

# T H E E L E C T R O N

## NEWSLETTER OF THE INSTITUTION OF ELECTRONICS

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### NEC HOSTS FOUR MAJOR EXHIBITIONS

Four major exhibitions of relevance to electronics practitioners were held at Birmingham's National Exhibition Centre between 25th. and 27th. September.

#### What's New in Electronics Live



The What's New in Electronics Live exhibition was a comprehensive event that covered the whole spectrum of the electronics industry and had around 100 exhibitors. Special features this year included the EMC UK Expo and Conference, the Embedded Live Expo and Conference, the Female Leaders in Tech everywhere (FLITE) networking event, the Industry Forum Zone (with roundtable discussions filmed by WNIE TV), the IPC Connected Factory Exchange, and the IPC Hand Soldering Competition (with winner to be flown to San Diego to compete in the global championship final).

WNIE Live was supported by the ground-breaking What's New in Electronics Online, which reaches a global audience of over 80,000 industry professionals.

The Embedded Live Conference covered subjects such as 'When Pre-Canned Agile doesn't fit', 'Software Development with an Agile Mindset in a Non-Agile Environment', 'Bringing secure IoT Products to Market - more than just Embedded Programming', 'Murphy vs Satan - Why programming Secure Systems is still so hard', 'Operating Systems for Embedded Applications', and 'Comparison of Virtualised and Non-Virtualised Embedded Systems'.

The EMC UK Conference was divided into six training sessions dedicated to the subjects of shielding, filtering and suppression, PCB layout for EMC, EMC compliance testing, EMC pre-compliance testing, and cabling practices for EMC. The following comments were made:

*'Shielding is the complementary part of filtering and transient suppression, and in 2018 has to deal with many GHz. We no longer always need metal or metallised plastic boxes: modern shielding can often be small, light, low cost and - if needed at all - can simply be a part that is assembled in the PCB.'*

*'The most cost-effective place to avoid EMC problems is in the PCB, but good PCB layout for EMC changes more rapidly than any other aspect of good EMC engineering, and in 2018 has to deal with many GHz. If PCB EMC design practices haven't been reviewed against the state-of-the-art since 2014 or 2015 it is important that we do so now.'*

## The TCT Show



This exhibition covered primarily the subjects of 3D Printing/ Additive Manufacturing, Inspection, Machine Tools, CAD/CAE/CAM/PLM Software, Metrology, Moulding and Tooling and Post Processing.

The show featured some 300 exhibitors and welcomed around 10,000 visitors. The eight Keynote sessions included '3D Printing Parts for Airbus' Commercial Aircraft Cabins', 'Transforming Production of High Performance Hybrid Composite Structures', 'How to scan a Blue Whale: 3D Scanning, Data Processing and Printing on a colossal Scale', 'Additive Manufacturing in the Automotive Area - New Ways with Digital Craftsmanship', and 'How Pessico R and D leverages 3D Printing to accelerate Innovation.'

The remaining 58 presentations included further specialised lectures on 3D Printing, including applications in aerospace, rocket science (3D printing liquid fuel injectors), 3D printing carbon fibre parts for custom motorcycles, laser sintered parts with anti-bacterial properties, 3D printing foot orthodontics, the role of 3D printing in re-imaging prosthetic breasts, design strategies for precious metal 3D printing, 3D printing abrasive materials using a ruby-tipped nozzle, laserflex conflux (3D multi-metal printing), 3D printing and blockchain technology, and 3D printing and the smart factory.

In introducing the show, Duncan Wood, Chief Executive of the TCT Group and Chairman of VNU Rapid News Company, stated:

*"As part of TCT's ongoing mission to educate future generations in the art and science of manufacturing, we are delighted to be able to present TCT Inspired Minds on the show floor again this year. For 2018 we have partnered exclusively with CREATE Education, who will be delivering training for more than 330 school-age students across the entire three days of the show."*

*As many of you will know TCT is now a global brand with events in Asia, Germany, and North America within our portfolio enabling us to extend our mission to accelerate the adoption of 3D technologies for design, development and manufacture across industry sectors around the globe."*

This year's event also saw the presentation of the second TCT Awards, with three more inductions to the TCT Hall of Fame.

## Sensors and Instrumentation



This exhibition, sponsored by Mouser Electronics, featured around 70 exhibitors and a CPD Accredited seminar programme consisting of eleven seminars. There was also a dedicated Engineering Workshop in which six market professionals explained how instruments work and where they can be applied. These 30-minute presentations included 'Using Thermal Imaging for Engineering Applications', 'Non-Contact Laser Measurement in Modern Metrology', and 'Gas Analysis using Tuneable Diode Laser Technology'. Seminar topics included 'Improving Manufacturing Outcomes with Spectroscopy', 'Platinum Temperature Sensors for Space Applications', 'High Temperature Condition Monitoring with a novel, flexible Thin Film Sensor', and 'Data Challenges and Opportunities in the Process Industries'.

Special features of the exhibition included a Flow Level and Control Zone and a networking platform with a Formula One Simulation Car as centrepiece. Product launches included a new communications expansion module (Mega-Bridge) from Churchill Controls which adds flexible and fully-featured internet protocol (IP) connectivity to the well-established Mega-Link family of Telemetry and Control Units. These are used in various industry sectors to pass two-way instrumentation, measurement and control data between sensors, equipment and industrial plant. Mantracourt Electronics also made their debut at the show, showcasing their latest product releases, a fast USB strain converter that delivers high-speed, high resolution data via USB into the company's powerful software, and a world-class telemetry system that provides sensor manufacturers and integrators with complete flexibility to build their own sensor modules around it.

## PPMA 2018



This show, with around 360 exhibitors, is the UK's leading processing and packaging machinery event, which this year celebrated its 30th. anniversary. Robotics, automation and vision systems were major features of the event, as was the Enterprise Zone,, which hosted live workshops, presentations, interactive discussions and panel debates. Topics included 'Smart Technologies and Robotics for Packaging Optimisation', 'Robotics and Automation in Food Manufacturing' and 'Cyber Security for Food and Packaging Manufacturers'. This year also saw the introduction of the Bright Ideas Ambassador Programme which offered free advice for start-up ventures and entrepreneurs.

## **ELECTRONICS INDUSTRY AWARDS**

The year of 2018 saw the launch of the Electronics Industry Awards, which were organised by Datastream Business Media in association with *Components in Electronics* (CIE) magazine.

The Awards were designed to recognise the many successes in the electronics industry, celebrating outstanding companies, people and products with the winners decided entirely by an industry vote.

The Awards were divided into three sections, namely Business Awards, Product Awards and the Special Award. The Business Awards recognised those who have gone above and beyond in their sector and companies that deserve recognition for what they have brought to the market. The Business Awards were sub-divided into 'Distributor of the Year', 'Electronics Manufacturer of the Year', 'Excellence in Innovation', 'Environmental Leadership', 'Best Customer Service', 'Academic Support', and 'Most Outstanding PR Agency'.

The Product Awards celebrated the excellence of a range of products from different markets within the electronics industry. These Awards recognised the best products in aerospace/military/defence, automotive, displays, enclosures, engineering development/design tools, interconnection, Internet of Things, power, test, measurement and inspection, and embedded solution.

The Special Award (Industry Personality) recognises an individual who has made a significant contribution to the industry, raising the profile of the industry, improving the supply chain, boosting their company, and working closely with their customers and suppliers.

## TOP CAT WINS HOME AUTOMATION CHALLENGE

For the past few years the annual Home Automation Challenge has provided an opportunity for apprentices to compete in an innovative design and manufacturing challenge to improve an everyday home or garden device.

Organised by the Young Members' Committee of the Institution of Mechanical Engineers, the Challenge is open to teams of apprentices from companies, colleges, and training providers involved with engineering and manufacturing technologies.

For 2018, as well as designing and manufacturing a product, each team was required to submit a report which included a design specification, manufacturing instructions, a user manual and a business case for the mass production and sale of the product. Ten teams entered and six were selected for the final at the Manufacturing Technology Centre in Coventry.

The winning design was Top Cat, a trio of engineers from PA Consulting Group, whose product involved the design of an automated pet station. Addressing the concerns of pet owners about leaving their pets at home, the device has two chambers, one for food and the other for water, as well as several modular puzzle attachments aimed at keeping pets occupied whilst owners are away.

*The Manufacturer* (Vol. 21, Issue 7, September 2018) quotes first year apprentice Callum Franks as follows:

*"Food is moved from the hopper to the tray via an auger-style spiral to automatically dispense food at times set by our custom-built mobile app. Water flows from a separate chamber down into the water tray."*

Also quoted is IMechE President Elect Ian Joesbury, who says:

*"Virtually nothing these days is purely electronic or mechanical. The fact that the teams have universally looked across technologies and disciplines is fantastic."*

## NEW AI CONTROLLER FOR FOOD AND BEVERAGE INDUSTRY



Many food and beverage companies are beginning to realise that artificial intelligence presents an opportunity to increase not only the Overall Equipment Effectiveness (OEE), and so combine reduced costs with increased productivity, but also to improve the analysis of data to support continuous improvement programmes such as reducing waste or process operations variability.

Many of the AI solutions advertised on the market, however, tend to be cloud-based with significant requirements in terms of infrastructure and IT, and work with a huge amount of data that is laborious and time-consuming to prepare and process. Consequently food and beverage providers have tended to remain sceptical about how an investment in AI would provide a return.

In order to address these concerns leading industrial automation company Omron has developed an alternative approach. Instead of laboriously searching a huge volume of data for patterns, in addition to the processes that are running, the required algorithms are integrated in the machine control system, thus creating the framework for real-time optimisation at the machine for the machine.

Omron states:

*'In contrast to cloud computing, where individual manufacturing lines or sites are analysed using limited processing power at a high level, the AI controller used by Omron, which features adaptive intelligence, is closer to the action and learns to distinguish normal patterns from abnormal ones for the individual machine.'*

*The AI controller integrated in Omron's SYSMAC platform - a complete solution for factory automation featuring modules for control, motion and robotics, image processing and machine safety - is primarily used in the packaging and production process at the points where the customer is experiencing the greatest efficiency problems (bottlenecks). The processes gain intelligence based on previous findings and improvements that have been made and subsequently drive holistic optimisation of the entire manufacturing process.'*

## **Further Information**

Omron was established in 1933 and has around 39,000 employees globally. Products and services are offered in 110 nations and regions.

Omron Electronics UK was an exhibitor at PPMA 2018 and may be contacted on 01908 258 258.

## **CASE STUDY: COMBILO**

Combilo, a leading fruit and vegetable wholesaler based in the Netherlands, recently installed a robot-assisted packaging line which instantly increased productivity by 30 per cent.

The line replaced a conventional line for packaging 'traffic light' packs of peppers containing one red, one yellow and one green pepper. The line was slow and labour-intensive requiring seven employees.

*Processing and Control News Europe* (Vol. 15, September 2018, p.26) quotes Combilo's Production Manager Mareel Villerius as follows:

*"One person would fill the trays with bell peppers of each colour. Three employees would then place the bell peppers by hand on the belt in the correct colour order. The bell peppers were then sent through a flow packer in sets of three, where they were packaged in film. An operator would stand by the packaging machine to check the supply to the machine and remove any failures. Once the bell peppers were packaged, the weight is checked and if a package was too light it was removed from the line. Two employees would stand at the end of the line to place the 'traffic lights' in a crate before stacking them on pallets."*

The manual handling operation rendered the system vulnerable to errors with some packages being too heavy, containing too much product, whilst others are too light and have to be rejected.

With the new system an employee fills the trays with bell peppers of each colour before three robots assume the role of employees who place the bell peppers on the belt. The robots pick up the bell peppers and correctly position them on the belt in the correct colour order ready for the flow packer.

Three Omron R6Y Delta-3 robots were deployed each with four servo-drives that control the three robotic arms and the rotation axis. Omron also supplied the FH-5010 vision system with three cameras and the controllers for the conveyor belts. Each robot has its own control box for the servo-drives and the central control box contains 27 frequency controllers for the belts, as well as an NJ501 robotics controller which processes the information about the weight, position and belt speed so steering the three Delta robots. An encoder is installed on the flow packer to control the speed of the robots, thus ensuring that they run at exactly the same speed as the packaging machine. All Omron components and controllers exchange data with each other via an EtherCAT network. Rons Electronics Supplies used the SYSMAC platform to configure the installation.

## **ROBOT TURNS 3D PRINTING INTO AN ART FORM**

Two journals, *Manufacturing Process Control Automation* (September 2018) and *Control and Process Engineering* (Issue 34, 2018) describe a project at the Centre for Fine Print Research at the University of the West of England in which 3D printing is being approached from the standpoint of meaningful expression rather than the accurate reproduction of digital data.

The centrepiece of the project is a Mitsubishi Electric MELFA RV Series articulated arm industrial robot. The MEPCA article (p.66) states the following:

*'The CFPR has expertise in ceramics, photo-cure resins and thermoplastics, all of which are being investigated with the new robotic platform. Previous work evaluated the 3D printer as a tool to manipulate materials or produce unusual surface textures.'*

*Using a 3D printer in unusual ways means moving beyond the use of CAD models and slicing algorithms, as these are too automated. By writing proprietary software it is possible to develop printing methods from the point of view of how the material can be expressively played with.'*

*To achieve this the project is using a robot arm to research technologies and techniques to sense and manipulate materials in a dynamic way rather than deposit them in fixed, rigid or "machine-like" ways. The robot is running printer paths defined by proprietary software and requires a high degree of automation and real-time effectiveness.'*

*Conventionally 3D printers are machines with three linear axes and fabrication occurs in fixed horizontal layers. The MELFA robot arm, however, can offer both freedom of movement and a set of expansion capabilities, including pneumatics and digital IO, which are integrated into the chassis of the arm itself; which makes for a useful combination of force control, movement, range and reliability.'*

*Proprietary software is being developed which must respond very quickly and dynamically to changes in the material's properties and the construction of the printed object. This means that the control program cannot be rigid in its operation. Instead it must constantly and iteratively interpret its working task environment and autonomously correct its behaviour.'*

The *Control and Process Engineering* article (p.62) adds:

*'The Mitsubishi Electric robot proved to be an ideal tool to help create artistic objects using PLA (poly lactic acid), a bio-degradable type of plant-based thermoplastic used in 3D printers. The development team used the full extent of the robot's movement to push the material beyond its normal operating envelope and create new effects. The intuitive and easy-to-use programming meant that it worked well with software developed by the university team that altered the deposition speed to pull the material into fine filaments. The same set up is planned to be used for developing artistic creations with ceramics and photo-cure resins, the production process for which could then feed back to commercial industrial applications.'*

The article quotes Dr. Paul Dowd, Research Fellow in Creative Electronics and Engineering as follows:

*"By pushing 3D printable materials to their limits, we have exposed unexpected properties in the materials. For instance, plastic deposition can be manipulated whilst it is hot and pulled into hairs or fine gauss or woven. Ceramics can also be deposited so that the material composition is capable of self-glazing in a single firing (as opposed to a multi-firing process). These material states may have applications in wider industry."*

### **3D SYSTEMS PRINT 72 DRAGONS**

TCT Show exhibitors 3D Systems, who provide comprehensive 3D products and services, have recently completed an interesting project in which they have 3D printed 72 large-scale replica dragons as part of the Historic Royal Palaces restoration of the 250-year-old Great Pagoda at Kew Gardens. This represents the most extensive use of 3D printing on a UNESCO renovation.

In *Controls, Drives and Automation* (August/September 2018), the article 'How to print your Dragon' reveals more about this fascinating project which involved the replacement of the painted wooden dragons that once adorned the Pagoda, but were removed permanently in the 1780s to make way for roof repairs:

*'HRP required a solution that would authentically replicate the dragons, yet could withstand the inclement British weather. 3D Systems' On Demand Manufacturing team delivered the lightweight, durable dragons using a scan-to-CAD workflow featuring Geomagic software Selective Laser Sintering 3D printing and high quality finishing. These technologies, combined with the expertise the 3D Systems team demonstrated through many hours of front-end engineering and back-end finishing, made this effort manageable, efficient and cost-effective.'*

*Bringing the dragons back to life required a unique combination of research and reverse engineering by the company's On Demand Manufacturing team to enable rapid digital production of the parts. The project involved scanning a wood-carved dragon with the FARO Design Scan Arm into 3D Systems' Geomagic Design X reverse engineering software.'*

*The use of CAD enabled innovative engineering solutions for the dragons, including hidden features to facilitate mounting them on the Pagoda, as well as a much lighter-weight hollowed statue that is 60 per cent lighter than wood alternatives. The significant weight reduction enabled by 3D printing ensures less stress is placed on this historic building, helping to preserve it for the future. The 3D Systems team also used the CAD data to scale the dragons, producing them in a variety of sizes from 1150mm to 1850mm in length.'*

3D Systems may be contacted on 08450 514 900 or [www.3dsystems.com](http://www.3dsystems.com)

## **SYMBIOSIS OF TOPOLOGY OPTIMISATION AND ADDITIVE MANUFACTURING IN ARCHITECTURE**

Also exhibiting at the TCT Show was Altair, a specialist in optimisation technology for the generation of efficient, organic looking shapes that are ideal for advanced manufacturing methods.

Until now the combined use of topology optimisation and additive manufacturing has been common in industries such as automotive or aerospace, but rarely used in architectural projects. Recently, however, OptiStruct, an optimisation tool and structural solver in Altair's HyperWorks suite, has been used, along with some additional tools, to pioneer a project that involved the redesign and adaptation of the outdoor canopy at Baku International Airport in Azerbaijan for 3D printing.

The new 3D printed design led to a potential weight reduction of around 32 per cent, with a reduced mass of about 9 tons. The redesign and topology optimisation was conducted by Bayu Prayudhi, an architectural student at the department of Architectural Engineering and Technology at the University of Delft, who created a small mock-up prototype to demonstrate the concept

He states:

*"Looking at the entire structure and the applied process, a joint use of topology optimisation and additive manufacturing could change the entire architectural creation process, from design to the actual construction, helping to save material, development and construction time and costs, while at the same time offering better and more aesthetic results."*

Altair's optimisation tool and FE-solver OptiStruct drove the new design, prepared it for additive manufacturing, and optimised the structural performance of the canopy, as well as reducing the weight and amount of material required. It also helped to create a functional and visually captivating design.

As a first step the geometry was imported into HyperWorks and the occurring load cases were applied. The HyperWorks model was created as a single independent node and each force was modelled manually.

Manufacturing constraints arising in additive manufacturing, such as supporting structures and printing direction, were then applied. The maximum size of the nodes was determined by and limited to the size of the building chamber of the used 3D FDM printer. The design space was then defined, which in this case only included the node, because the connecting beams were not the subject of the optimisation.

With computational power limited it was not possible to perform an analysis of the entire structure, so the optimisation was performed on just one node using the numerical data of different occurring forces. Results were then extrapolated so as to estimate the impact that an overall structural optimisation may have.

Metal printing of the prototype was done in binder jetting of stainless steel powder with 40 per cent infused with bronze powder, as opposed to direct laser sintering.

Altair Engineering Inc. is based at 1820 E. Big Beaver Road, Troy, MI 48083-2031 USA. They may be contacted in the UK on 01926 468 600.

## **TOPOLOGICALLY OPTIMISED 3D PRINTED COMPONENT GOES INTO SPACE**

RUAG Space is Europe's leading equipment supplier to the space industry and since 2013 has been conducting intensive research and development into how to 3D print some of its components.

The goal was to be able to equip one of the future Sentinel-1 satellites with antenna support components made by an industrial 3D printer, and the first step was identification of those components that could feasibly be additively manufactured. Engineers would then set up a development process and identify suitable materials for the AM technology.

An antenna support arm was identified as an appropriate component, having a high weight saving potential. Altair ProductDesign was selected to support the design for the 3D printing process, having substantial expertise in developing and utilising optimisation technologies.

Optimisation methods allow manufacturers to save weight by identifying where material is required in a structure and where it can be removed without negatively impacting performance. The technology has a close synergy with AM technology as the manufacturing method allows the creation of shapes that more closely match the ideal material layout identified during the optimisation process.

The team identified a 'design space' within OptiStruct and applied the known load cases to which the antenna would be subjected during launch and in space. With the resulting information OptiStruct was able to suggest an ideal, material efficient design that RUAG and Altair could use as a basis for the final design.

Engineers then used solidThinking Evolve, a surface modelling tool from solidThinking (a 100 per cent subsidiary of Altair), which offered a faster design process than traditional CAD tools. The design freeze was defined in four weeks.

RUAG's AM technology provider EOS then proceeded to manufacture the component using the system EOS M 400. The 40cm long antenna support then became one of the longest metal components ever to be produced using direct metal laser sintering.

Altair state:

*'The symbiosis of optimisation and Additive Manufacturing enables a new level of light-weight design since this manufacturing process is able to realise structurally efficient components which were not previously possible without a lot of time and effort using traditional production methods.'*

*Industrial 3D printing for space applications is still in its infancy, but the method, especially when combined with topology optimisation, will change the way products are developed and produced. Space applications have always been at the forefront of new technology and history shows that applicable technologies were always adopted by other branches quite quickly after having been used successfully in the space industry.'*

## **EPSRC LAUNCHES INTERNET OF FOOD THINGS**

The Engineering and Physical Sciences and Research Council has released £1.14 million in order to develop an 'Internet of Food Things' so as to enable the sector to greater harness digital advances.

The Internet of Food Things Network Plus will, in particular, investigate how artificial intelligence, data analytics and emerging technologies can be used to enhance the digitisation of the UK food industry supply chain.

Led by the University of Lincoln in partnership with the universities of Southampton, Surrey, East Anglia and the Open University, the project will examine the application of the IoT in connected homes of the future, with, for example, smart refrigerators triggering grocery orders. Food traceability will also be covered as will the potential for AI to extract value from data across the whole food supply chain.

## **NEW BLOCKCHAIN PLATFORM FOR FACT WATER**

In a first for the beverage industry Crown Bevcan Europe and Middle East, a business unit of Crown Holdings, has launched CrownConnect™ in conjunction with FACT (sparkling water-based drink). Using this each can will be marked with a 2D scannable code, enabling FACT cans to be the first ever to be produced with a unique digital identity.

The new technology incorporates Almond, a new blockchain platform that allows consumers to scan a unique hidden product code and rewards them by unlocking cash tokens.

CrownConnect™ technology provides the 2D codes beneath the tab of the beverage can that facilitate the engagement between the consumer (via a scanning application) and the brand. The platform, developed in partnership with IoT company EVERYTHNG, then intuitively generates rewards and offers based on previous purchases that reflect users' habits and purchases.

*Drinkworld Technology and Marketing* (Vol. 22, No. 2, June 2018) quotes Mark Twiss, Marketing and Business Development Director at Crown as follows:

*"From a brand's perspective, the value lies in the ability to capture valuable data about when and where customers consume their products. Our CrownConnect™ technology has been designed specifically to facilitate this level of interaction between brand and consumer."*

Olly Bolton, Founder of Almond, is also quoted:

*"The Almond app will allow users to interact with brands in a completely new way, directly reaping the rewards of their use of the app and pledging their allegiance to brands based on the way they approach transparency and their supply chain. Almond establishes a new type of relationship between brands and consumers: one that is symbiotic and mutually beneficial, giving consumers control and autonomy over the type of brand they buy, while also rewarding their loyalty."*

## **BREAKTHROUGH IN MAIZE SORTING TECHNOLOGY**

Aflatoxin is a major contaminant of maize, a vital staple food crop. It is classified as a primary human carcinogen by the International Agency for Research on Cancer, being responsible for around 155,000 cases of liver cancer every year.

Until now the sorting of maize for aflatoxin has proved to be difficult and imprecise, relying on indirect indications of contamination. Testing for contamination has traditionally been based on sampling, which is both inconclusive and time-consuming. With just two contaminated kernels in 10,000 being sufficient to make a batch unfit for purpose, it has been a serious problem for the industry, as over 500 million people worldwide are at risk of exposure.

In order to combat the problem Buhler, in partnership with Microsoft, has developed LumoVision™, the first optical sorting technology that is able to identify aflatoxin based on direct indicators of contamination, while simultaneously using real-time, cloud-based data to monitor and analyse the contamination risk.

*Innovations in Food Processing and Packaging* (Issue 44, August 2018) describes (p.9-10) how the system works:

*'It works by analysing the colour each kernel fluoresces as it passes under powerful UV lighting in the sorter. It is known that contaminated kernels fluoresce a specific bright green colour. LumoVision's proprietary, highly sensitive cameras detect precisely this colour of fluorescence. Within milliseconds of detection, air nozzles deploy to blow contaminated kernels out of the product stream. The machine processes up to 15 tons of product an hour, eliminating up to 90 per cent of contamination - a significant improvement on current solutions.'*

*A cloud-based solution using infrastructure provided by Microsoft is a key enabler to reducing overall yield loss. Combining data from the cameras with data stored in the cloud allows a local real-time analysis of the risk of contamination to be carried out. When the risk is minimal, sorting is halted while the machine continues to monitor. If the risk rises, sorting automatically restarts. LumoVision, coupled with the cloud service, reduces yield loss to below 5 per cent, compared with between 5 per cent and up to 26 per cent for other current solutions.'*

The article quotes Ben Deefholts, Senior Research Engineer for Digital Technologies at Buhler, as follows:

*"We are incredibly excited about this achievement. As an organisation we have strived to solve the problem of aflatoxin contamination for many years. Now, with today's technological advances we're able to bring this ground-breaking solution to market. With data science techniques and tools we can develop algorithms, while connectivity and IoT solutions allow us to combine our optical sorting with real-time risk models."*

Also quoted is Caglayan Arkan, General Manager for Manufacturing and Resources at Microsoft:

*"Buhler has built a truly revolutionary and aspiring piece of technology, not only to the food industry, but to manufacturing industry at so many levels. Buhler's revolutionary data-driven optical sorting system doesn't just predict a toxin in a food particle, but it can eliminate it altogether by tapping into the breadth and scale of Microsoft's global Azure cloud, which is powerful and meaningful to keeping all of us safer and healthy."*

### **SENSOR-BASED ROBOT REVOLUTIONISES SPINAL SURGERY**

Manual spine stabilisation surgery is one of the most frequent forms of back surgery performed, but the use of pedicle screws to fuse and stabilise functionally unstable vertebrae is hampered by the 'uneven terrain' of vertebral bone.

Andy Pye, Editor of *DAQ Sensors and Instrumentation* ( Vol 1, No.1, 2018, p.1) explains:

*'The functional articulation of the human vertebral spine that confers lateral and rotational mobility, static mobility and compressional strength is only possible because vertebrae have a complex shape and bone density composition. Drilling and positioning a screw into a highly variable part of the spine, whether manually or with image guidance technologies, has a success rate of just 85 per cent. The screw may miss the central part of the vertebrae or the sharp tip sticks out, irritating surrounding tissues or nerves.'*

A team of researchers from the University of Bern and the Swiss Centre for Electronics and Microtechnology have, however, now developed a high-precision, sensor-based surgical robot that is revolutionising this form of surgery:

*'By using the complexity of vertebral anatomy like a "sensor map", the robotic drill is able to "feel" across the bone terrain and together with so-called Electromyography (EMG) neuro monitoring can avoid obstacles including nerves and boundaries of the bone. Thicker bone, thinner bone and nerves are sensed with robotic perception and verified at high speed with the relevant information from*

*imaging data. This way, the surgical robotic technology potentially allows the neurosurgeon to place pedicle screws perfectly with precision every time.'*

Andreas Raabe, Chairman and Professor of Neurosurgery at the Inselspital, Bern University Hospital, is quoted as follows:

*"For the first time the neurosurgeon has real-time data on where the drilling instrument is during the procedure and the surgical robot acts with supreme accuracy shutting down the drilling far sooner than a human operator could, thereby avoiding breakthrough or injury. We see this as the future of spine surgery.*

*The use of EMG as a cross check control loop to give early warning on the proximity of nerve tissue and the overall integration of a sensor-driven surgical robotic system is a ground-breaking use of this technology in neurosurgery and will lead to many other clinical applications going forward."*

## **BREAKTHROUGH IN HIGH-PRECISION SENSING**

In the same journal (p.5) the article 'A Quantum of Precision' explains how research scientists from the UK and the Far East have succeeded in demonstrating experimentally how multiphon interference with thermal light can be observed beyond the coherence time. This is the first time that such demonstrations have been successful and it is paving the way towards the achievement of new levels of high-precision sensing across a wide range of applications.

The researchers from Korea's Pohang University of Science and Technology, and the University of Portsmouth, have described their observation as 'a counter-intuitive phenomenon to what would be expected with multi-path correlation interferometry with thermal light'. They state:

*"The intensity correlation between the outputs of two unbalanced Mach-Zehnder interferometers (UMZIs) with two classically correlated beams of thermal light at the input exhibits genuine second-order interference with the visibility of 1/3."*

A major surprise, however, was that 'the second-order interference does not degrade at all regardless of how much the path length difference in each UMZI is increased beyond the coherence length of the thermal light.' Also 'the second-order interference is dependent on the difference of the UMZI phases, independently of the distance between the two UMZIs.'

It is noted that 'it is the interference that is important in sensing and metrology' and therefore 'the independence of distance has important implications in terms of the possibility for applications involving high-precision measurements of remote phases.'

The technique is noted to be particularly useful for sensing the position and spacial structure of remote objects as well as measuring, for example, the difference in pollution rates between two remote regions to provide a more precise understanding of the distribution of pollution.

It is also noted that the results of the experiments differ substantially from those of the established entangled-photon Franson interferometer, which exhibits two-photon interference dependent on the sum of the UMZI phases and vanishing as the path length difference in each UMZI exceeds the coherence length of the laser.

Dr. Vincenzo Tamma, one of the researchers at the University of Portsmouth, is quoted as follows:

*"This interferometric technique can be used in metrology and remote sensing to measure the relative phase between two remote spacial regions independently of their distances. This work offers deeper insight into the interplay between coherence in multi-photon interferometry. Those working in engineering and technological development especially in metrology and imaging will be particularly interested, and the findings could inspire new technological schemes."*

## **X-RAY IMAGING TO PROBE METAL AM PROCESS**

Researchers at the Lawrence Livermore National Laboratory in California have successfully designed, built and tested a portable diagnostic machine which uses X-ray imaging to 'probe' the inside of

metal parts during Laser Powder Bed Fusion so as to reveal many of the complex mechanisms that can drive defect formation in metal Additive Manufacturing.

The instrument provides data on a combination of imaging and X-ray diffraction that allows researchers to observe how the metal solidifies, which is a key determinant of a part's strength. The ability to view the layers formed at the melt pool and compare the X-ray images to simulations is confirming predictions of how the laser's path, heat build-up and the gas plume caused by the laser can all contribute towards the creation of defects. Combining this understanding with modelling and detailed experiments could help accelerate improvements and confidence in parts produced using metal AM.

The article 'Researchers use X-ray Imaging to probe Metal AM Process' in the journal *Metal AM* (Vol.4, No.2, Summer 2018, p.45) explains more:

*'Researchers have already begun mapping pore formation and extracting information on cooling rates. Eventually the researchers want to exploit their flexibility to add optical diagnostics typically used on commercial machines to correlate with the X-ray imaging.'*

The article quotes researcher Nick Calta as follows:

*"A vast majority of diagnostics use visible light, which are extremely useful but also limited to analysing the surface of the part. If we are really going to understand the process and see what causes flaws, we need a way to penetrate through the sample. This instrument allows us to do that.*

*Success would be learning more about the physics in ways that let us modify the process to avoid defects. So far we're getting promising results. We want to continue to optimise the instrument and apply it to different material systems. We already have a big body of knowledge based on optical data. This lets us branch out and complement that knowledge."*

Also quoted is LLNL physicist and Laser Materials Science Group Leader Ibo Matthews:

*"We're getting information about the melt pool structure and what can go wrong during a build. The vapour plume created by laser heating the melt pool can create pockets and pores. These pore defects can serve as stress concentrators and compromise the mechanical properties of the part."*

## ULTRA FAST OSCILLOSCOPE INCORPORATES INNOVATIVE SIGNAL INTEGRITY

With test houses increasing their range of activities across ever broader and more complex technologies, so they have an ever greater reliance on high performance instrumentation for data acquisition and measurement.

In order to address this Rohde and Schwarz have developed a new kind of oscilloscope, the RTP, that has innovative signal integrity, higher measurement speed and an extended range of functions.

The new oscilloscope has an ultra-fast acquisition rate of one million waveforms per second, real-time compensation of transmission losses (de-embedding) between the signal source and the oscilloscope, and silent operation even at full load, making it especially suitable for the debugging of embedded components with fast digital or wideband RF interfaces.

The article 'Ultra Fast Oscilloscope' in *Testing and Test Houses*, 2018 (p.9) explains more about the workings of this versatile instrument:

*'In standard acquisition mode, it can measure a million waveforms per second, making it more than a thousand times faster than any other oscilloscope in its class. This helps users find sporadic errors much faster.'*

*It also compensates transmission losses from the signal source to the oscilloscope (de-embedding) in real-time. The advantage is the oscilloscope is still extremely fast even with signal correction activated. And thanks to its unique digital trigger architectures, it can precisely trigger on compensated signals.'*

*A further feature of the R and S RTP oscilloscope that saves developers a lot of time is hardware acceleration for a range of analysis functions. Mask tests, histograms and frequency domain analyses can be performed at high speed for fast results with high statistical reliability.'*

The instrument has sixteen logic channels, four voltage channels and four current measurement channels in addition to the analogue oscilloscope channels. Its footprint is 40 per cent lower than conventional models and its advanced cooling concept and silent fans make the RTP a very quiet instrument for laboratory use.

Rohde and Schwarz state:

*'Thanks to wide range of tools users can test many different types of signals from complex circuits time-correlated with each other with just one test and measurement instrument, and find related errors faster.'*

*'It is ideal for debugging electronic circuits with different signals during development, including high-speed buses (USB, PCI Express, MPI etc.), multi-channel RF interfaces (radio or radar), DDR memory interfaces, complex power management units and even simple control and programming buses (I2C, SPI etc.). The R and S RTP can test all applications where high-resolution signals need to be measured with a wide dynamic range and high sensitivity in the time and frequency domains.'*

Rohde and Schwarz are currently planning additional enhancements including more hardware options, such as a generator module with two analogue and eight digital channels and a 16GHz differential pulse source.

### **3D PRINTING PARTS FOR AIRBUS' COMMERCIAL AIRCRAFT CABINS**

Jose I. Ortiz, Head of Technology Product Management for Airbus, gave this Keynote presentation at the TCT Show.

Jointly developed with Hamburg's ZAL TechCenter, printed electrics is a new digital technology that uses conductive inks to print routes for data and power transmission to replace current harnesses. This enables a large reduction in part count to be achieved, which in turn leads to a reduction in weight and manufacturing cost as well as a simplified architecture, whilst also allowing for last minute customisation.

The article 'Shedding the Harnesses' in *Aerospace Test and Validation* , 2018 (p.5) further describes how Airbus, with partner Altran, has pioneered the technology which recently won a prestigious Crystal Cabin Award:

*'A joint Airbus and Altran project team has developed a demonstrator for a first-use case on an Airbus A320 airliner - the Printed Information Panel. This cabin interior panel displays passenger-related safety and comfort information. The new concept could replace the current electrical harness with printed circuits on a flexible foil, making the first step to a harness free aircraft.'*

*'Far from being limited to passenger information panels, the concept of replacing harnesses with printed flexible electronic circuitry for both power and data can be applied to other cabin functions. According to Airbus, in the future printed electrics technology could be introduced to the areas of cabling for air conditioning, data transmission and lighting.'*

## **AUTONOMOUS VEHICLES: SOME RECENT DEVELOPMENTS**

### **Robotic Convoy Vehicles**

The US army aims to have its first Robotic Convoy Robotic Demonstrator ready by 2012. A joint US-UK Coalition Assured Autonomous Resupply (CAAR) demonstration has already taken place in Michigan, where a ground-breaking convoy involved a truck leading two follower trucks incorporating on-board robotics that make autonomous decisions with regard to speed and steering.

The article 'Military Vehicles steer Course to Autonomy' in *Automotive Test and Automation* 2018 (p.16) quotes Mick Jordan, Technical Engineering Manager for Pailton Engineering as follows:

*"Once the bespoke steering is in place, the vehicle stands the best possible chance of taking on extreme conditions and rough terrain. Combined with autonomous driving technology, this holds*

*huge opportunities for the US and UK military industry to develop the most reliable and capable autonomous military vehicles in the world."*

### **Hyundai launches new Nexo Model**

Hyundai was granted a licence to test autonomous vehicles on public roads in Nevada in 2015, and the company has now launched its Nexo model, which combines consumer-ready autonomous technology in the form of advanced assist systems, which provides control functions in place of the driver where required.

The company believes it can market fully autonomous EAS level 4 autonomous vehicles by 2021, with the help of autonomous control specialist Aurora with whom they are partnered.

The article 'Tech Giants join Autonomy Race' by Jonathan Newell in *DAQ Sensors and Instrumentation*, Vol. 1, No.1, 2018, quotes Dr. Woong Chul Yang, Vice Chairman of Hyundai Motor as follows:

*"The fuel-cell powertrain will offer an ideal platform to implement autonomous driving technologies, which require a massive amount of power to support the large amount of data communication as well as the operation of hardware such as sensors."*

### **Lexus Platform 3.0**

Toyota has unveiled the Lexus Platform 3.0 prototype vehicle, which integrates automated vehicle technology with harmonised styling. It is noted to have a very sensor-rich package that makes it 'one of the most perceptive automated driving test cars on the road.'

The above article states the following:

*'The Luminar LiDAR system with 200-metre range, which had only tracked the forward direction on Toyota Research Institute's previous test platform, now covers the vehicle's complete 360-degree perimeter. This is enabled by four high-resolution LiDAR scanning heads, which precisely detect objects in the environment including notoriously difficult to see dark objects.'*

*Shorter-range LiDAR sensors are positioned low on all four sides of the vehicle - one in each front quarter panel and one each on the front and rear bumpers. These detect low-level and smaller objects near the car, like children and debris on the roadway.'*

### **System-on-Chip**

The Mobileye wing of Intel has developed a System-on-Chip (SoC) package for use with CMOS sensors to handle the vast amounts of data travelling from the sensors to the vehicle control system, a task that needs to be performed at extremely low latency and without packet loss to enable safe autonomous control. This is noted to be 'a massive challenge to the industry'.

### **AI enabled LiDAR**

One company, AEye, has taken LiDAR sensing technology one stage further by introducing artificial intelligence. The company has recently piloted iDAR (Intelligent Detection and Ranging), which is a robotic perception system allowing sensors to mimic the visual cortex so as to bring real-time intelligence to data collection. AS a result the system not only captures everything, but also brings higher resolution to key objects and exceeds industry required speeds and distances.

## Advances in Radome Testing

For reasons that have more to do with appearance than functionality, automotive radars are covered by a radar dome known as a radome, which is constructed from a material that is transparent to RF signals. This makes them act as RF components and this needs to be taken into account when they are designed so as not to have an adverse effect on the detection performance and accuracy of the radar.

The article 'Enabling Autonomous Driving' in *Rohde and Schwarz News* 219/18 (p.24-29) explains more:

*'The three-dimensional shape of the brand emblems with locally varying material thickness can cause RF performance problems for operation in the millimetre wave band. Bumpers are typically coated with metallic paint, which attenuates high frequencies. To ensure radar reliability, it is therefore essential to validate the material properties of radomes and examine their influence on radar signals. Uncertainties and risks in autonomous sensors are unacceptable for autonomous driving because any errors originating here cannot be adequately corrected by postprocessing. Consequently vehicle manufacturers and their suppliers need new measurement capabilities to be able to evaluate the radar conformity of radomes.'*

Traditional radome testing is flawed, either because they have a tendency to miss key problem areas in the radome, or else because they are time-consuming to the point of being impractical for production line testing.

Rohde and Schwarz have responded to this by developing the QAR quality automotive radome tester:

*'Instead of a golden device with a tiny antenna array, it uses a large panel with several hundreds of transmit and receive antennas operating in the extended automotive radar frequency range from 75GHz to 82GHz. It "sees" what an automotive radar would see if it also had hundreds of antennas. But thanks to the large aperture, it measures range, azimuth and elevation with a much higher resolution (in the millimetre range). This high resolution allows the measurement results (i.e. reflectivity) to be visualised as an X-ray image, enabling immediate quality assessment even by persons with limited test and measurement experience. Unlike measurements with real radars, time-*

*consuming measurement sequences are not necessary to determine the radome properties - the R and S® QAR obtains results in a one-shot process, similar to taking a picture with a camera.'*

## **Connected Car Testing goes live in Coventry**

A project to create one of the world's most advanced environments for connected and autonomous driving has entered its second phase of testing in Coventry, with connected cars going on trial on public roads to prepare the UK's road networks for self-driving cars.

Under the UK CITE programme Jaguar Land Rover will test a range of intelligent connected features such as emergency electronic brake light warning (EEBL), emergency vehicle warning (EVW), and in-vehicle signage (IVS) for road works warning and traffic condition warning.

The UK CITE project aims to create the UK's first fully connected infrastructure using a globally unique combination of wireless technologies, which can enable real-world testing in a safe and managed way. The project is funded by the Government's £100 million Connected and Autonomous Vehicle Fund, delivered by Innovate UK.

The UK CITE consortium comprises leading industry, academic and local and national governmental organisations. It is jointly led by Visteon Engineering Services Limited and Jaguar Land Rover, and includes Coventry City Council, the University of Coventry, the University of Warwick, Highways England, Huawei Technologies (UK) Limited, Siemens, and Vodafone Group Services.

More information is available on 0121 265 2760. Email: [ukcite@grayling.com](mailto:ukcite@grayling.com)

## Miniature AV Prototype speeds up Development

A group of final year engineering students at the University of Leicester has developed a miniature autonomous drive-by-wire vehicle prototype that is envisaged to lead to a completely new system of testing code and algorithms for connected autonomous vehicles.

The prototype, known as 'μpod' is a 1:6 scale version of the LUTZ Pathfinder Pod developed by Transport Systems Catapult, a not-for-profit technology and innovation company. It has been created to act as a representative initial platform for the testing of the code and algorithms which would then be applied to the full-size Pod.

*Engineering Integrity* (September 2018, p.30) describes how it works:

*'The vehicle can function in two modes - by remote control using a standard X-box controller and under autonomous control. The autonomous mode enables the vehicle to follow a previously mapped out route without further command input.'*

*This works by first recording a GPS route for a certain route through the X-box remoter control. After a completed GPS route recording is collected, the autonomous mode can work by following the recorded GPS file with latitude, longitude and heading as reference, allowing it to move to the destination with self-adjustment as necessary.'*