing. However, there is still much work to be done, bringing people together to take this technology further into industry.

**Technology could become pervasive**

In common with many other new technologies, printed electronics suffered in the early research period by over-promising both in terms of capability and of industrial readiness. The technology is not about to replace the silicon-based electronics covered by IEC TC 47: Semiconductor devices, in terms of complex capability. Equally, it is a long way off having the streamlined supply chains and established production of the conventional electronics covered by IEC TC 91: Electronics assembly technology. So what will it do?

Printing is a great manufacturing technique for patterning large areas of substrates with multiple layers. That is not to say that all the layers are necessarily printed – some layers requiring uniform application may be deposited using coating or evaporation. Printing also works particularly well on flexible substrates, allowing access to the flexible display, lighting and textiles markets.

In terms of product capability, printed electronics has the potential to be a pervasive technology, although not necessarily in printing entire products. Printed functional elements look likely to find their way into products in the form of components such as printed batteries, displays and sensors. Sectors such as automotive, aerospace and medical are already taking an interest in this. To facilitate this, connection needs to be made across the potential supply chain through links with other interest groups and project initiatives.

**Connecting interest groups**

There are a number of groups that are key to moving printed electronics forward. In the US the IS&T (Society for Imaging Science and Technology) provides insights into printing technologies as well as networking opportunities through its NIP/Digital Fabrication and Printing conference. Similarly the IPC (Association Connecting Electronics Industries) provides links into the semiconductor business and has also taken on a formal liaison with IEC TC 119.

In Europe the OE-A (Organic and Printed Electronics Association), which has been supporting IEC TC 119 from the start, provides a meeting place with potential user industries through its LOPE-C meeting in Germany.

In Asia a number of regional organizations are collaborating to bring the 5th ICFPE (International Conference on Flexible and Printed Electronics) to the region (Beijing, October 2014).

Conferences fulfil an important role. They facilitate networking with other communities, bring together all stakeholders that are interested in the field and offer the opportunity to explore specific topics or challenges in depth. In the next months, IEC TC 119 will be represented in events that cover photovoltaics and gas barrier layers, enabling it to investigate the interface with printed electronics.

Broad exposure to and collaboration with various stakeholders allow...
IEC TC 119 to bring this technology to industry in as wide-ranging a manner as possible.

**Project initiatives**
A number of initiatives have supported the transition from the lab to manufacturing. European Union FP7 (Framework programme 7), CLIP (Conductive Low-cost Ink Project) and COLAE (Commercialising Organic and Large Area Electronics) have provided support in terms of materials and supply chains. Collaborations with the likes of EPSRC (Engineering and Physical Sciences Research Council) and CIMLAE (Centre for Innovative Manufacturing in Large-Area Electronics) in the United Kingdom enable this to move forwards, addressing topics such as design for manufacture, high-throughput testing and system integration.

Similar initiatives exist in other geographical areas, notably Japan and South Korea. For example KoPEA (Korean Printed Electronics Association) has created a value chain for printed electronics by bringing together some of the country’s major companies and smaller companies from around the world.

**The role of International Standards**
Standardization helps accelerate the broad roll out of printed electronics. Both the IPC in the US and JEITA (Japan Electronics and Information Technology Industries Association) have been involved in standardization activities and members of both organizations (and IPC through a formal liaison) now participate in IEC TC 119. Organizations such as these also support TC 119 work through the organization of technical events.

The 1st Plenary meeting of IEC TC 119 was held in Korea and KoPEA held a local conference in association with the event. The 2nd Plenary was hosted by IPC while the 3rd, held in the UK, received significant support from KTN (The Knowledge Transfer Network), a government funded organization. In addition to providing the logistics for the Plenary meeting, KTN organized a one day conference, “Manufacturing for Printed Electronics”, and networking dinner event. JEITA will organize a similar day in association with the 4th Plenary at the IEC General Meeting in November 2014.

**Progress within IEC TC 119**
IEC TC 119 was established in 2011 and, guided by its Strategic Business Plan, continues to support the quest for the broad industrialization of printed electronics. The work therefore closely mirrors the route described above. Here are a few examples:

- IEC TC 119 has now brought together a community of over 70 experts from 13 participating and 8 observer countries, spread across the value chain. As would be expected at this stage in industrialization, members strongly represent the supply side of this chain with a healthy contingent coming from the printing industry.
- Cyprus, South Africa and Switzerland recently joined the TC 119 community, reflecting the widening reach of the technology and its applications.
- TC 119 has healthy interactions with other standards groups. In addition to the external liaisons it also receives input from members of other standards groups within both IEC and ISO (International Organization for Standardization). This is seen as particularly important for a technology with the potential to be as pervasive as printed electronics. Anyone with an interest in printed electronics is invited to interact with TC 119.
- TC 119 experts do not only cooperate during formal IEC meetings. Many also meet up informally at technical conferences and trade shows throughout the year. This allows for discussions around applications to continue with a widening community.
- The topics for standardization closely match the interests and needs of industry. Printed electronics began with significant investment being made in materials science, resulting in the production of new inks and substrates for this market. The focus then turned to addressing manufacturing needs in the form of equipment and product quality. Progress within IEC TC 119 has mirrored these developments.

TC 119 experts invite you to come and interact with them. Our next meeting will be held at the IEC General Meeting in Tokyo. We look forward to seeing you there.

Circuit boards being printed (Photo: California Polytechnic State University)
A number of new disruptive technologies, also known as KETs (key enabling technologies), have been the object of extensive R&D for years and even decades in some cases. This holds true for fibre optics, printed electronics and nanotechnologies. Some technologies have already found application in industry and elsewhere, while others are moving from the R&D and lab stages into production and mass markets, and benefit from IEC International Standards to support their progress. These KETs tend to interact as some of their domains of application overlap. The resulting synergies are set to revolutionize many industrial sectors.

Light and more at the end of the fibre
The principle of transmitting light through glass has been known for a long time. Glass rods (straight or bent) were used for internal illumination in medical examination as early as the 1880s.

Light can be transmitted through total internal reflection. It travels along the length of the carrier’s glass core, bouncing off its internal surfaces when it hits the external layer (or cladding) as this does not let the light escape.

The development of optical fibres for communication started in earnest in the 1960s with research into new types of glass resulting in the invention of the first commercially viable low-loss (i.e. one that absorbs very little light) hair-thin optical fibre by Corning Incorporated in 1970. This highly transparent strand of glass was capable of carrying 65,000 times more information (voice, data and video) than copper wire, an important consideration as, increasingly, copper wires were proving unable to meet the growing bandwidth needs of modern society.

The parallel development of semiconductor lasers capable of converting an electrical signal into light and transmitting that light through fibre optic cables over long distances, and of optical receivers converting light into electricity at the receiving end, made possible the transmission of information through optic fibre cables. Today these form the backbone of the telecommunication and broadcast industries, allowing the transmission of limitless volumes of data, audio and video across the world, linking continents and bringing this content from anywhere right through to what is known as the “last mile” – that is, to nodes, buildings or homes.

Fibre optic systems can also be found in many other sectors such as IT and multimedia (for storage, printed boards and connections), medicine (for viewing and working inside the body with endoscopes and lasers), test and measurement applications (where optic sensors and fibres are used to measure various parameters and to transmit them between devices or back to the sending device in loop tests) and in many other industrial and commercial domains.

IEC TC (Technical Committee) 86: Fibre optics, established in 1984, and its SCs (Subcommittees), are central to the development of the entire sector and all related industries as they prepare Standards, specifications and technical
reports for fibre optic-based systems, subsystems, modules, devices and components. As of September 2014 they had issued close to 440 publications.

**Always smaller**

Nanotechnology, the manipulation of matter at the atomic scale, is seen as another key technology with the potential to change economies and lives in the future in much the same way as the information technology revolution has done over the past two/three decades. It has been described as the resource for the next industrial revolution.

Its ultimate goal is to build nanomachines, mechanical or electromechanical devices whose dimensions are measured in nanometres (millionths of a millimetre).

Companies and governments are investing heavily in nanotechnology and some commercial products are beginning to appear on the market. Despite this, many major applications for nanotechnology are still some 5-10 years away. As private investors often look for short-term ROIs (returns on investment) of 1-3 years, some governments step in to ensure support for nanotechnology R&D in its early stages.

This is the case in the US where the President’s 2015 Budget provides over USD 1.5 billion for the NNI (National Nanotechnology Initiative), bringing the cumulative investment in this government initiative to nearly USD 21 billion since its inception in 2001. Recent investments in the NNI are aimed at “accelerating the transition from basic R&D to innovations that support national priorities, while maintaining a strong base of foundational research, to provide a pipeline for future nanotechnology-based innovations”.

Large investments in nanotechnologies can also be observed in the EU, Japan and in countries as diverse as Brazil, India and South Africa, according to a joint NNI/OECD (Organisation for Economic Co-operation and Development) symposium report. The nanotechnology sector covers a wide range of domains, many linked to electrotechnology. Among these are initiatives that aim to help overcome current performance barriers and substantially improve the collection, conversion and storage of solar energy.

The IEC commissioned a study on “Nanotechnology in the sectors of solar energy and energy storage” from the Fraunhofer Institute for Systems and Innovation Research ISI. The study found that there is a whole range of nanomaterials which will improve generation from solar sources and storage of renewable energies.

IEC TC 113 develops International Standards for the technologies relevant to electrical and electronic products and systems in the field of nanotechnology.

The TC is developing and has already published International Standards for the use of nanomaterials such as carbon nanotubes or graphene, as well as for nano-enabled electrotechnical products.

**Print that circuit!**

Printed technologies represent another recent KET, which is fast expanding as a result of rising demand for relatively low-cost and small consumer electronic goods. Producing conventional electronics using silicon-based components is costly and presents some environmental issues, making it necessary to find other technologies.

Using additive manufacturing processes, some producers have started printing electronic parts and components on rigid or flexible substrates.

Printing techniques are often similar to those used in conventional printing, such as offset, screen printing, flexography or inkjet. Each of these techniques for printed electronics production has been developed over preceding decades using a wide choice of substrates and inks and resulting in the availability of an extensive and expanding range
of products. They include printed circuit boards, flexible displays, PV (photovoltaic) cells, lights, memory, sensors, RFID (radio frequency identification) and NFC (near field communication) systems, to name but a few.

The demand for new kinds of electronic goods and the variety of low-cost products made possible by printing electronics and use of a range of printing techniques and materials point to the emergence of a very large market.

The research and consulting company IDTechEx expects the market to grow nearly 10-fold between 2013 and 2020 to exceed USD 55 billion.

Over 3 000 companies are currently active in the printed electronics domain, most of them in North America, East Asia and Europe.

Since the focus has been shifting in recent years from developing printed electronics technologies to manufacturing products, a need for standardization has emerged. TC 119: Printed electronics, was established in October 2011 to meet this need. It currently has 13 participating countries and 8 observer countries. It develops International Standards for terminology, materials, processes, equipment, products and health/safety/environment in the field of printed electronics.

**Overlapping areas**

A significant feature of these KETs is a frequent overlapping of many of their domains of application and even of the technologies and processes they use. This is reflected in the web of their relationships and sometimes derives from their origin.

TC 86 and its SC 86B: Fibre optic interconnecting devices and passive components, have a liaison with TC 113. Some techniques used in printed electronics can be applied in the production of fibre optic systems and components. Richard C. A. Pitwon, Secretary of TC 86/JWG (Joint Working Group) 9: Optical functionality for electronic assemblies, told e-tech that “optical waveguides can be manufactured using conventional printed circuit board processing techniques such as photolithography and laser direct imaging. Combining both disciplines to produce ‘printed photonics’ offers a potentially low-cost route to mass manufacture of embedded electro-optical systems”.

TC 113 had an advisory group on printed electronics; this was disbanded due to the creation of TC 119. TC 113 and TC 119 identified a significant overlap of their technical responsibility especially in the materials area since nanomaterials are widely used in printed electronics. The TC Secretaries maintain a close liaison so as to prevent duplication of work and the creation of inconsistent Standards.

3D printing, or additive manufacturing, another disruptive new technology, shares common features and can interact with the areas of fibre optics, printed electronics and nanotechnology.

For fibre optics Pitwon notes that “the accuracy of modern 3D printing techniques will soon make it suitable to rapidly prototype optical coupling and interconnect elements, which would be required to provide the critical connectivity to waveguides inside optical circuit boards”. As for printed electronics, they are produced applying additive manufacturing processes, which are also starting to be used to build up nanostructures.

All of these innovative and disruptive technologies, which depend to a great extent on IEC International Standards, will become more and more important in future manufacturing, making it possible to create new products and increase energy supply and storage from renewable sources, among many other benefits.
Print map for the electronic industry
IEC TC helps ground-breaking technology progress

Morand Fachot
Printed electronics is a relatively new technology that uses an additive process to create a variety of electronic components and systems. It is rapidly advancing from research and inventions into production and mass market. Calls for standardization in this sector by the industry led to the creation of IEC TC (Technical Committee) 119.

Expanding domain
The fast rising global demand for relatively low-cost consumer electronic goods has stimulated the emergence of various technologies to support this market. Producing conventional electronics using silicon-based components is costly and faces some environmental issues making it necessary to find other technologies.

Using additive manufacturing processes, some producers have started printing electronic parts and components on rigid or flexible substrates. Printing techniques are often similar to those used in conventional printing, such as offset, screen printing, flexography or inkjet. Each of these techniques for printed electronics production has been developed over the previous decades with a wide choice of substrates and inks that allow an extensive and expanding range of products. It includes printed circuit boards, flexible displays, PV (photovoltaic) cells, lights, memory, sensors, RFID (radio frequency identification) and NFC (near field communication) systems, to name only a few.

Huge market emerging
The demand for new kinds of electronic goods and the variety of low-cost products made possible by printing electronics and the range of printing techniques and materials point to a very large market.

The research and consulting company IDTechEx expects the market to grow nearly 10-fold between 2013 and 2020 to exceed USD 55 billion.

Need for standardization
Since the focus has been shifting in recent years from developing printed electronics technologies to manufacturing products, the need for standardization has emerged.

A proposal to establish a standardization body for the printed electronics was presented at Printed Electronics Europe 2011, the largest trade event in Europe for the industry. The proposal indicated the IEC was the most suitable organization for the standardization of printed electronics since the technology intends to develop mainly electronic and electric devices. Organizations such as the OE-A (Organic and Printed Electronics Association), the leading international industry association for the industry strongly supported the proposal.

TC 119: Printed electronics, was established in October 2011, it currently has more than 70 experts from 13 participating and 8 observer members. Its creation was welcomed by the industry with OE-A stating “The OE-A has been supporting IEC TC 119 from the start”.

Systems approach with other TCs
Since printed electronics emerged from conventional electronics by introducing printing technologies in the industry, the need to cooperate with pre-existing electronics sectors and IEC TCs is obvious. TC 119 established liaisons with the following IEC TCs:

• TC 47: Semiconductor devices

Over 3 000 companies are currently active in the printed electronics domain, most of them in North America, East Asia and Europe.
It is also considering establishing liaisons with the following IEC and ISO (International Organization for Standardization) TCs:

- TC 21: Secondary cells and batteries
- TC 34: Lamps and related equipment
- TC 40: Capacitors and resistors for electronic equipment
- TC 56: Dependability
- TC 82: Solar photovoltaic energy systems
- ISO/TC 61: Plastics

**Objectives**

TC 119 outlined its objectives for the medium term (3-5 years) in March 2014. They include:

- developing an international standardization roadmap for printed electronics to define the scope of printed electronics and document standardization issues in all the areas with priority level
- promoting and streamlining standardization efforts in the areas where marketing is under way
- identifying standardization needs in the areas where new technologies based on printing technologies are in incubation and helping standardize the technologies from the research stage
- helping the growth of the printed electronics industry and promoting the development of new technologies based on printing methods
- actively collaborating with other TCs and other academic/industrial organizations.

**Multiple domains**

To cover the standardization of printed electronics TC 119 has five WGs (Working Groups) to deal with terminology (WG 1), materials (functional materials and substrates - WG 2), equipment used for printing processes (WG 3), printability assessment (WG 4), quality assessment (WG 5). TC 119 also set up AhGs (ad hoc Groups) to look at printed products and at the printed electronics roadmap. The fast growing nature of the printed electronics sector, new techniques and materials and the absence of standardization for the industry so far point to a substantial workload for the recently created TC 119.
IECEE helps build customer confidence
Safe and reliable consumer goods for everyone, everywhere

Claire Marchand
Fast-evolving technologies and a wealth of electronic devices and equipment on the market have dramatically altered people’s lives in recent years. All facets of life have been affected by these changes; home chores, office and factory work, education, leisure activities and commercial endeavours have at some point all embraced a new technology.

What makes a person buy a certain type of equipment, a particular brand? What are the criteria that come into play?

Tech-savvy?
The proliferation of electronic consumer goods has certainly made today’s customers much more tech-savvy than their counterparts of 20-30 years ago.

The younger generations, who have never lived in a world without computers, mobile phones or smart appliances, are usually specific about the type of device and the brand they want. They seldom feel challenged by new technologies, and know intuitively how to use them.

Those born before the digital era may still be half-way up the learning curve and, when confronted with the multiplicity of devices and brands on the market, may take more time to choose the most user-friendly and suitable ones.

In both cases, the selection will be made according to criteria such as brand, size, price or overall performance. Add in energy efficiency and this may represent the sum of their concerns prior to the acquisition of a new piece of equipment.

Implicit trust
This is all very well, but, more often than not, what appeals to consumers in the first place is not actually the most important thing. Do they care about all the parts involved in manufacturing the goods they buy? Cords, cables, batteries, to name but a few? They probably don’t.

Why is this? Because they place their trust in the manufacturers and suppliers of the goods they purchase. They take it for granted that the products they acquire are safe and reliable.

Is this blind faith justified? In most cases, the answer is yes. Unless they opt to buy from disreputable vendors offering sub-standard goods that often carry the additional burden of being counterfeit, they have every reason to place their confidence in their chosen manufacturers and brands.

Independent testing
To be worthy of the trust put in them by consumers, manufacturers have to prove the safety, reliability and high quality of their products. How do they do that?

While they can perform their own in-house tests, or can have the tests carried out by an organization that has an interest in the product – a major reseller for example – there are innumerable benefits in having their products tested and certified by a third-party, a body that is totally independent of both seller and purchaser.

Safety on a global scale
The leader in third-party conformity assessment for consumer goods is the IECEE, the IEC System of Conformity Assessment Schemes for Electrotechnical Equipment and
Components. IECEE certification, based on the principle of mutual recognition (reciprocal acceptance) by its members of test results for obtaining certification or approval at national level, is essential in facilitating international trade and allowing access to the marketplace for vendors, retailers or buyers. It eliminates unnecessary duplicate testing and reduces the costs related to the certification process.

Since 1985, the IECEE has positioned itself as the global testing and certification system for electrotechnical equipment, enabling the issuance of certificates that are recognized worldwide. The system is still developing new programmes to provide manufacturers and consumers alike with the highest possible levels of safety, performance and reliability.

Trusted partner
Returning to the issue of trust, IECEE is foremost in providing confidence in the safety, reliability, durability and performance of any item of consumer goods and provokes a “chain reaction” that starts with the manufacturer and leads on to the wholesaler, the retailer and finally to the consumer. IECEE is the trust enabler, whether that is implicit or explicit.

Home appliances are getting smarter

Manufacturers have to prove the safety, reliability and high quality of their products
Lighting up Ex areas
IECEx certifies new generation of LED-based lighting solutions

Claire Marchand
In less than 20 years, the LED (light-emitting diode) technology has emerged as an increasingly popular light source. LED-based lighting solutions, first used in commercial and industrial environment, can now be found in all kinds of environments and applications. The new generation of LED lights is more efficient, less costly, lasts longer and can be fitted in any kind of lamp or luminaire available on the market.

LEDs light hazardous areas
The Ex (explosive) industry sector has also recognized the benefits of LED-based lighting solutions. LEDs, as a solid state technology, eliminate the risks linked to the hot filaments in incandescent bulbs, and lend themselves to higher degrees of protection. More and more manufacturers now offer LED lighting equipment that has the required level of protection to be operated in hazardous areas. In addition to protection levels, fixed and portable lights used in high-risk environments, harsh conditions, potentially explosive atmospheres need to be powerful enough to make even the smallest obstacle or obstruction visible. High-power LEDs offer a superior quality of light, an invaluable feature in hazardous locations.

From rescue operations...
Take the example of firemen going through the rubble of a house or factory during or after a fire or an explosion. They need powerful portable torches to find their way in the dark, among the debris. The LED technology has many advantages for this type of equipment. Robustness, excellent colour rendition improving night vision, instant switch-on, long life cycle provide added safety when entering dark areas and reduced maintenance.

...to night shifts
Or take offshore oil platforms, refineries, shipyards, gas and oil tankers that operate 24 hours a day. Night-shift crews need powerful and reliable lighting to be able to work when it is dark. Lighting fixtures, as any other piece of equipment or device used in hazardous areas, have to be explosion-proof. LEDs can be used for all types of offshore lighting, from floodlights to exit signs, from berth and bunk lighting to linear lighting mounted on walls or floors for interior areas. Lifebuoys and lifejackets are also equipped with powerful and explosion-proof LED lights.

The highest level of protection
Manufacturers offering high-specification LED lighting for hazardous areas have to meet the very strict requirements specified in the IEC 60079 series of International Standards on explosive atmospheres as well as those put in place by national or regional regulations and legislation. Proving their adherence to those requirements can be costly and time-intensive.

To do so, they can rely on IECEx, the IEC System for Certification to Standards Relating to Equipment for Use in Explosive Atmospheres, to have their products tested and certified.

Confidence and security
Testing, assessment and/or certification conducted within the IECEx are accepted in all its member countries and way beyond. The System is widely recognized as the truly international system for Ex equipment and has been endorsed by the United Nations, through UNECE (UN Economic Commission for Europe) as the
internationally recognized certification system for promoting the safety of equipment, services and personnel associated with explosive areas.

For manufacturers of Ex equipment, having IECEx certification is a kind of “security blanket” that proves their products have the highest possible level of protection and meet all specific requirements.

IECEx certification also provides access to the global market and drastically reduces costs by eliminating multiple re-testing and certification.

A rescue team pulls a woman from earthquake debris in Haiti in January 2010

Explosion-proof headlamp (Photo: Larson Electronics)

Casting a light on LEDs
IECQ provides solution for certification of LED-based lighting sources

Claire Marchand

From indicator lamps on electronic devices or numeric readouts on digital clocks to their current use in a wide variety of lighting solutions, LEDs (light-emitting diodes) have come a long way in a few decades. They are now replacing incandescent or CFL (compact fluorescent lamp) light bulbs in domestic, residential, commercial and industrial applications.

More popular than ever
LEDs have many advantages over incandescent or CFL light sources: lower energy consumption, longer lifetime, robustness (reduced cost of maintenance and replacement), smaller size and faster switching. They are also easy to control.

Aviation/airport and urban lighting, automotive headlamps, advertising, traffic signals, camera flashes and shopping malls are ever more reliant on LED lighting sources. Because initially they were expensive to produce, they found their market mainly in commercial use. Improved technologies and economies of scale have brought prices down, and made the devices increasingly attractive to domestic consumers.

Mass production must not affect quality adversely
The ever growing demand for LED lighting solutions carries with it a potential pitfall: the risk of sub-quality products flooding the market. While it is tempting for manufacturers to roll out their products as fast as possible, thus securing a share of the global market for themselves, this must not be done at the expense of quality and reliability. Whether or not they are mass-produced, all electronic components, parts, modules and assemblies that make up LED lighting solutions must work together in the best possible way. One faulty component can result in poor performance or, even worse, in the overall failure of the LED lighting system.

LED module (Photo: Samsung)
**CONFORMITY ASSESSMENT**

![COB (chip on board) LED light source (Photo: K-Bridge Electronics Co Ltd)](image)

“LED initiative”, intended to provide manufacturers, suppliers and buyers with the confidence that the products they sell or purchase have been independently verified and meet all requirements and specifications.

The IECQ AC Scheme, already in place and widely used by industry, can easily be applied to certify the manufacturers and suppliers of electronic components and assemblies that are part of the production of LED packages, lamps, luminaires and associated LED ballasts/drivers.

The IECQ AC Scheme provides the assurance that the requirements stipulated in safety and interoperability standards, and in industry specifications, are met. It also ensures that specific performance and environmental criteria associated with the components are satisfied, and takes care of material and component traceability. Moreover the Scheme makes sure the initial qualification of designs and any controls for subsequent design, manufacturing, process, material and supply chain changes are in place. Last but not least, it provides a constant checking and testing of production samples.

The IECQ AC Scheme is a powerful supply-chain management tool both for OEMs (original equipment manufacturers) and component and module suppliers.

**A win-win situation**

Suppliers benefit from the on-going assessment conducted by IECQ, as opposed to undergoing multiple assessments and having differing criteria set by each of their OEM customers.

The structured approach offered by IECQ allows for increased efficiency and substantial cost savings by eliminating sub-standard items during production.

As for OEMs, they know they can trust their IECQ-certified suppliers to provide them with high-quality components, thus removing the need for monitoring and controlling the supply chain from A to Z. Ultimately, this helps them protect the reputation of their brand on the market.

**Cooperation between IEC CA Systems**

Another ‘first’ for IEC CA (Conformity Assessment) Systems is that, while the IECO AC Scheme covers the quality and reliability of electronic components, parts, modules and assemblies, other aspects of LED lighting fall under the responsibility of another IEC CA System, IECEE (IEC System of Conformity Assessment Schemes for Electrotechnical Equipment and Components).

The IECEE CB Scheme addresses performance and safety issues for a wide variety of lighting products and their accessories, including LEDs.

This collaborative approach is expected to develop further as many industry sectors increasingly seek complete solutions to their compliance needs.
Call for papers
CIGRE/IEC Symposium on the development of electricity infrastructures in Sub-Saharan Africa

Interested in the development of electrical systems and networks in Sub-Saharan Africa? If so, you shouldn’t miss the CIGRE/IEC International Symposium that will take place in Cape Town, South Africa, on 26-30 October 2015. And you can do more than just save the date: you can contribute a paper to the event.

Huge energy resources - little infrastructure
About 20% of the population in Sub-Saharan Africa has access to electricity, and in some rural areas, the figure can drop to 8%. While the region has huge energy resources – solar and wind energies, hydropower – only a very small amount of those has been put into use until now.

Regular access to a reliable supply of electricity is of crucial importance for economic development, education, food safety and health care. With it, school children are able to study after dark, local industry is able to manufacture products of more consistent quality and businesses can stay open after nightfall; food can be refrigerated, slowing spoilage; vaccines can be cooled and patient care and child birth become safer. Low power quality and the absence of electricity are directly responsible for poverty, famines and the suffering of millions.

The objective of the Symposium is to provide a unique forum for the exchange of ideas and vision on the development of the electrical systems in Sub-Saharan Africa. The event offers a great opportunity to discuss the regional needs and how best to exploit the energetic riches of the region.

The Symposium
The Symposium is organized by CIGRE (International Council on Large Electric Systems) with the direct cooperation of IEC, AFSEC (African Electrotechnical Standardization Commission) and APUA (Association of Power Utilities of Africa), the former UPDEA. It will be held over three days, with a day of tutorials preceding the main event. It will include the classical sessions with presentations and discussions of reports, as well as one or two panel discussions.

Focus on specific issues
The topics to be addressed during the event include:
- Large generation projects and associated transmission infrastructure
- Decentralized solutions for generation and network to deliver to isolated rural areas
- Institutional issues such as the balance between public and private; the financing of projects; the help to customers at the initial stages; regulation of activities; fixing tariffs; and the progressive expansion of regional markets into a continental market.
- Current and future technical network solutions and standardization
Cooperation development between the different operators of electric systems

The role of CIGRE, IEC, APUA, AFSEC, African power pools and other international or regional organizations to help the development of electric systems in Sub-Saharan Africa

The use of IEC International Standards and Conformity Assessment Systems for rural electrification

Harmonization of African standards through adoption of international standards; or where necessary, their adaptation to African conditions

Who should attend?
The event is aimed at generation, transmission and distribution owners, system operators, suppliers, designers, traders, regulators research laboratories and universities.

Wish to contribute?
The event is more than a year away, but if you wish to contribute a paper – in English – that will be presented during the event, you have until 30 November 2014 to submit an abstract to the Central Office of CIGRE by email to sylvie.bourneuf@cigre.org

In the email, please indicate the topic(s) that will be addressed as well as your name, title, company affiliation, email and full postal address.

All registered participants will have access to the papers on the CIGRE website before the Symposium.

A report will be prepared after the event and published in ELECTRA, CIGRE’s bilingual bimonthly journal, and posted on the CIGRE, IEC and AFSEC websites.

If you plan to submit a paper, please take note of the following deadlines:

Receipt of abstracts:
30 November 2014

Notification of acceptance:
31 January 2015

Receipt of full papers:
1 May 2015

The general programme of the Symposium, with information on registration and accommodation, will be issued in April 2015.
2014 IEC Awards
Recognizing commitment to the IEC

Claire Marchand
Every year the IEC honours the commitment and work of a number of individuals in its community who, through their leadership and technical expertise, have contributed to making products and electrical systems safer, more energy efficient, more reliable and more compatible.

Lord Kelvin Award - the highest distinction of the IEC
Created and first bestowed in 1995, the IEC Lord Kelvin Award is named after the IEC first President, William Thompson, Lord Kelvin. It is the highest tribute of the IEC and is awarded in recognition of the long-term technical contributions that outstanding individuals have made to the Commission.

Nominations for the Lord Kelvin Award can be made by IEC NCs (National Committees), TC/SC (Technical Committee and Subcommittee) Chairmen, and members of the CB (Council Board), SMB (Standardization Management Board) and CAB (Conformity Assessment Board). They submit their proposals based on their recognition of contributions made over time, irrespective of the nationality or technical area of the nominee.

To date, 34 laureates have received the Lord Kelvin Award. To qualify, candidates must still be active in the IEC and have contributed significantly to IEC work over more than five years. The award honours exceptional leadership and technical contributions to international electrotechnical standardization, CA (Conformity Assessment) or related activities. It recognizes the role of the awardee in promoting the image of the IEC worldwide and contributions to global trade and industry.

Dr Shuji Hirakawa to receive the 2014 Lord Kelvin Award
The 2014 laureate is Dr Shuji Hirakawa of Japan. A special ceremony will be organized for him during the Presidents’ Dinner at the IEC General Meeting in Tokyo, Japan, on 12 November 2012. He is to receive his gold medal, gold lapel pin and certificate from IEC President Junji Nomura.

From 2004 to 2011, Dr Hirakawa was Secretary of IEC TC 100: Audio, video and multimedia systems and equipment. Since 2011, he has been the SMB member representing the Japanese NC and has also served as a member of several SMB ad hoc Groups. As a SMB member, he proposed the establishment of a new TC for electrical energy storage systems, now IEC TC 120, and made significant contributions for implementing the first IEC Systems Evaluation Group: SEG 1 on Smart Cities. Dr Hirakawa is also a member of the IEC DMT (Directive Maintenance Team) and the ISO/IEC Joint DMT.

2014 Thomas A. Edison Award recipients
The IEC Thomas A. Edison Award was bestowed for the first time in 2010. It recognizes exceptional achievement in committee management by either current TC/SC Officers or their CA counterparts. The Award can be given to a maximum of nine people in one year.

In 2014, the SMB chose three TC/SC Officers:
- Elaina Finger, Assistant Secretary, TC 86/SC 86C: Fibre optics/Fibre optic systems and active devices
- Jim Munro, Chair, TC 31: Equipment for explosive atmospheres
- Guy Perrot, Secretary, TC 86/SC 86A: Fibre optics/Fibres and cables, and TC 46/SC 46F: Cables, wires, waveguides, R.F. connectors, R.F. and microwave passive components and accessories/R.F. and microwave passive components

The CAB will bestow the Award on:
- Wolfgang Niedziella, IECEE (IEC System of Conformity Assessment Schemes for Electrotechnical Equipment and Components).

IEC Lord Kelvin Award
IEC Thomas A. Edison Award
1906 Award
The IEC 1906 Award was established in commemoration of the Commission’s foundation in that year and honours technical experts around the world whose work is fundamental to the IEC. Each year a maximum of five awards may be granted per TC, including its various subcommittees.

A total of 150 experts from 50 TCs (including ISO/IEC JTC 1) and 11 experts from the CA Systems, representing 21 NCs, were nominated to receive this year’s 1906 Award. It recognizes exceptional recent achievements that contribute in a significant way to advancing the work of the Commission.

Movin’ on up
Success stories from the IEC Young Professional programme

Janice Blondeau
On the eve of the fifth IEC Young Professionals programme workshop, due to take place this November in Tokyo, e-tech catches up with some previous participants. They’ve gone from strength-to-strength in their IEC involvement.

Marc Boolish, IEC 2010 YP from the United States
When Marc Boolish started as a battery design engineer with Energizer 18 years ago, he could hardly have imagined the path his career would take. In one of his early projects, Boolish was requested to carry out some basic research, analyzing how Energizer and competing batteries performed against standardized tests. After presenting his work and attending several UL standards meetings, he was offered a position within Energizer which helped him grow into a standards-focused role.

From Young Professional to TC Chairman
Today, Boolish leads a team of other managers, engineers and standards experts. His early engineering background allows him to communicate the often technical details of Standards both inside and outside his company. In his new role as Chairman of TC (Technical Committee) 35: Portable primary cells and batteries, he will take on a large amount of “behind the scenes” work to ensure meetings run smoothly and world-class Standards are published in a timely manner.

IEC insights
The experience with the IEC YP programme was invaluable to Boolish’s professional development. It showed him the importance of networking with others. He has been able to use the networks he’s built to compare notes and to share challenges and strengths across committees – skills he expects to take full advantage of in his new role.

In relation to the YP workshop, Boolish also enjoyed seeing how IEC leadership and different committees operate. This encouraged him to become more and more involved in the work of the IEC. Indeed, he has noticed that companies and individuals are becoming increasingly involved in the standards development process as a result of the IEC YP programme.

Keep on keepin’ on
What advice would Boolish give to other Young Professionals just starting
their standardization careers? “Be technically bold, yet respectful, and never be afraid to volunteer for tasks or ad hoc groups in a committee. Before long, your knowledge and contributions will be sought-out and lead to opportunities.”

Esther Ondiviela, IEC 2011 Young Professional from Spain
Esther Ondiviela works in the BSH Induction Development Laboratory as Induction Cooktop Approvals Engineer for the EU, USA and Canadian markets. In 2011, she participated in the second IEC Young Professionals workshop in Melbourne, as a representative of Spain.

Household appliances expertise opens the door wider
Following the workshop, Ondiviela became more involved in the Spanish National Committee as a Home Appliances expert, especially in regards to cooking products. In early 2013, she became member of IEC TC (Technical Committee) 61: Safety of household and similar electrical appliances and insulation co-ordination. Recently Ondiviela has become member of IEC TC 61: Safety of household and similar electrical appliances.

YP workshop participation a key
Ondiviela feels that participating in the IEC 2011 YP programme has aided her to be more involved with the IEC community, helping to develop future standards and improve existing ones. From her employer’s point of view, Ondiviela’s participation in the IEC 2011 YP programme gave her a global view of the standardization community. Her participation in this programme was taken into account, among other factors, when deciding to make her a representative of BSH Induction Cooktops within several IEC Committees.

Caihao Liang, IEC 2012 YP from China
Unlike many other Young Professional programme participants, who are active mainly in IEC standards development or conformity assessment activities, Caihao Liang is involved in IEC MSB (Market Strategy Board) work. Liang is a Senior Engineer and Deputy Director, in the Power Grid planning division, Power System Department of CEPRI (the China Electric Power Research Institute). It is affiliated with the SGCC (State Grid Corporation of China). He is also a Project Leader of R&D Nester, a research institute co-sponsored by CEPRI and REN (Redes Energéticas Nacionais), based in Lisbon, Portugal.

Active in large-capacity renewable energy
Liang participated in the MSB’s third White Paper project Grid Integration of large-capacity renewable energy and large-capacity electric energy storage published in October 2012, as a co-author. To improve the visibility of this White Paper in China, he led the translation into Chinese, with the Chinese version published in May 2014.

Based on the experiences he gained from this project, Liang supported the application to set up IEC SC (Subcommittee) 8A: Grid Integration of Large-capacity Renewable Energy Generation, which was established in July 2013. As well, he was involved in the preparation of the IEC MSB’s fourth White Paper Microgrids for disaster preparedness and recovery, published in March 2014.

Workshop benefits live on
In parallel to these MSB-related activities, in 2012 Liang participated in the IEC Young Professional programme workshop in Oslo. As he sees it, the workshop was very helpful as it comprehensively introduced the IEC – its history and future, architecture and culture. It was also beneficial to be amongst Young Professionals from all over the world, sharing their experiences and presenting suggestions to IEC. The knowledge and experiences he gained from this workshop continue to aid Liang as he participates in IEC activities today.
August 2014 nominations
Latest TC Chairmen nominations and extensions, approved by the SMB

New Chairman for IEC TC (Technical Committee) 31: Equipment for explosive atmospheres and IEC TC 115: High Voltage Direct Current (HVDC) transmission for DC voltages above 100 kV

About Mark Coppler
Mark Coppler began his term as Chairman of TC 31 on 1 August 2014 for a period of six years. Coppler is Senior Product Certification Specialist at Det Norske Veritas Certification Inc. and brings 29 years office and field experience in product development and certification of instruments for process measurement, safety and industrial hygiene to his new role. He has been a member of TC 31 since 1993 and is also Convenor of TC 31 WG 32.

About Marcus Häusler
TC 115 welcomed its new Chairman, Marcus Häusler, for the period 1 August 2014 to 31 July 2020. Häusler works in Product Portfolio Management HVDC & FACTS at Siemens and is an electrical engineer specialized in high voltage, power systems and HVDC & FACTS. He is Convenor of IEC SC (Subcommittee) 22F/WG (Working Group) 24 and Member of a number of IEC Working Groups, as well as the German representative to SC 22F and TC 115. Häusler is the co-author of a number of publications on the subject of electrical power engineering.

 Extensions
The SMB (Standardization Management Board) has approved the extension of the term of office of Pascal Tantin, Chairman of TC 38: Instrument transformer for the period 2014-08-01 to 2017-07-31.

 It is with great sadness that the IEC learned of the passing of Dieter Bergman, valuable member of the IEC community and Chairman

since 2001 of IEC TC (Technical Committee) 91: Electronics assembly technology. Bergman was a long-standing member of the IPC (Association Connecting Electronics Industries).

An esteemed electronics professional
Bergman began his career as a designer at Philco Ford in 1956 and remained with the company until 1974, at which point he was a member of the company’s advanced technology group specializing in printed circuit computer-aided design.

He went on to join IPC as Technical Director and in 1985 received the IPC Hall of Fame Award, its highest honour.

Bergman’s involvement with the IEC began in 1972 when he was US Deputy Technical Advisor to TC 52: Printed circuits (now disbanded) and in 1986 became its Chairman. In 1991 he was named US Technical Advisor to TC 91 and was elected Chairman of the Committee in 2001, a position he held until his death.

The IEC extends its deepest sympathies to his family, friends and colleagues.
Better cybersecurity for nuclear plants

The IEC publishes the first International Standard to tackle cyber-attacks in nuclear power plants

Morand Fachot

Safeguarding the security of critical infrastructure from malicious acts by digital means (cyber-attacks) is becoming a priority for most countries. Energy installations, nuclear power plants in particular, may be seen as prime targets for such attacks. The first IEC International Standard aimed at defining “adequate programmatic measures for the prevention of, detection of, and reaction to malicious acts by cyber-attacks” on computer-based systems in nuclear power plants, has just been published, so addressing this risk.

Multiple actors attacking multiple targets

The range and cost of global malicious cyber activities is growing. The latter was estimated in a January 2014 McKinsey & Company report as having the potential to “materially slow the pace of technology and business innovation with as much as USD 3 trillion in aggregate impact” by 2020. Recent examples of risks posed by cyber-attacks include:

• A warning issued in late August 2014 by the head of IOSCO (International Organization of Securities Commissions), a global financial watchdog, that the next major financial shock would be triggered by cyber-attacks
• Reports published in June 2014 indicating that an 18-month cyber-attack was believed to have compromised the computer systems of more than 1 000 European and US energy companies
• Hackers breaking into the systems of a major US retailer and stealing the personal information of 70 million people and the payment card data of 40 million customers in November 2013

Beyond potentially large financial losses, one very serious risk posed by cyber-attacks concerns critical infrastructure, such as power grids in general and nuclear power plants in particular.

IEC long involvement in cybersecurity

The IEC has been closely involved in the development of Standards for cybersecurity for years through its work in ISO/IEC JTC (Joint Technical Committee) 1/SC 27: IT security techniques.

IEC/ISO JTC 1/SC 27 has prepared dozens of documents covering various aspects of IT security techniques, including the information security management system family of Standards. In this area it published ISO/IEC 27001:2013 and ISO/IEC 27002:2013, late last year (see article on ISO/IEC 27001:2013 in e-tech December 2013).

However, previous Standards developed by IEC/ISO JTC 1/SC 27 have not addressed certain specific needs of the nuclear industry. As a result IEC SC (Subcommittee) 45A: Instrumentation, control and electrical systems of nuclear facilities, set out to develop a Standard to prevent, detect and react to cyber-attacks on NPPs (nuclear power plants).

This Standard, IEC 62645:2014, Nuclear power plants – Instrumentation and control systems – Requirements for security programmes for computer-based systems, has just been published.

From nuclear safety to cybersecurity

The scope of IEC SC 45A includes the preparation of “standards applicable to
the electronic and electrical functions and associated systems and equipment used in nuclear energy generation facilities (…) to improve the efficiency and safety of nuclear energy generation”.

Until recently SC 45A had dealt with safety, including some software aspects, but not tackled the generic issue of NPP cybersecurity. It has now started to address the latter with the publication of IEC 62645.

The Standard notes that “ISO/IEC 27001 and ISO/IEC 27002 are not directly applicable to the cyber protection of nuclear” computer-based systems “due to the specificities of these systems, including the regulatory and safety requirements inherent to nuclear facilities.”

However, it also states that “this standard builds upon the valid high-level principles and main concepts of ISO/IEC 27001 and 27002, adapts them and completes them to fit the nuclear context”.

Covering all aspects
Like other IEC SC 45A Standards, IEC 62645 was prepared taking into account “principles and basic safety aspects provided in the IAEA (International Atomic Energy Agency) code on the safety of NPPs”. The terminology and definitions used by SC 45A Standards are consistent with those used by the IAEA. The Standard refers to various IAEA publications, in particular its Computer Security at Nuclear Facilities manual.

The Standard also compares the overall security framework described in IEC 62645 with that of the framework developed by NIST (National Institute of Standards and Technology) in SP 800 82 and other supporting NIST documentation.

IEC 62645 covers the following issues, among others:

- Establishing and managing a nuclear computer-based system security programme. This includes overall concepts for the preparation of programme, policies and procedures, roles and responsibilities, establishment, implementation and operation of the programme
- Life-cycle implementation for system security, which embraces requirements, planning, design, installation, operation and maintenance activities and more
- All aspects of security controls, such as policy, organizing security, asset management, access control, etc.

IEC 62645, developed to prevent and/or minimize the impact of attacks against computer-based systems is intended to be used by designers and operators of NPPs (utilities), licensees, systems evaluators, vendors and subcontractors, and by licensors.

It is the first of its kind specifically designed for cybersecurity in NPPs. As such, it should prove essential for the nuclear power industry. Together with other TC 45 International Standards, IEC 62645 will help improve safety and security in nuclear power installations.
Enclosing Ex risks
Redline versions of latest Standards for Ex-flameproof and pressurized enclosures published

Morand Fachot
Flameproof enclosures for housing pieces of electrical apparatus is one of the well known and most used explosion protection techniques essential for use in explosive atmospheres, such as may be encountered on oil and gas platforms, in chemical and petrochemicals plants, grain silos and in many other sectors. The latest edition of IEC 60079-1:2014, also available in a Redline version, contains specific requirements for flameproof enclosures intended for use in explosive atmospheres. IEC 60079-2:2014, which has already been released, which covers pressurized enclosures for use in the same environments is another well-known explosion protection technique.

Putting a lid on flames
S+ IEC 60079-1:2014, the Redline version of the seventh edition of IEC 60079-1:2014, Explosive atmospheres – Part 1: Equipment protection by flameproof enclosures “d”, has just been released. A Redline version clearly highlights all the changes to have taken place between the issue of the new edition and the previous one.

This seventh edition of IEC 60079-1 replaces the sixth edition, published in 2007, and constitutes a technical revision. It also supplements and modifies the general requirements of IEC 60079-0:2011, Explosive atmospheres -- Part 0: Equipment -- General requirements

A flameproof “d” enclosure is an enclosure in which any parts that may ignite in an explosive atmosphere are placed. The enclosure has the internal strength required to withstand the pressure that will develop if a mixture explodes. A second characteristic of this form of explosion protection technique is that this type of enclosure prevents the flames from the internal explosion from transferring to the explosive atmosphere surrounding it. When incorporated with an appropriate IP rating, such enclosures may also protect their internal components from adverse environmental elements like humidity, dirt, dust or water. This type of enclosure prevents the explosion from transferring to the explosive atmosphere surrounding it.

Protecting a critical path
Central to the efficacy of a flameproof enclosure is the flamepath or flameproof joint, defined in IEC 60079-1 as the “place where the corresponding surfaces of two parts of an enclosure, or the conjunction of enclosures, come together and which prevents the transmission of an internal explosion to the explosive gas atmosphere surrounding the enclosure”.

Flameproof joints being a critical part of “d” enclosures, IEC 60079-1 lists the requirements and characteristics of the various types of flameproof joints (threaded, non-threaded, gaskets, etc.). It also describes the features of the sealed joints used when enclosures are cemented directly into a wall or into a metallic frame, and of the fused seals formed by applying molten glass to the metal frame of the enclosure.

Many key characteristics
IEC 60079-1 also gives details of the many design characteristics required to ensure flameproof enclosures meet the most stringent safety requirements. These include:

• Supplementary requirements for shafts and bearings
• Light-transmitting parts
• Breathing and draining devices which form part of a flameproof enclosure
• Fasteners, associated holes and blanking elements and openings
• Materials and mechanical strength of enclosures
• Entries for flameproof enclosures (threaded, non-threaded holes, sealing devices, etc.)

The Standard also lists additional requirements for components and subsystems that may form parts of, or be used in, enclosures such as switchgear, the various types of suitable primary and secondary batteries, doors, lampholders and lamp caps.

The proof of the enclosures is in the testing
For flameproof “d” enclosures to comply with the necessary stringent constraints, tests have to be carried out. IEC 60079-1 sets out the requirements for various type and routine tests, including explosion containment, flame transmission along with mechanical and sealing tests.

All these make for a very comprehensive Standard, as would be expected given the type of environments in which these enclosures are deployed.

Redline versions for more convenience
S+ IEC 60079-1:2014, which includes both the Redline and Final versions, will prove essential for experts associated with equipment designers, testing and certification who need to see the changes that have been made to the previous version, want to access the latest technical content or will benefit from using both versions.

Published as an IEC Standard, this Redline version provides an authoritative list of changes between the previous and current editions.

Pressurized enclosures are enclosures in which a protective gas is maintained at a pressure greater than that of the external atmosphere. Pressurized “p” enclosures, like flameproof “d” enclosures, are intended for use in explosive gas or explosive dust atmospheres.

Both Standards were developed by IEC TC (Technical Committee) 31: Equipment for explosive atmospheres. Redline versions (available in English only) provide users with a quick and easy way of comparing all the changes between standards and their previous edition.

When changes introduced in new International Standards are as extensive as those in the case of the latest editions of IEC 60079-1 and 60079-2, Redline versions are extremely helpful as well as being highly valued by users.

Even cameras used in Ex environments need Ex-certified enclosures as they may produce heat or sparks (Photo: R. STAHL Camera Systems GmbH)

Explosion-proof enclosure used in mining operations (Photo: Mining Controls, Inc.)
In today’s global market, where products “made in a country” are rare occurrences, the “made in the world” concept has grown in importance and become a reality. This is certainly the case for the electrical and electronic industry sectors whose products represent the biggest share of goods traded globally, after raw energy.

Raw materials, components, parts, modules and assemblies have to be exported, imported, and re-exported multiple times to different countries before the final product is built and then shipped to the end-user who can be anywhere on the globe. In essence: without import it is nearly impossible to manufacture and export.

Interoperability and interconnectivity are essential to be and remain competitive on a global scale. All components and parts that enter into the manufacturing of a device have to fit together, to work together optimally.

This is where IEC International Standards play a major role. A number of IEC TCs (Technical Committees) and SCs (Subcommittees) prepare Standards that help industry produce safe and reliable. In complement, IEC CA (Conformity Assessment) Systems provide the testing and certification that give customers the assurance that the devices they acquire are indeed of the highest quality.