

# ADDITIVE, CONTROL, ENERGY, MEDICAL AND OTHER **HOT TOPICS**

The 14th International Conference of the European Society for Precision Engineering and Nanotechnology (euspen) was held in Dubrovnik, Croatia, on 2-6 June 2014. Among the hot topics discussed were additive manufacturing (AM), motion control in precision systems, renewable energy technologies, and precision engineering for medical products. The lowlands (i.e. the Netherlands and Belgium) were well represented in Dubrovnik. A (lowlands-biased) report.

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#### AUTHOR'S NOTE

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**E**uspen's 14th International Conference & Exhibition was held in Dubrovnik, Croatia, once an important Adriatic maritime republic and now a UNESCO World Heritage Site. The welcome reception for the conference was held in the old town of Dubrovnik (see Figure 1).

1 *The ASML-sponsored welcome reception in a hotel in the old town of Dubrovnik. (Photos courtesy of euspen)*

Once again, the euspen conference was a great opportunity to explore the latest advances in precision engineering fields such as metrology, ultra-precision machines and ultra-precision manufacturing and assembly processes. This year's event saw several new topics addressed in the oral sessions, such as "Precision Engineering for Medical Products", "Additive Manufacturing for Precision Engineering", "Renewable Energy Technologies", and "Motion Control in Precision Systems". Some 190 contributions and two workshops reported on the latest developments and fuelled the discussion between industry and scientists to improve and accelerate these developments.

The lowlands were well represented in Dubrovnik: one tutorial, six oral presentations (out of a total of 35), a strong presence at the exhibition, one oral presentation award and no less than three poster presentation awards (for Prof. Dominiek Reynaerts' group from KU Leuven).

#### Tutorials and workshops

The conference was preceded by two tutorials and one workshop. The first tutorial, "Advanced Mechatronic System Design", was given by Prof. Rob Munnig Schmidt (Delft University of Technology) and Dr Adrian Rankers (Mechatronics Academy); see Figure 2. They covered the





performance of actively controlled precision motor systems and controlled system dynamics, paying special attention to non-collocated actuation and sensing. The second tutorial, “Optical Surface Topography Measurement”, by Prof. Richard Leach of the National Physical Laboratory in the UK, covered instrument basics and types, traceability, calibration, verification, adjustment, instrument response, and good practice.

The first workshop was on large-volume metrology (LVM), the ability to measure, in situ, items that are too large for measurement using conventional coordinate measuring machines. As this is a key enabling tool for high-value advanced manufacturing in Europe, five European national metrology institutes and three universities embarked on a joint research project, funded by the European Metrology Research Programme (EMRP), to tackle the issues that are currently limiting the effective and widespread adoption of LVM techniques in the manufacturing industry. Various solutions were addressed during the workshop, as was measurement accuracy. One promising approach to achieve the highest 3D accuracy on large volumes is ‘multilateration’ using the Global Positioning System (GPS), which may yield a relative measurement uncertainty of approximately  $5 \cdot 10^{-7}$ .

The second workshop, which concluded the conference, presented results from an EMRP project on thermal design and dimensional drift. This workshop covered topics such as methods of ultra-high-resolution interferometry for the measurement of thermal dilatation and the aging of materials and joints, together with the use of nano-indentation techniques for creep measurements. A few examples for the preparation of suitable joints for direct



interferometric measurements were given. Also on the menu were methods of thermal modelling for the improved design of precision engineering tools and their application for designing new cooling elements and thermal controllers.

### Keynotes

The three conference keynotes covered a wide variety of subjects:

- “Creating Wealth Through Advanced Engineering”, by Paul Atherton (Figure 3), a technology entrepreneur and venture capitalist/investor (e.g. Queensgate Instruments, C2V and NaturalMotion) from the UK.

- 2 The “Advanced Mechatronic System Design” tutorial.
- 3 Paul Atherton delivering his keynote, “Creating Wealth Through Advanced Engineering”.





- “Technological Advances in Super Fine Finishing”, by Dr Anthony Beaucamp, Zeeko Research Lab, Chubu University, Japan.
- “Evolution and Development of In-Situ Automated Optical Inspection Applied to the Macro-, Micro-, and Nano-scale”, by Prof. Liang-Chia Chen, National Taiwan University.

4 Denis Loncke of ASML on the relevance of AM for precision engineering.

### Solar

With three presentations, the “Renewable Energy Technologies” oral session focussed on solar energy. The first was on the replication of a large-size Fresnel-type concentration lens for photovoltaic solar cells using spin coating. A report from the European Union’s Seventh Framework Programme NMP (nanosciences, nanotechnologies, materials & new production technologies) project, SolarDesign, covered on-the-fly alterable thin-film solar modules for design-driven applications. To conclude, the design and fabrication of a coating research machine to explore the nanometer-scale coating of glass tubes for Concentrating Solar Power (CSP) systems was discussed. There was one further presentation, which addressed the production and accuracy challenges for wind energy systems.

### Medical

The “Precision Engineering for Medical Products” oral session featured two presentations on manufacturing aspects of biomedical products and one on X-ray computed tomography for wear measurement of prosthetic components. Andy Gijbels of KU Leuven in Belgium gave a presentation on the development of a tele-operated robotic

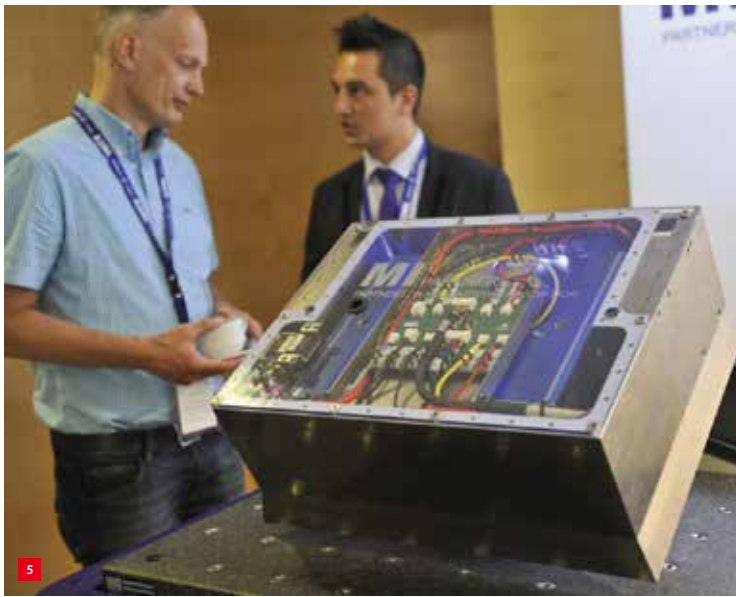
system for retinal surgery. The developed system consists of a haptic joystick and a surgical manipulator. The surgeon’s control actions are scaled down and tremor is filtered before being sent to the surgical manipulator. In addition, the interaction forces between the instrument and the retina are measured with a force sensor that is integrated in the instrument and fed back to the haptic joystick after being amplified up to 10 N. This allows the surgeon to feel how much force they are exerting on the delicate retinal tissue, so that they can react appropriately.

### Additive manufacturing

In the “Additive Manufacturing for Precision Engineering” oral session, a presentation by Denis Loncke of ASML (Figure 4) showed that AM is not just another research hype, but a serious enabling process for weight reduction and optimising cooling channels in precision equipment. That said, it does not necessarily result in a cost reduction yet. The other presentations in this session addressed manufacturing issues, quality assurance for the complete AM process chain and the chemical vapour polishing of AM parts.

### Motion control

In the “Motion Control in Precision Systems” oral session, three of the four presentations came from the Netherlands. Dennis Bruijnen of Philips Innovation Services gave a lecture on feed-forward (FF) design for high-precision motion systems. When enabling double FIR (finite impulse response) FF for a motion control system, a rigid design is no longer strictly necessary to be able to obtain good settling performance. This allows the mechanical designer



to consider alternative design options. To obtain good settling performance, linear and reproducible behaviour is sufficient.

Gijs van der Veen of Delft University of Technology gave a presentation on the design of high-performance mechatronic systems using topology optimisation. The idea is to directly optimise closed-loop systems by using an integrated approach of topology optimisation and controller design. Bram Krijnen of Demcon talked about the vacuum performance and control of a MEMS stage with integrated thermal position sensor, for which he won the oral presentation award. The fourth presentation in this session was by Carl Zeiss SMT, on optimising mirror manipulator performance by means of robustness analysis of dynamics and control.

### Dutch presence at the exhibition

Although Dubrovink is not that close to the Netherlands, several Dutch high-tech system developers and suppliers and the federation of the three Dutch universities of technology (3TU) had booths at the commercial exhibition.

Demcon showcased a precision eye surgery pump for D.O.R.C. The newly developed pump is a mechatronic system that interacts with a sterile disposable cartridge. The pump comprises a pressure sensor, a compensation piston, an inlet valve, a pump piston and an outlet valve. The pistons and valves are actuated using flexure-based rotation mechanisms comprising reinforced leaf springs which convert direct-drive actuator displacement into precision motion.

MI-Partners showed a small ground shaker, a seismic vibrator capable of applying precision low-frequency forces to the ground. One of the issues in tunnel boring is the uncertainty about the ground that lies in front of the tunnel boring machine (TBM). Therefore, it is desired to have a system and method for making predictions about the ground ahead of the TBM. This new vibrator, based on linear motor technology, was developed for installation on a TBM (Figure 5).

In the IBS Precision Engineering booth, a roll-to-roll concept using New Way Air Bearings products was on display. A cylinder-shaped porous media air bearing was developed to manipulate thin materials called webs without physically touching the web. The new process offers distinct advantages over current processes, such as contactless pre-load control of the web.

The 3TU booth featured several demonstrations, including a reconfigurable parallel kinematic 6-DoF platform (Figure 6), a UV-laser cutting method for silicon MEMS prototyping and a three-DoF, large-range-of-motion MEMS-based precision stage with integrated feedback.

### 2015

All in all, the 2014 euspen conference was well worth attending. Next year, precision engineers from industry and academia in the lowlands cannot use distance as an excuse for not attending. euspen's 15th International Conference & Exhibition will be held on 1-5 June 2015 at KU Leuven in Belgium. ■

5 Demo of MI-Partners' design for a seismic vibrator.

6 Discussion at the 3TU booth, featuring the reconfigurable parallel kinematic platform.

INFORMATION

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