Issue 03/2018

e-tech

news & views from the IEC

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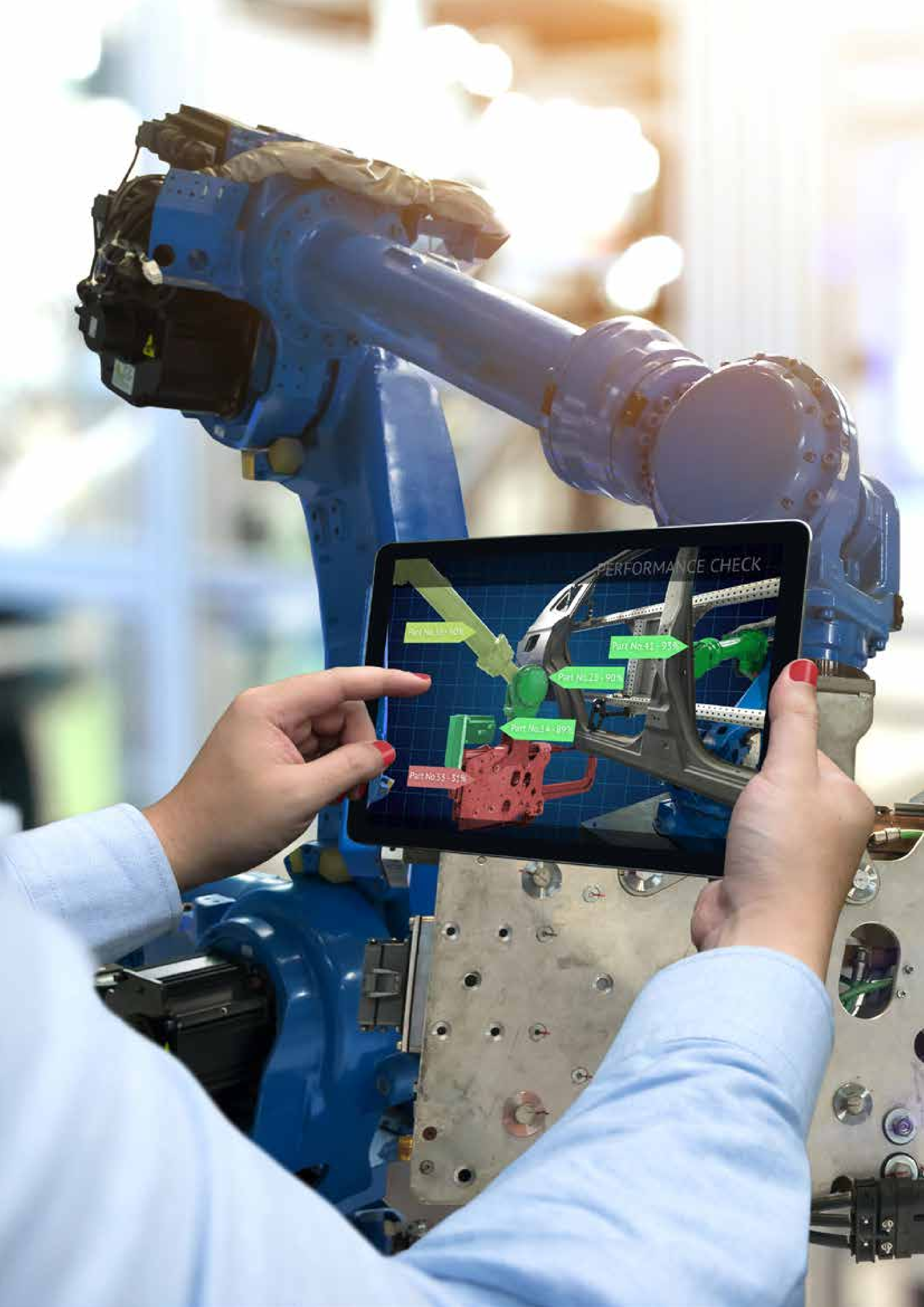
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Paving the way for innovation

Long considered a foe of innovation, standardization is at the very heart of the process

Zoë Smart
Managing Editor e-tech

Credited with increasing our quality of life and boosting economies and employee productivity, "innovation" is one term that is ubiquitous in today's media landscape.

International Standards provide a foundation for technological innovation But what is innovation?

All too often we tend to think of it as a light-bulb moment that dramatically changes the way we do things. But Thomas Edison's incandescent light bulb was not so much the result of a "eureka moment" as a culmination of five decades of inventions, testing and failures by his predecessors and contemporaries. These, combined with his new approach to creating a product that was safe and economical, and supported by the first commercial power station built by Edison himself a few years later, led to the light bulb's widespread adoption and success.

Innovation is built on trial and error, great ideas that never saw the light of day and others that did and failed and yes, standardization! For an innovative technology to make its mark on the world, consumers need to know that it works and is safe and it has to be able to be deployed worldwide. Manufacturers of appliances and consumer electronics as commonplace as the microwave and mobile phone rely on International Standards to ensure the safety and compatibility of their products. Another crucial aspect nowadays of course is the security not only of the technology but also of the data it makes use of. In this area too, International Standards are facilitating the process, by providing a reliable framework for cyber security.

Any current innovation also relies on all those, big and small, that have come before it. In this issue we take a look at the formidable women innovators whose ground-breaking work in fields as diverse as computer programming and solar energy led the way for many of the technologies and consumer goods we take for granted today. With women still gravely underrepresented in STEM fields, the IEC is committed to reaching out to its members to raise the importance of their participation in its technical committees and programmes.

New ideas also have an uncanny way of being developed for application in one field, only to find their way into others. Drones and other unmanned powered vehicles are examples of technologies which were designed originally for military use and are now being deployed in many different areas, including environmental conservation and clean-up.

As companies and governments worldwide continue to pursue and encourage technological innovation, International Standards provide the necessary foundations to help it succeed and flourish.

IEC *e-tech* is a magazine published by the International Electrotechnical Commission in English.

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A new Standard by IEC TC 13 significantly enhances the security of electricity metering prepayment systems

Women in a man's world

Women inventors and their influence on today's technologies

By Claire Marchand

Women's contributions to science, technology engineering and mathematics (STEM) have often been overlooked and left out of history books. When asked to name inventors, people tend to cite Thomas Edison, Graham Bell, Benjamin Franklin or Albert Einstein. Gender stereotypes die hard. Some women were fortunate enough to have their work recognized during their lifetime; many others received only posthumous recognition. This has changed in recent years and light is finally being shed on their essential work.

Ada Lovelace

Ada Lovelace, née Augusta Ada Byron, revealed a talent for numbers and language at an early age. The daughter of Lord Byron and Anne Isabella Milbanke, Baroness of Wentworth, she was brought up by her mother – Byron left them a few weeks after Ada's birth, never to return – and received a very unconventional education for an aristocratic girl of that time. Her tutors taught her mathematics and science because her mother thought that the rigor and discipline would help stifle the moody and unpredictable temperament shown by her father.

At 17, she met and became friends with Charles Babbage, a mathematician and inventor who served as her mentor. Through him, she began studying advanced mathematics at London University. Babbage had invented the difference machine – an ancestor of the computer that could perform mathematical calculations – and had made plans for the analytical engine, designed for more complex calculations. Asked to translate an article on the latter from French into English, Lovelace not only did what was required but also added her own thoughts and ideas on the invention. Her notes were three times as long as the original paper and her work was published in an English science journal in 1843.

Ada Lovelace (1815-1852) – The first computer programmer

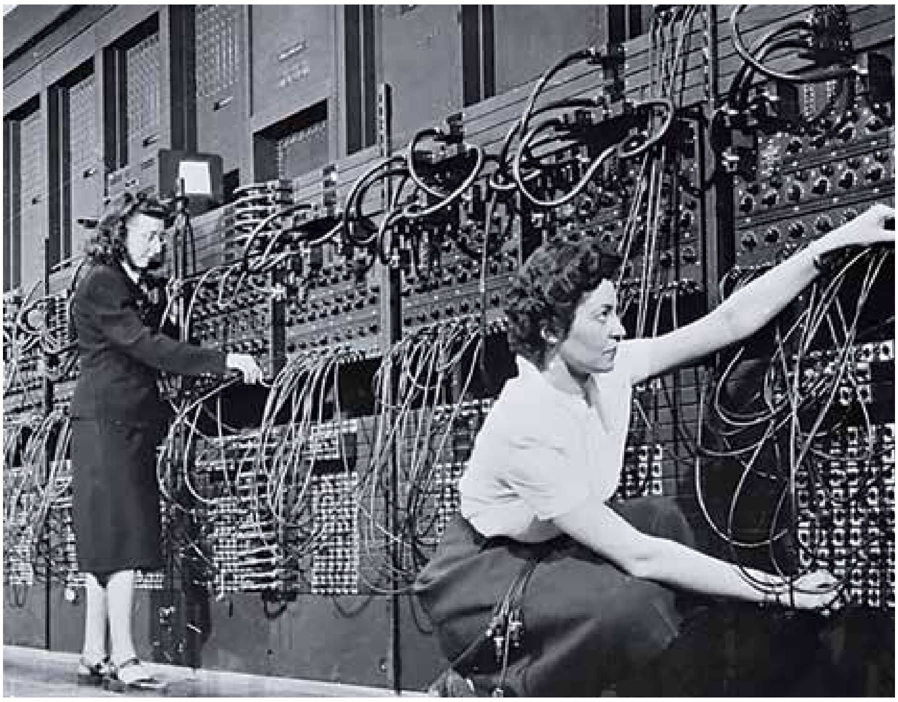
Her notes described how codes could be created for the device to handle letters and symbols along with numbers. She also devised a method for the machine to repeat a series of instructions, the looping process used by computer programmes today.

Her husband, William King, Earl of Lovelace, whom she married in 1835, was always very supportive of her scientific endeavour.

Lovelace's contributions to computer science remained a well-kept secret for more than 100 years. In 1953, her notes were republished in a book by B.V. Bowden, *Faster than Thought: A Symposium on Digital Computing Machines*. In 1980, the US Department of Defense honoured Lovelace, giving the name Ada to a new computer language.

ENIAC (1946) – The refrigerator ladies

In 1943, two men, John Mauchly and J. Presper Eckert, along with the United States Army, began designing and engineering a system called the Electronic Numerical Integrator and Computer (ENIAC), part of a secret World War II project. They explored the possibility of an electronic calculator made from wiring and vacuum tubes



The ENIAC programmers (Photo: Los Alamos)

and detailed their plans in a paper entitled *The Use of High-Speed Vacuum Tube Devices for Calculation.* To complete their project, they needed people, maths majors, to programme the machine.

Six mathematicians, all women, were chosen. They learned to programme without programming languages or tools, because none existed. They used only logical diagrams and the work they did calculating ballistic trajectories was extremely complex. When the project was completed, ENIAC could run missile trajectories in seconds.

When ENIAC was unveiled to the press and the public in 1946, the six women – Kay McNulty, Betty Jennings, Betty Snyder, Marlyn Wescoff, Frances Bilas and Ruth Lichterman – remained invisible. What's more, most of them didn't receive recognition for their work during their lifetime. They appeared in photos documenting the project but were, for many years, mistaken for models posing next to the machines. Some called them the "refrigerator ladies"!

Grace Hopper (1906-1992) – First Lady of software

"Amazing Grace" for some, the "First Lady of Software" for others, US Navy Rear Admiral Grace Murray Hopper was a leading figure in computer science and programming from the 1940s to the 1980s.

Born in New York, she graduated from Vassar College in 1928 with a bachelor in mathematics and physics. She then went to Yale where she earned a master's degree in mathematics in 1930 and a PhD in 1934. Née Grace Murray, she married New York University Professor Vincent Foster Hopper in 1930 and retained his name after their divorce in 1945.

From 1931 to 1943, Hopper occupied various positions, from mathematics assistant to associate professor, at Vassar. In 1940 she applied to the US Navy but was refused. She persisted and in 1943 joined the US Navy Reserve, enlisting in the Women Accepted for Volunteer Emergency Service (WAVES). A year later she was assigned to the Bureau of Ordnance Computation Project at Harvard where she was part of the Mark I computer programing staff headed by Howard Aiken. The Harvard Mark I, or IBM Automatic Sequence Controlled Calculator (ASCC) was a huge electromechanical computer (16 metres long, 2,4 metres high, weighing 4 500 kg), that was used to compute data for the scientists working on the Manhattan Project, the R&D undertaking that produced the first nuclear weapons. The Mark I also computed and printed mathematical tables, as inspired by Charles Babbage's analytical engine.

Programmers can thank Hopper for making their life and work easier. When she began her career, all computer programmes were written in numerical codes by people with a mathematical background. To make computer coding more accessible, she devised a human-friendly programming language that used English words that were then translated into machine codes. She met with much resistance but persisted in her endeavor, and in 1952, the first "compiler" was born.

Hopper was in the team that developed COBOL (Photo: Vassar Archives and Special Collections)

In the late 1950s, Hopper was part of the team that developed COBOL, the Common Business-Oriented Language used by businesses and governments. In the following years, many computer companies had developed their own – not always compatible – version of COBOL. In the late 1960s, Hopper was Director of the Navy Programming Languages Group and as such, developed validation software for COBOL and its compiler in an effort to standardize COBOL for the entire Navy. In the 1970s, she was responsible for the implementation of standards for testing computer systems and components, including COBOL. Since the 1980s, the National Institute of Standards and Technology (NIST) has taken over this role.

On a more anecdotal note, Hopper is said to have coined and helped popularize the terms "bug" and "de-bugging", after a moth was removed from inside her computer.

Hopper has received a great number of awards, including the first "Computer Science Man of the Year Award" in 1969. She retired in 1986, at 79, with the rank of US Navy Rear Admiral. In 1997, the US Navy named a new guided-missile destroyer in her honour: USS Hopper.

Lovelace, Hopper and the ENIAC women all contributed greatly to the development of today's computer programming languages. Hopper's efforts to standardize COBOL in particular, have shown the need for interoperable languages. In 1987, the IEC and ISO established ISO/IEC JTC 1: Information technology, a Joint Technical Committee that has brought about a number of very successful and relevant information and communication technologies (ICT) International Standards in many fields: IC cards (smart cards), automatic identification and data capture (AIDC) technologies, information security, biometrics, cloud computing, multimedia (MPEG), database query and programming languages as well as character sets, to name just a few. In particular, its Subcommittee ISO/IEC JTC 1/SC 22 deals with programming languages, their environments and system software interfaces.

Hedy Lamarr (1914-2000) – Hollywood star and inventor

Hedy Lamarr

MGM studios called her "the most beautiful woman in the world". After leaving her native Austria - and a first husband – in 1938, when Germany invaded her country, Hedy Lamarr – née Hedwig Eva Maria Kiesler in Vienna – met MGM studio head Louis B. Mayer who offered her a movie contract in Hollywood.

Beauty and acting weren't her only gifts. She was an inventor in her own rights, although the press took little interest in this aspect of her personality at the time. Long after her acting career went into decline at the end of the 1950s, Lamarr's inventions and love of science came to light, culminating in prestigious awards. In 1997, together with her friend and co-inventor, composer and pianist George Antheil, she received the Electronic Frontier Foundation (EFF) Pioneer Award and the BULBIE™ Gnass Spirit of Achievement Award, a prestigious lifetime accomplishment prize for inventors, dubbed "The Oscar™ of Inventing". In 2014 Lamarr and Antheil were posthumously inducted into the National Inventors Hall of Fame.

During World War II, not wanting to limit her contribution to the war effort to what was demanded of Hollywood actors, i.e. troop entertainment, Lamarr who had gained previous knowledge about torpedoes from her first husband, military arms merchant and munitions manufacturer Friedrich Mandl, asked Antheil to help her develop a communication system using frequency-hopping signals to guide radio-controlled missiles underwater so that they would be undetectable, and therefore could not be jammed, by the enemy. To create the device, Antheil synchronized a miniaturized player piano mechanism with radio signals. In 1942, they were granted a patent for their invention.

At the time, the US Navy seldom considered inventions made outside of the military and didn't use the "secret communications system". Twenty years

UNITED STATES PATENT OFFICE

2,292,387

SECRET COMMUNICATION SYSTEM

Hedy Kiesler Markey, Los Angeles, and George Antheil, Manhattan Beach, Calif.

Application June 10, 1941, Serial No. 397,412

6 Claims. (Cl. 250—2)

This invention relates broadly to secret communication systems involving the use of carrier waves of different frequencies, and is especially useful in the remote control of dirigible craft, such as torpedoes.

An object of the invention is to provide a method of secret communication which is relatively simple and reliable in operation, but at the same time is difficult to discover or decipher.

Briefly, our system as adapted for radio control of a remote craft, employs a pair of synchronous records, one at the transmitting station and one at the receiving station, which change the tuning of the transmitting and receiving apparatus from time to time, so that without knowledge of the records an enemy would be unable to determine at what frequency a controlling impulse would be sent. Furthermore, we contemplate employing records of the type used for many years in player pianos, and which consist of long rolls of paper having perforations variously positioned in a plurality of longitudinal rows along the records. In a conventional player piano record there may be 88 rows of perforations, and in our system such a record would permit the use of 88 different carrier frequencies, from one to another of which both the transmitting and receiving station would be changed at intervals. Furthermore, records of the type described can be made of substantial length and may be driven slow or fast. This makes it possible for a pair of records, one at the transmitting station and one at the receiving station, to run for a length of time ample for the remote control of a device such as a torpedo.

The two records may be synchronized by driv-

Fig. 2 is a schematic diagram of the apparatus at a receiving station;

Fig. 3 is a schematic diagram illustrating a starting circuit for starting the motors at the transmitting and receiving stations simultaneously;

Fig. 4 is a plan view of a section of a record strip that may be employed;

Fig. 5 is a detail cross section through a record-responsive switching mechanism employed in the invention;

Fig. 6 is a sectional view at right angles to the view of Fig. 5 and taken substantially in the plane VI—VI of Fig. 5, but showing the record strip in a different longitudinal position; and

Fig. 7 is a diagram in plan illustrating how the course of a torpedo may be changed in accordance with the invention.

Referring first to Fig. 7, there is disclosed a mother ship 10 which at the beginning of operations occupies the position 10a and at the end of the operations occupies the position 10b. This mother ship discharges a torpedo 11 that travels successively along different paths 12, 13, 14, 15 and 16 to strike an enemy ship 17, which initially occupies the position 17a but which has moved into the position 17b at the time it is struck by the torpedo 11. According to its original course, the enemy ship 17 would have reached the position 17c, but it changed its course following the firing of the torpedo, in an attempt to evade the torpedo.

In accordance with the present invention, the torpedo 11 can be steered from the mother ship 10a and its course changed from time to time as necessary to cause it to strike its target. In

Hedy Lamarr's patent

later, the importance of their work was finally recognized when an updated version of their design was used by the Navy during the Cuban missile crisis.

Last but not least, Lamarr and Antheil's work with spread spectrum technology contributed to the development of Bluetooth and Wi-Fi, technologies that are essential to the work of ISO/IEC JTC 1 and its subcommittees.

Mária Telkes (1900-1995) – The Sun Queen

Mária Telkes

Hungarian-born Mária Telkes moved to the US in 1925 after obtaining her PhD in physical chemistry from the University of Budapest. In 1939, she joined the Massachusetts Institute of Technology (MIT) Solar Energy Research Project where she worked until 1953. At MIT, she developed the first thermoelectric power generator in 1947 and the first refrigerator using the principles of semiconductor thermoelectricity in 1953.

During World War II, Telkes worked for the US Office of Scientific Research and Development, where she developed a solar distiller capable of vaporizing seawater and recondensing it into drinkable water. Army life rafts carried the distiller during the war and a rescaled version of it was deployed to supplement the water demands of the Virgin Islands.

Telkes is also remembered as the woman who, together with American architect Eleanor Raymond, designed and built the first modern residence heated by solar energy. The system used a chemical process that crystalized and retained the heat and then radiated it back to keep a constant temperature.

Telkes is considered one of the founders of solar thermal storage systems, earning her the nickname "the Sun Queen". She received many prestigious awards during her lifetime.
Telkes is one of the inventors and scientists whose research led to major advances in solar photovoltaic (PV) and solar thermal technologies in the second half of the 20th century, as well as to the creation of two IEC TCs whose standardization work addresses solar energy, IEC TC 82: Solar photovoltaic energy systems, and IEC TC 117: Solar thermal electric plants.

Marie Van Brittan Brown (1922-1999) – The first CCTV

In the 1960s, Marie Van Brittan Brown lived in the New York borough of Queens with her husband and two children. She was a nurse and her husband an electronics technician; both had irregular work schedules and she often didn't feel safe when alone at home. Crime rate was high and police response time often too long. Because she resented opening her door not knowing who was calling, she came up with a homemade solution that she devised with her husband's help: four peepholes and a camera that slid up and down to film what could be seen through each hole. What the camera picked up was transmitted to a monitor inside and a two-way microphone permitted conversation with anyone outside the door. In addition, buttons could sound an alarm or remotely unlock the door. In 1969, the Browns received a patent for their invention, the groundwork for CCTV and all modern home security systems.

In 1979, the IEC set up IEC TC 79: Alarm and electronic security systems, which prepares Standards for the protection of buildings, persons, areas and properties against fraudulent actions. The equipment and systems include access control, alarm transmission, video surveillance, building intercom, digital door locks, fire detection and fire alarm, intruder and hold-up alarm to name but a few.

Marie Van Brittan Brown

Good things come in pairs in Industry 4.0

Digital twins are real-time digital images of physical objects, or processes, that are optimizing performance in smart factories

By Michael A. Mullane

Imagine opening your email and finding a medical prescription to treat an illness you didn't know you had, without there being any need for physical tests and perhaps before you even felt unwell. Your doctor could have decided on the treatment after examining a digital replica of you, including real time data about your diet, lifestyle and current environment.

Medicine may not be there yet, but so-called "digital twins" are very much a reality in the world of smart manufacturing, also known as Industry 4.0. Smart manufacturing covers the whole value chain and life cycle of a product, from idea to order, construction and development, delivery, recycling and all related services, as well as real-time integration of user or consumer input and feedback.

Digital twins are the virtual representation of the elements and dynamics of how a product is made, how it operates and how it works throughout its lifecycle. Digital twins influence the design, production and operation of a product.

The technology is integral to the Siemens factory in Amberg, Germany. The plant in Bavaria is 75% automated, but still employs 1 300 people, as for the time being humans continue to be better than machines at many tasks.

The physical factory has a digital twin that is identical in every respect. It is used to plan the production process, programme machines, design products and test them.

When there is an efficient working model and all the bugs have been ironed out, the physical factory begins production. The technology has allowed the factory to scale production to 15 million units a year, a 13-fold increase since 1989, without hiring more people, or moving into larger premises.

Digital twins are being made possible by the prevalence of inexpensive sensors, reliable networks to transmit data and intelligent analytics systems to process and make decisions. The easily available technology is enabling manufacturers to understand how their machines influence the product's tolerances, stresses and design.

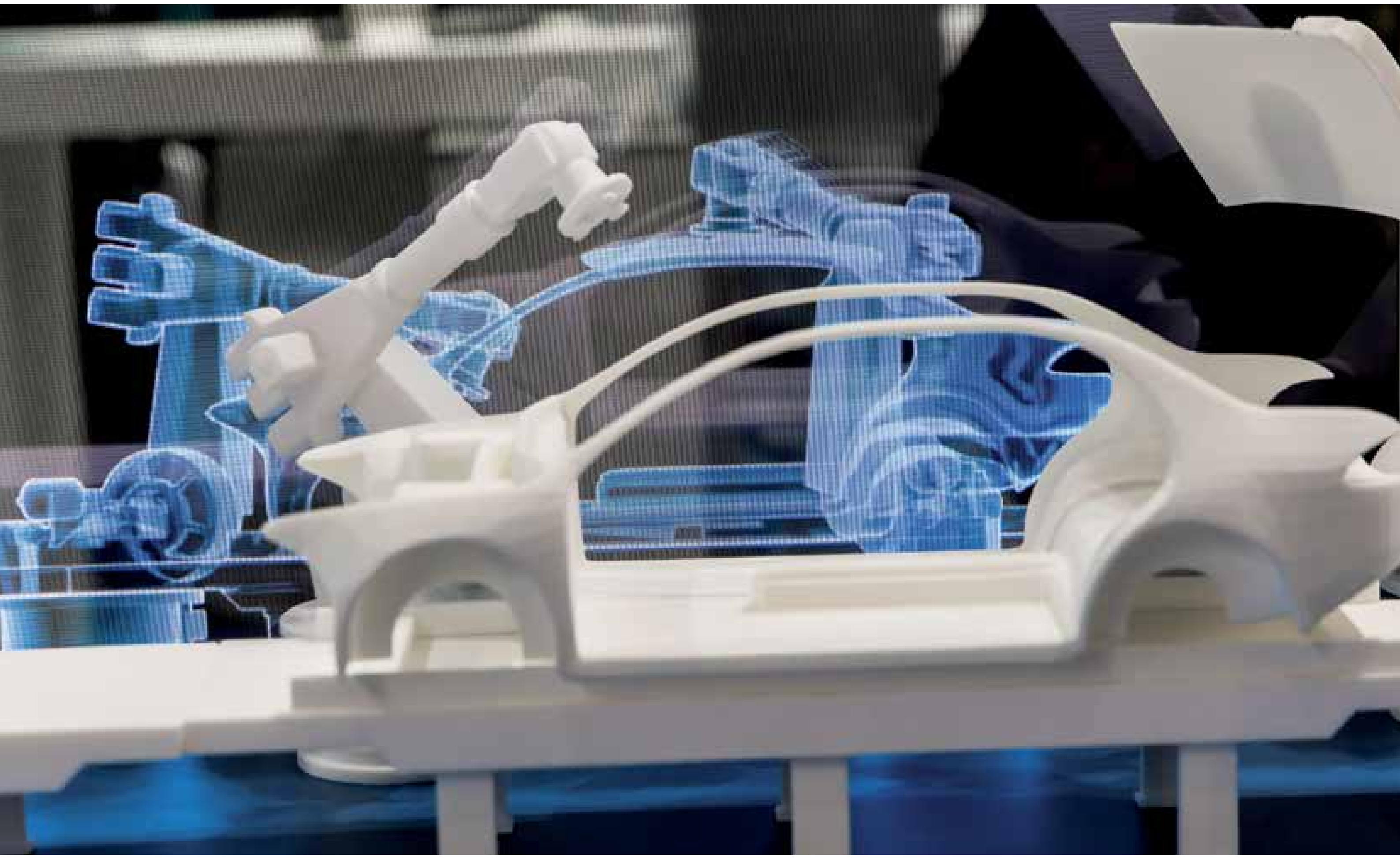
According to Siemens the defect rate at the Amberg plant is close to zero. This is all the more remarkable given that the plant produces 1 200 different products with the same lines.

Smart manufacturing can rely on International Standards

Standardization is of crucial importance, as more companies around the world adopt smart processes. Industry 4.0 requires an unprecedented integration of systems across domains, hierarchic boundaries and lifecycle phases.

For this reason, the IEC places a strong emphasis on systems work.

The IEC Standardization Management Board (SMB) has set up Systems Evaluation Group (SEG) 7 to pave the way for the creation of a Systems



Simulation of use of digital twin technology for car manufacturing at the Siemen's stand, Hannover Messe fair 2018 (Photo: Alexander Tolstykh / Shutterstock.com)

Committee (SyC). The group's scope includes providing an inventory of existing Standards and projects in progress, as well as inviting the cooperation of other organizations to assist in mapping smart manufacturing activities that are closely related and to participate in the activities of the proposed SyC.

SEG 7 works closely with and enhances collaboration between different IEC Technical Committees (TCs). These include:

- TC 3: Information structures and elements, identification and marking principles, documentation and graphical symbols
- TC 17: High-voltage switchgear and controlgear
- TC 22: Power electronic systems and equipment
- TC 44: Safety of machinery - Electrotechnical aspects
- TC 65: Industrial-process measurement, control and automation
- TC 77: Electromagnetic compatibility
- TC 111: Environmental standardization for electrical and electronic products and systems
- TC 121: Switchgear and controlgear and their assemblies for low voltage
- CISPR: International special committee on radio interference, and its SCs
- The Joint Technical Committee (JTC) 1 for Information technology, created by the IEC and ISO, also develops relevant Standards through its subcommittees, among them:
- ISO/IEC JTC 1/SC 27: IT security techniques
- ISO/IEC JTC1/SC 41: Internet of things and related technologies
- ISO/IEC JTC1/SC 42: Artificial intelligence

International Standards are helping manufacturers to develop their products and services in a more efficient, safer and sustainable way. Many companies, consortia and other industry bodies are actively involved in standardization work.

Standardization is of central importance for smart manufacturing. Industry 4.0 requires an unprecedented integration of systems across domains, hierarchic boundaries and life cycle phases.

Protecting the environment with drones and robots

New commercial and research roles for unmanned vehicles

By Peter Feuilherade

History provides many instances of technologies developed for military application being spun off and used in the civilian sector for different, broader uses and at lower prices. Drones and other unmanned powered vehicles are a good example.

The earliest recorded military action using unmanned aerial vehicles (UAVs), more commonly known as drones, dates back to 1849, when Austrian forces used pilotless balloons to drop bombs fitted with timed fuses on Italian revolutionaries besieged in Venice. However, strong winds blew many of the "flying bombs" back across the city, and they fell on Austrian troops encamped on the mainland.

World War I saw the development of pilotless vehicles launched by catapult or flown using radio control. Reconnaissance UAVs were widely used in the Vietnam War, and the first fully-autonomous battlefield drone was developed in Israel in 1973. In the last two decades, the US, the UK and Israel, among others, have used drones to carry out targeted killings.

Now drone technology has spread well beyond the confines of the military. Drones are used for hundreds of commercial applications, among which environmental research and conservation are growing sectors, particularly as many models are now small and relatively cheap.

Environmental monitoring robots, meanwhile, have been under development since the 1990s. Drones, maritime and terrestrial robots, used individually or deployed to work together, can gather data to assess and monitor the quality of the environment, particularly in areas that are too dangerous to access.

Several IEC technical committees (TCs) and subcommittees (SCs) cooperate on the development of International Standards for the broad range of electrotechnical systems, equipment and applications used in drones and robots.

Saving time and money with drones

Modern drones, whether rotor-based designs like quadcopters or fixed-wing versions, offer rapid, flexible and affordable aerial imagery as well as sensor and monitoring capabilities.

To study the effects of climate change, still images and video can be pieced together to form 3D representations and

An environmentalist flies a drone to capture aerial images of
(Photo: Wikipedia Commons)

maps that are used to predict events such as sea level rises in coastal areas. As important elements of civilian early warning systems, drones equipped with cameras and sensors for transmitting images and data on water levels, temperature, humidity and other parameters can play a vital role in helping to identify flood risks and other natural disasters.

Light-spectrum filtering captures information on physical factors such as heat, radiation and noise level, as well as the sources and types of contamination and pollution.

rehabilitated gold mine sites in Namibia

Environmentally-related uses for drones include collecting data on endangered species and on erosion and deforestation, monitoring active volcanos, assisting in demining operations, assessing nuclear power stations after accidents and surveying potentially dangerous areas such as abandoned mines and wells.

The use of drones and robots for inspection work at decommissioned power plants and mines has demonstrated both the financial savings and the speed and safety aspects they offer over traditional methods.

As well as flight controllers and electronic speed controllers, equipment common to battery-powered drones includes an internal global positioning system (GPS) module which tells the aircraft where it is and where the cameras are looking at all times, and a microcontroller (MCU) to allow the data coming from various connected sensors to be processed in real time. Onboard datalink communications allow navigation, piloting and camera operation instructions to be sent to the drone and positional and live video streams to be downlinked from its camera systems.

IEC International Standards cover the vast majority of the components used in drones, such as GPS units, wireless transmitters, signal processors, batteries, microelectromechanical systems (MEMS) and other sensors.

IEC TC 47: Semiconductor devices, and SC 47F: Microelectromechanical systems, are responsible for compiling International Standards for the semiconductor devices used in sensors and MEMS essential to the safe operation of drone flights. These include accelerometers, altimeters, magnetometers (compasses), gyroscopes and pressure sensors.

IEC TC 2: Rotating machinery, prepares International Standards covering specifications for rotating electrical machines and TC 91: Electronics assembly technology, is responsible for Standards on electronic assembly technologies, including components.

Smart sensors open up new uses

Motion sensors such as accelerometers, gyroscopes and compasses are used to navigate and accurately track a drone's position and keep it balanced. Other sensors for obstacle detection and collision avoidance include monocular vision, ultrasonic (sonar), infrared, light detection and ranging (LiDAR), time-of-flight (ToF) and vision sensors.

Photographic equipment ranges from cameras designed for visible light and operated in daylight to highresolution RGB (red, green, blue) cameras. Infrared sensing devices provide thermal imaging (heat signatures) during hours of darkness.

Multispectral, vision, ToF, LiDAR and photogrammetry camera sensors open up new uses for drones. Photogrammetry is a technique that pulls together the still images and video collected by drones from scores of oblique, top-down and lateral perspectives into image mosaics which are pieced together to form highly accurate 3D representations.

Other specialist sensors can be added for specific tasks. For instance, highly sensitive chemical-detecting sensors in drones used for inspecting gas and oil pipelines allow mechanical faults and defects to be detected and repaired quickly and efficiently.

Navigant Research noted in a 2017 report that advanced battery chemistries like lithium-ion (Li-ion) have seen price declines over the past several years and are used increasingly in unmanned powered air, ground and maritime vehicles. "They will play a key role in the further proliferation of unmanned aerial vehicles (UAVs), unmanned ground vehicles (UGVs), and unmanned underwater vehicles (UUVs)," Navigant predicts.

IEC SC 21A: Secondary cells and batteries containing alkaline or other non-acid electrolytes, compiles International Standards for batteries used in mobile applications, as well as for large-capacity lithium cells and batteries.

Robots help keep the oceans clean

As in the case of drones, robots developed for military purposes predate their industrial counterparts. The Soviet Union and Germany produced a series of wireless remote-controlled unmanned robotic tanks in the 1930s and early 1940s, while modern industrial robots were created from the late 1940s and evolved into machines capable of carrying out industrial tasks in the 1960s.

The technologies that armed forces used to build remote-controlled or autonomous ground, maritime and underwater vehicles to deploy in theatres of war have enabled the development of robots that can be used in environmental protection roles. These include dealing with toxic spills in mines, cleaning up pollution on beaches and public areas and monitoring undersea environments.

A notable example was the use of maritime robots to combat and measure the environmental damage caused by the oil spill in the Gulf of Mexico from the Deepwater Horizon platform in 2010.

Maritime autonomous vehicles use a range of technologies including sonar, cameras, sensors, magnetic detectors, laser scanners, water quality instruments and other specialist equipment, depending on the type of environmental data required to be collected. Examples of possible data types include ocean temperature, salinity, tidal currents, plankton abundance, weather and wave conditions.

Small autonomous ocean gliders, or underwater gliders, use wave motion and solar power to travel thousands of miles at sea without fuel. These unmanned craft are equipped with multiple sensors and are used for both military and non-military applications. The latter include offshore oil and gas operations and scientific research such as water sampling, environmental monitoring and acoustic surveillance.

On a smaller scale, autonomous marine robots or "aqua drones" powered by

WasteShark autonomous waste collection drone designed to tackle the problem of marine litter (Photo: RanMarine Technology) rechargeable electric batteries have been developed by inventors like Richard Hardiman, who runs a project called WasteShark, to cruise silently around urban waters such as harbours, marinas and canals and collect marine litter without disturbing fish and birds.

Aquabotix, a company with operations in Australia and the US which makes unmanned underwater vehicles, has developed hybrid (surface and underwater) vehicles capable of operating in multiple formations, or "swarms", on the surface of a body of water or diving up to 50 m. The robot submersibles are fitted with customized sensors that can work together and can be used for data-gathering operations such as marine ecological surveys, as well as in defence applications.

Designed for hazardous environments

Surface robots have found an important niche operating in radioactive and toxic environments. After the Three Mile Island nuclear accident in the US in 1979, robots were used for photographic and radiological inspection, concrete sampling and decontamination.

In 2017, six years after the accident at the Fukushima Daiichi nuclear power plant, Japanese engineers deployed an underwater robot fitted with radiation-hardened materials and sensors to find the melted uranium fuel inside one of the flooded reactors at the destroyed site. The shoebox-sized robot used small propellers to hover and glide through water, mimicking the movements of an aerial drone.

The US Department of Energy (DOE) plans to use customized autonomous robots to identify uranium deposits as part of the decommissioning of a closed uranium enrichment plant in Ohio. The robots will be fitted with LiDAR sensors and fish-eye cameras to detect and manoeuvre around obstacles, while other sensors will measure radioactivity.

Small, radiation-hardened screw-driven submersible robot developed by Toshiba and the International Research Institute for Nuclear Decommissioning to inspect the interior of the primary containment vessel at Fukushima Daiichi 3 (Photo: Toshiba)

As well as radiation-resistant robots, other types of robots being developed for dangerous environments include explosion-proof robots for use in coal mines, biochemical sampling robots and fire-fighting robots.

A number of IEC TCs and SCs are involved in drawing up International Standards for the electrotechnical systems, equipment and applications used in robots. In addition to IEC TC 47: Semiconductor devices, IEC SC 47F: Microelectromechanical systems, and IEC TC 2: Rotating machinery, mentioned above, other IEC TCs involved in standardization work for specific areas affecting environmental monitoring robots include IEC TC 44: Safety of machinery – Electrotechnical aspects; IEC TC 17: Switchgear and controlgear; and IEC TC 22: Power electronic systems and equipment. IEC TC 56: Dependability, covers the reliability of electronic components and equipment.

Drones and robots working together

Integrating the capabilities of drones and robots opens up greater opportunities for environmental protection as well as research such as the ability to collect imagery both under and above water.

The European Union (EU) has funded a series of projects involving cooperation between various types of robotic vehicles with different capabilities and characteristics to track and take action against oil spills. The fleet, consisting of aerial drones, autonomous underwater vehicles and unmanned surface vehicles, has completed a series of training exercises in the Adriatic and Mediterranean Seas since 2014.

Despite the many new applications for unmanned autonomous vehicles in environmental monitoring, this sector still accounts for only a small part of all sales of commercial drones and robots.

Where commercial drones are concerned, different market research companies offer widely varying forecasts of global market values over the next few years, because some predictions include sales of consumer drones. Research and Markets forecasts that the market is expected to grow from USD 755 million in 2017 to USD 2,034 billion in 2022, at a Compound Annual Growth Rate (CAGR) of 21,91% over the five-year period. Transparency Market Research predicts that the global commercial drones market will grow at 13,8% CAGR from 2017 to 2025, with revenue reaching USD 8,8 billion in 2025.

Demand for drones and robots designed specifically for use in environmental monitoring is set to grow as governments around the world launch more initiatives to assess and reduce pollution.

Building blocks for cyber security

Blockchain opens up new possibilities for data protection

By Ann-Marie Corvin

As we move towards more connected environments, cyber security threats are increasing. One technology that could help with data protection is blockchain, which is also starting to be used in some renewable energy projects.

In the IEC White Paper *Edge intelligence,* blockchain technology is defined as "a well-ordered distributed database that maintains a list of all transactions and which grows continuously over time". Each of these recorded transactions is called a "block".

Blockchain was invented by Satoshi Nakamoto in 2008 and was originally developed as the accounting method for the virtual currency Bitcoin. Blockchain uses cryptography to allow anyone granted access to a distributed database to digitize and insert data, as well as its metadata, in a secure way. Unlike traditional centralized databases, which are situated within a central cloud, the blockchain is not located and maintained on a single server that belongs to a central authority (a bank, for instance). It is spread across multiple points, making it much harder for hackers to gain access to it.

The technology was primarily devised to verify transactions but it is possible to code, digitize and insert practically any document in such a database. Once a block of data is recorded, it's extremely difficult to change or remove. The authenticity of the record can be verified by the entire community using the blockchain, instead of by a single centralized authority. Each time a block of data is completed, a new one is generated. The blocks are connected to each other, like links in a chain, in a proper linear chronological order. If an attacker gets hold of a component of data and attempts to tamper with a block, the system will try to locate the one that differs from the rest. If it is located, it is simply excluded from the chain and recognized as false.

Data protection and the IoT

The distributed storage of blockchain technology and its unique security and encryption features make it an ideal testing ground for internet of things (IoT) applications. The IoT refers to the increasing number of devices which connect to a network to provide information they gather from the environment through sensors and actuators.

These devices can be carried, worn or kept at home, they can be embedded in factory equipment, or form part of the fabric of the city people live in. Each one of them is able to convert valuable information from the real world into digital data that is stored on a centrally shared cloud, managed by a third party, usually the manufacturer of the device.

Increasing concern has been raised over the data protection issues related to this method of digital storage. The openness that gives the cloud its strength can also make it vulnerable. If the foundational or host hardware and operating system are compromised, every workload hosted there can be exploited by hackers.

This has led some companies to experiment with blockchain storage for IoT. Examples include a trial led by a Korean consumer electronics manufacturer and a US IT giant. The autonomous decentralized peer-to-peer telemetry (ADEPT) trial integrated blockchain software into a washing machine that could operate autonomously.

Based on the ethereum cryptocurrency blockchain, the washing machine – amongst other things – could order and pay for its own laundry detergent and if it broke down, could contact and pay a tradesman. This was enabled via smart contracts between the owner and the contract service provider. A smart contract is a computer protocol intended to digitally facilitate and verify the negotiation of a transaction. It allows the performance of credible transactions without third party verification.

Renewable energy projects

A growing number of companies in the energy industry view blockchain as a technology that could simplify the system of renewable energy trading dramatically. Some smart grid and microgrid projects are starting to use it. A recent example in New York saw a finance company join forces with a German electrical company and an energy start-up to launch the Brooklyn microgrid project. The grid consists of five homes on one side of the street with photovoltaic (PV) panels and five homes on the other without. These homes were connected to a microgrid and neighbours with excess renewable energy were able to trade electricity with those homes without solar panels using blockchain technology.

An example in the UK, which is currently edging its way towards commercialization, is a blockchain energy trading platform project backed by several household energy suppliers, the National Grid and a German electrical conglomerate. The trading platform is built on the ethereum blockchain and uses simulated data from 53 million metering points and 60 energy suppliers. One of the main objectives of the project is to allow consumers to switch more easily between energy suppliers. Joanna Hubbard, chief operating officer (COO) of the start-up company managing the project, believes that blockchain will lay the foundations for households to participate in peer-to-peer energy and flexibility trading. "Blockchain technology will allow the transition to a decentralized model capable of local optimization and significant cost and carbon efficiencies", she says.

Clouds on the horizon

Although many companies understand the huge benefits blockchain can offer, it is by no means a cyber security silver bullet. While blockchain is protected by business grade cryptography, where large sums of money or important assets are involved, hackers will follow. The IEC White Paper *Edge Intelligence* covers some of these risks. It points out that, because blockchain is a complex technology, it's difficult to understand where potential attacks may come from or what countermeasures to take.

Another concern focuses on the decentralized nature of blockchains. Keys are used instead of passwords and issued to devices. Users must manage their own private keys, and if one is lost, anything related to that private key is also lost. If a private key is stolen, the attacker will have full access to all digital assets controlled by that private key. The security of private keys is so important that many users rely on secure hardware to store them.

While the potential of blockchain is promising, it remains more essential than ever for companies to adopt the cyber security Standards published by the IEC and ISO Joint Technical Committee (JTC) 1, to protect their critical infrastructures from external attacks. These include the ISO/IEC 27000 series of Standards on information security management systems, published by ISO/IEC JTC 1 Subcommittee (SC) 27: IT security techniques. The challenge is to counter ever more sophisticated groups of hackers. Increasingly that must be done at an international level. New technology solutions will not suffice: they need the backing of International Standards to help achieve effective cooperation in cross-border and cross-community environments.

Renewable energy projects are beginning to use blockchain for energy trading (Photo: Andrew Glaser)

The lighting revolution

Lighting technology has been reinvented continuously since the first light bulb was patented in the late 19th century

By Catherine Bischofberger

The invention of the light bulb had a major effect on the lives of people in the 20th century. Over the years, lighting technology has never ceased to evolve. The various milestones reached along the way coincide with some important dates in the history of the IEC.

The evolution of lighting: incandescent, CFL and LED light bulbs (Photo: Petr Kratochvil)

The early days

One of the first incandescent electric light bulbs was patented by Thomas Edison in 1878. Edison profited from the work of scientists who had produced different forms of light bulbs and filed a number of patents before him. Most of these inventions were not ready for commercialization, however, as the bulbs drew a large supply of electric current. Edison was one of the first to realize that a more energy efficient light bulb was required. His patent was for an electric lamp using a carbon filament or strip coiled and connected to platina contact wires.

In 1904, tungsten filament lamps were first marketed by a Hungarian company. The luminous efficiency, the quality and the durability of tungsten filament light bulbs was much higher than for the carbon filament incandescent light bulbs which were the norm at the time. The company's records state that "the volume of production reached 25-30 000 pieces a day in the fiscal year 1905/1906".

New IEC technical committees

IEC Technical Committee (TC) 6: Lamp sockets and caps, was founded in 1919 and preceded the production of the first coil bulbs in the 1920s. Subsequent coiled-coil designs greatly reduced the length of the filament in the light bulb, producing brighter light, more efficiently than straight and single coil lamps. The TC was later disbanded and its work taken over by IEC TC 23: Electrical accessories, created in 1934.

IEC TC 34: Lamps and related equipment, was the first TC to be set up after World War II. "Engineers from different countries in the lamp industry had always communicated with each other. That spirit of cooperation survived the war. It was clear to most of them that after having lived through such terrible events, they needed to make their collaboration more official. This led to the creation of IEC TC 34 in 1948", explains Horst Porembski, who chaired the Technical Committee from 2003 to 2005.

Modern times

The first fluorescent lamp was invented in the 1890s but modern compact fluorescent lamps (CFLs) were commercialized in the 1980s. They were developed in response to the energy crisis of the 1970s. A Dutch company introduced the first successful screw-in CFL replacement for an incandescent lamp in 1980. CFLs use between one-fifth and one-third of the electric power of incandescent bulbs and last eight to 15 times longer. However CFLs are difficult to dispose of as they contain mercury. An electric current is driven through a tube containing argon and a small amount of mercury vapour. This generates invisible ultraviolet light that excites a fluorescent coating (phosphor) on the inside of the tube, which then emits visible light. Throughout the 1990s, IEC TC 34 published several Standards relating to CFLs; they have been updated regularly since then.

LEDs enter the fray

The first recorded appearance of an LED light can be traced back to 1962. In those days, light emitting diodes were expensive to make and could only emit a small output of infrared light. Scientists worked on increasing the efficiency of LEDs throughout the 1990s. When LED light bulbs first hit the market in the early 2000s, they lasted much longer than incandescent bulbs but were more expensive. As production volumes rose, prices gradually came down. IEC TC 34 has published several Standards relevant to LEDs from the 2000s onwards, including IEC 62031, which specifies the safety requirements for LEDs and was issued in February 2018.

In 2015, the IEC Quality Assessment System for Electronic Components (IECQ), created the IECQ Scheme for LED Lighting. IECQ can be applied as a means of certifying manufacturers and suppliers of the electronic components, modules and assemblies used in the production of LED packages, engines, lamps, luminaires and associated LED ballasts/drivers. It provides a standardized approach for evaluating suppliers and acts as a powerful supply chain management tool when assessing and monitoring the various tier-level suppliers. It gives consumers the assurance that suppliers who are covered by the Scheme, manufacture products which meet the appropriate standards in terms of reliability, safety and cost-efficiency.

The current Chair of IEC TC 34, Andreas Scholtz, is keen to stress the fundamental change brought about by the introduction of LED lighting. "LED is a revolution just as important as the invention of the first light bulb. It has a huge impact on the way TC 34 works as well. In the past, a limited number of players prepared Standards for lamps, luminaires, caps and holders as well as control gear. But with the advent of LED lighting and all its inherent possibilities, a new way of managing the TC is required. Light technology is now linked to the internet of things, to building automation, to IT applications and to artificial intelligence. This accelerated technology convergence, coupled with an increased number of stakeholders from different industries, changes the way we should be viewed. The TC must be seen as a centre of competence for the standardization of lighting products. This means we need to intensify existing liaisons and establish new partnerships", he says.

Smart lights for smart cities and homes

Smart public lighting management systems are already used in several cities around the world. As the proportion of the world's population living in urban dwellings is expected to grow to 66% by 2050, according to the UN, these systems will make increasing sense, as they enable considerable savings in energy to be made. Smart lights can switch themselves on when people are in the streets and off when these are deserted. They perform a rising number of tasks, such as guiding car drivers to the closest parking space. They are also increasingly used in the home. They can be voice-controlled from a distance and employed to convey information.

Li-Fi is a visible light communications system that uses LED light. It is capable of transmitting data at high speeds over the visible light spectrum as well as in the ultraviolet and infrared waveband. It is similar to Wi-Fi, but uses light to transmit data instead of radio frequencies. The technology has many advantages over Wi-Fi, including the lack of electromagnetic interference. It is also 100 times faster.

OLEDs and lasers

OLEDs use an organic compound as a semiconductor which emits light in response to an electric current. OLED displays can be manufactured on flexible plastic substrates. They are already used for car lights, mobile phone displays and even television screens. Inside Subcommittee (SC) 34A, Working Group 3 has been set up to prepare and maintain Standards for OLED light sources.

Scientists who are looking at laser lighting believe it could be the next big breakthrough. Steven DenBaars, the director of the solid state lighting and energy electronics centre at the University of California, Santa Barbara, has been leading research into how to route laser lighting through fibre optic cables. According to Andreas Scholtz, IEC TC 34 has work in the pipeline related to laser technology. "Standards are necessary because there has been some concern about the safety of laser lighting and how it could affect people's eyesight. We need to ensure that future products are safe and convince the public they are safe, as well."

From conflict to civvy street

For a very long time advances in military technology have spilled over into civilian applications

By Morand Fachot

In conflicts, throughout history all sides have tried to make the best possible use of inventions and technology to gain a decisive advantage over adversaries. At the same time developing systems to minimize one's own losses has also been a priority. Military needs have often accelerated many technologies, through improvements to existing systems or the development of new ones. More and more of these technologies have been adopted for civilian use, the reverse process from civilian to military applications is also observed, to a lesser extent.

From mechanical to electrical and electronic systems

Mechanical-based systems, such as motor vehicles, ships and primarily aircraft were the main beneficiaries of military-driven technological advances during World War I. Electrical and electronic systems were gradually introduced for defence applications in the 1930s.

Barely 10 years after the first motorized flight, aviation, described by some senior officers on both sides as irrelevant at the outset of the conflict, benefited hugely from the war.

The major belligerents on the Western front had very small numbers of fairly basic front-line aircraft in 1914, some 140 for France, 110 for Britain and 230 for Germany. At the end of the conflict these countries fielded, respectively, 4 500, 3 300 and 2 400 front-line combat aircraft, with much improved characteristics in terms of range, payload and speed. Soon after the war some military aircraft were converted for civilian use, for example mail and passenger services, with specific civilian models developed later.

With the risk of another major conflict looming in the mid to late 1930s fear of aerial attacks on cities led to research and the development of the radar, which used radio waves for the early detection of approaching enemy aircraft. Radar were later deployed onboard ships as well and have helped prevent accidents in the air and on the seas ever since.

Another early detection system, relying on sound propagation underwater was widely introduced in ships during World War II and is still extensively used to detect submarines. It relies on hydrophones and reversible transducers. Hydrophones are extensively used for underwater seismic and other deep-water-based surveys, and in systems used for tracking shoals of fish.

International Standards for hydrophones and reversible transducers are developed by IEC Technical Committee (TC) 87: Ultrasonics.

World's first A350 XWB full-flight simulator (Photo: CAE)

The 1970s, a glimpse into the future

Defence research agencies, such as the US Defense Advanced Research Projects Agency (DARPA), created in 1958, support "breakthrough technologies and capabilities for national security", the internet being the best-known example, which have positive overflow effects into the economy.

Other countries have introduced similar agencies, with more limited objectives and budgets.

The global positioning system (GPS), developed by the US Department of Defense (DoD) from the 1970s, which uses 24 satellites to provide military users with positioning, navigation and timing services, is another example of a system that has become omnipresent in countless non-military applications from mobile phones to land surveys, air traffic control or maritime navigation.

US President Ronald Reagan decided to make GPS available for civilian use after a Korean airliner was shot down by a Soviet air force aircraft after straying into restricted airspace in September 1983.

Flight simulators were also initially developed for the military. The need to rapidly train a large number of air force pilots led to their development. Flight simulators were based initially on rudimentary mechanical contraptions before the gradual introduction of electrical and electronic systems led to the development of the very advanced systems used to train military and civilian pilots today.

Flight simulators rely on mechanical systems for motion. IEC TC 2: Rotating machinery, develops International Standards for electric motors used for this.

Many other IEC TCs, such as IEC TC 20: Electric cables, IEC TC 23: Electrical accessories and its subcommittees (SCs); IEC TC 47: Semiconductor devices, and its SCs, or IEC TC 48: Electrical connectors and mechanical structures for electrical and electronic equipment, prepare International Standards for components installed in simulators.

The DoD has cooperative research development agreements (CRADAs) with private companies and researchers, which allow them to use government facilities, research and resources to build things that are mutually beneficial to both parties. The information that companies/researchers discover is protected for up to five years. Under many CRADAs companies/researchers do not receive money from the government but have the right to commercialize what they produce. The government retains a use license. The Guardbot spherical robot, which can be used for broadcasting, surveillance, security and detection was developed under a CRADA.

The development of robots for military applications, specifically for bomb disposal tasks, started in earnest in the 1970s. The British army had relied entirely on explosive ordnance disposal (EOD) operators to manually neutralize car bombs and other explosive devices planted by the Irish Republican Army (IRA) in Northern Ireland and mainland Britain until 1972.

After several EOD officers were killed or seriously injured a British army officer developed a remotely-controlled (through ropes) piece of equipment from an electrically-powered wheelbarrow bought from a local garden centre, which he modified to help drag car bombs to a safe distance. The initial device was further improved and has been expanded to an entire family of fully remotely-controlled unmanned ground vehicles (UGVs). The Wheelbarrow Mark9 was unveiled in 2011.

The US Armed Forces have also supported the development of many types of robots or adapted them for use on land, mainly to deal with improvised explosive devices (IEDs), and also in the air and under water and for surveillance tasks.

Robots developed for use in the defence sector must be particularly robust and are often required to be capable of operating in contaminated chemical, biological, radiological, nuclear and explosive (CBRNE) environments. Their electronics must be radiation-resistant.

After the tsunami-provoked meltdown at the Fukushima Daiichi nuclear power plant in Japan, Tokyo asked Washington to provide robots that could operate in a radioactive environment, remove wreckage and measure radiation levels. Some military-type robots from the US iRobot Defense and Security Business Unit (now Endeavor Robotics) capable of entering the plant and measuring radiation levels were sent to Japan.

Underwater and aerial remote-controlled robots were also deployed in Fukushima and elsewhere to survey sites too remote or hazardous for human intervention.

Being essentially electromechanical systems, robots and automated machines that include electrotechnical parts depend on international standards to operate properly and safely. Many of these are prepared by various IEC TCs and their subcommittees (SCs), such as TC 47: Semiconductor devices, TC 44: Safety of machinery – Electrotechnical aspects, or SC 65 A: Industrial process measurement, control and automation – Systems aspects. International Standards for rechargeable batteries, which are essential for many robots, are developed by IEC TC 21: Secondary cells and batteries. As robots are introduced in more fields, more IEC TCs and SCs will be involved in the preparation of International Standards for robotics in their respective domains.

From remotely-controlled to autonomous and semi-autonomous systems

An emerging trend in military technology, with spinoffs in other sectors, is a growing reliance on autonomous and semi-autonomous systems working along or even replacing remotely-controlled equipment.

Advances in these systems have been primarily driven by military technology used in remotely-controlled unmanned vehicles used in the air, on land and on water for surveillance or combat missions.

The use of these systems (deployed by the US and a few other militaries as early as the 1970s) has expanded to other fields such as law-enforcement, maritime surveillance, land surveys, agriculture and, increasingly, autonomous road and rail transport and shipping.

The expansion of these semi-autonomous and autonomous systems beyond the military was made possible with major improvements in – and falling unit cost of – a very wide range of sensors, which are being fitted into many systems in what has become known as the internet of things (IoT). The development of artificial intelligence (AI) and machine learning is reinforcing this trend.

AI is emerging as a solution for many complex systems and issues. The IEC and ISO have just created ISO/IEC JTC 1 / SC 42: Artificial intelligence, a Subcommittee of JTC 1, their Joint Technical Committee on information technology. The scope of this SC is to "serve as the focus and proponent for JTC 1's standardization programme on artificial intelligence" and to "provide guidance to JTC 1, IEC, and ISO committees developing artificial intelligence applications."

Ethical and legal issues

The deployment of autonomous and semi-autonomous systems in the military and other domains, such as transport, raises a number of ethical and legal issues.

When humans are "in the loop", ultimately controlling, for instance, combat drones, or road vehicles they can call off lethal action or decide to take over control of a vehicle in unforeseen circumstances. In case of unintentional civilian casualties from a military strike or death from a traffic accident it can be easier to determine responsibility. In the case of fully autonomous systems the burden of responsibility may be much more difficult to attribute, as hardware or software design fault, external or environmental factors such as lighting or temperature conditions may have caused the incident.

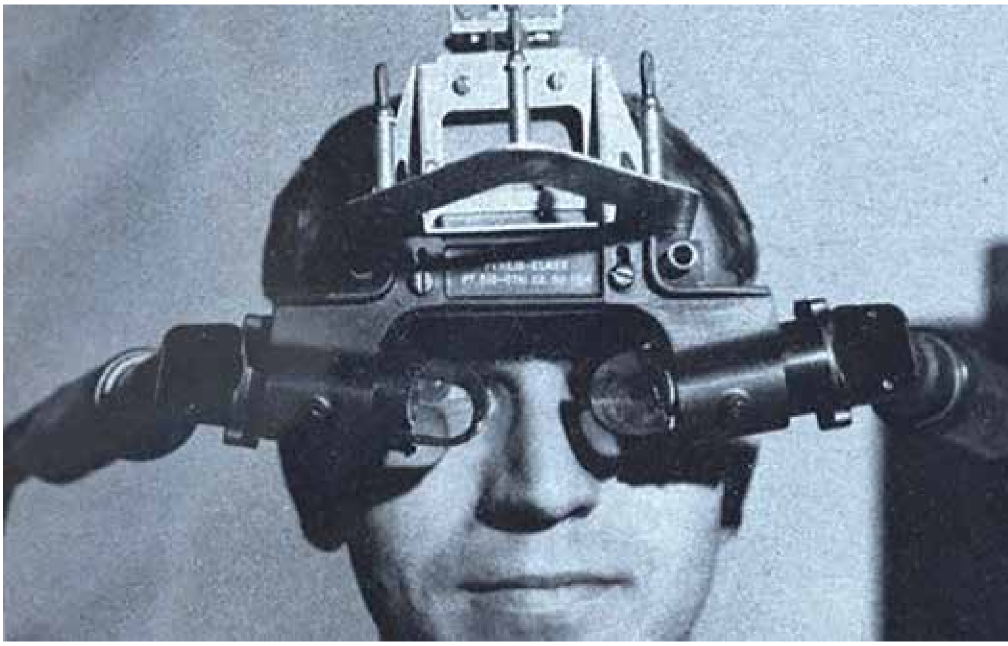
More technological developments are needed to make these autonomous and semi-autonomous systems more reliable. Totally excluding humans from the loop still poses a number of risks.

Back to the future of virtual reality

A brief history of virtual and augmented realities

By Natalie Mouyal

The new film *Ready Player One* provides a glimpse into a futuristic concept of immersive virtual reality. Set in 2045, the movie tells the story of a hidden game within a connected and interactive virtual reality platform in which characters can meet to escape from the hardship of their real-life city slums. While this may not be our experience yet, it is not far removed from the visions of the first pioneers in virtual reality.



"Sword of Damocles" is considered to be the first HMD system (Photo: www.lucas-studios.com)

While the term "virtual reality" did not enter mainstream discourse until the mid-1980s, the concept already existed in popular imagination. Initial exploration into 3D and a 360° field of view, simulated experiences, virtual worlds and head-mounted displays (HMD) had emerged by the late 1990s. However, it was not until the 21st century that the virtual reality experience became more established with the advent of smart phones, powerful computer graphics, motion controllers and computer interfaces that track gestures.

The theoretical beginnings of VR

Virtual reality began with works of fiction. Writers transported their characters to imaginary worlds that, based on today's technology, appear to be prophetic. In one of the first short stories to imagine a virtual reality*, Pygmalion's Spectacles,* published in 1935, characters wear goggles to experience "a movie that gives one sight and sound…taste, smell, even touch. […] You are in the story, you speak to the shadows, and the shadows reply, and instead of being on a screen, the story is all about you, and you are in it".

Other classics that stirred popular imagination included the television series *Welt am Draht* (1973) directed by Rainer Fassbinder, the movie *Tron* (1982) which transports a computer programmer inside a mainframe computer, *The Lawnmower Man* (1992) and *The Matrix* (1999).

However, it was the essay *The Ultimate Display*, written by Professor Ivan Sutherland in 1965, that provided one of the first scientific visions of virtual reality. It describes an "ultimate display" connected to a computer to create a virtual world that provides audible and tactile feedback and the ability to interact with objects. Many of the hypothetical suggestions made in the essay have since come to fruition, including gestural interfaces, eye-tracking, haptics, augmented reality and voice recognition.

Development of VR technologies

Initial attempts to create a virtual reality were based on photography and film. With the stereoscope developed by Charles Wheatstone in 1838, a viewer could perceive a 3D object by having each eye look at different 2D images. This technology remains relevant for augmented reality applications such as Google Cardboard which superimposes stereoscopic images onto a smartphone screen.

In the late 1950s, the cinematographer Morton Heilig developed the Sensorama, which sought to fully immerse the viewer in a short, multisensory film. A mechanical device that resembled an arcade game, the Sensorama provided the viewer with moving, 3D images, scents, vibrations and tactile sensations such as wind.

By the late 1960s, it had become possible to integrate electronics into virtual reality environments. In 1968, Ivan Sutherland, with his student Bob Sproull, developed the "Sword of Damocles" which is now considered to be the first HMD system. While the user interface and images were primitive, the system displayed output from a computer programme and could track the user's eyes and head position.

The US government, through its Department of Defense, National Science Foundation and National Aeronautics and Space Administration (NASA), has funded many projects essential to the development of virtual reality technologies. Areas of research have included computer graphics, networked environments and simulation.

Edward Link developed one of the first commercial flight simulators in 1929 which was later used extensively by the US military to train its pilots during World War II. While the first flight simulators relied upon mechanical systems to provide pilots with feedback, the introduction of electronic systems greatly enhanced the user's sense of reality. To train soldiers in dangerous situations, Charles Comeau and James Bryan developed the Headsight in 1961. This linked a remote camera to the movement of the user's head.

Sensorama (Photo: www.mortonheilig.com)

In the mid-1980s, the engineer Thomas Furness designed a helmet for military pilots that projected information in an immersive and 3D space that pilots could view and hear in real time. His work, which began in the 1960s, included motion tracking, 3D sound, and the use of speech and gesture as sources for user input. To further increase the sensory environment for pilots, Louis Rosenberg developed the virtual fixture platform in 1992 which provides 3D immersive reality.

Haptic feedback began with the use of telerobotics by NASA and the nuclear industry. A master arm controlled a remote – slave – arm, usually in order to operate a space vehicle or handle irradiated material. The haptic systems developed by the University of North Carolina at Chapel Hill, under the auspices of the GROPE project, have also provided an important insight into the use of master control arms for virtual reality applications.

Consumer interest

The video gaming industry has helped to propel the technologies used for virtual reality and inspire popular imagination. Consumers, buoyed by visions of virtual reality from books and movies, began accessing technologies in the 1980s and 1990s. Gear developed to provide haptic feedback became commercially available from the company VPL Research, whose team included such VR pioneers as Jaron Lanier and Tom Zimmerman. Its equipment included the Data Glove, EyePhone and Data Suit.

By the 1990s, the gaming industry had begun offering virtual reality headsets and games such as Sega's VR headset and Genesis console and Nintendo's Virtual Boy. The company Virtuality developed a network of arcade machines that allowed gaming


VR and AR are being increasingly used in the medical and healthcare fields

in a multiplayer immersive environment. However, by the late 1990s, the hype surrounding virtual reality had faded into disappointment and mass consumer demand diminished. Despite these setbacks, virtual reality continued to prosper within the gaming industry with the establishment of virtual communities and massively multiplayer, online role playing games (MMORG).

Current VR applications

Virtual and augmented reality applications are now flourishing beyond the gaming or home entertainment industries. From education and training to manufacturing and healthcare, these applications are becoming increasingly prevalent.

In education, students can interact with objects within a 3D environment. Medical students can be trained while watching live-streamed, 3D surgeries from anywhere in the world. Visitors can walk virtually through heritage sites or, in the case of the Kremer Museum, visit a virtual museum collection. First aid responders are immersed in seemingly real-life disaster scenarios while miners learn to recognize risks while walking through virtual mines.

Manufacturers benefit from virtual and augmented reality applications. Interactive 3D modelling tools used by car and rail manufacturers allow designers to view and test their products before production begins. HMDs provide employees with additional sources of data that are useful for inventory management or warehouse navigation. Construction crews can gather data to visualize real-time conditions and make adjustments as necessary.

In healthcare, virtual reality applications provide therapy to children with autism and help treat post-traumatic stress disorder. Surgeons use visual tools in preparation for an operation. Applications allow doctors to perceive the experiences of a patient with hearing and visual impairments.

IEC Standards

Virtual and augmented reality applications rely on components such as screens, processors, motion sensors, gyroscopes, cameras and images which are linked to hardware such as headsets. IEC technical committees (TCs) and subcommittees (SC) are responsible for producing International Standards that make the hardware and software used in these technologies possible.

The Joint Technical Committee of IEC and ISO, ISO/IEC JTC 1, provides standardization in information technology. Specifically, ISO/IEC JTC 1/SC 24 develops Standards relating to image processing, computer graphics and virtual reality.

IEC TC 47 and IEC SC 47F are responsible for the standardization of sensors and microelectromechanical systems. IEC TC 100 produces Standards which contribute to the quality and performance of audio, video and multimedia systems and equipment while IEC TC 110 covers electronic display devices including touchscreens.

What's next?

While the movie *Ready Player One* gives us a glimpse of the possible future for virtual reality, that future remains elusive. More recently, the most successful applications have been able to provide an augmented reality, whether that's finding Pokemons or tracking inventory. However, it is not yet clear how we will decide to merge virtual and real environments, much less why or which interfaces will be successfully adopted. Works of fiction may provide the best source of inspiration.

From a doodle in the sand to the barcode

A beachside brainwave proved to be the inspiration behind a revolution in manufacturing and retailing

By Antoinette Price

Technology has made it easier and quicker to perform many daily activities. Not only do we rely on it, it has brought massive changes to our lives.

Smart devices and connectivity are prime examples. We rarely leave home without our smartphones. We use them to make payments and purchases, read news, work on emails, communicate with friends, manage smart home systems, monitor health and fitness and for a host of other activities.

As modern consumers, we have come to expect to be connected wherever we are, so that we can choose exactly when we want to do all these things.

An ingenious innovation for sorting the world

Another invention that has completely changed life can be found on most products today. The barcode is a discreet label which facilitates shopping and enhances the global trade of goods. Without it, many of the online systems and services we use for purchasing products or finding information would not exist.

Joseph Woodland was an American inventor and mechanical engineer. He came up with an efficient way of capturing product information at the checkout, with the goal of speeding up the checkout process at the point of purchase. In 1948, the idea came to him unexpectedly from a drawing he did in the sand, adapting the dots of Morse Code into lines. So the modern barcode was born on a beach in Florida.

Woodland and his associate Bernard Silver received a US patent for "Classifying Apparatus and Method" in 1952, but at the time, the technology was too expensive to develop the idea for supermarkets.

Over the years, the striped-scan system would be refined. It was first used with a trackside scanner in the 1950s to identify the ownership and number of railway cars, but only reached the retail sector in June 1974, when a packet of chewing gum bearing the universal product code (UPC) barcode was scanned at a till in Ohio.

Patient identification wristbands with barcodes help to ensu

Identifying and tracking things

In addition to automating supermarket checkout systems, other tasks performed by various types of barcodes have become known generically as automatic identification and data capture (AIDC). Serving numerous applications – product/item identification, point-of-purchase/use, track and trace and product distribution for healthcare, manufacturing, retail sales, service industry, supply chain and transportation – AIDC technologies are vital for global trade and among the basic enablers of e-commerce. By providing timely and cost-effective data, they improve processes that cover product life cycles, such as ordering, back office operations, manufacture, distribution, sale, use, repair, warranty and return of products.

Established in 1996, the work of IEC and ISO Joint Technical Committee (JTC) 1 Subcommittee (SC) 31, includes data formats, syntax, structures and encoding, as well as technologies for the process of AIDC and associated devices used in industry and mobile applications. The SC publishes International Standards for barcode symbologies and radio frequency identification (RFID).

Technology that keeps on evolving

One dimensional…

The barcode is a machine-readable way of representing data. The traditional one-dimensional (1D) version is a rectangle containing straight lines in varying widths and spacings. Barcodes contain information about the item to which they are attached, such as the manufacturer, owner, identification number and price. These criteria can change depending on the item and reason for use.

When scanned, barcodes link product information to the stock database held by the retailer or manufacturer.

re the right patient receives the right treatment (Photo: www.flanderstoday.eu)

Over time, increasingly sophisticated software systems carry out other tasks (tracking and automatically reordering stocks when required) by using this information.

… to two

The two-dimensional (2D) matrix barcode is designed using geometric shapes (dots, hexagons and rectangles). Created in 1994 in Japan for the automotive manufacturing industry to enable components to be scanned at high speed, the quick response (QR) code has become very popular and adopted by many industries.

QR codes are also used in art and promotions. This poster was created after the 2011 earthquake and tsunami that hit northeastern Japan (Photo: www.setjapan.com)

Radio frequency identification tags

RFID tags are also used to identify and track the items they are attached to by using radio frequencies. Line of sight is not a pre-requisite, unlike standard barcodes which require optical scanners to be held directly in front of the label.

From the warehouse to the hospital – many uses and benefits

In our global world, there is a growing need for tracking and tracing solutions. Barcodes continue to evolve because they are versatile. As well as storing useful product information, they can be attached to almost any surface, are inexpensive to design and print, easy to use, reduce human error risk due to very low scanning error rates, and can be adapted to the scale of business as it grows. Some of the many uses include:

- Retail inventory management systems. These offer wireless, accurate, real-time access to inventory and enable automated reordering of stocks when they run low. Businesses save time and costs, since they require fewer employees who themselves need less training.
- Self check-out machines. These allow customers to process and pay for shopping faster.
- Advertising/payment QR codes. These enable retailers to boost sales by sending QR code offers to customers, who are able to compare prices and product information while in the shops. Other innovative smartphone apps allow shoppers to scan, create and save their lists and receipts, and pay by holding their phones over a QR code.
- Warehouse management systems. These help manufacturers and retail giants to work faster and more efficiently as a result of accurate, quick, automated product scanning, tracking and picking systems, improved product-to-market times and streamlined costs.
- Healthcare tracking solutions. Hospitals and medical centres use barcode labels to track medication, equipment and important patient details such as medical history and drug allergies so as to avoid the occurrence of medical errors. They also stop disease spreading by enabling users to know what equipment has been sterilized and is ready for use.
- Admission tickets. These save consumers time spent queuing at airports, museums and concerts. Customers buy tickets online and scan the QR code saved in their smart devices to board flights or gain entrance to events.
- Electronic luggage tags. These provide improved baggage handling and tracking. A state of the art airport baggage handling system streamlines processes by combining barcode and RFID technology with artificial intelligence and a robotic arm. Customers use machines to check in their own luggage, while behind the scenes, robotic arms load the luggage from a central area onto ramp carts and containers as needed. This technology is being used at Schiphol International Airport in the Netherlands.
- Building access. Employees access the workplace using badging systems and some companies use adhesive barcode labels on cars for those who drive, in order to improve security.

Staying on top of the trends

The internet of things (IoT) and related technologies are increasingly important in our world and are changing how we live. More industries are adopting AIDC technologies such as barcodes, QR codes and RFID to improve their operations. RFID is one of the primary sources of IoT data, which means ensuring its security is of the utmost importance. JTC 1/SC 31 follows these trends so that it can address market needs in a timely manner through its standardization activities.

Staying one step ahead

Cyber security and the role of International Standards

By Michael A. Mullane

Innovation brings new challenges – or, put another way, every silver lining has a cloud. While the internet has given us connected, smart and interactive technologies, it has also spawned the murky, underground world of cyber crime.

Challenges in cyber security are evolving continuously as an ever growing number of connected devices and smart technologies are incorporated into our homes and workplaces. In the past decade we have gone from worrying about protecting our computers and smartphones to being aware of the risks that refrigerators, thermostats, industrial machines and other systems pose to network security.

As defined by ISO/IEC JTC 1/SWG 5 in 2014, the internet of things (IoT) is "an infrastructure of interconnected objects, people, systems and information resources together with intelligent services to allow them to process information of the physical and the virtual world and react". It covers everything from household appliances to connected cars to widgets in nuclear power plants (NPPs).

Hackers stole 10 GB of data from a casino in Las Vegas (Photo: Pixabay)

In industrial environments, the growth of connected devices has accelerated the convergence of the once separate domains of information technology (IT) and operational technology (OT), resulting in industrial IOT (IIOT). This has made cyber security intrusions and threats more difficult to detect and prevent.

IHS Markit expects the number of connected IoT devices worldwide to jump from nearly 27 billion in 2017 to 125 billion in 2030. An increase in the number of connected devices means more potential vulnerabilities for cyber criminals to exploit.

According to a recent report, 978 million victims lost USD 172 billion to cyber crime in 2017. Most risk professionals believe that a data breach or cyber attack caused by insecure IoT devices could be "catastrophic" for their organization.

Fishy goings-on

Tools like the IoT search engine Shodan have made it easier than ever before for hackers to pinpoint vulnerable devices in a network. They might be looking for refrigerators, heating systems, or in the case of hackers targeting a casino in North America, a fish tank.

The casino hackers were able to transfer 10 GB of data out of the network, via a smart thermostat and up to the cloud, including the bank account details of wealthy patrons. The crux of the matter is that when connected to a network, any device with weak security poses a risk to the whole organization.

Malware gives hackers an even quicker route into a network if their targets can be tricked into opening infected documents. Secret papers leaked last year revealed that CIA agents regularly use malware to turn connected televisions into bugging devices.

Sometimes called industrial IoT, operational technology (OT) refers to hardware and software that controls physical processes, industrial devices and infrastructure. For example, the manufacturing industry is fast proving a popular target for hackers as it becomes better connected.

Elsewhere, protecting energy security and critical energy infrastructure against cyber attacks is rapidly emerging as an absolute priority. A May 2017 report by the FBI and Homeland Security warned that hackers were penetrating the computer networks of nuclear power stations and other energy facilities in the US and around the world.

Seven months later, in December 2017, a cyber attack shut down a power plant, believed to be in Saudi Arabia. Attacks targeting nuclear power plants (NPPs) could have devastating consequences for the entire power network and the ability to trigger an environmental catastrophe.

The IEC has issued 235 OT and IT security-related publications. Some 160 have been developed in cooperation with ISO, including the ISO/IEC 27000 family of Standards.

The need for Standards

In the fight against cyber crime it is of critical importance to understand when, if and how, an intrusion into a network, system or application occurs. Security systems must be able to identify what vulnerability was exploited in order to implement the right checks and controls so as to prevent similar intrusions in the future.

While organizations must continue to be vigilant, they can at least count on the standardization work of the ISO/IEC Joint Technical Committee (JTC) 1 for help. For example, ISO/IEC 27039 provides guidelines for preparing and deploying an intrusion detection and prevention system (IDPS).

JTC 1 has produced a series of Standards for information technology (IT) security techniques which define a common language for IT-related threats, help protect information in the cloud, offer integrated solutions for services and more. The widely known ISO/IEC 27000 family of Standards provides a powerful framework for benchmarking against best practices in the implementation, maintenance and continual improvement of controls. ISO/IEC 27001 identifies potential risks to client and stakeholder data and ensures that organizations implement the relevant controls to mitigate them. It takes in encryption, ongoing testing and risk assessment.

Inter-sector and inter-organizational communications

Within the ISO/IEC 27000 toolbox, ISO/IEC 27010 guides the initiation, implementation, maintenance and improvement of information security in inter-organizational and inter-sector communications. It helps to encourage the growth of global information-sharing communities, and includes general principles on how to meet these requirements using established messaging and other technical methods.

ISO/IEC 27010 is particularly relevant for the protection of critical national infrastructure, where exchanging sensitive information securely is of paramount importance. Security incident response teams also make use of this Standard.

Integrated solutions for services

Some organizations are choosing to combine ISO/IEC 27001 with ISO/IEC 20000-1, a service management system. The resulting integrated system enables organizations to manage the quality of their services efficiently while keeping data safe.

ISO/IEC 27013 offers a systematic approach to facilitating the integration of an information security management system with a service management system. This lowers implementation costs and avoids duplication efforts, as only one audit is needed for certification.

Communication networks, control systems and power installations

Other IEC series of Standards are relevant to the protection of communication networks, control systems and power installations against cyber threats. They include:

Protecting critical energy infrastructure against cyber attacks is emerging as an absolute priority

- IEC 62443, *Industrial communication networks — Network and system security*
- IEC 61850, *Communication networks and systems for power utility automation*
- IEC 60870, *Telecontrol equipment and systems*
- IEC 62351, *Power systems management and associated information exchange*

Addressing the specific needs of nuclear power plants (NPPs)

IEC develops bespoke solutions wherever needed. For example, IEC Subcommittee (SC) 45A: Instrumentation, control and electrical systems of nuclear facilities, is developing specific Standards for NPPs by adapting ISO/IEC 27001 and ISO/IEC 27002 to fit the nuclear context and coordinating with the IEC 62443 series.

SC 45A has developed IEC 62645, *Nuclear power plants — Instrumentation and control [I&C] systems — Requirements for security programmes for computer-based* systems, to protect microprocessor-based information and control systems. A second Standard, IEC 62859, *Nuclear power plants — Instrumentation and control systems — Requirements for coordinating safety and cyber security,* provides a framework to manage the interactions between safety and cyber security.

In common with other IEC SC 45A Standards, IEC 62645 and IEC 62859 take into account the safety principles for NPPs of the International Atomic Energy Agency.

Protecting critical infrastructure

Several other IEC technical committees (TCs) and SCs prepare International Standards that protect specific domains and keep industry and critical infrastructure assets safe. Here is a selection of them:

IEC TC 57: Power systems management and associated information exchange, develops, among many others, the IEC 61850 series of publications for communication networks and systems for power utility automation, and the IEC 60870 series for telecontrol equipment and systems.

IEC TC 65: Industrial-process measurement, control and automation, prepares publications that specify security requirements for industrial automation and control systems (IACS) in the IEC 62443 series.

IEC TC 62: Electrical equipment in medical practice, and its SCs, develop Standards to protect medical data security, integrity and privacy.

IEC TC 80: Maritime navigation and radiocommunication equipment and systems, has developed IEC 61162-450. In parallel, TC 80 has developed IEC 61162-460 to expand requirements when there is a need for enhanced safety and security standards.

Audit and certification

Increasing numbers of organizations are turning to third-party certification audits to demonstrate that they have a solid information security management system (ISMS) in place which conforms to the requirements of ISO/IEC 27001. ISO/IEC 27006 provides the requirements that certification and registration bodies need to meet to be accredited, so they can offer ISO/IEC 27001 certification services.

The IEC Advisory Committee on Security (ACSEC) deals with information security and data privacy matters which are not specific to a single IEC Technical Committee. ACSEC also coordinates activities related to information security and data privacy and provides advice to the SMB on these topics and guidance to TCs and SCs for the implementation of information security and data privacy.

Cyber security is the focus of the IEC Conformity Assessment Board (CAB) Working Group (WG) 17 and IEC Conformity Assessment for Electrotechnical Equipment and Components (IECEE) Certification Management Committee Task Force.

Staying one step ahead

"Technology breeds crime and we are constantly trying to develop technology to stay one step ahead of the person trying to use it negatively," says Frank Abagnale, a man who knows a thing or two about the criminal psyche. Abagnale, whose life story became the subject of a film by Steven Spielberg, worked for the FBI and a host of organizations as a security consultant, but in his youth was one of America's most wanted criminals.

Adhering to International Standards is the most effective way to stay one step ahead. They provide a robust and reliable framework for cyber security, based on best practices identified by the leading industry and technology experts around the world.

Cyber security breaches can occur if smart appliances, such as a dishwasher, are hacked

First International Standards committee for entire AI ecosystem

Industry recognizes standardization will be essential to broad adoption of AI

By Antoinette Price

Information technology has become an integral part of our lives whether it be in the consumer, industrial or commercial aspects. It is hard to imagine life, work or entertainment without it. Artificial intelligence (AI) presents the next digital frontier of the IT evolution.

It is capturing the world's attention and involves many stakeholders including research, academia, industry, practitioners, policy makers and ethics advocates. AI is expected to be one of the most crucial enabling technologies in our lifetime.

AI – the silent voice at the management table

AI is transforming industries, through the evolution of IT usage. Initially viewed as a tool to increase efficiency within organizations, for example, the use of computers to develop memos, the next inflection point saw IT becoming essential to measuring an organization's performance against key performance indicators (KPIs) established by the management team. The advent of the industrial internet of things (IIoT) saw IT go deeper into the management chain, all the way to decision makers and across more traditional industries that may not have been as reliant on IT in the past.

Today, AI is transforming the role of IT from one of measurement for the management team (performance relative to established KPIs), to one of providing insights to establish future goals and KPIs. Put simply, AI is taking a seat at the management table, adding its voice to where the organization should go via insights.

AI is already used in many applications, including healthcare for customizing patient treatments, the financial sector for fraud detection, autonomous vehicles for determining optimal speed, following and breaking distances and collaborative robots, designed to work safely alongside humans, lifting heavy loads, staging materials for human assembly, or completing repetitive motions.

Inaugural meeting establishes a structure for the programme of work

Against this backdrop, in 2017, IEC and ISO became the first international standards development organizations (SDOs) to set up a joint committee (ISO/IEC JTC 1/SC 42) which will carry out standardization activities for artificial intelligence.

e-tech caught up with Wael William Diab, Chair of SC 42, following its inaugural meeting in Beijing this April. Diab is a business and technology strategist with more than 875 patents to his name in the field of information and communication technologies (ICT). He is currently a Senior Director at Huawei.

The scope of AI is very broad. How will SC 42 approach these diverse aspects and areas of work?

"One of the unique things about what IEC and ISO are doing through SC 42 is that we are looking at the entire ecosystem and not just one technical aspect. Combined with the breadth of application areas covered in IEC and ISO technical committees (TCs), this will provide a comprehensive approach to AI standardization with IT and domain experts."

Diab explained the importance of taking a horizontal systems approach by working with as many people as possible, across IEC and ISO TCs, citing some examples of other JTC 1 SCs – internet of things, IT security and IT governance – the IEC Systems Committee for Smart Cities, and with external organizations. The key will be to get better leverage of liaisons and how to coordinate the work, so as to build on what already exists rather than duplicating it.

"This list will grow because the application domains are quite expansive, from digital assistants in smartphones to less obvious areas like online shopping market intelligence for determining a new market for a product, or healthcare, or the example of deciding whether someone will get a loan. All of these examples use learning algorithms."

Another key area Diab highlighted was manufacturing and robots that help in the plant. Robots and humans that work side by side on an automanufacturing line and all the way through to deep analytics, means having AI is almost like having an additional voice in an organization.

Within this context, IEC TC 65 which covers Industrial-process measurement, control and automation, will be another potential group to liaise with for AI and industrial automation.

SC 42 is also planning to collaborate with other external organizations working on AI. At the inaugural meeting, the Committee approved a Category A liaison with IEEE with additional future liaisons anticipated.

What key areas will be focused on initially?

SC 42 is mandated to serve as the focus and proponent for the JTC 1 standardization programme on AI and provide guidance to JTC 1, IEC, and ISO committees developing AI applications. During the meeting, it set up a structure to allow the ecosystem approach that will include:

Foundational standards

(Working Group 1)

Given the diversity of AI stakeholders, it is essential to have foundational standards that provide for a framework and common vocabulary. This enables stakeholders of different backgrounds and perspectives to speak the same language and sets the stage for how they and the technology providers and users will interact together. A priority will be the development of the International Standards for AI concepts and terminology ISO/IEC AWI 22989, and Framework for artificial intelligence systems using machine learning ISO/IEC AWI 23053.

Computational approaches and characteristics of AI systems

(Study Group 1)

At the heart of AI are the computational approaches and algorithmic techniques that empower the insights provided by AI engines. IT advances, specifically computational power, distributed computing methods and software capability techniques among others, allow for what was science fiction to become science faction. Standardization and best practices in this area are essential if innovation is to occur over open standards. SG 1 will:

- Consider different technologies (ML algorithms, reasoning etc.) used by the AI systems including their properties and characteristics.
- Look at existing specialized AI systems (NLP or computer vision) to understand and identify their underlying computational approaches, architectures, and characteristics.
- Investigate industry practices, processes and methods for the application of AI systems.
- Develop new work item proposals as appropriate and recommend placement.

Trustworthiness

(Study Group 2)

Connected products and services, whether a vehicle, smartphone, medical device or building security system must be safe and secure or no one will want to use them. The same goes for critical infrastructure like power plants or manufacturing sites. Trustworthiness and related areas from a system perspective, such as robustness, resiliency, reliability, accuracy, safety, security, and privacy must be considered from the get-go. Leading industry experts believe that ensuring trustworthiness from the outset is one of the essential aspects to wide-spread adoption of this technology. SG 2 will:

- Investigate approaches to establish trust in AI systems through transparency, verifiability, explainability and controllability.
- Look at engineering pitfalls and assess typical associated threats and risks to AI systems with their mitigation techniques and methods.
- Consider approaches to achieve AI systems' robustness, resiliency, reliability, accuracy, safety, security and privacy.
- Take account of types of sources of bias in AI systems with a goal of minimization, such as statistical bias in AI systems and AI aided decision making.
- Develop new work item proposals as appropriate and recommend placement.

Use cases and applications

(Study Group 3)

Use cases are the currency by which SDOs collaborate with each other. As both the focal point of AI's role as an

JTC 1 Subcommittee for AI holds its inaugural meeting in April 2018

enabling horizontal technology and in its role as an AI systems integration entity committee tasked with providing guidance to IEC, ISO and JTC 1 committees looking at application areas, it is essential for SC 42 to collaborate with other committees and bring in their use cases.

For example, experts in AI algorithms, who may never have set foot in a factory, will be able to liaise with domain experts in the TCs who come from industry and are able to make the use cases more meaningful, so that the subtleties can be understood – such as the difference between machine learning and neural learning, or how algorithms are trained. This means flagging up that it is not just the algorithms that need correcting, but also the datasets for training. In this way, use cases provided by other committees looking at different vertical application areas can allow SC 42 to consider these technical requirements as it drafts its Standards, technical reports and best practices. SG 3 will:

→ Identify different AI application domains (social networks and embedded systems) and the different context of their use (fintech, healthcare, smart home, and autonomous cars).
→ Collect representative use cases.
→ Describe applications and use cases using the terminology and concepts defined in ISO/IEC AWI 22989 and ISO/IEC AWI 23053 and extend the terms as necessary.
→ Develop new work item proposals as appropriate and recommend placement.

Big data

JTC 1 will transfer the work programme for big data (JTC 1/WG 9) to SC 42. Initiated a few years ago, it has two foundational projects for overview and vocabulary and a big data reference architecture (BDRA).

These projects have received tremendous interest from industry. From a data science perspective, expert participation, use cases and applications, future anticipated work on analytics, and the role of systems integration (working with other ISO, IEC and JTC 1 committees on application areas), the big data work programme lines up well with the initial work programme for SC 42. From an industry practice point of view, it's hard to imagine applications where one technology is present without the other.

"It stands to reason that AI will be one of the most crucial enabling technologies in our lifetime. JTC 1/SC 42 is looking at the entire AI ecosystem from an IT perspective. Combined with the breadth and depth of application areas covered by IEC and ISO, the resulting standardization efforts will not only be fundamental to practitioners but essential to all stakeholders interested in the deployment of AI in the respective verticals", Diab concludes.

Riding the crest of the wave

Renewed focus on marine energy relies on ground-breaking IEC publications

By Catherine Bischofberger

Large marine energy facilities are being deployed, with the help of pioneering standardization work accomplished by IEC TC 114.

Marine energy projects are moving apace. Since IEC Technical Committee (TC) 114: Marine energy - Wave, tidal and other water current converters, celebrated its 10th anniversary last year, the world's first large-scale tidal energy farm became fully operational. Based in the Pentland Firth, in the North of Scotland, the MeyGen facility's ultimate aim is to provide power for 175 000 homes. "Larger projects are entering the deployment phase after much testing and investment in R&D. The outlook for marine energy is positive and there are plenty of reasons to be optimistic", affirms Chair of TC 114, Jonathan Colby.

Oceans and, in some cases, rivers can provide an enormous source of power harnessed from waves as well as tidal and water currents. Unlike with solar photovoltaic (PV) and wind energy systems, marine energy projects have struggled to move out of the demonstration phase. "The design cycle of marine energy systems takes more time and testing is significantly more complicated. This makes the production of marine generated power more costly even as prices are coming down", Colby adds.

French leadership

Many countries have shown a renewed interest in marine energy of late, including China and Japan. In Europe, France has become a key player in recent years. "We have witnessed the change inside TC 114. French experts have become much more involved. The country is steadily moving into a leadership position on marine energy globally", Colby notes.

France was the first country to establish a marine energy facility using tidal energy across the mouth of the Rance estuary, off the coast of Brittany. It was built in 1966 and remains a pioneering installation. A number of new projects are close to completion, the most advanced being near Bréhat Island, also off the coast of Brittany. Like the MeyGen farm, it uses submarine turbines to harness the energy of tidal streams. Electricité de France (EDF), the predominantly state-owned utility company, is pushing ahead with these projects with the full support of its main shareholder. The country is trying to reduce its dependence on nuclear power and investing in marine energy makes a lot of sense: according to the French Renewable Energies Association (SER), the country lays claim to 11 million square metres of water, with overseas territories in every ocean around the globe.

New working groups

This new momentum for utilizing marine energy is reflected in the work of TC 114. The TC has been blazing a trail since its creation in 2007 by issuing ground-breaking publications. These have paved the way for the various marine technologies being tested and used around the world today. "We held a TC 114 meeting in Seattle in March 2018. Around 50 members attended from 12 countries, showing great commitment from a very dynamic group of people. We have an incredible team of dedicated experts. It's a pleasure to work with them", Colby enthuses.

Prior to that meeting, TC 114 had agreed to create a new Maintenance Team (MT), IEC 114 MT 62600-2:

Design requirements for marine energy systems. A new Project Team, IEC 114 PT 62600-3, was also established. It deals more specifically with the measurement of mechanical loads, induced by the external pressure or resistance of the marine environment.

At the meeting, four new MTs were formed and an updated strategic business plan was approved. This brings the total number of Working Groups (WG) inside TC 114 to 16, including six *ad hoc* Groups, five of which are currently transitioning to MTs to publish second editions of existing Technical Specifications (TS). "These *ad hoc* Groups tracked examples of *in situ* applications and the information they received has been really useful. The first Technical Specifications we developed were state of the art but written before any form of implementation. That's why we needed feedback from the field, so to speak", Colby explains. "We also decided that IEC 114 MT 200: Power performance assessment of electricity producing tidal converters, will now include an annexe with guidance for assessment of the power performance of ocean current energy converters", he adds.

The TC 114 gathering was followed by an IECRE meeting focused on marine energy which also took place in Seattle. IECRE is the IEC System for Certification to Standards Relating to Equipment for Use in Renewable Energy Applications. Colby, who is also Chair of the Operational Management Committee for the IECRE Marine Energy Sector comments: "The certification requirements have changed the way we write our Standards. It obliged us to think of why we were issuing Standards and that has been very beneficial for the industry as a whole."

The TC comprises 15 participating member countries and 11 observer ones. "We have high hopes that a number of other countries will join our TC in the not too distant future and that existing observer countries will increase their involvement and participation", Colby says.

This powerbuoy draws electrical energy from the ocean's waves (Photo: Lance Cpl. Vanessa M American M)

The resurgence of renewables

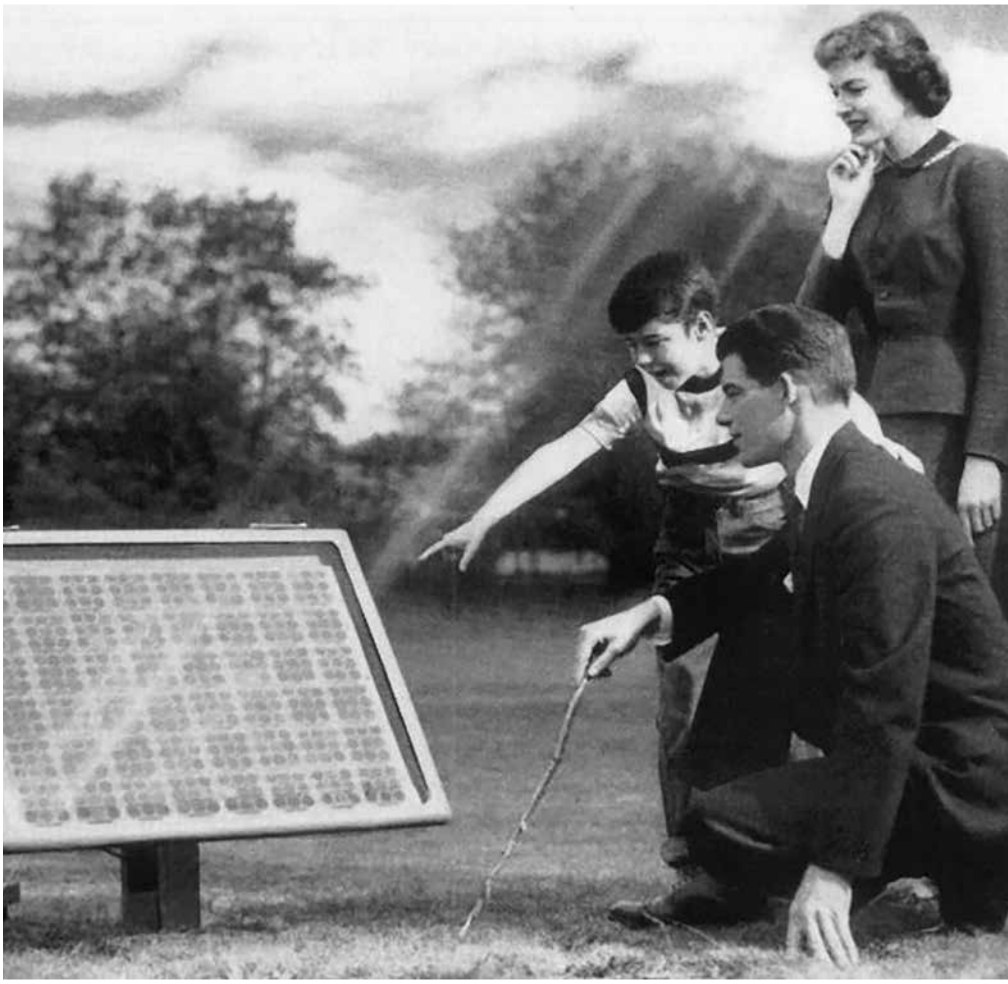
New technologies and age-old natural resources generate clean energy

By Antoinette Price

The global transition from fossil fuels to renewable energy is well under way, with record new additions of installed renewable energy capacity, thanks in part to rapidly falling costs, particularly for solar PV and wind power.

Imagine if trees had nanoleaves that could generate power from wind, sun and rain, or if solar panels could be printed onto walls, windows and packaging thanks to a new flexible ink. What if just five floating wind turbines anchored to the seabed could produce enough energy to power 20 000 homes, or it were possible to convert carbon dioxide into clean energy by using light, a little like photosynthesis. And what if solar power could be harnessed from space, to provide a continuous energy source that is sustainable from outside the Earth's surface.

These are not farfetched ideas; these are some of the innovative renewable energy technologies being tested around the world.



The first solar PV cells were developed in the early 1950s

Overtaking fossil fuels

According to the Renewables 2017 Global Status Report, by REN21 – the global renewable energy (RE) policy network, which works towards a rapid global transition to renewable energy – for the fifth consecutive year, investment in new renewable power capacity (including all hydropower) was roughly double the investment in fossil fuel generating capacity, reaching USD 249,8 billion.

In other words, globally, more renewable power capacity is added annually than the added net new capacity from all fossil fuels combined. The cost of electricity from solar PV and wind continues to fall rapidly and in 2016, solar photovoltaic (PV) accounted for around 47% of the total additions, wind power 34% and hydropower 15,5%.

Standards and testing advance the RE sector

The demand for electricity continues to increase, while the RE sector continues to develop and grow rapidly. Against this backdrop IECRE, the IEC System for Certification to Standards Relating to Equipment for Use in Renewable Energy Applications, was established in 2014 to address the specific requirements of the solar PV, wind and marine RE sectors. The System covers the design, manufacture, transportation, installation and maintenance and testing of the equipment using IEC International Standards.

Thus, IECRE certification reassures investors, manufacturers and users of RE technologies that the complex equipment and systems are safe, secure, and interoperable and function correctly wherever they are in the world.

A part of the mix from the outset

Almost all energy used up until the industrial revolution of the 19th and 20th centuries was renewable, from biomass for making fires, to wind for powering ships and windmills that converted wind energy into rotational energy in order to mill grain and pump water.

During the industrial revolution, coal was developed on a large scale for industry and transport. It became the main source of power for steam engines, heating buildings and generating electricity, as the transition to new manufacturing processes took place, in which machines replaced hand work.

Windmills converted wind energy into rotational energy to pump water (Photo: https://ourdistantsojourns.wordpress.com/tag/dutch-windmills)

Nonetheless, during this time, some scientific journals and prominent inventors made reference to the fact that fossil fuels would one day run out. For example, Augustin Mouchot, French inventor of the earliest solar power engine for converting solar energy into steam power, was spurred on to carry out pioneering solar energy research, such was his belief that coal would eventually be depleted. He published the book *Solar heat and its industrial applications* in 1869 and later presented a paper on an experimental solar generator he invented, to the Academy of Sciences in 1875.

In 1885, when talking about the photovoltaic effect, German industrialist Werner von Siemens, who founded the electrical and telecommunications company Siemens, also noted that solar energy would last for countless ages after the exhaustion of coal.

The inventive years

Though it would take many decades for RE technology to be developed and used to power homes, buildings and become integrated into the grid, as well as used for off-grid energy provision, the basis for modern-day RE technology was discovered and built during the 19th and 20th centuries:

- → 1839, the observation that sunlight striking certain materials could generate detectable electric currents. French physicist Alexandre-Edmond Becquerel discovers the photovoltaic effect or the operating principle of the solar cell.
- → 1887, Scottish professor James Blyth builds the first windmill for electricity production.
- → 1887, US professor Charles F. Brush builds a 12kW wind turbine to charge 408 batteries stored in his cellar.
- → 1966, the world's first large-scale tidal power station built in France becomes operational.

Greening the future

There is still a long way to go, and oil remains the world's leading fuel, accounting for one third of global consumption, according to the *BP Statistical Review of World Energy June 2017*. However, global energy is transitioning towards greener, cleaner, sustainable energy sources, in order to protect the environment. As the world's energy demand continues to grow, technological developments, policies and regulations are helping countries, regions, states and cities to improve energy efficiency. They also encourage countries to use more renewables to generate electricity for infrastructure, such as transport, the grid, heating and cooling systems, to power buildings and homes, and for off-grid rural electrification.

Small and powerful

IECQ: the trusted partner of electronic component manufacturers and suppliers

By Claire Marchand

Electronics are omnipresent today. For the younger generations, it must be difficult to imagine life without the array of electronic, smart devices that are an integral part of our daily interactions. Few realize that, without the inventors, thinkers and scientists of the past, the world as they know it, would be very different.

Capacitors come in all shapes and sizes (Photo: Sparkfun)

Once upon a time…

From Thales of Miletus (circa 624 - 546 BC), a philosopher, mathematician and astronomer, one of the Seven Sages of Greece, who discovered static electricity by rubbing wool against amber, to the first Motorola mobile phone created by Motorola in 1973 and the first smartphone put on the market by Apple in 2007, there is a long list of innovators whose contributions to modern electronics is critical.

Significant milestones include the battery, invented by Alessandro Volta in 1800; the diode by John Ambrose Fleming in 1904; the printed circuit board by Paul Eisler in 1943; the integrated circuit by Jack Kilby in 1958; the laser by Theodore Harold Maiman in 1960; LEDs by Nick Holonyak Jr. in 1962; and the first INTEL microprocessor in 1970. This list is by no means exhaustive but it shows the weight of past discoveries on today's technological advances.

As for sensors, indispensable in 21st century technology, they have been around for quite some time. In 1883, the first thermostat – considered to be the first manmade sensor – was put on the market. The 1940s saw the emergence of infrared sensors and motion detectors, now widely used in numerous applications.

Ubiquitous sensors

Nowadays, sensors come in many shapes and forms: vision, flow, fibre optic, gas, motion, image, colour, light, pressure, infrared, photoelectric and so on.

Sensors and sensor systems are a key underpinning technology for a wide range of applications. They can be used to improve quality control and productivity in manufacturing processes by monitoring variables such as temperature, pressure, flow and composition. They help ensure the environment is clean and healthy by monitoring the levels of toxic chemicals and gases emitted in the air, both locally and – via satellites – globally. They monitor area and regional compliance with environmental standards. They enhance health, safety and security in the home and workplace through their use in air-conditioning systems, fire and smoke detection and surveillance equipment. They play a major role in medical devices, transportation, entertainment equipment and everyday consumer products.

The George W Woodruff School of Mechanical Engineering is developing minute systems that can be mounted on a catheter used to find blockages in arteries (Photo: Georgia Tech)

Technological innovations have brought a new generation of tiny sensors, such as microelectromechanical systems (MEMS) and nanoelectromechanical systems (NEMS). These are smaller, smarter and can be integrated into fixed and portable devices.

But whatever the size of the sensor, of any electronic component, it has to be accurate and reliable. Whatever it measures, the measurement has to be extremely precise. A defective sensor can have serious consequences, even putting human lives in jeopardy.

Smaller and smaller

Sensors are not the only miniaturized components. The aerospace sector was in need of smaller pieces of equipment, including electronic components, to make rockets lighter as they left our atmosphere.

Semiconductors and the move towards integrated circuits also drove to the miniaturization of electronic components; today thousands of transistors exist in a single micron of space. Because semiconductors were part of printed circuit boards (PCBs), designers and manufacturers soon realized that they had to reduce the size of the passive components they used – resistors, capacitors, inductors, etc., were quite large until then – to make them fit on PCBs.

The medical industry was in need of smaller components as an increasing number of devices, e.g. pacemakers, were intended for placement on or inside the body.

Last but not least, the trend towards consumer portable smart devices such as phones, tablets and wearables was also a major driver that led to the miniaturization of all electronic components.

The ultimate tool

Manufacturers and suppliers of all types of electronic components throughout the world have a powerful tool at their disposal, enabling their products to meet the strictest requirements: IECQ testing and certification. IECQ is the IEC Quality Assessment System for Electronic Components.

As the worldwide approval and certification system covering the supply of electronic components, assemblies and associated materials and processes, IECQ tests and certifies components using quality assessment specifications based on IEC International Standards.

In addition, there are a multitude of related materials and processes that are covered by the IECQ Schemes. IECQ certificates are used worldwide as a tool to monitor and control the manufacturing supply chain, thus helping to reduce costs and time to market, and eliminating the need for multiple re-assessments of suppliers.

IECQ operates industry specific Certification Schemes:

→ IECQ AP (Approved Process)
→ IECQ AP-CAP (Counterfeit Avoidance Programme)
→ IECQ AC (Approved Component)
→ IECQ AC-TC (Technology Certification)
→ IECQ AC-AQP (Automotive Qualification Programme)
→ IECQ Scheme for LED Lighting (LED components, assemblies and systems)
→ IECQ Avionics
→ IECQ HSPM (Hazardous Substances Process Management)
→ IECQ ITL (Independent Testing Laboratory)

For more information on IECQ: www.iecq.org

Ex industry: a risky business

Certified explosion-proof equipment through IECEx

By Claire Marchand

Natural disasters may lead to industrial accidents but man, through non observance of strict safety measures, is more often than not responsible for damages, injuries and fatalities.

Nature vs technology

Natural disasters, such as earthquakes, floods, hurricanes and storms, often have devastating human and material consequences. They not only leave thousands of people homeless, they may also lead to industrial accidents, triggering massive power outages and damaging chemical plants, oil and gas refineries and pipelines. Forecasts and preventive measures may, in some cases, mitigate their impact but because nature always has its way, they cannot be eliminated completely. The list of such incidents, linking nature and industry has been growing rapidly since the industrial revolution of the early 19th century.

Most recent on the list are the Fukushima I nuclear accidents in Japan in March 2011. Considered the largest nuclear disaster since Chernobyl, there were no direct deaths but a few of the plant's workers were severely injured or killed by the disasterous conditions resulting from the earthquake. And in October 2012, Hurricane Sandy caused a ConEdison power plant to explode, causing a blackout in most of

Explosion aboard the Grandcamp in Texas City (Photo: The Portal to Texas History) midtown Manhattan. No person was killed or injured.

High-risk industries

Nature, however, cannot always be blamed for industrial accidents. Negligence, incompetence or poor maintenance is often the primary cause of such disasters, resulting in great material damage, injury or loss of life. While the oil, gas and mining sectors have their share of accidents, many other industries – chemical, pharmaceutical or food plants, mills, agribusiness, to name but a few – have had to deal with explosions and fires over time.

The two examples given below, from the 1920s and 1940s, are again part of a long list of occurrences. In both cases, ammonium nitrate fertilizer was involved:

Silo explosion in Oppau, Germany

On 21 September 1921, a tower silo storing 4 500 tonnes of ammonium nitrate fertilizer and ammonium sulfate exploded at a BASF plant in Oppau, a suburb of Ludwigshafen in Germany. Experts later estimated that the explosion was the equivalent of about 1-2 kilotonnes TNT. The blast was of such magnitude that it ripped roofs off and destroyed windows up to 30 km away. About 80% of all buildings in Oppau were destroyed, killing between 500 and 600 people, injuring 2 000 and leaving 6 500 homeless.

Texas City disaster aboard fertilizer-laden ship

On 16 April 1947, an explosion occurred aboard a docked ship, the Grandcamp, in Texas City. The explosion, and subsequent fires and explosions, is referred to as the worst industrial disaster in America. At least 578 people died and 3 500 were injured as the blast shattered windows from as far away as 40 km. Large steel pieces were thrown more than a mile from the dock. The origin of the explosion was fire in the cargo onboard the ship. The detonation of 3 200 tons of ammonium nitrate fertilizer aboard the ship led to further explosions and fires. The fertilizer shipment was to aid the struggling farmers of Europe recovering from World War II.

Taking dusts, vapours, mists, gases seriously

During the first decade of the 20th century came the realization that coal dust could lead to mine explosions. A series of accidents in the US and in Europe led the authorities to investigate and take the first measures to improve the security of their mine workers. But dust – and the risk of explosion – is present in many other sectors. Flour, sawdust and sugar can be as explosive as coal dust. Vapours, mists and gases are other factors that may trigger explosions when in presence of spark ignition.

Increased awareness of Ex risks across the world…

Throughout the second half of the 20th century, authorities and industries honed their knowledge and expertise, developing more stringent measures to increase the safety of workers and installations in hazardous environments.

…and in the IEC

The growing use of electrical equipment by mines and factories made it even more critical to devise appropriate measures, and to standardize all equipment destined for the explosive (Ex) sector. The IEC, sharing the concerns expressed by authorities and industry, set up Technical Committee (TC) 31: Equipment for explosive atmospheres, to "address the need to develop techniques for ensuring electrical equipment would not provide an explosion risk when used in hazardous areas involving gases, vapours, dusts and mists." For the past 70 years – the TC was set up in 1948 – it has prepared International Standards – the IEC 60079 series – that provide the Ex industry with the strictest requirements covering the whole life cycle of Ex equipment, from design and manufacture to installations, maintenance and repair. They also deal with the competence of personnel working in Ex areas.

More recently, with ISO 80079-36 and ISO 80079-37, TC 31 has added non-electrical equipment, i.e. "equipment which can achieve its intended function mechanically" to its library of Standards.

More than 20 years of IECEx certification

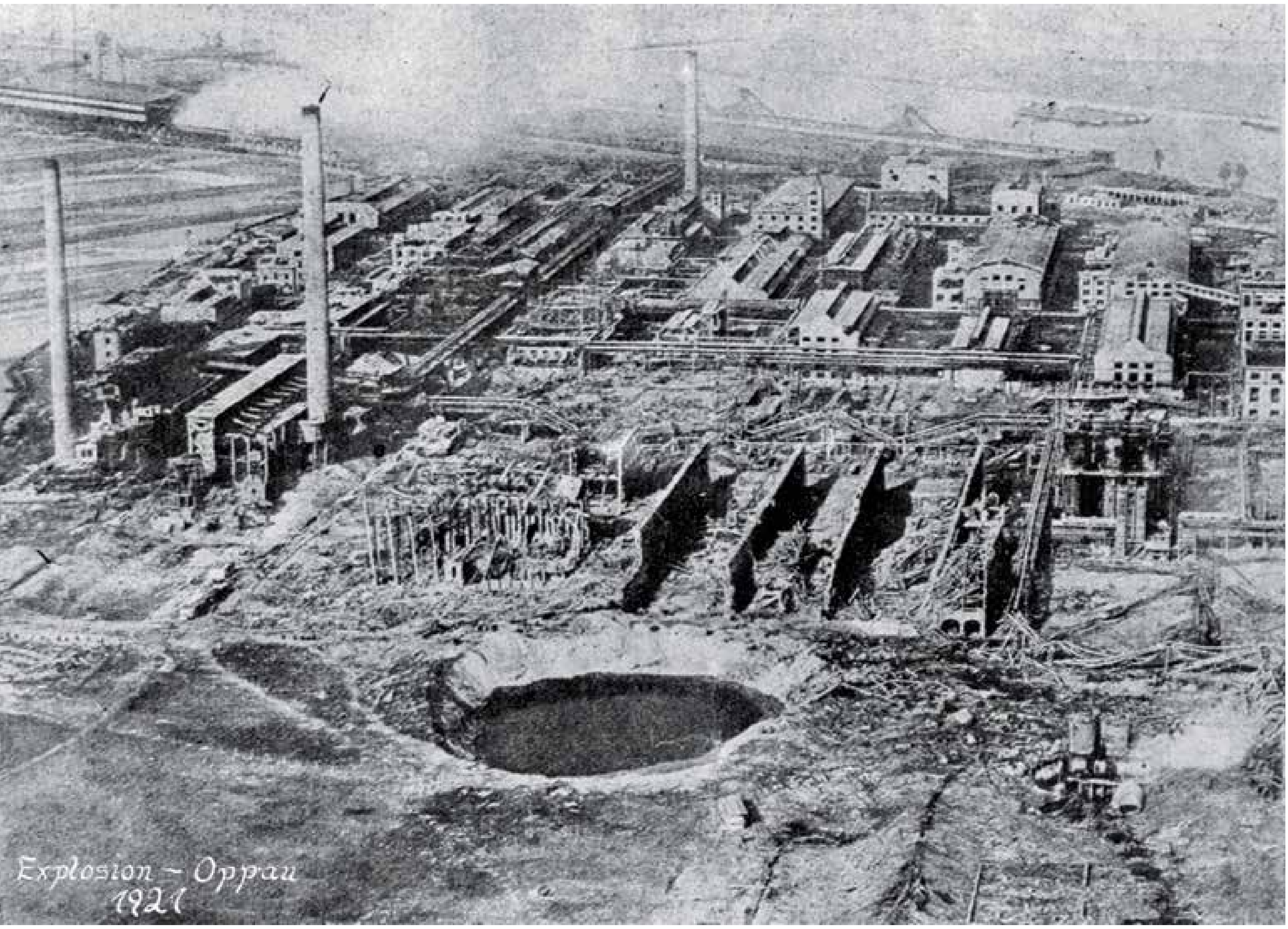
The first meeting of IECEx, the IEC System for Certification to Standards Relating to Equipment for Use in Explosive Atmospheres, took place in London, UK, in July 1996. With the establishment of a Conformity Assessment System dedicated to explosive atmospheres, the IEC reinforced its presence and growing influence in the sector. From then on, industry, regulators and governments had the tools to ensure that equipment used in hazardous areas did indeed meet the strict requirements enunciated in IEC 60079.

In its more than 20 years of existence, IECEx has extended its offer, leading to the creation of two schemes to complement the original IECEx Certified Equipment Scheme. First the IECEx Certified Service Facilities Scheme, then the IECEx Scheme for Certification of Personnel Competence. And in 2016, following the publication of ISO 80079-36 and ISO 80079-37, it began the testing and certification of non-electrical equipment as well.

IECEx has been endorsed by the United Nations (UN) through the UN Economic Commission for Europe (UNECE) as THE certification system for the assessment of conformity in Ex areas.

Standards, testing and certification, technological advances and increased security measures have definitely helped in the prevention of and decrease in industrial accidents. The more manufacturers and buyers of Ex equipment rely on them, and the more regulators and legislators use them as a basis for their legislation, the better, although their complete elimination may still be a utopia for some years to come.

More information on IECEx:
www.iecex.com



Aftermath of the explosion at the BASF plant in Oppau (Photo: Stadt Archiv, Ludwigshafen)

April-May nominations and extensions

The latest TC Chair nominations and extensions approved by the SMB

By Claire Marchand

Over the past few months, the Standardization Management Board (SMB) nominated several new Chairs for different IEC technical committees (TCs). The SMB has approved the extension of the term of office of:

Richard Barham

A graduate from the Institute of Sound and Vibration Research, Southampton University, UK, Richard Barham joined the National Physical Laboratory (NPL) in 1986 where he continued his academic pursuits, gaining a PhD (again from Southampton University) in 1995. In 2016 he left the NPL to start Acoustic Sensor Networks, a new private business set up to exploit his knowledge and technical expertise developed during his 30-year career at NPL.

Barham's research interests lie in electroacoustics and measurement science for all airborne sound applications. Working initially with measurement microphones, his interests soon extended to ear simulators and the measurement of human hearing. Some of his innovations include the development of methods for measuring acoustic impedance, now incorporated in IEC 60318-1, and for pioneering the transient response which is set to change the way traceability for objective audiometry techniques is established. His latest research in this field is on new specifications for ear simulators designed for children, where he is working within a consortium of European measurement institutes and most recently was instrumental in obtaining significant new research funding to continue this important work, under the project known as Embodied Audition for RobotS (EARS).

Barham's predominant research interest is currently the development of new measurement systems exploiting acoustic micro-sensors based on MEMS technology, for which Acoustic Sensor Networks has been set up. However, he is maintaining an active role in acoustical metrology, standardization and training.

As a long-standing expert in acoustics and electroacoustics, Barham represents the UK on IEC technical committees. He is now Chair of IEC TC 29: Electroacoustics. He also convenes TC 29/Working Group (WG) 5 on measurement microphones, and makes significant contributions (through leading projects and developing strategic goals) to WG 10 on audiometric equipment and WG 21 on head and ear simulators.

Richard Barham, Chair of IEC TC 29

Barham is a regular contributor to Institute of Acoustics (IOA) activities.

He has been voted chair of IEC TC 29 for the period of 2018-04-01 to 2024-03-31.

Extensions

The SMB has approved the extension of the term of office of:

- Christian Eric Bruzek, Chair of IEC TC 90: Superconductivity, for the period of 2018-04-01 to 2021-03-31.
- Alan Hodgson, Chair of IEC TC 119: Printed electronics, for the period of 2018-04-01 to 2021-03-31.
- Paul Holdstock, Chair of IEC TC 101: Electrostatics, for the period of 2018-05-01 to 2021-05-01

Making prepayment meters future proof

State of the art encryption in a new edition of IEC 62055-41

By Catherine Bischofberger

IEC TC 13: Electrical energy management and control, has published a new Standard which significantly enhances the security of electricity metering prepayment systems, widely used in developing countries around the world.

IEC 62055-41, *Electricity metering – Payment systems – Part 41: Standard transfer specification (STS) - Application layer protocol for one-way token carrier systems,* replaces the previous edition of the Standard published in 2014. It is also published as a Red Line Version (RLV), which clearly highlights all the changes in the new Standard. Additions and deletions are displayed in red, with deletions being struck through.

"We wanted to improve the encryption algorithms drastically and make them state of the art secure. The idea is for the encryption levels to be valid for the next 30 years," explains Don Taylor, convenor of Joint Working Group (JWG) 16 which was set up within IEC TC 57: Power systems management and associated information exchange. "TC 57 started looking at smart meters around ten years ago and we formed a joint working group to make sure that our smart metering and prepayment Standards were harmonized with their metering specifications," he adds.

Many people in developing countries buy their electricity in advance (Photo: Graham Maclachlan)

Don Taylor is also an active member of WG 14: Data exchange for meter reading, tariff and load control and of WG 15: Smart metering functions and processes. Furthermore, he is chair of the Standard Transfer Specification (STS) Association, the custodian of the STS prepayment metering technology Standard, initiated in South Africa and adopted by the IEC as IEC 62055-41 and IEC 62055-51 International Standards on prepayment meters.

According to Don Taylor, there are around 50 million prepayment meters deployed in 102 countries at present. "This comprises most African countries, many South East Asian and Middle Eastern nations as well as many South American countries," he says.

Don Taylor, Convenor of JWG 16 (IEC TC 13 and IEC TC 57)

A metering solution adapted to developing nations

Current prepayment systems are based on a 20 digit token solution which enables consumers to buy their electricity in advance. "Most people living in developing nations find it very difficult to predict how much money they will have left at the end of the month. Salaries are often paid in weekly wages and a monthly electricity billing system, similar to what exists in Europe or the US, would be totally impractical," Taylor continues.

The previous edition of IEC 62055-41 made specifications based on the data encryption standard (DES), an encryption algorithm which is now considered too weak. The new edition is based on the MISTY1 cryptographic algorithm which uses a 128-bit decoder key.

"We wanted the encryption to be as future proof as possible. While there has yet to be any evidence of cyber attacks on metering prepayment systems, they could happen one day and we have to be prepared. We also want to be ready for smart grids and smart meters," Taylor indicates.

While the new Standard is applicable only to one-way token carrier systems, the STS association is working on a two-way carrier system. "The STS association will make a proposal for TC 13 to consider. I would expect a two-way edition of the Standard to be published in a couple of years," Taylor concludes.

The new Standard by IEC TC 13 will significantly enhance the security of electricity metering prepayment systems (Photo: Eskom)

In the next issue:

The year in review – Issue 04/2018

This issue takes stock of standardization and conformity assessment activities since the IEC GM took place in Vladivostok in October 2017. It will cover important technical committee work in diverse areas, such as artificial intelligence, cyber security, self-driving vehicles, virtual reality, and information technology. The review also considers major developments in the four IEC Conformity Assessment Systems – IECEE, IECEx, IECQ and IECRE.

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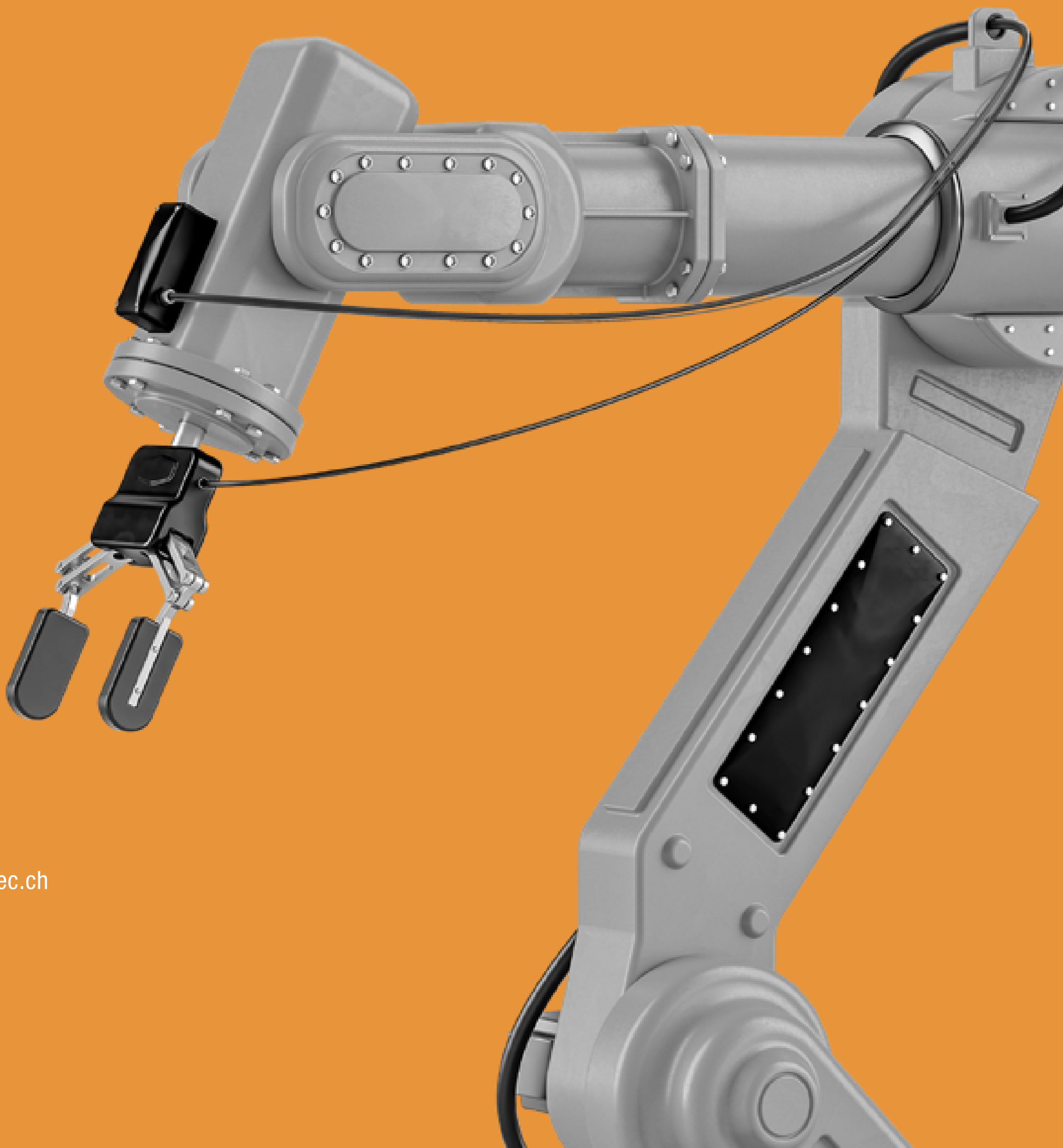

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